FISHERIES REASSESSMENT

1.0 RESIDUAL EFFECTS ASSESSMENT

The section was developed as a result of the fourth round of Federal supplemental information requests. The relevant request is stated below:

> "Taking into account the proposed Fish Habitat Compensation Plan provided in Shore's April 2013 response, provide an updated characterisation of the residual effects on Fisheries and Aquatic Resources. Also provide a combined assessment of the tributaries and Saskatchewan River using the criteria listed in Section 6.1 of the EIS, including an overall conclusion on significance for this VC."

As such, this document should replace Sections 6.3.1.7 and 6.3.1.8 of the Revised EIS.

This section provides the results of the residual effects assessment completed for each study area, Project phase, and an assessment of the impacts without mitigation and the residual impacts remaining after mitigation measures were considered. A summary of the residual effects assessment for components making up Fisheries and Aquatic Resources is provided in Table 1 and discussed below.

Table 1: Effects Assessment for Fish and Aquatic Resource Components

Study Area	Project Phase	Residual Effect	Direction	Initial Magnitude	Residual Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context	Level of Certainty	Probability of Effects
Caution Creek	Construction and Operations	Increase in mean annual discharge	Positive	High	High	Local	Long-term	Intermittent	Yes	Low	Medium	Unknown
	Operations and Closure	Changes in water quality	Adverse	Low	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Low
101 Ravine	Construction and Operations	Increase in mean annual discharge	Positive	High	High	Local	Long-term	Intermittent	Yes	Low	Medium	Unknown
	Operations and Closure	Changes in water quality	Adverse	Low	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Low
West Ravine	Construction Operations, Closure	Direct loss	Adverse	High	Low	Local	Long-term	Once	No	High	High	Unknown
	Construction and Operations	Decrease in mean annual discharge	Adverse	High	Low	Local	Long-term	Continuous	Yes	High	High	Unknown
	Operations and Closure	Changes in water quality	Neutral	Low	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low
East Ravine	Construction Operations, Closure	Direct loss	Adverse	High	Low	Local	Long-term	Once	No	High	High	High
	Construction and Operations	Decrease in mean annual discharge	Adverse	High	Low	Local	Long-term	Continuous	Yes	High	High	High
	Operations and Closure	Changes in water quality	Neutral	Low	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low

Study Area	Project Phase	Residual Effect	Direction	Initial Magnitude	Residual Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context	Level of Certainty	Probability of Effects
Duke Ravine	Construction and Operations	Increase in mean annual discharge	Adverse	High	Low	Local	Long-term	Continuous	Yes	High	Medium	High
	Operations and Closure	Changes in water quality	Adverse	Low	Low	Local	Long-term	Continuous	Yes	Low	Medium	High
English Creek	Construction and Operations	Decrease in mean annual discharge	Adverse	Low	Low	Local	Long-term	Continuous	Yes	Low	High	Low
	Operations and Closure	Changes in water quality	Neutral	Low	Low	Local	Long-term	Continuous	Yes	Low	Medium	Low
Stream F	Operations and Post-Closure	Decrease in mean annual discharge	Adverse	High	Moderate	Local	Long-term	Continuous	Yes	High	Low	Unknown
Peonan Creek	Operations and Post-Closure	Decrease in mean annual discharge	Adverse	Low	Low	Local	Long-term	Continuous	Yes	High	Low	Unknown
Saskatchewan River	Construction, Operations, and Closure	Construction of Diffuser and Intake Structures	Adverse	Low	Low	Local	Long-term	Once	Yes	Low	High	Low
	Construction and Operations	Increase in mean annual discharge	Neutral	Low	Low	Local	Long-term	Intermittent	Yes	Low	High	Low
	Operations and Closure	Changes in water quality	Adverse	Low	Low	Local	Long-term	Continuous	Yes	Low	Medium	Unknown

1.1 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 magnitude of this positive effect remains the same after mitigation measures described in the FHCP.

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 of the Revised EIS). 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 magnitude remains low after mitigation.

1.2 101 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 the residual magnitude of this positive effect remains high after mitigation.

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 of the Revised EIS). 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: low in magnitude.

1.3 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 magnitude of habitat loss and a decrease in mean annual discharge in West Ravine were given overall ratings low as a result of offsetting measures to habitat loss as described in the FHCP.

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 of the Revised EIS).

1.4 EAST RAVINE

The loss of East Ravine during the construction and operational phases of the Project will result in a loss of fish habitat that was found to interact with the VCs. In the initial 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 residual magnitude of fish habitat loss in East Ravine caused by construction of the Star pit is reduced to low as a result of fish habitat compensation measures described above.

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 of the Revised EIS).

1.5 DUKE RAVINE

During the operational period, changes to site drainage and seepage from the PKCF results in an almost three-fold increase in the discharge of Duke Ravine from the baseline rate. This increase has the potential to negatively affect fisheries resources if detrimental erosion occurs, or improve fisheries resources if additional habitat is created.

The most erosion-prone area is the lowest reach of Duke Ravine near the discharge to the Saskatchewan River. There are areas where the banks exhibit natural slumping (Appendix 6.3.1-B of the revised EIS) and this is common in the regional study area. Generally, in the lower reach the banks of the creek are lined in deep rooted vegetation, contain dense willow, and are stable. It is also noted that the creek contains dense large woody debris throughout and is frequented by beavers creating dams in the area. These factors could naturally change the landscape of Duke Ravine regardless of Project-related increases in flows. Therefore, further bank stabilization efforts, such as re-grading slopes and covering banks in rip-rap or erosion cloth, undertaken prior to increases in stream flow may potentially be ineffective as well as invasive. A phased approach is proposed whereby the monitoring program described above will be used to gauge if significant channel erosion and sediment mobilization are occurring. If it is found that there are areas of Duke Ravine that will benefit from mitigation measures such as bank stabilization, then a mitigation plan will be implemented. Further details can be found in Appendix 6.3.1-B of the revised EIS.

To be conservative, a rating of adverse in direction was used for the residual effects assessment. The initial magnitude was rated as high, ecological context was rated as high since juvenile white sucker currently utilize Duke Ravine and the increased flow could alter rearing habitat. The residual magnitude considering the mitigation described above was considered low.

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 sewage lagoon. Water quality modelling illustrated that iron and chloride concentrations in Duke Ravine will be elevated above baseline during the operational period (Tables 6.2.7-5 and 6.2.7-6 of the Revised EIS). Chloride levels are predicted to exceed the guideline of 120 mg/L in upper Duke Ravine with the 95^{th} percentile concentration predicted to be 129.8 mg/L. Iron concentrations increase slightly to 0.8 mg/l in the upper Duke Ravine as compared to a background concentration of 0.6 mg/l, however iron levels are variable within the environment and this increase is within the range of expected natural variability. Although treated sewage will be discharged into Duke Ravine from the sewage lagoon, 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, low in initial and residual magnitude, low in ecological context, and high in probability of effects.

1.6 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 of the Revised EIS). Thus effects on the aquatic environment in English Creek are rated as low residual magnitude.

1.7 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 of the Revised EIS). Shore is committed to monitoring Stream F to confirm impact predictions as the level of certainty is low. The FHCP also contains sufficient offset measures to further mitigate any effects on fisheries resources, thus reducing the residual magnitude to moderate.

1.8 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 of the Revised EIS). The initial and residual magnitude is low, with the remaining ratings the same as for Stream F.

1.9 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.

2.0 CONSTRUCTION OF DIFFUSER AND INTAKE STRUCTURES

The conceptual design of the outfall structure and water intake 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 into 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 magnitude of construction within the Saskatchewan River is determined to be low, and further mitigated by inclusion of fish habitat loss caused by the construction in the FHCP as described above.

3.0 CHANGES IN FLOW

The Saskatchewan River is part of a large watershed and the predicted increase in flow caused by Project-related activities is minimal. 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 low (<1%), ecological context, and probability of effects are low.

4.0 CHANGES IN WATER QUALITY

The primary parameters of concern in the Project water discharge is chloride, while elevated total dissolved solids (TDS), sodium, and sulphate concentrations are also expected to increase (Table 6.2.7-4 in the Revised EIS). 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 of the Revised EIS). 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 of the Revised EIS). Additional toxicity testing conducted on pure Mannville formation water (TDS= 4,400 mg/l) also showed no acute toxic effects as discussed in Section 6.2.8 of the Revised EIS.

Concentrations within the diffuser discharge of TDS (mean = 2,688 mg/L), chloride (mean = 1,120 mg/L), sodium (mean = 8809 mg/L), and sulphate (mean = 509 mg/L) are predicted, and are lower than the full Mannville water concentrations tested for the Project (Table 6.2.7-4 of the Revised EIS). 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 of the Revised EIS). 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 of the Revised EIS). Although there is the potential for very localized chronic effects to occur immediately at the site of the diffuser should aquatic biota be capable of existing long term in the immediate site of the diffuser, the non-acutely toxic nature of the effluent and subsequent incorporation provided by the river cause this residual magnitude to be rated as low. Water quality monitoring will ensure that parameter concentrations in the vicinity of the diffuser are not exceeding concentrations that are considered acceptable.

5.0 COMBINED FISHERIES AND AQUATIC RESOURCES RESIDUAL EFFECT

The Project has the potential to impact fisheries and aquatic resources through direct impact, changes to habitat as a result of flow changes, and potential effects on water quality. The FHCP provides a plan to offset losses of fish habitat, while flow supplementation in English Creek, Duke Ravine and the 101 Ravine will mitigate for potential reductions in base flow. Water quality effects are rated as low magnitude for each component. A combined residual effect assessment is summarized in Table 2.

Potential effects were rated based on interpretation of all information contained in Table 1. Although there will be impacts on certain tributaries, the overall magnitude after mitigation measures for each effect is low. 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. Overall impacts of the Project on Fisheries and Aquatic Resources are predicted to be not significant.

Table 2: Combined Fisheries and Aquatic Resources Residual Effect Assessment

Potential Effect	Direction	Residual Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context	Level of Certainty	Probability of Effects	Significance
Direct loss	Negative	Low	Local	Long-term	Intermittent	Yes	High	High	High	n/a
Changes in Flow	Neutral	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Medium	n/a
Changes in Water Quality	Negative	Low	Local	Long-term	Intermittent	Yes	Low	Medium	Medium	n/a
All effects	Negative	Low	Local	Long-term	Intermittent	Yes	Moderate	Medium	Medium	Not Significant