SECTION 6.3

BIOLOGICAL ENVIRONMENT

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6.3 BIOLOGICAL ENVIRONMENT

The subsections in this Section detail the effects assessments for aspects of the biological (natural) environment that may be affected by Project construction, operation and closure and which were screened in as VCs by the scoping process (see Section 6.1). These VCs include fisheries and aquatic resources, vegetation and plant communities, wildlife and wildlife habitat and biodiversity. The respective Section references are the following:

Fisheries and Aquatic Resources	6.3.1	Wildlife and Wildlife Habitat	6.3.3
Vegetation and Plant Communities	6.3.2	Biodiversity	6.3.4

6.3.1 Fish and Aquatic Resources

This Section assesses potential impacts of the Star-Orion South Diamond Project (the Project) on fish and aquatic resources in the Local Study Area (LSA) and Regional Study Area (RSA). The LSA for the aquatic environment includes nine streams located on the north side of the Saskatchewan River in the vicinity of the Project and the area of the Saskatchewan River contained between Caution Creek and English Creek (Figure 6.3.1-1).

Groundwater modeling conducted in 2010 identified three additional streams located outside the LSA that have the potential to be impacted by pit dewatering (Stream F, Peonan Creek, and Stream T; Figure 6.2.5-1). In 2011, aquatic investigations were undertaken to characterize water quality, fish communities, and fish habitat in these study areas (CanNorth 2012; Appendix 6.3.1-A) and these streams have been included in the effects assessment. Crossings of the White Fox River, East Ravine, Duke Ravine, and 101 Ravine by proposed access and mine roads are also included in the effects assessment (Figure 6.2.5-1).

Each stream may be impacted by the Project in different ways and to different extents; potential impacts include:

- loss of sections of certain streams;
- changes in stream flow; and
- changes in water quality.

The Saskatchewan River is the most important waterbody in the LSA as it contains a dense and diverse fish community, including lake sturgeon, an endangered species[1]. Potential effects of the Project on the Saskatchewan River include:

[1] This species has been identified as endangered by COSEWIC and is currently being considered for listing under the federal Species at Risk Act (COSEWIC 2010).

- the installation, operation, and removal of the water discharge pipeline and diffuser (Figure 6.2.5-1);
- changes in water levels; and
- changes in water quality.

Potential impacts affecting each stream in the LSA, RSA, and the Saskatchewan River are evaluated during each Project phase (construction, operations, and closure/decommissioning) to establish mitigation measures and compensation plans. The residual effects assessment (i.e., effects predicted to occur after mitigation measures are implemented) provides an overall rating of the significance of each impact on the aquatic environment in each study area. Shore Gold Inc. (Shore) is committed to reducing Project-related impacts on the aquatic environment as much as feasibly possible and to provide compensation for areas of fish habitat loss.

6.3.1.1 Scoping, Issues Identification and Confirmation

The purpose of the issues identification and scoping was to evaluate Project components by Project phase and to determine the key issues that will potentially impact fish and aquatic resources in the LSA and RSA. Numerous forms of issue scoping have been undertaken including engagement with local communities and Aboriginal groups (Section 4.0). There has been ongoing communication with regulatory agencies that included numerous meetings held to help identify potential fish and aquatic resources related issues. A meeting was held with provincial and federal regulators on June 7th, 2010 to discuss preliminary information about the Project. Meetings have occurred with Fisheries and Oceans Canada (DFO) on March 24th, 2010, May 25th, 2011, and March 7th, 2012 to specifically discuss the process of quantifying fish habitat loss and compensation by the Project.

The primary source for key issue identification was the baseline aquatic surveys conducted between 2006 and 2008 and in 2011; additional information was obtained on lake sturgeon populations in the Saskatchewan River collected by the Saskatchewan Watershed Authority (SWA). The results of the baseline investigations are summarized in Section 5.2.8, Section 5.3.1, and Appendix 6.3.1-A, and are detailed in Golder (2006) and CanNorth (2010, 2012). These surveys provided specific information on key aquatic resources present in the LSA and RSA which enabled the selection of Valued Components (VC).

Using information collected from regulatory agency and community engagement, the baseline surveys, and scientific literature, the Project components were evaluated to determine their potential for causing effects on fish and aquatic resources in the LSA and RSA. The Project-related effects that are evaluated in this Section are described below.

Direct Loss of Habitat

Considerable effort has been taken to adapt the Project footprint so that the amount of direct loss of streams in the LSA is minimized (Section 3.4). Project infrastructure will cause the direct loss of the following stream sections (Figures 6.3.1-1 and 6.3.1-2):

- mid and upper reaches of West and East ravines will be lost due to development of the Star pit;
- areas where culverts will be placed in East Ravine, Duke Ravine, and 101 Ravine; and
- areas of the Saskatchewan River where the diffuser pipe will be situated.

Changes in Flow

The streams in the LSA, RSA, and the Saskatchewan River will be subject to changes in stream flow due to the following activities:

- groundwater drawdown;
- construction and operation of the Star pit;
- release of Project water into the Saskatchewan River;
- surface water runoff from Project facilities; and
- water diversions.

Note that the NTS mapping shows small water courses under the Overburden and Rock Storage pile and the PKCF. These small tributaries were not identified as aquatic habitat in the constraints mapping (Section 3.4) and are not included in calculations of direct loss of habitat. Although the features have not all been ground truthed, vegetation mapping, slope and relief of these features indicate that open water is not present.

A water balance model was completed for the Project that predicts the volume of water gained and lost on a monthly basis for a period of 24 years (refer to Section 6.2.4 and Appendix 6.2.7-A). The results from the water balance model were used to predict effects of Project development on drainage areas and stream discharge in the LSA and RSA. Also provided are predicted changes to flow in the Saskatchewan River from the inflowing tributaries and the Project water released through the diffuser. This information has been used to predict Project impacts on the aquatic environment, to discuss mitigation measures, and to determine the significance of residual effects resulting from changes in flow.

Changes in Water Quality

Changes in surface water quality in the LSA have the potential to occur from many sources including Star Pit and Orion South Pit sumps, deep well pumps, shallow groundwater, vehicle wash facility, site facilities runoff, sewage lagoon, PKCF and Coarse Processed

Kimberlite (PK) pile seepage, overburden and rock storage pile runoff, and watershed drainage and runoff. The collective effects from all sources were modelled for each stream in the LSA during each Project phase. Detailed methods and results of the modelling are provided in Section 6.2.7. In addition, a two-dimensional flow and transport model was used to model water effluent dispersion from the diffuser into the Saskatchewan River (see Appendix 6.2.7-A for details).

Road Corridor

An access corridor is proposed that includes a roadway, communication lines, and a natural gas pipeline extending from Highway 55 near Smeaton south through the FalC forest to the mine site (Figure 6.2.5-1). The alignment was chosen to reduce the number of stream crossings and by utilizing the same corridor for all these ancillary developments, the environmental effects are reduced. The access corridor will cross the White Fox River at the northern boundary of the forest and the upper reach of East Ravine. As outlined in the Project Description (Section 2), the preferred option for crossing the White Fox River is widening the existing clear span bridge and the preferred option for crossing East Ravine is the temporary installation of a culvert. Additionally, mine roads will cross Duke Ravine and 101 Ravine and culverts will be installed at these locations (Figure 6.2.5-1).

Water Discharge Outfall

The only Project-related development to be located in the Saskatchewan River is the discharge structure. The proposed outfall location is approximately 40 km downstream of the confluence of the North and South Saskatchewan Rivers near FalC Ravine (Figure 6.2.5-1). Details of the conceptual design are provided in Appendix 6.3.1-B. In summary, the diffuser pipe will extend 50 m horizontally into the river bank where it will intercept a drop shaft. The pipe will be buried beneath the river bed with the 60 m long diffuser located mid-channel in the deepest area. The diffuser design parameters are preliminary and will be refined with input from the regulators during the detailed design phase.

6.3.1.2 Valued Components

The selected VCs that are used to evaluate the extent and significance of impacts caused by the above described activities on the aquatic environment in the LSA include lake sturgeon, white sucker, walleye, and their critical habitat. Benthic invertebrates are also included as a VC due to their importance as a food source for juvenile and adult lake sturgeon. Rationale for selecting these VCs is provided below.

Lake sturgeon was selected as a VC because of their federal ranking as a species of special concern and their provincial ranking as rare. Lake sturgeon has a global status of G3G4 (vulnerable, uncommon and at moderate risk for extinction), and the Saskatchewan River population was federally ranked as special concern by COSEWIC in November 2006 (COSEWIC 2010). The Species at Risk Public Registry currently has no schedule or status for the Saskatchewan River lake sturgeon population (Government of Canada 2010), however, it is expected to be scheduled soon (SWA 2009). As such, a recovery plan for the Saskatchewan River lake sturgeon population has not yet been developed. Provincially, lake sturgeon are ranked as S2, meaning they are rare and imperilled (SKCDC 2009). As discussed in Section 5.3.1, lake sturgeon have been captured and tracked in the LSA by the Saskatchewan Watershed Authority (SWA) between 2007 and 2010.

Lake sturgeon typically reside in deeper waters, are bottom feeders, and are capable of migrating over great distances in search of food, suitable spawning habitat, or to avoid unfavourable conditions (Peterson et al. 2007). Spawning and nursery habitat for lake sturgeon includes shallow areas (<5 m deep) with swift currents over clean rocky substrate (Block 2001; Bruch and Binkowski 2002; Langhorne et al. 2001; Peterson et al. 2007; Scott and Crossman 1998; SWA 2008). Rearing habitat for lake sturgeon is generally correlated with an abundance of preferred prey, which consists of benthic invertebrates for both juvenile and adult sturgeon (Chiasson et al. 1997).

White sucker was selected as a VC because they represent an abundant large-bodied fish species captured in the Saskatchewan River within the LSA and RSA, they were found to be utilizing East Ravine, English Creek, and the Saskatchewan River near 101 Ravine for spawning activities, and juvenile white sucker were captured in East Ravine, Duke Ravine, English Creek, Stream F, and Peonan Creek during the baseline surveys. White sucker are not an important species for recreational fishing or local Aboriginal groups, but are an important forage fish. Adult white sucker reside in large rivers and lakes and feed almost exclusively on benthic organisms. For spawning, white sucker usually migrate from lentic systems or stream pools to spawning riffles in lotic systems. Their preferred spawning habitat is generally considered to be areas in inlets, outlets, small creeks, and rivers with relatively swift, shallow waters running over a gravel bottom (Forbes and Richardson 1920; Dence 1948; Nelson 1968; Carlander 1969; Schneberger 1977). Larval and juvenile white sucker are known to rear in shallow backwaters, riffles with moderate water velocity, and sand-rubble substrates in streams (Twomey et al. 1984).

Walleye were selected as a VC because they represent a predatory fish species captured in the LSA, they have local importance to the sport fishery and Aboriginal groups, and juvenile walleye were captured in the Saskatchewan River, East Ravine, English Creek, Stream F, and Peonan Creek during the baseline surveys. However, the abundance of walleye captured in the LSA was very low being less than 4% of the fish captured within each study areas.

Walleye appear to reach their greatest abundance in large, shallow, turbid lakes, however, large streams or rivers provide suitable habitat as well (Scott and Crossman 1998). Walleye spawn in shallow riffle areas along the shorelines of lakes or in streams. Habitat requirements for juvenile walleye seem to be similar to those of adults and they are often found in deep or turbid water or in contact with the substrate under cover during the day due to their sensitivity to light (Colby et al. 1979; Ryder 1977). Unlike lake sturgeon and white sucker, the diet of juvenile and adult walleye consists primarily of fish, but aquatic invertebrates may be locally or seasonally important (Scott and Crossman 1998).

Since adult lake sturgeon, white sucker, and walleye all typically reside in deeper waters of larger river systems or lakes, it is considered highly unlikely that they would permanently reside in any of the nine tributaries located in the Project LSA. The streams in the Project LSA are too small and shallow, and too full of obstructions, such as waterfalls, log jams, beaver dams, and subsurface flow, to provide year-round habitat for adult large-bodied fish (Section 5.3.1 has detailed information and photographs of the streams); however, as mentioned above, some of the larger streams such as East Ravine and English Creek provide spawning and/or rearing habitat for white sucker and/or walleye. Portions of the near shore areas of the Saskatchewan River in the LSA provide potential spawning and rearing habitat for all three species selected as VCs for the Project. Therefore in terms of assessing critical fish habitat as a VC, the effects assessment is focussed on spawning and rearing habitat for these species.

Benthic invertebrate community composition was documented in the lower reaches of eight of the nine streams in the LSA (Wapiti Ravine was not sampled due to an early freeze-up in 2008) and in regions of the Saskatchewan River downstream of each stream and upstream from the mouth of Caution Creek. The communities illustrated a high degree of variability in terms of density, diversity, and dominant taxa between study areas. This resulted in few significant differences being identified in measures of density, richness, Simpson's diversity, Simpson's evenness, and %EPT[2] between study areas (Section 5.3.1.3). An important function of the streams is to provide nutrient sources to the Saskatchewan River and the benthic invertebrate diversity (>0.6) and %EPT (mostly >50%) were relatively high in all study areas. However, assessing how the Project-related impacts will alter the nutrient contribution of benthic invertebrates to the Saskatchewan River is not a quantifiable measure and is difficult to assess. Therefore the use of benthic invertebrates as a VC in this effects assessment is focused specifically on their ability to provide feeding and rearing habitat in the Saskatchewan River for lake sturgeon.

[2]%EPT = percentage of Ephemeroptera, Plecoptera, and Trichoptera. This index is calculated because these taxa are generally considered more pollution sensitive and can be used in the future as bioindicators of changes in environmental quality (Rosenberg et al. 2008). In addition, members of the orders Ephemeroptera and Trichoptera are generally considered an important food source for juvenile lake sturgeon along with Diptera (Chiasson et al. 1997; Kempinger 1996).

6.3.1.3 Applicable Regulations, Standards and Guidelines

Fish Habitat Compensation Agreement

Construction and operation of the Project will result in the harmful alteration, disruption, or destruction (HADD) of fish habitat in certain areas of the LSA. A HADD of fish habitat is defined as "any change in fish habitat that reduces its capacity to support one or more life processes of fish" (DFO 1998). An implicit assumption in the application of this definition to habitat compensation planning is that any reduction in the capacity of the habitat to support the life processes of fish will also reduce the capacity of the habitat to produce fish (DFO 1998). Therefore, a link is made between a HADD of fish habitat, which is dealt with explicitly in the *Fisheries Act*, and the habitat's productive capacity, which underlies DFO's guiding principle for the management of fish habitat in Canada. The federal *Fisheries Act* prohibits the HADD of fish habitat in Canada (section 35.1 of the Fisheries Act). However, Section 35(2) of the *Fisheries Act* provides that the alteration, disruption or destruction of fish habitat can be undertaken if done under conditions authorized by the Minister or under regulations pursuant to the Act (that is, the DFO can authorize the HADD of fish habitat if the DFO is satisfied that all HADDs can be compensated such that there is "no net-loss of productive capacity" of fish habitat).

Section 34 of the *Fisheries Act* defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes." By this definition, fish habitat includes areas that currently produce fish, or that could potentially produce fish, or are areas that provide the nutrients, water, or food supply to fish-bearing habitat downstream. Because the Project will result in a HADD, it requires compensation in order to achieve no net-loss of productive capacity. The amount of compensation must be determined based on the residual net loss of productive capacity after relocation, redesign, and mitigation are accounted for. In order to move ahead with the Project, Shore is negotiating a Fish Habitat Compensation Plan (FHCP) with DFO and will secure federal approval for the HADD of fish habitat caused by the Project. Preliminary information on the FHCP is provided below (Section 6.3.1.9) and a comprehensive report will be provided to DFO during the detailed design stage.

Water Quality Guidelines

The water quality guidelines used to assess potential effects of the predicted parameter concentrations on freshwater aquatic life include the Saskatchewan Surface Water Quality Objectives for the Protection of Freshwater Aquatic Life (SSWQO, SE 2006) and the Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life (CEQG, CCME 2011). These guidelines are only available for some parameters and apply to total metal concentrations.

6.3.1.4 Effects Assessment Methods

This section outlines the methods used to assess the potential impacts identified above that could affect fish and aquatic resources in the LSA and RSA due to Project-related development. For a Project-environment interaction to occur, there needs to be a source of impact, a receptor that could be affected, and a valid connection from the source to the receptor in the environment. The effects assessment acts to identify which Project-related impacts specifically apply to each of the nine streams in the LSA, three streams in the RSA, the Saskatchewan River, and the road crossing locations, and how these would potentially interact with the VCs. Study areas were moved forward in the assessment process depending on the magnitude of impact predicted to occur and the potential that the impact could positively or negatively affect the VCs. Mitigation measures that will be implemented to reduce predicted Project-related impacts to the aquatic environment were developed based on best practices and standard operating procedures issued by regulatory agencies such as DFO. Situations are identified where direct loss of fish habitat is unavoidable and habitat compensation will occur.

The assessment of residual effects was a qualitative process that involved determining the significance of each impact during each Project phase on the VCs after consideration of mitigation measures. The magnitude, geographic extent, duration, frequency, reversibility, ecological context, level of certainty, and probability of each residual effect was evaluated. This process was used to determine the overall significance of Project-related impacts to the aquatic environment in the LSA and RSA. The ratings were based on scientific literature, professional judgment, experience with similar projects, and water quality guidelines.

6.3.1.5 Effects Assessment

This section identifies interactions between Project components and the VCs in the aquatic LSA and RSA, and identifies the study areas and impacts to be further evaluated in the effects assessment under the mitigation and residual effects sections. This section includes a description of the Project-related impacts predicted to occur in each stream and the Saskatchewan River and pertinent information obtained on fish and fish habitat, particularly the VCs, during the baseline surveys. Table 6.3.1-1 provides a matrix summarizing potential Project-environment interactions.

Table 6.3.1-1: Potential Interactions Between Project Activities and the Valued Components for the Aquatic Environment

Project Phase	Project Activity	Lake Sturgeon	White Sucker	Walleye	VC spawning and rearing habitat	Lake Sturgeon feeding and rearing habitat
Construction	Installation of the diffuser	X	X	X	X	X
	Construction of the overburden and rock storage pile					
	Construction of the Star pit		X	X	X	X
	Construction of the PKCF					
	Construction of the Coarse PK Pile					
	Widening of the White Fox River bridge					
	Installation of culvert at East Ravine road crossing		X		X	
	Installation of culvert at Duke Ravine road crossing		X		X	
	Installation of culvert at 101 Ravine road crossing					
Operations	Operation of the diffuser	X	X	X	X	X
	Operation of the overburden and rock storage pile					
	Operation of the Star pit		X	X	X	X
	Operation of the PKCF					
	Operation of the Coarse PK Pile					
Closure/Decommissioning	Removal of the diffuser	X	X	X	X	X
	Reclamation of piles and facilities					
	Stream restoration in East Ravine		X	X	X	X
	PKCF runoff discharged into Duke Ravine		X		X	
	Removal of culvert from East Ravine road crossing		X		X	
	Removal of culvert from Duke Ravine road crossing		X		X	
	Removal of culvert from 101 Ravine road crossing					

Notes: X = denotes a potential Project-environment interaction.
VC = Valued Component.
PKCF = Processed Kimberlite Containment Facility; CPKP = Coarse Processed Kimberlite Pile.

Wapiti Ravine, FalC Ravine, and West Perimeter Ravine

Wapiti, FalC, and West Perimeter ravines host extremely small streams that will not be subject to direct impacts from the Project. The upper reach of Wapiti Ravine was investigated during baseline surveys since it is located within the PKCF; however, at the time of the survey (August 2008), the study area was dry and typified by abundant terrestrial vegetation, suggesting that it had been dry for some time (Appendix 6.3.1-C, Photo 1). It is predicted that the drainage area of Wapiti Ravine will be reduced by 59% during the operational period due to development of the PKCF (see Section 6.2.4).

There were no fish captured in these streams during baseline investigations. Stream habitat near the mouths of each stream consisted of narrow, shallow channels with steep gradients that contained substantial obstructions to fish movement from the Saskatchewan River into the streams (Appendix 6.3.1-C, Photos 2, 3, and 4). Similar habitat was identified under different flow regimes during surveys conducted in the spring, summer, and fall. Since there is no interaction between Project components and the VCs for these streams, no fish were captured, and their potential to provide critical habitat for the VCs is low, these streams are not considered further in this effects assessment.

Caution Creek

Predicted Project-related impacts to Caution Creek include the following:

- an increase in mean annual discharge due to runoff from the overburden and rock storage pile; change from baseline predicted to be 34% during the construction phase and as high as 44% during the operations phase;
- an overall decrease in the drainage area due to groundwater drawdown; change from baseline predicted to be -8% during the construction phase and –10% during the operations phase; and
- changes in water quality due to runoff and seepage from the overburden and rock storage pile.

The only fish captured in Caution Creek during the baseline surveys conducted between 2006 and 2008 were two brook stickleback located in the lower reach. In terms of fish habitat, riffles and runs were dominant within 500 m of the mouth of the Saskatchewan River and fish passage from the Saskatchewan River into Caution Creek would be limited by fast flow and obstructions, such as boulders and log jams (Appendix 6.3.1-C, Photos 5 and 6). The VCs selected for this Project (white sucker, walleye, and lake sturgeon) were not captured in Caution Creek during the baseline surveys. However, potential spawning and rearing habitat for walleye and white sucker would be present near the mouth under higher water levels, provided that fish migration is possible[3]. Therefore, potential Project-related impacts to Caution Creek are considered in this effects assessment.

[3] It is difficult to assess the ability of fish to migrate from the Saskatchewan River into the tributaries because of the high level of beaver activity in the study area constantly creating new obstructions that may block fish passage for undetermined amounts of time.

101 Ravine

Predicted Project-related impacts to 101 Ravine include the following:

- an increase in mean annual discharge due to runoff from the overburden and rock storage pile; change from baseline predicted to be 70% during the construction phase and as high as 86 % during the operations phase;
- an overall decrease in the drainage area due to groundwater drawdown; change from baseline predicted to be –21% during the construction phase and –42% during the operations phase; and
- changes in water quality due to runoff and seepage from the overburden and rock storage pile.

The baseline surveys assessed fish and fish habitat in 101 Ravine within 500 m of the Saskatchewan River and in a portion of 101 Ravine that was slated to be lost due to development of the overburden and rock storage pile during the preliminary phase of Project planning. However, since that time the location of the overburden and rock storage area has been moved to avoid fish habitat loss in 101 Ravine. The uppermost reaches of four small tributaries to 101 Ravine noted on NTS mapping and within the Project footprint are not considered aquatic habitat due to vegetation and topography.

The fish species captured in the 101 Ravine study area included fathead minnow, lake chub, and northern redbelly dace. No large-bodied fish were found to be utilizing 101 Ravine for spawning, rearing, or other activities. This is not surprising considering the fish habitat present in the lower reaches of 101 Ravine, which was dominated by riffles and runs, with the channel's wetted width and maximum depths ranging from 0.95 to 2.60 m and 0.20 to 0.42 m, respectively. Log jams were prevalent throughout the area and near the mouth of the stream there was a large log jam that would prevent large-bodied fish passage from the Saskatchewan River into the stream (Appendix 6.3.1-C, Photos 7 and 8). However, immediately upstream of the log jam, 101 Ravine contains predominantly run habitat with sand/gravel substrate that could provide potential spawning and rearing habitat for white sucker and walleye under higher water levels if obstructions did not prevent fish passage (Appendix 6.3.1-C, Photos 9 and 10). The habitat in the mid-reach of 101 Ravine located near to the overburden and rock storage pile differed from the lower reach in that it consisted primarily of wetlands and pools and contained organic/silt/clay substrate and abundant aquatic vegetation that is not considered highly suitable spawning or rearing habitat for the VCs (Appendix 6.3.1-C, Photos 11 and 12).

Based on the above information, the VCs do not interact with the Project components since white sucker, walleye, and lake sturgeon were not located in the study area and the migration potential for large-bodied fish from the Saskatchewan River into 101 Ravine is considered low due to obstructions near the mouth. However, if the water levels were higher and fish passage was not obscured, critical habitat for the VCs is present in the lower reach of the stream. Because 101 Ravine will be subject to Project-related impacts, it contains fish, and could provide higher quality critical habitat for the VCs under different water regimes, it is moved forward within this effects assessment.

West Ravine

Predicted Project-related impacts to West Ravine include the following:

- the upper half of West Ravine, located approximately 1.2 km from the mouth of the Saskatchewan River and extending for approximately 1.3 km, will be lost due to development of the Star Pit;
- a decrease in mean annual discharge due to the Star Pit; change from baseline predicted to be –5% during the construction phase and as high as –33% during the operations phase;
- an overall decrease in the drainage area due to the Star Pit; change from baseline predicted to be –40% during the construction phase and –75% during the operations phase; and
- changes in water quality due to runoff and seepage from upstream facilities.

During the baseline surveys, the only fish captured in West Ravine was one lake chub located near the confluence with the Saskatchewan River. No fish were captured in the area where the Star Pit will be located. The habitat was similar to 101 Ravine in that near the mouth, the habitat type was dominated by riffles and runs, while the upper reach consisted mostly of wetland type habitat. Near the mouth of the creek, West Ravine is an insufficient size for large-bodied fish to reside in. Additionally, approximately 100 m upstream from the mouth of the Saskatchewan River, subsurface flow was identified which would prohibit fish passage from the Saskatchewan River to the upper reaches of West Ravine unless a channel reformed under a different flow regime (Appendix 6.3.1-C, Photo 13).

West Ravine does not support large-bodied fish species or fish habitat suitable for lake sturgeon, walleye, and white sucker. The loss of West Ravine could indirectly affect fish habitat, such as lake sturgeon feeding and rearing habitat, in the Saskatchewan River near the mouth of creek. West Ravine will be subject to substantial Project-related impacts and is moved forward within this effects assessment.

East Ravine

Predicted Project-related impacts to East Ravine include the following:

- the lower half of East Ravine, located approximately 1 km from the mouth of the Saskatchewan River and extending for approximately 3 km, will be lost due to development of the Star Pit during the construction and operations phases;
- the upper reach of East Ravine will be bermed and water will be used at site or will be diverted to the runoff pond during the construction and operations phases;
- a culvert will be temporarily installed in the upper reach of East Ravine at the access road crossing;
- a decrease in mean annual discharge due to the Star Pit; change from baseline predicted to be –100 % during the construction phase and –100 % during the operations phase;
- an overall decrease in the drainage area due to the Star Pit; change from baseline predicted to be –100 % during the construction phase and –100 % during the operations phase; and
- changes in water quality due to runoff and seepage from upstream facilities.

Near the mouth of East Ravine (within 500 m of the Saskatchewan River), juvenile white sucker was the most abundant species captured (50% of total catch). Other species captured included burbot, emerald shiner, lake chub, and walleye (3.7% of total catch). In the middle reaches of East Ravine where the Star pit will be located, the fish catch was predominantly small-bodied fish species; juvenile white sucker were captured, but comprised <3% of the total catch. Baseline studies were not completed at the specific location of the access road crossing; however, for this effects assessment it will be assumed that juvenile white sucker reside at that location and that spawning and rearing habitat is available in order to be conservative.

The only walleye located in East Ravine were three juveniles captured in a hoop net set in the mouth of the creek in May 2007 during the walleye spawning period. In the section of East Ravine near the Saskatchewan River, the habitat was rated unsuitable or unsuitable to marginally suitable for walleye spawning largely because water depths were too shallow (mean centre depth ranged between 0.09 and 0.2 m). It is unlikely that walleye could ascend East Ravine to spawn because of the shallow depths and large number of obstructions.

During the spring spawning survey conducted in May 2007, there was evidence of white sucker using the lower reach of East Ravine to spawn. Adult white sucker in ripe spawning condition were captured migrating up the stream and were observed in the stream during the spawning period. Areas containing suitable white sucker spawning and rearing habitat were identified in the lower reach of East Ravine during the aquatic habitat assessment conducted in August 2007 (Appendix 6.3.1-C, Photo 14). However, it should be noted that subsequent to the spawning period, two large beaver dams were built near the mouth of

East Ravine that changed the habitat in the stream and would temporarily prohibit large-bodied fish movement into East Ravine from the Saskatchewan River (Appendix 6.3.1-C, Photo 15). Juvenile white sucker were located throughout East Ravine providing evidence that the habitat in East Ravine is utilized for rearing by this species.

Due to the presence of juvenile white sucker and walleye in East Ravine, as well as white sucker spawning and rearing habitat, there is a valid interaction between Project components and VCs. It is predicted that a large portion of East Ravine will be lost due to development, therefore East Ravine is moved forward in this effects assessment.

Duke Ravine

Predicted Project-related impacts to Duke Ravine include the following:

- an increase in mean annual discharge due to water diverted from the runoff pond; percent change from baseline predicted to be 33% during the construction phase and as high as 365% during the operations phase;
- an overall decrease in the drainage area due to groundwater drawdown; percent change from baseline predicted to be 0% during the construction phase and –25% during the operations phase; and
- changes in water quality due to runoff and seepage from upstream facilities as well as discharge of treated sewage from the infiltration pond.

During the baseline surveys, six species of fish were captured in the lower reach of Duke Ravine (within 500 m of the Saskatchewan River), with juvenile white sucker comprising 52.7% of the catch. The remainder of the fish species captured throughout the stream were small-bodied. The habitat type in the lower reach was dominated by shallow riffles with mean wetted widths ranging from 0.1 to 4.0 m and a maximum depth of <0.25 m. The steep gradient and shallow depths (0.1 m) near the mouth of the Saskatchewan River would make large-bodied fish passage from the river into the stream difficult (Appendix 6.3.1-C, Photo 16). Thus, although juvenile white sucker were abundant in the lower reach of Duke Ravine, it is considered unlikely that adult white sucker or walleye could migrate up this stream to spawn, unless water levels are substantially higher. Since Project-related impacts are predicted, and there is a valid interaction between Project components and VCs due to the presence of juvenile white sucker, Duke Ravine is moved forward in this effects assessment.

English Creek

Predicted Project-related impacts to English Creek include the following:

- a decrease in mean annual discharge due to groundwater drawdown; change from baseline predicted to be 0% during the construction phase and as high as –12% during the operations phase; and
- an overall decrease in the drainage area due to groundwater drawdown; change from baseline predicted to be 0% during the construction phase and –1% during the operations phase; and,
- changes in water quality due to runoff and seepage from upstream facilities.

A total of eight species of fish were captured in English Creek during the baseline surveys and two other species have been previously reported to occur within the stream. Juvenile white sucker represented 32.5% of the total catch and juvenile walleye represented 1.3% of the total catch within 500 m of the mouth of the Saskatchewan River. English Creek is the largest stream in the LSA and unlike the other streams, it provided good quality spawning habitat for walleye and sucker in the lower reaches that could be accessed by these species (Appendix 6.3.1-C, Photo 17). Evidence of white sucker spawning was found approximately 70 m upstream from the stream mouth during the 2007 spring spawning survey as eggs were located.

Due to the presence of juvenile white sucker and walleye in English Creek, as well as white sucker and walleye spawning and rearing habitat, there is a valid interaction between Project components and VCs. English Creek is one of the larger and more productive systems in the LSA and is moved forward in the effects assessment, although predicted Project impacts are negligible and flow supplementation will be provided if required.

Stream F

Predicted Project-related impacts to Stream F include the following:

- Percent reduction in discharge from pre-development conditions is predicted to be 21.3% (annual average) in Year 24 at the end of mining and to peak in Year 43 (annual average = 35.2%).

Stream F, located south of the Saskatchewan River, is a relatively large stream compared to the streams assessed in the LSA with habitat consisting of mostly riffles and runs and no major barriers to fish migration located near the mouth (Appendix 6.3.1-C, Photo 18). In the portion of Stream F within 500 m of the Saskatchewan River, lake chub were the most abundant species captured (62% of the total catch). Other species captured included northern redbelly dace, river shiner, fathead minnow, white sucker, brook stickleback, longnose dace, and walleye. All white sucker and walleye captured were juveniles.

The upper portion of the reach of Stream F where gravel, cobble, and boulder substrates occurred along with riffles and runs, provides moderately suitable spawning habitat for white sucker and marginally suitable spawning habitat for walleye. Both juvenile white sucker and walleye were captured in the study reach, illustrating that these species utilize this habitat for rearing.

Due to the presence of juvenile white sucker and walleye in Stream F, as well as white sucker and walleye spawning and rearing habitat, there is a valid interaction between Project components and VCs. Stream F is moved forward in this effects assessment.

Stream T

Predicted Project-related impacts to Stream T include the following:

- Percent reduction in discharge from pre-development conditions is predicted to be 14.3% (annual average) in Year 24 at the end of mining and to peak in Year 58 (annual average = 23.1%).

Stream T, located northeast of the Project, is a tributary of the White Fox River and drains a headwater fen-type area. In 2011, fish habitat and community composition were investigated in the uppermost reach of Stream T located nearest to the Project. At the time of the habitat assessment, stream flow was obstructed by beaver activity resulting in flooding of the riparian zone and lowlands (Appendix 6.3.1-C, Photo 19). The reach of Stream T assessed was not found to contain suitable spawning or rearing habitat for any of the VC fish species. Despite an extensive amount of effort, no fish were captured in Stream T during baseline investigations. Since no fish were captured, it's potential to provide critical habitat for the VCs is low, and there is no interaction between Project components and the VCs, Stream T is not considered further in this effects assessment.

Peonan Creek

Predicted Project-related impacts to Peonan Creek include the following:

- Percent reduction in discharge from pre-development conditions is predicted to be 8% (annual average) in Year 24 at the end of mining and to peak in Year 48 (annual average = 16.3%).

Peonan Creek is a relatively large stream consisting of riffles, runs, and pools situated south of the Saskatchewan River (Appendix 6.3.1-C, Photo 20). In the portion of Peonan Creek within 500 m of the Saskatchewan River, lake chub was the most abundant species captured (69% of the total catch). Other species captured included walleye, brook stickleback, white sucker, burbot, river shiner, longnose dace, northern redbelly dace, fathead minnow, northern pike, spottail shiner, and yellow perch. All white sucker and walleye captured were juveniles.

Sections of Peonan Creek within 500 m of the Saskatchewan River contained riffle/run habitats and gravel/cobble substrate free of aquatic macrophytes and associated debris. Most areas were rated as containing unsuitable to marginally suitable spawning habitat for walleye; however, one area was identified as highly suitable. The majority of the reach assessed was rated as marginally to moderately suitable spawning habitat for white sucker. It is noted that both juvenile white sucker and walleye were captured in the study reach.

Due to the presence of juvenile white sucker and walleye in Peonan Creek, as well as white sucker and walleye spawning and rearing habitat, there is a valid interaction between Project components and VCs. Peonan Creek is moved forward in this effects assessment.

Saskatchewan River

Project-related impacts to the Saskatchewan River include the following:

- the footprint of the diffuser;
- an increase in mean annual discharge; change from baseline predicted to be 0.2% during the construction phase and as high as 0.5% during the operations phase; and
- changes in water quality due to loadings from the streams and Project water released through the diffuser.

Fish and fish habitat in the Saskatchewan River was assessed during the baseline surveys approximately 100 m upstream and 200 m downstream from the mouth of each of the nine streams included in the LSA. Seventeen fish species were captured in the Saskatchewan River study area in 2007 and 2008 and another six species are known to occur in the Saskatchewan River. The most abundant species captured was emerald shiner (51.4% of total catch), followed by shorthead redhorse (9.6%), sauger (8.6%), spottail shiner (8.3%), and white sucker (7.8%). Spring spawning surveys indicated evidence of adult white sucker in spawning condition throughout the LSA and white sucker eggs were found in the Saskatchewan River upstream from the mouth of 101 Ravine in May 2007.

Studies conducted by the Saskatchewan Watershed Authority (SWA) between 2007 and 2010 captured lake sturgeon on the eastern extremity of the Project LSA near English Creek. The habitat in the Saskatchewan River study area was largely characterized by silt/clay/sand substrate interspersed with rocky areas, a lack of aquatic vegetation, gentle/moderate bottom slope, and moderate flow (Appendix 6.3.1-C, Photos 21 to 25). The majority of the rocky substrate present in the Saskatchewan River study area was somewhat embedded and contained a layer of silt/clay and/or algae moss clogging interstitial crevices. Several areas were identified as containing marginal to moderate spawning habitat for the VCs in the Saskatchewan River study areas (refer to Section 5.3.1 for detailed information). Lake sturgeon nursery habitat in the Project LSA was considered limited due to the lack of quality spawning habitat; however, rearing and feeding habitat is potentially abundant based on information collected during the habitat assessments and benthic invertebrate community survey. It is important to note that the habitat type predominant in the Saskatchewan River study area for the Project is not unique and is found throughout the river system.

Due to the presence of white sucker, walleye, and lake sturgeon in the Saskatchewan River, as well as spawning and rearing habitat for these species, there is a valid interaction between Project components and VCs. The Saskatchewan River is one of the key study areas moving forward in this effects assessment.

6.3.1.6 Mitigation and Management

Direct Loss of Habitat

During the Project planning process, extensive consideration was given to the placement of infrastructure to limit impacts to the aquatic environment in the LSA. For example, the location of the overburden and rock storage pile has been re-located subsequent to preliminary planning so that it does not result in direct aquatic habitat loss in Caution Creek or 101 Ravine. However, because of the location of the kimberlite deposit, some aquatic habitat loss due to development of the Star pit is unavoidable.

In the initial stages of pre-stripping on Star pit, the middle reach of East Ravine will be cleared and graded to provide an access ramp to the Star pit. All ravine water will be temporarily diverted to flow to its natural outlet. Fish salvages will be conducted prior to construction activities and all fish captured will be re-located to the Saskatchewan River. As the Star pit progresses, water from the upper reaches of East Ravine will be diverted to a runoff pond, which is then diverted to Duke Ravine. At closure, the middle reaches of East Ravine will be re-established so that catchment water flows into the Star pit, which in turn will discharge into the lower reach of East Ravine, and eventually flow into the Saskatchewan River (dependant on water quality). This is predicted to occur 326 years after mining ends.

Since the Project will result in the direct loss of fish habitat in East Ravine, Shore is working with DFO to develop a FHCP; more information is provided below. A compensation plan is considered a mitigation measure under the *Canadian Environmental Assessment Act*.

Changes in Flow

Mitigation measures will be employed to reduce effects of the Project on surface water hydrology such as re-using water within the plant and diverting catchments around facilities. Shore will supplement low flows in 101 Ravine, Duke Ravine and English Creek, as required, by directing water of suitable quality to the ravines. The predicted annual increase in flow of the Saskatchewan River due to the Project is low in magnitude and does not require mitigation.

During closure and decommissioning, stream restoration activities will be undertaken. As described above, the Star pit will fill naturally with groundwater and could provide additional fish habitat in the LSA once the Project is completed. East Ravine will be re-established so that it flows into the Star pit lake and then overflows down the existing channel. In the West Ravine, overflow from the Star pit lake is not expected to re-establish flow in the existing channel, as the elevation of the East Ravine outlet is lower than that of the West Ravine.

Reductions in low flow conditions will be mitigated in 101 Ravine, Duke Ravine, and English Creek with flow supplementation and are reversible post-closure; however, long term effects of high magnitudes are predicted to occur in the LSA and this impact is carried forward in the residual effects assessment.

Changes in Water Quality

During site clearing, temporary sedimentation ponds will be constructed as needed to prevent sediment export to surface waterbodies, and will operate to settle total suspended solids and prevent sediment introduction into receiving streams. Erosion and sediment control structures will be installed where necessary to control surface flows and limit transport of deleterious substances into watercourses.

It is predicted that 90% of seepage and runoff from the exterior slopes of the PKCF will be captured in ditches around the toe of the facility and pumped back into the PKCF. The remaining 10% will flow through wetlands, where possible, prior to discharging into adjacent creeks, which will provide passive treatment to improve water quality.

During operations, groundwater from the pit dewatering will first be pumped into a polishing pond to allow sediment to settle out and water not used for other activities will be discharged in the Saskatchewan River using a multi-port diffuser (further information is provided below). Ongoing water quality monitoring will be completed in the streams and in the Saskatchewan River downstream of the discharge location to ensure that parameter concentrations are acceptable. Closure water quality is predicted in Section 6.2.7 and is summarized in Section 7.5. Should the water quality of the Star pit lake after closure be not sufficient to permit its release to the Saskatchewan River, the former East Ravine channel will be armoured (if it is to be used as drainage channel) or raised to prevent drainage from the Star pit lake to the Saskatchewan River.

Mitigation measures will act to limit changes in water quality in the LSA and Saskatchewan River as much as possible; however, residual effects will remain and this activity is carried forward in the residual effects assessment.

Road Corridors

White Fox River

Potential impacts to fish and aquatic resources due to widening of the clear span bridge on the White Fox River would be limited to the construction phase of the Project since the White Fox River road crossing will not be decommissioned following closure of the Project. The upgrade to the clear span bridge should not require DFO review since the work will meet the conditions outlined in Fisheries and Oceans Canada Operational Statement for Clear-Span Bridges (DFO 1997). However, if infilling of off channel or floodplain habitat will result in an alteration of fish habitat, then DFO will be consulted.

Clear span bridges are the preferred crossing structures since they do not cause a loss of aquatic habitat or alter natural channel processes. Mitigation measures to be used during the widening of the bridge include the installation of temporary sediment control devices, such as silt fencing around the construction area to limit the introduction of silt, sediment, and construction debris into the White Fox River. Sediment control devices will be installed before starting work, and will be inspected regularly during the course of construction. Necessary repairs will be made if any damage occurs. All machinery will be operated in a manner that minimizes disturbance to the banks and avoids deleterious substances from entering the water.

There is potential for the bridge widening to negatively affect riparian habitat. Riparian vegetation occurs adjacent to the watercourse and directly contributes to fish habitat by providing shade, cover, and areas for spawning and food production. To mitigate this potential impact, only the vegetation contributing to operational and safety concerns for the crossing structure and approaches within the right-of-way will be removed. Since the predicted Project-related impacts for this activity can be effectively controlled with mitigation measures, the White Fox River crossing is not carried forward in the residual effects assessment.

East, 101, and Duke Ravines

The site access road will cross the upper reach of East Ravine with a substantial embankment and culvert. The culvert installed in the access road embankment will be sized to allow flow from the upper reach of East Ravine to the lower portion of the ravine. The culvert under the access road is designed to be 1600 mm x 88 m long buried by 20 m of fill. The mine haul road will be removed at closure and the natural drainage in East Ravine will be re-established.

Culverts will also be installed at mine road crossings of Duke Ravine and 101 Ravine. These culverts will be appropriately sized to allow fish passage and will follow all DFO and MOE regulations for crossing structure design, installation, and removal. The mine roads will be reclaimed during decommissioning which will include removal of the culverts and re-establishing natural flows on 101 Ravine and Duke Ravine.

Mitigation measures to be employed during construction and decommissioning of the culverts will be similar to those described above for the White Fox River crossing and will involve the use of accepted best practices. The project will require review by DFO as well as an Aquatic Habitat Protection Permit from MOE. Timing windows restricting in-stream construction during certain sensitive windows for fish spawning will be adhered to. Although construction impacts on fish and fish habitat will be mitigated and the culvert structures will be appropriately sized for fish passage, the East Ravine, Duke Ravine, and 101 Ravine crossings are carried forward in the residual effects assessment because in-stream activities are occurring.

Water Discharge Outfall

Details of the conceptual design of the diffuser are provided in Appendix 6.3.1-B. The use of a diffuser will act to reduce effects of sediment disturbance on the river bottom and will allow dispersion of potential parameters of concern affecting water quality. Mitigation measures have been implemented in the design of the outfall structure, including relocation of the structure to a deeper channel cross section to improve mixing performance and to reduce chances of the diffuser being affected by ice forces and sedimentation. Additionally, changes to the design the footprint limit habitat loss to the mid-channel area since the pipeline will be buried beneath the river bed and near shore habitat is no longer being impacted. Currently, the preliminary diffuser design suggests that the diffuser will be armoured with clean riprap to provide erosion protection. However, DFO has expressed concern that this may attract fish to use the area for spawning and rearing. The final configuration and construction material to be used will be determined with input from the regulators at the detailed design stage.

During installation and removal of the structure, mitigation measures will include the use of temporary silt fencing around the construction area to limit the introduction of silt, sediment, and construction debris into the Saskatchewan River. Sediment control devices will be installed before starting work, and will be inspected regularly during the course of construction. Efforts will be made to minimize disturbance of the river bank and in-stream habitat with the construction equipment used to install and remove the pipeline and diffuser. It is proposed that the main diffuser pipe will be installed using a trenchless method which decreases the width of the worksite by 1.5 to 2 times compared to open trench methods. To accommodate work in the channel while minimizing obstruction to flow, a vertical coffer dam will be installed. The coffer dam and temporary access berm will be designed to meet safety and environmental requirements.

All construction activities will be completed outside of closed construction timing windows. Timing windows protect fish during spawning and incubation periods when spawning fish, eggs, and fry are vulnerable to disturbance or sediment, and are just one of many measures used to protect fish and fish habitat when carrying out or undertaking a work in or around water. In central Saskatchewan, the closed construction timing window to protect fall/winter and spring spawning fish is from October 1st to July 15th (DFO 2007). This timing window includes the VCs for the Project (white sucker, walleye, and sturgeon).

Mitigation measures will largely act to prevent impacts to the aquatic environment during installation and removal of the diffuser pipe; however, the footprint of the structure during the operational period will alter fish habitat. This effect is moved forward in the residual effects assessment and habitat loss is included in the FHCP.

6.3.1.7 Residual Effects Assessment

This section provides the results of the residual effects assessment completed for each study area, Project phase, and impact remaining after mitigation measures was considered. A summary of the residual effects assessment is provided in Table 6.3.1-2.

Table 6.3.1-2: Residual Effects Assessment for Fish and Aquatic Resources

Study Area	Project Phase	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context	Level of Certainty	Probability of Effects	Significance
Caution Creek	Construction and Operations	Increase in mean annual discharge	Positive	High	Local	Long-term	Intermittent	Yes	Low	Medium	Unknown	Not Significant
	Operations and Closure	Changes in water quality	Adverse	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Low	Not Significant
101 Ravine	Construction and Operations	Increase in mean annual discharge	Positive	High	Local	Long-term	Intermittent	Yes	Low	Medium	Unknown	Not Significant
	Operations and Closure	Changes in water quality	Adverse	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Low	Not Significant
West Ravine	Construction, Operations, Closure	Direct loss	Adverse	High	Local	Long-term	Continuous	No	High	High	Unknown	Significant
	Construction and Operations	Decrease in mean annual discharge	Adverse	High	Local	Long-term	Continuous	Yes	High	High	Unknown	Significant
	Operations and Closure	Changes in water quality	Neutral	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low	Not Significant
East Ravine	Construction, Operations, Closure	Direct loss	Adverse	High	Local	Long-term	Continuous	No	High	High	High	Significant
	Construction and Operations	Decrease in mean annual discharge	Adverse	High	Local	Long-term	Continuous	Yes	High	High	High	Significant
	Operations and Closure	Changes in water quality	Neutral	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low	Not Significant

Study Area	Project Phase	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context	Level of Certainty	Probability of Effects	Significance
Duke Ravine	Construction and Operations	Increase in mean annual discharge	Adverse	High	Local	Long-term	Continuous	Yes	High	Medium	High	Significant
	Operations and Closure	Changes in water quality	Adverse	High	Local	Long-term	Continuous	Yes	High	Medium	High	Significant
English Creek	Construction and Operations	Decrease in mean annual discharge	Adverse	Low	Local	Long-term	Continuous	Yes	Low	High	Low	Not Significant
	Operations and Closure	Changes in water quality	Neutral	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low	Not Significant
Stream F	Operations and Post-Closure	Decrease in mean annual discharge	Adverse	High	Local	Long-term	Continuous	Yes	High	Low	Unknown	Significant
Peonan Creek	Operations and Post-Closure	Decrease in mean annual discharge	Adverse	Low	Local	Long-term	Continuous	Yes	High	Low	Unknown	Not Significant
Saskatchewan River	Construction, Operations, and Closure	Water discharge outfall structure	Adverse	Low	Local	Long-term	Continuous	Yes	Low	High	Low	Not Significant
	Construction and Operations	Increase in mean annual discharge	Neutral	Low	Local	Long-term	Intermittent	Yes	Low	High	Low	Not Significant
	Operations and Closure	Changes in water quality	Adverse	Low	Local	Long-term	Continuous	Yes	Low	Medium	Unknown	Not Significant

Caution Creek

The magnitude of effect that runoff will cause in mean annual discharge at the mouth of Caution Creek is considered high because there is a >10 % change. The duration is long-term since the model predicts a mean increase of >32 % in the flow regime in all years assessed. Surface runoff from the overburden and rock storage pile will follow natural flow patterns as there is no berm or collection ditch around the pile. Therefore, the frequency of occurrence of the impact is difficult to predict and will depend on variables such as precipitation events and runoff flow patterns. For this reason, the frequency was rated as intermittent.

At the current flow regime, Caution Creek does not support an abundant fish population. During the baseline surveys there was no evidence of the VC fish species using the stream during any life stage. The narrow creek width, shallow depths, and abundance of boulders likely inhibit large-bodied fish from moving into Caution Creek from the Saskatchewan River; however, unlike several of the other streams in the study area, the lower reach of Caution Creek does not contain a steep gradient or major barriers to fish movement. Near the mouth of the creek, areas with suitable spawning and/or rearing habitat for walleye and/or white sucker were located and it is possible that if water levels were higher, these areas may become useable by these species. This causes the direction of the effect to be rated as positive since a beneficial change in aquatic habitat may occur if discharge is increased near the mouth of the creek. However, considering the frequency of flow changes and the quantity of critical habitat created by increases in flow are both undetermined, the ecological context is low and the probability of effects is unknown. The residual effect of an increase in mean annual discharge in Caution Creek was given an overall rating of not significant.

Water quality modeling illustrated that parameter levels are predicted to remain largely within the range of natural variability in Caution Creek during the operational period and after mine closure (Tables 6.2.7-5 and 6.2.7-6). The same parameters that exceeded guidelines during the baseline period are also predicted to exceed guidelines during the operational period, with the exception of zinc. Zinc measurements taken during the baseline period in Caution Creek did not exceed the provincial and federal guideline of 0.03 mg/L, while the predicted median concentrations exceed guidelines during the operational phase (0.1 mg/L) and after mine closure (0.06 mg/L). However, the CEQG and SSWQO do not take into account the ameliorating effects that higher water hardness has on zinc toxicity (US EPA 1995; BC MOE 1999). The residual effect of changes in water quality in Caution Creek was rated as not significant.

101 Ravine

The predicted increase in mean annual discharge in 101 Ravine may result in a positive change regarding the VC of providing spawning and/or rearing habitat for walleye and/or white sucker. However, unlike Caution Creek, the area of 101 Ravine located near the mouth has a steep gradient, low water flow, and a large log jam currently impeding large-bodied fish movement from the river into the stream. Upstream of the log jam, some potential spawning and rearing habitat for walleye and white sucker was located, therefore if the barrier was removed and water levels were substantially increased, there is the potential for this type of habitat to become available. The level of certainty that enhancement of the habitat in 101 Ravine will occur to the degree that white sucker and/or walleye would utilize the stream for spawning or rearing activities is low. The impact of changes in stream flow for 101 Ravine was given the same ratings described above for Caution Creek and obtained the overall rating of a not significant impact.

Water quality modelling predicted similar elevations in zinc levels as those described above for Caution Creek (Tables 6.2.7-5 and 6.2.7-6). All other parameters were predicted to occur at concentrations similar to those measured during baseline surveys in 101 Ravine. The residual effect of changes in water quality was given the same rating as Caution Creek of being not significant.

West Ravine

The development of the Star pit will cause the direct loss of approximately half of West Ravine and is predicted to substantially reduce the drainage area and discharge during the operational phase of the Project. The impacts of habitat loss and reduction in flow were given the same ratings of being adverse, with a high magnitude, long-term in duration, and continuous. West Ravine did not interact with the chosen VCs; however, West Ravine could provide nutrients, water, or food supply to fish-bearing habitat downstream (i.e., the Saskatchewan River). Thus the ecological context was rated as high, but the probability that reduced flow in West Ravine will have a negative impact on the downstream environment was rated as unknown. The residual effects of habitat loss and a decrease in mean annual discharge in West Ravine were given overall ratings of significant.

Surface runoff and seepage from upstream facilities are not predicted to negatively impact the water quality in West Ravine (Tables 6.2.7-5 and 6.2.7-6).

East Ravine

The loss of East Ravine during the construction and operational phases of the Project will result in a significant loss of fish habitat that was found to interact with the VCs. In the residual effects assessment, the loss of East Ravine is rated as adverse, high in magnitude, long-term in duration, continuous, with a high probability of effects and a high ecological context. The impact of fish habitat loss in East Ravine caused by construction of the Star pit requires fish habitat compensation; further information on the FHCP is provided below.

Surface runoff and seepage from upstream facilities are not predicted to negatively impact the water quality in East Ravine (Tables 6.2.7-5 and 6.2.7-6).

Duke Ravine

During the operational period, runoff from East Ravine will be diverted to Duke Ravine and this accounts for a portion of the almost three-fold increase in the discharge of Duke Ravine from the baseline rate. It is not known whether such a substantial increase in water levels in Duke Ravine will negatively impact the stream or enhance fish habitat. To be conservative, a rating of adverse in direction was used for the residual effects assessment. The ecological context was rated as high since juvenile white sucker currently utilize Duke Ravine and the increased flow could alter rearing habitat. The residual effect of increase in mean annual discharge was given an overall rating of significant in Duke Ravine.

Duke Ravine will receive runoff and seepage (treated through wetlands) from the PKCF, the Coarse PK pile, water diverted from East Ravine, and treated sewage from the infiltration pond. Water quality modelling illustrated that some parameter concentrations in Duke Ravine will be elevated during the operational period (Tables 6.2.7-5 and 6.2.7-6). These include chloride, sodium, sulphate, boron, strontium, tin, and zinc. Chloride levels are predicted to exceed the guideline of 120 mg/L in Duke Ravine during operations, with the median concentration predicted to be 169 mg/L. Parameter concentrations predicted to occur after mine closure are similar to baseline levels, with the exception of zinc. Although treated sewage will be discharged into Duke Ravine from the infiltration pond, there are no predicted increases in nutrient concentrations and the ammonia concentrations are predicated to remain below guidelines. The residual effect of changes in water quality in Duke Ravine was rated as adverse, high in magnitude, high in ecological context, high in probability of effects, and was given an overall rating of significant.

English Creek

English Creek is one of the larger and more productive systems in the LSA and contains juvenile white sucker and walleye, as well as white sucker and walleye spawning and rearing habitat. Flow reductions in English Creek caused by groundwater drawdown are predicted to be minor and will be mitigated with flow supplementation. Water quality modelling illustrated that predicted parameter concentrations in English Creek are within the range of natural variability measured during the baseline surveys (Tables 6.2.7-5 and 6.2.7-6). Thus residual effects on the aquatic environment in English Creek are rated as not significant.

Stream F

Stream F is located south of the Project and the Saskatchewan River and no portions of the stream will be directly lost due to development; however, the drainage area is located within the cone of depression caused by groundwater draw down. The effect is rated as adverse and high in magnitude due to decreases in base flows to the creek. As the cone of depression will be maintained post-closure, the duration was rated as long-term and the frequency was rated as continuous. Following the operational period, groundwater will recharge, thus the effect is reversible.

Stream F supports an abundant fish population, including two of the VC fish species. The ecological context of the effect was rated as high, since decreases in flow during critical periods have the potential to impact white sucker and walleye spawning and rearing success, as well as overwintering habitat. The probability of effects was rated as unknown, as groundwater drawdown has the potential to impact spawning and rearing habitat; however, surface runoff during the spring spawning period may mitigate the impact of reductions in base flow in Stream F. In addition, the effect of groundwater pumping is predicted to be most significant in the winter months (Figure 6.2.4-13). To be conservative, the impact was given an overall rating of significant due to the abundance of VCs and VC habitat present in Stream F, but the level of certainty is low.

Peonan Creek

Peonan Creek is also located south of the Project and the Saskatchewan River and will not be directly impacted due to development; however, the drainage area is located within the cone of depression caused by groundwater draw down from pit dewatering. The magnitude of impact is predicted to be lower than in Stream F, with flow reductions <6.5% between the months of April to October, even during the estimated peak impact (Figure 6.2.4-14). The magnitude is low, with the remaining ratings the same as for Stream F. When applied to Peonan Creek the overall residual effect rating is not significant with a low certainty.

Saskatchewan River

Residual effects in the Saskatchewan River include fish habitat alteration at the site where the diffuser will be located, a minor increase in flow, and predicted changes in water quality.

Water Discharge Outfall Structure

The conceptual design of the outfall structure proposes a direct alteration of fish habitat in the middle of the stream channel where the 60-m long diffuser will be located. The remainder of the pipeline will intersect a drop shaft in the stream bank and will be buried beneath the stream bed. The near shore area will only be disrupted during the construction and decommissioning phases, which will be timed to avoid sensitive fish spawning windows.

The diffuser pipeline, as currently planned in the conceptual design, will extend 190 m in to the stream channel and the diffuser will emerge in the deepest part of the channel. It is highly likely that the substrate in the diffuser location is comprised of sand considering stream bed composition in nearby areas of the river at this depth; however, a site survey will be conducted to confirm bed material composition prior to finalization of the design. It is noted that it is highly likely that fish habitat where the diffuser will be situated is abundant throughout the river system.

The residual effects assessment of the discharge outfall structure determined that the footprint of the area disturbed by the discharge pipe and diffuser is not significant. Fish habitat loss caused by the diffuser requires inclusion in the FHCP; see below for further information.

Changes in Flow

The Saskatchewan River is part of a large watershed and the predicted increase in flow caused by Project-related activities is nominal. The change in flow is due to the contribution of the tributaries as well as the diffuser discharge and is reversible post-decommissioning of the Project. The direction of effects is considered neutral and the magnitude (<1%), ecological context, and probability of effects are low. The residual effect of a 0.5% increase in flow in the Saskatchewan River is rated as not significant.

Changes in Water Quality

The primary parameters of concern in the Project water discharge are elevated total dissolved solids (TDS), sodium, chloride, and sulphate concentrations caused by water from the Mannville aquifer (Table 6.2.7-4). In 2007, toxicity testing was conducted using samples collected from the end-of pipe discharge (Station MWS-01) and West Ravine (Station WRS-03) to examine potential effects of TDS and other potential parameters of concern on aquatic biota (CanNorth 2008; Appendix 6.3.1-D). Two acute and four sublethal toxicity tests were conducted on various types of aquatic biota using standard methods from Environment Canada. The tests used are required by the Canadian Metal Mining Effluent Regulations (Environment Canada 2002) for metal mines and are the accepted industry standards in Canada for toxicity testing. The results from the tests found no acute toxicity effects caused by the 100% sample concentration at both stations, and the sample collected from the receiving environment in West Ravine did not exhibit any significant sublethal toxicity effects at 100% concentration. In West Ravine, concentrations of TDS (1,870 mg/L), sodium (500 mg/L), chloride (810 mg/L), and sulphate (168 mg/L) in the sample used for toxicity testing were substantially higher than those predicted to occur in the Saskatchewan River 40 m downstream of the discharge (Table 6.2.7-4). Additional toxicity testing is discussed in Section 6.2.8.

Predicted concentrations of TDS (mean = 2,865 mg/L), chloride (mean = 1,212 mg/L), sodium (mean = 876 mg/L), and sulphate (mean = 537 mg/L) entering the river are predicted to be highly elevated (Table 6.2.7-4). However, these concentrations represent the source water quality and the concentration will decrease immediately at the location of the diffuser. Parameter concentrations predicted to occur in the Saskatchewan River during the operational and post closure periods under full mixing conditions (combined effects on water quality from the diffuser and all tributaries) are within the range of natural variability measured in the river during baseline surveys (Tables 6.2.7-5 and 6.2.7-6). Additionally, parameter concentrations predicted to occur 40 m downstream of the discharge point are similar to those predicted under full mixing conditions (Table 6.2.7-4). Although there is the potential for very localized effects to occur immediately at the site of the diffuser, the use of a diffuser and dilution provided by the river cause this residual effect to be rated as not significant. Water quality monitoring will ensure that parameter concentrations in the vicinity of the diffuser are not exceeding concentrations that are considered acceptable.

6.3.1.8 Summary of Residual Effects

The study areas where the potential for Project-related impacts to cause significant effects on fish and aquatic resources in the tributaries include West Ravine, East Ravine, Duke Ravine, and Stream F (Table 6.3.1-2). Portions of East Ravine and West Ravine will be lost due to mine infrastructure during the construction and operations phases of the Project. Duke Ravine is predicted to be subject to substantial increases in flow and a reduction in water quality. The impacts of water drawdown in Stream F are unknown, but this effect was included as potentially significant due to the VCs present in these streams.

The Saskatchewan River is the most important aquatic ecosystem in the LSA with lake sturgeon, an endangered species, shown to utilize the area. Potential impacts of the Project on the Saskatchewan River are predicted to be not significant. Water quality parameters were predicted to remain at concentrations similar to those that currently exist in the river close to the diffuser. An extensive water quality monitoring program will be conducted throughout the life of the Project to allow for early identification of potential issues and to monitor aquatic ecosystem health. After decommissioning, water will not be released from the Star pit to the Saskatchewan River until it is of an acceptable quality and meets regulatory guidelines.

Fish Habitat Compensation Plan

As discussed above, the Project will result in a HADD of fish habitat and will require the development and implementation of a FHCP in order to offset fish habitat loss caused by the Project. The objective of this section is to provide preliminary information on Shore's proposed FHCP. A comprehensive FHCP report will be prepared for DFO during the detailed design stage. Additional field investigations will be needed to finalize design of the compensation measures.

Quantifying Fish Habitat Loss

The amount of compensation required must be determined based on the residual net loss of productive capacity after relocation, redesign, and mitigation are accounted for. For the majority of potential Project-related effects, Shore took the approach of avoidance and mitigation. Project infrastructure was relocated subsequent to preliminary planning to avoid fish habitat loss in the tributaries and the Saskatchewan River. For example, the overburden and rock storage pile was reconfigured to avoid habitat loss in 101 Ravine and the water management reservoir is no longer located in Duke Ravine. The diffuser design avoids loss of near shore habitat in the Saskatchewan River by running the pipeline beneath the river bed. Shore plans to mitigate effects of water drawdown on fish-bearing waterbodies by supplementing seasonal baseflow, as required, by directing water of suitable quality to 101 Ravine, Duke Ravine, and English Creek.

The habitat quantification process for the Project LSA has been unusually challenging due to the complexity of habitat types in the streams, a high level of seasonal and temporal variation, abundant beaver activity in the area, as well as other types of natural obstructions acting as barriers to upstream fish migration. A proposed approach for calculating the quality and quantity of fish habitat that will be impacted due to Project development was submitted to DFO in August 2010. The approach taken was to divide the study area into habitat types (pool, riffle, and run) based on slope differences using Light Detection and Ranging (LiDAR) imagery (taken in 2005), aerial photography (taken in 2007), and field data collected during the 2007 and 2008 baseline surveys. A habitat evaluation procedure was then used to calculate the net loss in habitat productive capacity for the test study area (the lower reach of East Ravine). Following a meeting with DFO on May 25th, 2011 to discuss the test approach, it was decided to quantify fish habitat solely by habitat type (pool, riffle, and run) rather than using species-specific habitat suitability ratings. DFO was satisfied with the desktop approach, as long as the results were compared with field data. A comprehensive report applying this approach to all nine tributaries in the LSA was submitted to DFO in December 2011 (Appendix 6.3.1-E). The desktop approach was successful in quantifying the habitat types for the purposes of developing a compensation plan.

The process of quantifying fish habitat in the LSA has been occurring over a two year time period and as mentioned previously, many Project-related effects have been minimized or avoided through changes in project design and site layout. During a meeting held with DFO on March 7th, 2012, it was agreed that flow supplementation mitigation measures in 101 Ravine, Duke Ravine, and English Creek were sufficient to avoid the need for compensation, as long as the current quantity and quality of fish habitat is maintained or improved during the life of the Project by diverting surface water down these waterbodies at appropriate times of year to replicate natural flow events. It was also agreed that the tributaries found to contain no fish during the baseline surveys (including West Ravine[4], West Perimeter Ravine, FalC Ravine, and Wapiti Ravine) did not require inclusion in the offset calculation for the FHCP. Their small size, shallow depth, limited watershed area, and barriers to fish migration make these streams unlikely to support or sustain fish populations.

The portions of the LSA included in the offset calculation for the FHCP include the following:

- all of East Ravine which will be permanently altered due to the Star pit;
- areas of 101 and Duke ravines where culverts will be situated during the construction and operation phases of the Project; and
- the portion of the Saskatchewan River that will be temporarily impacted during the construction and operation of the diffuser.

East Ravine

The upper reach of East Ravine will be preserved through water diversions throughout the life of the Project. During the initial stages of pre-stripping on Star, water will be temporarily diverted to the outlet of East Ravine. As the Star pit progresses, the natural outlet will be blocked and water from the upper reaches will be diverted to a catchment pond. During the operational period, seepage from around Star pit will be re-directed to the lower reaches of East Ravine to provide passive flow supplementation that replicates natural downstream flows. Throughout the Project, flow and fish habitat in the reaches of East Ravine located above and below the Star pit may be maintained; however, the upper reach will lose connectivity with the Saskatchewan River. At closure, the mid-reach will be re-established so that catchment water flows into the Star pit, which, when the pit refills enough to spill in approximately 350 years, will rejoin with the lower reach of East Ravine, and the Saskatchewan River (Section 6.2.7). Although certain reaches of East Ravine will be retained during the operational phase of the Project, all of East Ravine is included in the offset calculation because of the alteration of fish habitat caused by changes in flow, water levels, and temporary loss of connectivity with the Saskatchewan River.

Aquatic habitat information was collected from reaches of East Ravine located near the Saskatchewan River, within the Star pit, and north of the Star pit in August 2007 and 2008. The results of the baseline investigations are summarized in Section 5.3.1 and are detailed in CanNorth (2010a). The habitat was found to be a mixture of riffles, runs, and pools with several habitat sections containing beaver dams and ponds. The desktop approach calculated that East Ravine contained 93.5% pool, 4.9% run, and 1.6% riffle habitat

[4] One lake chub was captured close to the confluence of West Ravine with the Saskatchewan River.

(CanNorth 2011; Appendix 6.3.1-E). The desktop approach and field data were compared; however, there were issues in temporal variability of the information used, observer bias during field investigations, and potential model flaws for the desktop approach since habitat characterization was based solely on topography differences of the stream channel. As a result, it is likely that the quantity of pool habitat calculated using the desktop approach is overestimated.

Habitat types in East Ravine are subject to frequent changes and even extensive field documentation would not accurately determine percentages and locations of each habitat type along the stream. For example, in May 2007, the lower reach of East Ravine contained a riffle area near the mouth of the stream that white sucker were using for spawning (Appendix 6.3.1-C, Photo 14). However, in August 2007, the habitat type had changed entirely because a beaver dam had flooded the riffle area and formed an impoundment (Appendix 6.3.1-C, Photo 15). The habitat quantification process has illustrated that habitat classifications of the streams in the Project LSA vary depending on the month that the information is collected and are not reliable predictors of future habitat availability. Considering this, it was agreed by DFO that the total areal quantity of habitat in East Ravine will be used to determine the amount of offset required without consideration of habitat types (Aaron Schweitzer, pers.comm. April 3rd, 2012).

During the desktop approach, the location of the stream channel in East Ravine was defined from an analysis of a high resolution (1 m accuracy) LiDAR-derived digital elevation model using the hydrology toolset in ArcGIS. To check the accuracy of this method, a comparison was made with the aerial photography. The comparison showed that this approach produced a close correspondence with the actual channel locations. In a few locations where the approach failed to place the stream in the correct locations within the ravine, the line was manually edited. A number of beaver ponds were apparent in the aerial photography which could not be represented as part of the stream network using the hydrology tools described above. To define these areas, a separate shapefile was created and polygons were manually digitized around the boundaries of these ponds.

The areal quantity of habitat in East Ravine was calculated by multiplying the length of the stream channel by the average stream width of riffle and run habitats measured during the field assessments[5]. In addition, the areal quantity of pool habitat within beaver ponds was represented by summing the area within individual shapefiles created to delineate the boundaries of these ponds. The resulting areal quantity of fish habitat loss that requires offset in East Ravine is 76,103 m^2.

[5] Average wetted width and bankfull width were both 1.7 m in East Ravine.

Road Crossing Structures

The approximate locations of the culverts to be installed in Duke, East, and 101 ravines are shown in Figure 6.2.5-1. The portion of East Ravine that will be impacted by the road crossing is already accounted for in the above section since the entire stream is included in the offset calculation. Therefore, the following discussion is based solely on the road crossing structures planned for Duke and 101 ravines.

Information on fish communities and fish habitat was collected in the upper reaches of Duke and 101 ravines in August 2008 in the vicinities of where the mine roads are proposed to cross (Figure 6.3.1-1). The habitat in the upper reach of 101 Ravine is characterized by beaver dams, impoundments, and wetlands and was classified as pool habitat. The fish species captured in the upper reaches were all small-bodied and included fathead minnow, northern redbelly dace, and lake chub. Although the study area contains numerous large ponds (>40 m bankfull width), there were a few sections where the creek channel narrows and is distinguishable. Considering the variability of the environment, the final crossing location will need to be determined during the detailed design phase.

The upper reach of Duke Ravine also contained beaver dams, impoundments, and pool/glide habitat; however, the beaver ponds consisted mostly of flooded terrestrial vegetation and between flooded areas the creek channel was distinct and narrow (<1 m bankfull width). The fish species captured in the upper reaches of Duke Ravine included fathead minnow, northern redbelly dace, lake chub, and longnose dace. Similar to 101 Ravine, the road crossing will be positioned at a location on the creek deemed most suitable for culvert placement and this will be established during the detailed design phase.

The crossing sites at Duke and 101 ravines do not contain migratory large-bodied fish and forage fish habitat is not limited in the watercourses. Crossing structure design is still pending; however, it will be ensured that the culverts maintain stream connectivity by meeting standards for culvert embedment and being installed in relatively flat areas.

Since culvert dimensions and creek width at the crossing sites are unknown, assumptions will be made for the offset calculation. To be conservative, for 101 Ravine it is assumed that the crossing will be constructed using earthen fill over the wetland areas, with a 4 foot (1.22 m) culvert in the main channel and two 3 foot (0.91 m) culverts on each side to accommodate peak flows. In addition, there will likely be smaller culverts within the earth filled zone to maintain hydraulic connectivity. For Duke Ravine, it is assumed that a single 5.25 foot (1.6 m) culvert installed in the main channel will be sufficient since the tributary is similar in size to East Ravine. If side channels are encountered in either stream during the detailed design phase, additional culverts will be installed.

The above estimated culvert sizes are considered an overestimation of requirements. A study done on Caution Creek at the Division road crossing recommended three, 4 foot (1.22 m) culverts to handle the 1:25 peak and the drainage area for that crossing is many times larger than that of 101 and Duke ravines (Timberline 2007, Appendix 6.3.1-F). To accommodate haul traffic, conveyer, side barricade, and build-up of the road surface sufficient to cover the heavy gauge culverts, it is estimated that the crossing width of the mine roads will be 70 m. Since the culverts will extend beyond the right-of-way, a culvert length of 88 m is assumed to match the design for East Ravine.

Using the dimensions listed above, the predicted amount of fish habitat loss due to culvert placement in Duke and 101 ravines can be calculated. For Duke Ravine, assuming the installation of a single 5.25 foot (1.6 m) wide x 88 m long culvert, the total amount of habitat loss would be 140.8 m^2. For 101 Ravine, assuming the installation of one 4 foot (1.22 m) wide culvert and two 3 foot (0.91 m) wide culverts extending 88 m in length, the total amount of habitat loss would be 267.52 m^2.

The resulting areal quantity of fish habitat loss that requires offset due to culverts being installed in Duke Ravine and 101 Ravine is conservatively estimated to be 408.32 m^2.

Saskatchewan River

Details on the conceptual design of the diffuser that will discharge water from the Project into the Saskatchewan River are provided in Appendix 6.3.1-B. It is noted that the diffuser design parameters are preliminary and will be refined during the detailed design phase. The footprint of the diffuser is designed to be 60 m long and will be situated mid-channel in areas that exceed 2.3 m in depth during average flows. A site survey will be conducted prior to finalization of design plans to confirm bed material composition and channel section bathymetry. At this time, it is assumed that river bed material in this reach is predominantly sand. During the detailed design phase, the exact location of the diffuser structure will be discussed with the regulators to ensure that high quality sturgeon habitat is being avoided.

To accommodate work within the channel during the installation of the diffuser, it is proposed that a vertical sheet pile or caisson coffer dam will be installed by barge. There will be an earthen access berm connected to the coffer dam by an earthen coffer dam segment that is parallel to the flow (Appendix 6.3.1-B, Figure 1). Using dimensions estimated for these structures, the area that will be impacted will measure approximately 3250 m^2. Construction will take place in the summer to avoid sensitive windows of fish spawning periods. Since the access berm and coffer dam will be temporary structures that will only impede fish use of the area during a short period of time, the offset value was weighted since all other impacts being included in the offset calculation will extend the life of the Project. The Project lifespan is predicted to be 25 years, while the installation of the diffuser is only estimated to occur during a portion of one year. Therefore, a weighting factor of 75 was used (25 years multiplied by 3 to account for construction only occurring over one third of the year). Using this factor, the resulting aerial quantity of fish habitat loss that requires offset due to the access berm and coffer dam is estimated to be 43 m^2.

The diffuser pipe being installed in the Saskatchewan River will alter fish habitat throughout the life of the Project. In order to provide erosion protection for the diffuser pipe, it is currently proposed in the conceptual design that clean riprap will be used to armour the existing bed along the segment with risers where the depth of cover is small. Initial estimates suggest that 300 mm diameter riprap, 600 mm thick, placed to a width of 3 m on both sides of the diffuser pipe would provide adequate protection along a total length of 75 m. However, it is noted that the material used for the cover will be discussed with regulators prior to being finalized since DFO expressed concern that the use of rip rap may attract fish to use the area for spawning or rearing.

Using these dimensions, the resulting areal quantity of fish habitat loss that requires offset due to the diffuser in the Saskatchewan River is estimated to be 450 m^2.

Overall Offset Amount

The total amount of fish habitat loss that requires offset by the Project is calculated to be 77,004 m^2. Table 6.3.1-3 provides a summary of the breakdown of the total amount.

Table 6.3.1-3: Summary of Fish Habitat Loss Quantification

Location	Type of Impact	Aerial Quantity (m^2)	Temporary or Permanent	Lifespan of Impact
East Ravine	Star Pit and Culvert	76,103	Permanent	Permanent
Duke Ravine	Culvert	140.8	Temporary	~25 Years
101 Ravine	Culvert	267.5	Temporary	~25 Years
Saskatchewan River	Access Berm and Coffer Dam	43	Temporary	0.3 Years
Saskatchewan River	Diffuser Pipeline	450	Temporary	~25 Years

Proposed Measures to Offset Habitat Loss

Shore is committed to completing habitat compensation that provides adequate compensation to offset fish habitat loss caused by the Project. Shore's objective is to select a habitat compensation project that provides value to local aquatic ecosystems and is of interest to local Aboriginal groups and communities. Through review of the draft EIS, the James Smith Cree Nation (JSCN) and the Muskoday First Nation (MFN) requested the opportunity to provide input on the proposed compensation projects. Efforts to obtain these opinions have been ongoing since mid-2011, with recent attempts made via email with MFN on March 12th, 2012, and at a meeting with JSCN on April 20th, 2012.

A list of candidate habitat compensation projects has been compiled; however, this list is not exhaustive and Shore is open to other options such as contributing to large-scale projects that DFO deem worthwhile. Some project options were identified during a meeting held with DFO and SMOE on March 7th, 2012, and others project options were taken from the recently published Carrot River Watershed Source Water Protection Plan (SWA 2012). The Carrot River watershed is located southeast of the Project and extends approximately 300 km from Wakaw Lake, through James Smith Reserve Land, and eventually discharges into the Saskatchewan River in Manitoba. The Carrot River Watershed is an important waterway that is located near to the Project and several initiatives were identified that are required to improve water quality and fish habitat.

A list of potential fish habitat compensation plans amassed by Shore is provided below for evaluation. Once a conceptual plan is approved, further information and field work will be required in order to calculate the exact amount of compensation offset that the option will provide. It is possible that a combination of compensation measures will need to be implemented in order to achieve an acceptable offset ratio. This will be determined during the detailed design phase of the FHCP.

The first three projects have been identified by Shore as the preferred options because they are local to the Project, will have a positive impact on local Aboriginal groups and communities, and provide improvements to fish habitat.

- Improve habitat quality in areas of Peonan Creek that are currently impacted by agricultural practices. This initiative was identified by DFO as being desirable and is moved forward as the primary compensation plan (see below for more information).
- Upgrade crossing structures where Caution Creek and English Creek cross Division Road in the Project RSA. This initiative is very local to the Project, has been identified as necessary, and would act to improve fish passage, fish habitat, and public safety. This project is proposed as a secondary compensation plan if additional offset measures are required.
- Reconnect the side channel located southwest of the bridge at MFN to the main channel in the South Saskatchewan River (Appendix 6.3.1-B, Photos 26 and 27). Improving connectivity would prevent fish from becoming trapped in the side channel when water levels subside. This project is also proposed as a secondary compensation plan if additional offset measures are required.

- Rehabilitate and improve fish passage for the Smoky Burn low-level crossing on the Carrot River. This project was given low priority in the Carrot River Watershed Source Protection Plan, but was mentioned in the meeting with DFO and SMOE on March 7th, 2012 as a desirable initiative.
- Contribute to improving passage for sturgeon at the weir located in Saskatoon. This is a large-scale project where other proponents requiring habitat compensation would likely need to pool their resources to achieve the end goal.
- Conduct a biomass balance research project on streams along the Saskatchewan River. This initiative was put forth by MOE as a relevant study since the LSA consists of numerous small tributaries whose value in terms of contributing nutrients, etc. to the Saskatchewan River is currently unknown. However, this type of information, as well as the amount of compensation offset the research study would provide, would be difficult to quantify.
- Restore fish passage at an old PFRA dam located near the downstream end of Red Deer Creek north of MFN that may be preventing fish movement up the creek from the South Saskatchewan River.
- Assist in decommissioning abandoned water wells in order to protect groundwater quality in the Carrot River watershed. This initiative was given high priority in the Carrot River Watershed Source Protection Plan; however, the amount compensation offset this initiative would provide would be difficult to quantify.
- Conduct some of the identified research needs in the Carrot River watershed which include a hydrological study, fish and fish habitat assessments, and a water quality study. These initiatives were given different priorities and timelines in the Carrot River Watershed Source Protection Plan. High priority was given to conducting a five-year baseline water quality study using Burntout Brook as a case study. However, the amount compensation offset completing research studies would provide is difficult to quantify.
- Increase capacity of the culvert on Burntout Brook north of the Highway 23 bridge on the north-south grid road. This project was given high priority in the Carrot River Watershed Source Protection Plan.

Each of these projects was assessed based on the proximity of the compensation measures to the impacted habitat, the similarity of the habitat to the impacts, if the area of compensation or the benefits gained are comparable, the environmental benefit, and the community/Aboriginal benefit (Table 6.3.1-4 and 6.3.1-5).

Table 6.3.1-4: Comparison of Potential Fish Habitat Compensation Projects

Project	Proximity	Similarity	Area Equivalence	Environmental Benefit	Community/ Aboriginal Benefit	Sum
Peonan Creek	1	1	1	0	1	4
Crossing Structures at Caution and English Creeks	1	1	0	0	1	3
South Sask. Side Channel	0	1	0	0	0	1
Smoky Burn Low Level Crossing	0	1	0	0	-1	0
Sturgeon Passage	-1	-1	1	1	-1	-1
Fish Passage at Red Deer Creek	0	1	0	0	0	1
Decommissioning Water Wells	0	-1	1	0	0	-1
Research Initiatives	0	-1	1	0	0	0
Burntout Brook Culvert	0	1	0	0	-1	0

Table 6.3.1-5: Ratings Used to Compare Potential Fish Habitat Compensation Projects

Classification	Criteria/Rating	Value
Proximity to Impacted Habitat	Within FalC	1
	Within RSA	0
	Outside of RSA	-1
Similarity to Impacted Habitat	Same	1
	Different	-1
Approximate Area of Compensation/Equivalence	Similar to Impacted Habitat	1
	Smaller than Impacted Habitat	0
Environmental Benefit	High	1
	Moderate	0
	Low	-1
Community/Aboriginal Benefit	High	1

Classification	Criteria/Rating	Value
	Moderate	0
	Low	-1

After evaluating the above listed options, the proposed compensation measure to offset habitat loss in the Project area is to improve habitat quality in areas of Peonan Creek that are currently impacted by agricultural practices and roads. Peonan Creek is located approximately 18 km upstream of the Project on the south side of the Saskatchewan River (Figure 6.2.5-1). It extends for approximately 50 km from Highway 3 approximately 5 km north of Birch Hills to the Saskatchewan River and flows mainly through agricultural land. The creek is part of the Saskatchewan River watershed; several streams enter along its length but none appear to flow from any major lakes. The downstream portion of the creek flows through JSCN land; thus upgrades to the corridor will positively affect JSCN.

Peonan Creek is one of the larger tributaries in the area and contains an abundant and diverse fish community (Table 6.3.1-5). In July 2011, baseline aquatic surveys were conducted in the lower reach of Peonan Creek within 500 m of the Saskatchewan River (detailed report is provided in Appendix 6.3.1-A). During the fish community survey, 11 minnow traps set overnight (total effort 241.6 hr) resulting in the capture of 154 fish. Backpack electrofishing was conducted for approximately 2,461 s across various in-stream habitat types and yielded 50 fish.

Table 6.3.1-6: Summary of Fish Capture Information from Peonan Creek, July 2011

Common Name	Scientific Name	Number Captured
Burbot	*Lota lota*	4
Brook stickleback	*Culaea inconstans*	14
Fathead minnow	*Pimephales promelas*	1
Lake chub	*Couesius plumbeus*	141
Longnose dace	*Rhinichthys cataractae*	2
Northern pike	*Esox lucius*	1
Northern redbelly dace	*Phoxinus eos*	3
River shiner	*Notropis blennius*	4
Spottail shiner	*Notropis hudsonius*	1
Walleye	*Sander vitreus*	20
White sucker	*Catostomus commersoni*	12

Common Name	Scientific Name	Number Captured
Yellow perch	*Perca flavescens*	1
Total		204

Fish habitat in the lower reach (within 500 m of the Saskatchewan River) was characterized by a mixture of riffle, run, and pool habitat with bankfull widths ranging between 6 and 9 m and mean center depths ranging between 0.4 and 1.5 m (Appendix 6.3.1-B, Photo 20). There were no major obstructions to fish migration from the Saskatchewan River into Peonan Creek noted in July 2011. Suitable white sucker spawning habitat was identified during the habitat assessment and it has been established that Peonan Creek is highly utilized by white sucker for spawning (CanNorth, unpublished data). Juvenile white sucker, walleye, northern pike, and yellow perch were captured in the study reach, illustrating that the lower reach of Peonan Creek provides important habitat for these large-bodied migratory fish. In addition, both northern pike and white sucker have been documented as far up the creek as Brancepeth (Vince Harper, pers. comm., July 2012).

Portions of Peonan Creek do contain a riparian buffer zone between the upland and the stream; however, there are sections of the creek where the buffer zone is absent or marginal. Buffers are important management tools used to reduce agricultural pollutants such as sediment, nutrients, and pesticides from entering watercourses (Dosskey 2002; Teels et al. 2006; Yates et al. 2007). Research has found that streams dominated by riparian corridors without gaps or fragmentation have healthier fish and benthic invertebrate communities (Wichert and Rapport 1998; Stewart et al. 2001; Teels et al. 2006). Water quality testing conducted in July 2011 in the lower reach of Peonan Creek illustrated the creek contained elevated concentrations of ions (total dissolved solids = 1060 mg/L), turbidity (11 NTU), and nutrients (total phosphorus levels classify the stream as hyper-eutrophic (Wetzel 2001)). Nutrient enrichment is indicative of reduced water quality downstream of agricultural lands (Riseng et al. 2011).

The preferred compensation plan proposed by Shore is to upgrade the riparian zone along areas of Peonan Creek most impacted by agricultural and other developments. This will include using exclusion fencing to keep livestock and/or cultivation encroachment from disturbing the creek and re-vegetating disturbed areas to enhance the riparian zone. This is the preferred option for the following reasons:

- the plan meets Option 1 on DFO's hierarchy of compensation options (create or increase the productive capacity of like-for-like habitat in the same ecological unit);
- the plan benefits a local First Nations' group who have a keen interest in the Project and in being involved in the habitat compensation plan; and

- literature illustrates that enhancing riparian habitat impacted by agricultural practices improves stream ecosystem quality including fish habitat and fish community structure.

A field reconnaissance survey was conducted in early July 2012 assessing the riparian health along a stretch of Peonan Creek extending approximately 5 km upstream from the Saskatchewan River (Figure 6.3.1-2). The survey identified that the most impacted area was near the gravel road crossing located approximately 4.6 km upstream of the Saskatchewan River (Point B on Figure 6.3.1-2; Appendix 6.3.1-C, Photos 28 to 32). At this location, there are roads going into the creek from both sides and this site has high potential for soil erosion impacting the creek. Consultations with JSCN members indicated that numerous crossings have been installed at this location but they have always washed out. The roads leading to the creek serve as travel routes for the water during precipitation events and are eroded. It appears as though the crossing was still being used by vehicles that just drive across the creek, although the creek was fairly high at the time of visit and unlikely to be used at that particular time. There are homes of JSCN members on the north side of the creek so in order for them to get to the band office they have to travel a far distance around the creek or else use this crossing. Thus in addition to providing restoration of the riparian habitat of the creek in this area, there is also the potential to install a crossing structure that can be utilized by JSCN members. At Point C on Figure 6.3.1-2 (Appendix 6.3.1-C, Photos 33 and 34) there are trails leading to the river that are causing erosion. The lower reach of the study area (Points C to E on Figure 6.3.1-2; Appendix 6.3.1-C, Photos 35 to 38) is showing erosion from stream flow, but the banks are generally well vegetated.

To further pinpoint locations of riparian habitat that require upgrading, local knowledge from the Band, landowners, and the Conservation and Development groups will be elicited. In addition, a site visit with DFO personnel will be conducted and a quantitative riparian health assessment will be completed. The information obtained will be used to determine locations where cattle most utilize the creek, and locations where the riparian zone will benefit most from enhancement.

Shore will work with SWA agrologists, landowners, and vegetation specialists to establish a detailed design plan for the compensation project and this will be provided in the FHCP. This will include determining exactly where to put fencing, how long the fencing will be in place, how to provide off-site watering for the cattle, where to provide re-vegetation, and how to most effectively rehabilitate the road crossing area. For the re-vegetation program, information such as what species to plant in each area, time of year of planting, and density of plants will be compiled. An implementation plan will be completed which will include construction methods and schedule as well as a follow-up monitoring program. The follow-up monitoring program will repeat the riparian health assessment and quantify the success of compensation efforts on a cyclical basis (e.g., every three years). In-stream studies will also be completed to evaluate the extent of the positive effect that the compensation project has on the aquatic environment in Peonan Creek.

Since the exact quantity of fish habitat that will be improved on Peonan Creek has not been established, it is not possible to determine the ratio of amount of habitat compensation:reduction/loss of productive capacity. It is noted that a significant stretch of aquatic habitat located downstream of enhancement areas will be improved due to a decrease in soil erosion. An estimation of the areal quantity of fish habitat gain that the compensation project will provide will be included in the FHCP. As mentioned previously, Shore will ensure that the quantity of compensation is sufficient to offset Project habitat losses and if required, additional compensation measures listed in Table 6.3.1-4 will be completed.

6.3.2 Vegetation and Plant Communities

The following section contains the vegetation impact assessment for the Project.

6.3.2.1 Introduction

This section evaluates the Project impact on local and regional indicators at full Project development (Project Case). Cumulative effects are discussed in Section 9.0 of this EIS.

The assessment was conducted within the Local (LSA) and Regional (RSA) study area boundaries as defined in Section 5.3.2 (Vegetation and Plant Communities). The assessment assumes the full Project layout (maximum footprint), and does not consider on-going reclamation efforts planned for parts of the proposed development throughout the life of the Project as operational areas are decommissioned. Results from this section were used to support other sections of the application and EIS including:

- Closure and Reclamation Plan (Section 7.5);
- Terrain, Soils and Geology (Section 6.2.1);
- Wildlife and Habitat (Section 6.3.3);
- Biodiversity (Section 6.3.4); and
- Traditional Knowledge and Traditional Land Use (Section 6.4.2).

At the time the baseline portion of the draft EIS (Section 5.3.2) was prepared, a standard guide to vegetation classification for the study areas did not exist. Therefore an appropriate classification system was developed as described in Section 5.3.2 of the EIA. Shortly after submission of the draft EIS, Saskatchewan's Ministry of Environment (MoE) published a Field Guide to the Ecosites of Saskatchewan's Provincial Forests (McLaughlan *et al.*, 2010). At the request of the MoE through the review of the draft EIS, the ecosites were re-classified according to McLaughlan *et al.* (2010) Individual sampling sites were reclassified under the new guide using the field data, and mapped polygons were reclassified based on the existing Saskatchewan Forest Vegetation Inventory (SFVI) data. Baseline values under the new system are presented in each table below. The approach and methods of assessing impacts to each indicator have not changed, however the new classification system necessitated new calculations for rare plant potential and traditional (previously "historical") plant potential (Appendix 6.3.2-A). Rare plant and weed lists were also updated based on the most recent listings and legislation (Appendix 6.3.2-A). The re-classified polygons were used to conduct the revised impact assessment described below.

6.3.2.2 Assessment Criteria and Valued Components (VC)

Five VCs were selected to provide a description of the potential impact of the Project on the natural vegetation. They are:

- habitat distribution (vegetation types, including wetlands);
- old growth forest;
- riparian habitat (according to both ecological and forestry management delineations);
- species at risk (rare plant species, communities, and rare plant potential); and
- traditionally used plant species.

Each VC is made up of several resource measures that can be quantified and may be affected by activities within the study area. Changes in these measures can then indicate changes in vegetation qualities. An indicator approach was used for each VC to reduce redundancy in the assessment since assessment of appropriate indicators can accurately reflect potential effects on a wide range of species in the LSA and RSA.

Good indicators include those that:

- are likely to change in response to potential development activities;
- are directly related to the resource being measured; and
- are easily measured or estimated using available information and/or existing models.

The rationale for selection of the vegetation indicators was based on issues raised in similar environmental impact assessments, issues identified in published biological literature and government reports, and issues specific to the LSA and RSA based on an understanding of the potential Project effects on vegetation.

The criteria used to assess impacts on vegetation are described in Section 6.1, Overview and Methods, and include definitions of the assessment cases. Each selected vegetation resource measure used to quantify a particular VC was assessed relative to the maximum effect that would occur due to Project development. Residual impacts for each resource measure were assessed by comparing the Project after successful reclamation to the baseline case. In some cases successful reclamation may be a period as short as 5 years while in others it could be longer. In either case, EIA methods define these time periods as long-term (Section 6.1). Residual effects were then used to determine whether a cumulative effects assessment was required.

Impacts were summarized by resource indicators, and were assessed to determine an overall impact rating from low to high based on standard criteria of magnitude, geographic extent, duration, frequency, reversibility, ecological context, level of confidence/certainty, and probability of effects. Residual impacts were also assigned a significance rating using defined criteria for significance (Section 6.1). Where impacts are quantified, numerical values are rounded to the nearest integer, with values greater than 0 but less than 1 being reported as <1.

6.3.2.3 Issues Scoping

Issues related to vegetation addressed in this Section are based on the following:

- community engagement by Shore;
- regulatory engagement with provincial and federal government agencies by Shore;
- existing regional scientific literature and publicly available data;
- professional judgment based on experience in the region and/or with similar projects;
- evaluation of the interaction between Project components and the biophysical setting; and
- requirements included in the Project Specific Guidelines (PSGs) outlined in Section 1.0 and listed in Appendix 1-D and the federal scoping document.

Vegetation Distribution

Loss of natural vegetation communities due to clearing associated with Project development is the primary direct impact on vegetation resources. Indirect impacts include changed vegetation growth and reproduction dynamics associated with Project activities that alter the environmental conditions (e.g., impaired vegetation growth due to water impoundment or altered vegetation community composition due to the spread of non-native species). These changes could result in altered distributions of uncommon or sensitive vegetation communities, or the loss of unique vegetation features (e.g., rare plants).

Weed Spread into Natural Areas

Weeds and other non-native plants may establish resident populations on newly disturbed land, for linear developments or other clearings for industrial use, and then spread into undisturbed areas. Weeds may enter a natural community along waterways, via air or animal borne seeds, or on equipment brought in from areas where weeds have proliferated. Without proper precautions, weed seeds can also be introduced in contaminated seed mixes used for reclamation purposes.

Vegetation Health and Availability of Resources

The quality and availability of plants are influenced by a number of factors, including dust, emissions, and hydrological changes. These factors have the potential to affect plants or plant parts (e.g., berries) that are collected for traditional consumption or medicinal purposes. A change in the vegetation availability or quality could in turn affect wildlife health or habitat.

Dust Deposition

Dust deposited on leaves may affect plants by reducing light penetration, abrading leaf cuticles, and/or by blocking stomata resulting in reduced photosynthetic capability, respiration, and uptake of water (Farmer 2003). These impacts have adverse effects on plants, inhibiting growth and survival. In addition, the palatability of vegetation for human or animal consumption may be reduced with dust accumulation, reducing the suitability of plant species for collection and the quality of wildlife habitat. Prolonged exposure to road dust may increase soil pH and therefore affect communities such that species adapted to acidic conditions (e.g., peatland mosses) are inhibited, while those adapted to alkaline conditions (e.g., graminoids) are enhanced (Walker and Everett 1991).

Air Emissions

Air emissions (e.g., acidifying compounds) from the Project are expected to be minimal and consequently potential effects on vegetation not measureable. A detailed analysis of potential air emissions is covered in Section 6.2.2 (Air Quality) and is not discussed further here. The potential effects of deposition from background and/or emission sources are discussed in the environmental health risk assessment section (Section 6.4.5).

Hydrological Effects

Wetland vegetation types can be affected due to draining or clearing and the subsequent alteration of wetland function. If Project activities affect the water table, nutrient levels or other structural and dynamic features, wetlands can be impacted. Wetland alteration may, in turn, contribute to changes in the local and/or regional hydrological cycle, for example, by reduced attenuation of precipitation and runoff. In addition, water impoundment adjacent to roads and other Project facilities may alter the structure, function and composition of wetlands.

6.3.2.4 Cumulative Effects

Cumulative effects were assessed only where the Project-specific residual effect had a measurable or demonstrable effect on vegetation (including wetlands), and where the Project-specific residual effect is predicted or likely to act in a cumulative fashion with the effects of other past, present or likely future projects within the RSA. Regional cumulative effects were estimated on the assumption that all existing, approved, and proposed future projects would be developed to their maximum extent and be fully operational at one time, concurrent with full development of the Project.

The Cumulative Effects Assessment (CEA) was completed using qualitative and, where possible, quantitative analyses and is presented in Section 9.0 of this EIS. Cumulative effects were assessed based on distribution and habitat use within the RSA using the same criteria from which residual Project effects were assessed (Section 6.1 Overview and Methods).

6.3.2.5 Effects Assessment

This Section summarizes the potential effects of the Project on vegetation VCs based on the issues and assessment criteria described above.

Effects on Habitat Distribution

The following describes potential direct and indirect effects to various vegetation communities, including uplands and wetlands. Effects on vegetation type distribution, uncommon vegetation types, and sensitive vegetation types are discussed.

Direct Effects on Vegetation Types

There will be a 14% decrease in upland vegetation types and 3% decrease in wetland vegetation types resulting from proposed clearing for the Project within the Project Case prior to reclamation in the LSA (Table 6.3.2-1 and Figure 6.3.2-1). In the RSA, the Project disturbance results in a 1% decrease in upland vegetation types and a <1% decrease in wetland vegetation types prior to reclamation. A slightly larger area (54 ha) is affected in the RSA compared to the LSA due to the access road to be constructed for the Project.

“Other” cover types listed in Table 6.3.2-1 include areas that have been burned, affected by harvest/silviculture (i.e., forestry), insect/disease, and human disturbance, as well as lakes, rivers, and flooded areas. These “other” cover types account for the majority (76%) of the land base in the LSA where 28% of the baseline LSA area is burned, 24% is salvage (previously burned or cleared areas that have had the timber removed for sale), and 16% is affected by insect/disease. There will be a 38% decrease in other cover types in the LSA and 5% decrease in the RSA prior to reclamation as a result of the Project.

Table 6.3.2-1: Direct Effects on Vegetation Types in the Study Areas including Baseline, Project Impact, and Post Reclamation Vegetation Distributions

ELC Code	Vegetation Type	Baseline LSA (ha)	% of Total Baseline LSA	Project Impact in LSA (ha)	% of Veg. Type in LSA Affected	Post Reclamation Area in LSA (ha)	Post Reclamation % change in LSA	Baseline RSA (ha)	% of Total Baseline RSA	Project Impact in RSA (ha)	% of Veg. Type in RSA Affected	Post Reclamation Area in RSA (ha)	Post Reclamation % change in RSA
	Upland Vegetation Types												
BP01	June grass - mountain goldenrod grassland[B]	11	<1	<1	3	11	2	41	<1	<1	0	41	<1
BP01a	Dry shrubland[B]	65	1	<1	<1	65	<1	195	<1	<1	0	195	<1
BP02	Jack pine - lichen[B]	0	0	0	0	294	-	172	<1	1	1	465	170
BP03	Jack pine - feathermoss	445	4	101	23	962	116	9059	7	115	1	9562	6
BP04	Jack pine - trembling aspen - feathermoss	232	2	54	23	680	193	4280	3	57	1	4724	10
BP05	Trembling aspen - prickly rose - grass	764	6	112	15	665	-13	10347	8	119	1	10241	-1
BP06	Trembling aspen - beaked hazel - sarsaparilla	332	3	36	11	301	-9	8862	7	37	<1	8830	<-1
BP07	Trembling aspen - white birch - sarsaparilla	232	2	5	2	230	<-1	2529	2	5	<1	2527	<-1
BP09	White spruce - trembling aspen - feathermoss[L]	154	1	23	15	790	412	4123	3	23	1	4758	15
BP10	Trembling aspen - white spruce - feathermoss[B]	1	<1	0	0	1	0	1522	1	0	0	1522	0
BP11	White birch - white spruce - balsam fir[B]	22	<1	<1	1	22	<1	126	<1	<1	<1	126	<1
BP12	Jack pine - spruce - feathermoss[L]	38	<1	1	3	443	1077	2043	2	6	<1	2444	20
BP13	White spruce - balsam fir - feathermoss[B]	0	0	0	0	0	-	6	<1	0	0	6	0
BP14	Black spruce - Labrador tea - feathermoss[L]	77	1	10	13	289	275	4805	4	14	<1	5013	4
BP15	Balsam poplar - white spruce - feathermoss[B]	3	<1	2	47	180	5480	313	<1	2	<1	490	56
BP16	Balsam poplar - trembling aspen - prickly rose[L]	166	1	18	11	150	-10	3200	2	19	1	3182	<-1
	Total Upland Vegetation Types	*2543*	*21*	*362*	*14*	*5084*	*100*	*51624*	*39*	*401*	*1*	*54126*	*5*
	Wetland Vegetation Types												
BP18	Black spruce - tamarack - treed swamp[L]	150	1	6	4	144	-4	8201	6	8	<1	8194	<-1
BP18a	Deciduous -mixedwood swamp[B]	4	<1	0	0	5	22	506	<1	<1	<1	506	<1
BP19	Black spruce - treed bog[B]	1	<1	0	0	1	0	101	<1	0	0	101	0
BP23	Tamarack - treed fen[B]	3	<1	0	0	3	0	1292	1	0	0	1292	0
BP24	Leatherleaf - shrubby poor fen[B]	0	0	0	0	0	-	22	<1	0	0	22	0
BP25	Willow - shrubby rich fen	207	2	6	3	306	48	6368	5	10	<1	6458	2
BP26	Graminoid fen[B]	0	0	0	0	0	-	11	<1	0	0	11	0
BP28	Seaside arrow-grass - marsh[B]	2	<1	0	0	134	6205	1242	1	0	0	1373	11
	Total Wetland Vegetation Types	*368*	*3*	*12*	*3*	*594*	*61*	*17743*	*13*	*19*	*<1*	*17957*	*1*

ELC Code	Vegetation Type	Baseline LSA (ha)	% of Total Baseline LSA	Project Impact in LSA (ha)	% of Veg. Type in LSA Affected	Post Reclamation Area in LSA (ha)	Post Reclamation % change in LSA	Baseline RSA (ha)	% of Total Baseline RSA	Project Impact in RSA (ha)	% of Veg. Type in RSA Affected	Post Reclamation Area in RSA (ha)	Post Reclamation % change in RSA
	Other Cover Types												
	Agricultural Land[B]	0	0	0	0	0	-	330	<1	0	0	330	0
	Burn	3393	28	873	26	2520	-26	14990	11	873	6	14116	-6
	Harvest/Silviculture	473	4	323	68	151	-68	9994	8	330	3	9664	-3
	Insect/Disease Affected	1917	16	1186	62	731	-62	16313	12	1192	7	15119	-7
	Salvage	2893	24	964	33	1929	-33	19130	14	964	5	18165	-5
	Human Disturbance[R]	255	2	161	63	110	-57	1635	1	155	10	1557	-5
	Lakes, Rivers and Flooded Land[R]	375	3	1	<1	1100	193	1009	1	1	<1	1734	72
	Total Other Cover Types	*9306*	*76*	*3508*	*38*	*6540*	*-30*	*63402*	*48*	*3516*	*5*	*60685*	*-4*
	Total Study Area	**12218**	**100**	**3882**	**32**	**12218**	**<-1**	**132768**	**100**	**3936**	**3**	**132768**	**<1**

Notes: * rounded to the nearest integer;
[B]vegetation type uncommon in both LSA and RSA (i.e., less than or equal to 1% of either study area);
[L]vegetation type uncommon in LSA only
[R]vegetation type uncommon in RSA only

Following reclamation in the LSA, upland vegetation types are expected to occupy 5,084 ha resulting in an increase of 2,540 ha (100%) in upland vegetation in the LSA. Most of this increase is a result of reclamation of previously burned or harvested vegetation types (i.e., other cover types) that would most likely have been upland vegetation types prior to disturbance. Wetland vegetation types, mostly in the form of shrubby rich fen and marsh vegetation types, will occupy 594 ha of the disturbed landscape, resulting in an overall increase in native wetland vegetation types of 226 ha (61%) in the LSA. Post reclamation "other" cover types will occupy 6,540 ha, resulting in a decrease of 2,766 ha (30%) in the LSA. Proposed pit lakes were categorized similarly to the Lakes, Rivers, and Flooded Land cover type, and are expected to occupy 1,100 ha of the landscape. This represents a 193% increase from the baseline case in the LSA (Table 6.3.2-1).

In the RSA, the residual increase in upland vegetation cover will be 2,502 ha (5%). The increases in shrubby rich fen and marsh area will translate into an overall 1% increase in wetland area within the RSA. Post reclamation, the "other" cover types will occupy 60,685 ha, a decrease of 2,717 ha (4%) in the RSA. The end pit lakes result in a 72% increase in the Lakes, Rivers, and Flooded Lands compared to the baseline condition.

The residual increase in upland vegetation is considered positive in the LSA and RSA. While the mathematical increases can be considered positive and are high and moderate in magnitude for the LSA and RSA respectively, the post-reclamation impact rating is described as low and adverse to account for the redistribution of vegetation communities, the time required for them to re-establish, and the uncertainty associated with reclamation. This uncertainty will be reduced throughout operations by conducting reclamation trials on progressively reclaimed areas.

Duration of the impact is long-term, although progressive reclamation will reclaim much of the overburden and rock storage area (2,247 ha) during operations. The remainder of the clearing is expected to persist throughout the life of the Project. Nonetheless the existing access road to site will be straightened and paved, and consequently the abandoned portions of the existing road will be reclaimed in the short term. The frequency of the disturbance can be considered intermittent throughout the Project life since the clearing itself happens periodically in different locations, however the effects of the clearing remain for a period of time following the intermittent impact. Adverse impacts to upland vegetation types are considered reversible. The reclaimed landscape will replace some diversity in terms of vegetation types, as revegetation prescriptions will be adapted to specific moisture and nutrient regimes at closure. The likelihood of impact is high, and confidence in the assessment is moderate, because details of reclamation are conceptual and may change as a result of adaptive management.

The residual effect on wetland vegetation is also mathematically calculated as high and positive in the LSA and moderate and positive in the RSA, but is conservatively estimated to be low and adverse due to the inherent uncertainty in re-establishing native vegetation communities. Similar to changes in the upland vegetation, the frequency of the impact itself is intermittent, however the duration of effects continue into the long term. There is a high likelihood of occurrence, and moderate confidence in the assessment due to the conceptual details of reclamation.

The residual effect of the Project on “other” cover types is high and adverse (NB: adverse in this instance and throughout the document refers to a decrease in magnitude as per section 6.1) in the LSA and moderate and adverse in the RSA. The frequency of disturbance is intermittent, and the duration of the impact varies from short to long term. The sites (e.g., burn, harvest/silviculture, insect/disease, salvage) are in variable phases of regeneration, and areas classified as human disturbance will be reclaimed during the Project life. The likelihood of impact and confidence in the assessment is high.

The positive changes in upland and wetland vegetation post reclamation are primarily attributable to the conversion of vegetation types from the “other” category at baseline, most notably from the burn (decrease by 873 ha) and salvage (decrease by 964 ha) classes to upland and wetland ecosites post reclamation. The presumed future ecosites of these “other” areas are based on soil moisture and nutrient regimes and thus account for the moderate confidence levels. Baseline conditions represented by the “other” category (burn, forest harvest, and insect/disease) are not equivalent to mining or other industrial disturbance from a vegetation perspective, as these sites are in various stages of regeneration, and support corresponding vegetation communities. In general the soil structure is not completely altered during forest harvest, burning, or insect infestations. While there can be changes to the moisture and nutrient regime as a result of forestry, forest regeneration is generally considered to be less impacted by forestry than by industrial disturbance. These effects on soil are assessed in detail in Section 6.2.1. In addition, since the soil is not removed from a forested site, a seed source exists for the reestablishment of pre-existing vegetation communities. Harvested areas are assumed to naturally return to a pre-harvest vegetation type at some future date, whereas reclaimed mined areas may be better suited to a different vegetation type compared with the pre-disturbance state.

Another consideration when evaluating the post-reclamation landscape is the conversion of open pits at the mine to end pit lakes in the post-closure scenario. The pit lakes will be created such that they provide riparian habitat near their margins as the mine benches will ensure that a more shallow zone of water will occur around the pit-lakes, thus increasing wetland vegetation communities. The increase in area of the Lakes, Rivers, and Flooded Lands vegetation type is determined to be very high in both the LSA and RSA and in a positive direction. The water quality in the pit lakes are modeled in Section 6.2.7. Closure water quality in the Star pit-lake is expected to support wetland communities similar to those in the FalC forest. For the Orion South pit-lake, water quality is expected to support wetland communities, but they may be more similar in composition to those existing in the surrounding farmland due to higher total dissolved solids. The effect is considered long-term and continuous, not reversible, and the level of confidence in the assessment is moderate. Probability of occurrence is high.

In summary, although the assessment calculates a net gain in upland cover types, this gain is at the expense of ”other” cover types that would naturally progress to upland cover types over time. As a result of reclamation, the permanent, direct effect on vegetation types is mostly limited to the conversion of vegetated areas to open water in the pit lakes.

Direct Loss of Uncommon vegetation types in the Project Case

Eighteen of the twenty-nine vegetation ecosite types (i.e., excluding those in the “other” category) represented by mapped polygons are considered uncommon vegetation types either in the LSA or RSA or both (Table 6.3.2-1). This is in part because the majority of both study areas has been affected by forest fires or forest harvest. Therefore many of the remaining vegetation types fall into the uncommon category (constituting less than or equal to 1% of the study area (either LSA or RSA)). Of the 698 ha of all uncommon vegetation types in the LSA, approximately 59 ha (9%) will be disturbed by the Project. The majority of disturbance occurs in the BP09 White spruce – trembling aspen – feathermoss (23 ha) and BP16 Balsam poplar – trembling aspen – prickly rose (18 ha) plant communities of which there are 132 ha and 148 ha remaining in the LSA after disturbance, and an additional 4100 ha and 3180 ha in the RSA, respectively.

In the RSA, uncommon ecosite vegetation types prior to reclamation are distributed across 5549 ha, of which ~3 ha (<1%) will be disturbed as a result of the Project. Important context for evaluating this impact includes considering the effect of spatial scale on the result. In the RSA, seemingly larger effects on undisturbed vegetation types are reduced due to an increased area of undisturbed vegetation and fewer vegetation types categorized as uncommon. It is also important to remember that the vegetation has been classified in a conservative manner, in that areas affected by forest fires, forest harvest, etc. are classified as such, rather than by their ecological designation. It is likely that a percentage of these fire or disturbance affected areas are at different stages of regeneration, and some areas will be closer to their “undisturbed” ecosite classification than others. For the purposes of this assessment however, all cover types falling under the “other” category in Table 6.3.2-1 were treated equally.

Site specific revegetation prescriptions will be applied to specific moisture and nutrient regimes at closure (Section 7.5). Although the specific locations of uncommon vegetation communities will differ post closure, the variation in moisture and nutrient regimes recreated at closure may support similar diversity that existed prior to disturbance. After reclamation, the adverse effect on uncommon vegetation types in the LSA is predicted to be moderate in magnitude, long term but reversible, and highly likely to occur. In the RSA, this adverse impact is rated as low and also long term, reversible, and highly likely to occur. Confidence in the assessment is moderate and the residual effect is expected to persist following reclamation.

Effects on Sensitive vegetation types

The potential indirect effects of dust generated through construction and operational activities and water table drawdown on vegetation types within the LSA are discussed below. The effects of dust are very limited, however RSA spatial context is provided for comparison.

Dust Effects on Vegetation Types

Effects from dust were assessed based on the potential of the Project road traffic, pit development, and overburden disposal to increase windblown fugitive dust. Water features and tailings (e.g., PKCF) were not included in the analysis.

Vegetation types are not considered equally sensitive to dust. The level of acidity of soils susceptible to the neutralizing effects of road dust and the relative amount of mosses and lichens were used to rate the potential sensitivity of vegetation types to road dust (Walker and Everett 1991). The BP19 Black spruce - treed bog was the only vegetation type rated as highly sensitive, due to its high acidity and high percentage of mosses. The acidic pine dominated uplands (BP02 Jackpine/lichen, BP03 Jack pine /feathermoss, BP04 Jack pine – trembling aspen / feathermoss, and BP12 Jack pine – spruce - feathermoss) were rated moderate in sensitivity. BP05 Trembling Aspen – prickly rose – grass, BP06 Trembling aspen – beaked hazel – sarsaparilla, BP07 Trembling aspen – white birch – sarsaparilla, and BP14 Black spruce – Labrador tea - feathermoss were also rated as moderately sensitive due to either their nutrient regime and/or moss component. BP01 June grass – mountain goldenrod grassland and BP01a Dry Shrubland were also included in the moderately sensitive category mainly due to their risk of exposure to dust with little barrier to prevent widespread dust accumulation. All other vegetation types were considered low in sensitivity.

The area of sensitive vegetation types was determined by buffering roads and major disturbances by varying widths, since dust travels further in sites with more open cover. Forested sites were assumed to have a 25 m zone of dust influence; that is, dust could travel and settle on vegetation within 25 m of the edge of disturbance. Shrubby sites were assumed to have a 50 m zone of influence, and open areas (i.e., areas with only graminoid vegetation) were assumed to have a 100 m zone of influence. Disturbed areas and open water were not assessed. This buffering exercise assumes equal proportions of dust settling across the entire width of the buffer, when in reality higher concentrations of dust will occur closer to the disturbance, likely affecting soils and vegetation closest to the road or other dust producing disturbance to a greater degree.

Project related dust may influence sensitive vegetation over an area of 3535 ha in the LSA (Table 6.3.2-2). The zone of dust influence will not affect highly sensitive vegetation classes, and will affect 19% of the moderately sensitive classes and 50% of the least sensitive vegetation classes in the LSA remaining after Project disturbance. With effective mitigation such as road watering this impact can be effectively reduced. Therefore this impact is expected to be moderate following mitigation. The impact is intermittent (seasonal) and the duration is long-term, although impacts will cease once facilities are reclaimed. Likelihood of some impact occurring due to road dust is high, and the confidence in the assessment is moderate, since it is based on a simple area estimation of dust spread, rather than on quantitative modeling predictions of dust generation and dispersion. All adverse impacts are reversible following cessation of mining activities. No effect is expected in the RSA since the access road will be paved.

Table 6.3.2-2: Impact of Road Dust on Sensitive Vegetation Types

Dust Sensitivity Class	LSA Area (ha) (remaining after project impacts)	Area Within Dust Zone of Influence (ha)	Percent of Undisturbed Vegetation Type in LSA Affected by Dust (%)*
High	1	0	0
Moderate	1878	359	19
Low	6364	3176	50
Total Sensitive Classes	*8243*	*3535*	*43*

Note: * rounded to the nearest integer.

Hydrological Effects

Wetland vegetation types in the LSA and RSA consist of marshes, swamps, bogs, and fens. Marshes and swamps are characterized by seasonal water fluctuations and influenced by both ground and surface waters. Often marshes have an area of open water with sedge and rush vegetation species at their margins. Swamps are typically more forested or shrubby than marshes and may be quite diverse in terms of plant species. Bogs and fens are considered peat forming wetlands due to a combination of hydrologic, chemical, and biologic factors which decrease decomposition rates. Bogs and fens generally have more stable seasonal water levels than marshes or swamps and there is some restriction of water flow through these wetlands, allowing for the establishment of a bryophyte (mosses, liverworts, hornworts) layer. Fen water tables are usually at or near the peat surface, while bog water tables may be 40 to 60 cm below the peat surface, and are generally more influenced by surface precipitation than groundwater flow (Halsey and Vitt 1997).

Wetland vegetation types are more vulnerable to long-term changes in the water table than upland vegetation types. Fens may be particularly sensitive to effects of water table drawdown, whereas bogs are somewhat sensitive to drawdown effects, and are not adapted to wetting/drying cycles. Swamp areas are adapted to seasonal wet and dry cycles; consequently vegetation within these areas are less sensitive to changes in water table.

For the Project, potential water table drawdown was modelled in the hydrogeology section (Section 6.2.6 Regional Geology and Hydrogeology). Modelling included defining sustained drawdown contours resulting from mining operations as low as 0.5 m, however shorter term drawdown of up to 1 m may be considered within climatic and seasonal variation. The hydrogeologic model used is best interpreted at the macro scale.

Drawdown greater than 0.5 m in depth was predicted by the model to extend well beyond the boundary of the LSA at the end of mining (Figure 6.3.2-2). The area of vegetation within the >0.5 m drawdown area includes 10% of the wetlands in the LSA and 7% of wetlands in the RSA remaining after full Project layout (Table 6.3.2-3). These effects will diminish over time as aquifers re-charge and the pit-lakes fill naturally with water. The end of mining effects were selected for the assessment as this corresponds closely to the maximum drawdown in the surficial sands. Areas disturbed by forest fire (burn), forest harvest (harvest/silviculture), and insect/disease falling into a wetland vegetation class based on nutrient and moisture regime were included in the assessment for a more complete estimation of drawdown effects.

Creation of pit lakes at the mine site and lowland areas on reclaimed tailings and overburdens sites may offset the areas of wetland vegetation affected to some degree post closure. However, given the extended time frame required for bog and fen vegetation type restoration, time required to fill the pit lakes, and lag time in restoration of the water table, effects of drawdown have the potential to persist into the long term.

At the end of mining, it is expected that the magnitude of residual effects of drawdown on wetlands will be moderate in both the LSA and RSA, however post-reclamation conditions will reduce drawdown effects to low. The frequency of this effect is continuous and long-term, with very long-term reversibility through natural processes. Likelihood of an effect is high in the LSA and moderate in the RSA. The confidence in the degree to which wetlands are affected is low due to uncertainties in the hydrogeological modeling results described above, vegetation mapping error, and variances in water table effects on specific wetland vegetation communities.

Table 6.3.2-3: Impacts of Water Table Drawdown on Wetland Vegetation

ELC Code	Descriptor	Wetland Area After Project Impact in LSA (ha)	Area Affected by ≥ 0.5 m Drawdown in LSA (ha)	% Affected by Drawdown in LSA*	Wetland Area After Project Impact in RSA (ha)	Area Affected by ≥ 0.5 m Drawdown in RSA (ha)	% Affected by Drawdown in RSA*
BP18	Black spruce - tamarack - treed swamp	144	68	47	8193	1355	17
BP18a	Deciduous - mixedwood swamp	4	4	100	506	153	30
BP19	Black spruce - treed bog	1	0	0	101	16	16
BP23	Tamarack - treed fen	3	1	33	1292	164	13
BP24	Leatherleaf - shrubby poor fen	0	0	0	22	0	0
BP25	Willow - shrubby rich fen	76	76	100	6358	1081	17
BP26	Graminoid fen	0	0	0	11	6	54
BP28	Seaside arrow-grass - marsh	2	2	94	1242	175	14
	Burn (BP18, 18a, 25)	2520	143	6	14117	275	2
	Harvest/Silviculture (BP18,23)	150	0	0	9664	7	0
	Other (BP18,23,25,28)	731	28	4	15121	598	4
	Lakes/Rivers/Flooded Lands	374	79	21	1008	87	9
Total		*4005*	*401*	*10*	*57635*	*3917*	*7*

Note: * rounded to the nearest integer

Impacts from the Spread of Weed Species

Since the original EIS was filed, changes in weed species rankings required that the data be re-evaluated for potential weed species of concern. The revised list of weed species is provided in Appendix 6.3.2-A. Twenty-nine weed species, all of which are considered invasive and nine of which are considered noxious (Saskatchewan Conservation Data Centre 2011) were found during the course of field investigations within the LSA and RSA. Noxious species included common burdock (*Arctium minus*), Canada thistle (*Cirsium arvense*), annual hawkweed (*Crepis tectorum*), summer cypress (*Kochia scoparia*), Ox-eye daisy (*Leucanthemum vulgare*), scentless chamomile (*Matricaria perforata*), field sow-thistle (*Sonchus arvensis*), prickly sow-thistle (*Sonchus asper*), and Tansy (*Tanacetum vulgare*). Some of these species may be cleared during Project construction and operations. The potential exists for certain weed species to proliferate with disturbance or spread via the use of contaminated salvage soil used for reclamation purposes. The potential impact from weed species is difficult to quantify, but is considered a major threat to biodiversity if not managed effectively (UNEP 2010). With an appropriate weed management strategy serving to mitigate spread of weed species into natural vegetation types, the residual adverse effect of this impact may be low, long-term, and intermittent, but reversible. The likelihood of occurrence is unknown and confidence in an adverse impact is moderate, given the inherent difficulties in quantifying a potential impact of this nature.

Direct Impacts to Old Growth Forest

Of the 18 ha of old growth forest occurring in the LSA, <1 ha (1%) is expected to be cleared as a result of the Project. In the RSA there are 4,014 ha of old growth forest, of which 7 ha (<1%) will be cleared (Table 6.3.2-4 and Figure 6.3.2-3). Forest harvest and forest fires inject uncertainty into the location and extent of future old growth, and may contribute to the fact that old growth forest occurs very rarely in the LSA. The adverse effect on this VC in the LSA is moderate, while it is low within the RSA. In both the LSA and RSA the effect is expected to occur into the long term on a periodic basis, but any given area of old growth will be affected only once. Effects are reversible in the far future, and highly likely to occur. Confidence in this assessment is moderate.

Table 6.3.2-4: Impacts to Old Growth Forest

ELC Code	Old Growth Year of Origin	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
BP02	Jack pine - lichen	0	0	0	35	1	3
BP03	Jack pine - feathermoss	11	0	0	125	<1	<1

ELC Code	Old Growth Year of Origin	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
BP04	Jack pine - trembling aspen - feathermoss	0	0	0	58	0	0
BP05	Trembling aspen - prickly rose - grass	0	0	0	24	0	0
BP06	Trembling aspen - beaked hazel - sarsaparilla	0	0	0	7	0	0
BP09	White spruce - trembling aspen - feathermoss	1	0	0	874	<1	<1
BP10	Trembling aspen - white spruce - feathermoss	0	0	0	37	0	0
BP12	Jack pine - spruce - feathermoss	0	0	0	154	3	2
BP14	Black spruce - Labrador tea - feathermoss	6	<1	3	936	2	<1
BP18	Black spruce - tamarack - treed swamp	0	0	0	1720	0	0
BP18a	Deciduous -mixedwood swamp	0	0	0	40	0	0
BP23	Tamarack - treed fen	0	0	0	3	0	0
Total		*18*	*<1*	*1*	*4014*	*7*	*<1*

Note: * rounded to the nearest integer.

Direct Impacts to Riparian Habitat

A total of 7% of the riparian area in the LSA and 1% of the riparian area in the RSA is expected to be cleared as a result of the Project (Table 6.3.2-5 and Figure 6.3.2-4). At closure, riparian habitat will be created around the perimeters of the Star and Orion South pit lakes. Riparian areas will be built within and near drainage channels on the overburden and rock storage area, and within the PKCF. The revegetation prescriptions (Section 7.5) for these areas will replace appropriate vegetation for these moist areas, and are expected to return these areas to functioning riparian habitat over time. Prior to reclamation the adverse effect of the Project on riparian areas is moderate in both the LSA and RSA, long-term, continuous, and reversible in the very long-term. Reclamation may reduce the effect of the Project on riparian areas to low in both the LSA and RSA. Confidence in the assessment is low due to the uncertainty of the reclaimed landscape, but the probability of some effect occurring is moderate. This effect is discussed further in Section 6.3.4, Biodiversity.

Table 6.3.2-5: Impacts to Riparian Habitat

ELC	Riparian Area Vegetation Type	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
BP01a	June grass - mountain goldenrod grassland	71	<1	<1	5	0	0
BP01a	Dry shrubland	0	0	0	129	<1	<1
BP02	Jack pine - lichen	0	0	0	<1	0	0
BP03	Jack pine - feathermoss	6	<1	2	93	<1	<1
BP04	Jack pine - trembling aspen - feathermoss	32	<1	1	151	<1	<1
BP05	Trembling aspen - prickly rose - grass	92	5	5	527	5	1
BP06	Trembling aspen - beaked hazel - sarsaparilla	56	2	3	756	2	<1
BP07	Trembling aspen - white birch - sarsaparilla	80	<1	<1	448	<1	<1
BP09	White spruce - trembling aspen - feathermoss	134	13	10	1209	13	1
BP10	Trembling aspen - white spruce - feathermoss	<1	0	0	178	0	0
BP11	White birch - white spruce - balsam fir	18	<1	<1	46	<1	<1
BP12	Jack pine - spruce - feathermoss	13	0	0	110	0	0
BP14	Black spruce - Labrador tea - feathermoss	27	4	13	314	4	1
BP15	Balsam poplar - white spruce - feathermoss	0	0	0	37	0	0
BP16	Balsam poplar - trembling aspen - prickly rose	84	<1	<1	668	<1	<1
BP18	Black spruce - tamarack - treed swamp	38	2	5	767	2	<1
BP18a	Deciduous -mixedwood swamp	0	0	0	44	0	0
BP19	Black spruce - treed bog	1	0	0	3	0	0
BP23	Tamarack - treed fen	<1	0	0	184	0	0
BP24	Leatherleaf - shrubby poor	0	0	0	1	0	0

ELC	Riparian Area Vegetation Type	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
	fen						
BP25	Willow - shrubby rich fen	189	1	<1	842	1	<1
BP28	Seaside arrow-grass - marsh	2	0	0	734	0	0
	Agriculture	0	0	0	20	0	0
	Burn	416	79	19	1419	79	6
	Harvest/Silviculture	4	<1	2	137	<1	<1
	Lakes/Rivers/Flooded	597	1	<1	987	1	<1
	Other	177	16	9	864	16	2
	Salvage	80	20	25	497	20	4
	Human Disturbance	8	5	60	61	5	8
Total Riparian Area		*2125*	*142*	*7*	*11231*	*142*	*1*
Total Area		**12218**	**142**	**1**	**132769**	**142**	**<1**

Note: * rounded to the nearest integer.

Direct Impacts to Riparian Management Areas

As discussed in the Baseline report for vegetation (Section 5.3.2 Vegetation and Plant Communities), riparian management areas (RMA) are forestry management tools, rather than ecological delineations of riparian habitat. The Project is expected to remove 216 ha of existing RMA, translating to 11% of available RMA in the LSA and 2% of available RMA in the RSA (Table 6.3.2-6). Since RMAs are a management unit rather than an ecological one, the impact cannot be rated. It is unknown whether RMA boundaries will be reassigned following reclamation.

Table 6.3.2-6: Impacts to Riparian Management Areas

ELC	Riparian Management Area Vegetation Type	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
BP01a	June grass - mountain goldenrod grassland	63	<1	<1	4	0	0
BP01a	Dry shrubland	0	0	0	114	<1	<1
BP02	Jack pine - lichen	0	0	0	3	0	0
BP03	Jack pine - feathermoss	14	<1	1	164	<1	<1

ELC	Riparian Management Area Vegetation Type	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
BP04	Jack pine - trembling aspen - feathermoss	46	2	3	205	2	1
BP05	Trembling aspen - prickly rose - grass	76	4	5	487	4	1
BP06	Trembling aspen - beaked hazel - sarsaparilla	43	3	8	639	3	1
BP07	Trembling aspen - white birch - sarsaparilla	65	1	1	309	1	<1
BP09	White spruce - trembling aspen - feathermoss	116	14	12	1240	14	1
BP10	Trembling aspen - white spruce - feathermoss	<1	0	0	154	0	0
BP11	White birch - white spruce - balsam fir	10	<1	1	30	<1	<1
BP12	Jack pine - spruce - feathermoss	15	0	0	157	0	0
BP14	Black spruce - Labrador tea - feathermoss	38	6	17	377	6	2
BP15	Balsam poplar - white spruce - feathermoss	0	0	0	39	0	0
BP16	Balsam poplar - trembling aspen - prickly rose	30	<1	<1	488	<1	<1
BP18	Black spruce - tamarack - treed swamp	40	3	7	1033	3	<1
BP18a	Deciduous -mixedwood swamp	<1	0	0	52	0	0
BP19	Black spruce - treed bog	1	0	0	4	0	0
BP23	Tamarack - treed fen	1	0	0	272	0	0
BP24	Leatherleaf - shrubby poor fen	0	0	0	1	0	0
BP25	Willow - shrubby rich fen	134	1	<1	1063	1	<1
BP28	Seaside arrow-grass - marsh	2	0	0	813	0	0
	Agriculture	0	0	0	29	0	0
	Burn	559	116	21	2112	116	6
	Harvest/Silviculture	12	1	5	182	1	<1
	Lakes/Rivers/Flooded	375	1	<1	999	1	<1
	Insect/Disease (Other)	126	17	13	1181	17	1
	Salvage	139	36	26	919	36	4
	Human Disturbance	16	10	64	73	10	14

ELC	Riparian Management Area Vegetation Type	Baseline LSA (ha)	Project Impact in LSA (ha)	% of Vegetation Type in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% of Vegetation Type in RSA*
Total Riparian Management Area		*1923*	*216*	*11*	*13141*	*216*	*2*
Total Area		**12218**	**216**	**2**	**132769**	**216**	**<1**

Note: * rounded to the nearest integer.

Impacts on Species at Risk

This VC is assessed by evaluating potential impacts to rare plant potential and known locations of rare species. Rare plant communities are not defined in Saskatchewan and therefore are not considered in the assessment.

Impacts on Rare Plant Potential

A total of 203 ha (13%) of habitat in the LSA with high rare plant potential will be cleared in the Project Case (Table 6.3.2-7). A slightly greater area (215 ha) of habitat with high rare plant potential will be cleared in the RSA (<1% of the RSA). More than half of the high rare plant potential habitat affected in the LSA falls into the BP05 Trembling aspen/prickly rose/grass vegetation cover type. In the reclamation scenario, it is plausible that over time, the impacts to high rare plant potential habitat would be reduced through return of native vegetation cover types to the landscape. However, reestablishment of the exact soil, moisture, and nutrient regime suitable for individual rare plants occurrences may not occur until well beyond Project closure. Some rare plants (e.g., *Leucophysalis grandiflora*) thrive in disturbed areas, and may increase in numbers at closure. The closure plan (Section 7.5) specifies that a variety of microsite locations will be created by contouring and establishing drainage channels within reclaimed areas. Following reclamation, it is expected that the impact to rare plant potential habitat in the local context will be reduced from high to moderate, and will be adverse in direction, long term, and continuous. Effects on medium and high rare plant potential vegetation types in the RSA context are low. The effects are reversible, and probability of occurrence is high. Confidence in the assessment is moderate due to the difficulty in predicting the suitability of reclaimed landscapes to achieve high rare plant potential.

Table 6.3.2-7: Direct Impacts to Ranked Areas of Rare Plant Potential Classes in the LSA

Rare Plant Potential Rank	Baseline LSA (ha)	Project Impact in LSA (ha)	% Rare Plant Potential Rank in LSA*	Baseline RSA (ha)	Project Impact in RSA (ha)	% Rare Plant Potential Rank in RSA*
High (BP01, 01a, 04,05,07,09,13,18,18a,23)	1616	203	13	31519	215	<1

Rare Plant Potential Rank	Baseline LSA (ha)	Project Impact in LSA (ha)	% Rare Plant Potential Rank in	Baseline RSA (ha)	Project Impact in RSA (ha)	% Rare Plant Potential Rank in
Medium (BP02,03,06,10)	780	136	17	20858	153	<1
Low (BP11,12,14,15,16,19,24,25,26)	515	38	7	16990	53	<1
Not Ranked (All "Other" cover types)	9306	3508	38	63402	3516	6
Total	*12218*	*3885*	*32*	*132768*	*3936*	*3*

Note: All values <1 in Table 6.3.2-1 were counted as 1 for a conservative estimate of area.
* rounded to the nearest integer.

Impacts to Rare Plants

Table 6.3.2-8 provides the names of the 6 rare plant species out of the 47 found in the LSA and RSA that are expected to be affected by Project clearing. A complete list of rare plants found in the study areas can be found in Appendix 6.3.2-A. Locations of known rare plants are presented in Figure 6.3.2-5.

Overall, 13 of a total of 136 occurrences of rare plants in the field data are expected to be cleared as a result of the Project. For all species, additional locations exist outside of the proposed Project footprint except for swamp fly honeysuckle (*Lonicera oblongifolia*). Swamp fly honeysuckle is considered an S2 species by the Saskatchewan Conservation Data Centre, meaning that it usually has between 5 and 20 occurrences in the province, or many individuals in fewer occurrences. S2 species are considered susceptible to extirpation (SKCDC 2010). For this reason, special consideration will be given to avoiding or transplanting the known locations of swamp fly honeysuckle prior to disturbance. However, since transplanting rare plants has had limited success, particularly for individual species at risk (Fahselt 2007), other mitigation measures will be considered, such as seed collection and focused searches for other locations of this species prior to the known location being cleared.

Soil salvage may help to restore the rare plant populations either during progressive reclamation or at Project closure. Viability of rare plant seeds in stockpiled soil is not well understood, therefore certainty regarding the potential success of soil salvage as a rare plant mitigation measure is low.

The Project effect on plant species is rated with a moderate magnitude since 1 of the 46 (2%) species found would be completely removed. This impact is rated as being adverse, regional, and not reversible. The removal of a rare plant occurs intermittently but the effect extends into the long term. There is moderate confidence in this rating given that other locations of the species affected are known to exist in all instances but one, and the ecological context of the effect is also moderate since potential loss of species diversity can have high ecological consequence. Pre-disturbance rare plant surveys to locate additional occurrences of the affected species outside of the Project disturbance area and implementation of mitigation measures as described above could reduce this impact to a low magnitude.

Table 6.3.2-8: Impacts of the Project on Known Rare Plants in the LSA

Scientific Name	Common Name	Provincial Rank	# of occurrences affected in LSA	# of additional occurrences in LSA/RSA
Carex pseudocyperus	Cyperus-like Sedge	S2S3	1	1
Leucophysalis grandiflora	Large White-flowered Ground-cherry	S2	1	3
Lilium philadelphicum var. andinum	Western Red Lily	S3S4	5	19
Listera cordata var. cordata	Heart-leaved Twayblade	S2	3	1
Lonicera oblongifolia	Swamp Fly Honeysuckle	S2	2	0
Polygala paucifolia	Pink Fringed Milkwort	S2S3	1	2

Impacts to Traditional Use Plant Potential

A total of 2,006 ha and 42,256 ha of vegetation ranked medium to high for traditional use plant potential exists in the LSA and RSA respectively (Table 6.3.2-9). The total amount of these combined classes will decrease by 261 ha (13%) in the LSA and 282 ha (<1%) in the RSA as a result of Project clearing. Jack pine and trembling aspen dominated forests are expected to be the predominant vegetation type in the reclaimed landscape, and since these two forest types are responsible for a large proportion of the high and medium rankings of vegetation for traditional use plant potential, residual effects are expected to be reduced to low at Project closure for both the LSA and RSA. The effect is adverse in direction, continuous and long-term in duration. Likelihood of this impact is high and confidence in this assessment is moderate. Reclaimed areas may not gain back all traditionally used species originally present in the base case due to changes in the growth conditions of soils, increases in competitive weeds, or changes in the water table. Certain species may not reestablish on disturbance affected areas until the very far future.

Table 6.3.2-9: Direct Impacts to Ranked Areas of Traditional Use Plant Potential

Traditional Use Potential Rank	Baseline LSA (ha)	Project Impact in LSA (ha)	% Traditional Use Plant Potential Rank in LSA*	Baseline Area RSA (ha)	Project Impact in RSA (ha)	% Traditional Use Plant Potential Rank in RSA*
High (BP28)	2	0	0	1242	0	0
Medium (BP04, BP05, BP06, BP07, BP09, BP12, BP13,BP14, BP15, BP16, BP18a)	2003	261	13	41014	282	<1
Medium +High	2006	261	13	42256	282	<1
Low(BP01, BP01a, BP02, BP03, , BP10, BP11, , BP18, BP19, BP23, BP24, BP25, BP26, Burn,	4299	986	23	42101	1008	2
Unranked (Agriculture, Harvest/Silviculture, Insect/Disease, Salvage, Human Disturbance, Lakes/Rivers)	5913	2635	45	48411	2643	5
Total	12218	3882	32	132768	3933	3

Note: * rounded to the nearest integer.

6.3.2.6 Summary of Residual Effects

The impacts of the Project on vegetation are predominantly rated low to moderate in magnitude in the post reclamation scenario and not significant (Table 6.3.2-10). These predictions are based in part on assumptions regarding reestablishment of native vegetation following Project reclamation in the long term. Significance ratings were based on the criteria in Section 6.1.

The low confidence assigned to the assessment of effects on riparian habitat in the LSA and RSA warrant post-reclamation monitoring to ensure that the objectives of reclamation toward restoring riparian habitat are met. Similarly the low confidence in the hydrogeological modeling predictions indicate that a longer term monitoring program is required to determine the impact of drawdown on vegetation community composition in the RSA.

Table 6.3.2-10: Summary of Impact Ratings for Vegetation Resource Indicators - Project Case

Indicators/VC	Nature of Effect	Geographic Extent	Impact Direction	Pre-reclamation Magnitude	Post Reclamation Magnitude	Duration	Frequency	Reversibility	Ecological Context	Level of Confidence	Probability	Significance
Upland vegetation	Clearing	Local	Adverse	High	Low	Long term	Continuous	Reversible	High	Moderate	High	Not Significant
	Clearing	Regional	Adverse	Moderate	Low	Long term	Continuous	Reversible	Low	Moderate	High	Not Significant
Wetland vegetation	Clearing	Local	Adverse	High	Low	Long term	Continuous	Reversible	High	Moderate	High	Not Significant
	Clearing	Regional	Adverse	Moderate	Low	Long term	Continuous	Reversible	Low	Moderate	High	Not Significant
"Other" classes	Clearing	Local	Adverse	High	Low	Short to Long term	Continuous	Reversible	Low	High	High	Not Significant
	Clearing	Regional	Adverse	Moderate	Low	Short to Long term	Continuous	Reversible	Low	High	High	Not Significant
Uncommon vegetation	Clearing	Local	Adverse	Moderate	Moderate	Long term	Continuous	Reversible	Moderate	High	High	Not Significant
	Clearing	Regional	Adverse	Low	Low	Long term	Continuous	Reversible	Moderate	High	High	Not significant
Area of sensitive vegetation types	Dust deposition	Local	Adverse	Moderate	Low	Long term	Intermittent	Reversible	Low	Moderate	High	Not significant
	Dust deposition	Regional	n/a	n/a								
Area of wetland vegetation types	Water drawdown	Local	Adverse	Moderate	Moderate	Long term	Continuous	Reversible	Moderate	Moderate	High	Not significant
	Water drawdown	Regional	Adverse	Moderate	Moderate	Long term	Continuous	Reversible	Moderate	Low	Moderate	Not significant
Native vegetation	Proliferation of weed species	Local/regional	Adverse	Low	Low	Long term	Intermittent	Reversible	High	Moderate	Unknown	Not Significant
Old growth forest	Clearing	Local	Adverse	Moderate	Low	Long term	Periodic	Reversible	Moderate	Moderate	High	Not Significant
	Clearing	Regional	Adverse	Low	Low	Long term	Periodic	Reversible	Moderate	Moderate	High	Not Significant
Riparian habitat	Clearing	Local	Adverse	Low	Low	Long term	Continuous	Reversible	Moderate	Low	Moderate	Not Significant
	Clearing	Regional	Adverse	Moderate	Low	Long term	Continuous	Reversible	Moderate	Low	Moderate	Not Significant
Riparian Management Areas	Clearing	Local/regional		n/a								
Rare Plant Potential	Clearing	Local/regional	Adverse	Moderate	Low	Long term	Continuous	Reversible	Low	Moderate	High	Not Significant
Rare plant species	Clearing	Regional	Adverse	Moderate	Low	Long term	Continuous	Not-reversible	Moderate	Moderate	High	Not Significant
Traditional use plant potential	Clearing	Local	Adverse	High	Low	Long term	Continuous	Reversible	Low	Moderate	High	Not Significant
	Clearing	Regional	Adverse	Low	Low	Long term	Continuous	Reversible	Low	Moderate	High	Not Significant

6.3.3 Wildlife

This Section provides an assessment of potential effects on wildlife and wildlife habitat expected to result from Project-related disturbances.

6.3.3.1 Introduction

The assessment evaluates the potential effects of the Project's construction, operations, and closure and reclamation phases on wildlife and wildlife habitat. Project effects include direct and functional habitat loss/alteration, sensory disturbance, disruption of wildlife movement, and increased mortality risk.

6.3.3.2 Scoping, Issues Identification and Confirmation

The purpose of scoping is to focus the assessment on key wildlife-related issues that are determined by the physical Project, the natural environment setting, and the human environmental setting. The scoping, issues identification, and confirmation process is described in Section 6.1 (Overview and Methods)

Project-Specific Guidelines (PSGs) for the Project (SMOE 2009) provide direction from the Saskatchewan Ministry of Environment on the required assessment focus on wildlife and wildlife habitat VCs, which include:

- identification of potential destruction or disturbance of rare, threatened or endangered species or their habitat including proposed mitigation measures;
- identification of damage or destruction of sensitive ecosystems such as wetlands, including proposed mitigation measures;
- disturbance to wildlife habitat including a discussion of potential effects on the incidence of wildlife diseases, and depredation of agricultural crops by wildlife;
- description of the nature and extent of the "no hunting" area proposed for safety reasons, including plans to manage wildlife within that area;
- discussion and evaluation of vulnerability of wildlife species as a result of altered access for predators to wintering locations, travel corridors, dens, nests, and related hunting opportunities resulting from potential increased hunter access; and
- potential for human-wildlife predator (black bear, wolf) interaction.

Key issues and potential Project effects associated with the interactions of diamond mining processes and wildlife VCs were identified from the PSGs (SMOE 2009), public input, and professional judgement. Key wildlife issues (potential Project effects) are:

- **Loss / alteration of habitat** – clearing of habitat within the Project footprint (as a consequence of construction of mine infrastructure); changes in surface water extent, quality and drainage patterns; and changes in the amount and quality of wildlife habitat from dust and contaminants. Activities associated with construction and operation will result in direct and functional habitat loss. The effects of habitat loss / alteration vary by species and by individuals within species. Species with small home ranges and lower mobility are likely to incur a greater degree of effect than larger and / or more mobile species. Loss of important (or critical) habitat will have a greater effect than loss of non-critical wildlife habitat components;

- **Sensory disturbance** – auditory, olfactory, human activity, and visual disturbances may further result in loss of wildlife habitat effectiveness (functional habitat loss) by disturbance and displacement from areas proximate to construction and operation activities (Jalkotzy *et al*. 1997). The extent of effective habitat loss will be influenced by the duration and magnitude of a disturbance, as well as the behavioural response of a species or individual (Bromley 1985). The effects of sensory disturbance are generally greater during the nesting / denning period and during the critical late winter period when energy reserves are low. Therefore the potential effects of sensory disturbance are greatest in areas of breeding and overwintering habitat. The effects of sensory disturbance are considered reversible once the disturbance ceases. Non-lethal disturbance can result in a response by wildlife that is similar to predation risk, resulting in reduced feeding, parental care or mating opportunities (Frid and Dill 2002);
- **Disruption of wildlife movement** – daily and seasonal wildlife movement patterns and habitat linkage corridors may be disrupted by Project development. The effect of the Project on movement can be physical (development of roads and facilities resulting in habitat loss and fragmentation), or sensory (avoidance of equipment noise and human activity); and
- **Wildlife mortality risk** – direct wildlife mortality during vegetation clearing may occur, with the greatest effect on species with limited mobility, or for eggs / young at den sites, nests, burrows and hibernacula. Wildlife-vehicle collisions are possible throughout the construction and operations phases. Indirect mortality may occur as a result of increased access which may increase hunting and trapping activities, predator efficiency and wildlife-human encounters. Wildlife mortality may also occur as a result of the increased health risk of contaminants produced during Project operations.

6.3.3.3 Valued Components (VCs)

Valued components (VCs) represent species, habitats and/or processes of the biophysical environment vital to healthy ecosystem function or of high importance to people. They are key descriptors of issues resulting from the Project selected as the focus of an EIA. VCs are significant by virtue of their particular aesthetic, cultural, or economic value to a region. For wildlife these may include terrestrial and aquatic environmental features (e.g. rivers, lakes, landforms), habitats (e.g. native grasslands, wetlands, specific vegetation communities), species (e.g. species of conservation concern or of subsistence value), species assemblages (e.g. raptors, waterbirds, waterfowl), and indicators of environmental health and integrity (e.g. rare species occurrence, species diversity, habitat connectivity). VCs provide a focal point for environmental assessment because they have the potential to interact with project components and are used to evaluate the extent and significance of the impacts caused by the Project at various spatial scales (Local Study Area (LSA) and Regional Study Area (RSA)) and temporal scales (project phase, short-term and long-term). Wildlife VCs selected for detailed assessment, and rationale for their selection, are presented in Table 6.3.3-1.

Table 6.3.3-1: Valued Components (VCs) Selected for Detailed Effects Assessment

Valued Component (VC)	Rationale for Selection	Issues
Moose (representative ungulate)	Important for traditional and recreational hunting. High importance with regulators. The Project will directly affect moose, elk and white-tailed deer populations, habitat availability and displacement in the same way.	Effect of improved access due to the Project on populations (e.g. increased mortality risk from hunting and vehicle collisions, displacement because of potential increased recreation activities). Effect on habitat effectiveness, disruption of movement patterns, movement corridors.
Black Bear (representative terrestrial fur-bearer)	Important for traditional and recreational hunting. High importance with regulators. Wide ranging, regularly distributed species that is sensitive to human disturbance; effects assessment on populations can be accomplished using habitat disturbance metrics. Grey wolf was considered as a candidate VC, but not selected because they are not sensitive to local habitat change, and their distribution is linked to regional ungulate abundance and distribution. Project effects on local habitat change in the LSA are unlikely to indicate a wolf population effect at a regional scale because project-related disturbance is localized.	Effect on habitat effectiveness, disruption of movement patterns, movement corridors, important / critical habitat. Effect on populations from habitat loss and increased access.
Beaver (representative aquatic and semi-aquatic fur-bearers)	Sensitive to changes in hydrology and diversion or removal of drainages. Ability to modify habitat to the benefit of aquatic species. Important traditional fur harvest species and most commonly and consistently harvested fur-bearer in P-85 fur block over the past 10 years (2000-2009); 48% of fur harvest (2000-2009) was beaver; 76% of harvested fur-bearers were aquatic or semi-aquatic species (beaver, muskrat, otter, mink).	Effect on populations from habitat loss.

Valued Component (VC)	Rationale for Selection	Issues
Red Squirrel (surrogate for terrestrial fur-bearers and small mammals)	Importance of fur-bearers with regulators. About 24% of the fur-bearer harvest (2000-2009) was terrestrial species.	Effect on populations from habitat loss.
Wildlife Species-at-Risk	High importance with regulators. Several species can be sensitive to disturbance. SARA-listed and/or Provincially protected species.	Effect on habitat effectiveness, disruption of movement patterns, movement corridors, important / critical habitat.
Raptors - Bald Eagle is surrogate for accipiters - Great Grey Owl is surrogate for owls	Several sensitive species occur in the LSA and RSA can be sensitive to development. Raptors are sentinel species which indicate ecosystem health. Bald eagle is a locally occurring species that meets VC criteria, and is particularly appropriate choice considering reliance on a fish diet and proximity of the Project to the Saskatchewan River for foraging habitat. The Project LSA and RSA are within great grey owl range. There are documented occurrences of this species within FalC forest. They forage for small mammals from perches adjacent to openings and clearings in boreal forest habitats, preferring foraging areas with low tree canopy closure and low shrub cover. Nesting habitat is often associated with mature and old growth forest. They are a species that is naturally uncommon and are considered a sensitive species because they are associated with habitats that can change at a landscape scale (ie. RSA or FalC forest).	Effect on habitat effectiveness, disruption of movement patterns, movement corridors, important/ critical habitat.
Waterfowl	Utilize surface water in the Project area and region.	Effect on populations from habitat change. Effect on habitat effectiveness, disruption of movement patterns.
Songbirds	Several sensitive species (species at risk potentially occur in the Project area). These include olive-sided flycatcher, Canada warbler, whip-poor-will, chimney swift, rusty blackbird and yellow rail.	Effect on populations from habitat change. Effect on habitat effectiveness, disruption of movement patterns.

6.3.3.4 Effects Assessment

Vertebrate species display a broad range of responses to disturbance. The type of response and degree of effect varies with species behaviour, population status, site characteristics and cumulative effects on the landscape (Andersen *et al*. 1990; Arsenault 2009; Frid and Dill 2002; Hebblewhite and Merrill 2008; Laliberte and Ripple 2004; Riffell *et al*. 1996; Rost and Bailey 1979). Environmental changes may benefit some species, ecosystems and ecological processes, while causing adverse effects to others. The zone of disturbance influence does not imply a functional response of 100% avoidance or effect (Arsenault 2009), with the response or effect varying by species response threshold and the disturbance characteristics.

Habitat Suitability Index (HSI) modelling rates the ability of a particular land unit to provide key life requisites (e.g. food, cover, breeding habitat) based on species-habitat relationships and resource selection functions. HSI models are based on a synthesis of technical literature, identification and measurement of biophysical and spatial variables known to influence species habitat selection, and professional knowledge of the species or species group being assessed. HSI models provide estimates of habitat value ranging from 0.0 (no value) to 1.0 (optimal). Even though some habitats may be highly suitable for a given species, effective use may be functionally reduced due to limiting factors such as human disturbance. Habitat effectiveness is integrated in the HSI model for a particular species or group by reducing the index coefficient of a particular habitat attribute within the zone of influence by the limiting factor. The size and shape of a zone of influence depends on the species' sensitivity, the terrain, vegetation characteristics surrounding the activity, and intensity and duration of the activity. Therefore, the zones of influence are variable among species and areas. Habitat Suitability Index (HSI) modelling was used to evaluate changes in habitat quality and availability at the RSA scale for moose (represents the ungulate VC), beaver (represents the aquatic and semi-aquatic fur-bears VC), and black bear (represents the terrestrial fur-bearers and large carnivores VC) as a result of habitat loss and effects in the Project footprint.

Vegetation in portions of the LSA will be changed throughout the mine life. This will have an effect on wildlife at the local (LSA) and landscape (RSA) scales.

The Project contemplates straightening and improving the existing access road to site (Shipman Trail) to a paved surface. The portions of the existing road that would be abandoned would be reclaimed to compatible vegetation types. Approximately 32% (3,960.7 ha) of the LSA vegetation will be cleared for waste rock storage, pit development, kimberlite storage, and access, during the construction and operations phases of the Project. A brush and shrub windrow corridor is planned for the footprint perimeter using vegetation cleared within the Project footprint. The corridor width will vary with available materials, averaging ±50 m width, with the majority of the corridor on the Project side of the windrow. Windrow height is estimated to be 2.4 m. The area contained within the corridor windrow will vary in size depending on Project phase. The area enclosed during the construction phase will be 4,641 ha (38% of the LSA), during the Star Phase will be 5,381 ha (44% of LSA), and during the Orion South Phase will be 4781 ha (39% of LSA). The remaining portions of the LSA vegetation at each project phase will not be cleared and therefore will retain some wildlife value. The brush pile windrow will likely function as a semi-permeable barrier for some wildlife species and would likely offer thermal/hiding cover and denning/nesting habitat for some wildlife species (e.g. rabbits, squirrels, chipmunks, mice, voles, resident upland birds, ground nesting migratory songbirds, etc.). Within the area enclosed by the brush pile boundary, regardless of project phase, there will be retention of vegetation, wetlands and creek/riparian habitat interspersed with the Project footprint. There will also be progressive vegetation reclamation of the Project footprint during the operational phase of the Project.

The effects assessment was conducted for VCs with the assumption of 100% of the disturbance footprint area affected (ie. direct habitat loss) for operations. The disturbance footprint varies depending on project phase but averages about 40% of the LSA (i.e., the average size of area enclosed by the brush pile barrier for all project phases). Buffer distances around the disturbance footprint were used to assess potential functional habitat loss resulting from displacement or avoidance by wildlife because of noise disturbance and human presence within the Project footprint. The methods followed for the effects assessment are described in Section 6.1 (Overview and Methods).

At decommissioning, about 791.1 ha of the 3,960.7 ha will become aquatic habitat in the form of marsh habitat (runoff pond, 6.4 ha; polishing pond, 39.2 ha, water management reservoir, 32.7 ha, and the sewage lagoon 2.9 ha) or a lake (north end of Star pit, 353.3 ha; Orion South pit, 427.6 ha). This represents a net gain of 780.9 ha of aquatic habitat from the baseline condition at the expense of terrestrial habitat. The balance of the 3960.7 ha will be reclaimed to vegetation types compatible with the FalC forest vegetation types, with the exception of the Project access road (79.6 ha), which would be transferred to the Rural Municipality.

Ungulates

Ungulate species in temperate environments are sensitive to human disturbance, particularly during winter when their survival depends on minimizing energy expenditure (Arsenault 2009). Even minor disturbances resulting in increased stress or movement can affect an ungulate's energy budget. The latter part of winter is when ungulate energy reserves are at their lowest. The period of time (late-March through April) when ungulate rumen micro-flora composition transitions from low quality (low protein) winter woody browse to high quality green forage is a critically sensitive period, particularly following a severe winter (Arsenault 2009).

Moose *(Alces alces)* were used to represent FalC ungulate species because they will respond to habitat changes in a similar fashion to elk *(Cervus elaphus),* white-tailed deer *(Odocoileus virginianus)*, and mule deer *(Odocoileus hemionus)*. Moose are a sub-climax species dependant on early successional stages of forest regeneration (woody browse) which result from natural (wildlfires, manipulation by beaver, windfall, forest diseases) and anthropogenic (commercial logging, resource exploration, clearing) disturbances (Arsenault 2000; Peek 1998; Thompson and Stewart 1998). Availability of browse is a primary component of moose habitat (Peek 1997). Habitat quality for moose and other sympatric ungulate species is a function of habitat structure and configuration, forage amount and quality, snow condition, protection from thermal stress, and security cover (Allen *et al*. 1987; Arsenault 1998; Arsenault 2000; Arsenault 2008).

Table 6.3.3-2 compares the baseline habitat conditions (Base Case) to the changes resulting from the Project (Project Case), and to the Project residual effect case (post-mitigation).

***Table 6.3.3-2*: Projected Moose Habitat Changes in RSA Resulting from the Project**

	RSA Base Case	Project Case (Baseline – footprint)		Residual Case (Post - Project Closure)	
Moose Habitat Type	**Area (ha)**	**Area (ha)**	**% Change from Base Case**	**Area (ha) (Project + Reclaimed**	**% Change from Base Case**
Regenerating forest (<30 yrs old)	32,220	30,267	-6.1	33,226	+3.1
Conifer winter cover (>30 yr conifer)	37,806	36,507	-3.4	36,507	-3.4
>30 yr old deciduous	29,042	28,795	-0.8	28,795	-0.8
>30 yr old mixedwood	8,088	7,982	-1.3	7,982	-1.3
Non-forested wetland (marsh, shrub-swamp)	8,356	8,331	-0.3	8,412	+0.7
Treed wetland (bog, fen, swamp)	12,955	12,938	-0.1	12,938	-0.1
Lake [1]	1,009	1,009	0.0	1,714	+69.8
Riparian [1,2]	8,512	8,475	-0.4	8,475	-0.4
Moose Habitat Total	128,468	124,819	-2.8	127,859	-0.5
Non-moose Habitat	4,301	7,947		4,908	
Total RSA Covertypes	132,767	132,767		132,767	

Note: [1] not included in calculation of total moose habitat.
[2] riparian habitat is accounted for in the other covertypes

A Habitat Suitability Index (HSI) model was used to rate moose habitat suitability of the LSA and the RSA under baseline conditions, and the RSA under the Project case. The HSI model was adapted from Model 2 in Allen *et al*. (1987), which assesses moose habitat at a large landscape scale using vegetation cover metrics. Model inputs included:

- V1 - Amount of regenerating forest <30 yrs old (provides high quality browse). Optimally 40 to 50% of the evaluation area should be composed of this cover type;
- V2 - Amount of coniferous cover >30 yrs old (provides winter thermal cover, escape cover and hiding cover). Optimally 5 to 15% of the evaluation should be composed of this cover type;
- V3 - Amount of mixedwood and mature deciduous forest >20 yrs old (provides browse and cover). Optimally 30 to 55% of the evaluation area should be composed of this covertype; and
- V4 - Amount of non-forested riverine, lacustrine or plaustrine wetlands (provides preferred summer aquatic forage, thermal regulation, escape cover, and escape from insect harassment). Optimally 5 to 10% of the evaluation area should be composed of this covertype.

The moose HSI model ((V1 + V2 + V3 + V4) / 4) provides an index rating between 0.0 (unsuitable) to 1.0 (optimal). The HSI moose model output for baseline conditions was 0.755 for the LSA, and 0.970 for the RSA, which indicates moose habitat suitability is greater in the RSA relative to the LSA. The HSI model output for the Project case is 0.962 which indicates that addition of the Project does not substantially impact moose habitat quality in the RSA during all phases of the Project. However, there will be habitat loss at the local scale within the Project footprint which may have a minor population effect at the RSA scale. Figure 6.3.3-1 illustrates the distribution of moose habitat and the associated HSI ratings in relation to the Project footprint.

The effect on ungulate populations was estimated using direct habitat loss (project footprint) and functional habitat loss at three threshold distances (250 m, 500 m and 1000 m) from the Project footprint. Functional habitat loss represents potential ungulate displacement distances as a result of 100% avoidance of the Project footprint and provides a representation of potential reduction in habitat effectiveness to support the ungulate population, depending on degree of displacement.

Population models for moose and elk were constructed using the baseline population survey data and historical survey data for FalC (from Arsenault 2000; Arsenault 1998; Arsenault 2008) and is illustrated in Figure 6.3.3-2. This allowed an assessment of historical population performance in relation to the baseline population estimates for these two species (Figure 6.3.3-2). Baseline winter populations for moose and elk were both near their 10-year (1999-2008) mean. Addition of the Project footprint did not substantially reduce the respective winter populations (Table 6.3.3-3) from the baseline estimates or 10-year mean. There was insufficient data to conduct a similar analysis for white-tailed deer or mule deer. White-tailed deer populations for FalC have incurred significant winter mortality in 2006-07 and 2007-08 which greatly reduced their numbers and density. SMOE conducted a population survey during 2007-08 of FalC forest and surrounding area resulting in a population estimate of 0.33 deer/km², which was similar to the baseline estimate of 0.31/km² for the wildlife core survey area conducted in the same period (Ecodynamics Consulting Inc. 2009).

Table 6.3.3-3: Potential Reduction of Ungulate Populations Resulting from Direct and Functional Habitat Loss

		Base Case		Project Case			
		Baseline Population		Effect of Project Footprint on Baseline Population			
Species		**2007- 08 Baseline RSA Population Estimate**	**10 yr (1999-2008) Mean Winter RSA Population**	**Project Footprint with No Buffer**	**Project Footprint with 250 m Buffer**	**Project Footprint with 500 m Buffer**	**Project Footprint with 1000 m Buffer**
Moose	Projected changes in number of moose	638	690	622	608	598	580
	% reduction from mean	-	-	2.5	4.7	6.3	9.1
Elk	Projected changes in number of elk	622	638	604	590	578	559
	% reduction from mean	-	-	5.3	7.6	9.4	12.4
White-tailed Deer	Projected changes in number of deer	438	-	425	414	406	392
	% reduction from baseline estimate	-	-	3.0	5.5	7.4	10.7
Mule Deer	Insufficient data	-	-	-	-	-	-

Note: Project footprint and project footprint with buffer. Assumes 100% effect.

When threshold buffers are applied at 100% effect (i.e., potential functional habitat loss) for moose, elk and white-tailed deer, all populations remain within 10% of the baseline population estimate. It is unlikely however, that there would be 100% effect resulting in population reduction. Rather, ungulate populations will most likely incur some local displacement which the surrounding habitat can accommodate, without a substantial effect on the population performance trends illustrated in Figure 6.3.3-2.

Project effects on ungulates within the Project footprint will likely involve direct loss of habitat types that commonly occur within the LSA and RSA. Ungulate species may be displaced as much as 500 – 1000 m from the Project footprint depending on the type, duration, frequency and permanency of disturbance resulting in avoidance behaviour. It is anticipated that most of the functional habitat loss resulting from avoidance behaviour would occur during periods of active construction. Moose compensate for habitat loss and disturbance by expanding the area they use (Dussault *et al*. 2007; Laurian *et al*. 2008). Moose, elk and white-tailed deer populations in the RSA are likely to experience a minor change at the local scale by construction and operational activities of the Project. The potential reduction of ungulate populations at each of the threshold distances (Table 6.3.3-3) as a result of direct and functional habitat loss represents the worst case scenario of 100% avoidance in this effects assessment. However, ungulate response to disturbance is seldom 100% avoidance, and more likely the response will be displacement into other suitable habitat within the respective ungulate population management units, and acclimation to the disturbances. Also, about 32% (3,944 ha) of the LSA will experience vegetation clearing during the course of the Project, and there will be some progressive reclamation and re-vegetation of the Project footprint during the operations phase and decommissioning phase which will restore some of the direct habitat loss and potential effects of functional habitat loss. Therefore, the Project effects on ungulate populations within the RSA are small, reversible, and can be mitigated through:

- SMOE making minor adjustments in hunting season draw quotas, season timing and bag limits within the ungulate population management units;
- SMOE initiating an RSA scale access management plan to improve general habitat conditions by actively closing unnecessary trails by all forest users to reduce overall road/trail density on the landscape; and
- at the local scale, Shore initiating construction activities primarily during winter to avoid sensitive periods for ungulates (fall rut for moose and elk (1 Sep – 15 Oct), late winter (15 March – 15 April/green-up), and spring calving (15 May – 15 June)) when possible in areas of high quality habitat. These periods have some overlap with the construction restriction window for migratory birds (1 April – 31 August).

Assessment of existing roads and trails in the LSA and RSA yielded a baseline access (road density) of 1.60 and 1.45 km/km² respectively. There is no substantial change in access resulting from the Project because existing access will be used which involves an upgrade of much of the Shipman Trail to a paved surface. The abandoned portions of Shipman Trail would be reclaimed to compatible vegetation types. Road densities in elk habitat of 0.6 km/km² can reduce potential habitat utilization by 45 to 55% (Arsenault 2008; Christensen *et al*. 1993; Morgantini and Hudson 1979), with mortality risk increasing at road densities >1.25 km/km² (Friar *et al*. 2008). The effect of road density on ungulates is also dependant on other metrics such as road width, traffic speed, and traffic volume.

Upgrading the Shipman Trail to access the Project site would be the only alteration in access of importance with respect to these additional metrics. Moose and elk avoid travelled roads by up to 400 to 500 m, particularly during the winter months (Arsenault 2009; Friar *et al*. 2008; Laurian *et al.* 2008), but can be attracted to them as a salt source, and during spring green-up. Upgrading the Shipman Trail to a right-of-way width to 46 m, reducing the number of corners and curves, increasing the posted speed to 90 km/hr and increasing the traffic volume along this corridor to the Project will likely result in displacement of ungulates by up to 500 m (particularly during winter) from the right-of-way, and will increase mortality risk from vehicle collisions with ungulates attracted to the right-of-way during spring green-up.

Black Bear

Bears are a wide-ranging highly mobile species and therefore must be evaluated at a regional scale rather than at a local scale (Schoen 1990). They are sensitive to habitat changes and human disturbances that affect access to, and availability of, food resources. Their population status can be assessed based on amount of change in habitat availability and amount of area affected by human disturbance in comparison to baseline habitat condition. Typical black bear habitat consists of aspen / poplar-dominated forest cover with relatively thick understory vegetation, interspersed with small clearings and early stages of forest succession which provide a wide variety of forage (Gunson 1993; Rogers and Allen 1987), as well as water, thermal cover and escape cover (Rogers 1993). They have a low degree of social organization and therefore tend to be solitary (except for cub-sow groups, breeding pairs, and congregations at feeding sites) and widely distributed, as a consequence of food resource availability both spatially and seasonally (Costello and Sage 1994; Gunson 1993; Pelton *et al*. 1999; Pelton 2000).

They are large omnivores and lack the physiology necessary to digest cellulose. Habitat use is influenced by seasonal food availability, proximity to hiding cover, and denning requirements (Pelton 2003). Black bear distribution and productivity are nutritionally regulated by the availability of high quality food resources (Rogers 1987a; Schoen 1990). A key factor in black bear habitat quality is the ability of habitat to provide abundant, reliable, and well-distributed food in the spring, summer, and fall (Rogers 1993). As a consequence, they must range over large areas to acquire sufficient quantities of digestible fats, proteins and simple carbohydrates in their diet (Iverson *et al*. 2001). Populations typically fluctuate within a narrow range over a period of years, but major food resources (fruits, nuts, berries, grains) can fluctuate widely from year to year (Rogers 1993).

Bear population densities vary by cover type and, in western Canada, are typically 0.60/km² in deciduous forest, 0.41/km² in mixedwood forest, 0.22/km² in coniferous forest, and 0.18/km² in muskeg habitat (Gunson 1993). Based on these cover type density estimates, the expected black bear population was calculated and effect of the Project footprint assessed, which indicated a potential reduction of the bear population by 3%, assuming 100% effect (Table 6.3.3-4).

During spring, open habitats are selected for newly emerged vegetation (high protein-low fat and low carbohydrate foods including grasses, sedges and horsetails) most of which are found in more hydric ecosites such as riparian habitats, grassland meadows, shrublands, fens, bogs and marsh areas. They will opportunistically scavenge on carrion and predate on newborn deer fawns, elk calves and moose calves (Pelton 2000).

Summer dietary preferences shift to soft mast (foods high in sugars and carbohydrates such as buds, berries, nuts, flowers, fruits, colonial insects and herbs), which generally occur in regenerating forests, meadows, grasslands, and shrubby habitats.

Table 6.3.3-4: Estimated Black Bear Population in FalC Forest

Black Bear Forest Covertypes	Area (ha)		Expected Bear Population Density (bears/km²)	Base Case	Project Case	
	Footprint	RSA		Estimated Black Bear Population	Estimated Black Bear Population	% Change from Base Case
Riparian	61	8,512	0.60	51.1	50.7	-0.7
Deciduous (non-riparian)	527	41,499	0.60	249.0	245.8	-1.3
Mixedwood (non-riparian)	374	13,811	0.41	56.6	55.1	-2.7
Coniferous (non-riparian)	2,860	50,816	0.22	111.8	105.5	-5.6
Treed Muskeg	18	1,697	0.18	4.6	4.5	0.7
POPULATION ESTIMATE				**422.0**	**411.0**	**-2.6**

Late summer and fall is a critical period during which black bears need to increase fat stores (Jonkel and Cowan 1971). Dietary preferences during late summer and fall hyperphagia shift to hard mast (foods high in fats and proteins such as nuts, grains and colonial insects), and ingestion of simple carbohydrates (berries). In north-western Canada hard mast availability is limited resulting in a selection for habitats rich in fruit (berry) production (Gunson 1993; Lindzey and Meslow 1976). Berries have a high sugar content and digestibility which results in rapid weight gain during the pre-denning period. Cereal grains can also supplement fall diet for individuals that can access cropland within their range. Food availability during fall in western Canada is also seasonally limited compared to other portions of black bear range (Rogers 1993). In Saskatchewan, the proportion of cover consisting of berry-producing (Saskatoon, chokecherry, cranberry, raspberry, bearberry, bunchberry, gooseberry, currant, buffaloberry) shrubs (as well as rose and hazel nut) is considered important, with $\geq$35% assumed to be optimal.

Water must be readily available and well distributed throughout the year if black bears are to use an area in an unrestricted manner (Hugie 1979; Rogers 1993). They drink frequently when feeding on vegetation, nuts or insects (Rogers 1993). Wetland and riparian habitats are used for cooling and provide seasonal foods (Rogers and Allen 1987).

Thermal cover is a hibernaculum in winter, which can be in the form of a burrow, tree hollow, rock crevice, brush pile, or surface nest (Rogers 1993). Tree dens appear to be preferred but are not of critical importance in boreal habitat (Rogers and Allen 1987; Rogers 1993). A component of escape cover includes readily available large refuge trees (e.g. >15 cm diameter) with sturdy creviced bark that cubs and sub-adults can safely climb (Rogers 1993). During food scarcity bears may roam beyond their normal range, often into fragmented forest habitats or areas with limited forest habitat, which places them at higher mortality risk because of lack of escape cover (Rogers 1987a, 1987b).

Black bears favour areas of high landscape connectivity as habitat fragmentation can limit their ability to effectively access the resources they require (Kindell and Van Manen 2007). Habitat suitability is reduced by roads and trails and their associated disturbance (depending on road density and traffic volume) for distances of 100 to 900 m (Rogers and Allen 1987; Jalkotzy *et al*. 1997), and with typical avoidance distances of >200 m (Forman *et al*. 1997). Hillman and Yow (1986) recommended road densities remain below 0.25 km/km^2 to minimize mortality risk. Assessment of road and trail development in the LSA and RSA resulted in baseline densities of 1.60 and 1.45 km/km^2, respectively. The Project will not substantially alter baseline road density because existing access would be used. The effect on black bears at a population level would have already occurred as a result of the current road/trail network within the RSA and LSA. In the FalC forest, the zone of human influence affecting bears is considered to be all habitats within 250 m of a trail and within 1000 m of a major trail/road or the LSA footprint.

Table 6.3.3-5 summarizes changes in habitat availability during the lifespan of the Project. Bear habitat would be reduced by about 3.1% during the construction and operations phases of the Project. A substantial portion of the habitat reduction is in coniferous cover types which have a lower suitability than deciduous and mixedwood. The net effect on the RSA bear population would be about a 2.6% reduction, with the majority of that potential population restored at decommissioning.

Table 6.3.3-5: Potential Black Bear Habitat Changes Resulting from the Project

Black Bear Habitat Cover Type	Base Case Area (ha)	Project Case (Baseline - footprint)		Residual Case (Post – Project Closure)	
		Area (ha)	% Change from Base Case	Area (ha) (Project + Reclaimed)	% Change from Base Case
Deciduous	41,758	40,820	-2.2	41,479	-0.7
Mixedwood	14,242	13,643	-4.2	14,094	-1.4
Coniferous	51,156	48,752	-4.7	50,644	-1.0
Meadow (brushland, grassland)	2,518	2,466	-2.1	2,518	0.0
Swamp (treed and shrub)	15,897	15,813	-0.5	16,361	2.9
Total Black Bear Habitat	**125,571**	**121,494**	**-3.3**	**125,096**	**-0.4**
Non-Black Bear Habitat	**7,196**	**11,273**		**7,671**	
Total RSA Covertypes	**132,767**	**132,767**		**132,767**	

A Habitat Suitability Index (HSI) model was applied to rate black bear habitat suitability of the LSA and the RSA. The HSI model was adapted from Rogers and Allen (1987), Larson *et al*. (2003) and Samson (1996); this model assesses bear habitat at a large landscape scale using food, vegetation cover and human disturbance metrics. Model inputs included:

$V1 = HSI_{Food} = (F1 + F2 + F3) / 3$

- F1 – Amount of area in wetland cover types for provision of spring foods. Optimally 7 to 50% of the evaluation area should be composed of this cover type (Rogers and Allen 1987);
- F2 – Amount of area in un-forested cover types for provision of summer foods. Optimally 25 to 50% of the evaluation should be composed of this cover type (Rogers and Allen 1987); and
- F3 – The proportion of canopy cover of the evaluation area composed of berry-producing shrubs for provision of fall foods. Optimally >35% of the shrub layer should be composed of these shrub species.

$V2 = HSI_{Cover}$

- V2 – Amount of shrub canopy cover of the evaluation area. A canopy cover of 50 to 80% is considered optimal. Shrub canopy cover exceeding 80% impedes bear movements and reduces potential for herbaceous ground cover.

V3 = $HSI_{Disturbance}$

- V3 – Amount of evaluation area within the zone of human influence. In the RSA and LSA this was considered to be the proportion of area within 1,000 m of a major road or trail and the amount of area within 250 m of a seasonal trail. The smaller the area of human influence, the greater the habitat suitability rating.

HSI_{Total} = ((0.7 x V1) + (0.3 x V2)) x V3

The black bear HSI model provides an index rating between 0.0 (unsuitable) to 1.0 (optimal). The HSI black bear model output for baseline conditions for the RSA and LSA were 0.53 and 0.42 respectively, which indicates that overall bear habitat is better in the RSA as a whole in comparison to the LSA. The differences in HSI ratings between the RSA and LSA are largely attributed to the excessive amount of existing road and trail development (ie. slightly higher in the LSA), and the somewhat better summer food availability in the RSA relative to the LSA. Figure 6.3.3-3 illustrates the distribution of black bear habitat and the associated HSI ratings in relation to the Project footprint.

Beaver

Beaver are a keystone species in aquatic and riparian habitats because their activities have substantial and cascading effects through alteration of biogeochemical pathways, hydrology, and influence on other species that can occur in its presence (Lawton 1994; Martinsen *et al*. 1998). They are highly specialized aquatic rodents that require permanent water, prefer a seasonably stable water level, and prefer low gradient (<6%) streams to impound water (Allen 1983; Slough and Sadleir 1977), extend their aquatic area, and get closer to their food sources (Fortin *et al*. 2002). They prefer ponds, small lakes with muddy or loamy bottoms, or slow-flowing, winding streams (Fortin *et al*. 2002). Typical beaver habitat consists of low marshy areas and slow flowing streams that allow channelization and damming of water to allow access to and transportation of food materials (Allen 1983). The amount of potential beaver habitat in the RSA is summarized in Table 6.3.3-6.

Table 6.3.3-6: Potential Beaver Habitat within 200 m of Streams, Rivers, and Permanent Open Water Marshes

Beaver Habitat Cover Type (Vegetation within 200m of a stream, river, or permanent wetland)	Base Case	Project Case		Residual Case (Post – Project Closure)	
	Area (ha)	**Area (ha) (Baseline – LSA)**	**% Change from Base Case**	**Area (ha) (Project + Reclaimed)**	**% Change from Base Case**
Deciduous	13,691	13,171	-3.8	13,215	-3.5
Mixedwood	2,308	2,203	-4.5	2,070	-10.3
Fen	1,773	1,765	-0.5	1,773	0.0
Swamp (Treed and Shrub)	8,562	8,400	-1.9	8,562	0.0
Marsh	1,140	1,139	-0.1	1,222	+7.2
Total Beaver Habitat	**27,475**	**26,678**	**-2.9**	**26,842**	**-2.3**
Non-Beaver Habitat	**105,292**	**106,089**		**105,925**	
Total RSA Covertypes	**132,767**	**132,767**		**132,767**	

The leaves, twigs and bark of woody plants as well as aquatic and terrestrial herbaceous vegetation are eaten, with preferences that vary seasonally or annually depending on nutritional value and availability (Jenkins and Busher 1979; Fortin *et al*. 2002). Food preference is for aspen, willow, balsam poplar, paper birch, alder, red-osier dogwood and the roots and rhizomes of aquatic vegetation (Allen 1983; Fortin *et al*. 2002). Foraging of trees and shrubs usually occurs within 50 m of the water's edge, but foraging distances can extend to 200 m (Allen 1983; Fortin *et al.* 2002). Woody stems cut by beavers are usually <10 cm in diameter (Allen 1983), but larger diameter trees may also be felled.

A Habitat Suitability Index (HSI) model was applied to assess beaver habitat in the LSA and RSA. The model was adapted from Allen (1983). Model inputs included:

$V1 = HSI_{WATER} = (W1 + ((0.5 \times W2) + (0.5 \times W3))) / 2$

- W1 – Suitable habitat within a 200 m buffer from rivers, creeks and permanent wetlands. Suitable habitat located closer to water receives a higher rating;
- W2 – Stream gradient of the evaluation area. Cumulative length (m) of low gradient streams receives a higher rating than higher gradient streams; and
- W3 – Stream width.

$V2 = HSI_{FOOD} = F1 \times F2$

- F1 – Cover type area (ha) within the evaluation area. Aspen and poplar are considered optimal and conifers are considered minimal value; and
- F2 – Mean canopy closure (%) of deciduous and deciduous dominated mixedwood cover types in the evaluation area.

$HSI = V1 \times V2$

The beaver HSI model provides an index rating between 0.0 (unsuitable) to 1.0 (optimal). Habitat suitability is lower in the LSA (HSI = 0.316) relative to the RSA (HSI = 0.517) under baseline conditions. Habitat suitability of the RSA in the Project Case (HSI = 0.523) is essentially unchanged from the Base Case. There would be a 2.9% decrease in potential beaver habitat (Table 6.3.3-6) within the RSA based on the anticipated project footprint during construction and operations of the Project. Some of this would be regained during the closure phase of the Project, resulting in a net loss of about 2.3% of potential beaver habitat. Figure 6.3.3-4 illustrates the distribution of beaver habitat and the associated HSI ratings in relation to the Project footprint. The Project is unlikely to have a measurable effect on the beaver population in the RSA and may have a limited local effect in the LSA since most of the potential beaver habitat affected is at the upstream ends of seasonally flowing creeks and only about 32% of the LSA will actually incur vegetation clearing, with avoidance of most of the creek drainages within the LSA (Figure 6.3.3-4).

Furbearers

Eleven fur-bearer species have been harvested from the FalC fur block in recent years (Table 6.3.3-7) (SMOE 2010a). Beaver and red squirrel were used as representative species for aquatic and terrestrial furbearers, respectively, to assess Project effects.

Table 6.3.3-7: Summary of Harvest of Fur-bearer Species in the RSA

Year	Aquatic and Semi-aquatic Fur-bearers				Terrestrial Fur-bearers						
	Beaver	**Muskrat**	**Mink**	**Otter**	**Black Bear**	**Coyote**	**Fisher**	**Red Fox**	**Squirrel**	**Weasel**	**Lynx**
99/00	54	48		4							
00/01	88	6	4	1	3		1				
01/02	16										
02/03	58					24		11	36		
03/04	12			1			1	1	53	3	
04/05											
05/06	54	29		7		5	1	2	3		1
06/07	5	71				6		3		4	
07/08	9	17									
08/09	28			1	1	1					
Total	**324**	**171**	**4**	**14**	**4**	**36**	**3**	**17**	**92**	**7**	**1**

Beaver is the primary furbearer species consistently harvested annually in the FalC fur block, representing 48% of furbearer pelts (324 of 674) harvested between 1999 and 2009. Aquatic and semi-aquatic furbearers (beaver, muskrat, otter, and mink) represent 76% of pelts harvested in the fur block. Terrestrial furbearers harvested in FalC include black bear, fisher, coyote, red fox, squirrel, weasel and lynx, which represent 24% of harvest pelts between 1999 and 2009. The greatest potential effect on fur-bearers would be on the aquatic and semi-aquatic species, since they represent the bulk of the fur harvest for the area.

Red squirrel was used as a representative species to assess the Project effects on terrestrial fur-bearers VCs because they are a potential food source for several carnivorous mammals (e.g. fisher) and bird species (e.g. raptors), and are dependent on conifer seed availability. They are also a nest predator for songbirds nesting in conifer habitats. White spruce habitat is biologically important to red squirrels (Wheatley 1999; Rusch and Reeder 1978). They are most abundant in spruce stands (1.61 to 6.84 squirrels/ha), moderately abundant in jackpine stands (0.86 to 2.64 squirrels/ha) and least abundant in aspen stands (0.00 to 0.99 squirrels/ha) (Rusch and Reeder 1978), with abundance related to mast (cone) production. Their territory size also varies, ranging from 0.24 ha (spruce) to 0.35 ha (mixed spruce) to 0.66 ha (jackpine). Population models were constructed for the RSA and LSA using the forest cover types and population metrics (population density, territory size) reported in Rusch and Reeder (1978) to gauge potential effect on the RSA squirrel population. The model simulations estimated a maximum effect of 3.3 (based on relative population densities by vegetative cover type) to 3.9% (based on territory size by vegetative cover type) reduction in the squirrel population, assuming 100% effect resulting from the addition of the Project footprint during the Project construction and operations phases.

Assessment of Project effects on beaver and red squirrel in the RSA indicates a minimal impact based on habitat loss which amounts to an estimated maximum of 2.9% habitat loss for beavers, and a maximum 3.3 to 3.9% population reduction in the RSA red squirrel population. The estimated loss in beaver habitat is easily mitigated by avoidance during actual construction. The planned project footprint would avoid beaver habitat, with the exception of loss of potential foraging sources at the upper ends of affected ravines. Also, it is highly unlikely that there would be 100% effect on the squirrel population within the LSA since only about a third would be cleared and significant habitat would be retained to support squirrels, including within portions of the project footprint. Therefore, effects assessment on terrestrial, aquatic and semi-aquatic fur-bearer populations within the RSA in general is also considered minimal during the construction and operations phases.

Waterfowl

Waterfowl observed during baseline surveys, and from incidental sightings, include Canada goose, dabbling ducks (mallard, northern pintail, blue-winged teal, green-winged teal, bufflehead, ruddy duck) and diving ducks (ring-necked duck, lesser scaup, common golden-eye).

A qualitative assessment of changes in habitat availability for breeding waterfowl was conducted. Waterfowl frequently nest in suitable habitat (sedge or grassy meadows, wetland shrubs such as willow, tall dense clumps of vegetation) within 100 m of shallow-water feeding areas, or in stands of emergent vegetation on floating mats, because nesting success is positively correlated with distance from water (Bellrose 1980; Lister and Bailey 1994; Page and Cassel 1971; Richkus 2002). Canada geese and other waterfowl species select larger-sized wetlands (>5 ha) or wetland complexes that contain ≥2 ha of open water, with a relatively large amount of basin edge, and are also associated with larger lakes and streams (Arsenault 1990; Brace 1972; Burger 1985; Giroux *et al.* 1983; Kaminski and Prince 1977; Kaminski and Prince 1984; Malecki *et al*. 1981; Schroeder *et al*. 1976).

Wetlands and adjacent upland cover in the LSA would be minimally affected by the Project development because the Project design is intended to avoid wetlands and riparian areas, with the exception of those associated with the Star pit footprint and possibly the upper reaches of creeks associated with the overburden pile and PKCF. The Project area and the RSA in general are not typical of high quality waterfowl breeding habitat which largely occurs in the Prairie ecoregion and farmland portions of the Boreal transition ecozone. Breeding habitat in the FalC forest is limited by a lack of suitable wetlands and adjacent upland cover types preferred by nesting waterfowl.

About 47 ha in the LSA are considered to provide potential waterfowl nesting and feeding habitat, as well as 375 ha along the Saskatchewan River (which may also provide staging habitat). The extent of potential waterfowl habitat in the RSA is predicted to decrease by 0.2% (9 ha) during the operation phase of the Project (Table 6.3.3-8). No affected wetlands are expected to be reclaimed, but up to 780.9 ha of new aquatic habitat is expected to result from lakes created at the north end of the Star pit (353.3 ha) and Orion South pit (427.6 ha), and marsh habitat resulting from the decommissioning of the polishing pond (1.2 ha), runoff pond (6.2 ha), and the sewage lagoon (2.9 ha). It is unlikely that the new wetlands will provide substantial waterfowl habitat value during the operation phase of the Project, but will provide habitat value upon decommissioning. Waterfowl habitat is anticipated to increase by 14.2% in the decommissioning phase.

Table 6.3.3-8: Wetland Habitat Assessment

	Base Case	Project Case		Residual Case (Post –Project Closure)	
Wetland Type	**Area (ha)**	**Area (ha)**	**% Change from Base Case**	**Area (ha)**	**% Change from Base Case**
Marsh	1,278	1,278	0.0	1,288	+0.8
Fen	3,218	3,209	-0.3	3,209	-0.3
Lakes, Rivers	1,009	1,009	0.0	1,790	+77.4
TOTAL	**5,505**	**5,496**	**-0.2**	**6,287**	**+14.2**

Raptors

Bald eagle and great grey owl were used as surrogate species for accipiters (hawks and eagles) and owls, respectively, to assess project effects. Raptors (falcons, hawks, eagles, vultures, ospreys and owls) are top avian food web predators, and therefore are biological indicators of ecosystem health (Arsenault 2009). Population regulation in many raptor species occurs through competition for breeding space. Several raptor species are considered sensitive because they are dependent upon appropriate nest sites for breeding success (Arsenault 2009). Raptors have a high degree of fidelity to nest sites and nesting territories (Kennedy and McTaggart-Cowan 1998). Each raptor nest, its offspring, and supporting habitats are important to the long-term viability of raptor populations and are vulnerable to disturbance by human activities (Arsenault 2009).

In undisturbed raptor habitat, breeding population densities are naturally limited by prey supply or nest sites. Changes to raptor habitats alter the available prey base and / or nesting territories, which can strongly influence raptor populations and may be beneficial to some raptor species and detrimental to others (Arsenault 2009; Bechard *et al*. 1990; Harlow and Bloom 1987; Olendorff *et al*. 1989). A variety of disturbance effects, which include disturbing nesting and feeding patterns, habitat loss, alteration of community dynamics, nest abandonment, increased mortality risk through exposure of eggs and nestlings to weather, premature fledging, bioaccumulation of toxins and accidental deaths (Arsenault 2009) are possible.

There are historical records for 23 raptor species in the RSA. Fourteen of these species were observed during baseline surveys or through incidental observations for the Project. The baseline raptor surveys reported one active bald eagle nest overlooking the Saskatchewan River near the east boundary of the LSA and 2 horned owls observed in the LSA. No nesting raptors were detected within the LSA. Golden eagle and bald eagle are among the most sensitive accipiter species (hawks and eagles) in the RSA. Bald eagle was a VC chosen for effects assessment because of its reliance on a fish diet, proximity of the Project to the Saskatchewan River for foraging habitat, and fidelity of bald eagles to nest sites. The Project is not anticipated to affect use of nesting habitat or existing nest use in proximity to the LSA.

The Project LSA and RSA are within great grey owl range. There are documented occurrences of great grey owls within FalC forest. They forage for small mammals from perches adjacent to openings and clearings in boreal forest habitats, preferring foraging areas with low tree canopy closure and low shrub cover. Nesting habitat is often associated with mature and old growth forest. They are a species that is naturally uncommon and are considered a sensitive species because they are associated with habitats that can deteriorate at a landscape scale (ie. RSA or FalC forest). The Project is not anticipated to have significant negative effects on habitats used by great grey owls at the RSA scale and is not anticipated to have landscape scale impacts affecting occurrence within the RSA. However, occurrence may be enhanced locally by improving potential forage habitat and foraging opportunities.

A disturbance activity buffer of 750 m from active accipiter nests should be sufficient to protect against local project effects (Arsenault 2009). The juxtaposition of proposed disturbance activities by the Project relative to locations of active raptor nests is beyond the recommended buffer distance.

Songbirds

Songbirds and songbird communities are sensitive to habitat features including stand age, vegetation structure, and vegetation composition (Harrison *et al.* 2005; Hobson and Schieck 1999). Habitat loss will occur with the removal or disturbance of any of these features by natural processes (wildfire, blow-down, flooding) or human-caused activities (logging, linear development). Effects associated with this change include increased habitat fragmentation, reduced connectivity, edge effects, alteration in species composition, loss of interior forest habitat, and potential loss in species diversity. Some bird species will respond positively to the change and others negatively. Effects of the Project on songbirds will be local in nature.

Passerine species that favour edge (e.g., olive-sided flycatcher, most sparrow spp., brown-headed cowbird) will likely benefit from increased access to multiple habitat types for feeding and nesting (Hobson and Schieck 1999). Patch size (area of breeding habitat) is correlated with avian density and species richness (diversity), particularly with insectivorous species, forest-dwelling insectivorous species (generally neotropical migrants) favouring larger patches and omnivorous edge species (resident and short-distance migrants) favouring smaller patches (Hobson and Schieck 1999; Johns 1993; Whitcomb 1981).

Interior forest species (e.g., many warbler species, rose-breasted grosbeak, and ovenbird) will likely be negatively affected within the LSA as more edge is created and habitat patch size declines, whereas edge species will likely respond positively. The concentration of many species near edges can increase competition, predation and nest parasitism (Paton 1994). Loss of local wetland habitat in the Project area will adversely affect passerine species that rely on these habitats for breeding and foraging, but reclamation plans at decommissioning will provide new wetland habitat at the Project site at closure.

Wide-ranging forest generalist songbird species such as yellow-rumped warbler and red-eyed vireos are generalist foragers adapted to exploit heterogeneous habitats (Simon *et al*. 2003). Their populations might be linked to local habitat changes or could simply be random fluctuations in regional populations (Canterbury and Blockstein 1997). Therefore, generalist species are an inappropriate choice as a VC for effects assessment.

Resident forest songbirds (e.g. black-capped chickadee, boreal chickadee, grey jay) utilize a wide variety of habitats to maximize foraging efficiency and to cache food. Resident bird species inhabiting northern latitudes are considered to be the species most exposed to the effects of habitat loss and fragmentation of boreal forests (Hadley 2006). However, the winter suitability is not expected to be significantly diminished by the Project, which will likely have the effect of locally enhancing foraging opportunities by creating structural diversity and providing additional Project-related food sources.

Songbirds will likely be affected by the presence of humans at the mine site, mining operations and traffic along the access road. Effects will reduce habitat quality through local displacement because of noise, reduction in nest density causing depressed bird production, and disruption/interference with breeding and territorial calls (Reijnen and Foppen 1994). The effects are usually associated with high traffic volumes. As the Project access is an upgrade of an existing road, the increase in traffic is unlikely to have a strong effect on displacement, edge effect, or habitat fragmentation; however, increased traffic volume and speed can result in direct mortality and displacement from nearby habitats. Effects of industrial noise are likely very similar to that of road noise. Some songbirds have the ability to habituate to continuous noise disturbance through increase vigilance (Bisson *et al*. 2009), but most science literature indicates displacement distances dependent upon tolerance level (Rheindt 2003) and nature of the noise source (frequency, duration, magnitude, predictability, etc.) (Pater *et al*. 2009).

Songbirds are susceptible to direct mortality associated with construction and operation of the mine such as collision with vehicles, and destruction of nests during vegetation clearing. Songbirds attracted to roadsides are at higher mortality risk through vehicle collisions. Vegetation clearing is most likely to occur during winter. However there may be a need to do some minor clearing during spring or summer, which could result in mortality of adults and their eggs/nestlings. Pre-construction surveys would be necessary in advance of any clearing activities during the migratory bird breeding and nesting period to confirm whether the vegetation clearing of a particular area could proceed.

Species-at-Risk

The ranges of 10 species-at-risk overlap the RSA. A qualitative assessment of anticipated Project effects on these species was based on existing species status reports and/or recovery plans, and selective review of the scientific literature and government reports with respect to the ecology, habitat requirements, and disturbance thresholds for these species. The effects were considered at the LSA and RSA scales. Assessment of anticipated Project effects on species-at-risk indicates the Project will either benefit or be neutral, as identified in Table 6.3.3-9.

Table 6.3.3-9: Assessment of Project Effects on Species-at-Risk

Species-at-Risk	Status	Ecology	Occurrence	Project Effect on Species
Common Nighthawk	Threatened	Common in Saskatchewan (S4S5B, S4S5M). Breeds throughout Saskatchewan, makes use of open habitats (forest openings / clearings, recent burnovers), peatlands, riverbanks, mine tailings, quarries, etc. (Arsenault 2009, COSEWIC 2007a)	Observed in RSA during baseline surveys	Local benefit through increased potential habitat created in the LSA
Olive-sided Flycatcher	Threatened	Common in Saskatchewan (S4B, S4M). Patchy local distribution. Associated with natural forest openings, forest edges near natural openings, or open to semi-open conifer and mixedwood forests, and treed peatlands of the boreal plain ecozone. Less common in deciduous dominated forests or dense regenerating forest (Erskine 1992).	Observed in RSA during baseline surveys	Local benefit through increased potential habitat created in the LSA.
Canada Warbler	Threatened	Common and widespread in Saskatchewan (S5B). Commonly associated with wet mixedwood forest with a well developed shrub layer, including shrub marshes, black spruce swamps, and riparian woodlands along rivers and lakes (COSEWIC 2008a). They have a degree of tolerance and adaptability to human disturbances such as fragmented forests and regenerating cutovers (Hobson and Schieck 1999).	Historical occurrence in RSA	Neutral. Species would be tolerant of local Project disturbances planned within the LSA. The species is common and habitat within the RSA is not is short supply.
Whip-poor-will	Threatened	Rare in Saskatchewan (S3B). Range extends into central-east Saskatchewan near FalC forest. Nest in old burns or other disturbed sites in a state of early to mid-regeneration (COSEWIC 2009a)	Historical record near LSA	Neutral. Species is at the extreme periphery of its continental range in Saskatchewan. Potential habitat is readily available in the RSA and LSA.
Chimney Swift	Threatened	Very rare during breeding season (S2B). Confirmed breeder in Nipawin, which is at the western edge of the species' range in Saskatchewan (Arsenault 2009, COSEWIC 2007b).	Confirmed breeder near FalC forest	Neutral. Potential local benefit through increased potential nesting habitat created in the LSA. No effects anticipated at the RSA scale for this species.

Species-at-Risk	Status	Ecology	Occurrence	Project Effect on Species
Horned Grebe	Special Concern	Very common and widespread in Saskatchewan (S5B). Nest on small ponds, marshes, and shallow bays of lakes where open water and emergent vegetation are present (COSEWIC 2009b)	Observed in RSA	Neutral. The Project is unlikely to affect habitat availability or use by this species within the LSA or RSA. Potential local habitat may be created during the decommissioning phase.
Short-eared Owl	Special Concern	Rare during the breeding period and very rare during the non-breeding period (S3B, S2N). Breeds in open habitats such as grasslands, bogs, marshes and clear-cuts (COSEWIC 2008b). Their distribution and abundance closely follows that of cyclic small mammal species such as meadow voles (Holt 1993, Ims and Anderson 2000).	Historical record in RSA	Neutral. There is no short-eared owl habitat in the LSA. The Project would not affect potential habitat or use within the RSA.
Rusty Blackbird	Special Concern	Common and secure during the breeding period in Saskatchewan (S4B). Suitable habitat includes boreal forest wetland areas such as bogs, swamps, beaver ponds slow moving streams, marshes and sedge meadows (COSEWIC 2006).	No records in RSA	Neutral. The Project is unlikely to affect habitat availability or use by this species within the LSA or RSA. Potential local habitat may be created during the decommissioning phase.
Yellow Rail	Special Concern	Uncommon local resident of Saskatchewan (S3B, S2M). There are no confirmed breeding records for Saskatchewan since 1956 (Arsenault 2009). Preferred habitat includes marshy areas with low ground cover, grassy flood plains, wet meadows and bogs with low vegetation.	No records in RSA	Neutral. The Project is unlikely to affect habitat availability or use by this species within the LSA or RSA.
Northern Leopard Frog	Special Concern	Uncommon in Saskatchewan (S3). They use a variety of wetlands for breeding including beaver ponds, quiet backwaters and marshes. Their range encompasses the study area, therefore there is potential for the species to occur.	Not recorded by baseline or previous surveys	Neutral. The Project is unlikely to affect habitat availability or use by this species within the LSA or RSA. Potential local habitat may be created during the decommissioning phase.

6.3.3.5 Other Effects Considered

The issues addressed in this sub-section were raised during public engagement activities (Section 4.0).

Crop Depredation

Displacement of ungulates and field-feeding waterfowl species as a result of the Project is unlikely to affect existing occurrence of ungulate (primarily elk and deer) or waterfowl depredation of agricultural cereal, pulse or forage crops proximate to the RSA. Crop depredation occurrence and magnitude is a function of crop type, crop amount, crop juxtaposition to wildlife habitat, and harvest chronology, which is weather dependant and variable from year to year, and independent of wildlife population size (Arsenault 1994, 1996, 1998). There is adequate native habitat to accommodate the limited displacement of ungulates and waterfowl resulting from the Project. Ungulate and field-feeding waterfowl population densities would not be significantly altered from the natural range of variability within the respective ungulate population management units or waterfowl staging areas associated with the RSA.

Human-Wildlife Interactions

Human-wildlife predator (black bear, grey wolf) interactions are unlikely to be a significant issue provided appropriate measures are taken to avoid attracting or conditioning wildlife to human-related food sources (e.g., through use of wildlife-proof food waste disposal sites). Further, training on wildlife safety will be provided to Project workers to reduce interaction or risk associated with potential wildlife encounters at the site.

Wildlife Diseases

The Project is unlikely to have an effect on the incidence or persistence of wildlife diseases (e.g., chronic wasting disease in ungulate species, which occurs in white-tailed deer and elk proximate to the eastern edge of the RSA on farmland (SMOE 2010b)). The Project would not have an effect that would result in attracting or concentrating any wildlife species, therefore a disease transmission risk resulting from the Project is negligible.

6.3.3.6 Other Species Guilds Considered

Other non-VC species guilds considered in the effects assessment include bats, amphibians and reptiles to supplement the effects assessment for the Project.

Bats

The FalC forest lies within the ranges of several bat species. Bats are specialist species with nocturnal activity patterns. Bats may be potentially affected by light sources associated with the Project. No baseline bat surveys were conducted and occurrence data for the FalC forest is very limited in the provincial Saskatchewan Conservation Data Centre (SKCDC) database, however a qualitative effects assessment was used to evaluate the potential effects of the Project on this nocturnal mammal guild. The qualitative assessment was based on a scientific literature review of species status, the habitat requirements and disturbance ecology of the bat species with their potential to occur in the RSA and/or LSA, and on professional judgement of potential project disturbance effects. Status, ecology and potential project effects are summarized in Table 6.3.3-10.

Bats occurring in the vicinity of the Project will likely benefit from increased potential habitat creation and increased foraging opportunities where insect prey are drawn to lights associated with the Project infrastructure. However, light can affect feeding ecology by delaying bats from emerging if the light source is near a roost access point and shorten the amount of time available to them for foraging. Some bat species may be deterred from their usual forage areas by avoidance of the light, as a predator avoidance strategy (ie. *Plecotus* and *Myotis* species). Other bat species may be attracted to the light to access a concentrated insect food source.

Amphibians and Reptiles

Several herptile species were documented during baseline surveys (Table 6.3.3-11). Amphibians have limited mobility at large scales. Potential effects on amphibians include noise, altered moisture and humidity resulting from vegetation clearing, and changes in aquatic habitat availability associated with the Project. A qualitative effects assessment indicates no significant project effects are anticipated for amphibians or reptiles. Project design is intended to maximize avoidance of wetland habitats within the LSA and the Project footprint used by amphibians and reptiles. Project effects may result in additional habitat creation during the operation phase and decommissioning phase.

Table 6.3.3-10: Assessment of Project Effects on Bats

Species	Status	Ecology	Project Effect on Species
Little Brown Myotis	S5B, S5M	Partial migrant. Very common, able to exploit a wide range of roosts (buildings, trees, and rock piles) and food, thrives with human structures. Prefers forested habitat near water. Diet includes midges, beetles, caddisflies, moths, mayflies and mosquitoes. Known predators include owls, hawks, weasels, racoons, martens, and fishers.	Benefit through increased potential habitat
Northern Long-eared Myotis	S3B, SNRN	Partial migrant. Uncommon in Western Canada with sporadic distribution in Saskatchewan boreal forest; little known about abundance; associated with boreal forest and dependant on mature old-growth trees for roosts; avoids prairie habitat. Roost sites include buildings, crevasses under loose bark and tree cavities. They nocturnally forage over watercourses, small ponds, clearings next to forest edges at a height of 1 to 3 m. Diet includes caddisflies, moths, beetles, flies and leafhoppers.	Neutral
Silver-haired Bat	S3B, S3M	Migrant. Uncommon but widely distributed with erratic abundance through its range. Naturally occurs at low population density in forested areas interspersed with small waterbodies (riparian areas). They nocturnally forage over streams and small waterbodies in forested areas and at tree-top level in upland areas. Diet includes medium-sized flying insects (mostly moths, but also beetles, midges, flies and leaf hoppers). They are relatively cold-tolerant. Known predators include skunks and great-horned owls.	Neutral
Big Brown Bat	S5	Resident, hibernates. Very common and widespread; abundance greatly decreases in coniferous dominated forests. Nocturnally forage within 1 to 2 km of roost. They are generalists in foraging behaviour and foraging habitat selection. Diet is primarily small Coleopterans (beetles). Common predators include grackles, kestrels, owls, and weasels.	Neutral
Eastern Red Bat	S4B, S5M	Migrant. Very common and widespread and highly migratory; roost in forest edge habitats (shrubs, deciduous trees and sometimes coniferous trees) adjacent to streams and clearings. Diet is primarily moths, but also consumes beetles and flies. Predators include hawks, kestrel, merlin, great-horned owl and blue jay.	Benefit through increased potential habitat
Hoary Bat	S5B, S5M	Migrant. Very common and widespread; breeding range is restricted to forested areas. Thought to prefer trees at clearing edges. Nocturnal foraging occurs about tree tops, and along streams and lakeshores. Diet is primarily moths, but also consumes flies, beetles, wasps and dragonflies. Predators unknown, but likely include hawks and owls.	Benefit through increased potential habitat

Table 6.3.3-11: Assessment of Project effects on Amphibians and Reptile Species

Species	Status	Ecology	Occurrence	Project Effect on Species
Amphibians				
Wood Frog	S4	Most widely distributed amphibian in Canada. In Saskatchewan it occurs in aspen parkland and boreal forest regions, occupying moist woodlands and woodland ponds.	RSA, LSA	Minimal
Boreal Chorus Frog	S5	Occur throughout most of Saskatchewan in grasslands, aspen parklands and forested areas, usually in wet grassy areas or wooded areas near ponds. Reeds in almost any fishless pond with at least 10 cm of water. Hibernate beneath rocks, logs or underground.	RSA, LSA	Minimal
Northern Leopard Frog	S3 Special Concern	Breeding habitat includes a variety of relatively permanent wetland types, stream/creek/river backwaters, ponds, oxbow lakes and flooded meadows with a freshwater depth $\geq$1.5 m, ph range between 6.5 to 8.5, and a combination of emergent and submergent vegetation for protective cover and to provide a substrate to attach egg masses. Wetlands selected generally do not support a fish community.	No records in SKCDC database for FalC area. Discontinuous distribution in Saskatchewan with most observations documented in the Prairie ecozone	None
Canadian Toad	S4	Active from April through September, spending the rest of the year burrowed in loose soil. They forage during the day in open areas adjacent to sloughs, marshes, ponds, lake margins and on river flood plains. They burrow into moist sandy soil for the night.	RSA, LSA	Minimal
Tiger Salamander	S5	Habitat includes leaf litter and burrows near water in prairie, parkland and southern boreal forest ecoregions. They are primarily nocturnal and remain buried from September through April. Breeding occurs in permanent or semi-permanent ponds or lakes. They feed on earthworms and other slow moving invertebrates. In tadpole form they feed on larval aquatic insects and fish.	RSA Most common in Saskatchewan Prairie Ecozone	None
Reptiles				
Red-sided Garter Snake	S5	Found in a variety of habitat types including, wetland edges, stream edges and woodlands.	Historical occurrence. Not detected during baseline surveys	None

6.3.3.7 Mitigation Measures

Disturbance is any factor that disrupts a species' natural behaviour, and causes it to lose an opportunity that is important to its survival and reproduction. Mitigation is defined as a reasonable action to reduce or alleviate the potential risk (likelihood of occurrence or ecological significance), and/or exposure effect to disturbance. The disturbance effect (scale/magnitude, extent, duration, timing, frequency) depends on the disturbance type (habitat loss/alteration, sensory, disruption of movement, mortality risk), as well as the species response (avoidance, displacement, mortality) (Environment Canada 2009, Arsenault 2009). The wildlife species chosen as VCs in this environmental assessment are representative of guilds, and can be used to assess Project effects at various spatial (LSA, RSA) and temporal (short-term, long-term) scales, and Project phases (construction, operation, decommissioning), and to suggest appropriate mitigation measures.

Activity setback distance guidelines and recommendations (SMOE 2003, Environment Canada 2009, Arsenault 2009) were used during Project planning and mitigation planning for vertebrate species occurring in the RSA and LSA that may be potentially affected by the Project footprint.

Habitat Loss / Alteration

Unavoidable impacts, such as changes in wildlife habitat associated with mine development, may have a local, long-term effect on wildlife habitat until the vegetation used in restoration has grown sufficiently to become fully functional wildlife habitat. The following mitigation measures were incorporated into the Project design and were intended to reduce environmental effects and minimize the potential for impact occurrence:

- disturbance of sensitive wildlife areas / features such as wetlands and creeks were avoided where possible by situating facilities, infrastructure, and stockpiles in previously disturbed and / or less sensitive areas;
- habitat connectivity was maintained wherever possible through minimizing the footprint of the development area and progressive reclamation of Project-disturbed areas, and progressive clearing of areas where possible;
- existing roads (eg. Shipman Trail) and utility corridors will be used where possible to avoid increases in habitat fragmentation or increased loss of habitat connectivity;
- wetland and riparian habitats were avoided where possible in the Project design resulting in a limited project effect on these habitat types; and
- a 100 m setback from wetlands and streams was established for the Project design and construction to further limit potential Project effects.

The following mitigation measures are planned for Project construction, operation and closure:

- retain natural drainage patterns where possible through project design and construction avoidance;
- re-establish natural drainage patterns at closure of any streams or wetland areas affected by the Project footprint;
- implement erosion control measures on disturbed sites when needed according to industry best management practices;
- implement dust control measures on mining operations as needed according to industry best management practices;
- where possible, re-vegetate project affected sites so that vegetation communities post-closure are similar to naturally occurring vegetation communities in the FalC forest post-closure;
- progressively reclaim with native vegetation throughout the operation phase, including re-vegetating disturbed areas as soon as they are no longer active to mitigate for local loss of habitat connectivity and habitat availability;
- reclamation and re-vegetation of temporary work / access sites to vegetation types compatible with RSA vegetation associations; and
- follow the Closure and Reclamation Plan (Section 7.5) to restore the developed area to a productive ecosystem consistent with the surrounding FalC forest.

Sensory Disturbance

Sensory disturbance (noise, artificial light, odours, movement) associated with mine development and operation may reduce the local availability of effective habitat for wildlife depending on the type of disturbance and the wildlife response to it.

Noise is expected to be highest during construction. Noise effects on terrestrial mammals can take many forms including altered habitat use and activity patterns, increased predation risk, increased stress response, and reduced reproductive success (Pater *et al*. 2009). Noise is usually associated with visual cues (e.g., movement, light) (Pater *et al*. 2009). The functional response of a particular individual or species is related to stimuli duration, frequency, type, magnitude, timing, variability, distance, and past experience (Larkin *et al*. 1996; Arsenault 2009; Pater *et al*. 2009). During the operations phase, habituation of many species of wildlife to the ongoing noise and movement will reduce the extent of indirect loss of effective habitat by displacement and avoidance behaviour.

Movement (humans, machinery) associated with all Project phases may displace some wildlife species responding to perceived threat. This may result in increased use of adjacent suitable habitat at distances tolerable to the specific species affects. Some species (e.g. squirrels, some birds) may tolerate or acclimate to human presence.

Lights associated with the Project may locally affect nocturnal and crepuscular wildlife species (e.g., bats, owls, common nighthawk) by altering foraging ecology and mortality risk.

Odours (e.g., oils, solvents, dust, etc.) may detract or repel some wildlife species; however, the Project is not anticipated to produce substantial dust or chemical odours associated with kimberlite processing. Sewage treatment (odours) may attract scavenging wildlife species.

The Project may increase mortality risk for wildlife species in or near the development area; however, vegetation clearing outside of the breeding bird period and pre-construction surveys for den sites and nests will largely reduce the risk to birds, terrestrial fur-bearers, and large carnivores, as well as other wildlife.

The following mitigation has been incorporated into project design:

- avoidance of sensitive wildlife areas (e.g., wetlands, ravines);
- a 100 m buffer between these areas and development; and
- the sewage lagoon will be enclosed with wildlife-proof fencing.

The following mitigation is planned for construction, operation and closure:

- conduct clearing and grading activities outside of sensitive wildlife periods (March 15 to April 15/green-up, 15 May to 15 June calving and 1 September- 15 October rut for elk and moose) for ungulates, and during breeding season (1 April -31 August for birds) where appropriate;
- prohibit Project personnel from disturbing, harassing, and feeding wildlife at all work areas;
- use low pressure sodium lights to minimize attraction of insects and potential effects on nocturnal wildlife; and
- reduce upward lighting by fitting hoods that direct the light below the horizontal plane, preferably at an angle <70°.

Disruption of Wildlife Movement

Mitigation measures:

- sensitive wildlife areas and features will be avoided wherever possible;
- maintain habitat connections, where possible; and
- disturbance to ravine systems will be avoided where possible using a 100 m setback.

Mortality Risk

The following mitigation is planned for construction, operation and closure:

- during construction, initiate clearing and grading outside of the breeding bird season (to minimise destruction of active nests;
- avoid initiating construction, where appropriate, during the late winter (March 15 to April 15) period when ungulates are in a low energy / nutritional condition;
- establish a strict policy to prohibit staff and contractors from feeding wildlife to avoid conditioning wildlife to human presence;
- establish and enforce strict speed limits for all Project vehicles on the Project site roads and trails, with wildlife given the right-of-way;
- erect wildlife cautionary signage on the access road;
- maintain (mow) the access right-of-way to maximize visibility for traffic and wildlife;
- remove any carrion from the Project access road to avoid attracting scavenging wildlife and reduce potential for wildlife-vehicle collisions;
- all wildlife collisions will be investigated with specific management practices adopted to avoid repeat incidents;
- establish the active mining areas within the lease as “no hunting” areas around the mine; this provides a measure of the safety of mine workers during a licensed hunting season, and may provide a reduced mortality risk for wildlife within the “no hunting” area;
- develop and implement a worker education program and wildlife awareness orientation program to educate personnel on wildlife issues (e.g. encounters, safety, feeding, collisions), required best operating practices, worker responsibilities and reporting requirements;
- coordinate efforts with the appropriate wildlife authorities to resolve issues where wildlife may become conditioned to human presence and pose a safety issue; utilize deterrence conditioning, or trap and relocation as the initial response, and euthanasia as a last resort; and
- prohibit hunting and trapping in the LSA by the Project personnel and contractors.

Monitoring

- Pre-construction wildlife surveys will be conducted by trained Shore employees. The pre-construction surveys will be subject to the timing of construction activities relative to construction activity restriction windows, to identify active nests or dens of species of conservation concern. Activity restriction buffers (distance and timing) during construction will be followed as per industry best practice. The majority of clearing is planned to occur during early and mid-winter, outside of the activity restriction windows.

However limited clearing of smaller blocks may occur during an activity restriction window. Should such instances arise, appropriate pre-construction surveys (e.g. a migratory bird nest search) will be conducted within 7 days of the clearing activity to confirm whether the clearing can proceed without affecting a species of conservation concern.

- Wildlife monitoring will be conducted to ensure adequacy of mitigation measures and to access actual effects of predicted project impacts.
- The monitoring program will initially be conducted annually during construction and for at least the first 2 years of operation to establish an appropriate baseline. The monitoring will then be adjusted (e.g 3 year intervals) where appropriate to monitor trends during the operation phase. Monitoring will include:
  - Wildlife winter track and ungulate pellet transect surveys to assess changes in range occupancy by ungulates and other wildlife within the LSA ±10 km buffer.
  - Wetland monitoring within the LSA ±5 km buffer to assess changes in wildlife distribution and use in relation to project activities by amphibians (spring call survey), waterfowl/waterbirds (spring nesting survey) and passerine birds during breeding/nesting season
  - Systematic point-count bird surveys of the LSA and a control area to assess changes in community structure in relation to the project footprint and to monitor use by migratory birds and bird species of conservation concern.
  - Nesting raptor survey of LSA ±5 km buffer during construction and operation phases to assess whether local project activities might be having an effect on raptors (particularly for species that reuse platform nests) proximate to the project area
- In addition the Project Footprint will be monitored annually for seasonal wildlife use during the life of the project to identify potential or actual wildlife-project conflicts that can be mitigated or avoided.
- Reclaimed areas will be monitored as appropriate, to assess effectiveness of reclamation on wildlife re-colonization and use.
- The project footprint will be monitored annually to identify problem areas with invasive/exotic plants that might impact adjacent local wildlife habitats (including wetlands, riparian area and upland covertypes.

6.3.3.8 Summary of Residual Effects on VCs

Residual effects are project-specific effects that remain after mitigation. They are assigned a significance rating based on established metrics (Table 6.1-2 in Section 6.1, Overview and Methods). The construction, operation, and decommissioning of the Project will impact wildlife and wildlife habitat in a number of ways as discussed in the previous section.

Wildlife habitat availability and habitat connectivity will be reduced until post-closure. Reclamation will be undertaken to provide replacement wildlife habitat.

Sensory disturbance (Section 6.3.3.6) associated with the Project will further reduce the amount of available habitat, although the effects of sensory disturbance will vary among species and individuals, and will depend on the timing and nature of the disturbance. The Project will affect local wildlife movement near the site, and could affect large scale regional north-south movements within the FalC forest. Direct mortality may occur during clearing and grading, and from collisions with traffic. Residual effects are summarized by Project phase for each VC in Tables 6.3.3-12 to 6.3.3-21. The attribute effects and ranking criteria used to assess residual effects are described in Table 6.1-2 (Section 6.1, Overview and Methods).

Residual effects were assessed at the RSA scale for each wildlife VC because the VCs (or surrogate species) are highly mobile species and/or widely distributed throughout the RSA. The Project effects on each wildlife VC would be local in nature (limited to the LSA) and should be assessed at a scale appropriate for highly mobile, wide-ranging species. However, local habitat changes within the LSA at each phase of the Project are included in the quantitative HSI model analyses for moose, black bear and beaver to assess effects at the RSA scale.

Table 6.3.3-12: Residual Effects on Moose and Sympatric Ungulates by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Low-Moderate	Low-Moderate	Negligible–Low
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	-
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	Partially	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Nil-Low	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise)	Magnitude	Low-Moderate	Low	Negligible–Low
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	Yes	Yes	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Low	Nil-Low	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Low-Moderate	Low	Negligible–Low
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Low	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-13: Residual Effects on Black Bear by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	Operations Phase	Closure Phase
Loss / alteration of habitat from project footprint	Magnitude	Low-Moderate	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, odour)	Magnitude	Low-moderate	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	Yes	Yes	Yes
	Direction	Adverse	Intermittent	Neutral
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Intermittent	Neutral-Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Intermittent	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-14: Residual Effects on Beaver and Other Aquatic and Semi-aquatic Fur-bearer Species by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	Operations Phase	Closure Phase
Loss / alteration of habitat from project footprint	Magnitude	Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	-
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral – Adverse	Neutral –Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, odour)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	Yes	Yes	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Continuous	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-15: Residual Effects on Red Squirrel and Other Terrestrial Fur-bearers by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	Operations Phase	Closure Phase
Loss / alteration of habitat from project footprint	Magnitude	Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral – Adverse	Neutral –Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	Yes	Yes	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible-Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil-Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-16: Residual Effects on Waterfowl by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral–Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil-Low
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-17: Residual Effects on Bald Eagle and Other Accipiter Species by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral-Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, movement)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Long-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-18: Residual Effects on Great Grey Owl and Sympatric Owl Species by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Long-term
	Frequency	Continuous	Intermittent - rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral-Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, light)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent-rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Long-term
	Frequency	Continuous	Rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-19: Residual Effects on Olive-sided Flycatcher and Other Migrant Songbirds

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	Operations Phase	Closure Phase
Loss / alteration of habitat from project footprint	Magnitude	Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent-rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral-Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, movement)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent-rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Low	Low
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent-rare	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Low	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-20: Residual Effects on Yellow-rumped Warbler and Forest Interior Migrant Birds

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Low	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Long-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Neutral-Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, movement)	Magnitude	Low	Low	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Long-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Low	Low	Low
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Low	Low
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

Table 6.3.3-21: Residual Effects on Wildlife Species-at-risk by Project Phase

Residual Effect in RSA	Effect Attribute	Attribute Rank		
		Construction Phase	**Operations Phase**	**Closure Phase**
Loss / alteration of habitat from project footprint	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Neutral	Neutral-Positive	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Sensory disturbance (noise, movement)	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Disruption of movement / displacement	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Neutral-Adverse	Neutral-Positive	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	High	High	Low
Mortality risk	Magnitude	Negligible	Negligible	Negligible
	Geographic Extent	Local	Local	Local
	Duration	Short-term	Long-term	Short-term
	Frequency	Continuous	Intermittent	Rare
	Reversibility	No	No	Yes
	Direction	Adverse	Adverse	Neutral-Positive
	Ecological Context	Nil	Nil	Nil
	Confidence Level	High	High	High
	Probability of Effect	Low	Low	Low
Significance rating		Not Significant	Not Significant	Not Significant

6.3.4 Biodiversity

This Section describes the assessment of effects of the Project on biodiversity.

6.3.4.1 Issue Scoping and Assessment

The Project may result in several effects on biodiversity, and may occur during the pre-construction, construction, operations and/or reclamation/decommissioning phases of the Project. Potential effects on biodiversity by project phases are provided in Table 6.3.4-1.

Table 6.3.4-1: Potential Effects on Biodiversity from Project Activities

Project Stage	Project Activities	Effects on Ecosystems	Effects on Species and Communities
Project Pre-construction/ Construction	clearing of natural habitat	plant community loss reduced connectivity reduced patch size	reduced species richness reduced spatial distribution reduced population sizes
	clearing of road and pipeline corridors in undisturbed areas	increased human access to waterbodies and ecosystems increased edge effects increased number of patches	increased spread of invasive plants and wildlife wildlife sensory disturbance fish and wildlife mortality
	draining of wetlands	reduced water table increased aeration of peat increased decomposition	altered wetland community composition
	creek diversions	altered aquatic habitat leaching of nutrients	reduced fish populations altered benthic communities
Project Operations	mine dewatering	surficial aquifer and wetland drawdown	shift in community composition
	vehicle and equipment travel on roadways	dust spread into adjacent ecosystems	wildlife mortality from collisions
	vehicle and equipment creek crossings	foreign materials entering waterways	altered aquatic species composition
	air emissions	soil/peatland fertilization acidification of soils and waterbodies	increased plant growth reduced health of plants and aquatic life
	spills, malfunctions	contamination of soils and waterways	altered species composition
Reclamation and Decommissioning Activities	removal of equipment and buildings	spread of contaminated soils soil compaction	altered soil invertebrate communities
	reclamation activities	re-development of ecosystems	increased native and non-native species distribution introduction of foreign genetic cultivars

6.3.4.2 Assessment Methods

Assessment methods for all disciplines are provided in Section 6.1, Overview and Methods, and describe the spatial and temporal bounds for the Project, the assessment cases, and the criteria for assessment of effects and for the rating of significance. These methods have been adapted or clarified within the biodiversity assessment, where needed.

Biodiversity cannot be directly measured and assessed, but is examined using surrogate measures or indicators within each VC (Table 6.3.4-2).

The quantitative assessment is completed by examining each VC in relation to the established assessment criteria of:

- Direction (positive, adverse, neutral);
- Geographic Extent (local, regional, beyond regional);
- Magnitude (low, moderate, high, or negligible);
- Duration (short-term or long-term);
- Frequency (rare, intermittent, or continuous);
- Reversibility (fully, partially, or non-reversible);
- Probability of effect (low, high, unknown); and
- Confidence (high, medium, or low).

For this assessment, Probability of effect assesses the likelihood that the effect will impact species composition, abundance and/or ecological functions.

Assessment of effects on biodiversity is therefore a two stage process involving a quantitative assessment of changes to indicators, followed by a qualitative assessment determining whether this level of change results in a risk (i.e. Likelihood) to maintaining biodiversity at current levels (or within the natural range of variability).

Table 6.3.4-2: Biodiversity Valued Components and Indicators

Biodiversity Level	Valued Components	Indicators
Landscape Diversity	Landscape Composition	L1. Area (ha) and Distribution of Landform Classes
	Landscape Intactness	L2. Disturbance Area (ha) by Landform Class L3. Density of Linear Disturbances (km/km^2) by Landscape Class L4. Aquatic Connectivity (Stream Crossings per km)
	Landscape Spatial Structure	L5. Patch Number and Size Class Distribution
	Landscape Disturbance Regimes	L6. Forest Harvest and Natural Disturbance Areas (ha)
Habitat Diversity	Habitat Composition	H1. Ecosite Area (ha)
	Forest Structure	H2. Forest Age Classes (including old-growth forest) H3. Structure within Ecosites
	Habitat Intactness	H4. Anthropogenic Edge to Area Ratio (km/km^2) among Ecosites
Species Diversity	Species at Risk	S1. Species at Risk within Taxonomic Groups: Butterflies Birds Fish Plants
	Species Richness	S2. Species richness and habitat rating areas (ha) within taxonomic groups: Songbirds Vascular Plants Non-vascular Plants
	Taxonomic Groups of Interest	S3. Habitat Associations for Taxa of Interest: Ungulates Carnivores Furbearers Waterfowl Amphibians
	Native Species Diversity	S4. Distribution of Non-native Species

When assessing biodiversity, impact criteria are assessed on the individual categories within indicators rather than on the sum of the categories. This focuses the assessment on those categories that experience the largest Project-related changes, and is part of the overall conservative approach to examine potential risks on biodiversity (i.e. if any category within an indicator is at risk, the entire indicator is considered to be at risk). The impact magnitude is also assessed conservatively, with changes of 1 % or higher considered to be moderate and changes of 10 % or higher considered to be high.

The qualitative assessment considers whether the estimated effects could ultimately affect the composition, distribution or viability of species and/or ecosystem functions. The spatial focus of this examination is the RSA. It is recognized that species and functions will be lost or altered within directly disturbed areas; however, it is important to know whether these losses are likely to affect the regional distribution of species or regional functioning of ecosystems.

The assessment for biodiversity is also dependent on the timescale for the Project. The Project will be constructed and operated over a 25 year time-span and will then be decommissioned and reclaimed within 2 years of the Project completion. Because the time that it will take disturbed and reclaimed ecological systems to be restored to natural systems will likely be much longer than these time periods, the assessment will examine effects during two cases:

- Project (i.e. the construction and operations phases); and
- Post-reclamation.

Effects are examined and rated for both cases, but assessment of significance is based only on post-reclamation results.

The post-reclamation case was developed following the results of the conceptual reclamation plan (i.e future soils and ecosites on reclaimed surfaces) as described in Section 7.5 Closure and Reclamation Plan. Based on the planned replacement of soil and terrain features, reclaimed project areas are assumed to develop into natural ecosites; however, it cannot be assumed that all ecosystem functions and originally-present species will be fully restored within the 2 year time period for closure and reclamation; a much longer time period is likely needed to restore ecosystem composition, structure and functions.

Additional reclamation conditions specific to the biodiversity assessment include the following:

- the offsite access road will be maintained as a paved access corridor into the future maintaining human access into the reclaimed project area;

- large terrestrial reclaimed areas (i.e. overburden and rock and kimberlite storage areas) will develop as uplands with different slopes and drainage compared to the original landscape and ecosystem classes; small terrestrial reclaimed areas including onsite access and facility sites will remain in their baseline landscape classes; and end pit lakes will be classified as riparian;
- end-pit lake water quality is modeled in Section 6.2.7, and the results indicate that it is reasonable to assume that surface water quality and shoreline features will allow semi-aquatic and shoreline habitats to develop naturally, however, there is uncertainty regarding the future water and habitat quality in deepwater areas; and,
- forests in undisturbed areas are assumed to remain undisturbed by fire or harvest for the 25 year period between baseline and reclamation; these forests are assumed to age by 25 years. Newly reclaimed areas are assumed to be 2 years in age at closure and any previously cleared exploration pads that were not redeveloped by the project are assumed to be 10 years of age at closure.

6.3.4.3 Effects Assessment

Effects on LVC1: Landscape Composition

Landscape Composition was assessed using Indicator L1: Area and Distribution of Landform Classes (Table 6.3.4-3, Figure 6.3.4-1). In the Project Case, local effects will range from a loss of 9 % of riparian areas to a loss of 41.6 % of lowland areas. Regional effects will range from a loss of 1 % of riparian areas to a loss of 5 % of upland areas.

Table 6.3.4-3: Project Effects on Landform Classes

Study Area	Landform Class	Baseline Area (ha)	Project Case		Post-reclamation case	
			Area[1] (ha)	Change (%)	Area (ha)	Change (%)
LSA	Upland	7,581	5,089	-32.9	7,912	+4.4
	Lowland	2,991	1,748	-41.6	2,065	-30.1
	Riparian	1,646	1,499	-8.9	2,241	+36.1
RSA	Upland	51,684	49,189	-4.8	52,015	+0.6
	Lowland	69,854	68,553	-1.9	68,928	-1.3
	Riparian	11,232	11,085	-1.3	11,827	+5.3

Note: 1. Project Area shows area of each landform class not affected by project disturbance.

Post-reclamation, disturbed landform areas will be redeveloped; however, some will be converted among landform classes. For example, areas within and adjacent to pit lakes will become part of the riparian class, and areas in the overburden storage area will become uplands. Locally these changes will range from a long-term 30.1 % loss of lowlands to a 36.1 % gain of the riparian landform. Regionally these will range from a 1.3 % loss of lowland areas to a 5.3 % gain of the riparian landform.

The effects rating criteria for LVC1 (Landscape Composition), are provided in Table 6.3.4-4. Effects are adverse, regional, high in magnitude, long-term, and continuous. The probability of effect on biodiversity (species composition, abundance or ecosystem function) due to these changes is low for the following reasons:

- the predicted residual changes will affect only a small portion of the RSA, with the maximum residual effect of 1.3 % of the lowland landform and postive residual effects on uplands and lowlands;
- the remaining landscape areas are likely to continue to maintain species and functions throughout the duration of the project; and
- following reclamation, species are likely to recolonize these landforms from undisturbed areas.

These effects are partially reversible, since the mine pits, overburden storage and processed kimberlite facilities will be re-developed into new upland, lowland and riparian areas, however, the proportion of these areas will differ from the baseline condition.

Post-reclamation, the effect is variable in direction and low to moderate in magnitude. The Final Residual Impact Rating is low and the effect is not significant

Table 6.3.4-4: Effects Rating Criteria – LVC1 Landscape Composition

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	High
Magnitude (Post-reclamation)	Moderate
Duration	Long-term
Frequency	Continuous
Reversibility	Partially Reversible
Confidence	Moderate
Probability of Effect	Low
Final Residual Impact Rating	Low

Significance	Not Significant

Effects on LVC2: Landscape Intactness

Landscape Intactness was assessed using three indicators: Indicator L2 – Disturbance within Landform Classes (Table 6.3.4-5), Indicator L3 - Density of Linear Disturbances within Landform Classes (Table 6.3.4-6) and Indicator L4 - Creek Crossing Density (Table 6.3.4-7).

In the Project Case, local effects will range from a 51 % increase in lowland landform disturbances to a 138 % increase in riparian landform disturbance (Table 6.3.4-6), and regional effects will range from an increase of 5.7 % in lowlands to a 17.5 % increase in riparian areas (Figure 6.3.4-1).

Post-reclamation, all new disturbances will be reclaimed, resulting in no remaining Project effects. New disturbances built on pre-existing disturbances will also be reclaimed to natural classes, resulting in a net gain of undisturbed areas within landforms or a loss of disturbed areas compared to baseline. Forest harvest areas are expected to naturally recover Post-reclamation, further reducing the area disturbed.

Table 6.3.4-5: Project Effects on Landform Class Disturbance

Study Area	Landform Class	Baseline*		Project Case*			Post-Reclamation		
		Area (ha)	Percent Ratio (ha/ha)	Area (ha)	Percent Ratio (ha/ha)	Change (%)	Area (ha)	Percent Ratio (ha/ha)	Change (%)
LSA	Upland	2,313	30.5	3,859	50.9	66.8	45	0.6	-98.1
	Lowland	1,219	40.7	1,841	61.6	51.1	36	1.3	-96.8
	Riparian	89	5.4	211	12.8	137.9	3	0.2	-96.6
RSA	Upland	15,099	29.2	16,647	32.2	10.3	745	1.4	-95.1
	Lowland	14,300	20.5	15,114	21.6	5.7	935	1.3	-93.4
	Riparian	699	6.2	821	7.3	17.5	63	0.6	-90.9

Note: * includes forest harvest areas.

In the Project Case, in the LSA (Figure 6.3.4-2), the density of linear disturbance will decrease 5.2 % in the riparian landform and will increase by 15.5 % in uplands and by 7.9 % in lowland areas. In the RSA a 1.0 % reduction is predicted for lowlands, a decrease of 0.5 % is predicted for riparian areas and an increase of 1.9 % is predicted for upland areas.

Post-reclamation, density of linear disturbance will be below baseline values in all landform classes in the LSA and RSA.

Table 6.3.4-6: Project Effects on Density of Linear Disturbance

Study Area	Landform Class	Baseline Density (km/km^2)	Project Case		Post-Reclamation	
			Density (km/km^2)	Change (%)	Density (km/km^2)	Change (%)
LSA	Upland	1.369	1.582	15.5	0.633	-53.8
	Lowland	2.822	3.043	7.9	1.498	-46.9
	Riparian	0.401	0.380	-5.2	0.152	-62.2
RSA	Upland	1.516	1.545	1.9	1.403	-7.4
	Lowland	1.572	1.556	-1.0	1.516	-3.6
	Riparian	0.446	0.444	-0.5	0.413	-7.5

In the Project case, the number of creek crossings will decrease from 23 to 20, but the density of crossings will increase from 0.270/km to 0.308/km, an increase of 14.0 %. This increase is a result of a loss of creek length, with the remaining creek length having an increased density of crossings. In the RSA, creek crossings are reduced from 146 to 143, and crossing density increases from 0.250 to 0.258, a 3.0 % increase.

Post-reclamation, these effects will be reduced below baseline levels.

Table 6.3.4-7: Project Effects on Aquatic Connectivity (Stream Crossings per km)

Study Area	Baseline Case		Project Case			Post-Reclamation		
	Creek Crossings	Density (#/km)	Creek Crossings	Density (#/km)	Change (%)	Creek Crossings	Density (#/km)	Change (%)
LSA	23	0.270	20	0.308	14.0	10	0.150	-44.4
RSA	146	0.250	143	0.258	3.0	133	0.240	-4.0

The effects rating criteria for LVC2 (Landscape Intactness) are provided in Table 6.3.4-8. Effects are adverse, regional, high in magnitude, long-term, and continuous. Probability of effect on biodiversity (species composition, abundance or ecosystem function) is high since there are high levels of baseline disturbance in the regional area, and this will be increased substantially during construction of the Project; with disturbance densities between 20 and 30 % in the RSA (in uplands and lowlands) it is possible that some habitats have already been reduced to levels low enough to reduce species abundances, and effects are more likely on species that occur in uncommon habitats. Linear density is within the range of 1 to 2 km/km^2 where effects on vulnerable species are more likely. These effects are fully reversible.

Post-reclamation, the effect is predicted to be positive in direction and moderate in magnitude. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-8: Effects Rating Criteria – LVC2 Landscape Intactness

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	High
Magnitude (Post-reclamation)	Moderate (positive)
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Moderate
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on LVC3: Landscape Spatial Structure

Development of the Project will result in changes to the distribution of patches among size classes (Table 6.3.4-9, Figure 6.3.4-3). Total patch number is predicted to decrease in both the RSA and LSA; however, different changes are predicted for the various size classes. The mean patch size is predicted to decrease from 18.5 ha in the LSA to 16.5 ha (11.1 %) in the LSA and to decrease from 41.2 ha to 41.1 ha in the RSA (0.2 %) in the Project Case.

The largest patches (>400 ha) in the RSA will not change in patch number, however, the next largest size patches, from 100 to 400 ha, 25 to 100 ha and 5 to 25 ha will increase in patch number, due to the bisection of existing patches by project infrastructure. There is also a decrease in the smallest patches, including those from 0 to 1 ha and from 1 to 5 ha, associated with the creation of large disturbances in areas that are currently composed of numerous small patches. The LSA is predicted to have similar results, except for a decrease in patches >400 ha (from 3 to 2 patches).

Post-reclamation, patch number will decrease in all size classes, and mean patch size will be larger than baseline mean patch sizes in both the LSA and RSA.

Table 6.3.4-9: Project Effects on Patches

Study Area	Patch Metric	Baseline Value	Project Case		Post-Reclamation	
			Value	Change (%)	Value	Change (%)
LSA	0-1 ha	334	242	-27.5	19	-94.3
	1-5 ha	90	81	-10.0	12	-86.7
	5-25 ha	28	30	7.1	8	-71.4
	25-100 ha	11	16	45.5	2	-81.8
	100-400 ha	3	4	33.3	0	-100.0
	>400 ha	3	2	-33.3	1	-66.7
	Total Patches	469	375	-20.0	42	-91.0
	Mean Size (ha)	18.5	16.5	-11.1	288.9	1458.9
RSA	0-1 ha	1,676	1,599	-4.6	257	-84.7
	1-5 ha	484	478	-1.2	213	-56.0
	5-25 ha	182	190	4.4	221	21.4
	25-100 ha	73	80	9.6	105	43.8
	100-400 ha	43	44	2.3	54	25.6
	>400 ha	29	29	0.0	27	-6.9
	Total Patches	2487	2420	-2.7	877	-64.7
	Mean Size (ha)	41.2	41.1	-0.2	149.4	263.0

The effects rating criteria for LVC3 (Landscape Spatial Structure) are provided in Table 6.3.4-10. Effects are adverse, regional, moderate in magnitude for patch number, but low in magnitude for mean patch size. Effects are long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is low because large patch areas, that are most important for sensitive species, are not decreasing regionally. These effects are fully reversible.

Post-reclamation, the effect is positive in direction and moderate in magnitude. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-10: Effects Criteria – LVC3 Landscape Spatial Structure

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate
Magnitude (Post-reclamation)	High (positive)
Duration	Long-term
Frequency	Continuous
Reversibility	Fully reversible
Confidence	Moderate
Probability of Effect	Low
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on HVC1: Habitat Composition

Table 6.3.4-11 shows predicted changes to ecosites in the Project Case (Figure 6.3.4-4) and Post-reclamation case (Figure 6.3.4-5). Project effects in the LSA will range from no loss to ecosites BP19, BP23 and BP28, to losses exceeding 50 % of ecosites BP02 and BP15. In the RSA, impacts range from no loss in several ecosites to 16 % of BP02. Among all ecosites, there will be a 32 % loss in the LSA and a 2.9 % loss in the RSA, whereas uncommon ecosites will be reduced by 28.2 % in the LSA and 2.9 % in the RSA.

Post-reclamation, the effects range from positive in direction to as much as 43 % loss among classes in the LSA or up to 11.4 % loss in the RSA, and uncommon ecosites are predicted to increase relative to baseline levels in both the LSA and RSA. Post-reclamation losses for some classes will remain because ecosites will not be restored to baseline proportions in large reclaimed pit and overburden/kimberlite storage areas. Instead these areas will be reclaimed based on the newly developed terrain and soil conditions in these sites, resulting in some ecosites greater in abundance and others lower in abundance than at baseline. In addition, the central area of the two mine pits will be developed as end-pit lakes, resulting in a loss of upland and lowland ecosites at the expense of open water and marsh classes.

Table 6.3.4-11: Project Effects on Ecosites

Ecosite	LSA					RSA				
	Baseline	Project Case		Post-Reclamation		Baseline	Project Case		Post-Reclamation	
	Area (ha)	Area (ha)	Change (%)	Area (ha)	Change (%)	Area (ha)	Area (ha)	Change (%)	Area (ha)	Change (%)
BP01	141	140	-1.2	140	-0.8	1,680	1,677	-0.2	1,678	-0.1
BP01a	184	104	-43.4	104	-43.3	704	624	-11.4	624	-11.4
BP02	340	95	-72.2	389	14.3	1,528	1,282	-16.1	1,576	3.1
BP03	5,061	2,837	-43.9	3,453	-31.8	32,799	30,552	-6.9	31,167	-5.0
BP04	1,392	926	-33.5	1,426	2.4	14,996	14,525	-3.1	15,025	0.2
BP05	1,163	938	-19.4	951	-18.2	18,109	17,876	-1.3	17,889	-1.2
BP06	780	640	-18.0	645	-17.4	11,394	11,252	-1.2	11,257	-1.2
BP07	557	465	-16.4	468	-16.0	3,661	3,570	-2.5	3,572	-2.4
BP09	185	160	-13.2	818	342.7	4,440	4,415	-0.6	5,073	14.3
BP10	22	16	-29.8	16	-29.6	1,795	1,788	-0.4	1,788	-0.4
BP11	79	78	-1.2	78	-0.8	249	249	-0.4	249	-0.3
BP12	48	43	-9.8	450	833.3	3,615	3,605	-0.3	4,012	11.0
BP13	0	0	0	0	0	6	6	0.0	6	0.0
BP14	135	100	-25.8	322	138.4	5,639	5,600	-0.7	5,822	3.2
BP15	10	3	-70.8	181	1791.7	380	373	-1.8	551	45.0
BP16	779	681	-12.5	683	-12.3	6,479	6,380	-1.5	6,382	-1.5
BP18	215	200	-7.3	200	-7.1	11,080	11,063	-0.2	11,063	-0.2
BP18a	104	77	-25.8	78	-24.9	752	725	-3.6	726	-3.5
BP19	1	1	0.0	1	0.0	121	121	0.0	121	0.0
BP23	3	3	0.0	3	0.0	1,574	1,574	0.0	1,574	0.0
BP24	0	0	0	0	0	57	57	0.0	57	0.0
BP25	384	358	-6.8	468	21.8	7,448	7,417	-0.4	7,527	1.1
BP26	0	0	0	0	0	11	11	0.0	11	0.0
BP28	2	2	0.0	134	6206.8	1,275	1,275	0.0	1,406	10.3
Total Ecosites	11,588	7,868	-32.1	11,008	-5.0	129,796	126,018	-2.9	129,158	-0.5
Cutbank	0	0	0	0	0	12	12	0.0	12	0.0
Open Water	375	380	1.3	1,100	193.2	1,009	1,015	0.5	1,734	71.8
Disturbances	255	3,970	1457.7	110	-57.0	1,953	5,724	193.1	1,864	-4.5
Total	12,218	12,218	0.0	12,218	0.0	132,769	132,769	0.0	132,769	0.0
Uncommon Ecosites	383	275	-28.2	1,304	240.6	3,810	3,701	-2.9	4,731	24.2

The effects rating criteria for HVC1 (Habitat Composition) are provided in Table 6.3.4-12. Effects are adverse, regional, moderate in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is high because the loss of habitat will affect the ability of the site to maintain species in these areas and the affected ecosites will differ in their functional capabilities (e.g. water holding and runoff). These effects are partially reversible with reclamation of some classes increased compared to baseline, and others, such as some wetland classes, reduced from baseline levels.

Post-reclamation, the overall effect on uncommon ecosites is positive in direction and high in magnitude. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-12: Effects Criteria – HVC1 Habitat Composition

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate to High
Magnitude (Post-reclamation)	High (positive)
Duration	Long-term
Frequency	Continuous
Reversibility	Partially Reversible
Confidence	Moderate
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on HVC2: Forest Structure

Table 6.3.4-13 shows the predicted changes to forest age classes in the Project Case (Figure 6.3.4-6) and Post-reclamation case. At total of 33.4 % of forested land will be affected in the Project case; the affected classes range from 9 to 44 % loss. Forests greater than 120 years (old growth forest) will decrease 3 ha (9.4 %) compared to baseline. In the RSA, the total loss of forested land is predicted to be 3.2 % in the project case and to range from 0.2 to 13.2 % among age classes; old growth forest is predicted to decrease 0.2 %.

The post-reclamation case include changes in age class areas that result from the aging of forests and the return of reclaimed forests to the initial (<20 year) class. These calculations assume no additional natural or anthropogenic disturbances in the project area. Total forested lands will increase to 0.2 % higher than baseline levels, due to the reclamation of footprint areas constructed on areas disturbed at baseline. Post-reclamation old growth forests are predicted to increase by 251 ha from baseline. In the RSA, a small gain of forested classes and a large increase in old growth forest is predicted.

Table 6.3.4-13: Project Effects on Forest Age Classes

Study Area	Age Class	Baseline	Project Case		Post-Reclamation	
		Area (ha)	Area (ha)	Change (%)	Area (ha)	Change (%)
LSA	<20 year	931	547	-41.3	3,887	317.7
	20-39 year	5,603	3,876	-30.8	546	-90.3
	40-59 year	2,079	1,150	-44.7	3,874	86.3
	60-79 year	561	403	-28.1	1,150	104.9
	80-99 year	2,060	1,427	-30.7	403	-80.4
	100-119 year	279	254	-9.0	1,425	410.6
	>120 year[1]	24	21	-9.4	275	1,068.5
	Forest Land	11,536	7,678	-33.4	11,560	0.2
	Non-forested	681	4,540	566.4	658	-3.4
	Total	12,218	12,218	0.0	12,218	0.0
RSA	<20 year	24,675	24,287	-1.6	3,949	-84.0
	20-39 year	13,139	11,411	-13.2	24,287	84.9
	40-59 year	15,324	14,380	-6.2	11,408	-25.6
	60-79 year	23,362	23,198	-0.7	14,380	-38.4
	80-99 year	33,624	32,970	-1.9	23,198	-31.0
	100-119 year	7,367	7,341	-0.4	32,968	347.5
	>120 year[1]	5,714	5,705	-0.2	13,045	128.3
	Forest Land	123,205	119,291	-3.2	123,235	0.0
	Non-forested	9,564	13,477	40.9	9,534	-0.3
	Total	**132,769**	**132,769**	**0.0**	**132,769**	**0.0**

Note: 1. Old Growth Forest defined as forests >120 years.

The effects rating criteria for HVC2 (Forest Structure) are provided in Table 6.3.4-14. Project effects are adverse, regional, moderate in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is low due to the small observed changes to old growth forests (that are considered most important among age classes for maintenance of biodiversity) and due to the changes being small compared to the natural range of variation in forest ages. The effects are fully reversible, although the proportions of forest in each age classes will continue to change over time.

Post-reclamation, the effect on age classes and old growth forests will be positive in direction and low to high in magnitude. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-14: Effect Rating Criteria – HVC2 Habitat Structure

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Low
Magnitude (Post-reclamation)	High (positive)
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Moderate
Probability of Effect	Low
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on HVC3: Habitat Intactness

Predicted changes to habitat intactness were examined with indicator H4: Anthropogenic Edge to Area Ratio (Table 6.3.4-15) in the Project and Post-reclamation cases. Changes to anthropogenic edge to area ratio may result from the clearing of habitat areas or from the increase (or decrease) in perimeter surrounding linear or area disturbances. In the Project case, in the LSA, edge to area ratio (for all ecosites) was predicted to increase from 0.9 km/km^2 to 1.1 km/km^2 (23.6 %). Among ecosites, the change ranged from a 100 % loss to 615 % increase in edge to area ratio. In the RSA the total change is less than 0.1 km/km^2 increase or 2.2 %, and ranges from 0.1 to 2.4 % among ecosites.

Post-reclamation, edge to area ratio decreases from baseline in both the LSA and RSA.

Table 6.3.4-15: Project Effects on Anthropogenic Edge to Area Ratio

	LSA					RSA				
	Baseline	Project Case		Post-reclamation		Baseline	Project Case		Post-reclamation	
Ecosite	Edge to Area Ratio (km/km2)	Edge to Area Ratio (km/km2)	Change (%)	Edge to Area Ratio (km/km2)	Change (%)	Edge to Area Ratio (km/km2)	Edge to Area Ratio (km/km2)	Change (%)	Edge to Area Ratio (km/km2)	Chang e (%)
BP01	2.2	2.3	2.5	2.2	-0.7	2.4	2.4	0.6	2.4	0.3
BP01a	0.6	0.3	-52.8	0.1	-83.4	1.0	1.0	3.4	1.0	-3.3
BP02	0.7	0.7	0.0	0.1	-86.8	0.7	0.8	2.2	0.6	-19.2
BP03	1.2	1.7	45.0	0.9	-25.2	1.1	1.2	4.8	1.1	-2.5
BP04	0.9	1.2	33.3	0.5	-40.1	1.1	1.2	2.9	1.1	-2.6
BP05	0.7	0.8	18.4	0.4	-40.3	0.8	0.8	1.8	0.8	-0.9
BP06	0.5	0.5	2.5	0.3	-43.8	0.5	0.5	1.1	0.5	-2.0
BP07	0.8	0.7	-10.5	0.5	-34.8	0.5	0.4	-3.7	0.4	-9.3
BP09	0.1	0.3	435.5	0.0	-75.9	0.3	0.3	7.5	0.2	-12.2
BP10	0.0	0.6	N/A	0.0	-100.0	0.5	0.5	3.2	0.5	0.3
BP11	0.7	0.8	11.7	0.7	0.8	0.4	0.5	19.1	0.4	0.3
BP12	0.2	0.0	-100.0	0.0	-100.0	0.5	0.6	4.0	0.5	-6.8
BP13	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.7	0.2
BP14	0.3	0.2	-29.5	0.0	-96.8	0.3	0.3	3.5	0.3	-1.8
BP15	0.4	2.5	614.7	0.1	-85.1	0.5	0.5	3.7	0.3	-28.5
BP16	0.4	0.5	20.2	0.3	-9.5	0.6	0.6	3.2	0.6	0.4
BP18	0.1	0.2	203.9	0.0	-69.1	0.3	0.3	1.5	0.3	0.5
BP18a	0.8	0.4	-49.6	0.1	-90.4	0.6	0.5	-8.6	0.5	-15.3
BP19	1.1	1.1	0.0	1.1	0.0	0.1	0.1	0.0	0.1	0.0
BP23	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.0
BP24	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.6	-0.1
BP25	0.3	0.5	91.0	0.2	-19.3	0.4	0.4	0.0	0.4	1.5
BP26	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.6	0.4
BP28	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	-9.3
Total Ecosites	***0.9***	***1.1***	***23.6***	***0.5***	***-43.9***	***0.8***	***0.8***	***2.2***	***0.7***	***-3.6***
Cutbank	0.0	0.0	0.0	0.0	0.0	0.0	142.5	N/A	0.0	0.0
Open Water	0.0	0.0	0.0	0.0	0.0	0.0	0.1	N/A	0.0	0.0
Total	**0.9**	**1.0**	**22.0**	**0.5**	**-42.0**	**0.8**	**0.8**	**4.1**	**0.7**	**-4.2**

The effects rating criteria for HVC3 (Habitat Intactness) are provided in Table 6.3.4-16. Effects are adverse, regional, moderate in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is high because conditions along edges are favourable for invasive species and these areas provide variable habitat required by species including many ungulates and carnivores; these changes in turn may begin to displace some native forest interior species. These effects are fully reversible once revegetated disturbances are re-integrated into the intact forest matrix.

Post-reclamation, the effect is positive in direction and moderate in magnitude. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-16: Effects Criteria – HVC3 Habitat Intactness

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate
Magnitude (Post-reclamation)	Moderate (positive)
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Moderate
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on SVC1: Species at Risk

Predicted changes to SVCI (Species at Risk) were examined in relation to four taxonomic groups: Birds, Butterflies, Plants and Fish (Table 6.3.4-17). Assessment of effects focussed on predicted changes to high ranked habitat classes, since these represent areas considered moist important for the sustainability of species at risk in the LSA and RSA. In the LSA, Project development was predicted to affect 2.4 % of the high ranked habitat for birds at risk, 7.7 % of high ranked habitats for butterflies at risk and 8.3 % of high ranked habitat for plants at risk. No open water areas with the potential to support high ranked habitat for fish at risk were predicted to be affected by Project development. In the RSA, project effects on habitats supporting birds at risk, butterflies at risk, and plants at risk were predicted to range from 0.2 to 0.7 % below baseline.

Post-reclamation, high ranked habitat for birds and plants were predicted to increase by 64.7 % and 20.3 %, respectively, over baseline values, but high ranked habitat for butterflies at risk was expected to remain below baseline values by 7.7 %. In the RSA, these effects were predicted to include increases in high ranked habitat for birds at risk and plants at risk, but high ranked habitat supporting butterflies at risk was predicted to be reduced by 0.6 % below baseline values.

Table 6.3.4-17: Project Effects on Species at Risk

Taxonomic Group	Richness Ranking	LSA					RSA				
		Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)	Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)
Birds	High	1,760	1,717	-2.4	2,897	64.7	27,397	27,353	-0.2	28,533	4.1
	Medium	2,271	1,748	-23.0	2,397	5.5	43,422	42,874	-1.3	43,523	0.2
	Low	7,950	4,786	-39.8	6,459	-18.8	60,393	57,199	-5.3	58,872	-2.5
Butterflies	High	161	149	-7.7	149	-7.7	2,088	2,074	-0.6	2,074	-0.6
	Medium	1,597	1,516	-5.1	1,646	3.0	12,020	11,938	-0.7	12,068	0.4
	Low	10,223	6,586	-35.6	9,958	-2.6	117,105	113,413	-3.2	116,785	-0.3
Plants	High	850	780	-8.3	1,023	20.3	23,832	23,755	-0.3	23,999	0.7
	Medium	10,658	7,010	-34.2	9,906	-7.1	105,724	102,026	-3.5	104,923	-0.8
	Low	454	459	0.9	1,179	159.4	1,259	1,263	0.3	1,983	57.5
Fish	High	371	371	0.0	371	0.0	766	766	0.0	766	0.0
	Medium	1	0	-100.0	1	0.0	1	0	-100.0	1	0.0
	Low	0	0	0.0	725	0.0	225	225	0.0	950	322.6

Effects rating criteria for SVC1 (Species at Risk) are provided in Table 6.3.4-18. Effects are adverse, regional, low in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition) is likely. Confidence in this assessment is low, because it was based only on published habitat values assigned to ecosites, rather than a comprehensive species database. Although the RSA will maintain over 95 % of the high rated habitat throughout the Project duration, providing a source population to colonize reclaimed areas, rare species may not easily repopulate reclaimed areas, especially among plants that are limited in the local species pool and in dispersal ability. These effects are, however, considered to be fully reversible, even though the length of time to return all species at risk to affected areas may be considerable.

The post-reclamation magnitude of effects on species at risk is assessed as low in magnitude and variable in direction. The Final Residual Impact Rating is low and the effect is not significant.

Table 6.3.4-18: Effects Criteria – SVC1 Species at Risk

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Low
Magnitude (Post-reclamation)	Low (variable)
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Low
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on SVC2: Species Richness

Three taxonomic groups were examined: breeding birds, vascular plants and nonvascular plants (Table 6.3.4-19), that were ranked among ecosites based on local site data. Assessment of effects focussed on predicted changes to high ranked classes, which represent habitat areas important for sustainability of these species. In the Project case High ranked species richness habitats for birds, vascular plants and nonvascular plants were predicted to decrease from 11.0 to 18.2 % from baseline values in the LSA and from 0.8 to 1.2 % in the RSA.

Table 6.3.4-19: Project Effects on Species Richness within Taxonomic Groups

Taxonomic Group	Richness Ranking	LSA					RSA				
		Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)	Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)
Breeding Birds	High	1,176	1,048	-11.0	1,467	24.7	15,598	15,463	-0.9	15,882	1.8
	Medium	5,785	4,049	-30.0	4,464	-22.8	54,488	52,737	-3.2	53,152	-2.5
	Low	5,020	3,155	-37.2	5,099	1.6	61,107	59,206	-3.1	61,151	0.1
Vascular Plants	High	819	684	-16.4	927	13.2	11,889	11,749	-1.2	11,991	0.9
	Medium	1,816	1,381	-24.0	2,796	53.9	36,967	36,518	-1.2	37,933	2.6
	Low	9,345	6,186	-33.8	7,307	-21.8	82,025	78,830	-3.9	79,950	-2.5
Nonvascular Plants	High	1,514	1,238	-18.2	1,469	-3.0	34,834	34,545	-0.8	34,545	-0.8
	Medium	8,164	5,073	-37.9	6,906	-15.4	69,497	66,371	-4.5	66,371	-4.5
	Low	2,302	1,940	-15.7	2,653	15.3	26,550	26,180	-1.4	26,180	-1.4

Post-reclamation, high ranked species richness habitat classes were predicted to increase over baseline values in the LSA by 24.7 % for breeding birds and by 13.2 % for vascular plants, while a decrease of 3.0 % was predicted for high ranked habitats supporting nonvascular plants. In the RSA, post-reclamation effects on high ranked habitats supporting breeding birds and vascular plants were predicted to increase 1.8 and 0.9 % respectively; however, the effect on high ranked habitats supporting nonvascular plants was predicted to remain reduced below baseline values by 0.8 %.

The effects rating criteria for SVC2 (Species Richness) are provided in Table 6.3.4-20. Effects are assessed as adverse, regional, moderate in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is high. Although the RSA will maintain over 95 % of the high rated habitat throughout the Project duration, providing a source population to colonize reclaimed areas, certain species may not easily repopulate reclaimed areas; this may be a particularly important consideration for uncommon plants that are limited in the local species pool and in dispersal ability. These effects are, however, considered to be fully reversible, even though the length of time to return all species to affected areas may be considerable.

The post-reclamation magnitude of effects on species richness will be low in magnitude and variable in direction. One mitigation strategy that may prove effective is to use direct placement of upper soil and organic layers to progressively reclaim the overburden and rock storage piles. Impacts on plant species should be reduced by this mitigation strategy. The Final Residual Impact Rating is assessed as low and the effect is not significant.

Table 6.3.4-20: Effects Rating Criteria – SVC2 Species Richness

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate
Magnitude (Post-reclamation)	Low
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Moderate
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on SVC3: Taxonomic Groups of Interest

Taxonomic groups examined included furbearers, ungulates, carnivores, waterfowl and amphibians. The assessment focussed on high ranked habitat areas for each group. High ranked areas are likely to provide high quality food or cover resources to support species among each taxonomic group.

In the Project case, high ranked habitat supporting furbearers was predicted to be reduced 33.7 % from baseline in the LSA and 2.4 % in the RSA (Table 6.3.4-21). High ranked habitat supporting ungulates was predicted to be reduced 18.3 % from baseline in the LSA and 1.6 % in the RSA (Table 6.3.4-21). High ranked habitat supporting carnivores was predicted to be reduced 56.5 % from baseline in the LSA and 2.7 % in the RSA (Table 6.3.4-21), and high ranked habitats supporting waterfowl and amphibians were not predicted to be affected by project development.

Post-reclamation, high ranked habitat for furbearers and ungulates was predicted to increase relative to baseline, while high ranked habitat for carnivores was predicted to remain slightly decreased relative to baseline. Waterfowl and amphibians were predicted to increase greatly following reclamation, assuming water quality and habitats in the reclaimed lakes and wetlands proves to be suitable for species in these groups.

The effects rating criteria for SVC3 (Taxonomic Groups of Interest) are provided in Table 6.3.4-22. Effects are assessed as adverse, regional, moderate in magnitude, long-term and continuous. Probability of effects on biodiversity (species composition, abundance or ecosystem function) is low since over 95 % of the high rated habitat for these groups will be maintained throughout the Project duration, and the species in these groups are highly mobile and should be able to recolonize reclaimed habitats once they are suitable in terms of food, shelter and other habitat needs. These effects are considered to be fully reversible. Confidence of this assessment was low because it was based on published values of species habitat associations rather than rigorous datasets of wildlife habitat use.

The post-reclamation magnitude of effects on species richness is assessed as low in magnitude and variable in direction. The Final Residual Impact Rating is assessed as low and the effect is not significant.

Table 6.3.4-21: Project Effects on Habitat Associations for Taxa of Interest

Taxonomic Group	Richness Ranking	LSA					RSA				
		Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)	Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)
Furbearers	High	4,560	3,021	-33.7	5,272	15.6	64,973	63,434	-2.4	65,646	1.0
	Medium	1,670	1,376	-17.6	1,518	-9.1	27,804	27,510	-1.1	27,640	-0.6
	Low	5,751	3,854	-33.0	4,963	-13.7	38,487	36,590	-4.9	37,693	-2.1
Ungulates	High	5,862	4,792	-18.3	6,098	4.0	67,660	66,574	-1.6	67,880	0.3
	Medium	3,269	1,986	-39.2	2,779	-15.0	20,940	19,647	-6.2	20,439	-2.4
	Low	2,850	1,473	-48.3	2,876	0.9	42,665	41,257	-3.3	42,661	0.0
Carnivores	High	9,253	6,896	-25.5	8,995	-2.8	89,828	87,445	-2.7	89,544	-0.3
	Medium	2,291	997	-56.5	1,431	-37.5	22,093	20,775	-6.0	21,209	-4.0
	Low	437	358	-18.1	1,328	203.6	19,344	19,258	-0.4	20,228	4.6
Waterfowl	High	6	6	0.0	862	15570.9	1,517	1,517	0.0	2,374	56.4
	Medium	1,493	1,491	-0.1	1,491	-0.1	10,086	10,085	0.0	10,084	0.0
	Low	235	180	-23.3	292	24.1	6,805	6,745	-0.9	6,857	0.8
Amphibians	High	6	6	0.0	137	2389.1	1,293	1,293	0.0	1,424	10.2
	Medium	1	0	-100.0	726	65909.1	226	225	-0.5	951	321.1
	Low	1,909	1,839	-3.7	1,949	2.1	28,465	28,389	-0.3	28,499	0.1

Table 6.3.4-22: Effect Rating Criteria – SVC3 Taxonomic Groups of Interest

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate
Magnitude (Post-reclamation)	Low
Duration	Long-term
Frequency	Continuous
Reversibility	Fully Reversible
Confidence	Low
Probability of Effect	Low
Final Residual Impact Rating	Low
Significance	Not Significant

Effects on SVC4: Native Species Diversity

The assessment of SVC4 focussed on indicator S4: Distribution of Non-native (plant) Species. In the LSA, disturbed areas and reclaimed habitat, moist shrublands, open marshes and swamps were predicted to be at the greatest risk of invasion by non-native species. In the Project Case, these areas were predicted to increase by 227 % in the LSA and by 16 % in the RSA (Table 6.3.4-23). Post-reclamation, the reclaimed habitat areas are at continued risk of non-native species establishment. High risk habitat therefore remains much higher than baseline, and is predicted to be 179.9 % higher in the LSA and 12.6 % higher in the RSA.

Table 6.3.4-23: Project Effects on Habitats at Risk to Invasion by Non-Native Species

Richness Ranking	LSA					RSA				
	Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)	Baseline Area (ha)	Project Area (ha)	Change (%)	Reclaimed Area (ha)	Change (%)
High	1,525	4,987	227.1	4,267	179.9	22,102	25,613	15.9	24,893	12.6
Medium	2,022	1,580	-21.8	1,580	-21.8	31,215	30,756	-1.5	30,756	-1.5
Low	8,671	5,650	-34.8	6,370	-26.5	79,452	76,400	-3.8	77,120	-2.9

The effects rating criteria for SVC4 (Native Species Diversity) are provided in Table 6.3.4-24. Effects are assessed as adverse, regional, long-term and continuous. Effects on native plant species due to an increase in non-native species are likely to occur if weed species are able to establish and compete with native species. In this situation the effects would be adverse in direction and high in magnitude. There are several established weed populations in the RSA (Section 5.3.1), and development of the Project may provide additional opportunities for non-native plants to establish. New and existing corridors may provide opportunities for non-native species dispersal, and new pathways for non-native plants into the RSA by dispersal of weed seeds on equipment or in reclamation materials brought to the site. To reduce these effects, Shore Gold will develop and implement a Weed Management Plan which will reduce the likelihood of new weed populations becoming established in the LSA and RSA. Successful implementation of this plan will reduce local and regional effects.

Post-reclamation, with adequate time, ecosites are expected to develop until native species are dominant and non-native species are less common. The effect on SVC4 is rated low and not significant.

Table 6.3.4-24: Effect Rating Criteria – SVC4 Native Species Diversity

Criteria	Assessed Effect
Direction	Adverse
Geographic Extent	Regional
Magnitude (Project Case)	Moderate
Magnitude (Post-reclamation)	Low
Duration	Long-term
Frequency	Continuous
Reversibility	Partially Reversible
Confidence	Moderate
Probability of Effect	High
Final Residual Impact Rating	Low
Significance	Not Significant

6.3.4.4 Summary of Biodiversity Effects

A summary of effect ratings for each VC is provided in Table 6.3.4-25.

Residual effects on biodiversity from alterations to the LVC1, Landscape Composition were rated low following reclamation of developed mine footprint areas. Although the future landscape will have a different distribution of landscape classes compared to baseline, effects on biodiversity are not likely given the small percentage of the RSA affected.

Overall, the effect on biodiversity from changes to landscape composition was rated as not significant.

Residual effects on biodiversity from changes to LVC2, Landscape Intactness were assessed as low. The Project will add a large area of disturbance, including increases in linear density and density of creek crossings, and effects on biodiversity from these changes are likely since disturbances can affect species use of habitats, access, and dispersal. Following reclamation, however, all new Project disturbances will be removed and reclaimed. The residual effect rating was rated low and not significant.

Residual effects on biodiversity from changes to LVC3, Landscape Spatial Structure, were rated low. It is unlikely that the changes to spatial structure will affect biodiversity given the large proportion of the RSA that occurs within large patches, during the project and post-reclamation cases. These effects are not significant.

Changes to the first HVC1, Habitat Composition, included high local losses of several ecosites, with losses to some ecosites continuing after reclamation. At the regional level these effects were moderate. These losses were assessed as likely to increase the risk to biodiversity. Most of the impacts were considered reversible, resulting in redevelopment of more ecosite areas than was removed by the project. The residual impact rating was therefore low and not significant.

Residual effects on HVC2, Habitat Structure, were rated low. Forest Structure will be altered by project development, since cleared areas will reduce the area within medium-aged to old age class forests and these areas will be reclaimed to the youngest age class. Probability of effects on biodiversity is unlikely due to the small observed changes to old growth forests and because these changes among all age classes are small compared to the natural range of variation in forest ages. This effect is not significant.

Changes to HVC3, Habitat Intactness, were moderate in magnitude in the regional study area and likely to affect biodiversity, but will be fully reversed following reclamation. The residual effect was rated low and not significant.

Residual effects on SVC1, Species at Risk, and SVC2, species richness, were both rated low and not significant. Probability of effects on biodiversity in the project case was likely in the regional study area; however, following reclamation this effect was predicted to be fully reversed, given adequate time for species recolonization.

Residual effects on SVC3, Taxonomic Groups of Interest, were rated as low and not significant. Large effects were predicted in the project case, with effects remaining on some taxonomic groups, but Probability of effects on biodiversity was considered to be unlikely due to the ease of recolonization of the affected species groups.

Residual effects on SVC4, Native Species Diversity, were examined in relation to the spread of non-native species due to project activities. The project occurs in an area with source non-native plant populations and could result in additional opportunities for non-native plants to establish. Shore Gold's commitment to develop and implement a Weed Management Plan mitigates the potential effect on biodiversity. The residual effect was rated low and not significant.

Although the effects on VCs were assessed as not significant Post-reclamation, there are several impacts predicted during the Project construction and operation stages. It is possible that over the long-term, there may be some long term risks to biodiversity. Monitoring of species at risk, wildlife, plants and aquatic organisms is described in Section 7.4.

Table 6.3.4-25: Final Residual Effect Ratings for Biodiversity Valued Components

Indicator	Direction	Geographic Extent	Magnitude (Project)	Duration	Frequency	Reversibility	Confidence	Probability of Effect	Magnitude (Post-reclamation)	Residual Effect Rating	Significance
LVC1. Landscape Composition	Adverse	Regional	High	Long-term	Continuous	Partial	Moderate	Low	Moderate	Low	Not Significant
LVC2. Landscape Intactness	Adverse	Regional	High	Long-term	Continuous	Full	Moderate	High	Moderate (positive)	Low	Not Significant
LVC3. Landscape Spatial Structure	Adverse	Regional	Moderate	Long-term	Continuous	Full	Moderate	Low	High (positive)	Low	Not Significant
HVC1. Habitat Composition	Adverse	Regional	Moderate to High	Long-term	Continuous	Partial	Moderate	High	High (positive)	Low	Not Significant
HVC2. Forest Structure	Adverse	Regional	Low	Long-term	Continuous	Full	Moderate	Low	High (positive)	Low	Not Significant
HVC3. Habitat Intactness	Adverse	Regional	Moderate	Long-term	Continuous	Full	Moderate	High	Moderate (positive)	Low	Not Significant
SVC1. Species at Risk	Adverse	Regional	Low	Long-term	Continuous	Full	Moderate	High	Low (positive)	Low	Not Significant
SVC2. Species Richness	Adverse	Regional	Moderate	Long-term	Continuous	Full	Moderate	High	Low	Low	Not Significant
SVC3. Taxonomic Groups of Interest	Adverse	Regional	Moderate	Long-term	Continuous	Full	Moderate	Low	Low	Low	Not Significant
SVC4. Native Species Diversity	Adverse	Regional	Moderate	Long-term	Continuous	Partial	Moderate	High	Low	Low	Not Significant