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15. SUBJECTS OF NOTE

15.2 CANAL CONSTRUCTION

15.2.1 Introduction to Subject of Note

The purpose of the Canal Construction Subject of Note is to identify the potential interactions between construction activities at the Twin Gorges area and Nonacho Lake, with the fisheries and terrestrial resources at those locations. As the proposed construction activities would result in considerably different effects to both the aquatic and terrestrial resources, this Subject of Note analyzes the effects to each resource separately.

Construction works associated with the Twin Gorges area include the construction of the North Gorge canal, the South Gorge spillway, and the minimum release structure at the South Valley Spillway. Proposed activities at Nonacho Lake include the construction of a new control structure and upgrades to the existing dam facility. The construction methodologies associated with the in-stream and near-stream works are discussed in Section 6.5.4 – Construction Methodologies.

In accordance with the Terms of Reference (TOR) for the Developer's Assessment Report (DAR) (Mackenzie Valley Environmental Impact Review Board [MVEIRB], 2008), the following assessments have been conducted to assess the potential effects from construction on the terrestrial resources:

- Assessment of the acid rock drainage potential of waste rock, including contingency plans for the management of any acid generating rock that might be discovered;
- Planning and management strategies for the extracted rock and overburden including: the amount of land proposed to be affected by spoil pile, potential impact of runoff that may contain sediment and/or residual explosives, water management for potentially contaminated runoff, and spoil pile reclamation options;
- Predicted levels of noise and its impact on surrounding Valued Components due to explosions and heavy machinery operation related to canal excavation; and
- An assessment of the potential impact of dust generated by traffic, explosives, the exposed canal or the waste rock piles.

The TOR also identifies specific information requests to complete the effects assessment of the in-stream and near-stream works as a component of the Water Fluctuations in the Taltson River Watershed Key Line of Inquiry and as Remaining Issues. These identified assessments are contained in the Canal Construction Subject of Note and include:

- Effects that in-stream works, such as construction of the Nonacho control structure, would have on water quality and aquatic habitat;
- Impacts of in-stream works on fish; and
- Impacts of ANFO explosives.

Although the effects associated with the terrestrial and fisheries resources at the Twin Gorges area and Nonacho Lake were analyzed separately, the overall effects classification and determination of significance was combined for works associated with the Project.

15.2.2 Terrestrial Resources

The proposed works have the potential to interact with the terrestrial environments associated with both the North Gorge canal and Nonacho control structure; the effects associated with the South Gorge spillway and the SVS minimum release structure encompass very small areas and would require minimal disturbance to the terrestrial environment.

The construction works associated with the North Gorge canal and the Nonacho control structure differ and the local study areas do not overlap. As such, the potential interactions between the construction activities and the terrestrial resources at the North Gorge and Nonacho Lake were analyzed separately.

15.2.2.1 North Gorge Terrestrial Resources

15.2.2.1.1 Existing Environment

The North Gorge is situated in the Rutledge Upland Ecoregion, of the Taiga Shield (Ecosystem Classification Group 2008). This area is dominated by Precambrian intrusive bedrock, and soils of the Nonacho Lake association. Vegetation is dominated by rock lichen, rock lichen woodland and moss forest communities of black and white spruce. Some areas are pine-dominated because of recent fires (Ecosystem Classification Group 2008a). Lakes occupy rock fractures and tend to be long and narrow. Moose have been observed in the area, but the North Gorge is not within the range of barren-ground caribou, woodland caribou, or wood bison.

Existing vegetation at the North Gorge canal site is characterized by exposed bedrock and an emerging spruce forest. The site was subject to a forest fire in July 1999, and is in the process of regeneration. There are isolated pockets of mature spruce and mixed forest along the shoreline of the Twin Gorges Forebay, North Gorge canal, and the lower Taltson River.

It is proposed that the spoil excavated from the North Gorge canal would be placed in two separate areas, labelled Areas 1 and 2 on Figure 6.5.6 in Chapter 6. The spoil from the power canal would be stored in Area 1 and the spoil from the penstocks, powerhouse and tailrace would be stored in Area 2. Spoils are located between the North Gorge alignment and the existing plant to minimize the environmental footprint of the overall Project, as this area would be essentially isolated from the surrounding areas. Area 2 is entirely in a recent burn zone and comprises bare rock. Area 1 is primarily small deciduous tree cover with fairly deep silt soil cover over rock. Spoil disposal is limited to this area where wildlife would have limited access in the future. The total area of surface disturbance is approximately 25 ha.

15.2.2.1.2 Valued Components

Valued Components were selected based on the comments received by government and community agencies during the MVLWB screening, MVEIRB scoping session and known habitat conditions within and adjacent to the North Gorge. The identified Valued Components are passerines (songbirds) and vegetation; rationale for their selection is provided below.

Passerines (songbirds) were selected as a Valued Component to measure the effects of dust, noise and vegetation loss, because they have small home ranges, making them susceptible to small area environmental changes. Further, they are abundant, easily studied, and there is available literature on their reaction to noise and vegetation loss.

Vegetation was selected as a Valued Component to measure potential effects of vegetation loss and dust on plants.

15.2.2.1.3 Assessment Pathways and Endpoints

The following sources of information were used to identify pathways associated with terrestrial habitats:

- Public information sessions in Fort Smith, Fort Resolution, Hay River in March, 2004 (Rescan 2004);
- Feedback received from Aboriginal organizations and territorial and federal government departments during the land use permit application to the Mackenzie Valley Land and Water Board (MVLWB 2007); and
- Public hearings hosted by the MVEIRB, and the MVEIRB Terms of Reference (MVEIRB 2008).

Table 15.2.1 summarizes the assessment endpoints, and the pathways leading to those endpoints for the Valued Components passerines and vegetation. Pathway diagrams for these Valued Components are contained in Section 15.4 – Species at Risk and Key Bird Species.

Table 15.2.1 — Valued Component, Assessment Endpoints and Pathways for Construction Activities in the Twin Gorges Forebay

Valued Component	Assessment Endpoint	Pathway
Passerines	Persistence of passerine abundance	Sensory disturbance leading to changes in passerine behaviour
Vegetation	Persistence of existing vegetation communities	Dust leading to changes in vegetation communities

15.2.2.1.4 Spatial and Temporal Boundaries

The analysis of pathways between the construction activities and the terrestrial environments was conducted on a local study area (LSA) only. The extent of the local study area was dependent on the construction activity, as described in the following sections. Considering the spatial extent of the disturbances, a local study area of 5 km surrounding both the North Gorge facilities and Nonacho Lake control structure was selected.

15.2.2.1.4.1 *Dust and Noise*

Attenuation distances for dust and noise are summarized in Section 15.6 - Climate Change and Air Quality.

15.2.2.1.4.2 *Noise*

The initial stages of construction for the canals at North Gorge and Nonacho Lake would employ clearing and preparation activity similar to the transmission line construction. Noise from these activities in relation to the canal construction is expected to be similar to the level already predicted in the previous section. The analysis of noise from canal construction is focused on quarrying type activity (material movement) and blasting.

Emissions

The scenario used to represent the expected noise from heavy equipment constructing the canal used a combination of rock drills, a portable crusher, a loader, and a dump truck all working within a 100 m by 200 m area. One large, or quarry-scale, blast per day is also assumed. Typical sound emissions for this scenario are provided in Table 15.2.2. The character and source references for each emission considered are also provided.

Table 15.2.2 — Construction Sound Emissions

Source Name	Sound Power (dBA)	Type	Reference
Large scale blasting	137[1]	Impulsive, tonal	TCPL 2005
Crusher	111	Continuous	Field measurement
Wheeled loader	110	Continuous	DEFRA 2004
Dump truck	113	Continuous	FHWA 2006
Rough terrain rock drill	111	Continuous	TCPL 2005

[1] 12 dBA penalty included in sound power based on the type of source.

The blasting noise sources have been noted to be highly impulsive in nature. The sound emission reported for this source includes a penalty of 12 dBA due to the tendency of blasting to be particularly annoying (Can: ISO 1996-1 2006).

Noise attenuation factors considered in the calculations include absorption of sound by the atmosphere, ground conditions (soft versus hard surfaces) and distance. The duration of construction activity for Nonacho Lake was assumed to be 10 hours per day, with no activity during the night (day = 07:00 – 23:00; night = 23:00 – 07:00). For the North Gorge canal, construction activity is expected to continue on a 24-hour, 7-day-a-week basis.

Noise Predictions

Table 15.2.3 lists the results of the noise calculations for this scenario based on varying distances from the ROW or limit of activity. The calculation points were placed perpendicular to the centre of activity for the scenario. The two ground based scenarios assumed that equipment noise sources were working continuously within a 500 m by 250 m area.

Table 15.2.3 — Construction Scenario Noise Predictions by Distance from Activity

Distance from Source to Nearest Receiver (m)	Predicted Noise Level L_d (dBA) [1]	
	Canal Construction	Large Scale Blasting
250	65	75
500	58	71
1,000	50	63
2,000	42	55
3,000	36	49
4,000	32	45
5,000	29	40
10,000	19	25

[1] L_d (daytime) noise levels, average hourly noise level for any hour (day or night).

Based on results presented, noise from continuous construction work for the canals is expected to be lower than the average existing noise level of 35 dBA (day or night) at approximately 3 km from most construction activity. For blasting, the values represent the maximum only for the time in which the blast occurs. Blasting would attenuate to 35 dBA at about 7 km; however, this is a short-term or instantaneous event, so disturbances to this distance would not be sustained. This does not mean that Project-generated sound would not be heard, as the character of construction noise would differ from natural sounds.

15.2.2.1.5 Project Components

Project components associated with the North Gorge construction activities are summarized in Table 15.2.4.

Table 15.2.4 — Project Components Associated with the Construction Activities in the Twin Gorges Forebay

Project Component	Sub-Components	Associated Activities	Geographic Extent	Schedule	Duration	Phase
North Gorge Facilities	Water conveyance canal construction (SON)	Mobilization and site preparation (vegetation clearing and leveling)	Facilities footprint + 500 m buffer	1st Q 2010 to 3rd Q 2010	6 months	Construction
North Gorge Facilities	Water conveyance canal construction (SON)	Terrestrial blasting Trucking Waste management Riparian zone clearing	As above	3rd Q 2010 to 4th Q 2011	14 months	Construction

Project Component	Sub-Components	Associated Activities	Geographic Extent	Schedule	Duration	Phase
North Gorge Facilities	Water conveyance canal construction (SON)	Aggregate processing	As above	2nd Q 2010 to 4th Q 2011	18 months	Construction
North Gorge Facilities	Water conveyance canal construction (SON)	In-stream blasting	As above	4th Q 2011	2 months	Construction
North Gorge Facilities	Powerhouse, excavation and penstocks	Terrestrial blasting Trucking	Powerhouse footprint	2nd Q 2010 to 3rd Q 2010	4 months	Construction
North Gorge Facilities	Powerhouse, excavation and penstocks	Terrestrial concrete work and equipment	Powerhouse footprint	3rd Q 2010 to 2nd Q 2012	18 months	Construction
North Gorge Facilities	Rock tailrace canal	In-stream blasting	See canal	4th Q 2011	1 month	Construction
North Gorge Facilities	Switchyard	Installation	See canal	2nd Q 2011 to 4th Q 2011	5 months	Construction
North Gorge Facilities	Waste rock stockpile	Earthmoving equipment Runoff	See above	2nd Q 2011 to 4th Q 2011	7 months	Construction

15.2.2.1.6 Mitigation

The mitigation measures associated with the construction activities in the North Gorge are summarized in Table 15.2.5.

Table 15.2.5 — Mitigation Measures Associated with the Construction Activities of the North Gorge

Pathway	Pathway Duration	Proposed Mitigation
Sensory disturbance leading to changes in passerine behaviour	Construction	No vegetation clearing would occur during the passerine breeding season (May 15 to July 31). Blasting activities would only occur during the construction phase and would not involve substantial re-handling of material, which tends to decrease the fines content and thus the available particulate matter to become airborne. Spoil piles would be situated adjacent to the excavation areas, minimizing the need to transport the spoil and thus limiting the creation of dust. Compact layout of the surface facilities would be limited to the area disturbed at

Pathway	Pathway Duration	Proposed Mitigation
		construction. Helicopters would be flown above 300 m whenever possible. Environmental sensitivity training would be provided for personnel. Feeding and harassment of wildlife would not be permitted. The Human-Wildlife Conflict EMP would be implemented and adhered to. Recreational use of vehicles would not be permitted.
Dust deposition leading to change in vegetation communities	Construction	Spoil piles would be situated adjacent to the excavation areas, minimizing the need to transport the spoil and limit the creation of dust. Use of winter roads would reduce transportation dust. Compact layout of the surface facilities would be limited to the area disturbed at construction. Provide environmental sensitivity training for personnel. Recreational use of vehicles would not be permitted. Spoil areas would be isolated between the canal and the Taltson River.

15.2.2.1.7 Pathway Validation

The results of the pathway validation assessment are summarized in Table 15.2.6. Rationale for the classification of pathways as Valid, Minor or Invalid is provided following the table.

Table 15.2.6 — Pathways to the Valued Component from Various Project Components

Project Component	Pathway	Pathway Validation
North Gorge Facilities	Sensory disturbance leading to changes in passerine behaviour	Minor
North Gorge Facilities	Dust deposition leading to change in vegetation communities	Minor

In total, two pathways have been identified between the Project components and the terrestrial components at the North Gorge. Of the two identified pathways, none are Valid pathways, two are Minor pathways, and none are Invalid pathways.

15.2.2.1.7.1 *Valid Pathways*

No Valid pathways were identified.

15.2.2.1.7.2 *Minor Pathways*

Sensory Disturbance Leading to Changes in Passerine Behaviour

No clearing of vegetation would take place during the migratory bird nesting season, May 15 to July 31 (EC 2007). However, there are several areas where there would be some overlap between nesting activity and Project construction. No raptor nests were identified within the LSA. The construction schedule (Figure 6.5.9, Chapter 6) indicates that passerines may be exposed to construction activity during the 2010 and 2011 nesting seasons.

Construction activities during the summer breeding season would generate noise and activity that may affect the movement, behaviour or reproductive success of passerines. As described in Section 15.2.2.5.1, noise created by the Project would likely attenuate to baseline levels within 2.5 km. Blasting noise may travel farther, up to 7 km, but this is a short-term event and disturbance would not be sustained. However, the character of the noise may be different from natural sounds, and may be audible for greater distances.

Recent studies of passerines at the Ekati Diamond Mine (Smith et al. 2005) indicated that the density of passerines was not affected within 1 km of the mine footprint and species diversity was slightly higher in some of the plots near the mine. Concurrent studies of Lapland longspurs at the Ekati Diamond Mine indicated that nest success was unaffected within 300 m of major haul roads (Male 2004). Specific to the effects of noise, recent research has focused the effect of noise on bird songs. For example, Habib et al. (2007) found that although ovenbirds were present and continued to reproduce near sources of continuous industrial noise in northern Alberta, there was reduced pairing success and a higher proportion of young birds nesting for the first time in ovenbird populations.

Although it is likely that the Project would affect songbirds within the LSA, the effects are likely limited to passerine song and the resulting mate selection within 2 km of sources of continuous noise during the nesting season. There are no other developments within the LSA, indicating that there would be negligible cumulative effects due to the canal construction. There are, however, other developments within the passerine cumulative effects study area, and these effects are assessed in Chapter 15.4 – Species at Risk and Key Bird Species. Construction activities are limited to a three-year period. During operations, noise emissions would be at or slightly above background levels at the North Gorge. The effect of noise to songbirds was considered to be of local geographic extent, medium-term, and would be periodic rather than continuous over the construction phase. Overall, the pathway was considered to be Minor. Effects of Project construction (including all Project components) are assessed in Section 15.4.

Dust Deposition Leading to Change in Vegetation Communities.

Canal construction would be the largest single source of dust from the Project. Existing vegetation along the canals is characterized by exposed bedrock and an emerging spruce forest. The site was subject to a forest fire in July 1999 and is in the process of regeneration. There are isolated pockets of mature spruce and mixed forest along the shoreline of the Twin Gorges Forebay, North Gorge canal, and the lower Taltson River. The location of the spoil piles was selected to minimize environmental impacts. The spoil piles would be placed between the canal and the Taltson River, which would isolate it and maintain a compact footprint for the Twin Gorges area.

During the construction phase of the Project, there is potential for dust deposition from blasting activities, equipment operation, aircraft, and vehicles. Accumulation of fugitive dust (i.e., total suspended particulate [TSP] deposition) produced from the Project may affect vegetation within the LSA.

All hauling would be done in winter, with the exception of the existing all-season road between the Twin Gorges facilities and airstrip, which covers a distance of approximately 5 km. In general, dust emission from the winter access road is minimal and, if extended over the whole year, should result in a negligible effect on annual depositions. Other minor sources of dust include staging areas, where limited summer activities may occur during the construction phase (up to three years).

The most deleterious effects of blasting dust are generally confined to the immediate area adjacent to the dust source, such as roads (Everett 1980; Walker and Everett 1987). Auerbach et al. (1997) stated that although the species composition may change and the above-ground biomass is lowered due to dust deposition, the ground cover is still maintained.

Direct effects from dust deposition from construction activities are predicted to be largely confined to within the Project footprint, with a negligible effect on adjacent habitat. Further, the short duration of construction (less than two years at the North Gorge) is unlikely to be of sufficient duration for the dust to cause effects to the vegetation community in the LSA. Therefore, this pathway was determined to be Minor for its effects to vegetation communities.

15.2.2.1.7.3 *Invalid Pathways*

No Invalid pathways were identified.

15.2.2.1.8 <u>Effects Analysis</u>

In the pathway validation analysis, all the identified pathways and mitigation measures were reviewed, and the magnitude of all the pathways following mitigation were determined to be Minor. Minor pathways were not carried through the effects assessment as the effects associated with these pathways are considered to be negligible.

15.2.2.2 NONACHO LAKE TERRESTRIAL RESOURCES

15.2.2.2.1 <u>Existing Environment</u>

Nonacho Lake is in the Nonacho Lake Ecoregion of the Taiga Shield (Ecosystem Classification Group 2008). The vegetation is dominated by black spruce forest with a shrubby or feature moss understory. Rock lichen and rock lichen woodland communities are also common. Precambrian metamorphic rock is most common in the Nonacho Lake area, the terrain is hummocky to hilly. Some eskers are also present (Ecosystem Classification Group 2008). Moose and barren-ground caribou are present, and muskox have recently expanded their range into the northern end of this Ecoregion, near Nonacho Lake and the Snowdrift River.

15.2.2.2.2 Valued Components

The identified Valued Components and rationale for their selection are as follows:

- Passerines (songbirds),
- Rare plants,
- Wetlands,
- Furbearers (beaver and muskrat),
- Moose,
- Waterfowl (canada goose, mallard, loons) and shorebirds,
- Whooping crane, and
- Rusty blackbird.

Passerines (songbirds) were selected as a Valued Component to measure the effects of dust, noise, and vegetation loss because they have small home ranges, making them susceptible to small area environmental changes. Further, they are abundant, easily studied, and there is available literature on their reaction to noise and vegetation loss.

Rare plants were selected as a Valued Component to measure potential effects of vegetation loss and dust on plants.

Wetlands were selected as a Valued Component as wetlands contribute to the ecological function and provide habitat for many wildlife species.

Furbearers (beaver and muskrat) were selected as a Valued Component as they have a significant social, economic, cultural and ecological role in the ecosystem. Beaver and muskrat are both important food and economic resources with respect to subsistence lifestyles and traditional land use. Concerns regarding the effects of changes in water levels on muskrat and beaver populations have been expressed during scoping sessions. Beaver and muskrat were identified as a valued ecosystem component during consultation with community stakeholders for the initial Water Effects Monitoring Program (Clark 1999). Their abundance, distribution, and condition were identified as important indicators of environmental change by the Åytsÿl K'e Dene First Nation (Åytsÿl K'e Dene First Nation 2002).

Moose were selected as a Valued Component as it is an important food source for the communities of Łutsel K'e, Fort Smith, and Fort Resolution (refer to Section 9.6 – Existing Human Environment). Concerns regarding the effects of the Project on moose populations were raised during the scoping sessions for the Project.

Waterfowl (Canada goose, mallard, loon) and shorebirds were selected as a Valued Component as they have a significant social, economic, cultural and ecological role in the ecosystem. The south shore of Great Slave Lake between the Slave River delta and Taltson River has been identified as a key migratory bird terrestrial habitat site and a globally significant Important Bird Area of Canada (Latour et al. 2006; Important Birds Areas of Canada 2004). This is due to its importance as a spring and fall staging area for migrating waterfowl and for the habitat available to nesting ducks. Waterfowl that should be given particular attention for assessing hydrological effects are species that build their nests on the ground close to water, species that feed primarily on fish, and species that feed on submerged aquatic plants within the littoral zone (i.e., dabbling ducks). Ducks and geese are important food items for residents of Łutsel K'e, Fort Smith, and Fort Resolution (refer to Section 9.6 – Existing Human Environment). They have also been selected as indicators of environmental change by the Åytsÿl K'e Dene First Nation (Autsyl K'e Dene First Nation 2002).

Whooping crane and rusty blackbird were selected as Valued Components as these are federally-listed species at risk that have a potential to be affected by the water drawdown.

15.2.2.2.3 Assessment Endpoints and Pathways

Many pathways identified for the construction activities at the Nonacho control structure and their validation were identical to those identified as part of the construction activities within the North Gorge area. This is a result of the similar construction components, techniques, and mitigation measures. Therefore, these pathways are not included below, and only those pathways that differ at Nonacho compared to Twin Gorges are presented in this section. The pathways that differ relate to water drawdown, as summarized in Table 15.2.7.

Pathway diagrams are contained in Section 13 – Water Fluctuations in the Taltson Watershed.

Table 15.2.7 — Specific Pathways Identified for Construction of the Nonacho Lake Control Structure

Valued Component	Assessment Endpoint	Pathway
Furbearers (beaver and muskrat)	Preservation of furbearer harvesting opportunities	Water drawdown: Direct mortality through lower water levels leading to reduced population abundance
Wetlands	Preservation of wetland extent	Water level changes leading to a change in flood regime which alters wetland extent in the Nonacho Lake Zone
Wetlands	Maintenance of wetland function	Water level changes leading to a change in flood regime which alters wetland function (hydrological, habitat and ecological) in the Nonacho Lake Zone
Moose	Preservation of moose harvesting opportunities	Water drawdown: Riparian habitat loss/modification leading to change in population abundance
Waterfowl (Canada goose, mallard, loons) and Shorebirds	Preservation of waterfowl harvesting opportunities Preservation of habitat and populations	Water drawdown: Riparian habitat loss/modification leading to change in population abundance

Valued Component	Assessment Endpoint	Pathway
Waterfowl (Canada goose, mallard, loons) and Shorebirds	Preservation of waterfowl harvesting opportunities Preservation of habitat and populations	Water drawdown: Reduced reproductive success leading to reduced population abundance
Waterfowl (Canada goose, mallard, loons) and Shorebirds	Preservation of waterfowl harvesting opportunities Preservation of habitat and populations	Water drawdown: Sub-lethal effect (changes to diet/submerged aquatic plant community) leading to reduced population abundance
Whooping crane	Preservation of habitat and populations	Water drawdown: Riparian habitat loss/modification leading to change in population abundance
Rusty blackbird	Preservation of habitat and populations	Water drawdown: Riparian habitat loss/modification leading to change in population abundance

15.2.2.2.4 Spatial and Temporal Boundaries

Environmental effects resulting from the required water drawdown activities would extend over the surface area of Nonacho Lake. As such, the local study area includes the riparian and shoreline areas of Nonacho Lake and the habitats at and immediately downstream of the Nonacho control structure.

Water drawdown through the existing sluice gates is anticipated to occur over a two, or more, month period beginning in autumn (October). The waterline elevation would remain lowered during the construction works associated with the spillway channel.

15.2.2.2.5 Project Components

Project components associated with construction of the Nonacho control structure are summarized in Table 15.2.8.

Table 15.2.8 — Project Components Associated with Construction of the Nonacho Control Structure

Project Component	Sub-components	Associated Activities	Geographic Extent	Schedule	Duration	Phase
Nonacho Lake Control Structure	Intake canal Control structure and hydro generation plant	Mob and site prep (clearing, levelling)	Facilities footprint + 100 m buffer	1st Q 2011to 2nd Q 2011	6 months Continuous	Construction
	Intake canal Control structure and hydro generation plant	Terrestrial blasting and excavation Trucking Waste management Waste rock storage Riparian zone clearing	Facilities footprint + 100 m buffer	1st Q 2010 to 4th Q 2011	12 months Continuous	Construction

Project Component	Sub-components	Associated Activities	Geographic Extent	Schedule	Duration	Phase
Nonacho Lake Control Structure	Intake canal Control structure and hydro generation plant	Aggregate processing	Facilities footprint + 100 m buffer	2nd Q 2011	4 months	Construction
	Intake canal Control structure and hydro generation plant	Terrestrial concrete works	Facilities footprint + 100 m buffer	2nd Q 2011	3 months	Construction
	Intake canal Control structure and hydro generation plant	In-stream concrete works	Not required			
	Intake canal Control structure and hydro generation plant	In-stream blasting	Facilities footprint + 100 m buffer	4th Q 2011	2 weeks	Construction
	Intake canal Control structure and hydro generation plant	Site reclamation	Facilities footprint + 100 m buffer	4th Q 2011	2 weeks	Construction
	Dam modification	In-stream rock placement	Facilities footprint and a 100 m buffer	2nd to 3rd Q 2011	2 months	Construction
	Spillway raise	In-stream concrete work (dry work as lake lowered)	Facilities footprint and a 100 m buffer	2nd Q 2011	1 month	Construction
	Mechanical and electrical	Transport and installation of equipment	Facilities footprint and a 100 m buffer	1st Q 2011 to 1st Q 2012	15 months Q1 delivery, Q4/Q1 install	Construction
	Construction camp and work zone	Mob; setup; Waste (sewage, refuse, metals, incineration, etc.); Demob & reclamation		1st Q 2011 to 2nd Q 2012	18 months	Construction

15.2.2.2.6 Mitigation

The mitigation measures are summarized in Table 15.2.9.

Table 15.2.9 — Summary of the Proposed Mitigation by Pathway for Construction Activities Associated with the Nonacho Control Structure

Pathway	Pathway Duration	Proposed Mitigation
Water Drawdown: Changes in Waterline Elevation with Respect to Bird and Amphibian Habitat	Construction	Water levels would be drawn down in late autumn and early winter

15.2.2.2.7 Pathway Validation

The results of the pathway validation assessment are summarized in Table 15.2.10. Rationale for the classification of pathways as Valid, Minor or Invalid is provided in the following table.

Table 15.2.10 — Pathways to the Valued Components from Various Project Components Associated with the Construction of the Nonacho Control Structure

Project Component	Pathway	Pathway Validation
Nonacho Lake Control Structure	Water drawdown: Furbearers (beaver and muskrat) direct mortality through lower water levels leading to reduced population abundance	Valid
	Water level changes leading to a change in flood regime which alters wetland extent in Nonacho Lake	Minor
	Water level changes leading to a change in flood regime which alters wetland function (hydrological, habitat and ecological) in Nonacho Lake	Minor
	Water drawdown: Moose riparian habitat loss/modification leading to change in population abundance	Invalid
	Water drawdown: Waterfowl riparian habitat loss/modification leading to change in population abundance	Invalid
	Water drawdown: Waterfowl reduced reproductive success leading to reduced population abundance	Invalid
	Water drawdown: Waterfowl sub-lethal effect (changes to diet/submerged aquatic plant community) leading to reduced population abundance	Invalid
	Water drawdown: Whooping Crane riparian habitat loss/modification leading to change in population abundance	Invalid
	Water drawdown: Rusty Blackbird riparian habitat loss/modification leading to change in population abundance	Invalid

In total, nine pathways have been identified between the terrestrial components and the Project component Nonacho Lake Control Structure. Of the nine identified pathways, one is a Valid pathway, two are Minor pathways and six are Invalid pathways.

15.2.2.2.7.1 *Valid Pathways*

Water Drawdown: Furbearers (Beaver and Muskrat) Direct Mortality Through Lower Water Levels Leading to Reduced Population Abundance

The pathway of direct mortality to furbearers was Valid as water levels would decrease to an elevation of 322.45 cm. This decrease would range from 0.5 m to 0.8 masl between November and April. Furbearers (beaver and muskrat) are known to be directly affected by the water levels, as they depend on the aquatic habitat for feeding and shelter. Changes in the water levels in the winter may affect the freezing elevation at and within the furbearers' shelter, causing direct mortality.

15.2.2.2.7.2 *Minor Pathways*

Water Level Changes Leading to a Change in Flood Regime Which Alters Wetland Extent in the Nonacho Lake Zone

Marsh wetland communities undergo structural changes if their hydrological regime is not maintained; this includes both water level increases and reductions. Reducing water levels would not alter the flood regime because of the timing (i.e., winter) and duration of this activity. There would be little to no alteration of wetland extent. As such, the pathway was considered Minor.

Water Level Changes Leading to a Change in Flood Regime Which Alters Wetland Function (hydrological, habitat and ecological) in the Nonacho Lake Zone

Reducing water levels would not alter the flood regime because of the timing and duration of this activity. There would be little to no alteration of wetland function. As such, the pathway is considered Minor.

15.2.2.2.7.3 *Invalid Pathways*

Water Drawdown: Moose Riparian Habitat Loss/Modification Leading to Change in Population Abundance

Moose use riparian areas for foraging on submerged aquatic vegetation during the spring and summer; however, foraging within the riparian habitat during the winter would occur on willows, which would not be affected by the lower water levels. As such, pathways for moose were considered Invalid.

Water Drawdown: Changes in Waterfowl, Whooping Crane and Rusty Blackbird Population Abundance

No waterfowl, shorebirds, or songbirds would be present within the area during the drawdown as it would occur during autumn and winter. As such, the pathways for waterfowl, whooping crane and rusty blackbird are considered Invalid.

15.2.2.2.8 Effects Analysis

In the pathway validation analysis, all the identified pathways and mitigation measures were reviewed, and one of the pathways following mitigation was determined to be Valid: *Furbearers (beaver and muskrat) direct mortality through lower water levels leading to reduced population abundance.*

The lowering of water levels in Nonacho Lake during the winter in order to proceed with construction activities was assessed as an adverse effect with a moderate magnitude for muskrat and a low magnitude for beaver at the local scale. Lowered water levels could result in freeze-out and/or entranceways to shelters becoming exposed and subsequent increased susceptibility to predation. Water levels would be lowered to 322.45 masl, which is up to 0.8 m lower than baseline conditions during the winter.

The overall effects classification and determination of significance for the identified residual effect on the terrestrial resources was combined with all the residual effects associated with the aquatic resources in Sections 15.2.5 and 15.2.6 of this Subject of Note.

15.2.3 Fisheries Resources

The proposed in-stream and near-stream works have the potential to interact with the aquatic environment at the North Gorge canal, South Gorge spillway, minimum release structure at the South Valley Spillway and the Nonacho control structure.

The construction methodologies and in-stream works required for the construction of the North Gorge, South Gorge spillway and the minimum release structure at the SVS are relatively similar (refer to Section 6.5.4 – Construction Methodologies), and the habitat conditions at each of these sites are also similar, with slight variances in the depth and cover conditions. As such, the effects assessment analyzed the interactions between the construction activities and the fisheries resources within the Forebay concurrently.

The aquatic habitat conditions in Nonacho Lake differ in comparison to the Twin Gorges Forebay. As such, the potential interactions between the construction activities and the fisheries resources within Nonacho Lake were analyzed separately from the Twin Gorges area.

15.2.3.1 Twin Gorges Forebay Fisheries Resources

15.2.3.1.1 Existing Environment

The Twin Gorges Forebay is a lake that was flooded during the installation of the Twin Gorges dam. The shoreline is variable, though generally composed of bedrock supporting small shrubs and trees. Due to the past flooding of the Forebay, the shoreline is littered with large and small woody debris and standing dead trees. A significant amount of standing timber remains under the surface of the water. Aquatic vegetation is variable and ranges from no vegetation to sparse sedge coverage along the steeper shorelines, to areas of dense aquatic vegetation along the more shallow shorelines.

North Gorge Canal

Aquatic habitat around the inlet location to the North Gorge is similar to the surrounding area in the Twin Gorges Forebay and is characterized by a rocky shoreline with steep stream margins (Plate 15.2.1). Under baseline conditions, a shallow bedrock bench extends approximately 2 m to 5 m into the aquatic habitat at the inlet location before dropping off steeply to depths greater than 5 m. No in-stream submergent and/or emergent vegetation or large woody debris is present.

Plate 15.2.1 — Proposed Inlet Location of the North Gorge Canal

The river bank up and downstream of the proposed tailrace is characterized by bedrock cliffs interspersed with small elevated wetlands (Plate 15.2.2). At the confluence of the proposed tailrace and the Taltson River, a small (approximately 45 m^2) wetland platform consisting of various emergent vegetation species and extends approximately 3 m from the bedrock cliff to the edge of the aquatic environment; the wetland platform does not extend into the aquatic habitat at flows of about 200 m^3/s. At the edge of the wetland platform, water depths drop steeply and no in-stream submergent or emergent vegetation is present. Fish sampling (Cambria Gordon 2008b) identified a considerable number (>1,000) of juvenile white suckers immediately up and downstream of the tailrace confluence with the Taltson River.

Plate 15.2.2— Proposed Tailrace Location of the North Gorge Canal

South Gorge Bypass Spillway

The aquatic habitat conditions associated with the South Gorge spillway are nearly identical to those at the North Gorge. Substrates are dominated by bedrock with significant amounts of large angular rip-rap associated with the existing dam facilities. No in-stream submergent/emergent vegetation or woody debris was present. A snorkel survey conducted by Cambria Gordon (2008b) noted that the placement of the rip-rap has created numerous crevasses that provide excellent cover for fish. The stream margins are steeply sloped and no bench habitats exist. Figure 6.4.7 in Chapter 6 illustrates the location and profile of the South Gorge spillway.

Minimum Release Structure

The aquatic habitat immediately adjacent to the SVS is similar to the aquatic habitat conditions at both the North and South Gorge locations, with the exception of velocities. Water velocities within the Forebay increase closer to the sill of the SVS. The substrate conditions are primarily bedrock with no in-stream submergent or emergent vegetation (Plate 15.2.3).

Plate 15.2.3— Minimum Release Structure Location and Habitat Map

15.2.3.1.2 Valued Components

Valued Components were selected based on the comments received by government and community agencies during the MVLWB screening, MVEIRB scoping sessions, and known habitat conditions within and adjacent to Twin Gorges Forebay. The identified valued component is fish populations, and rationale for this selection is provided below.

Fish populations were selected as a Valued Component as it has a significant social, economic, cultural and ecological role in the ecosystem. Fish are present and widely distributed throughout the Project area and follow the requirements for the valued component selection: this component is important and easily understood by the local residents, it is regulated by the government agencies, it can be easily measured or described, it represents current environmental conditions, and it allows for a cumulative effects analysis.

15.2.3.1.3 Assessment Endpoints and Pathways

The Department of Fisheries and Oceans Canada (DFO) has developed Pathways of Effects (POEs) for common in-stream and land-based activities. These POEs describe "cause and effect relationships" that are known to exist and the mechanisms by which stressors ultimately lead to effects in the aquatic environment. Each cause-and-effect relationship is represented as a line, known as a pathway, connecting the activity to a potential stressor, and a stressor to some ultimate effect on fish and fish habitat, known as an assessment endpoint. For each pathway, mitigation measures can be applied to reduce or eliminate a potential effect.

To date, DFO has identified 19 in-stream and land-based activities, of which 5 have direct interactions with the Project construction activities. The identified POE's include Vegetation Clearing, Excavation, Use of Explosives, Use of Industrial Equipment and Removal of Aquatic Vegetation as summarized in Figure 15.2.1 to Figure 15.2.5, respectively.

In addition to the above noted DFO POEs, DFO Protocols for Winter Water Withdrawal in the Northwest Territories (DFO 2005) and professional knowledge of acid-rock drainage issues were used to identify other aquatic pathways. A complete review of the available DFO Risk Assessment Methodology, pathways and assessment endpoints is available on the DFO web page: http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/pathways-sequences/water-aquatique_e.asp.

Figure 15.2.1 — Vegetation Clearing Pathway of Effect Flow Diagram

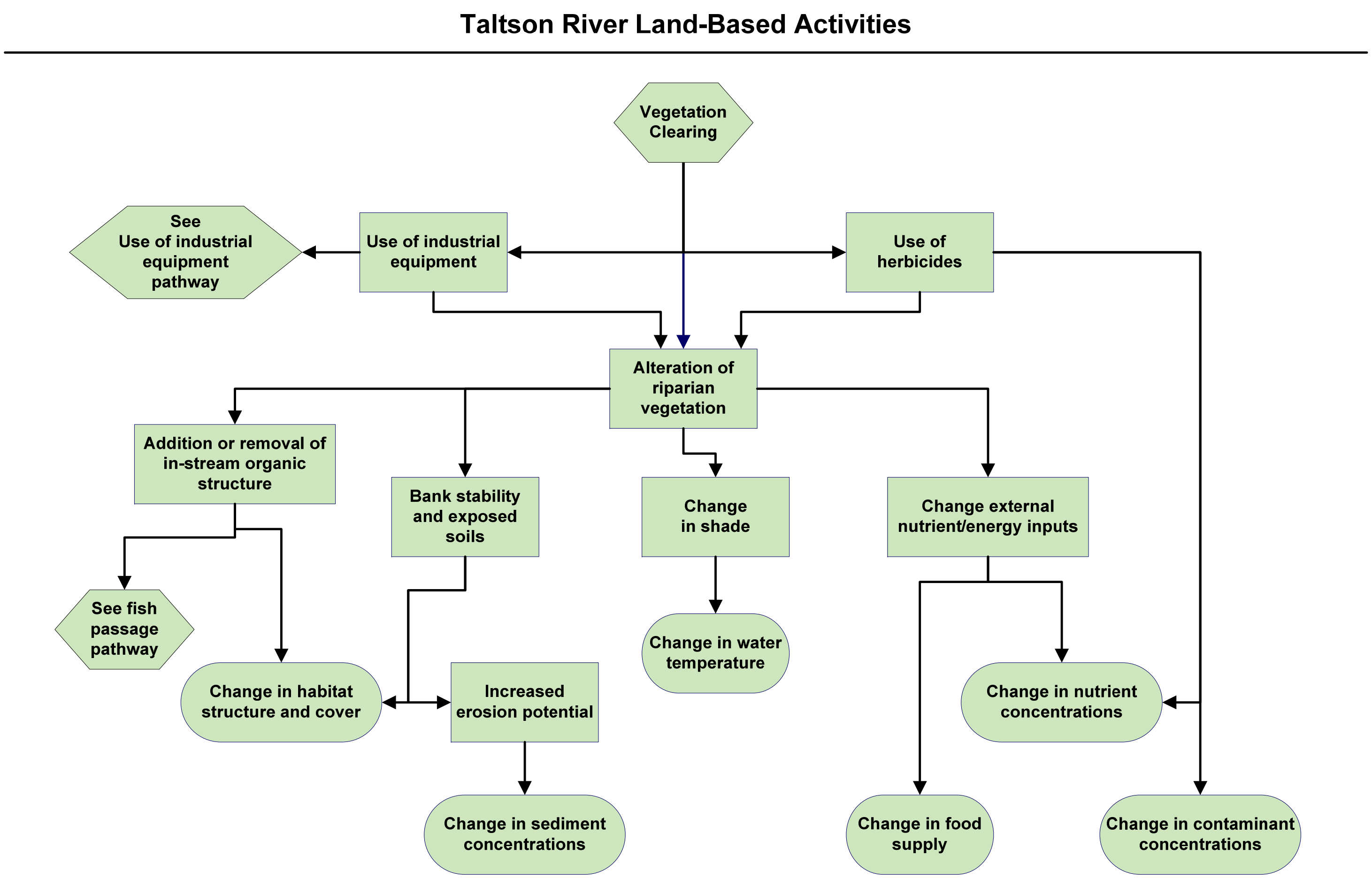


Figure 15.2.2 — Excavation Pathway of Effect Flow Diagram

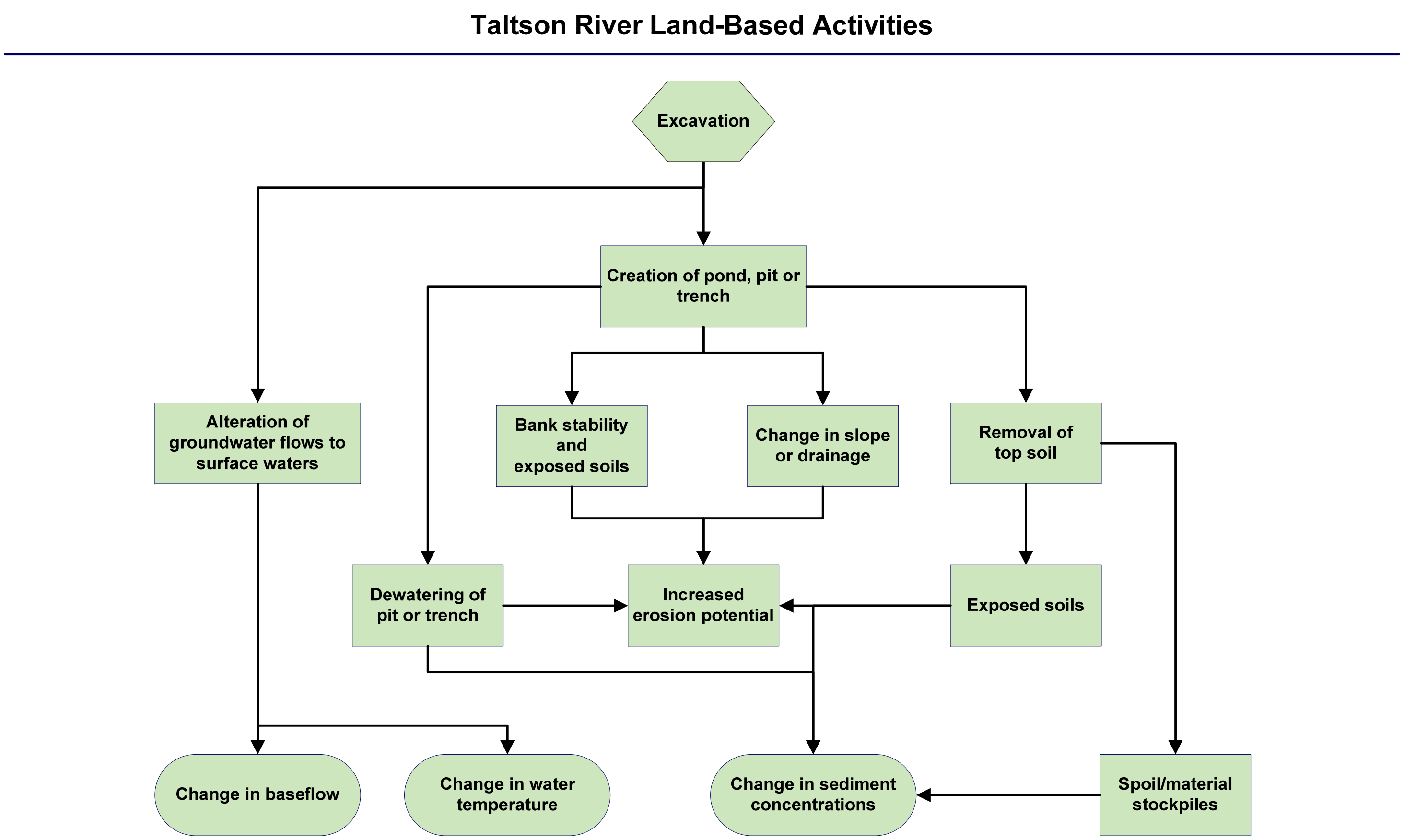


Figure 15.2.3 — Use of Explosives Pathway of Effect Diagram

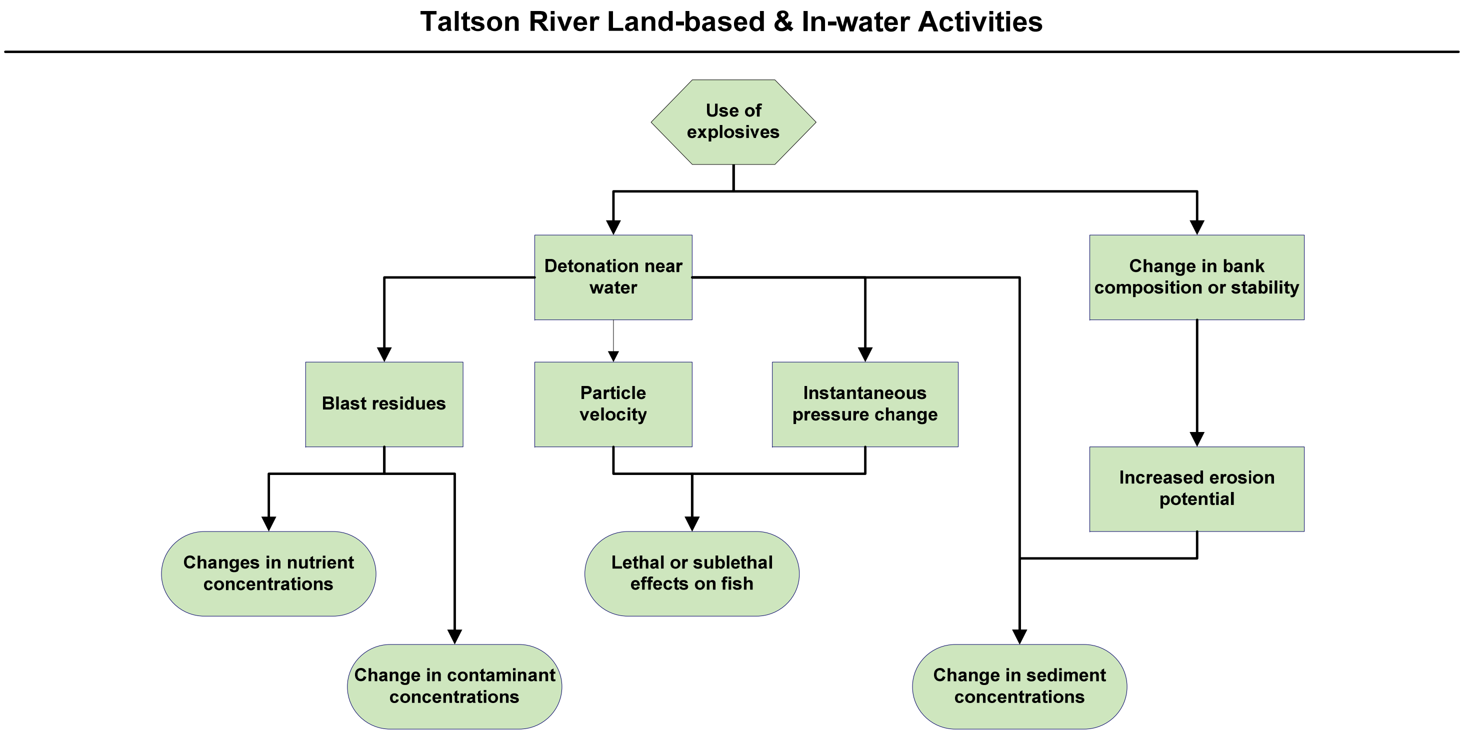


Figure 15.2.4 — Use of Industrial Equipment Pathway of Effect Diagram

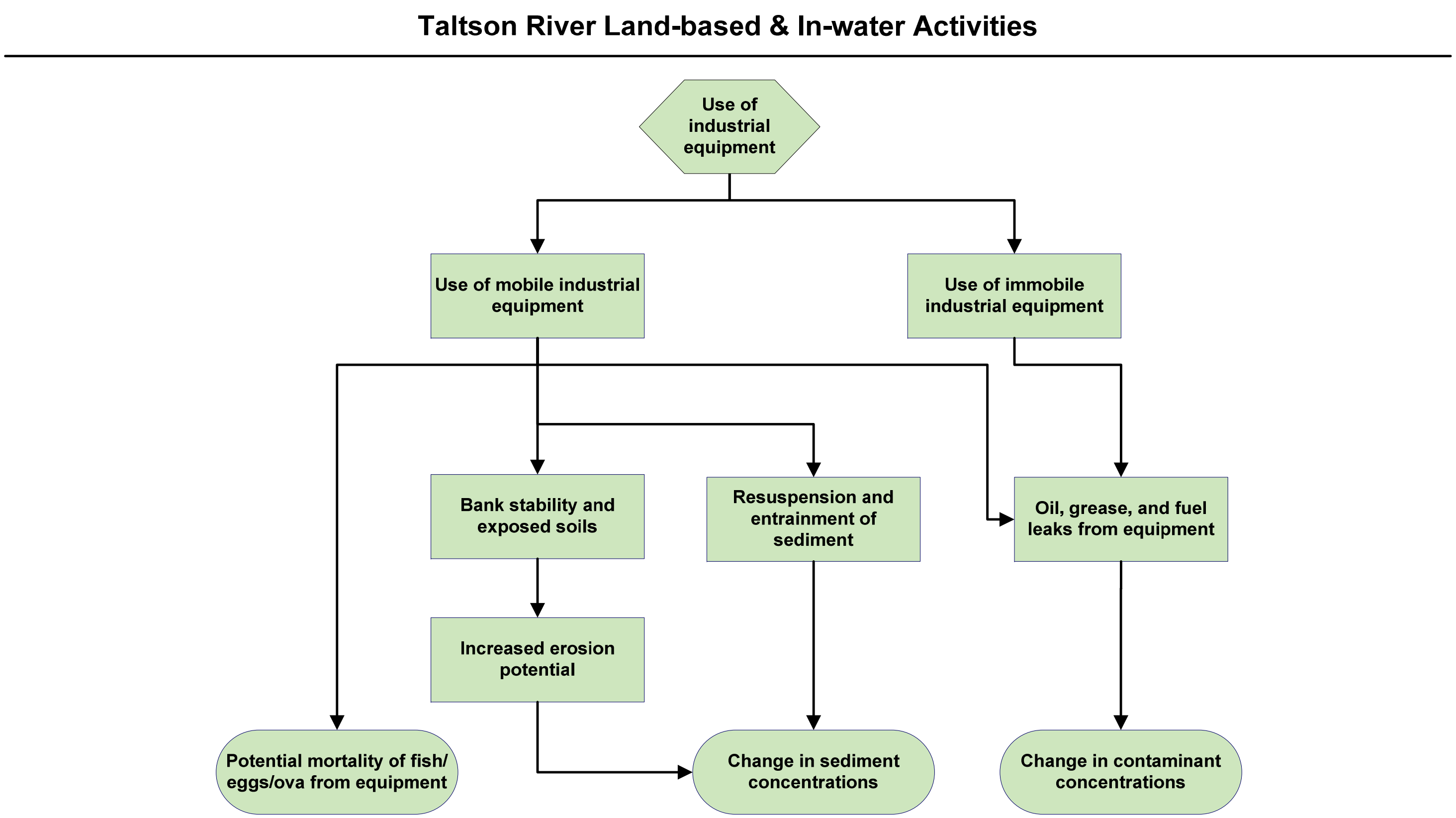


Figure 15.2.5 — Addition or Removal of Aquatic Vegetation Pathway of Effect Diagram

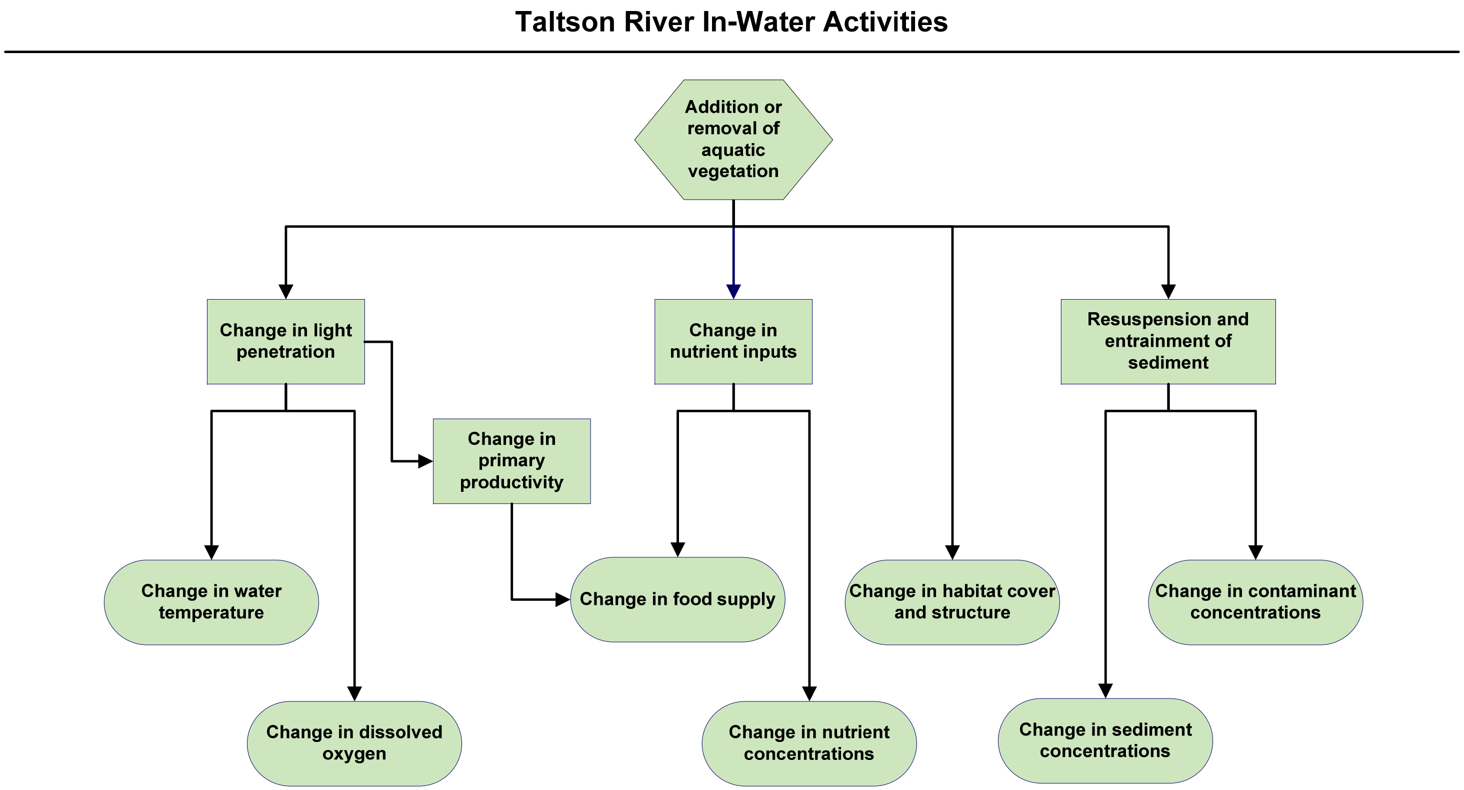


Table 15.2.11 summarizes the assessment endpoints, and the pathways leading to those endpoints for the valued component fish populations. As many of the pathways identified in Figure 15.2.1 to Figure 15.2.5 are similar and lead to identical assessment endpoints, duplicated pathways were not considered for this assessment.

Table 15.2.11 — Valued Component, Assessment Endpoints and Pathways for Construction Activities in the Twin Gorges Forebay

Valued Component	Assessment Endpoint	Pathway
Fish Populations	Persistence of Fish Abundance	Vegetation Clearing Leading to Change in Bank Stability or Aquatic Habitat
		Vegetation Clearing: Use of Herbicides Leading to Change in Contaminant Concentrations
		Excavation Leading to Change in Bank Stability and Erosion Potential
		Excavation Leading to Change in Groundwater Flows
		Addition or Removal of Aquatic Vegetation Leading to Change in Habitat Structure, Cover, or Nutrient Inputs
		Addition or Removal of Aquatic Vegetation Leading to Change in Light Penetration
		Water Withdrawal Leading to Change in Fish or Fish Habitat
		Explosives Leading to Change in Bank Stability and Increased Erosion Potential
		Explosives Leading to Blast Residues
		Explosives Leading to Fish Mortality
		Industrial Equipment Leading to Change in Sediment Concentrations
		Industrial Equipment Leading to Change in Contaminant Concentrations
		Industrial Equipment Leading to Fish Disturbance or Mortality
		Acid Rock Drainage Leading to Contaminated Runoff

15.2.3.1.4 Spatial and Temporal Boundaries

The analysis of pathways between the construction activities and the aquatic environment was conducted on a local study area only. The extent of the local study area was dependent on the construction activity, as described in the following sections.

15.2.3.1.4.1 Riparian Vegetation Clearing

Vegetation clearing is required to facilitate the construction activities within the Twin Gorges Forebay. The spatial extent considered for potential interactions between riparian vegetation clearing and the aquatic environment encompassed the width of the disturbance areas and extended inland 30 m perpendicularly from the high water mark.

15.2.3.1.4.2 *Addition or Removal of Aquatic Vegetation*

The removal of in-stream vegetation may be required to facilitate the entrance and discharge conditions at each of the proposed construction sites. The spatial extent considered for potential interactions between in-stream vegetation removal and the aquatic environment encompassed a 30 m radial width from the disturbed area.

15.2.3.1.4.3 *In-stream Excavation*

Excavation of bedrock substrates may be required at each of the proposed construction sites in the in-stream environment. The spatial extent considered for potential interactions between the excavation activities and the aquatic environment encompassed a 30 m radial width from the disturbed area.

15.2.3.1.4.4 *Water Withdrawal*

The use of concrete may be required at each of the construction sites in the Twin Gorges Forebay. Concrete would be cast in place, thereby requiring a considerable amount (>100 m^3) of water from the Twin Gorges Forebay. The spatial extent considered for potential interactions between the water withdrawal required for the concrete mix and the aquatic habitats in the Twin Gorge Forebay include a 5 m radius from the point of water extraction. A spatial extent of 5 m is based on the anticipated increase in velocity conditions as a result of the water pump.

15.2.3.1.4.5 *In-stream Use of Explosives*

In-stream blasting may be required at each of the construction sites within the Twin Gorges Forebay. The spatial extent considered for potential interactions between in-stream blasting activities and the aquatic habitat in the Twin Gorge Forebay includes a 100 m radius from each blast location. The 100 m radius is based on the anticipated charge size and the DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters.

15.2.3.1.4.6 *Use of Industrial Equipment*

Industrial equipment such as dump trucks and loaders would be required to remove fractured bedrock from the in-stream habitats following in-stream blasting. Industrial equipment movement in the in-stream habitats would be limited to the width (15 m) and length (30 m) of a rock causeway.

15.2.3.1.4.7 *Acid Rock Drainage*

The excavation and storage of waste rock would be required to facilitate the construction of the North Gorge and South Gorge spillway; storage of blast rock would not be required adjacent to the SVS. The spatial extent considered for the interaction between acid rock drainage from the waste rock and the aquatic environment includes the point source of runoff.

15.2.3.1.5 Project Components

Refer to Section 15.2.2.1.5 for a complete discussion on the Project components associated with the construction activities within the Twin Gorges Forebay.

15.2.3.1.6 Mitigation

The mitigation measures associated with the construction activities in the Twin Gorges Forebay are summarized in Table 15.2.12.

Table 15.2.12 — Mitigation Measures Associated with the Construction Activities in the Twin Gorges Forebay

Pathway	Pathway Duration	Proposed Mitigation
Vegetation clearing leading to change in bank stability or aquatic habitat	Construction	An Erosion and Sediment Control Environmental Management Plan would be implemented and followed. Vegetation clearing activities would be conducted in winter. Vegetation clearing would be limited to the width of the proposed North Gorge canal. Selection of the inlet and tailrace locations along the proposed North Gorge canal.
Vegetation clearing: Use of herbicides leading to change in contaminant concentrations.	Construction	The Project would not use herbicides for vegetation clearing purposes.
Excavation leading to change in bank stability and erosion potential	Construction	An Erosion and Sediment Control Environmental Management Plan would be implemented and followed.
Excavation leading to change in groundwater flows	Construction	Excavation would be restricted to competent rock.
Addition or removal of aquatic vegetation leading to change in habitat structure, cover, or nutrient inputs	Construction	Selection of the location of the inlet and tailrace locations of the North Gorge to limit the quantity of aquatic vegetation removal.
Addition or Removal of aquatic vegetation leading to change in light penetration	Construction	Selection of the location of the inlet and tailrace locations of the North Gorge canal to limit the quantity of aquatic vegetation removal.
Water Withdrawal Leading to change in fish or fish habitat	Construction	DFO Protocols for Winter Water Withdrawal in the Northwest Territories would be followed. DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines would be followed.
Explosives leading to change in bank stability and increased erosion potential	Construction	DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters would be followed. Charge size would be limited to that required to fracture the bedrock channel (large blasts would weaken the integrity of the rock causeway). An Environmental Construction Monitor would be present during in-stream construction activities.

Pathway	Pathway Duration	Proposed Mitigation
Explosives leading to blast ersidues	Construction	DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters would be followed. Water-resistant stick explosives would be used for in and near-stream works. Blast size would be limited to that required to fracture the bedrock and ensure vaporization of explosives. An Environmental Construction Monitor would be present during in-stream construction activities.
Explosives leading to fish mortality	Construction	DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters would be followed. Prior to blast, the immediate area would be isolated of fish.
Industrial equipment leading to change in sediment concentrations	Construction	An Erosion and Sediment Control Environmental Management Plan would be implemented and followed. An Environmental Construction Monitor would be present during the in-stream construction activities.
Industrial equipment leading to change in contaminant concentrations	Construction	A Spill Response Environmental Management Plan would be implemented and followed. An emergency spill response kit would be on-site during all in-stream construction activities. An Environmental Construction Monitor would be present during the in-stream construction activities.
Industrial equipment leading to fish disturbance or mortality	Construction	Industrial equipment would not be directly within the in-stream habitat.
Acid rock drainage leading to contaminated runoff	Construction	Testing would be conducted to determine acid-rock generation potential. Blast rock would be properly stored and handled.

15.2.3.1.7 Pathway Validation

The validation process involved linking the effects of the construction activities to the specific life history traits (survival, growth and reproductive potential) of the Valued Components. Therefore, a pathway was considered Valid if the effect could result in a change to an assessment endpoint. Minor pathways recognize there may be a change to an assessment endpoint; however, the resulting effect is anticipated to be negligible. A pathway classified as Invalid is often associated with hydroelectric projects; however, is not applicable, or has no effect for this Project.

The results of the pathway validation assessment are summarized in Table 15.2.13 below. Rationale for the classification of pathways as Valid, Minor or Invalid is provided following the table.

Table 15.2.13 — Pathways to the Valued Component from Various Project Components

Project Component	Pathway	Pathway Validation
Twin Gorges Facilities	Vegetation clearing leading to change in bank stability or aquatic habitat	Minor
	Vegetation clearing: use of herbicides leading to change in contaminant concentrations	Invalid
	Excavation leading to change in bank stability and erosion potential	Minor
	Excavation leading to change in groundwater flows	Invalid
	Addition or removal of aquatic vegetation leading to change in habitat structure, cover, and nutrient inputs	Minor
	Addition or removal of aquatic vegetation leading to change in light penetration	Invalid
	Water withdrawal leading to change in fish or fish habitat	Minor
	Explosives leading to changes in bank stability and increased erosion potential	Minor
	Explosives leading to blast residues	Minor
	Explosives leading to fish mortality	Minor
	Industrial equipment leading to change in contaminant concentration	Minor
	Industrial equipment leading to change in sediment concentrations	Minor
	Industrial equipment leading to fish disturbance or mortality	Minor
	Acid rock drainage leading to contaminated runoff	Invalid

In total, 14 pathways have been identified between the Project components and the aquatic and terrestrial components in the Forebay. Of the 14 identified pathways, none are Valid pathways, 10 are Minor pathways and 4 are Invalid pathways.

15.2.3.1.7.1 *Valid Pathways*

No Valid pathways were identified.

15.2.3.1.7.2 *Minor Pathways*

Vegetation Clearing Leading to Change in Bank Stability or Aquatic Habitat

Riparian vegetation removal can lead to a decrease in bank stability and increase bank erosion, which can alter the habitat structure and cover conditions through undercutting and bank sloughage. The riparian zone (30 m inland from the high water mark) associated with the proposed inlet locations along the canals are dominated by steep bedrock cliffs that contain sparse riparian vegetation and limited erodible substrates.

The existing communities of vegetation within the riparian zone provide little to no solar protection, insect fall or bank stabilization. The limited removal of sparse vegetation at the inlet and tailrace locations would result in no or negligible changes to the habitat structure and cover conditions, sediment, water temperature, or nutrient concentration in the Twin Gorges Forebay and the lower Taltson River. As such, the pathway has been classified as Minor.

Excavation Leading to Change in Bank Stability and Erosion Potential

Increased erosion of stream bank soils and rocks results in an excess of fragmented organic and inorganic material, which can be transported by water, wind, ice and gravity. Changes to sediment concentrations can alter the physical process, structural attributes and ecological conditions in a water body.

The excavation of substrates along the terrestrial environment of the Forebay would involve the removal of bedrock with explosives and industrial equipment. Substrates within the in-stream habitat would also be required to facilitate the engineered entrance and discharge conditions at the construction site locations.

Within the Twin Gorges Forebay, aquatic habitats are primarily steep bedrock slopes that drop off steeply to depths between 2 m and 5 m. No in-stream submergent and/or emergent vegetation or large woody debris is present and substrates are dominated by bedrock. At the outlet of the North Gorge, a small (about 45 m^2) wetland platform consisting of various emergent vegetation species extends approximately 3 m from the bedrock cliff to the edge of the aquatic environment; the wetland platform did not extend into the aquatic habitat at flows of ~200 m^3/s. The wetland was dominated by silt and sand substrates; however, at the edge of the wetland platform, the stream margin is steeply sloped and is dominated by bedrock and boulders.

Due to the substrate types associated with the Forebay, sediment concentrations are not anticipated to be altered by the excavation of materials within the in-stream habitats; however, the tailrace location of the North Gorge canal would result in an initial flush of finer (silts and sands) substrates that would wash out in a short duration. Therefore, the required construction activities would result in negligible changes to the bank stability and sediment concentrations within the Twin Gorges Forebay and lower Taltson River. As such, the pathway has been classified as Minor.

Addition or Removal of Aquatic Vegetation Leading to Change in Habitat Structure, Cover or Nutrient Input

Fish habitat structure and cover is predominately a measure of four parameters: depth, velocity, cover and substrate. The removal of in-stream submergent and emergent vegetation could result in a change to baseline cover conditions for spawning and rearing fish. In addition, the aquatic food supply must be plentiful and diverse to sustain the productivity of a watershed. Typically, the productivity of the benthic food web is limited by the nutrient elements phosphorus and nitrogen. Nutrient exchanges that provide phosphorus and nitrogen to a water body occur between the near-shore zone and riparian zones during high-flow events (Clarke et al, 2008).

There is no in-stream submergent or emergent vegetation associated with the Twin Gorges Forebay. The river bank up and downstream of the North Gorge canal is characterized by bedrock cliffs interspersed with small elevated wetlands. At the confluence of the proposed North Gorge tailrace and the Taltson River, a small (about 45 m^2) wetland platform consisting of various emergent vegetation species extends approximately 3 m from the bedrock cliff to the edge of the aquatic environment; the wetland platform did not extend into the aquatic habitat at flows of ~200 m^3/s. At the edge of the wetland platform, water depths drop steeply and no in-stream submergent and emergent vegetation was present. It is not likely that northern pike would utilize the area due to the lack of in-stream submergent and/or emergent vegetation, except for the small wetland platform when inundated during high flow events. Therefore, the removal the in-stream vegetation at the tailrace would result in negligible changes to the cover conditions or nutrient concentrations for fish in lower Taltson River; there are no changes to in-stream baseline vegetation conditions at the inlet location. As such, the pathway has been classified as Minor.

Water Withdrawal Leading to a Change in Fish or Fish Habitat

Fish habitat structure and cover is predominately a measure of four parameters: depth, velocity, cover and substrate. Water withdrawal activities would be conducted in accordance with the DFO Protocol for Winter Water Withdrawal in the Northwest Territories and would result in less than 0.01 m drop in waterline elevation in the Twin Gorges Forebay. Therefore, water withdrawal would result in no change to the baseline fish habitat structure and cover conditions.

Water withdrawal activities would require the use of pumps, which could result in fish entrapment and potential mortality. The DFO Freshwater Intake End of Pipe Fish Screen Guidelines would be adhered to, which would prevent fish entrapment within the pumps. Therefore, water withdrawal would result in no changes to fish mortality within the Twin Gorges Forebay. As such, water withdrawal has been classified as Minor.

Explosives Leading to Fish Mortality

The proposed construction activities within the Twin Gorges Forebay would require in-stream blasting. In-stream blasting activities could result in underwater particle movement, vibrations within the bedrock channel bottom, or instantaneous pressure change in the aquatic environment.

Underwater particle movement and vibrations within the channel bottom have the potential to interact with rearing and spawning fish and incubating eggs at and adjacent to the blast site location. An increase in pressure can interact with the swim bladders of spawning and rearing fish at or adjacent to the blast site. The DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters would be adhered to, which would guide setback restrictions for the protection and conservation of fish. Therefore, in-stream blasting would result in negligible changes to the disruption, disturbance and/or mortality of spawning and rearing fish and incubating eggs. As such, the pathway has been classified as Minor.

Explosives Leading to Change in Bank Stability and Increased Erosion

Increased erosion of stream bank soils and channel beds can increase sediment concentrations and affect the physical processes, structural attributes and ecological conditions of a water body.

The channel bed and banks at the proposed construction sites are predominately characterised by bedrock and boulder substrates; however, some sands and silts are found at the tailrace location of the North Gorge canal. At the tailrace of the North Gorge a small (about 45 m^2) wetland platform consisting of silt and sand substrates is present. The removal of the sand and silt substrates at the inlet and tailrace locations would be completed by industrial equipment prior to the use of explosives, which has been addressed by other pathways.

The alteration of the bank and channel bottom conditions underlying the sands and silts would not expose erodible substrates or result in bank destabilization. Therefore, the use of explosives would result in no or negligible changes to sediment concentrations as a result of increased erosion and bank instability. As such, the pathway has been classified as Minor.

Explosives Leading to Blast Residues

Blast residues could cause contamination or nutrifying elements such as nitrogen and phosphorus and mineral compounds such as ammonia, nitrates, nitrites and orthophosphates to be introduced into the aquatic environment of the Twin Gorges Forebay and/or the lower Taltson River.

Blast residue is typically associated with loose or bulk explosives in unconfined holds and/or poor handling practices, which allows unconsumed product to be dissolved and transported by surface water. In-stream blasting would occur under a constructed rock causeway and in the bedrock channel bottom. Water-resistant encased (“stick”) explosives would be used in lieu of pellet ANFO. Holes would be PVC-lined to avoid collapse and ensure all explosives are completely detonated. Terrestrial blasting away from in-stream habitat would use pellet ANFO explosives, which would be openly poured into drill holes. The bedrock along the proposed canals is competent rock; therefore explosives would not escape the drill hole. In addition, through the proper handling and appropriately sized charges, the majority, if not all, the explosives would become vaporized upon detonation. Therefore, the use of explosives would result in no or negligible changes to contaminant concentrations as a result of blast residues. As such, the pathway has been classified as Minor.

Industrial Equipment Leading to Change in Contaminant Concentration

Site clearing and preparation would require the use of heavy machinery and concrete for construction. These activities could cause an increase in contaminant concentrations, including toxins and pollutants in sediments and waters that breach the range of chemical parameters that support healthy aquatic communities, and seriously affect fish and fish habitat. Working with heavy machinery introduces the potential for spills or accidental discharges during the construction phase of the Project. Sources of accidental discharges and/or spills include concrete wash water, gasoline or diesel spills, exposed soils and sediments, and hydraulic lines on machinery.

General construction practices would adhere to the Erosion and Sediment Control Environmental Management Plan and the Spill Response Environmental Management Plans. In general, construction works with heavy machinery would be performed using best management practices and techniques to contain the work site and limit the potential for contaminated releases into the aquatic environment. All concrete work would be managed so pours are done in the dry. When concrete works can not be completed in the dry, site-specific operational and management plans would be developed with the contractor, and submitted to DFO prior to conducting the works. Where in-stream or near-stream concrete work is required, mitigation measures may include site isolation and/or the introduction of carbon dioxide to maintain pH within the CCME standards for the protection of aquatic life. Therefore, the use of heavy machinery would result in no or negligible changes to the contaminant concentrations in the Twin Gorges Forebay and lower Taltson River as a result of oil, grease and fuel leaks. As such, the pathway has been classified as Minor.

Industrial Equipment Leading to Change in Sediment Concentrations

An increase in sediment concentrations could result in an excess of fragmented organic and inorganic material within the water column, which could affect water quality, light penetration and damage fish gills. The use of industrial equipment within and adjacent to in-stream habitats could result in fine substrates and sediments to become re-suspended in the water column.

Heavy machinery use within the aquatic habitats would be required at each of the construction site within the Twin Gorges Forebay. Movement of heavy machinery would be limited to a constructed rock pad. The pad would be constructed from waste rock associated with the terrestrial component of the canals and would be relatively clean of finer particles. Addition of the waste rock is anticipated to re-suspend some of the finer particles associated with the channel bottom. Overall, the addition of substrate material into the aquatic environment of the Twin Gorges Forebay would result in an initial flush of finer particles that would wash out in a short duration. Velocity conditions at the proposed construction sites are low (<0.1 m/s), which would limit the transport of suspended sediments downstream.

The removal of the rock pad could also create a flush of suspended sediments over a short duration. The Erosion and Sediment Control Environmental Management Plan and appropriate construction best management practices would be adhered to throughout the process. Therefore, the use of industrial equipment could result in minor changes to the sediment concentrations in an isolated area and over a short duration. As such, the pathway has been classified as Minor.

Industrial Equipment Leading to Fish Disturbance or Mortality

The use of heavy machinery in and about a watercourse can result in the direct mortality of fish, temporary displacement of spawning and/or rearing fish, and disturbance to incubating eggs.

A rock pad would be created to facilitate blasting and heavy machinery movement within the in-stream habitats at the each of the proposed construction sites. The fish and fish habitat assessment (Cambria Gordon Ltd. 2008) suggests that juvenile rearing lake trout could be present along each of the construction site locations; however, the preferred spawning conditions for the known species in the Forebay are fair to poor. During construction, the use of machinery would likely displace rearing fish. Rearing habitat is found immediately adjacent to each construction area and would result in a negligible change. Therefore, the temporary displacement of habitat at the construction sites would result in negligible changes to fish rearing, spawning and incubating eggs. As such, the pathway has been classified as Minor.

15.2.3.1.7.3 *Invalid Pathways*

Vegetation Clearing: Use of Herbicides Leading to Change in Contaminant Concentrations

An increase in concentrations of toxins and pollutants from herbicide use in sediments and water can breach the range of chemical parameters that support healthy aquatic communities. The proposed soils vegetation clearing would not utilize herbicides or chemical reagents. Therefore, vegetation clearing would result in no changes to contaminant concentrations as a result of herbicide use. As such, the pathway has been classified as Invalid.

Excavation Leading to Change in Groundwater Flows

An alteration in the quantity of groundwater flowing into springs, streams, rivers, lakes and wetlands caused by a change in land use and land surface characteristics can lead to the permanent change in baseflow conditions. All excavation activities associated with the canals would be of bedrock, which is competent rock. Therefore, the excavation of the canals would not result in the alteration of groundwater flows and/or baseflow conditions. As such, the pathway has been classified as Invalid.

Addition or Removal of Aquatic Vegetation Leading to Change in Light Penetration

To facilitate the construction of the canals, removal of in-stream submergent and emergent vegetation would be required at the inlet and tailrace locations. This can result in changes to water temperature and dissolved oxygen, both necessary to support the life of fish and other aquatic organisms.

Under baseline conditions, light is able to penetrate to the bottom of the Twin Gorges Forebay and lower Taltson River. The removal of the sparse riparian and in-stream vegetation would not alter this baseline condition. Therefore, the removal and/or displacement of riparian and in-stream vegetation would not result in a change of water temperature or dissolved oxygen as a result of light penetration. As such, the pathway has been classified as Invalid.

Acid Rock Drainage Leading to Contaminated Runoff

An increase in concentrations of toxins and pollutants from acid rock drainage in stormwater runoff can decrease the pH of a water body or breach the range of chemical parameters that support healthy aquatic communities. Unweathered rock samples along the canals were tested for acid rock generating potential. The results indicate that rock is non-acid generating (refer to Appendix 6A). Therefore, the storage of waste rock associated with the canals would not result in the generation of acid rock drainage or alter contaminant concentrations or pH levels. As such, the pathway has been classified as Invalid.

15.2.3.1.8 Effects Analysis

In the pathway validation analysis, all the identified pathways and mitigation measures were reviewed, and all the pathways following mitigation were determined to be either Minor or Invalid. Minor and Invalid pathways were not carried through the effects assessment as the effects associated with these pathways are considered to be negligible.

15.2.3.2 NONACHO LAKE FISHERIES RESOURCES

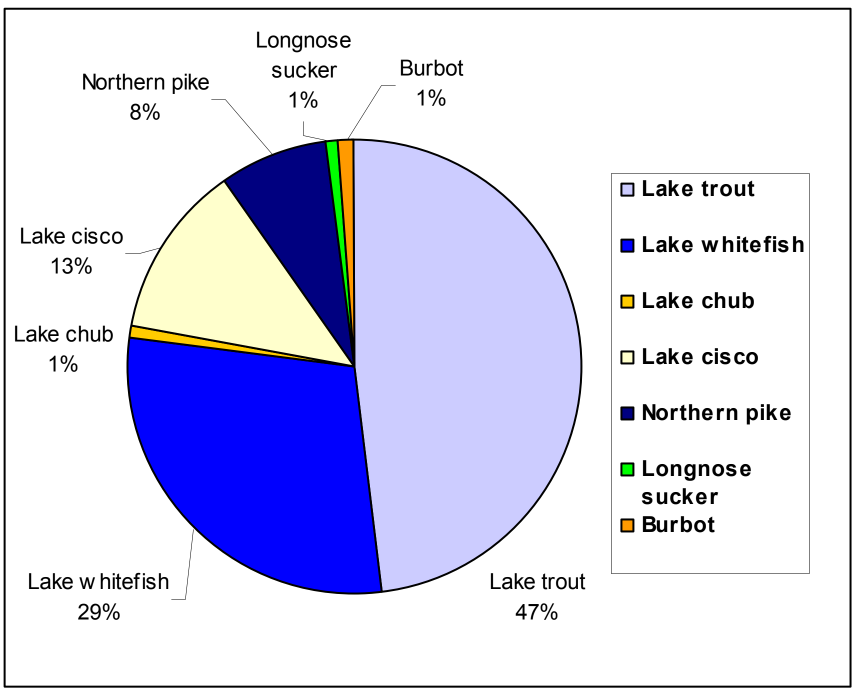
15.2.3.2.1 Existing Environment

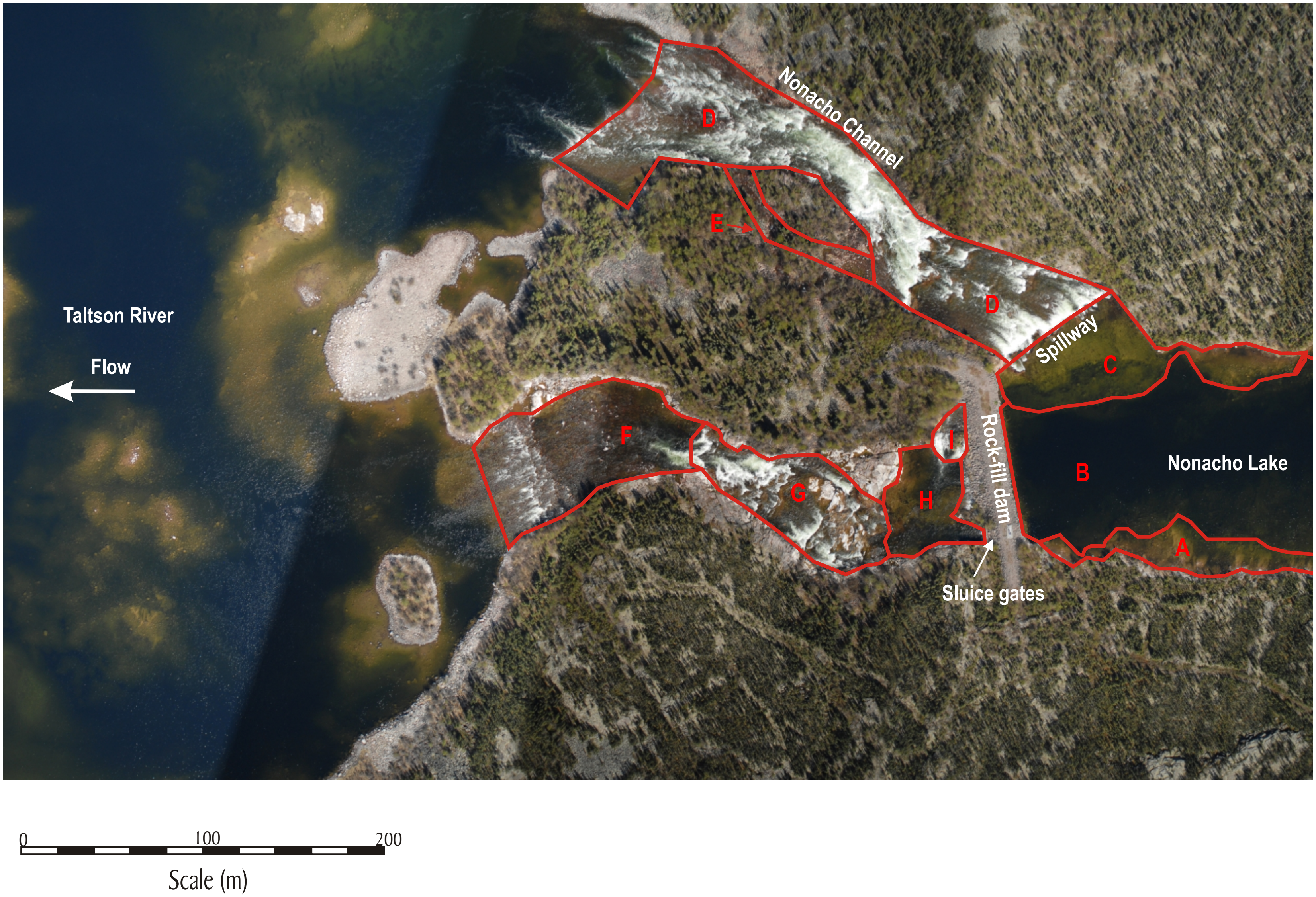
Habitat typing of the aquatic environment at and adjacent to the existing Nonacho control structure was completed by Cambria Gordon Ltd. (2008) (Appendix 15.2A). This assessment identified nine distinct habitat polygons (Figure 15.2.7). The following description of the existing environment at the Nonacho control structure is a summary from the Cambria Gordon Ltd. and has been broken into three sections: the Nonacho control structure inlet, the Nonacho control structure outlet, and the spillway channel. Aquatic habitats in the vicinity of the control structure are shown in Figure 15.2.7.

A full description of the habitat and fish use of the area is contained in Section 15.3 Turbine and Conveyance Canal Operation.

Fish species composition was determined from fish sampling programs conducted by Rescan Environmental Services (2003-04) and Envirocon (1973). In total, seven fish species were captured including: lake whitefish, lake cisco, longnose sucker, lake trout, northern pike, lake chub and burbot. The results of these sampling efforts have been compiled and are illustrated in Figure 15.2.6.

Figure 15.2.6 — Fish Species Composition within Nonacho Lake





TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report** **2009**	**Habitat Polygons Identified at** **Nonacho Control Structure**	**Figure** **15.2.7**

The preferred habitat conditions of these species were cross-referenced with the habitat at the inlet location to the control structure under baseline conditions. Table 15.2.14 qualifies the habitat conditions at the inlet by species life-stage.

Table 15.2.14 — Habitat Conditions of the Identified Species at the Nonacho Control Structure Inlet

Life Stage	Lake Whitefish	Northern Pike	Lake Trout	Lake Cisco
Juvenile rearing	Fair	Good	Fair	Good
Adult rearing	Fair	Good	Fair	Fair
Overwintering	Fair	Fair	Fair	Fair
Spawning	Fair	Fair	Fair	Good

As Table 15.2.14 describes, habitat conditions at the inlet for northern pike rearing are good and lake cisco juvenile rearing and spawning are good. The habitat conditions associated with the Nonacho control structure outlet and the spillway channel are defined by fast flowing waters and a lack of in-stream complexities. Therefore, these areas provide poor spawning and rearing potential for all of the identified species.

15.2.3.2.2 Valued Components

The identified valued component (fish populations) and rationale for its selection are the same as identified in Section 15.2.3.1.2.

15.2.3.2.3 Assessment Endpoints and Pathways

The proposed construction activities and required in-stream works associated with the Nonacho control structure are similar to those described for the Twin Gorges Forebay, with the exception of the drawdown of waters in Nonacho Lake and the addition of rip-rap to the in-stream environment. As such, the same five DFO Pathways of Effect as described in Section 15.2.3.1.3 were used to identify potential assessment endpoints and pathways associated with the aquatic habitats at the Nonacho control structure location. In addition, the DFO POE for the Placement of Material in Water (Figure 15.2.8) and the DFO Protocols for Winter Water Withdrawal in the Northwest Territories were used to identify additional pathways associated with the required water drawdown and placement of rip-rap.

A proposed drawdown of Nonacho Lake is planned over a six-month period during the winter of 2010-11, prior to commencement of in-lake construction activities. Water levels would be decreased by 50 to 80 cm to the level of the spillway in Nonacho Lake. Minimal permitted water levels would be maintained. The drawdown would be required to drop water levels below the existing spillway elevation. However, this level of drawdown would be smaller than expected on an annual basis under the expansion scenarios. Timing of construction activity was designed to mitigate effects to aquatic resources which are minimally active at this time. Based on the design mitigation, effects from construction on aquatic (i.e., benthic communities) resources would be negligible and thus, effects from construction were not formally assessed.

Figure 15.2.8 — Placement of Material or Structures in Water Pathway of Effect Diagram

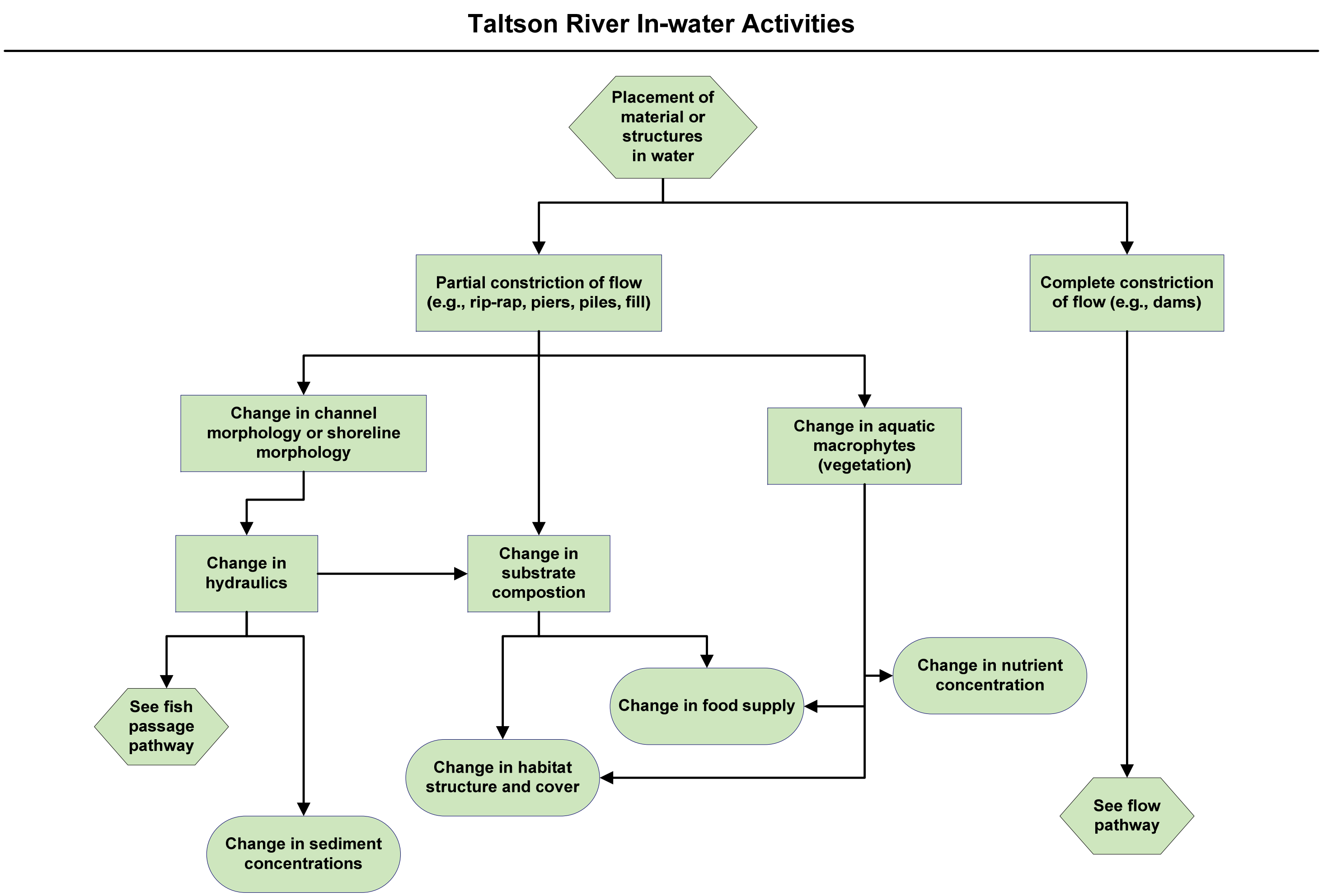


Table 15.2.15 summarizes the assessment endpoints and pathways leading to those endpoints for the Valued Components. Most pathways identified for Nonacho control structure construction and their validation were identical to those identified as part of the construction activities within the Twin Gorges area. This is a result of the similar construction components, techniques, and mitigation measures. Therefore, these pathways are not included below, and only those pathways that differ at Nonacho compared to Twin Gorges are presented in this section. The pathways that differ relate to water drawdown and the placement of material or structures in water.

Table 15.2.15 — Valued Components, Assessment Endpoints and Pathways Identified for Construction of the Nonacho Lake Control Structure

Valued Component	Assessment Endpoint	Pathway
Fish populations	Persistence of fish abundance	Water drawdown: Changes in waterline elevation with respect to fish habitat structure and cover Placement of material or structures in water: change in substrate composition with respect to habitat structure and cover
	Change in water temperature	Water drawdown: Changes in waterline elevation with respect to water temperatures
	Change in food supply	Placement of material or structures in water: Change in substrate composition with respect to food supplies
	Change in dissolved oxygen	Water drawdown: Changes in waterline elevation with respect to dissolved oxygen
	Change in displacement and/or stranding fish	Water drawdown: Changes in waterline elevation with respect to fish displacement or stranding and dewatering of incubating eggs
	Change in access and/or migration to off-channel habitats	Water drawdown: Changes in waterline elevation with respect to access and/or migration to off-channel habitat

15.2.3.2.4 Spatial and Temporal Boundaries

The analysis of potential interactions between the construction activities at the Nonacho control structure and the aquatic environment was conducted on a local level only. Environmental effects resulting from the required water drawdown activities would extend over the surface area of Nonacho Lake. As such, the local study area includes the entire surface area of Nonacho Lake and the habitats at and immediately downstream of the Nonacho control structure.

Water drawdown through the existing sluice gates is anticipated to occur over a two, or more, month period beginning in autumn (October). The waterline elevation would remain lowered during the construction works associated with the spillway channel.

15.2.3.2.5 Project Components

Project components associated with construction of the Nonacho control structure are summarized in Table 15.2.8.

15.2.3.2.6 Mitigation

The mitigation measures are summarized in Table 15.2.16.

Table 15.2.16 — Summary of the Proposed Mitigation by Pathway for Construction Activities Associated with the Nonacho Control Structure

Pathway	Pathway Duration	Proposed Mitigation
Placement of material or structures in water: Change in substrate composition with respect to habitat structure and cover	Construction	None
Placement of material or structures in water: Change in substrate composition with respect to food supplies	Construction	None
Water drawdown: Changes in waterline elevation with respect to fish habitat structure and cover	Construction	None
Water drawdown: Changes in waterline elevation with respect to water temperatures	Construction	None
Water drawdown: Changes in waterline elevation with respect to dissolved oxygen	Construction	None
Water drawdown: Changes in waterline elevation with respect to fish displacement or stranding and dewatering of incubating eggs	Construction	Water levels would be drawn down over a two or more month period limiting the potential for fish stranding and/or displacement Water levels would be drawn down in late autumn and early winter
Water drawdown: Changes in waterline elevation with respect to access and migration to off-channel habitats	Construction	Water levels would be drawn down in late autumn and early winter

15.2.3.2.7 Pathway Validation

The results of the pathway validation assessment are summarized in Table 15.2.17. Rationale for the classification of pathways as Valid, Minor or Invalid is provided in following the table.

Table 15.2.17 — Pathways to the Valued Components from Various Project Components Associated with the Construction of the Nonacho Control Structure

Project Component	Pathway	Pathway Validation
Nonacho Lake Control Structure	Placement of material or structures in water: Change in substrate composition with respect to habitat structure and cover	Minor
	Placement of material or structures in water: Change in substrate composition with respect to food supplies	Minor
	Water drawdown: Changes in waterline elevation with respect to fish habitat structure and cover	Minor
	Water drawdown: Changes in waterline elevation with respect to water temperatures	Minor
	Water drawdown: Changes in waterline elevation with respect to dissolved oxygen	Minor
	Water drawdown: Changes in waterline elevation with respect to fish displacement or stranding and dewatering of incubating eggs	Minor
	Water drawdown: Changes in waterline elevation with respect to access and/or migration to off-channel habitat	Minor

In total, seven pathways have been identified between the aquatic components and the Project component Nonacho Lake Control Structure. Of the seven identified pathways, none are Valid pathways, seven are Minor pathways, and none are Invalid pathways.

15.2.3.2.8 Valid Pathways

No Valid pathways were identified.

15.2.3.2.9 Minor Pathways

Placement of Material or Structures in Water: Change in Substrate Composition with Respect to Habitat Structure and Cover

Fish habitat structure and cover is predominately a measure of four parameters: depth, velocity, cover and substrate. The placement of materials and/or structures in the in-stream habitats can alter one or all of these parameters, which could result in changes to the community of aquatic organisms, decrease cover and protection capabilities from predators, and decrease the availability of diverse and stable habitats.

Rehabilitation of the dam would require the placement of a series of coarse and finer rock layers into the aquatic environment on the upstream face. The new substrate would be composed of material similar to the existing substrate of the rock-filled dam. Therefore, the placement of new substrates adjacent to the existing dam would not result in an alteration to the substrate or cover conditions. As such, the pathway has been classified as Minor.

Placement of Material or Structures in Water: Change in Substrate Composition with Respect to Food Supplies

The aquatic food supply must be plentiful and diverse to sustain the productivity of a watershed. An increase or decrease in the quantity or composition of the food supply can alter the aquatic community. Food supplies can be altered by a change in vegetation, substrate, nutrient exchanges, temperature and organic debris conditions.

Rehabilitation of the dam would require the placement of a series of coarse and finer rock layers into the aquatic environment on the upstream face. The new substrate would be composed of material similar to the existing substrate of the rock-filled dam and provide similar food supply. Therefore, the placement of a rip-rap in water would not result in a considerable change to food supplies in the Nonacho Lake. As such, the pathway has been classified as Minor.

Water Drawdown: Changes in Waterline Elevation with Respect to Habitat Structure and Cove

Fish habitat structure and cover is predominately a measure of four parameters (depth, velocity, cover and substrate), which are known to directly affect opportunities for organisms to use, colonize and move between existing aquatic environments.

The decrease in waterline elevation would primarily affect depth conditions; however, cover and substrate conditions could also change along the lower elevation stream margins. It is anticipated that water levels would decrease between 0.5 m and 0.8 m. Based on this anticipated drop in waterline elevation, an abundant amount of deep-water and shoreline habitats would remain. In addition, water levels would be lowered in late autumn and remain lowered throughout the winter. Fish typically overwinter at depth during this period and would not be affected by the potential changes in substrate and cover conditions. Therefore, the drawdown of water would result in negligible changes to the fish habitat structure and cover conditions in Nonacho Lake. As such, the pathway has been classified as Minor.

Water Drawdown: Changes in Waterline Elevation with Respect to Water Temperatures

Water temperature directly affects many physical, biological and chemical characteristics of a water body. In order to complete the required in-stream construction works at the spillway channel, the waterline elevation would need to be drawn down. The decrease in depth of between 0.5 m and 0.8 m would have negligible effects to water temperature based on the abundance of deep water habitat. As such, the pathway has been classified as Minor.

Water Drawdown: Changes in Waterline Elevation with Respect to Dissolved Oxygen

Adequate concentrations of dissolved oxygen in water are necessary for the life of fish and other aquatic organisms. Dissolved oxygen concentrations within a water body can be affected by a number of parameters, namely water temperature, biological activity, and turbulence.

The decrease in depth of 0.8 m would have negligible effects to temperature, biological activity and turbulence. As such, the pathway has been classified as Minor.

Water Drawdown: Changes in Waterline Elevation with Respect to Fish Displacement or Stranding and Dewatering of Incubating Eggs

An alteration in waterline elevation has the potential to strand or isolate fish that utilize the shoreline or pool habitats that become disconnected from the mainstem channel. In addition, incubating eggs in water depths 1 m or less could become dewatered.

The waterline elevation in Nonacho Lake would be reduced between 0.5 m and 0.8 m slowly over a two, or more, month period commencing in late autumn. Slow or non-abrupt reductions in waterline elevation typically allow fish the opportunity to move out of the pool habitats before they become disconnected; however, a possibility still exists for shallow habitat users (i.e., northern pike) that do not disperse to become displaced and potentially stranded.

Of the known fish species present in Nonacho Lake (Figure 15.2.6) northern pike, lake chub, lake cisco, longnose sucker and burbot are shallow water spawners. Of these species, egg incubation period of lake cisco overlaps with the proposed timing of the water drawdown. Lake cisco spawn in depths between 1 m and 5 m from September through November. Based on a drop in waterline elevation of between 0.5 m and 0.8 m, there would be limited potential for lake cisco incubating eggs to become dewatered.

Since lake cisco typically spawn from September to November, if water level drawdown occurs at the beginning of September, the potential to dewater incubating eggs further decreases. If water level drawdown occurs in the later months of autumn (i.e., October or November), the potential for dewatering of incubating lake cisco eggs increases. As such, the pathway has been classified as Minor.

Water Drawdown: Changes in Waterline Elevation with Respect to Access and/or Migration to Off-Channel Habitat

An alteration in waterline elevation could cause a disruption in access to fish habitats essential for the various life processes within a given fish population.

The waterline elevation in Nonacho Lake would be reduced between 0.5 m and 0.8 m slowly over a two, or more, month period in autumn (October). Off channel habitats are typically shallow, densely vegetated pool habitats that provide rearing to shoreline species such as northern pike. During the late summer and winter months, rearing fish typically move to deeper waters to overwinter as the majority of off-channel habitats would freeze. As such, fish use and migration to and from off-channel habitats is anticipated to be low during the drawdown period. Therefore, a decrease in the waterline elevation would result in no or negligible changes to fish access and/or migration to off-channel habitat. As such, the pathway has been classified as Minor.

15.2.3.2.10 Invalid Pathways

No Invalid pathways were identified.

15.2.3.3 EFFECTS ANALYSIS

In the pathway validation analysis, all the identified pathways and mitigation measures were reviewed, and all the pathways following mitigation were determined to be Minor. Minor pathways were not carried through the effects assessment as the effects associated with these pathways are considered to be negligible.

15.2.4 Effects Classification

The proposed construction activities associated with the Twin Gorges Forebay and Nonacho Lake identified one Valid pathway: *Furbearers (beaver and muskrat) direct mortality through lower water levels leading to reduced population abundance*.

The effects associated with this pathway would have a moderate magnitude to muskrat and a low magnitude to beavers, and would be short-term and isolated (Table 15.2.18). The overall residual effect is considered low.

Table 15.2.18 — Incremental Effects Classification of Pathways to the Valued Component Furbearers Populations

Project Component	Pathway	Direct-ion	Magni-tude	Geo-graphic Extent	Dur-ation	Revers-ibility	Fre-quency	Likeli-hood	Overall Risk / Assess-ment Effect
Nonacho Lake Control Structure	Direct mortality through lower water levels leading to reduced population abundance	Adverse	Muskrat: moderate Beaver: low	Local	Short-term	Reversible	Isolated	Low Likeli-hood	Low / Negative

15.2.5 Cumulative Effects

The anticipated cumulative effects associated with the construction activities in the Twin Gorges Forebay and Nonacho Lake are discussed in Chapter 13 (Water Fluctuations in the Taltson River Watershed).

15.2.6 Significance Determination

Table 15.2.19 summarizes the determination of significance for the incremental effects on the valued component furbearers.

Table 15.2.19 — Determination of Significance to the Valued Component

Valued Component (VC)	Valued Component Assessment Endpoint	Pathways	Overall Significance	Uncertainty
Furbearers (Muskrat and Beaver)	Preservation of habitat and populations	Direct mortality through lower water levels leading to reduced population abundance	Not Significant	Low

15.2.7 Uncertainty

The primary assumption made during the analysis of potential effects was that water level drawdown would begin in October. Should the Project become delayed or the drawdown activities occur at a different time, the potential effects, particularly to wildlife and incubating fish eggs, would have to be re-evaluated.

15.2.8 Monitoring

A qualified professional would undertake on-site environmental construction monitoring. An environmental representative would attend all pre-job meetings to ensure the contractor understands the requirements of the Environmental Management System and the sensitivities of the work site.

The environmental monitor would remain on-site full-time throughout the duration of the in-stream works to perform the following tasks:

- Ensure compliance with the Environmental Management System, acts and regulations;
- Address any potential environmental issues;
- Identify and report any emerging environmental issues;
- Keep complete records of inspections and make regular reports to the Project manager; and
- If necessary, meet with environmental agency personnel and other stakeholders.