CHO PROJECT SCENARIO MATRIX							
Phase	**Activity**	**Alternative**	**Receiving Waterbody (s)**	**Env Control Cost**	**Water Quantity Outcome**	**Water Quantity Outcome**	**Water Quality Outcome**
					Positive	**Negative**	**Positive**
Construction	PKCA Construction	Drain fully	Long Lake, Str C3, Lake C3	Moderate	Headwater Lake; low contribution to Lake C3. ~150,000 m^3 to pump out in spring/summer of Year 1.	Increased flows in Str C3; erosion not an issue or can be mitigated using controlled pump out.	None
		Partially drain	Long Lake, Str C3, Lake C3	Moderate	Headwater Lake; low contribution to Lake C3	See 1a	See 1a
	Fine PK storage locations	Long Lake	Long Lake, Stream C3	High	Headwater Lake; low contribution to Lake C3; average annual discharge ~150,000 m^3; 0.5% of MAR for Lake C3 @ 250 mm r/o	No dam installation until the end of construction therefore having no impact on stream C3 flows until oeprations.	None
		Rescan alternatives (1997)	Lynne, Key, Pocket, Contwoyto lakes	High	Moderation of spring freshet to a small degree.	Much larger drainage areas affected by construction; additional drainage basin for some runoff; pump out would significantly affect water flow into Contwoyto Lake	None
		KIA proposal - Holubec	Lake C1, Stream C1	High	Zero discharge suggested but without water balance analysis; storage piles undersized based on chosen design criteria	Completely eliminate drainage from Lake C1 drainage basin; could mean lower Stream C1 dries up in the summer; initial pump out of Lake C1 will increase flows in Str C1	None
	Water intake	Causeway	Carat Lake	Moderate	None	Not significant; water withdrawal up to ~260,000 m^3/year or <1% of Carat Lake annual discharge @ 250 mm r/o	Less sedimentation than buried pipe because less disturbance of lake bottom during construction. Mine rock will be used.
		Buried pipe	Carat Lake	High	None	See 3a	Water circulation not affected - Lake currents not obstructed however water intake draw point will impact circulation the same for both options
	Waste rock dump locations	Dumps 1 & 2	Carat Lake	Moderate; winter const	None	None significant if water not diverted Potentially significant if uncontrolled released to Carat Lake.	None
		Dump 3	Carat Lake and Lake C1	Moderate; winter const	None	See 4a	None
		KIA proposal - Holubec	Str C1 and Carat Lake	Moderate; winter const	None	Reduction in natural flows to Str C1 by ~80%; little significant change to Carat Lake because of very small contribution from Str C1 (~1%)	None
	Stream C1 Diversion	Naturalize	Str C1 and Carat Lake	High	No change to natural hydrograph; winter construction	None	Clean water around open pit
		Conduit	Str C1 and Carat Lake	Moderate	No change to natural hydrograph; winter construction	See 5a	See 5a
Operation	Fine PK storage	Long Lake	Long Lake; Stream C3; Lake C3; Carat Lake	High	Increased temporary water storage; moderate spring freshet; higher than baseline flows most of the time. Annual total flow for Str. C3 at the mouth approximately 3 times pre-mining flow volume. Releases to follow shape of natural hydrograph	Flows reduced by approx. 50% if no discharge to Stream C3 from PKCA Plans are to maintain water flows with annual discharges	Provides treatment of raw PK and mine water Provides storage capacity for all water effluents not meeting discharge criteria
		Rescan alternatives (1997)	Lynne, Key, Pocket, Contwoyto lakes	High	Increased temporary water storage; moderate spring freshet	Flows reduced some years	Provides treatment of raw PK and mine water. Not as high in basin, higher catchment area, lower concentration, same loading
		KIA proposal - Holubec	Lake C1, Str C1; Carat Lake	High	None	Eliminate most of the flow in Str C1 which may dry out in summer	See 6b
	Waste rock dumps	Dumps 1 & 2	Carat Lake	Moderate	None	None significant unless water redirected to PKCA; then 0.6% of Jericho River flow (Ponds A&B, 2 yr return r/o; 250 mm basin r/o) if water is not discharged from the PKCA, e.g. use of spray irrigation.	None
		Dump 3	Carat Lake; Lake C1	Moderate	None	None significant	None
		KIA proposal - Holubec	Lake C1, Str C1, Carat Lake	Moderate	None	Reduction in flows to Str C1; little significant change to Carat Lake (1% maximum reduction)	None
	Stream C1 Diversion	Naturalize	Str C1 and Carat Lk	Moderate	Maintains Stream C1 flow in lower channel	Annual discharge of C1 at the mouth reduced to 53% of pre-mining discharge, 0.8% of flow for Carat Lake at outlet	Clean water diversion from pit area
		Conduit	Str C1 and Carat Lk	Low	Maintains Stream C1 flow in lower channel	See 8a	See 8a

CHO PROJECT SCENARIO MATRIX					
Phase	**Activity**	**Alternative**	**Water Quality Outcome**	**Fish Health Outcome**	**Fish Health Outcome**
			Negative	**Positive**	**Negative**
Construction	PKCA Construction	Drain fully	Some potential for elevated sediments in water from lake; est. 50% pump out without settling to remove sediment.	Most fish can be salvaged. Low numbers of fish and low species diversity compared to typical fish bearing waterbodies in area.	Fish moved to Lake C3 or Carat may have low survival rate. Fish habitat in Carat Lake or C3 Lake may be nutrient limited therefore incapable of handling additional fish.
		Partially drain	Less potential for elevated sediments because water left in lake	See 1a	See 1a
	Fine PK storage locations	Long Lake	Some sediment export to Str C3 possible from dam construction, but construction in winter and polishing pond will minimize. No stream water flows incur in winter therefore there shouldn't be any quality issues during construction.	Fish populations very limited in number and species to slimy sculpin and burbot	Fish populations in Long Lake eliminated
		Rescan alternatives (1997)	More drainage basins affected; potential to affect both Carat Lake and Contwoyto Lake basins from sediment, metals, TDS, nutrients	None	Fish populations in Lynne and Key lakes eliminated with one configuration: arctic char, lake trout, slimy sculpin
		KIA proposal - Holubec	Some sediment export to Str C1 possible	Fish populations in Lake C1 very limited: lake trout, slimy sculpin	Fish populations in Lake C1 eliminated: lake trout and slimy sculpin
	Water intake	Causeway	Zero sedimentation not possible, some construction related sediment; some potential to affect water circulation	None - Causeway forms natural fish screen surrounding intake well.	Sedimentation may affect fish eggs.
		Buried pipe	Even with silt curtain fine lake bottom sediments will increase sediment in surrounding water temporarily - construction of trench for pipeline will cause heavy sediment loads. Silt curtains limited effectiveness The handling and disposal of lake bottom sediments creates additional environmental issues	None	Sedimentation may affect fish eggs. Fish screen intake.
	Waste rock dump locations	Dumps 1 & 2	Sediment settled by sed pond; any ammonia should be absorbed by tundra before Carat Lake. Pump to PKCA if does not meet water licence criteria	None	Water quality effects (which see)
		Dump 3	See 4a	None	Water quality effects (which see)
		KIA proposal - Holubec	See 4a	None	Dam becomes much of waste rock storage; loss of fish populations in Lake C1 (lake trout and slimy sculpins)
	Stream C1 Diversion	Naturalize	More sedimentation potential from first flush because longer channel in overburden; potential to destablize due to fish structures	Maintains fish food and spawning in lower channel. Upper channel available to fish, but will not be used based on studies	Sedimentation from first flush could affect spawning slimy sculpins
		Conduit	Sedimentation from first flush; greater structure stability	Maintains fish food and slimy sculpin spawning in lower channel	Sedimentation from first flush could affect spawning slimy sculpins
Operation	Fine PK storage	Long Lake	Increase in TDS, some metals, ammonia and possibly phosphorus over background. **Note: #s to come when model completed Possible increase in TDS and ammonia however cpaacity to store water until parameters meet discharge criteria**	None	Fish eliminated include slimy sculpin and burbot.
		Rescan alternatives (1997)	Analysis of water quality effects not done; by analogy similar effects to Long Lake PK storage. Volume of water to treat higher.	None	Fish eliminated include lake trout, arctic char, slimy sculpin and burbot
		KIA proposal - Holubec	Increase in TDS, some metals, ammonia and possibly phosphorus over background in Stream C1 and Carat Lk from seepage	None	Fish eliminated include lake trout and slimy sculpin
	Waste rock dumps	Dumps 1 & 2	Sediment settled by sed pond; any ammonia should be absorbed by tundra before Carat Lake. If metals, ammonia above Water Licence pump to PKCA	None	Water quality effects (which see)
		Dump 3	See 7a	None	Water quality effects (which see)
		KIA proposal - Holubec	Seepage would affect a smaller water body with less absorptive capacity than the other sites (Str C1)	None	Dam becomes much of waste rock storage; therefore part of loss of fish populations in Lake C1
	Stream C1 Diversion	Naturalize	Sedimentation potential; higher than shorter channel; mitigation through management	Maintains fish food and spawning in lower channel; upper channel unlikely to be used by fish based on baseline studies	Temporay reduction in food production for lower section of Stream C1
		Conduit	Sedimentation potential; mitigation through management	Maintains fish food and spawning in lower channel	See 8a

CHO PROJECT SCENARIO MATRIX					
Phase	**Activity**	**Alternative**	**Fish Habitat Outcome**	**Fish Habitat Outcome**	**Mitigation**
			Positive	**Negative**	
Construction	PKCA Construction	Drain fully	Fish habitat is marginal and lower quality compared to typical fish bearing lakes in area	Long Lake fish habitat will be lost (92,500 m^2)	Fish moved to other lake or harvested.
		Partially drain	See 1a	See 1a	See 1a
	Fine PK storage locations	Long Lake	Fish habitat of limited value and common at site	Fsh habitat in Long Lake eliminated and Stream C3 reduced quality.	See 1a
		Rescan alternatives (1997)	Fish habitat common at site.	Fish habitat in Lynne and Key lakes eliminated with one configuration	See 1a
		KIA proposal - Holubec	See 2b	Fish habitat in Lake C1 and potentially Stream C1 eliminated.	See 1a
	Water intake	Causeway	Some new habitat created by submerged sides of causeway (~600 m^2).	1163 m^2 feeding habitat and 272 m^2 spawning habitat lost	Improve causeway sides to create fish habitat
		Buried pipe	No permanent habitat loss	Higher operational risk of submerged pipeline will result in higher likelihood of habitat disturning repairs	Silt fence during construction
	Waste rock dump locations	Dumps 1 & 2	None	None	Mine water management; monitor and direct discharge to fundra or pump to PKCA . Dump design to drain to pit sumps during initial operation to allow for monitoring of water quality.
		Dump 3	None	None	See 4a
		KIA proposal - Holubec	None	Loss of Lake C1 and upper part of Str C1	Pump back seepage and runoff to PKCA; mine water management
	Stream C1 Diversion	Naturalize	Maintains existing habitat in lower channel	Sedimentation from first flush may temporarily eliminate spawning habitat	Minimize sedimentation silt fences; winter construction. Stream C1 kept intact until 3rd year of operation therefore Adaptations of site experience to construction is possible. Run of mine granite available for slope protection and channel enhancements.
		Conduit	See 5a	See 5a	See 5a
Operation	Fine PK storage	Long Lake	None	Slimy sculpin and burbot habitat lost: 92,500 m^2	See 1a
		Rescan alternatives (1997)	None	Lake trout, arctic char, slimy sculpin and burbot habitat lost	See 1a
		KIA proposal - Holubec	None	Lake trout and slimy sculpin habitat lost	See 1a
	Waste rock dumps	Dumps 1 & 2	None	None significant	See 4a. Ability to construct dumps so that initial flows are directed to pit to allow monitoring of water quality from waste dumps.
		Dump 3	None	None significant	See 4a
		KIA proposal - Holubec	None	Loss of Lake C1	See 4b
	Stream C1 Diversion	Naturalize	Creates more potential fish habitat than conduit	Some potential for sediment.	Minimize sedimentation with washed fill and silt fences; winter construction Defer installation of channel until 3rd year of operations
		Conduit	Provides limited fish habitat	Shorter channel eliminates some potential fish habitat compared to natural channel. Some potential for sediment.	See 8a

Phase	Activity	Alternative	Receiving Waterbody (s)	Env Control Cost	Water Quantity Outcome	Water Quantity Outcome	Water Quality Outcome
					Positive	**Negative**	**Positive**
Post-closure	PKCA Discharge Scenarios	Base Case: Discharge to Str C3 Base Case Operation	Long Lake; Stream C3; Lake C3; Carat Lake	Moderate	Increase over natural flow; freshet moderated	Increase over natural flow if high enough could cause erosion. Str. C3 has experienced comparable magnitude flows previously.	Reduction in ammonia, metals, phosphorus; CCME met in Lake C3; **model results pending**
		Scenario B: Hold water for 1 year and discharge to Str C3;	Long Lake; Stream C3; Lake C3; Carat Lake	Moderate	None	Flows in C3 at the mouth reduced by approx. 50% for 1 year and increased thereafter	prevents higher concentrations of ammonia, metals, phosphorus being discharged; CCME met in Lake C3; no direct discharge to receiving water if water quality does not meet discharge criteria
		Scenario C: Hold water for 2 years	Long Lake; Stream C3; Lake C3; Carat Lake	Moderate	None	See 9a	No direct discharge to receiving water during 2 year period if water quality does not meet discharge criteria. Allows time for mitigating plan such as spray irrigation to be developed
	Stream C1 Diversion	Re-direct part of Stream C1 to pit	Stream C1	Moderate	Maintain most of Stream C1 flows after closure	None significant. Decrease in peak freshet flows. Long-term maintenance of diversion required.	Upper stream sediment settled in pit lake.
		Redirect all of C1 into pit	Stream C1	Moderate	None	No flow in C1 diversion or in Stream C1 until pit fills (~17 years)	None
		Maintain diversion	Stream C1	High	Maintain Stream C1 flows after closure	None significant. Long-term maintenance of diversion required.	Pit water quality does not affect lower Stream C1
	End pit fill	Rapidly fill pit	Stream C1, Carat Lake	Moderate	None	Some reduction on Carat Lake discharge; dependent on rate of filling of pit. Loss of all flow to Stream C1	None
		Let pit fill over 15 - 20 years	Stream C1, Carat Lake	Low	Temporary reduction of Carat Lake discharge for 15 to 20 years.	Reduce runoff to Stream C1 and Carat Lake (~400,000 m^3/yr--1% of annual discharge) for 17 years.	Pit acts as storage/treatment facility while filling
	End pit discharge	Pit overflow to open channel	Carat Lake	High	Reestabish runoff to Carat Lake (~400,000 m^3/yr--1% of annual discharge of Carat Lake @ 250 mm annual r/o)	Flows to Stream C1 reduced permanently by about 47%	Pit will act as settling pond for sediment and provide reservoir to hold water for extended period of time until water quality stabilizes.
		Pit overflow to Stream C1	Stream C1, Carat Lake	Low	Reestabish runoff to Carat Lake (~400,000 m^3/yr--1% of annual discharge of Carat Lake @ 250 mm annual r/o)	None significant	See 12a
		Pit overflow to Carat Lake diffuser	Crat Lake	High	See 12a	See 12a	See 12a; Stream C1 unaffected by any water quality issues associated with the closure pit
	Stream C1 Flows	Flows maintained at natural levels with diversion until pit fills, then flow returned to pre-mining drainage pattern	Stream C1, Carat Lake	Moderate	None	None	None
		Flows maintained in perpetuity by diversion	Stream C1, Carat Lake	High	None	None	None
		Flows cut off until pit filled by redirecting stream to pre-mining drainage pattern on closure; no diversion	Stream C1, Carat Lake	Moderate	Once pit fills flows in Stream C1 will be the same as pre-mining except that spring freshet peaks will be reduced due to the storage effects of the pit. Summer lows will also be less pronounced.	No water flows in lower stream until overflow from pit	None
	End pit use	End pit lake fish habitat	Pit	Moderate	None	None	Pit water quality would be at CCME guidelines
		End pit lake treatment facility	Pit	High	None	None	Improve water quality, particularly metals
		End pit lake no treatment	Pit	Low	None	None	Sediment settling
	PKCA	Dry land	Str C3, Lake C3	Low	None Water Runoff from PKCA should mimic pre-mine Flows	Str. flows will mimic natural hydrograph; but would be more peaky than before mining	None
		Wetland	Str C3, Lake C3	Low	Flows similar to pre-mining	None significant; may be difficult to establish and maintain	None. Residula PKCA lake/pond will act as settling pond for PKCA runoff providing some settling capacity
Costs	Low	Less than $20,000					
	Medium	$20,000 to $100,000					
	High	More than $100,000					

Phase	Activity	Alternative	Water Quality Outcome	Fish Health Outcome	Fish Health Outcome
			Negative	**Positive**	**Negative**
Post-closure	PKCA Discharge Scenarios	Base Case: Discharge to Str C3 Base Case Operation	Some potential for chronic effects in Str C3, Lake C3 and Carat Lake; **model results pending. Expect model to confirm that water quality expected to meet CCME guidelines with natural diffusion in Lake C3**	CCME met in Lake C3 if discharge concentrations low enough.	Some potential for chronic effects on fish in Str C3 and Lake C3
		Scenario B: Hold water for 1 year and discharge to Str C3;	Pilot tests will be controlled so as not to result in negative impacts to Lake C3. **Note: add predictions when spray plan completed**	CCME met in Lake C3.	Same as Scenario A
		Scenario C: Hold water for 2 years	Same as Scenario B.	No direct discharge to receiving water; limited effects on fish.	Some potential for chronic effects if seepage exceeds CCME
	Stream C1 Diversion	Re-direct part of Stream C1 to pit	Pit water quality will (may) affect lower Stream C1; quality depends on whether pit used for treatment or not. Water quality won't be known with certainty until after several years of monitoring during operation.	Water quality maintained in Stream C1	Pit water quality could potentially negatively affect fish and fish food organisms; suspended sediment caused by diversion failure may affect lower section of Stream C1
		Redirect all of C1 into pit	Pit water quality may affect lower Stream C1; quality depends on whether pit used for treatment or not. Water quality won't be known with certainty until after several years of monitoring during operation.	None	Pit water quality could potentially negatively affect fish and fish food organisms; suspended sediment caused by diversion failure may affect lower section of Stream C1
		Maintain diversion	Potential for sedimentation; mitigation through maintenance	See 10a	Sedimentation could potentially negatively affect fish and fish food organisms
	End pit fill	Rapidly fill pit	Loss of treatment potentially required for mine runoff resulting in contaminant export or need to treat	None	Potentially contaminated water discharged from pit, particularly ammonia
		Let pit fill over 15 - 20 years	None	Issue of contaminants entering Carat Lake deferred for several years.	Contaminant potential reduced but chronic metals levels may still be present
	End pit discharge	Pit overflow to open channel	Metals may be at chronic levels and would affect Carat Lake	Move potentially lower quality water away from fish egg deposition areas	Water exiting the pit may potentially be lower quality than pre-mining
		Pit overflow to Stream C1	Metals may be at chronic levels and would affect Stream C1 and Carat lake	Most closely reestablish pre-mining conditions for fish in lower Str C1	See 12a
		Pit overflow to Carat Lake diffuser	See 12a	See 12a	See 12a
	Stream C1 Flows	Flows maintained at natural levels with diversion until pit fills, then flow returned to pre-mining drainage pattern	None	None	None
		Flows maintained in perpetuity by diversion	None	None	None
		Flows cut off until pit filled by redirecting stream to pre-mining drainage pattern on closure; no diversion	Water quality may be degraded over pre-mining due to contaminants in the pit	Moderated water flows may allow increased rearing use of the lower part of the stream	No fish use of the stream until the pit overflows. Degraded water quality could affect fish populations once pit overflows.
	End pit use	End pit lake fish habitat	Pit water quality may be unsuitable for fish use depending on quality of water directed to pit. Under some discharge scearios pit lake water may be unsuitable..	Potential replacement of lake fish populations from Long Lake	Water quality may be lower than background
		End pit lake treatment facility	Some metals will likely remain above natural background, e.g. copper	Potential replacement of lake fish populations from Long Lake if contaminants above chronic levels without treatment	Not applicable
		End pit lake no treatment	No change of runoff except settling of sediment	None	Not applicable
	PKCA	Dry land	None significant	Not applicable	Not applicable
		Wetland	PKCA pore water quality may affect Str C3 water quality	Not applicable	Not applicable
Costs	Low	Less than $20,000			
	Medium	$20,000 to $100,000			
	High	More than $100,000			

Phase	Activity	Alternative	Fish Habitat Outcome	Fish Habitat Outcome	Mitigation
			Positive	**Negative**	
Post-closure	PKCA Discharge Scenarios	Base Case: Discharge to Str C3 Base Case Operation	Maintains possibility of use of Stream C3; increased flow would increase habitat quantity and quality	If erosion occurs, may reduce quality of habitat in Stream C3	Compensation plan for fish habitat effects. PKCA storage capacity of water is mitigation
		Scenario B: Hold water for 1 year and discharge to Str C3;	Possibility of use of Stream C3 after Year 2	Reduced quality of habitat in Stream C3 for one year.	See 9a. Containing water in PKCA for 1year would mitigate quality impact.
		Scenario C: Hold water for 2 years	None	As per 9b but for 2 years.	Compensation plan for fish habitat effects. Containing and storing water in PKCA for 2 years would mitigate water quality impacts
	Stream C1 Diversion	Re-direct part of Stream C1 to pit	Water quality and quantity effects on fish (see water quality)	Water quality and quantity effects on fish (see water quality)	Maintains base flows of Stream C1 downstream of diversion
		Redirect all of C1 into pit	None	Loss of lower Stream C1 habitat until pit overflows	None for fish habitat or flows
		Maintain diversion	See 10a	Water quality and quantity effects on fish populations (see water quality)	Maintains near-natural flows of Stream C1 downstream of diversion
	End pit fill	Rapidly fill pit	If water quality adequate potential fish habitat could be created in end pit	Water quality less likely to be suitable for fish habitat in short period	Meter pump rates to minimize effects on Carat Lake drawdown
		Let pit fill over 15 - 20 years	Pit water more likely to be suitable for fish use than rapidly filled pit due to less contam runoff from waste dumps	Metals may still be above chronic effects levels making pit unsuitable (aluminum, cadmium, copper and possibly others)	Allows pit to be used as a storage and treatment facility until it fills substantially reducing ammonia and providing reduction of metals from freeze back effects in dumps
	End pit discharge	Pit overflow to open channel	None significant	Reduced flows may decrease available habitat in Stream C1; introduction of contaminants may affect habitat quality along Carat Lake shoreline	Prevents water of lower quality entering Stream C1 and potentially negatively affecting fish
		Pit overflow to Stream C1	Most closely reestablish pre-mining conditions for fish in lower Str C1	Introduction of contaminants may affect habitat quality in Stream C1 and along Carat Lake shoreline	Returns lower Stream C1 flows to pre-mining condition
		Pit overflow to Carat Lake diffuser	None significant	See 12a	See 12a
	Stream C1 Flows	Flows maintained at natural levels with diversion until pit fills, then flow returned to pre-mining drainage pattern	Fish habitat maintained	None	Maintains flows in lower Sream C1; maintains fish habitat and opportunity for use
		Flows maintained in perpetuity by diversion	See 13a	None	Maintains flows in lower Sream C1; maintains fish habitat and opportunity for use
		Flows cut off until pit filled by redirecting stream to pre-mining drainage pattern on closure; no diversion	Fish habitat eliminated until the pit fills (2-3 years for rapid fill; 15-20 years for natural fill).	Fish habitat in lower stream eliminated until the pit overflows; then habitat may be somewhat improved if summer low flows are higher than pre-mining due to pit lake storage effects.	None
	End pit use	End pit lake fish habitat	Replacement of fish habitat - est 4800 m^2	Fish do not naturally reach the pit area in Stream C1	If viable (**predicted under some conditions that may not to be due to water quality concerns**) could provide for fish habitat compensation
		End pit lake treatment facility	Not applicable	Not applicable	Water quality treatment prior to discharge to Carat Lake
		End pit lake no treatment	Depending on water quality may provide fish habitat	Not applicable	Settle sediments and increase holding time for mine area runoff
	PKCA	Dry land	Not applicable	Not applicable	Rehabilitate and stabilize the PKCA area; provide wildlife habitat
		Wetland	Not applicable	Not applicable	Partial rehabilitation of PKCA; water quality and stability may be concerns
Costs	Low	Less than $20,000			
	Medium	$20,000 to $100,000			
	High	More than $100,000			