7. FISH AND FISH HABITAT

Introduction

The findings of the environmental impact assessment for fish and fish habitat for the Mackenzie Gas Project (see EIS Volume 5, Section 7) were based on the following project components (see Section 1, Introduction, of this document):

- anchor fields
- gathering pipelines and associated facilities
- NGL and gas pipeline corridor
- infrastructure
- NGTL NWML Dickins Lake Section

See under EIS Summary for a summary of the EIS findings for fish and fish habitat.

The two NGTL pipeline sections, Dickins Lake Section and Vardie River Section, are located in northwestern Alberta. The Dickins Lake assessment was included in the EIS. This EIS supplemental information includes:

- updated information for the Dickins Lake Section
- new information for the Vardie River Section
- an impact assessment for northwestern Alberta based on the updated and new information
- a combined project effects assessment that includes the Mackenzie Gas Project and NGTL's Dickins Lake and Vardie River sections

EIS Summary

The EIS (Volume 5, Section 7) stated that potential effects from the Mackenzie Gas Project on fish and fish habitat are related to factors such as:

- direct effects on fish habitat from project activities
- change in water level and water flow related to project activities
- sediment suspended in water during work, such as pipeline construction

The EIS identified 10 fish species as valued components (VCs). Of these, only five are present in northwestern Alberta and therefore considered in this assessment:

- burbot
- walleye
- northern pike
- Arctic grayling
- lake whitefish

To assess effects on these VCs, the following key indicators (KIs) were examined:

- fish habitat
- fish health
- fish abundance and distribution

Effects on fish and fish habitat will range from no effect to low magnitude, local to regional in extent, with most effects not extending beyond long term.

Study Areas

The fish and fish habitat baseline study area in northwestern Alberta extends from the Northwest Territories–Alberta boundary to the NGTL Thunder Creek compressor station near the South Shekilie River, a distance of about 103 km (see Figure 7-1).

The local study area (LSA) for pipeline crossings of watercourses extended from 100 m upstream of the crossing location to the estimated downstream margin where 90% of the sediment entrained during crossing construction would be deposited. This distance downstream is about 45 times the bankfull width of the watercourse at the crossing location. For predictions of sediment deposition and supporting rationale, see EIS Volume 3, Section 6.

The regional study area (RSA) includes the Petitot River and Shekilie River drainages, which form part of the Mackenzie River basin.

Sampling was focused in the LSA, as it is unlikely the effects of the Dickins Lake and Vardie River sections will extend beyond LSA boundaries. Fish sampling was done to indicate the species and life stages in the area of the proposed watercourse crossing.

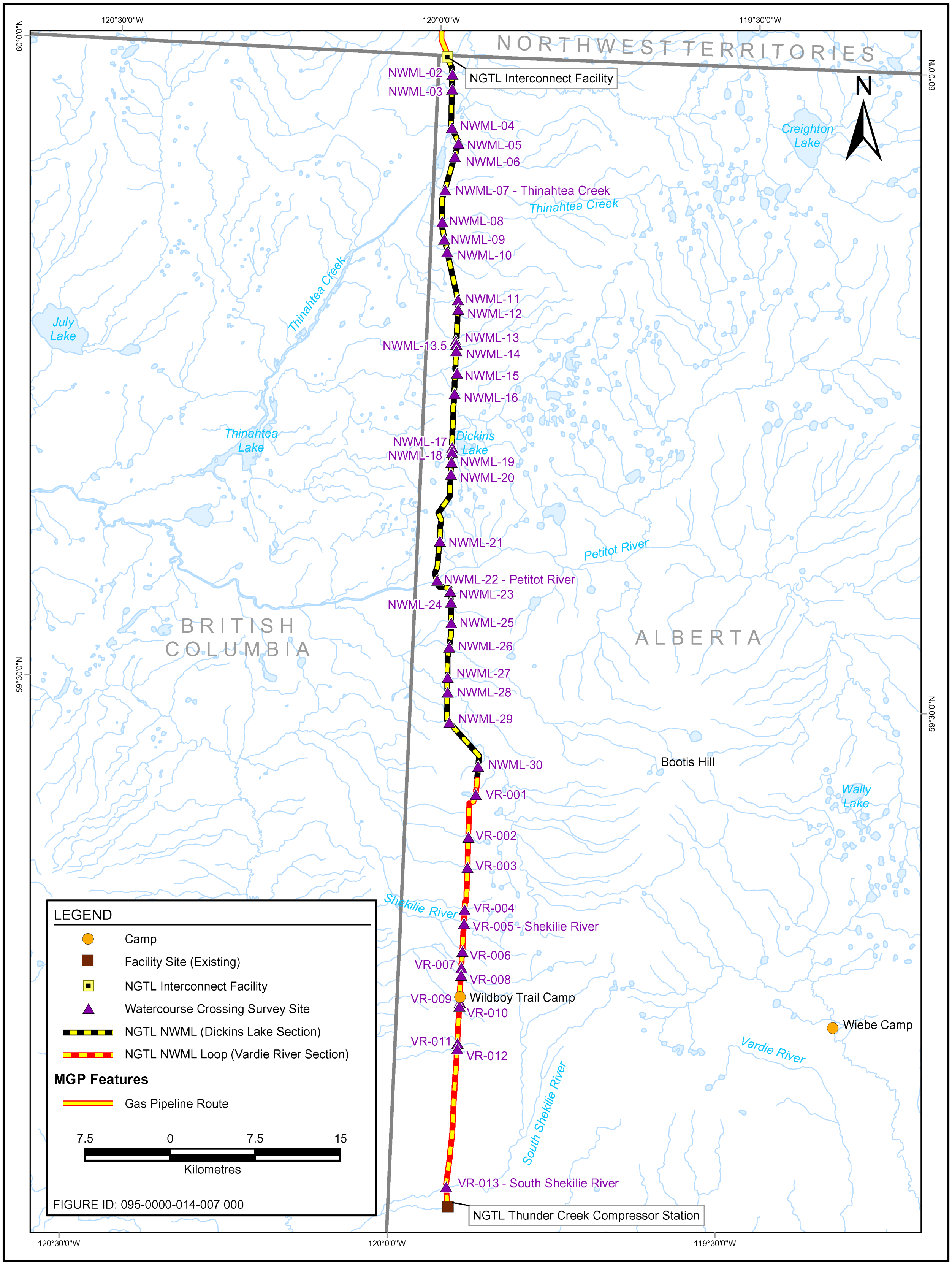

Figure 7-1: Watercourse Crossing Survey Sites

Baseline Methods

Methods used for the fish and fish habitat baseline study included:

- identifying potentially affected waterbodies
- reviewing and compiling historical baseline information from previous studies
- conducting aerial reconnaissance surveys to document all waterbodies crossed or potentially influenced
- conducting detailed summer fish and fish habitat surveys
- conducting spring and fall surveys to assess fish spawning use
- conducting winter habitat surveys to evaluate fish overwintering potential

For detailed descriptions of each method, see EIS Volume 3, Section 7.

Watercourse Classes

Watercourses along the pipeline route vary from Vegetated Channels to Large River Channels, such as the Petitot River. These watercourses were grouped into four classes according to their hydrologic regime, morphology and drainage area (see Table 7-1). For descriptions and photographic examples of each watercourse class, see EIS Volume 3, Section 7.

Regional Setting

Surface Water Features

The topography along the Dickins Lake and Vardie River sections is flat and poorly drained, and characterized by boreal forests and large areas of wetland and muskeg. Thaw proceeds slowly in spring and summer as surface vegetation and muskeg provide good insulation. A considerable volume of water is held in the organic material at or near the surface, and is released slowly through the summer. Beaver impoundments are common in many watercourses.

The pipeline will cross 43 watercourses along its route from the NGTL interconnect facility to the NGTL Thunder Creek compressor station. Of these crossings, 30 occur along the Dickins Lake Section and 13 along the Vardie River Section.

Larger watercourses include:

- Thinahtea Creek
- Petitot River
- Shekilie River
- South Shekilie River

Table 7-1: Watercourse Classification System

Watercourse Class	Description
Large River Channel	• Drainage area >1,000 km^2 • Perennial flow • Wetted width >25 m
Active I Channel	• Drainage area <1,000 km^2 • Perennial flow • Discernible banks and substrate, including silt and organic materials • Might be partially frozen to the bottom in winter, because of the influence of groundwater input, beaver activity or presence of large, deep pools
Active II Channel	• Drainage area <1,000 km^2 • Intermittent flow • Discernible banks and substrate, including silt and organic materials • Frozen to the bottom, or dry below ice during the winter
Vegetated Channel	• Ephemeral watercourses, including vegetated waterways, depressions and swales • Flow primarily during spring runoff, and are dry during late summer and winter • No discernible banks or evidence of annual sediment transport • Areas of dispersed overland flow, i.e., wetland drainages • Shallow flow through shrubs and trees

Watercourses crossed by the pipeline form part of two major drainage basins. The northernmost 31 crossings are in the Petitot River watershed, which originates on the west slopes of Cameron Hills and flows west to the Liard River. The southernmost 12 crossings are in the Shekilie River watershed, which drains south to the Hay River.

About 67% of the watercourses along the pipeline are Vegetated Channels and flow only during snowmelt or rain events. These Vegetated Channels have poorly defined flow paths and are unlikely to provide suitable fish habitat. The remaining watercourses usually have discernible beds and banks and include:

- small watercourses with intermittent flow that freeze to the bed in winter, i.e., Active II Channels
- watercourses with flowing water under the ice or that partly freeze to the bed, i.e., Active I Channels
- larger rivers with all-year flow, i.e., Large River Channels

Smaller watercourses exhibit various channel features, e.g., riffles, runs, pools and impoundments, which can provide seasonal rearing and feeding habitat, and potential habitat for spring spawning. Larger watercourses can provide all-year habitat for fish species, including spring and fall spawning habitat and overwintering habitat in deep pools or runs.

Fish Species Present

The Petitot and Shekilie river systems in northwestern Alberta support 15 species of fish of nine families (see Table 7-2). Of these, five species are harvested for food (commercially or for local consumption) or are used for recreation:

- burbot
- walleye
- northern pike
- Arctic grayling
- lake whitefish

The Petitot River drainage in northern Alberta contains six more fish species than the Shekilie River drainage. The low species diversity in the Shekilie River is likely because of 33-m high Alexandra Falls, which forms a major barrier on the Hay River in the Northwest Territories. Alexandra Falls likely impeded postglacial dispersion of fish species from the Great Slave Lake region into the Hay River system (McPhail et al. 1998b). The Petitot River was colonized through the Liard River system, which was more accessible to upstream fish movements.

For descriptions of habitat conditions necessary to support critical life stages (spawning, rearing, adult feeding and holding, and overwintering) of the main fish species in the Petitot and Hay River systems, see EIS Volume 3, Section 7.

Species of Concern

The *Alberta Wildlife Act*, the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2003) and the federal *Species at Risk Act* (SARA) have not listed any of the fish species in the study area as endangered, threatened or of special concern.

Baseline – Dickins Lake Section

Previous Studies

A number of references provided historical information on watercourses crossed by the Dickins Lake Section of the NGTL NWML pipeline route, including:

- studies associated with the Norman Wells to Zama oil pipeline (Fernet 1985, 1987; McCart and McCart 1982)
- fish and fish habitat inventory reports specific to the Petitot River drainage either in northwestern Alberta (Griffiths and Ferster 1974) or in British Columbia (McPhail et al. 1998a)
- description of the geographic distribution of fish species in Alberta (Nelson and Paetz 1992)

Table 7-2: Fish Species Likely Present in Northwestern Alberta Watercourses

Family	Common Name	Scientific Name	Spawning Period	Presence by Drainage Basin[1]	
				Petitot	Shekilie
Carp and Minnow – Cyprinidae	Emerald shiner	*Notropis atherinoides* Rafinesque	Spring and early summer	●	–
	Finescale dace	*Phoxinus neogaeus* Cope	Spring and mid-summer	●	●
	Lake chub	*Couesius plumbeus* (Agassiz)	Spring and mid-summer	●	●
	Spottail shiner	*Notropis hudsonius* (Clinton)	Spring and early summer	●	–
Cod – Gadidae	Burbot[2]	*Lota lota* (Linnaeus)	Winter	●	●
Perch – Percidae	Walleye[2]	*Sander vitreus* (Mitchill)	Spring and early summer	●	●
Pike – Esocidae	Northern pike[2]	*Esox lucius* Linnaeus	Spring	●	●
Sculpin – Cottidae	Slimy sculpin	*Cottus cognatus* Richardson	Spring	●	–
Stickleback – Gasterosteidae	Brook stickleback	*Culaea inconstans* (Kirtland)	Late spring and early summer	●	●
	Ninespine stickleback	*Pungitius pungitius* (Linnaeus)	Spring and early summer	●	–
Sucker – Catostomidae	Longnose sucker	*Catostomus catostomus* (Forster)	Spring	●	●
	White sucker	*Catostomus commersoni* (Lacépède)	Spring	●	●
Trout – Salmonidae	Arctic grayling[2]	*Thymallus arcticus* (Pallas)	Spring	●	–
	Lake whitefish[2]	*Coregonus clupeaformis* (Mitchill)	Fall	●	–
Trout-Perch – Percopsidae	Trout-perch	*Percopsis omiscomaycus* (Walbaum)	Spring and early summer	●	●

NOTES:
● = fish species likely to be present
– = fish species unlikely to be present
1 based on Nelson and Paetz (1992) and McPhail et al. (1998a, 1998b)
2 harvested commercially, recreationally or for food

Site-specific historical data on fish and fish habitat was found for only one watercourse crossing (Site NWML-22 on the Petitot River) sampled in the Dickins Lake Section.

Although previous studies in this watershed provide information on the species and life stages of fish and general habitat conditions in the watershed, they do not provide site-specific habitat information for crossing locations on the proposed Dickins Lake Section. Fernet (1985, 1987), Griffiths and Ferster (1974), Mann and Snyder (1975), McCart and McCart (1982) and McPhail et al. (1998a) provide valuable information on winter habitat conditions in the Petitot River system, which complements data collected for this study.

Reconnaissance Surveys

Reconnaissance surveys between September 29 and October 3, 2003 identified 30 watercourses along the Dickins Lake Section. According to the watercourse classification system (see under Watercourse Classes), eight (27%) of the watercourses are Active I Channels. These are Thinahtea Creek and seven unnamed watercourses (see Table 7-3). The remaining 22 watercourses included 20 Vegetated Channels, one Active II Channel and one Large River Channel, the Petitot River.

Table 7-3: Watercourse Classes in the Dickins Lake Section

Watercourse Class	Number of Sites	Percentage
Large River Channel	1	3
Active I Channel	8	27
Active II Channel	1	3
Vegetated Channel	20	67
Total	30	100

Nine sites were selected for detailed studies (see Table 7-4) based on:

- observations during the reconnaissance surveys
- watercourse classification
- historical information on fish distribution and catch
- hydrogeological information

Table 7-4: Watercourses for Detailed Surveys – Dickins Lake Section

Site	Name	Watercourse Class	Drainage Area (km^2)
NWML-05	Unnamed watercourse	Active I Channel	40
NWML-07	Thinahtea Creek	Active I Channel	71
NWML-08	Unnamed watercourse	Active I Channel	52
NWML-10	Unnamed watercourse	Active I Channel	36
NWML-14	Unnamed watercourse	Active I Channel	43
NWML-16	Unnamed watercourse	Active I Channel	102
NWML-22	Petitot River	Large River Channel	7,710
NWML-26	Unnamed watercourse	Active I Channel	90
NWML-28	Unnamed watercourse	Active I Channel	260

All surveyed watercourses were Active I, except for the Petitot River, which was classified as a Large River Channel.

Site NWML-05 – Unnamed Watercourse

General Location

The watercourse crossed at Site NWML-05 originates in the muskeg east of the crossing location. About 3 km downstream of the crossing, the watercourse flows into Lake May and continues to its confluence with Thinahtea Creek. Thinahtea Creek flows southeast through Thinahtea Lake to the Petitot River in British Columbia.

The drainage area upstream of the crossing is 40 km², and the average gradient near the pipeline crossing is 8 m/km. Site NWML-05 is about 2 km east of the British Columbia boundary and about 7.5 km south of the Northwest Territories–Alberta boundary.

Detailed Habitat Assessment

Field surveys were done on September 28, 2003 and March 21, 2004.

Open Water Conditions

A detailed survey was done along 326 m of the watercourse. Moderate-depth impoundment (IP2) was the dominant habitat, with shallow run (R3) and moderate-depth flat (F2) as the subdominant habitat types. One riffle section was also recorded.

Wetted channel width was 3.5 to 40 m, with a mean width of 8.7 m. Water depths at the three transects were shallow, with a mean depth of 0.4 m, and a maximum depth of 0.8 m. Water velocity levels were low, with a mean value of 0.2 m/s and a maximum of 0.6 m/s.

Silt was the major substrate type in the slow-flowing habitats, with cobble and boulder dominant in the riffle and run habitats. Aquatic vegetation and submerged woody debris provided most of the instream cover. Less abundant sources of cover included overhanging vegetation, depth and turbulence, boulder gardens and undercut banks.

Riparian vegetation consisted of muskeg, grass, forbs and coniferous forest.

Winter Conditions

Four holes were drilled through the ice to evaluate habitat potential for overwintering fish. Mean ice thickness was 0.58 m. Under-ice water was recorded at all holes. The maximum water depth was 0.48 m. There was no measurable flow, and the dissolved oxygen concentration, at 0.8 mg/L, was low. A strong odour of hydrogen sulphide confirmed the low level of dissolved oxygen.

Fish Populations

Fish sampling was done on September 28, 2003 by backpack electrofishing (678 s) and minnow trapping (14.7 h). No fish were captured by either sampling method.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Abundant aquatic vegetation in this watercourse provides potential spawning habitat for northern pike. Pockets of gravel and cobble in the riffle and run habitats could be used for spawning by Arctic grayling and sucker species (see Table 7-5). The riffle and run habitats provide adult feeding and holding opportunities for species believed to occur at this crossing. Woody debris and aquatic vegetation provide good cover for juvenile rearing. Although the watercourse did not freeze to the bottom in winter 2004, the nearly anoxic conditions would make it not suitable as overwintering habitat.

Table 7-5: Potential Use of Site NWML-05 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	●	●	●
Northern pike	–	●	●	●
Sucker species	–	●	●	●
Burbot	–	–	●	●

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

Alberta Code of Practice Classification

Based on the classification system outlined in Schedule 6 of the *Code of Practice for Pipeline and Telecommunication Lines Crossing a Waterbody* (Alberta Environment 2001), this unnamed watercourse was classified as a Class C watercourse. This class of watercourse is defined as moderately sensitive, where broadly distributed habitats supporting local fish populations are sensitive enough to be potentially damaged by unconfined or unrestricted activities in the watercourse. The restricted activity period for pipeline construction in this watercourse is April 16 to July 15.

Site NWML-07 – Thinahtea Creek

General Location

Thinahtea Creek originates north of Bootis Hill in northwestern Alberta and flows into the Petitot River in British Columbia. The watercourse flows about 16 km from its headwaters, through two unnamed lakes, before reaching the crossing site. The watercourse continues downstream another 47 km to its confluence with the Petitot River. About 9 km upstream of the confluence, the watercourse passes through Thinahtea Lake.

The drainage area upstream of the crossing site is 71 km^2. Near the crossing, the topography is flat and the average channel slope is about 5 m/km. Beaver dams greatly affect habitat in the watercourse.

Detailed Habitat Assessment

Seasonal surveys in Thinahtea Creek were done on March 26, June 1, September 6, 2002 and April 6, 2003, about 12.4 km upstream from the pipeline crossing location. The watercourse was resurveyed October 5, 2003 and March 21, 2004 at the pipeline crossing location.

Open Water Conditions

Because of unsafe landing conditions at the crossing, a fish habitat survey was done from the air along an 850-m length of the watercourse near the pipeline crossing. The instream habitat was dominated by deep impoundments (IP1) and deep flat (F1) habitats. Wetted width ranged from 4 to 40 m, with a maximum depth estimated to be about 1.5 m. Mean water velocity along the discharge transect, measured about 900 m downstream of the crossing location, was 0.2 m/s, and the maximum was 0.5 m/s. Four beaver dams observed downstream of the crossing would likely impede fish movement.

The dominant substrate type was silt and organic matter. Instream cover consisted of aquatic vegetation, overhanging vegetation and woody debris. Riparian vegetation was grass, forbs, shrubs and coniferous forest.

Winter Conditions

Winter surveys were done on March 26, 2002 and April 6, 2003 to evaluate habitat potential for overwintering fish and incubating eggs from fall and winter spawners. These surveys were done about 12.4 km upstream of the crossing location. The winter 2002 survey documented 0.95 m of water under 0.4 m of ice cover. There was no measurable flow, and the dissolved oxygen concentration, at 1.8 mg/L, was low. Two holes were drilled through 0.43 m of ice cover in winter 2003. Nonflowing water, 0.37 and 0.43 m deep, was recorded at both holes.

However, with a dissolved oxygen level of 0.4 mg/L, conditions were nearly anoxic and there was a strong hydrogen sulphide odour.

Four holes were drilled through the ice at the crossing location on March 21, 2004. Mean ice thickness was 0.46 m. Nonflowing water was recorded under the ice at all holes. Maximum water depth was 0.17 m. Dissolved oxygen concentration was 0.9 mg/L and a strong hydrogen sulphide odour was noted. These nearly anoxic conditions would be lethal to most fish or incubating eggs.

Fish Populations

2002 Fish Sampling

Fish sampling in Thinahtea Creek was done in the spring and summer, about 12.4 km upstream of Site NWML-07. Backpack electrofishing was done in the spring (276 s) along a 74-m length of the watercourse, and in the summer (246 s) along a 150-m length of the watercourse. No fish were captured or observed. The lack of fish in the surveyed section was likely because fish movement was blocked by beaver dams in the Thinahtea Creek system.

2003 Fish Sampling

Fish sampling was done in October 2003 about 900 m downstream of the crossing at the landing site closest to the crossing. Various methods were used, including:

- backpack electrofishing (882 s)
- angling (0.2 h)
- minnow trapping (39.3 h)

The catch was one juvenile northern pike, 136 mm in fork length, captured by backpack electrofishing.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Impoundment conditions provided suitable adult feeding and holding habitat for species known to occur in the Petitot River drainage system. Spawning conditions appeared unsuitable for Arctic grayling and sucker species because of the lack of riffles with gravel or cobble substrate. Submerged and flooded vegetation in shallow, low-velocity areas provided potential habitat for northern pike spawning and rearing. The watercourse would not provide suitable spawning habitat for fall or winter spawning species (see Table 7-6).

Table 7-6: Potential Use of Site NWML-07 – Thinahtea Creek

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	–	–	●
Northern pike	–	●	●	●
Sucker species	–	–	–	●
Burbot	–	–	–	●

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, only northern pike has been confirmed in the creek

The deepest areas recorded during the fall survey, i.e., maximum depth of 1.5 m, might not freeze to the bottom in winter. However, the silt and organic material substrates, in combination with limited flow, are likely to result in near anoxic conditions, which would cause winterkill. Winter surveys 12.4 km upstream of the crossing documented nearly anoxic conditions in 2002 and 2003. Similar results were obtained at the crossing location in 2004.

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-07 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-08 – Unnamed Watercourse

General Location

The watercourse crossed at Site NWML-08 originates in the muskeg area southeast of Creighton Lake. This watercourse flows west and crosses into British Columbia where it joins the unnamed watercourse that Site NWML-10 is located on. From this point, the watercourse flows north to its confluence with Thinahtea Creek. Thinahtea Creek runs southeast through Thinahtea Lake to the Petitot River in British Columbia.

The pipeline route crosses the watercourse about 2.2 km upstream of the confluence with the unnamed tributary to Thinahtea Creek. The drainage area upstream of the crossing is 52 km². Terrain near the crossing is low relief, with an average gradient of 3 m/km. Beaver dams greatly affect habitat in the watercourse.

Detailed Habitat Assessment

Seasonal surveys were done on September 29, 2003 and March 21, 2004 near the pipeline crossing location.

Open Water Conditions

A detailed habitat assessment was done along a 350-m length of the watercourse. Dominant habitat types were moderate-depth impoundments (IP2) and moderate-depth flats (F2). Deep flats (F1) and deep impoundments (IP1) were the subdominant habitat types. Three beaver dams upstream and three beaver dams downstream of the proposed crossing likely impede fish movement.

Mean wetted channel width was 8 m, and widths ranged from 4 to 20 m. Mean depth at the three transects surveyed was 1 m and maximum depth was 1.3 m. As a result of beaver impoundments in the area, water velocity levels at the transects were low, and the maximum was 0.04 m/s. The deepest part of the watercourse in the surveyed area was upstream of the crossing location. This flat had a maximum depth of 1.6 m.

Organic matter and silt were the dominant substrate types. Depth, turbulence, aquatic vegetation, woody debris and overhanging vegetation provided instream cover. No eroding or slumping banks were identified in the area. Riparian vegetation was grass, forbs, shrubs and coniferous forest.

Winter Conditions

One hole was drilled through 0.35 m of ice cover to evaluate habitat potential for overwintering fish. Under-ice water depth was 1.1 m. The water was stagnant and exuded a strong smell of hydrogen sulphide. The dissolved oxygen concentration, at 0.3 mg/L, was very low and would be lethal to overwintering fish.

Fish Populations

Fish sampling was done on September 29, 2003 by:

- backpack electrofishing (396 s)
- minnow trapping (12.7 h)
- angling (0.2 h)

No fish were captured. The absence of fish in the surveyed section was likely a result of beaver dams impeding fish movement.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Abundant aquatic and flooded vegetation and low-velocity flow provide potential spawning areas for northern pike. The flat habitats and fine substrates are not suitable for spawning of Arctic grayling or sucker species.

Adult feeding and holding by species other than northern pike was limited by several beaver dams upstream and downstream of the proposed crossing. Northern pike might be able to access the area during high flow in the spring and remain there after spawning (see Table 7-7).

Although the deepest sections of the watercourse do not freeze to the bottom in the winter, the lack of flow and low dissolved oxygen levels recorded in late winter would make the watercourse unsuitable as overwintering habitat for fish.

Table 7-7: Potential Use of Site NWML-08 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	–	–	–
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-08 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-10 – Unnamed Watercourse

General Location

The unnamed watercourse at Site NWML-10 originates in a region of muskeg southeast of Creighton Lake. It flows west beyond the crossing, turns abruptly north and flows into Thinahtea Creek at Site NWML-07.

The pipeline crosses this watercourse about 8.5 km upstream of the confluence with Thinahtea Creek. The drainage area upstream of the crossing is 36 km^2, and the average gradient near the crossing is 2 m/km. The crossing is about 1.5 km east of the Alberta–British Columbia boundary.

Detailed Habitat Assessment

Field surveys were done on October 5, 2003 and March 21, 2004 near the pipeline crossing location.

Open Water Conditions

Because of unsafe landing conditions, a fish habitat survey was done from the air along a 650-m length of the watercourse near the pipeline crossing. Wetted widths ranged from 2 to 50 m, with a mean width of 24 m. Moderate-depth impoundment (IP2) was the dominant habitat type, with shallow flat (F3) as the subdominant habitat type. Organic matter was the dominant substrate in the surveyed area. Maximum water depth, about 1.5 m, was in an impoundment upstream of the crossing location. Beaver dams greatly affected habitat in the watercourse.

Depth, turbulence, aquatic vegetation, woody debris and overhanging vegetation provided instream cover. Riparian vegetation was muskeg, grass, forbs, shrubs and coniferous forest.

Winter Conditions

Two holes were drilled through 0.34 m of ice cover to evaluate habitat potential for overwintering fish. Nonflowing water was recorded under the ice at both holes. Maximum water depth was 0.25 m. The dissolved oxygen concentration was 0.2 mg/L and a strong hydrogen sulphide odour was noted. These nearly anoxic conditions would be lethal to fish or incubating eggs.

Fish Populations

Fish sampling was done on October 5, 2003 at the closest landing site, which was about 4.3 km downstream of the pipeline crossing. No fish were captured in 0.4 h of angling.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Flooded and submerged aquatic vegetation might provide spawning habitat for northern pike. The lack of riffles and gravel substrates precludes spawning by Arctic grayling and sucker species. Low dissolved oxygen levels in winter preclude spawning by burbot. Adult feeding and holding by species other than northern pike was limited by several beaver dams upstream and downstream of the proposed crossing. Northern pike might be able to access the area during high flow in the spring and remain there after spawning (see Table 7-8).

Beaver dams likely prevent migratory fish movement, except in spring, if a beaver dam is breached or is otherwise passable at high flow.

Although the deepest sections of the watercourse do not freeze to the bottom in the winter, lack of flow and low dissolved oxygen levels recorded in late winter would make the watercourse unsuitable as overwintering habitat for fish.

Table 7-8: Potential Use of Site NWML-10 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	–	–	–
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-08 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-14 – Unnamed Watercourse

General Location

The unnamed watercourse at Site NWML-14 originates in a region of muskeg and flows southwest to the pipeline crossing. The watercourse continues to its confluence with another unnamed watercourse at Site NWML-16 and flows into Thinahtea Creek at Site NWML-07.

The pipeline route crosses the watercourse about 25 km upstream of its confluence with Thinahtea Creek. The drainage area upstream of the crossing is 43 km^2, and the surrounding topography is low, with an average gradient near the pipeline crossing of 4 m/km.

Detailed Habitat Assessment

Field surveys were done on October 5, 2003 and March 20, 2004 near the pipeline crossing location.

Open Water Conditions

A detailed fish habitat survey was done along 250 m of watercourse. The wetted channel width of the watercourse ranged from 0.2 m to 50 m, with a mean wetted width of 4.4 m. Mean water depth at the three transects was 0.1 m, and maximum depth was 0.7 m. Mean water velocity at the transects was less than 0.01 m/s, and the maximum was 0.13 m/s. The dominant habitat type was shallow impoundment (IP3), with shallow flat (F3) as the subdominant habitat type. Silt was the dominant bed material, with some areas of sand also present. There were two abandoned beaver dams near the crossing site. One dam was about 25 m upstream of the crossing and the other was about 60 m downstream of the crossing.

Aquatic and overhanging vegetation was the dominant instream cover. Undercut banks, depth, turbulence and woody debris provided the remaining cover. Stream bed material was compacted throughout the reach. Stream bank riparian vegetation was grass, forbs, shrubs and conifers.

Winter Conditions

Two holes were drilled through 0.45 m of ice cover to evaluate habitat potential for overwintering fish. The watercourse was frozen to the substrate at both drilled locations.

Fish Populations

Fish sampling was done on October 5, 2003 by:

- backpack electrofishing (1,014 s)
- angling (0.4 h)
- minnow trapping (4.2 h)

No fish were captured by these sampling methods. The beaver dams in the area likely act as barriers to fish movement in the watercourse.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Aquatic vegetation and flooded grasses provide spawning, rearing and holding habitat for northern pike. The shallow depth of the impoundments and the flat habitat types limit rearing and holding habitat for other species. Spring and fall spawning habitat was rated unsuitable for all species except northern pike, because of the lack of riffle and run habitat with moderate velocities and coarser gravel and cobble substrates preferred by Arctic grayling and sucker species. Old beaver dams upstream and downstream of the crossing would be barriers to fish movement during periods of low water (see Table 7-9). There is no potential for fish overwintering, because the watercourse freezes to the bottom.

Table 7-9: Potential Use of Site NWML-14 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	–	–	–
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-14 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-16 – Unnamed Watercourse

General Location

Many small lakes interspersed with muskeg feed the headwaters of unnamed watercourse NWML-16. From the headwaters, the stream flows northwest to its confluence with Thinahtea Creek.

The pipeline would cross this watercourse about 20 km upstream of its confluence with Thinahtea Creek. The drainage area upstream of the crossing is 102 km^2, and the average stream gradient near the crossing is low, at 7 m/km. The crossing is about 2.7 km east of the Alberta–British Columbia boundary and about 3.4 km north of Dickins Lake in northwestern Alberta.

Detailed Habitat Assessment

Field surveys were done at the proposed pipeline crossing location on October 1, 2003 and March 20, 2004.

Open Water Conditions

A detailed fish habitat survey was done along a 292-m length of the watercourse. Mean wetted channel width was 4.8 m, with widths ranging from 2.5 to 9 m. The watercourse was mostly less than 0.5 m deep. Maximum depth was 0.8 m, immediately upstream of the crossing. Mean water velocity at the three transects was 0.2 m/s, and the maximum was 0.5 m/s.

Shallow flat (F3) was the dominant habitat type, comprising 64% of the surveyed watercourse. Moderate-depth flat (F2), shallow impoundment (IP3), shallow pool (P3) and riffle made up the remaining 36% of the habitat types. Compacted silt was the dominant substrate type. Gravel was the dominant substrate in the riffle habitat, followed by a mixture of sand, cobble and boulder. Substrate in these higher velocity sections was moderately compacted. Unstable and slumping banks occurred throughout the surveyed section, i.e., 100% of the left downstream bank and 98% of the right downstream bank were rated as unstable and prone to erosion in high flow.

Deep or turbulent water and woody debris provided most of the instream cover in the surveyed section. Riparian vegetation was grasses, forbs and coniferous forest.

Winter Conditions

Six holes were drilled through the ice at the crossing location on March 20, 2004. Mean ice thickness was 0.31 m. Under-ice water was recorded at all drilled sites. Maximum water depth was 0.54 m. Water flow was observed at one of the drilled holes in a riffle area, but water velocity could not be measured because of the shallow depth. The dissolved oxygen concentration of 6.8 mg/L was adequate to provide overwintering habitat for fish or incubating eggs.

Fish Populations

Fish sampling done in fall 2003 by backpack electrofishing (1,050 s) captured four fry and four juvenile white sucker, with fork lengths ranging from 35 to 288 mm. Two baited minnow traps (4.1 and 4.2 h) did not capture any fish.

Fish sampling methods in winter 2004 included angling (1.0 h), baited minnow traps (1.5 h) and underwater viewer observations (0.3 h). No fish were captured or observed.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Shallow riffle habitat with gravel, sand and cobble substrates creates limited spawning habitat for Arctic grayling and sucker species. Although adequate levels of dissolved oxygen were recorded in winter, the shallow depths likely reduce habitat suitability for spawning and egg incubation by burbot. Flat habitat, and backwater and snye areas provide feeding and holding opportunities for adult and juvenile fish, although shallow depths might impede adult fish movement at low flow. The diversity of instream cover enhances opportunities for juvenile rearing (see Table 7-10).

Table 7-10: Potential Use of Site NWML-16 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	●	●	●	●
Northern pike	●	●	●	●
Sucker species	●	●	●	●
Burbot	●	–	–	●
NOTES: ● = potential use of the waterbody habitat – = no potential use of the waterbody habitat Of the species and species groups listed, only sucker species have been confirmed in the watercourse				

Moderate beaver activity, noted near the crossing and at the downstream end of the surveyed section, might impede movement by juvenile and adult fish during low flow. However, during sampling, water was observed flowing under the dam, indicating the potential for fish movement.

The dissolved oxygen concentration during winter was sufficient to provide overwintering habitat for fish. Additional overwintering habitat might be available in Dickins Lake, about 6 km upstream of the crossing.

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-16 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-22 – Petitot River

General Location

The Petitot River originates in the Cameron Hills in northwestern Alberta and flows northwest nearly 400 km to the Liard River in the Northwest Territories. From the headwaters near Beatty Lake, the river flows into Thurston Lake and then into Spawn Lake at the Northwest Territories–Alberta boundary. From Spawn Lake, the Petitot River flows into Bistcho Lake and continues northwest to its confluence with the Liard River. The crossing site on the Petitot River is about 150 km from its confluence with the Liard River.

The drainage area upstream of the crossing is 7,710 km^2, and the average channel slope at the crossing site is about 1 m/km.

Detailed Habitat Assessment

Seasonal surveys in the Petitot River were done on March 27, May 31 and September 9, 2002, about 6.7 km upstream of the crossing location. A winter assessment, on April 6, 2003, targeted deep-water locations identified in the 2002 summer survey. Habitat conditions at the crossing location were assessed on October 5, 2003 and September 28, 2004.

Open Water Conditions

A detailed fish habitat survey was done along a 2,300-m length of the river near the pipeline crossing in September 2004. The river was at a low stage with a discharge of 2.02 m^3/s. Wetted channel widths ranged from 40 to 51 m. Mean water depth at the two transects was 0.3 m, and the maximum depth was 0.6 m. Mean velocity at the discharge transect was 0.22 m/s, and the maximum was 0.43 m/s. Much greater depths and velocities, i.e., up to 1.7 m and 0.9 m/s, were recorded in October 2003, when the river was at a higher stage.

Instream habitat was largely homogeneous, with shallow run (R3) habitat dominating the surveyed area. One riffle area was recorded upstream of the proposed crossing. Substrate was mostly cobble and boulder, with occasional sections of gravel. Abundant instream cover was provided by boulder gardens and turbulence. River banks were mostly stable, with about 5% of each bank showing signs of bank erosion. Riparian vegetation was mostly grass and shrubs, surrounded by mixed forest.

Winter Conditions

Winter surveys done on March 27, 2002 and April 7, 2003, evaluated habitat potential for overwintering fish and incubating eggs from fall and winter spawners. These surveys were done about 6.7 km upstream of the crossing location. In winter 2002, flowing water, with an average depth of 0.6 m under 0.45 m of ice cover, had a dissolved oxygen concentration of 6.4 mg/L. On April 7, 2003, 14 holes were drilled through ice up to 1.2 m thick. Flowing water was found at all the holes. Mean water depth was 0.56 m, and the maximum depth was 0.86 m. The dissolved oxygen concentration was 6.3 mg/L, indicating suitable overwintering conditions.

Fish Populations

2002 Fish Sampling

Fish sampling in the Petitot River was done 6.7 km upstream of Site NWML-22 by backpack electrofishing in spring (426 s) and summer (2,677 s). In the spring survey, three slimy sculpin were captured. In the summer survey, four adult longnose sucker and one slimy sculpin were captured. Also observed, but not captured in the summer survey, were one northern pike and two suckers (see Table 7-11).

Table 7-11: Fish Species Captured or Observed at Site NWML-22 – Petitot River, 2002

Species	Number Captured or Observed			Fork Length	
	Spring	Summer	Total	Number Measured	Range (mm)
Longnose sucker	0	4 (A)	4 (A)	4	271–284
Northern pike	0	1	1	0	–
Sucker species	0	2	2	0	–
Slimy sculpin	3	1	4	4	62–79

NOTES:
A = adult
– = fork length range not measured

2003 Fish Sampling

Fish sampling was done on October 2, 2003 using boat electrofishing (2,340 s), angling (2.3 h) and three minnow traps (71.3 h). The electrofishing captured four Arctic grayling, 10 longnose sucker, four white sucker and one trout-perch. Also observed, but not captured, were seven unidentified suckers (see Table 7-12).

Table 7-12: Fish Species Captured or Observed at Site NWML-22 – Petitot River, 2003

Species	Number Captured or Observed				Fork Length	
	Fry	Juveniles	Adults	Total	Number Measured	Range (mm)
Arctic grayling	0	3	1	4	3	172–210
Longnose sucker	0	0	10	10	10	279–385
White sucker	0	0	4	4	4	310–365
Sucker species	N/I	N/I	N/I	7	0	–
Trout-perch	N/I	N/I	N/I	1	1	41[a]

NOTES:
– = fork length range not measured
N/I = forage fish species were not identified to life stages
a Because only one fish was measured, its fork length is recorded and no range is given

2004 Fish Sampling

Fish sampling was done on September 28, 2004 using backpack electrofishing (1,343 s) and three minnow traps (7.3 h). The electrofishing captured two Arctic grayling, one longnose sucker, nine slimy sculpin and three trout-perch (see Table 7-13). No fish were captured in the minnow traps.

Table 7-13: Fish Species Captured or Observed at Site NWML-22 – Petitot River, 2004

Species	Number Captured or Observed				Fork Length	
	Fry	Juveniles	Adults	Total	Number Measured	Range (mm)
Arctic grayling	0	2	0	2	2	112–122
Longnose sucker	0	1	0	1	1	126[a]
Slimy sculpin	N/I	N/I	N/I	9	9	41–85
Trout-perch	N/I	N/I	N/I	3	3	49-86

NOTES:
N/I = forage fish species were not identified to life stages
a Because only one fish was measured, its fork length is recorded and no range is given

Previous Studies

Griffiths and Ferster (1974) captured walleye, Arctic grayling, northern pike, burbot and longnose sucker at two sites in the Petitot River mainstem, about 21 and 28 km upstream of the proposed pipeline crossing. McPhail et al. (1998a) documented northern pike, Arctic grayling, walleye, longnose sucker, longnose dace and slimy sculpin in the British Columbia part of the upper Petitot River, about 35 km downstream of the proposed pipeline crossing. Other species documented farther downstream in the Petitot River and its tributaries in British Columbia included burbot, white sucker, lake chub, finescale dace, trout-perch, brook stickleback and ninespine stickleback (McPhail et al. 1998a).

McCart and McCart (1982) identified similar fish habitat use for the Petitot River near this crossing, although the conclusions about overwintering suitability differed from the present study. They reported that overwintering was unlikely in the Petitot River because of small water volumes and low oxygen concentrations. The moderate dissolved oxygen levels and water depths identified under the ice in the March 2002 and April 2003 surveys of the Petitot River indicate a potential for overwintering in the area.

Habitat Use

Predominant deep run habitat and coarse substrate in the surveyed section provided suitable conditions for adult feeding and holding, and rearing, by species known to occur in the Petitot River drainage (see Table 7-14). Riffles and coarse substrates create conditions suitable for spawning by Arctic grayling, sucker species and walleye. Submerged and flooded vegetation in shallow, low-velocity areas create suitable spawning habitat for northern pike. Predominance of deep run habitat and the moderate dissolved oxygen concentration measured in winter indicate that suitable overwintering conditions exist for all species. Coarse substrate and sufficient water depth, velocity and dissolved oxygen levels would make conditions suitable for winter spawning by burbot. No barriers to fish passage were identified in the surveyed section.

Table 7-14: Potential Use of Site NWML-22 – Petitot River

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	●	●	●	●
Northern pike	●	●	●	●
Sucker species	●	●	●	●
Walleye	●	●	●	●
Burbot	●	●	●	●

NOTES:
● = potential use of the waterbody habitat
Of the species and species groups listed, all have been confirmed in the river

Alberta Code of Practice Classification

Petitot River was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-26 – Unnamed Watercourse

General Location

The unnamed watercourse at site NWML-26 is a tributary to the Petitot River and originates in northwestern Alberta at a small unnamed lake at Bootis Hill. From its headwaters, it flows northwest about 32 km to the proposed pipeline crossing Site NWML-26, and continues northwest about 12 km from there to the Petitot River in British Columbia.

The drainage area upstream of the crossing is 90 km^2. Near the crossing, the topography is flat. Average channel slope at the site is about 7 m/km.

Detailed Habitat Assessment

Seasonal field surveys were done on March 27, May 31 and September 11, 2002 about 6 km upstream of the pipeline crossing. The watercourse was surveyed at the pipeline crossing location on October 5, 2003 and March 19, 2004.

Open Water Conditions

A detailed survey was done along 575 m of the watercourse near the pipeline crossing in October 2003. Deep flats (F1) and deep impoundments (IP1) were the most common habitat types, with shallower flats (F2 and F3) and deeper pools (P1 and P2) as the subdominant habitat types.

Wetted channel widths ranged from 4 to 50 m, with a mean width of 14.7 m. Mean water depth at the three transects was 0.6 m, and the maximum depth was 1.1 m. Mean water velocity at the three transects was 0.1 m/s, and the maximum was 0.2 m/s. Most of the water depths were greater than 1 m throughout the survey section, and water depths greater than 1.5 m were noted downstream of the crossing location.

The dominant substrate type was silt, with areas of cobble along the bank. Depth and turbulence provided most of the instream cover. Less abundant types of instream cover included aquatic vegetation, woody debris and overhanging vegetation. Riparian vegetation near the watercourse was grass, forbs and shrubs, with deciduous and coniferous forest habitat. No evidence of bank instability was seen.

Winter Conditions

The winter survey on March 27, 2002 was done about 6 km upstream from the pipeline crossing. One drilled site had 1.41 m of water under 0.43 m of ice cover, but there was no measurable flow. The dissolved oxygen concentration was 0.9 mg/L, indicating near anoxic conditions.

Five holes were drilled through the ice near the crossing location on March 19, 2004. Mean ice thickness was 0.35 m. Nonflowing water was recorded under the ice at all drilled sites. Maximum water depth was 0.56 m. The dissolved oxygen concentration, at 0.8 mg/L, was low and would be lethal to most overwintering fish species.

Fish Populations

2002 Fish Sampling

Sampling for fish was done in spring and summer about 6 km upstream from the pipeline crossing. Sweep-net sampling at eight potential northern pike spawning sites in spring did not capture eggs or larvae. Backpack electrofishing in spring (361 s) and summer (647 s) did not capture fish.

2003 Fish Sampling

Fish sampling at the crossing was done using backpack electrofishing (852 s) and two minnow traps (5.9 h). One Arctic grayling, with a fork length of 89 mm, and one slimy sculpin, with a length of 65 mm, were captured and another Arctic grayling was observed.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Large beaver impoundments in the surveyed section provided suitable adult feeding and holding habitat for sucker species and northern pike. Cobble substrate along the watercourse margins provided restricted adult holding and feeding habitat for Arctic grayling. Depth and diverse instream cover provided juvenile rearing habitat for all major species. Spring and fall spawning habitat was rated as low for Arctic grayling and sucker species but cannot be ruled out. Although the gravel and cobble substrate was limited and higher velocity riffle habitat preferred by these species was absent, the presence of juvenile Arctic grayling in the watercourse indicates there might be limited spawning success in areas of marginal habitat. Submerged and flooded vegetation in shallow, low-velocity areas provided suitable spawning habitat for northern pike. Habitat conditions do not appear suitable for spawning burbot, which usually spawn in lakes or in large rivers (see Table 7-15).

Table 7-15: Potential Use of Site NWML-26 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	–	●	●	●
Northern pike	–	●	●	●
Sucker species	–	●	●	●
Burbot	–	–	●	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, only Arctic grayling has been confirmed in the watercourse

Although deep areas in beaver impoundments do not freeze to the bottom, low winter dissolved oxygen levels would preclude overwintering use of this watercourse by fish. Large beaver dams near the crossing would likely limit fish movement most of the year.

Alberta Code of Practice

The unnamed watercourse at Site NWML-26 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site NWML-28 – Unnamed Watercourse

General Location

Unnamed watercourse NWML-28 originates at the southwest end of Bootis Hill and flows northwest into the Petitot River in British Columbia. Total length of the watercourse from the headwaters to the confluence with the Petitot River is about 60 km. The pipeline crosses the watercourse about 21 km upstream of the Petitot River confluence.

The drainage area upstream of the crossing is 260 km^2. Near the crossing, the topography is flat and beavers have affected the watercourse. Average channel slope in the area of the crossing is about 3 m/km.

Detailed Habitat Assessment

Seasonal field surveys were done on March 27, May 31 and September 11, 2002, about 6.6 km upstream from the pipeline crossing location. The watercourse was surveyed at the crossing location on September 27, 2003 and March 19, 2004.

Open Water Conditions

Deep flats (F1) and deep impoundments (IP1) were the most common habitat types (60%) along the surveyed watercourse length of 696 m. Runs (R1, R2 and R3) made up 29% of the watercourse, and riffles and moderate-depth pools (P2) made up the remaining 11%. Wetted channel width ranged from 6 to 18 m, and mean wetted width was 12.3 m. Mean water velocity along the transects was 0.3 m/s, and the maximum was 1.3 m/s. Substrate in the impoundments and flats was mostly silt, whereas runs, riffles and pools were dominated by cobble and boulder, with some sand and silt. A large beaver dam upstream of the crossing would likely be a barrier to fish movement most of the year.

Depth and turbulence, with a small contribution from boulder gardens, woody debris, aquatic vegetation, overhanging vegetation and undercut banks, provided most of the instream cover. Unstable or slumping banks were not common in the surveyed section, with 6% unstable and prone to erosion in high flow. Riparian vegetation was grass and shrubs with some coniferous and deciduous trees.

Winter Conditions

The initial winter survey was done on March 27, 2002, about 6.6 km upstream of the crossing location. The survey documented 0.1 m water depth under 0.46 m of ice cover. Flow, at less than 0.01 m/s, was negligible, and dissolved oxygen concentrations were low, at 2.8 mg/L.

One hole was drilled through 0.62 m of ice near the crossing location on March 19, 2004. Nonflowing water, 0.78 m deep, was recorded under the ice. The dissolved oxygen concentration was 7.4 mg/L, indicating potentially suitable overwintering conditions for fish.

Fish Populations

2002 Fish Sampling

Fish sampling was done in the spring and summer, 6 km upstream of crossing Site NWML-28. Sweep-net sampling along vegetation at 15 potential northern pike spawning sites in spring 2002 did not capture eggs or larvae. Backpack electrofishing (1,602 s) in spring and summer captured two slimy sculpin, one in each survey. In addition, one slimy sculpin and one longnose sucker were observed in summer (see Table 7-16).

Table 7-16: Fish Species Captured or Observed at Site NWML-28 – Unnamed Watercourse, 2002

Species	Number Captured or Observed			Fork Length	
	Spring	Summer	Total	Number Measured	Range (mm)
Longnose sucker	0	1	1	0	–
Slimy sculpin	1	2	3	2	78–105

NOTE:
– = fork length range not measured

2003 Fish Sampling

Fish sampling was done using backpack electrofishing (540 s) and three minnow traps (11.2 h). Five Arctic grayling, one white sucker, three finescale dace and 10 slimy sculpin were captured (see Table 7-17).

Table 7-17: Fish Species Captured or Observed at Site NWML-28 – Unnamed Watercourse, 2003

Species	Number Captured or Observed				Fork Length	
	Fry	Juveniles	Adults	Total	Number Measured	Range (mm)
Arctic grayling	4	1	0	5	5	61–135
White sucker	1	0	0	1	1	43[a]
Finescale dace	N/I	N/I	N/I	3	3	31–51
Slimy sculpin	N/I	N/I	N/I	10	10	28–83

NOTES:
N/I = forage fish species were not identified to life stages
a Because only one fish was measured, its fork length is recorded and no range is given

2004 Fish Sampling

Winter fish sampling was done at the crossing site using two minnow trap sets (22.4 h) and underwater viewer observations (0.1 h). No fish were captured or observed.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Deep run habitats in the surveyed section provide suitable conditions for adult feeding and holding, and rearing for all the major species. Riffle habitats, with gravel and cobble substrates, made conditions suitable for spawning by Arctic grayling and sucker species. Submerged aquatic vegetation and flooded terrestrial vegetation in shallow, low-velocity areas in the spring would provide suitable habitat for northern pike spawning and rearing. Habitat conditions did not appear to be suitable for burbot spawning (see Table 7-18).

Table 7-18: Potential Use of Site NWML-28 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Arctic grayling	●	●	●	●
Northern pike	●	●	●	●
Sucker species	●	●	●	●
Burbot	●	–	●	●

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, only Arctic grayling and sucker species have been confirmed in the watercourse

Deep-water areas and adequate dissolved oxygen levels reported in March 2004 suggest the watercourse provides overwintering habitat for major fish species.

Alberta Code of Practice Classification

The unnamed watercourse at Site NWML-28 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Baseline – Vardie River Section

Previous Studies

A literature review provided historical information on watercourses crossed by the Vardie River Section. Although the previous studies were not specific to the present Vardie River Section crossing locations, they provide valuable information on the species and life stages of fish and general habitat conditions in the watershed. Nelson and Paetz (1992) and McPhail et al. (1998b) were reviewed for information on fish distribution in the upper Hay River drainage system.

Table 7-19 lists watercourses for which historical information on fish and fish habitat is available.

Table 7-19: Watercourses Along the Vardie River Section with Historical Information

Site	Name	References
VR-005	Shekilie River	Diversified Environmental Services (1995a, 1995b); McPhail et al. (1998b); RL&L Environmental Services Ltd. (1999)
VR-013	South Shekilie River	Golder Associates Ltd. (1996); McPhail et al. (1998b)

Reconnaissance Surveys

Reconnaissance surveys were done on September 29 and 30, 2004. Thirteen watercourses were identified along the Vardie River Section. According to the watercourse classification system, three of the watercourses, or 23%, are Active I Channels: the Shekilie River, South Shekilie River and one unnamed watercourse (see Table 7-20). The remaining 10 watercourses included nine Vegetated Channels and one Active II Channel.

Table 7-20: Watercourse Classes – Vardie River Section

Watercourse Class	Number of Sites	Percentage
Large River Channel	0	0
Active I Channel	3	23
Active II Channel	1	8
Vegetated Channel	9	69
Total	13	100

Three sites were selected for detailed studies based on observations during the reconnaissance surveys, watercourse classifications and review of historical information on fish distribution (see Table 7-21 and Figure 7-1, shown previously).

Table 7-21: Watercourses for Detailed Surveys – Vardie River Section

Site	Name	Watercourse Class	Drainage Area (km^2)
VR-005	Shekilie River	Active I Channel	20
VR-007	Unnamed watercourse	Active I Channel	29
VR-013	South Shekilie River	Active I Channel	174

Site VR-005 – Shekilie River

General Location

The Shekilie River originates from a series of ponds along the southwest edge of Bootis Hill in Alberta and flows west for about 13 km before it crosses into British Columbia. The river continues northwest for an additional 15 km and then flows south for about 200 km to its confluence with the Kotcho River. About 10 km farther downstream, the Kotcho River flows into the Hay River, which flows back into Alberta and eventually into Great Slave Lake.

The pipeline crossing is about 5 km east of the British Columbia boundary in the headwaters of the Shekilie River. The drainage area upstream of the crossing is 20.3 km^2 and average channel slope is 3 m/km. Near the pipeline crossing, the topography is flat, and the watercourse is affected by beaver activity.

Detailed Habitat Assessment

Field surveys were done on May 30, 2002, September 11, 2002 and September 28, 2004.

A detailed survey was done along 422 m of the watercourse in 2004. Beaver impoundments were the dominant habitat in the surveyed area, but shallow flat (F3) sections made up about 70% of the surveyed length of the watercourse. Nine beaver dams were recorded in the surveyed section. The largest beaver dam resulted in a vertical drop of 1.9 m.

Wetted channel width in the flat habitat was 1.5 to 3 m, and the mean width was 2 m. Impoundments were up to 45 m wide. Water depth at the two transects was shallow. The mean depth was 0.6 m, and the maximum depth 0.75 m. Water velocities were less than 0.01 m/s and only minimal flow through the beaver dams was observed. Water depth in the largest impoundment was greater than 1.5 m.

Silt substrate was dominant throughout the surveyed section. Submerged woody debris and overhanging vegetation provided most of the instream cover. Less abundant sources of cover included aquatic vegetation and undercut banks.

Banks were stable. Riparian vegetation was grass, shrubs and coniferous forest.

Fish Populations

2002 Fish Sampling

Fish sampling in the Shekilie River was done in spring and summer. Backpack electrofishing in spring (329 s) captured 10 finescale dace. Backpack electrofishing (779 s) and minnow trapping (11.1 h) in late summer resulted in a total catch of 188 finescale dace and 41 brook stickleback (see Table 7-22).

Table 7-22: Fish Species Captured or Observed at Site VR-005 – Shekilie River

Species	Number Captured or Observed			Fork Length	
	Spring 2002	Summer 2002	Fall 2004	Number Measured	Range (mm)
Finescale dace	10	188	7	45	21–72
Brook stickleback	0	41	4	23	29–69

2004 Fish Sampling

Fish sampling was done on September 28, 2004 by backpack electrofishing (455 s) and setting three baited minnow traps for about 2 h each. No fish were captured by backpack electrofishing, but the minnow traps captured seven finescale dace and four brook stickleback.

Previous Studies

Fish species documented in the Shekilie River during previous studies include walleye, northern pike, burbot, white sucker, longnose sucker, lake chub, finescale dace, trout-perch and brook stickleback (Diversified Environmental Services 1995a, 1995b; McPhail et al. 1998b; RL&L Environmental Services Ltd. 1999). The previous studies were done in the lower and middle reaches of the Shekilie River, at least 20 km downstream of the pipeline crossing.

Habitat Use

Deep-water habitat in the beaver impoundments was suitable for adult feeding and holding of large-bodied fish species. However, numerous beaver dams likely act as fish barriers that impede access to these habitats (see Table 7-23). The predominantly silt substrates were unsuitable spawning habitat for sucker species and burbot. Suitable habitat was available for northern pike spawning and rearing because of the presence of flooded vegetation in shallow, low-velocity areas.

The deeper impoundments (IP1) might not freeze to the bottom in the winter. However, their substrates of silt and organic material would likely cause a depletion of dissolved oxygen so the impoundments would not be suitable as overwintering habitats for VCs. Brook stickleback and finescale dace, species that were captured at this site during the open water season, can tolerate low levels of dissolved oxygen and appear to survive through the winter.

Table 7-23: Potential Use of Site VR-005 – Shekilie River

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

Alberta Code of Practice Classification

The unnamed watercourse at Site VR-005 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site VR-007 – Unnamed Watercourse

General Location

The unnamed watercourse at Site VR-007 originates on the southwest slope of Bootis Hill and flows west for about 18 km before entering a tributary of the Shekilie River.

The pipeline crossing is about 16 km downstream of the headwaters and about 6 km east of the British Columbia boundary. The drainage area upstream of the crossing is 29.3 km^2 and average channel slope is 4 m/km. Near the pipeline crossing, the topography is flat and the watercourse is heavily affected by beaver activity.

Detailed Habitat Assessment

The detailed habitat survey was done on September 29, 2004 along a 462-m length of the watercourse near the pipeline crossing. Deep and moderate-depth impoundments were the dominant habitat in the surveyed area, but shallow run (R3) sections made up about 56% of the surveyed length of the watercourse. Two large beaver dams were recorded in the surveyed section. The largest beaver dam resulted in a vertical drop of 1.5 m.

Wetted channel width in the run habitat ranged from 1.4 to 1.8 m. Impoundments were up to 65 m wide. Water depth at one transect in the run habitat was shallow, and the maximum depth was 0.75 m. Water velocities were less than 0.01 m/s and only minimal flow through the beaver dams was noted. Water depth in the largest impoundment was greater than 1.5 m.

Silt substrate was dominant throughout the surveyed section. Submerged woody debris and overhanging vegetation provided most of the instream cover. Less abundant sources of cover included aquatic vegetation, depth and undercut banks.

Banks were stable. Riparian vegetation was mainly burnt conifers.

Fish Populations

Fish sampling was done by backpack electrofishing (577 s) and minnow trapping (6.7 h). Backpack electrofishing captured eight brook stickleback, which ranged from 18 to 39 mm in total length, and one finescale dace, 32 mm in fork length. No fish were captured in the minnow traps.

Previous Studies

A literature review did not identify previous fish and fish habitat studies for this watercourse.

Habitat Use

Deep-water habitat in the beaver impoundments was suitable for adult feeding and holding of large-bodied fish species. However, numerous beaver dams likely act as fish barriers that impede access to these habitats (see Table 7-24). The predominantly silt substrates were unsuitable spawning habitat for sucker species and burbot. Submerged and flooded vegetation in shallow, low-velocity areas provided suitable habitat for northern pike spawning and rearing.

Table 7-24: Potential Use of Site VR-007 – Unnamed Watercourse

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–

NOTES:
● = potential use of the waterbody habitat
– = no potential use of the waterbody habitat
Of the species and species groups listed, none has been confirmed in the watercourse

The deepest areas recorded during the fall survey might not freeze to the bottom in winter. However, the silt and organic substrates are likely to result in anoxic conditions making the watercourse unsuitable as overwintering habitat for VCs.

Alberta Code of Practice Classification

The unnamed watercourse at Site VR-007 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Site VR-013 – South Shekilie River

General Location

The South Shekilie River originates along the south edge of Bootis Hill. It flows southwest for about 22 km and then turns west for about 13 km before reaching British Columbia. The river continues southwest for an additional 17 km to its confluence with the Shekilie River, which forms part of the Hay River system.

The pipeline crossing is about 23 km upstream of the confluence with the Shekilie River and 28 km downstream of the headwaters. The drainage area upstream of the crossing is 174 km^2. Average watercourse slope near the crossing is about 6 m/km. The watercourse is affected by beaver activity.

Detailed Habitat Assessment

The detailed habitat survey was done on September 29, 2004 along a 473-m length of the watercourse near the pipeline crossing. The most common habitat types were shallow flats (F3) and deep impoundments (IP1), with moderate-depth flats (F2), pools (P2) and shallow runs (R3) also present. Six beaver dams in the surveyed section resulted in vertical barriers up to 3 m high that likely prevented upstream fish movement most of the year.

Mean wetted channel width was 3.2 m, and widths ranged from 0.6 to 8 m. Mean depth at the three transects surveyed was 0.5 m and maximum depth was 0.9 m. Water velocities were less than 0.01 m/s and only minimal flow was observed through the beaver dams. Water depth in an impoundment upstream of the crossing was greater than 1.5 m.

Silt substrate was dominant throughout the surveyed section. A few large boulders were also present. Aquatic vegetation and depth provided most of the instream cover. Less abundant sources of cover included submerged woody debris and boulders.

No eroding or slumping banks were identified in the area. Riparian vegetation was mainly grass and shrubs, with coniferous and deciduous forest away from the banks.

Fish Populations

Fish sampling was done on September 29, 2004 by backpack electrofishing (496 s) and minnow trapping (6.7 h). In total, 155 finescale dace and 32 brook stickleback were captured or observed (see Table 7-25).

Table 7-25: Fish Species Captured or Observed at Site VR-013 – South Shekilie River, 2004

Species	Number Captured or Observed			Fork Length	
	Backpack Electrofisher	Minnow Traps	Total	Number Measured	Range (mm)
Finescale dace	66	89	155	105	29–75
Brook stickleback	6	26	32	32	41–58

Previous Studies

In July 1996, Golder Associates Ltd. (1996) captured finescale dace, lake chub and brook stickleback in the South Shekilie River at a site about 5 km upstream of the watercourse crossing. Fish sampling in September 1997, near the confluence of the South Shekilie River with the Shekilie River, documented walleye, northern pike, burbot, white sucker, lake chub and finescale dace (McPhail et al. 1998b).

Habitat Use

Abundant aquatic and flooded vegetation and low-velocity flow provide potential spawning areas for northern pike. The flat habitats and fine substrates are not suitable for spawning and rearing of sucker species or burbot.

Access to potentially suitable habitat for adult feeding and holding by species other than northern pike was hindered by large beaver dams upstream and downstream of the crossing. Northern pike could access the area during high flow in the spring and remain there after spawning (see Table 7-26).

Table 7-26: Potential Use of Site VR-013 – South Shekilie River

Species	Overwintering	Spawning and Incubating	Rearing	Adult Feeding and Holding
Northern pike	–	●	●	●
Sucker species	–	–	–	–
Burbot	–	–	–	–
NOTES: ● = potential use of the waterbody habitat – = no potential use of the waterbody habitat Of the species and species groups listed, none has been confirmed in the watercourse				

The deeper impoundments (IP1) might not freeze to the bottom in the winter. However, their substrates of silt and organic material would likely cause a depletion of dissolved oxygen, so the impoundments would not be suitable as overwintering habitat for VCs. Brook stickleback and finescale dace, species captured at this site, can tolerate low levels of dissolved oxygen and appear to survive through the winter.

Alberta Code of Practice Classification

The unnamed watercourse at Site VR-013 was classified as a Class C watercourse, with the restricted activity period from April 16 to July 15.

Effects on Fish and Fish Habitat

Effect Pathways

The impact assessment focused on only those pathways that are applicable to the Dickins Lake and Vardie River sections in northwestern Alberta. Any pathways considered not applicable were eliminated from further assessment.

Each pathway was evaluated according to criteria that involved:

- using the project description to determine if a key pathway is valid
- using the assessments by other technical disciplines involved in the EIS, such as air quality, hydrology, groundwater and water quality, to determine if a pathway is likely to affect fish

- determining whether mitigation that is 100% effective was available that would make a pathway inoperable

For the process for screening effect pathways, see Figure 7-2. For a detailed discussion of the screening process, see EIS Volume 5, Section 7.

A pathway that was considered applicable following the screening process was evaluated in subsequent steps of the assessment. The results of the evaluation of pathways for applicability are summarized in Table 7-27.

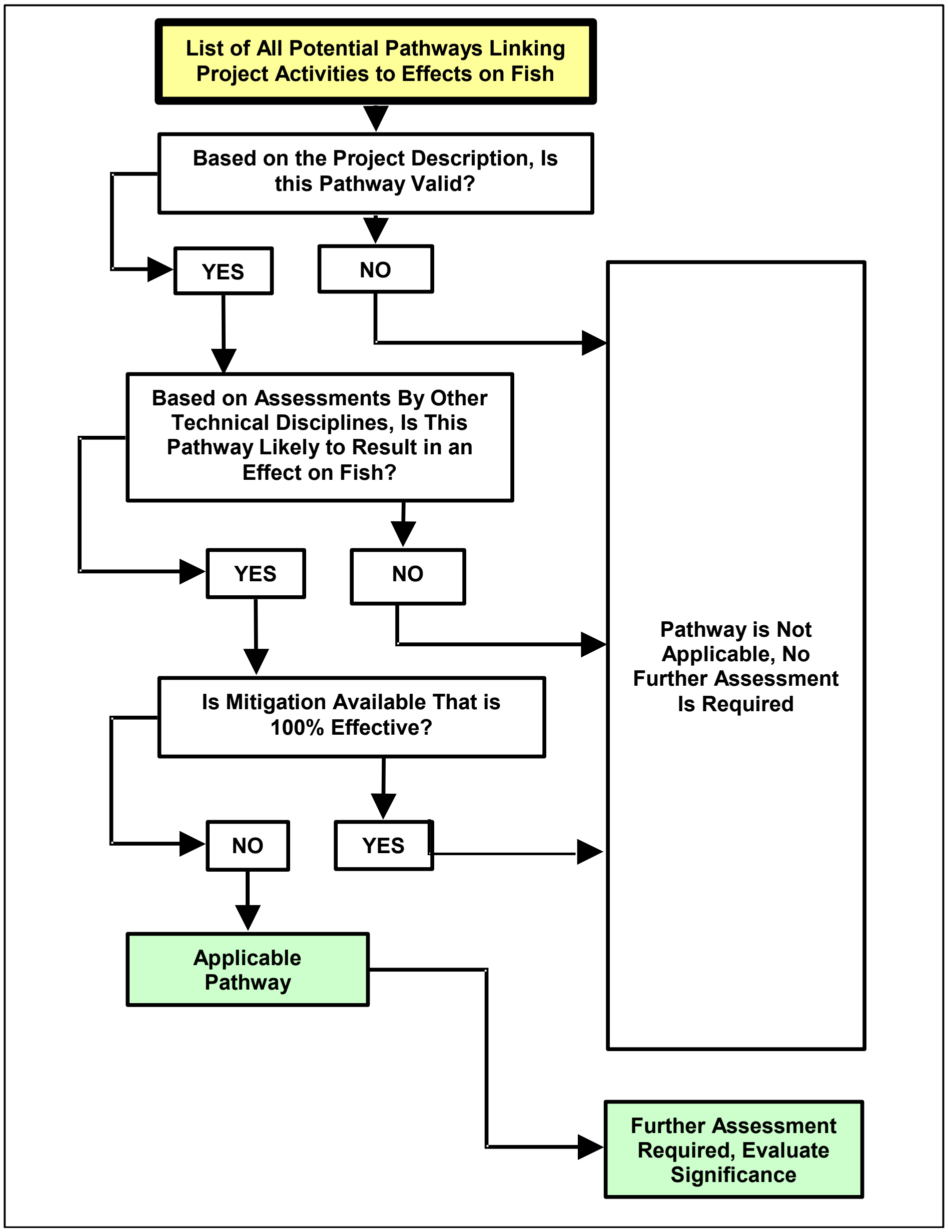

Figure 7-2: Process for Screening Effect Pathways for Fish

Table 7-27: Summary of Effect Pathways Considered for Fish in Northwestern Alberta

Key Effect Pathways	Intermediate Effect Pathways	Applicability	Justification for Why Pathway is Not Further Assessed for Specific Project Components
Key Indicator: Changes in Fish Habitat			
Direct habitat effects	Pipeline crossing construction	Y	
Change in flow	Surface runoff	N	Hydrology assessment determined that effects of change in flow from surface runoff were low magnitude, so no effects on fish habitat are predicted.
	Groundwater	Y	
Change in channel morphology	Frost bulb formation	N	Hydrology assessment determined that changes in channel morphology are not expected from frost bulbs, so no effects on fish habitat are predicted.
	Bed and bank disturbance from crossing construction	Y	
	Bank subsidence	Y	
	Changes in runoff amount and sediment production	N	Hydrology assessment predicted low effects on flow and sediment concentrations from runoff, so no effects on channel morphology are predicted, and no effects on fish habitat are predicted.
Change in water levels	Water withdrawal	Y	
	Water discharge	N	Pathway will be mitigated. Discharge will be done according to regulatory requirements and is not expected to affect lake levels of fish-bearing lakes, so no effects on fish habitat are predicted.
Sediment deposition	Surface runoff	N	Hydrology assessment determined that effects of change in sediment yield from surface runoff were low magnitude, so no effects on fish habitat are predicted.
	Erosion at watercourse crossings	N	Pathway will be reduced through erosion and sediment-control planning, so no effects on fish habitat are predicted.
	Erosion at facilities	N	Pathway will be mitigated. Sites will be located with a minimum setback from waterbodies and mitigation measures applied, so no effects on fish habitat are predicted.
	Watercourse crossing construction at pipeline crossings	Y	
Key Indicator: Changes in Fish Health			
Effects of explosives	Use of explosives	Y	
Change in water quality	Spills	N	Pathway will be reduced. Mitigation measures implemented to reduce the potential of spills reaching receiving waterbodies, so no effects on fish health are predicted.

Table 7-27: Summary of Effect Pathways Considered for Fish in Northwestern Alberta (cont'd)

Key Effect Pathways	Intermediate Effect Pathways	Applicability	Justification for Why Pathway is Not Further Assessed for Specific Project Components
	Acidification of waterbodies	N	Water quality assessment determined that the acid deposition pathway is predicted to have no effect on water quality. Therefore, no effects on fish health are predicted.
	Wastewater discharge	N	Water quality assessment determined that discharge of wastewater is predicted to have no or low effect, based on expected magnitude of effects with or without mitigation, so no effects on fish health are predicted.
	Suspended sediment from watercourse crossing construction	Y	
	Suspended sediment from surface runoff	N	Hydrology assessment determined that effects of change in sediment yield from surface runoff were low magnitude, so no effects on fish health are predicted.
	Suspended sediment from erosion	N	Effects of this pathway for all project components will be mitigated with measures to ensure proper bank stabilization and revegetation and to limit erosion, so no effects on fish health are predicted.
Key Indicator: Changes in Fish Distribution and Abundance			
Change in fish habitat	As discussed for all key pathways leading to fish habitat key indicator	Considered applicable for project component only if significant effects are predicted for the Change in Fish Habitat effect pathways discussed previously.	
Change in fish health	As discussed for all key pathways leading to fish health key indicator	Considered applicable for project component only if significant effects are predicted for the Change in Fish Health effect pathways discussed previously.	
Change in harvest	Increased access	Y	
	Increased anglers	N	Pathway will be mitigated by enforcing strict policies that prohibit fishing while working on the project. Therefore, no effects on fish abundance and distribution are predicted.
Blockage of fish passage	Frost bulb formation	Y	
Change in water quality	As discussed for all key pathways leading to fish health key indicator	Considered applicable for project component only if significant effects are predicted for the Change in Water Quality effect pathways discussed previously.	

NOTES:
Y = pathway applicable and assessed further
N = pathway not applicable, and not assessed further

Valued Components

Fish VCs were selected by ranking the species present in the Mackenzie River drainage according to specific criteria (see EIS Volume 5, Section 7). The 10 highest-ranked species were selected as VCs:

- lake trout
- inconnu
- northern pike
- walleye
- lake whitefish
- Dolly Varden
- Arctic grayling
- broad whitefish
- burbot
- Arctic cisco

For the species present in northwestern Alberta, see Table 7-28.

Table 7-28: Fish Valued Components in Northwestern Alberta

Family	Common Name	Scientific Name	Spawning Period
Cod – Gadidae	Burbot	*Lota lota* (Linnaeus)	Winter
Perch – Percidae	Walleye	*Stizostedion vitreum* (Mitchill)	Spring and early summer
Pike – Esocidae	Northern pike	*Esox lucius* (Linnaeus)	Spring
Trout – Salmonidae	Arctic grayling	*Thymallus arcticus* (Pallas)	Spring
	Lake whitefish	*Coregonus clupeaformis* (Mitchill)	Fall and early winter

Effect Attributes

Effects on fish and fish habitat are described in Table 7-29 using the following effect attributes:

- direction
- magnitude
- geographic extent
- duration

The combination of these effect attributes is used to determine if an effect is significant. For a detailed description of these effect attributes, see EIS Volume 5, Section 7.

Table 7-29: Definitions of Effect Attributes for Fish and Fish Habitat

Attribute	Definition
Direction	
Adverse	Effect on VC is worsening compared with baseline conditions and trends
Neutral	Effect on VC is not changing compared with baseline conditions and trends
Positive	Effect on VC is improving compared with baseline conditions and trends
Magnitude	
No effect	No effect on key indicator(s), such that there are no effects on the VC
Low	Effect on key indicator(s) is such that a group of fish in a population found in a localized area, e.g., within the LSA or RSA might be affected
Moderate	Effect on key indicator(s) is such that a part of a regional population, within the LSA or RSA, might be affected, changing abundance or distribution of the VC and affecting harvest opportunities as currently practised
High	Effect on key indicator(s) is such that an entire population, within the LSA or RSA, might be affected, changing abundance or distribution so that natural recruitment would not likely return the population to its prior level, resulting in reduced population viability and unsustainable harvest as currently practised
Geographic Extent	
Local	Effect on VC within LSA
Regional	Effect on VC within RSA
Beyond regional	Effect on VC extends beyond the RSA
Duration	
Short term	Effect on VC is limited to less than one year
Medium term	Effect on VC lasts from one to four years
Long term	Effect on VC lasts longer than four years, but does not extend more than 30 years after decommissioning and abandonment
Far future	Effect on VC continues for more than 30 years after decommissioning and abandonment
NOTES: LSA = local study area RSA = regional study area	

Analysis and Significance

Effects on fish and fish habitat are determined by analyzing the effects on:

- change in availability, quality or quantity of habitat
- change in fish health
- change in distribution and abundance

Effects on fish will not exceed low magnitude, and will be local to regional in extent. Many of the effect pathways discussed are short term, occurring only during crossing construction, and the potential effects differ depending on the watercourse classification and the crossing method.

The geographic extent of effects will be confined to the local area, except for the effects of:

- change in flow caused by effects on groundwater
- blockage of fish movement by frost bulb formation

Effects from these pathways might extend beyond local to regional, but duration will not extend beyond long term. These occurrences are expected to be rare and site specific.

Effects on fish are predicted to be not significant (see Table 7-30).

Table 7-30: Effects on Fish and Fish Habitat

Key Indicators	Phase When Impact Occurs	Effect Attribute				
		Direction	Magnitude	Geographic Extent	Duration	Significant
Habitat	Construction	Adverse	Low	Local	Short term	No
	Operations	Adverse	Low	Regional	Long term	No
	Decommissioning and abandonment	Adverse	Low	Local	Long term	No
Health	Construction	Adverse	Low	Local	Long term	No
	Operations	Neutral	No effect	N/A	N/A	No
	Decommissioning and abandonment	Neutral	No effect	N/A	N/A	No
Distribution and abundance	Construction	Adverse	No effect	N/A	N/A	No
	Operations	Neutral	No effect	N/A	N/A	No
	Decommissioning and abandonment	Neutral	No effect	N/A	N/A	No

NOTE:
N/A = not applicable

Change in Availability, Quality or Quantity of Fish Habitat

Direct Habitat Effects – Pipeline Crossing Construction

The pipeline corridor will cross 43 watercourses, ranging from Vegetated Channels to Large River Channels (see Table 7-31). NGTL will use crossing methods and comply with timing restrictions prescribed for a Class C waterbody by the *Code of Practice for Pipelines and Telecommunication Lines Crossing a Waterbody* (Alberta Environment 2001). The period of restricted in-water activity for a Class C waterbody in northwestern Alberta is April 16 to July 15.

Table 7-31: Watercourse Crossings in Northwestern Alberta

Site ID	Watercourse Name	UTM Coordinates (NAD 83)			Watercourse Classification	DA[1] (km^2)	Spring Spawning	Fall/Winter Spawning	Overwintering	Rearing	Large-bodied Fish Species Captured or Reported
		Zone	Easting	Northing							
NWML-02	Unnamed stream	11	333764	6653598	Vegetated	10	–	–	–	–	ND
NWML-03	Unnamed stream	11	333744	6652298	Vegetated	6	–	–	–	–	ND
NWML-04	Unnamed stream	11	333716	6648916	Vegetated	0.6	–	–	–	–	ND
NWML-05	Unnamed stream	11	334303	6647545	Active I	40	●	–	–	●	ND
NWML-06	Unnamed stream	11	333976	6646416	Vegetated	2	–	–	–	–	ND
NWML-07	Thinahtea Creek	11	333124	6643480	Active I	71	●	–	–	●	Northern pike
NWML-08	Unnamed stream	11	332883	6640732	Active I	52	●	–	–	●	ND
NWML-09	Unnamed stream	11	333136	6639200	Vegetated	9	–	–	–	–	ND
NWML-10	Unnamed stream	11	333364	6638063	Active I	36	●	–	–	●	ND
NWML-11	Unnamed stream	11	334266	6633924	Vegetated	3.5	–	–	–	–	ND
NWML-12	Unnamed stream	11	334266	6633085	Vegetated	8.5	–	–	–	–	ND
NWML-13	Unnamed stream	11	334150	6630366	Vegetated	12.5	–	–	–	–	ND
NWML-13.5	Unnamed stream	11	334101	6630057	Vegetated	NA	–	–	–	–	ND
NWML-14	Unnamed stream	11	334114	6629487	Active I	43	●	–	–	●	ND
NWML-15	Unnamed stream	11	334029	6627563	Vegetated	7	–	–	–	–	ND
NWML-16	Unnamed stream	11	333948	6625746	Active I	102	●	–	●	●	White sucker
NWML-17	Unnamed stream	11	333743	6621037	Vegetated	<1	–	–	–	–	ND
NWML-18	Unnamed stream	11	333722	6620642	Active II	<4	–	–	–	–	ND

Table 7-31: Watercourse Crossings in Northwestern Alberta (cont'd)

Site ID	Watercourse Name	UTM Coordinates (NAD 83)			Watercourse Classification	DA[1] (km^2)	Spring Spawning	Fall/Winter Spawning	Overwintering	Rearing	Large-bodied Fish Species Captured or Reported
		Zone	Easting	Northing							
NWML-19	Unnamed stream	11	333659	6619766	Vegetated	1.6	–	–	–	–	ND
NWML-20	Unnamed stream	11	333642	6618727	Vegetated	NA	–	–	–	–	ND
NWML-21	Unnamed stream	11	332662	6612872	Vegetated	<0.5	–	–	–	–	ND
NWML-22	Petitot River	11	332639	6609518	Large River	7710	●	●	●	●	Arctic grayling, longnose sucker, northern pike, white sucker
NWML-23	Unnamed stream	11	333638	6608491	Active II	15	–	–	–	–	ND
NWML-24	Unnamed stream	11	333650	6607540	Vegetated	6	–	–	–	–	ND
NWML-25	Unnamed stream	11	333672	6605754	Vegetated	1	–	–	–	–	ND
NWML-26	Unnamed stream	11	333500	6603630	Active I	90	●	–	–	●	Arctic grayling
NWML-27	Unnamed stream	11	333350	6600979	Vegetated	9	–	–	–	–	ND
NWML-28	Unnamed stream	11	333345	6599701	Active I	260	●	–	●	●	Arctic grayling, longnose sucker, white sucker
NWML-29	Unnamed stream	11	333486	6597097	Vegetated	1	–	–	–	–	ND
NWML-30	Unnamed stream	11	336039	6593248	Active II	4.4	–	–	–	–	ND
VR-001	Unnamed stream	11	335818	6590786	Vegetated	1.3	–	–	–	–	ND
VR-002	Unnamed stream	11	335183	6587073	Vegetated	3.2	–	–	–	–	ND
VR-003	Unnamed stream	11	335104	6584423	Vegetated	1.5	–	–	–	–	ND
VR-004	Unnamed stream	11	334854	6580747	Vegetated	3.2	–	–	–	–	ND

Table 7-31: Watercourse Crossings in Northwestern Alberta (cont'd)

Site ID	Watercourse Name	UTM Coordinates (NAD 83)			Watercourse Classification	DA[1] (km^2)	Spring Spawning	Fall/Winter Spawning	Overwintering	Rearing	Large-bodied Fish Species Captured or Reported
		Zone	Easting	Northing							
VR-005	Shekilie River	11	334789	6579538	Active I	20.3	●	–	–	●	Burbot, longnose sucker, northern pike, white sucker
VR-006	Unnamed stream	11	334639	6577094	Vegetated	5.5	–	–	–	–	ND
VR-007	Unnamed stream	11	334563	6575677	Active I	29.3	●	–	–	●	ND
VR-008	Unnamed stream	11	334527	6575020	Vegetated	5.8	–	–	–	–	ND
VR-009	Unnamed stream	11	334404	6572649	Active II	2.2	–	–	–	–	ND
VR-010	Unnamed stream	11	334386	6572306	Vegetated	4.1	–	–	–	–	ND
VR-011	Unnamed stream	11	334216	6569072	Vegetated	6.0	–	–	–	–	ND
VR-012	Unnamed stream	11	334192	6568612	Vegetated	4.4	–	–	–	–	ND
VR-013	South Shekilie River	11	333221	6556570	Active I	174	●	–	UNK	●	ND

NOTES:
1 Drainage area of watershed upstream of the crossing location
UNK = Unknown; streams yet to be surveyed
ND = Presence of fish not documented in watercourse during current and previous studies
– = Suitable habitat not present
● = Suitable habitat potentially present

Crossing Vegetated and Active II watercourses is not expected to directly affect fish habitat because these watercourses will be either dry or frozen to the bed during crossing construction, and their bed and banks will be reclaimed to stable conditions before flow returns in the spring.

Large River and Active I channels, which are likely to provide overwintering habitat and could be used for spawning, egg incubation and rearing habitat by fall spawning species, might be crossed using a trenchless construction method where practical. Using a trenchless method will avoid the physical disturbance of habitat at a crossing location that occurs when an isolation or open-cut method is used. If local site conditions prevent the use of a trenchless method, or the risk of failure is high, the crossing will be constructed using either an isolation or open-cut method.

Isolation or open-cut methods will be used to cross Large River and Active I channels, where overwintering or spawning habitat for fall spawning species is not present at or near the crossing location.

Direct effects on habitat can only be avoided when trenchless methods are used. Habitat features at the crossing location will be disturbed by trenching, pipe installation and backfilling when an isolation or open-cut construction method is used. The extent of direct effects is related to the:

- size of the area disturbed
- type of habitat present
- duration of the disturbance
- ability of the habitat to recover from the disturbance

The size of the area disturbed by construction is small. The width of the trench is 1.5 to 2 m, and the maximum width of the right-of-way is 40 m. The area of stream bed habitat disturbed is typically less than 5 m on either side of the trench. Habitat features have been mapped upstream and downstream of the crossing locations at all Large River and Active I channels, making it possible to avoid or protect specific habitat features or habitat types potentially affected by construction.

The time required for crossing construction depends on the width of the watercourse. Typically, the duration of crossing construction for most Active I Channels is three to five days, although more time might be required for larger Active I and Large River Channels. Vegetated and Active II Channels can be crossed in one day. On completion of crossing construction, the disturbed stream bed materials are replaced with similar-sized material, the banks are reclaimed and the bed of the watercourse is reclaimed to its original contours.

Because of the small area of disturbance, short duration of the disturbance, the ability to avoid specific habitat types or features, and reclamation of the area after construction, the direct effects on fish habitat from crossing construction are adverse, low magnitude, local and short term (see Table 7-32).

Table 7-32: Direct Habitat Effects of Pipeline Crossing Construction

Class	Fall Spawning and Overwintering Habitat for Valued Components at Crossing	Flow	Crossing Method	Direction	Magnitude	Geographic Extent	Duration
Active I or Large River	Yes	Yes	Trenchless	Neutral	No effect	N/A	N/A
			Isolation or open-cut (if trenchless methods are not feasible)	Adverse	Low	Local	Short term
	No	Yes	Open cut	Adverse	Low	Local	Short term
Active II	N/A	No	Open cut[1]	Neutral	No effect	N/A	N/A
		Yes	Isolation	Adverse	Low	Local	Short term
Vegetated	N/A	No	Open cut	Neutral	No effect	N/A	N/A

NOTES:
N/A = not applicable
1 Isolation method will be used if flowing water is encountered during crossing construction

Change in Channel Morphology

Bed and Bank Disturbance – Pipeline Crossing Construction

Effects of small-scale changes in morphology, such as those resulting from watercourse crossing construction, are expected to be low magnitude and local in extent. Active I and Active II channels are most likely to be affected.

Locating pipeline crossings at sites where the channel is stable will increase the likelihood that banks can be successfully reclaimed, and the existing stream morphology will continue to evolve naturally. Erosion of weakened banks and unconsolidated substrate at crossing locations can be reduced by implementing shore-protection measures to maintain stability of the channel.

No effects are expected on Vegetated Channels because many do not have defined banks. Changes in morphology of Active I and Active II channels can be avoided by stabilizing and reclaiming bed and banks after construction.

Mitigation measures will limit the magnitude of any potential adverse effects on Active I and II channels to no effect or low magnitude. Effects of changes in channel morphology are likely to become evident during operations. Effects will be localized and can be eliminated by monitoring stability of banks and repairing eroded areas, as needed. Disturbance of banks at Large River crossings is unlikely to change channel morphology. Effects of construction-related changes in the banks of Large River Channels will be minor compared with the natural factors that affect and maintain channel morphology.

Bank Subsidence

Effects of bank subsidence will be similar to the effects of bed and bank disturbance. Effects of small-scale changes in morphology from bank subsidence at crossings are expected to be low magnitude and restricted to the LSA, therefore local in extent.

Change in Water Level – Water Withdrawal

The Dickins Lake and Vardie River sections will be pressure tested before they are put into service. If hydrostatic pressure testing is the preferred method, water must be withdrawn from local waterbodies. Water volumes for hydrostatic pressure-testing could be as high as 23,000 m^3 for filling and 2,300 m^3 for circulating heating water and pressurizing operations for the proposed 37-km-long NPS 36 pipeline in the Vardie River Section. For the Dickins Lake Section, the 66-km-long NPS 36 pipeline could require about 30,000 m^3 for filling and 3,000 m^3 for circulating heating water and pressurizing operations. Final selection of water sources has not been completed.

Additional water might be needed for ice roads and temporary camps during construction. These sources will be local lakes and watercourses adjacent to, or crossed by, the route. Potable water for camps and other infrastructure facilities during operations will come from commercial sources and will be delivered to the site.

Water withdrawals will be in accordance with the *Code of Practice for the Temporary Diversion of Water for Hydrostatic Testing of Pipelines* (Alberta Environmental Protection 1999a).

Water withdrawal is expected to be minimal for operations than during construction. The amount of water needed for either domestic or industrial uses will be small during operations and none will be needed for decommissioning. Consequently, water withdrawal will not affect fish habitat.

Sediment Deposition

Sediment Deposition – Crossing Construction

Sediment entrained during crossing construction will be transported and deposited downstream of the crossing. Most of the sediment, i.e., particles the size of coarse silt or larger, will settle within 45 bankfull widths of the crossing. The extent of effects of the sediment deposition on downstream habitats depends on the type of habitat that is present, the amount of sediment deposited and the ability of the habitat to recover. See EIS Volume 5, Section 7 for a discussion of the effects of suspended deposition on fish habitat.

The amount of sediment deposited downstream of the crossing depends on the:

- construction method
- watercourse classification
- flow conditions at the time of construction

The greatest amount of sediment is entrained and subsequently deposited when open-cut methods are used. Using isolation methods substantially reduces the amount of sediment entrained. No sediment is entrained when trenchless crossing methods are used. Selecting a crossing method that entrains the least amount of sediment, when sensitive habitats are present downstream, will reduce or eliminate adverse effects of sediment deposition.

The use of open-cut methods will be avoided when crossing Large River or Active I channels where overwintering or spawning habitat for fall spawning species are present. Although sediment deposition will occur if open-cut or isolation construction methods are used, low winter flow, less turbulence under ice and the presence of beaver dams will limit the distance sediment will travel. The amount of habitat affected by deposited sediment will be limited to the area near the crossing location.

Active II and Vegetated channels are unlikely to be affected by sediment deposition because these watercourses will be dry or frozen to the bottom during construction. Sediment disturbed during crossing of Active II and Vegetated channels, where standing water is present below the ice in beaver impoundments, will be contained by the beaver dams. Sediment entrained during crossing construction will not be transported downstream and deposition will be limited to the area immediately adjacent to the trench.

Effects of sediment deposition on VC habitat during construction are expected to be adverse, no effect or low magnitude (depending on the habitat and the crossing method), local and short term. Effects are restricted to the period of crossing construction. Once in-water work has been completed, and the bed material is replaced, no additional sediment will be deposited.

Change in Water Quality

Suspended Sediment – Crossing Construction

Pipeline crossing construction activities, such as trenching, pipe installation and backfilling, will entrain sediment in the water column and increase total suspended solids (TSS) concentrations. Exposure to suspended sediment can affect the health of fish and other aquatic organisms, with effects ranging from minor physiological stress to mortality. The magnitude of the effect is a function of the TSS concentrations and the duration of exposure. Fish are able to tolerate high concentrations of TSS for short periods, or low doses for long periods. For a discussion of the TSS dose-response relationship, see EIS Volume 5, Section 7.

The amount of sediment entrained during watercourse crossing construction depends on the:

- construction method
- watercourse classification
- flow conditions at the time of construction
- duration of in-water work

TSS concentrations when the open-cut methods are used are typically higher than those that occur when the isolation method is used. However, the duration of construction is often considerably longer with isolation methods. Virtually no sediment is entrained when trenchless methods are used.

Thirty-one of the 43 watercourses crossed by the Dickins Lake and Vardie River sections are expected to be dry or frozen to the bed in winter. As these watercourses will be dry or frozen to the bed during construction, no sediment will be entrained. Therefore, there will be no effect of sediment exposure on fish.

Late-winter surveys of the remaining 12 watercourses indicated that nine of these watercourses had a low dissolved oxygen concentration and most had numerous beaver impoundments at or downstream of the crossing (see Table 7-33). Although standing water could be present below the ice surface of beaver impoundment, the low dissolved oxygen concentrations precluded overwintering by VCs. Any sediment that is entrained during crossing construction at beaver impoundments will be contained by the beaver dam and transport of the material farther downstream will be prevented. Since VCs are not likely to be present and downstream transport of entrained material is prevented by beaver dams, no adverse effects on the health of VCs are expected to occur.

The remaining three watercourses crossings have overwintering habitat downstream of the crossing location:

- NWML–16 Unnamed stream
- NWML–22 Petitot River
- NWML–28 Unnamed stream

Isolation or trenchless methods will be used at these crossings. Increases in TSS concentrations during crossing construction of these watercourses are expected to be small for crossings constructed using the isolation method. No increase in TSS is expected when trenchless methods are used. For a summary of effects of increased sediment during pipeline watercourse crossing construction, according to watercourse classification and crossing method, see Table 7-34.

Table 7-33: Watercourse Crossings in Northwestern Alberta with No VC Overwintering Habitat

Crossing ID	Watercourse Name	Max Under-ice Depth[1] (m)	Mean Winter Velocity[1] (m/s)	Winter Conditions[2]
NWML-05	Unnamed	0.48	No flow	Low winter dissolved oxygen
NWML-07	Thinahtea Creek	0.17	No flow	Low winter dissolved oxygen, beaver dams downstream
NWML-08	Unnamed	1.10	No flow	Low winter dissolved oxygen, beaver dams downstream
NWML-10	Unnamed	0.40	No flow	Low winter dissolved oxygen, multiple beaver dams and impoundments
NWML-14	Unnamed	0.00	Frozen	Frozen to substrate in winter, beaver dams downstream
NWML-26	Unnamed	0.56	No flow	Low winter dissolved oxygen, beaver impoundments
VR-005	Shekilie River	N/A	N/A	Multiple beaver dams and impoundments
VR-007	Unnamed	N/A	N/A	Large impoundment at the crossing, dissolved oxygen levels in summer near anoxic and likely to be lower in winter
VR-013	South Shekilie River	N/A	N/A	Shallow, multiple beaver dams, likely frozen to substrate or with low under-ice dissolved oxygen

NOTES:
1 Winter water depth and flow data based on 2003 and 2004 late winter field surveys
2 For more details on winter conditions, see Baseline Conditions
Frozen = frozen to substrate during late-winter surveys
No flow = under-ice non-flowing water recorded during late-winter surveys
N/A = data not available

Change in Fish Health

Effects of Explosives

It is not known whether explosives will be required for any water crossings. If explosives are used, the affected area will be limited to the immediate crossing location. Effects of in-water detonation of explosives will be limited to fish occupying overwintering habitat in Active I or Large River channels. The affected area is limited to the immediate crossing location. No effects on fish are expected if there is no overwintering habitat at the crossing. Active II or Vegetated channels, which account for most of the watercourses crossed by the pipeline, will not be affected. Duration of the effect is short, i.e., limited to the period of detonation. If explosives are required, they will be used according to the *Guidelines for Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky 1998). However, operational requirements might make it necessary to exceed the setback distance specified in the guidelines. In such cases, fish in the area of detonation might be adversely affected. An application for authority to kill fish by means other than fishing will be submitted to Fisheries and Oceans Canada pursuant to Section 32 of the *Fisheries Act*, should guideline values need to be exceeded.

Table 7-34: Effects of Sediment Entrained During Crossing Construction on Fish

Class	Flowing Water Present	Crossing Method	Direction	Magnitude	Geographic Extent	Duration
Active I or Large River	Yes	Trenchless	Neutral	No effect	N/A	N/A
		Isolation	Adverse	Low	Local	Short term
		Open cut – trenchless or isolation methods not feasible	Adverse	Low	Local	Short term
	Yes	Isolation, or open cut when isolation method not feasible	Adverse	Low	Local	Short term
Active II	No	Open cut	Neutral	No effect	N/A	N/A
	Yes	Isolation	Adverse	Low	Local	Short term
Vegetated	No	Open cut	Neutral	No effect	N/A	N/A

Potential adverse effects on fish health arising from in-water use of explosives are considered low magnitude, only affecting fish in the immediate vicinity, short term, i.e., limited to trench construction and confined to the crossing location, so local in extent.

Change in Abundance and Distribution

Harvest

Increased Access

No effects on VC abundance and distribution are expected because of increased access from the pipeline rights-of-way. The existing NGTL right-of-way for the Vardie River Section will be used. The Dickins Lake Section will mostly use existing seismic lines. Ground access is already present in the area. It is unlikely that clearing the right-of-way will improve accessibility to waterbodies and increase the harvest of sport fish. No adverse effects are expected.

Prediction Confidence

Because of the precautionary approach used to predict effects on fish and fish habitat of adding the Vardie River Section, there is a high degree of confidence in the assessment of significance of effects. The level of confidence is consistent with that in EIS Volume 5, Section 7.

Combined Project Effects

Effects from the Dickins Lake and Vardie River sections are predicted to be adverse, local and long term. The magnitude of effects is low. No significant effects on fish and fish habitat are predicted.

The EIS concluded that the Mackenzie Gas Project, combined with NGTL's Dickins Lake Section, would produce no significant effects on:

- availability, quality or quantity of fish habitat
- fish health
- fish abundance and distribution

This assessment for northwestern Alberta concludes that the Mackenzie Gas Project combined with NGTL's Dickins Lake and Vardie River sections will also produce no significant effects.