13.8 Fisheries and Aquatic Resources

13.8.1 Baseline Setting

13.8.1.1 Fish Species Present

The proposed 83 km-long Project is located entirely within a portion of the Hay River watershed (Fort Nelson Lowlands) that is characterized by poorly drained muskeg lowlands, providing a mosaic of forest and wetland ecosystems (Meidinger and Pojar 1991; Appendix C). Streams generally have low fish habitat diversity and capacity. Channels are invariably sinuous, low gradient (<1 percent) with substrates dominated by fines.

The Hay River rises in the Naylor Hills of northwestern Alberta, flows westward into British Columbia before turning northeast back into Alberta, then north into the Northwest Territories and eventually into Great Slave Lake. Fish biodiversity in the British Columbia portion of the Hay River is low, with only nine species (six non-game or forage species and three game species) ever recorded, compared to 52 species in the Mackenzie System upstream of Great Slave Lake and 16 species for the Alberta portion of the Hay River (McPhail et al. 1998; Nelson and Paetz 1992).

Previous records of fish from the British Columbia portion of the Hay River watershed are summarized in Table 13.8-1. The three game fish species include; walleye (*Stizostedion vitreum*), burbot (*Lota lota*), and northern pike (*Esox lucius*). These previous records indicate that walleye and burbot are sporadic in occurrence and not present in sufficient numbers to support recreational fisheries (Table 13.8-1). The three walleye collected were all in areas characterize by coarse substrates (McPhail et al. 1998). Only the widely distributed northern pike may possibly support a recreational fishery in the BC portion of the Hay River watershed. The six non-game species include: lake chub (*Couesius plumbeus*), finescale dace (*Phoxinus neogaeus*), longnose sucker (*Catostomus catostomus*), white sucker (*Catostomus commersoni*), trout-perch (*Percopsis omiscomaycus*) and brook stickleback (*Culaea inconstans*). None of these species are red or blue listed in British Columbia.

Table 13.8-1 Records of Fish Collected from the British Columbia Portion of the Hay River Watershed

Date	Location	Site (UTM)	Reference	Sampling Methods[1]	Species Collected[2]
June 3, 1960	Kotcho Lake	10.601000.6550000	UBC	seine, GN	NP. WSU
August 19, 1980	Kotcho Lake	n/a	MoELP	GN, MT	NP, WSU, LSU, LKC
July 18, 1995	unnam trib Kotcho L	10.621158.6550464	UBC	seine	FDC, BSB
n/a, 1994	trib to Shekilie River	n/a	Diversified Env.	EF	NF (no fish)
May 25, 1995	Shekilie River	10.662815.6559150	Diversified Env.	EF	LKC, TP, WSU
May 25, 1995	Shekilie River	10.660100.6547900	Diversified Env.	EF	BSB, FDC, LKC, NP
July 25, 1995	Shekilie River	10.662800.6528100	Diversified Env.	EF	BB, LKC, LSU, TP, WSU
July 25, 1995	Shekilie River	10.662350.6543550	Diversified Env.	EF	LKC, LSU, NP, TP, WSU
July 29, 1995	Shekilie River	10.668100.6580400	Diversified Env.	EF	NP
September 20, 1995	trib to Shekilie River	10.642000.6596700	Diversified Env.	EF	BSB
September 9, 1997	Hay River	10.662346.6470773	McPhail et al.	seine, GN, MT, EF	LKC, LSU, TP, WP
September 9, 1997	Little Buffalo River	10.662346.6470773	McPhail et al.	seine, GN, MT, EF	
September 9, 1997	Hay River	10.650110.6482594	McPhail et al.	seine, GN, MT, EF	LKC, NP, TP, WSU
September 9, 1997	Hay River	10.658037.6511862	McPhail et al.	seine, GN, MT, EF	NP
September 9, 1997	Timberwolf Creek	10.658037.6511862	McPhail et al.	seine, GN, MT, EF	
September 9, 1997	Hay River	10.664215.6515688	McPhail et al.	seine, GN, MT, EF	TP
September 6, 1997	'Left Trib'	10.655076.6592122	McPhail et al.	seine, GN, MT, EF	BSB, FDC
September 6, 1997	Shekilie River	10.655076.6592122	McPhail et al.	seine, GN, MT, EF	NP
September 6, 1997	Shekilie River	10.663246.6552819	McPhail et al.	seine, GN, MT, EF	BB, LKC, TP, WSU
September 6, 1997	Shekilie River	10.661571.6568211	McPhail et al.	seine, GN, MT, EF	LKC, TP
September 6, 1997	Shekilie River	10.664448.6547476	McPhail et al.	seine, GN, MT, EF	BB, FDC, LKC, NP, WP, WSU
September 6, 1997	South Shekilie River	10.664460.6547500	McPhail et al.	seine, GN, MT, EF	LKC
September 4, 1997	Metlahdoa Creek	10.591568.6508840	McPhail et al.	seine, GN, MT, EF	BSB, FDC
September 8, 1997	unnam trib Kotcho L	10.621158.6550464	McPhail et al.	seine, GN, MT, EF	BSB, LKC
September 8, 1997	Kotcho River	10.609910.6541507	McPhail et al.	seine, GN, MT, EF	NF (no fish)
September 8, 1997	Metladoa Creek	10.595577.6519410	McPhail et al.	seine, GN, MT, EF	BSB, FDC
September 8, 1997	Lichen Creek	10.592257.6524302	McPhail et al.	seine, GN, MT, EF	
September 9, 1997	White Spruce Cr.	10.642100.6520700	McPhail et al.	seine, GN, MT, EF	FDC, WSU

Table 13.8-1 Records of Fish Collected from the British Columbia Portion of the Hay River Watershed (cont'd)

Date	Location	Site (UTM)	Reference	Sampling Methods[1]	Species Collected[2]
September 9, 1997	Townsoitoi Creek	10.646000.6510950	McPhail et al.	seine, GN, MT, EF	BB, FDC, NP, WSU
September 22, 2002	Townsoitoi Creek	10.635449.6496252	EDI	EF, MT	BSB
September 22, 2002	Townsoitoi Creek	10.616352.6487931	EDI	MT	BSB, FDC
September 22, 2002	Kyklo Creek	10.602984.6502074	EDI	MT	BSB
September 22, 2002	Klicho Creek	10.616914.6510178	EDI	MT	FDC, LSU

Notes:
[1] MT = minnow trapping, GN = gill netting, EF = electrofishing, AG = angling
[2] NP = northern pike, WP = walleye, BB = burbot, WSU = white sucker, LSU = longnose sucker, LKC = lake chub, FDC = finscale dace, BSB = brook stickleback, TP = troutperch

Walleye

Walleye overwinter in moderately deep lakes and deep pool areas in rivers. Migration to spawning areas occurs at or following ice breakup. Spawning occurs in natural lakes, reservoirs and rivers. Walleye broadcast spawn preferably over wind-exposed rocky shoals in lakes or clean gravel/cobble/boulder (riffle) sections in rivers with moderate current velocities. Seldom do walleye spawn in sheltered bays or in sand/silt-bottom backwater areas since their eggs perish on silt or sand bottoms (www.dnr.state.wi.us/org/water/fhp/fish/walleye/habitat.htm). Walleye prefer low clarity water, characteristic of bog-stained lakes and rivers, with optimum transparencies in the range of one to two metres. On bright days, adult walleye have been observed to hold in deep pools utilizing overhead cover consisting of large woody debris, boulders, and weed beds. Although riverine juvenile walleye utilize cobble and boulder substrate for overhead cover, very little is actually known regarding habitat requirements.

Northern Pike

Northern pike overwinter in relatively deep lakes and rivers. At ice breakup, northern pike move inshore or upstream to flooded marshes, wetlands or shallow shoreline inundations. Optimum spawning substrate is a dense mat of short vegetation in a shallow, wind-sheltered area (Inskip 1982). Spawning occurs when these shallows reach 8 to 12°C. Eggs are broadcast over vegetative hummocks and mats which entrap the eggs and suspend them above the substrate, where anoxic conditions can develop (Casselman and Lewis 1996). Optimum nursery habitat is dense submergent and emergent aquatic vegetation providing 40 to 90 percent cover and a location contiguous to spawning habitat. Optimum extent is greater than 10 times the size of the adjacent spawning habitat (Casselman and Lewis 1996). Adult and juvenile northern pike prefer habitat that is relatively shallow, clear, cool, and well oxygenated. Northern pipe exhibit a preference for type and density of vegetative cover (Casselman and Lewis 1996).

Burbot

Adult burbot reside in deep pools in rivers and the hypolimnion of lakes. They spawn in winter, from mid-December to early April. Spawning occurs at night, under ice cover, where burbot congregate in relatively shallow water over substrate composed of clean sand, gravel and stones (Morel 1980). Burbot spawn in a ball or globular mass of fish. Eggs and sperm are broadcast into the water column; demersal eggs randomly settle on the bottom. Eggs hatch in 70 days at 0 to 4°C. Juvenile burbot frequently reside along rocky shores and weedy areas of tributary streams.

Longnose Sucker

Longnose sucker overwinter in lake and river areas that provide adequate oxygen and suitable depth. Spawning movements begin after ice-off at temperatures of 5 to 9°C (Geen et al. 1966). Spawning itself occurs at 10 to 15°C as eggs are broadcast over clean gravel and rock (1 to 20 cm) riffle areas with current velocities in the range of 0.3 to 1.0 m/s (Edwards 1982). Longnose suckers also spawn along wave-swept shorelines, at depths 15 to 30 cm (Geen et al. 1966). Fry remain in the gravel for one to two weeks, then emerge to drift downstream primarily at night. Peak fry migration is usually one month after spawning (Geen et al. 1966). Fry spend their first year in riverine conditions and seek food and shelter in shallow, quiet water with vegetation cover. Fry congregate in the top 150 mm of water and within 2 m of shore (Hayes 1956). Although adult longnose sucker are more associated with lakes, they are well-adapted to high current velocities in stony-bottomed rivers (Walton 1980).

White Sucker

White sucker overwinter in lakes and rivers with deep pools and low velocities. White sucker utilize overhead cover elements such as undercut banks, large woody debris, boulders and vegetation in lotic habitats (Hayes 1956). Spawning movements usually occur from lakes to streams after ice-off when stream temperatures reach 10°C (Geen et al. 1966). Preferred spawning occurs in streams over shallow, gravel substrates; however, spawning may even occur in rapids (Scott and Crossman 1973). Juvenile white sucker utilized instream cover elements such as vegetation, woody debris and undercut banks; 50 percent total instream cover is considered optimum (Anon 1981). Instream cover becomes more important in those streams lacking pools. White sucker juveniles reside in shallow water, close to shore in mainstem channels and confluence areas of tributary streams to mainstem channels (McPhail et al. 1998).

Lake Chub

Lake chub are widely distributed across Canada and are the most abundant and widely distributed fish species collected in the Hay River watershed (McPhail et al. 1998). This indicates a tolerance to a wide range of habitat conditions. Although habitat preferences are unclear, lake chub can successfully reside in rivers in regions where lakes are not available (Scott and Crossman 1973). Lake chub overwinter in lakes and deeper parts of large rivers. Large school spawning movements from lakes to streams have been observed to occur April to August (Morel 1980). Broadcast spawning is conducted in over rocky and gravel bottoms of rivers and streams. Post spawning movements back to lakes and deep parts of rivers have been noted in the literature (Scott and Crossman 1973).

Trout-Perch

Trout-Perch are widely distributed across North America. They are typically found in deep water of lakes (depths of 10 to 61 metres) and in long, deep pools in rivers. Spawning movements occur in late spring and summer, as spawning fish move inshore or into tributary streams to lakes. Spawning occurs near the surface of the water column; demersal eggs sink to the bottom and adhere to whatever the eggs settle on (Scott and Crossman 1973). In lotic environments, trout-perch utilize overhead cover composed of large woody debris and undercut banks (Morel 1980). Juveniles seem to prefer mainstem channels and confluence areas of tributary streams to mainstem channels. Trout-perch feed at night in shallow water and then return to deep water habitats during the day. They are considered valuable forage fish for the three species of game fish that inhabit the Hay River watershed in British Columbia (Scott and Crossman 1973).

Finescale Dace

Although finescale dace are tolerant of large river conditions, preferred habitat appears to be the cool bog-stained lakes, ponds and streams with dense aquatic vegetation, soft substrates and lots of submerged woody debris. They co-exist with brook stickleback in these environs. Nelson and Paetz (1970) reported these species survive due to a high tolerance to the low oxygen conditions commonly found in boggy streams and beaver ponds. Both species use overhead aquatic vegetation, brush, logs and ice for cover. Finescale dace spawn after ice-off (April to July) in the cover of submerged brush and logs. The fertilized eggs sink to the bottom and receive no care from either parent. The male brook stickleback, on the other hand, build a nest on the stems of reeds or grass close to, or on, the bottom. Males guard and defend the nest until the fertilized eggs hatch.

13.8.1.2 Stream Habitats at Proposed Crossing Sites

The proposed Project crosses the following eight defined water courses. Detailed fisheries and habitat surveys are proposed for the spring period (May 2003) at these crossings to investigate use and habitat conditions, and to assist in the development of final crossing design plans for these streams. The crossing descriptions provided here are based on overview investigations undertaken in October and December 2003:

13.8.1.2.1 Kyklo Creek

Kyklo Creek is a low gradient (<0.1 percent), meandering channel with numerous oxbow sloughs contiguous to the mainstem channel. Channel width is approximately 17 to 22 metres in the vicinity of the proposed crossing (Appendix 13A, Sheet 4). Top of bank height approaches two metres. Channel substrate is predominantly fines (sand) and the stream habitat type is run with no riffle structure present within the study reach. The downstream reach break is located at the confluence of Klicho Creek.

Instream vegetation, small woody debris and stream depth appear to be the major contributors to instream cover. Kyklo Creek appears to have moderate overwintering potential, with bankfull depths to two metres and moderate flow (Anon 2002). However, during geotechnical investigations undertaken in February 2003 at the crossing site, the stream was found to be frozen to its substrates, indicating no to minimal overwintering potential in some years.

Brook stickleback reside in Kyklo Creek; while, finescale dace and longnose sucker juveniles were collected in Klicho Creek, a major tributary stream to Kyklo Creek (Table 13.8-1). It is interesting that northern pike were collected in neither Kyklo Creek nor Klicho

Creek, where there is habitat for spawning, incubation and juvenile rearing. An absence of northern pike in September suggests possible downstream movement to preferred overwintering habitat in Kotcho River or Hay River had occurred.

13.8.1.2.2 Unnamed Tributary to Kotcho River

This small drainage has been heavily modified by beaver activity. The proposed route has been shifted several hundred metres south of a more direct east-west alignment to encounter the stream upstream of the beaver impoundments (Appendix 13A, Sheet 6). The channel width at the crossing site is less than two metres and poorly defined. Substrate is predominantly fines. Fish use is unknown; it is suspected that only brook stickleback and finscale dace are likely present in the vicinity of the proposed crossing.

13.8.1.2.3 Townsoitoi Creek

Townsoitoi Creek is a large, low gradient tributary to the Kotcho River. Channel width is in the range 20 to 40 metres and bankfull depth is 1.5 metres at a measured site (Anon 2002). Habitat is classified as a slow-deep run. No riffle structure was observed in the Townsoitoi Creek channel. Substrate is predominantly fines with abundant instream vegetation. Habitat appears suitable for northern pike spawning and juvenile rearing. Although burbot, finescale dace, northern pike and white suckers were captured at the confluence of Townsoitoi Creek and Kotcho River September 9, 1997; only brook stickleback and finescale dace were captured in Townsoitoi Creek on September 22, 2002 (McPhail et al. 1997; Anon 2002; Table 13.8-1). The absence of northern pike adult and juveniles from collections in Townsoitoi Creek in September 2002 may indicate downstream movement to preferred overwintering habitat in Kotcho River or Hay River.

On the west side of the stream, the proposed crossing has been shifted approximately 100 metres north of an east-west trending seismic line to avoid beaver impoundments, wetter terrain and improve site conditions for directional drill set-up (Appendix 13A, Sheet 8). Channel width is approximately 12 to 15 metres; bank height is variable to 2 metres. Townsoitoi Creek appears to have some overwintering potential, as it is large enough to support some free water flow beneath the ice cover. However, low dissolved oxygen levels may limit overwinter utilization to brook stickleback and finscale dace. During geotechnical investigations undertaken in February 2003 at the crossing site, the stream was found to be frozen to its substrates, indicating no to minimal overwintering potential in some years.

13.8.1.2.4 Unnamed Tributary #1 to Townsoitoi Creek

This small drainage has been heavily modified by beaver activity upstream of the proposed crossing (Appendix 13A, Sheet 9). The route encounters a poorly defined channel immediately downstream of a large beaver dam, and there is a high probability that the channel freezes to the substrate. Fisheries values are suspected to be zero.

13.8.1.2.5 Unnamed Tributary #2 to Townsoitoi Creek

This slow moving tributary appears to be shallow with limited overwintering potential. The proposed crossing has been shifted approximately 100 m south of an east-wet trending seismic line to avoid a significant widening of the channel (Appendix 13A, Sheet 9). At the proposed crossing site, the channel is less than 5 m wide, with low bank structure and predominantly fine substrates. Winter fisheries values are suspected to be zero.

13.8.1.2.6 Hay River

The Hay River mainstem is a low gradient, meandering channel with bankfull widths ranging from 40 to 45 m and bank top widths exceeding 5 m (Appendix 13A, Sheet 9). Numerous oxbow sloughs providing high water fish refuge, flank the mainstem channel. Substrates are dominated by fines. Overhead cover is limited. Large woody debris is sporadic with a clumped distribution, usually on meander bends. Habitat type is predominantly run. There are no typical riffle-pool sequences as there are no hard points. Bankfull depth at the proposed crossing location is variable to two metres. Bank top height is variable to five metres.

The Hay River has the highest potential for overwintering fish of all the watercourses encountered on the proposed route, with anticipated winter flows in some years of between one and two m^3s^{-1}. However, during geotechnical investigations undertaken in February 2003 at the crossing site, the stream was found to be frozen to its substrates, indicating no to minimal overwintering potential in some years. With the possible exception of burbot, the Hay River mainstem does not provide suitable spawning habitat for game-fish species in the low gradient, meandering channel downstream of the proposed crossing site.

13.8.1.2.7 Unnamed Tributary to Hay River

Several large beaver dams downstream of the proposed crossing site have modified this stream (Appendix 13A, Sheet 10). The dams have resulted in a 25 to 30 m wide shallow impoundment channel with limited overwintering potential for fish. December discharge near the confluence of this channel with the Hay River was measured at less than 0.2 m^3s^{-1}. During geotechnical investigations undertaken in February 2003 at the crossing site, the stream was found to be frozen to its substrates, indicating no to minimal overwintering potential. Winter fisheries values are suspected to be zero.

13.8.1.2.8 Little Hay River

Little Hay River is a low gradient (<1 percent), meandering channel with numerous oxbow sloughs contiguous to the mainstem channel. Channel width is approximately 10 to 12 metres in the vicinity of the proposed crossing (Appendix 13A, Sheet 13). Bank height is variable to two metres, while channel substrate is predominantly sandy-fines. Stream habitat type in the vicinity of the proposed crossing site is run. Stream depth and ice cover appears to be the major sources of overhead cover for fish, as woody debris, undercut bank, boulder, and instream vegetation cover appears to be poor to non-existent. Little Hay River is suspected to provide moderate overwintering and perhaps spawning habitat for burbot. However, during geotechnical investigations undertaken in February 2003 at the crossing site, the stream was found to be frozen to its substrates, indicating no to minimal overwintering potential in some years. Based on preliminary investigations, suitable spawning and summer rearing habitat for walleye and northern pike does not appear to exist within one km of the proposed crossing site.

13.8.1.3 Field Survey Program

To verify elements of the baseline information discussed above, and to provide additional detail for the mitigation strategies discussed in the following sections, a Fish Habitat Assessment Procedures (FHAP) Level 1 field program is planned in 2003 (Johnston and Slaney 1996). The results of this field program described below will be submitted to the NEB upon finalization.

Field sampling will begin immediately following ice-off at each of the eight defined crossing sites. A Level 1 FHAP survey will be conducted from a point 100 m upstream to a point 600 m downstream of the ROW. If high quality habitat for regionally significant species occurs within this 700 m section, then additional increments of stream will be surveyed to include any necessary shifting of the ROW. In addition to the fish habitat surveys, inventory sampling for fish presence / absence will involve multiple capture methods including electrofisher, gill nets, seine nets and minnow traps. Timing of this field program is weather dependent and thus may be delayed by snow or ice conditions.

13.8.2 Results of Issues Scoping

13.8.2.1 Project Effects Analysis

Although pipeline developments represent narrow, linear disturbances on the landscape; pipeline water crossing construction has the potential to cause temporary adverse effects on stream and river ecosystems (Reid and Anderson 1999). Potential project effects include:

- sedimentation and instream habitat alteration from disturbing (trenching) riparian zone and stream channel
- sediment introductions from adjacent disturbed ROW
- drainage pattern alteration from ROW development
- increased fishing pressure from new access potential

Habitat Alteration

The major effects of pipeline developments on streams and associated fisheries resources are generally associated with instream activities during construction. Conventional trenched crossings involve bank and riparian modifications during ROW preparation and instream trenching for pipe installation, and can result in elevated levels of total suspended solids in the stream during the construction period. While trenchless techniques such as Horizontal Directional Drills (HDDs) are now commonly employed to install pipe below channels to reduce instream disturbance, the installation of vehicle crossing structures to accommodate construction traffic can still result in some level of disturbance to the bed and banks of the stream, even at drilled crossings.

An extensive review of the effects of sediments on fish, fish habitat and macroinvertebrates has been reported in Anderson et al. (1996), Newcombe and Jensen (1996), Newcombe (1994), Newcombe and Macdonald (1991). Riparian and stream habitat alterations within ROW's are discussed in Brown et al. (2000).

Sediment Introductions

During and immediately following construction, the newly developed ROW is generally void of vegetative cover, and potentially prone to surface erosion from wind and running water. Where the ROW encounters long approach slopes to watercourses, sediment laden run-off can enter the watercourse from the ROW, increasing TSS and downstream sedimentation, and potentially affecting fish habitat quality.

Altered Stream Flow Patterns

Pipeline developments can potentially affect flow rates in streams through:

- instream trenching activities during pipe installation
- water withdrawals for hydrostatic testing
- localized interception and diversion of surface or shallow groundwater flows from ditch subsidence along ROW (see Terrain and Soils section of EIA)

These are typically short-term events associated with open trench and construction activities but nevertheless must be considered in the planning of a pipeline Project.

Increased Access Potential

New ROW developments into previously remote terrain can increase access potential, particularly for off-road vehicles such as ATVs and snowmobiles. This increase in access can result in an increase in or redistribution of recreational fishing pressures which, in turn, can affect sport fish populations.

13.8.2.2 Key Impact Questions

The following table lists the key impact issues that could arise from the various activities associated with construction and operations of the Pipeline at stream crossings. The primary potential areas of impacts are associated with the actual crossing sites, while secondary effects are associated with downstream habitat alteration and access potential.

Key Impact Issue	Key Impact Questions
Habitat alterations from pipe installation and temporary construction bridges	What are effects of sedimentation and ROW habitat alterations on fish spawning, rearing, overwintering, feeding, migration and capacity to produce fish: What are the effects of any altered stream flow on above?
Sediment introductions from ROW	What are potential sedimentation effects from adjacent disturbed ROWs?
Altered stream flow patterns	How will the Project effect flow rates, particularly during low winter flows?
New access potential	What is potential of increase recreational fishing?

13.8.3 Study Area

The study area for this Project includes the riparian area on either side of the channel for a linear distance along the stream channel at least equal to the impacted area. The study area is bounded downstream by the transitional zone boundary or reach break for each stream crossing. The downstream reach breaks for this Project are as follows:

- Kyklo Creek – confluence with Klicho Creek
- Unnamed tributary to Kotcho River – confluence with Kotcho River
- Townsoitoi Creek – confluence with Kotcho River
- Unnamed tributary #1 to Townsoitoi Creek – confluence with Townsoitoi Creek
- Unnamed tributary #2 to Townsoitoi Creek – confluence with Townsoitoi Creek
- Hay River – two km downstream of proposed crossing
- Unnamed tributary to the Hay River – confluence with the Hay River
- Little Hay River – two km downstream of proposed crossing

13.8.4 Assessment Scenarios

This assessment addresses impacts associated with construction (winter 2003-2004) and operations (2007 and beyond). Baseline data will be collected in the spring of 2003 to verify data presented in the baseline setting section (i.e., Section 13.8.1) of this application. The 2003 baseline data survey will employ former British Columbia Watershed Restoration Program Level 1 Fish Habitat Assessment Procedure (FHAP) protocols, coupled with an intensive fish sampling program utilizing multiple collection techniques (i.e., gill and seine nets, minnow traps and electrofishing if field conditions are within electrofishing guideline criteria). All sampling will be conducted within the boundaries of the Project study area as outlined in Section 13.8.3.

13.8.5 Proposed Mitigation

The detailed fisheries and habitat surveys proposed for the spring period (May 2003) at these crossings to investigate use and habitat conditions will influence the development of final mitigation and crossing design plans for these streams. The information presented in this section will be modified and further defined as required, once spring surveys have been completed.

13.8.5.1 Habitat Alteration

The most effective mitigation for minimizing or eliminating adverse habitat alterations at watercourses is the development of effective crossing plans. Detailed crossing plans have been developed for the major watercourses crossed by this Project, and are presented in the Environmental Protection Plan (EPP) of this document (see Appendix 13D).

Briefly, horizontal directional drills (HDDs) are proposed for the four named stream crossings, including Kyklo Creek, Townsoitoi Creek, the Hay River and Little Hay River. Bore holes drilled next to these crossing in February 2003 indicated that all four crossings are good candidates for drills, as the drill path will encounter fine-textured fluvial deposits or stiff tills. For all of these crossings, the drill exit and entry points will be located a minimum of 125 m from the channel, ensuring protection for the bed, bank and riparian area of these streams. In spite of the fact that all of these streams were frozen to the substrates during February 2003, EnCana is committed to drilling these crossings regardless of flows next winter because of the reduced impacts to bed and banks associated with such crossing techniques. Should a drill fail at any of these sites, all sites are also suitable for isolated trenched crossings because of their low winter flows and flat to gently sloping approaches. Details of these contingency crossing methods are also presented in the EPP.

All other streams encountered by the ROW are small and/or shallow channels that will undoubtedly be frozen to their substrates during construction. They are considered to have no overwintering value for fish. If standing water is present under the ice at these sites during construction, isolated trenched crossings will be used. If no standing water is present, a simple trenched crossing will be employed.

Preferred crossing structures for construction traffic have also been developed in the crossing design plans in the EPP. For the Hay River, a two span bridge has been designed to eliminate bank grading and minimize instream channel disturbance. At all other crossings, the gentle approaches, low banks and minimal winter flows make these crossings ideal for simple snow/ice bridges. Clean snow borrowed from adjacent areas or water will be used to build up the bridge surface at these crossings. If water is drawn from the watercourse to construct the bridge, withdrawal rates will be limited to 10 percent of the measured flow at the time of construction.

13.8.5.2 Sediment Introductions

Given the flat terrain encountered by the Project on approaches to streams, sediment introductions from the Row will be a minor issue for this Project. Nevertheless, a number of standard construction and reclamation practices will be undertaken at the discretion of the Environmental Inspector to mitigate this potential impact.

- should thawed conditions be encountered during construction, temporary erosion and sediment control measures will be implemented to prevent sediment introductions from the ROW into streams, including the installation of silt fences on approaches to streams
- on the shallow approach slopes to Kyklo Creek and the Little Hay River, surface diversion berms will be installed at strategic intervals during clean-up to divert run-off from the ROW into stable, vegetated off-ROW areas
- all approach slopes will be seeded immediately following construction with an approved cover crop that will aid in the re-vegetation of suitable and stable plant species. A slower developing native revegetation seed mix will be applied at the same time.

13.8.5.3 Altered Stream Flow Patterns

The following measures will be implemented to reduced project-related effects on stream flows:

- isolated crossing techniques with pump around features will be used on all streams supporting flowing water beneath the ice at the time of crossing (with the exception of the HDD crossings) to maintain downstream flows during trenching
- all water withdrawals required from streams for ice bridge development or hydrostatic testing will be restricted to 10 percent of calculated stream flows at the time of construction, unless otherwise directed by federal or provincial authorities
- there is potential for ditch subsidence associated with pipeline development in peat-dominated lowland terrain to result in localized interception and diversion of surface and shallow groundwater flows. Measures to maintain natural cross-ROW drainage patterns will be implemented as part of good construction practice, including:
    - inspection during backfilling operations to ensure that ditchline is adequately backfilled and roached to accommodate subsequent settlement and reduced ditchline subsidence
    - breaks in elevated backfill at natural drainage channels and strategic intervals to maintain cross-ROW drainage

- inspection one year after ditchline remediation to correct significant areas of ditch subsidence, where necessary
- installation of mineral soil stub berms over ditchline at strategic locations to deflect water out of problematic ditchline areas (see Section 13.5, Terrain and Soils for more details)

13.8.5.4 New Access Potential

The naturally wet terrain encountered by the Project will greatly limit the degree of new access potential afforded by the ROW during periods of non-frozen ground. To limit winter access, an access management plan (see Appendix 13D.C of the EPP and Appendix 13A, Environmental Alignment Sheets) has been developed to limit the degree to which the new ROW represents an extension of the existing network of winter access in the area. The plan primarily involves the installation of timber and slash rollback along sections of the ROW at intersections with existing winter roads and at access point to the riparian areas of major stream channels. While designed primarily to protect long term wildlife habitat values, the plan will also effectively limit new access to and associated recreation fishing pressures on fish bearing streams crossed by the Project.

13.8.6 Residual Project Effects

13.8.6.1 Analytical Procedures

Project effects have been assessed based on similar projects in similar biological settings, baseline information for the Etsho Management Area, and qualitative assessment of current habitat and fish use at each crossing.

This qualitative assessment involved:

- comparing key habitat attributes within each stream crossing study area with species- specific preferred habitat attributes derived from the literature
- developing a description of key habitats that may be adversely affected by the Project both from trenching and downstream sediment deposition
- evaluating the relative contribution of each action to habitat alteration as a result of the Project

Additional analysis will be conducted based on the Spring field sampling in 2003 to verify this initial assessment. The Spring sampling program is outlined in Section 13.8.4.

13.8.7 Results

13.8.7.1 Instream Habitat Alterations

Based on preliminary investigations, all of the eight defined streams crossed by the Project are considered to support low instream habitat complexity, diversity and capacity (Section 13.8.1.2), a trend that is consistent with the region's low capacity to produce regionally significant fish populations. Geotechnical investigations at the crossings in February of 2003 found all of the major stream channels to be frozen to their substrates, suggesting that overwintering potential in the vicinity of the crossing sites is also very limited. In addition, the sediment size of riparian surficial deposits and channel substrate at normal winter discharge are favourable to quick deposition in a relatively short distance downstream of each crossing, even if instream activities result in channel disturbance. As well, all of the streams encountered have meandering characteristics with low gradient profiles, and are not as susceptible to perpetuating stream headcutting as higher gradient streams if banks are disturbed by pipeline activities.

These facts, coupled with the crossing techniques proposed for the Project (i.e., HDDs at the four named crossings, regardless of winter flows, isolated trenched crossings for all other streams with winter flows) make it reasonable to assume that no important habitat components or overall stream productive capacity will be affected by the Project. This assessment is, of course, subject to the findings of the proposed spring surveys. Therefore, project effects on instream habitat conditions are currently predicted to be low magnitude events, as indicated and defined in Table 13.8-2 below. The potential effects of the Project in the event of a failed HDD at one of the four named crossings are assessed under upset events in Section 13.12 of the EIA.

13.8.7.2 Sediment Introductions from ROW

All of the larger named streams meander through level fluvial deposits that are slightly elevated above the surrounding muskeg terrain. Therefore, approaches to the streams are flat, and actual approach slopes to the channels are either short and gradual, or non-existent. This greatly limits the potential for the ROW to contribute sediments to the stream channels during its early, non-vegetated state. The mitigation measures proposed for the ROW further reduce this potential. Therefore, ROW contributions to stream sedimentation are currently predicted to be low magnitude events, as indicated and defined in Table 13.8-2 below.

13.8.7.3 Altered Stream Flow Patterns

There is a high probability that streams encountered by the Project during winter construction will not be supporting below ice flows, and that the Project will have no effect on flow patterns. If flows are encountered, the proposed HDD crossings and isolated trenched crossings with pump around options will maintain natural flows throughout construction.

On the longer term, ROW effects on localized surface and shallow subsurface drainage patterns into streams are expected to be minimal with the proposed mitigation. The fact that the ROW is generally aligned at right angles to stream channels close to the crossing sites further reduces its potential to intercept measurable contributing inflows into fish-bearing streams in the area.

Effects on flows are most likely to be realized through water withdrawals for hydrostatic testing or ice bridge construction. Any approved water withdrawals from streams will comply with federal and/or provincial permitting restrictions, and will typically take 10 percent or less of existing flows to protect any local fisheries resources. However, there is the potential for minor shifts in fish distribution in reaches affected by withdrawals. Therefore, largely as the result of water withdrawals, project contributions to altered stream flow are currently predicted to be medium magnitude, short term (if they occur), reversible events, as indicated and defined in Table 13.8-2 below.

13.8.7.4 New Access Potential

Habitat within the study area appears to be under-utilized by regionally significant fish populations, a condition that does not encourage a high rate of exploitation or fishing interest, and winter fishing opportunities in streams crossed by the Project are negligible. No permanent access roads are proposed to be constructed to support construction or maintenance of the line, and all bridges will be removed following construction as well as corduroy material used to stabilize temporary winter roads. Furthermore, new winter access potential along the ROW will be further curtailed with access management initiatives identified in the mitigation section above. Accordingly, the ROW is not expected to measurably contribute to new access potential or increased fishing pressures after construction.

13.8.7.5 Summary

Effects on instream habitat, sediment levels and access potential are low in magnitude and extent, short term in duration and reversible and do not have potential to measurably contribute to cumulative effects. Only one potential effect is considered to be of moderate magnitude: altered stream flows during construction. However, this potential effect is predicted to be short term in duration and reversible, and will not have potential to contribute to cumulative effects.

Table 13.8-2 summarizes the predicted impacts assessments above, using impact descriptors as defined in the table footnotes below.

Table 13.8-2 Summary of Project Effects for Fisheries and Aquatic Resources

Assessment Scenario	Issue/Measurable Parameter	Magnitude/ Extent[1]	Duration[2]	Reversible/ Non-Reversible[3]	Potential for Measurable Contribution to Cumulative Effects[4]
Construction	Altered Instream Habitat	Low	Short-term	Reversible	no
	Sediment Introductions	Low	Short-term	Reversible	no
	Altered stream flows	Moderate	Short-term	Reversible	no
	New Access Potential	Low	Short-term	Reversible	no
Operations	Sediment Introductions	Low	Short-term	Reversible	no
	New Access Potential	Low	Long-term	Reversible	no

Notes: [1] **Magnitude/Extent** – refers to the degree of change (or risk) to biodiversity

Low – change in measurable parameter will have no effect on local species abundance and diversity (stream productive capacity) (i.e., within 2 km mapped corridor)

Moderate – change in measurable parameter will have possible effect on local species abundance and diversity (stream productive capacity) (i.e., within 2 km mapped corridor)

High – possible measurable effect on species abundance and diversity (stream productive capacity) within Etsho Resource Management Zone

[2] **Duration** – refers to the length of time over which the project-related effect is measurable

Short term – less than 1 year

Medium term – greater than 1 year but not beyond life of project

Long term – beyond life of project

[3] **Reversibility/Non-reversibility** – refers to the potential for conditions to return to baseline conditions, in the absence of the project

Reversible – will likely revert to baseline conditions following end of project life or before

Non-reversible – unlikely to revert to baseline conditions following end of project life

[4] **Potential for Measurable Contribution to Cumulative Effects**

Yes – measurable contribution to CE within Etsho Resource Management Zone(generally requires high magnitude and medium to long-term impact on species)

No – no measurable contribution to CE within Etsho Resource Management Zone

13.8.8 Cumulative Effects Implications

13.8.8.1 Combined Project Effects

The four main Project impacts that could combine to influence fisheries resources (in more diverse systems) are potential instream habitat alteration, sedimentation, water withdrawal and new access potential. The assessment has indicated that each of these effects will have a minimal influence on fish abundance/diversity or stream productive capacity, and no localized effects are expected to extend past the construction period. Consequently, the combined effects are considered insignificant.

13.8.8.2 Project Contribution to Regional Cumulative Effects

A number of other projects unrelated to the Ekwan pipeline are active in the Project area, and some are directly or indirectly interacting with streams crossed by the Ekwan Project. For example, an ice bridge is generally installed on the Little Hay River in support of an oil development near the B.C./Alberta border in the same general location as the proposed pipeline crossing, presenting the possibility of cumulative effects. However, the assessment for this Project has indicated that measurable effects from the Project are unlikely within the 2 km-wide study corridor. Consequently, the Project is not expected to contribute to cumulative effects either locally or at a broader regional level, and no further analysis is considered warranted.

13.8.9 Follow-up and Monitoring

During construction, downstream water flow and/or total suspended solids will be monitored for all HDD and isolated trenched crossings, provided standing water is present under the ice at the time of construction.

Post-construction monitoring is not anticipated for fisheries or fisheries habitat under the current crossing design proposals. Should contingency isolated crossing techniques be required on any of the four named streams, then assessments of bed and bank stability and riparian zone recovery will be made at the end of the first growing season after construction. Depending on the findings at that time, monitoring may be extended into a second year to adequately track outstanding issues.

13.9 Land and Resource Use

13.9.1 Baseline Setting

The proposed Project is located within the Northern Rockies Regional District of British Columbia and the Municipal District of Mackenzie No. 23 in Alberta. More specifically, the Pipeline traverses approximately 78 km of the Fort Nelson Forest District in British Columbia and about 5 km of the Upper Hay Rainbow Forest Area in Alberta.

Approximately 76 percent of the proposed route have been previously disturbed as a result of seismic lines and pipelines. The lands traversed are inhabited by white spruce-lodge pole pine, white spruce-balsam poplar riparian, black spruce, bog and sphagnum bogs with wetland types dominating the eastern two-thirds of the proposed route.

Land and resource use activities encountered within the Project area include trapping, traditional hunting, guide outfitting, oil and gas exploration and development. A protected area is also found near the Project area. Within the study region other land and resource uses include commercial timber harvesting, consumptive (sport hunting and fishing) and non-consumptive recreation (snowmobiling).

13.9.1.1 Trapping

The land traversed by the Project is located within the traditional territories of the Fort Nelson First Nation (FNFN) and the Dene Tha' First Nation (DTFN). The two traditional territories overlap one another in British Columbia. Trapping is socially, culturally and economically important to the two First Nations. Within these two overlapping territories are five designated trapping areas in British Columbia and one in Alberta that could be affected by the Project. The designated trapping areas are:

BC Trapline Territory 756-T013 (1 FNFN trapper)

BC Trapline Territory 756-T009 (in trust to FNFN, number of trappers varies each year)

BC Trapline Territory 756-T003 (3 FNFN trappers)

BC Trapline Territory 756-T002 (4 FNFN trappers)

BC Trapline Territory 756-T001 (14 DTFN trappers)

Alberta Registered Trapping Area 88 (24 DTFN trappers)

The land surrounding the Project area in British Columbia and Alberta provides habitat for a variety of commercially harvested furbearers including beaver, muskrat, lynx, marten, mink, weasel, red squirrel, coyote, fisher, red fox and wolverine (British Columbia Ministry of Water, Lands and Air Protection Alberta Sustainable Resource Development 2002). The species harvested in the greatest numbers within these trapping areas are beaver, lynx, marten and red squirrel (Alberta Sustainable Resource Development 2002b; Capot Blanc 2002, pers. comm.; McCarthy , pers. comm.; J.B. Tally 2003, pers. comm.; T. Tally 2003, pers. comm.). Species harvested with less frequency include the muskrat, weasel, red fox and mink (British Columbia Ministry of Water, Lands and Air Protection 2003b; Alberta Sustainable Resource Development 2002b).

In addition to the monetary value of the harvested furbearers, the beaver, muskrat, and in some instances lynx, are consumed as food by the trappers and their families. Furthermore, the trappers and other members of their families hunt moose and woodland caribou within the designated trapping areas throughout the year (Capot Blanc 2002, pers. comm.; McCarthy 2002, pers. comm.; J.B. Tally 2003, pers. comm.; T. Tally 2003, pers. comm.).

13.9.1.2 Guide Outfitting

In British Columbia, the Project is located within Wildlife Management Unit (WMU) 7-56 where several big game species reside including moose, woodland caribou, mule deer, grizzly bear and black bear. However, there is no guide outfitter assigned to WMU 7-56 due to the extensive wetlands and muskeg in the area and limited access to and within the area when the ground is not frozen (Damant 2002, pers. comm.).

In Alberta, the Project is located WMU 536. In this area, wetlands are less prevalent and ground access is better than the British Columbia portion of the Project area. Twelve guide outfitters hold big game allocations in WMU 536 that enables them to take non-resident hunters on guided hunts for black bear, mule deer, moose and white tailed deer. Approximately 60 percent of the allocations are for black bear hunting (Alberta Professional Outfitters Society 2003).

13.9.1.3 Oil and Gas Exploration and Development

On the British Columbia portion of the Project, the EnCana Oil and Gas Partnership (including Amber Energy/AEC Oil and Gas) and Nexen Canada (including Wascana Energy) have extensive natural gas and oil holdings and development activities. EnCana's oil and gas infrastructure along the proposed pipeline corridor includes:

- Approximately 20,000 km of seismic lines - average cut line width 5.5 m
- 92 well sites – average lease size 130 m x 130 m
- 175 km of flow lines – average width of ROW is 15 m
- 1 gas plant at Sierra (a-26-K/94-I-11) – size 250 m x 250 m, 3.53 x 10^{12} m^3 capacity

Further east Nexen Canada has intensive oil exploration and development near the British Columbia/Alberta border. The Nexen holdings are primarily oil but it also has some natural gas. Currently Nexen produces approximately 1400 m^3/day (8800 BBL/day) of oil from a series of production pads and batteries. The oil is transported via a 38 km 203 mm (8 inch) pipeline to a tie-in with the Husky oil pipeline in the area. The inventory of Nexen infrastructure includes:

- 14 production pads with 8 horizontal wells/pad – spaced 90 m apart with an average pad size 120 m x 150 m
- 2 water pad sites
- 2 gas wells – 50 m x 50 m each
- 50 vertical oil wells – 50 m x 50 m each
- 30 km of power line/pipeline/winter road corridor

The winter road is usable three months of the year. Access to and around the oil production facilities during the rest of the year is via helicopter and all terrain vehicles (Siemens 2003, pers. comm.).

Nexen has minor land holdings near the Project in Alberta but there are no development plans in the foreseeable future. Both Nexen and ConocoPhillips, who formerly held oil and gas leases adjacent to the Project in Alberta, have licenses of occupation (LOCs) for access roads in the vicinity of the proposed pipeline. The Nexen's LOC represents part of the winter road access to its oil production facilities in British Columbia (Currie 2003, pers. comm.; Siemens 2003, pers. comm.).

13.9.1.4 Parks, Protected Areas and Environmentally Sensitive Areas

The Project is not located in or adjacent to lands designated or proposed as a provincial or regional park, conservation area or recreation area. Further, no protected areas are traversed. The Project falls primarily within the Etsho RMZ, an enhanced resource development zone identified within the Fort Nelson Land and Resource Management Plan. It also crosses the Petitot/Hay River Corridors RMZ which poses no real impediment to development. The closest protected area to the proposed pipeline alignment is the Hay River Protected Area, whose southern boundary is less than two kilometres north of the Pipeline (Fort Nelson LRMP Working Group 1997).

The Hay River Protected Area is a Goal Two protected area category resource. The reasons for protection status include:

- ecosection representation of the Fort Nelson Lowlands
- historical use by Wood Bison and First Nations people
- an outstanding example of river meadows with associated wildlife values

Directional drilling for petroleum and natural gas with no surface access is permitted. New oil and gas tenures are permitted in these areas subject to review every ten years (Fort Nelson LRMP Working Group 1997).

The area encompasses 2,000 ha and is accessible via winter road or by aircraft with good fishing potential for northern pike, walleye, burbot and trout perch.

The general area has traditionally been used by the Slavey, Cree and Beaver cultures of the FNFN, DTFN and Fort Laird First Nations. It was identified as a protected area in the Fort Nelson Land and Resource Management Plan in 1997.

13.9.1.5 Commercial Timber Harvesting

The proposed Project is located in the Fort Nelson Forest District in British Columbia and the F14 Timber Quota Area of the Upper Hay/Rainbow Forest in Alberta. In British Columbia, the Project does not pass through any commercial timber harvesting areas (Thomas 2003, pers. comm.). However, three to four kilometres north of the Kotcho River crossing, Slocan Forest Products has a number of existing and proposed cut blocks. Slocan holds a volume based commercial timber harvesting license that allows it to harvest up to 1.3 million cubic feet of aspen and coniferous timber each year for their oriented strand board plant and sawmill/plywood mill operations in Fort Nelson. Three cut blocks north of the Kotcho River were harvested over the past two winters and two other designated blocks in this area are scheduled for harvesting sometime between 2008 and 2013. The Project would not affect either of the these future blocks (Kuhn 2003, pers. comm.).

In Alberta, the Project extends approximately five kilometres into F14 Timber Quota Area. There is no existing or planned timber harvesting in close proximity to the Project during the foreseeable future (Norris 2003, pers. comm.). However, two sawmills in High Level are tentatively planning to harvest coniferous and deciduous timber in an area located about five kilometres north of the Pipeline alignment in 2006-07 (Jenkins 2003, pers. comm.). In addition, Tolko Industries at High Level has a Forest Management Agreement (FMA) that encompasses land to the north, east and south of the Project in Alberta, but at its closest point the FMA is 15 km away (Jenkins 2003, pers. comm.).

13.9.1.6 Consumptive and Non-Consumptive Outdoor Recreation

Consumptive recreational activities in the British Columbia and Alberta regions where the Project is located include sport hunting and fishing. Non-consumptive recreation activity is primarily snowmobiling during the winter months when the ground is frozen. In British Columbia, sport hunting and fishing in WMU 7-56 in general, and the Project area in particular, are thought to be minimal due the abundance of wetlands and muskeg, the distance from urban centres, and limited permanent and seasonal access to the area (Webster 2003, pers. comm.). Some moose, black bear, cougar, wolves, spruce grouse, ruffled grouse and sharp-tailed grouse are hunted within this WMU (Thornton 2003, pers. comm.). Hunting seasons for most of these species occur between mid-August and mid-November or April to June when ground access is very difficult due to a lack of roads and the abundance of muskeg and wetlands (British Columbia Ministry of Water, Land and Air Protection 2002).

The Alberta portion of the Project is located in WMU 536 where moose, mule deer, white-tail deer, and black bear are harvested by sport hunters. Hunting seasons for these species are largely confined to the month of August. The exception is black bear, which can be hunted from mid-April to mid-July and the last week of August. Game birds hunted within the Project area include: ruffed and spruce grouse, sharp-tailed grouse, ptarmigan, ducks, and the Canada, white-fronted, snow and Ross geese. These game birds are hunted during the period from early September to mid-December (Alberta Sustainable Resource Development 2002b). Wetlands are also prevalent in the Alberta Project area and ground access is limited and difficult when the ground is not frozen.

In British Columbia the Project traverses the Hay River and three creeks (Kyklo, Kotcho, Townsoitoi) and in Alberta the Pipeline crosses the Little Hay River. Due to its size and protected area designation in the Fort Nelson Land and Resource Use Plan, there is some fisheries information available for the Hay River. It is known to support northern pike, walleye, inconnu, arctic grayling, whitefish, perch, white and long nose sucker. Very little information is available for Kyklo Creek, Kotcho River, Townsoitoi Creek and the Little Hay River in Alberta. The Alberta sport fishing regulations indicate that tributaries of the Hay River, including the Little Hay River, in the Northern Boreal Zone 3 Watershed Unit may contain arctic grayling, walleye and burbot that can be fished from June 1 to October 31 (Alberta Sustainable Resource Development 2002a). Aerial reconnaissance of the Pipeline alignment in British Columbia indicates that the Kyklo, Kotcho and Townsoitoi Creeks could support four or five fish species but very little information is available for these watercourses and they are not identified in the British Columbia sport fishing regulations for the Peace Region 7B (Bryden 2003, pers. comm.; British Columbia Ministry of Water, Land and Air Protection 2002).

The proposed Project is located entirely within a portion of the Hay River watershed (Fort Nelson Lowlands) that is characterized by poorly drained muskeg lowlands, providing a mosaic of forest and wetland ecosystems. Streams generally have low fish habitat diversity and capacity. Fish biodiversity in the British Columbia portion of the Hay River is low, with only nine species (six non-game or forage species and three game species) ever recorded. The three recorded game fish species include walleye, northern pike and burbot but all are sporadic in occurrence and only northern pike may be present in sufficient numbers to support a recreational fishery. The other two named creeks traversed in British Columbia (Kyklo and Townsoitoi) contain habitat that appears to be suitable for northern pike spawning and rearing (see Section 13.8). In Alberta the Little Hay appears to have the habitat diversity and capacity to support walleye, northern pike and burbot. However, in the vicinity of the proposed pipeline crossing there appears to be suitable habitat for over wintering burbot but not suitable habitat for summer rearing of walleye and northern pike (see Section 13.8).

The lack of information on fish habitat and game fisheries in the Project area in British Columbia and Alberta is partially attributed to the isolation of the area, prevalence of muskeg and wetlands, limited access, and better sport fishing opportunities closer to communities in the region. Taking into account these limitations and recognizing that industrial activity in this area is confined to winter months when the ground and watercourses are frozen, it is speculated that the occurrence of recreational fishing in the Project area in British Columbia and Alberta is low.

Limited ground access and the abundance of wetlands and muskeg in the Project area in British Columbia and Alberta severely limits non-consumptive recreation opportunities in the area. There is evidence of snowmobiling in the Project area during the winter months. However, the snowmobiling could be attributed as much to industrial activity in the area as it could to recreation activity for camp occupants (Backmeyer 2003, pers. comm.)

13.9.2 Results of Issue Scoping

Issue scoping of land and resource use was undertaken using the following process:

- review of all land and resource disposition holders on the proposed pipeline route
- contacts with the Fort Nelson First Nation and Dene Tha' First Nation that have overlapping traditional territories that could be affected by the Project
- contact with trappers assigned to designated trapping areas that would be traversed by the Project
- contact with guide outfitters with wildlife allocations in the Project area
- contact with petroleum companies with oil and gas leases and development infrastructure in close proximity to the Project
- contact with commercial timber harvesting companies in the Project area
- contact with government agencies responsible for forest management, land and resource use in the Project area
- contact with wildlife biologists on the environmental impact assessment team concerning potential effects on wildlife in the Project area

A chronological list of these contacts is provided in Section 11 of the EnCana Ekwan Pipeline application.

The proposed Project may affect wildlife during construction and operations phases. The effects on wildlife could occur due to clearing and Pipeline operation activities and increased access. The disturbance associated with development activities of the Pipeline rights-of-way (ROW) may affect wildlife both over the short-term and long-term. Over most of the Pipeline route where existing ROW (pipeline and seismic line) will be paralleled, the impacts on wildlife resulting from the Project are expected to be minimal in terms of reduced habitat availability and fragmentation, and will likely have little potential for affecting wildlife resources locally and regionally. Greater impacts on wildlife could occur in areas of new ROW development, but new ROW is limited to approximately 19 km or 23 percent of the Pipeline route. Potential effects in the areas of new ROW will be minimized through a combination of route selection, timing of construction, and through implementation of site specific mitigation measures (e.g., access control).

Project-related effects on wildlife could also affect trapping, traditional hunting, guide outfitting and sport hunting because all of these activities are directly linked to the local and regional availability and abundance of wildlife. However, route selection, timing of construction and implementation of site specific mitigation measures including access control, can effectively mitigate potential adverse effects on these resource uses.

The EnCana Oil and Gas Partnership and Nexen Canada have petroleum leases and development infrastructure in proximity to the Project. While the Project is complimentary to EnCana's existing activities in the area, it could potentially disrupt those of Nexen Canada. However, a combination of routing selection and site specific measures (e.g. depth of cover) could effectively mitigate any potential Nexen issues.

No parks, protected areas or commercial timber harvesting is encountered on the Pipeline route but the Hay River Protected Area is located within two kilometres of the proposed Pipeline route. Petroleum and natural gas exploration, logging, trapping, sport hunting and fishing and off-highway vehicle use are all deemed acceptable land and resource uses in the Project area (Fort Nelson LRMP 1997). However, because the region has experienced high levels of multiple land use developments, specific Project effects may interact in a cumulative manner with existing and future land use pressures. As a result, this assessment, while addressing the localized effects of the Project, also considered cumulative effects, where the Project was identified to potentially contribute to cumulative effects.

13.9.2.1 Project Effects Analysis

Potential effects on land and resource use from the proposed Project may occur from individual or combined effects of:

- reduced wildlife habitat availability
- blockage of wildlife movement
- direct and indirect wildlife mortalities
- disruption of petroleum development activities
- loss of merchantable timber

The following discussion summarizes these project-specific effects of the Pipeline on land and resource use.

13.9.2.1.1 Reduced Wildlife Habitat Availability

For pipelines, highly localized habitat loss occurs at permanent above-ground facilities (valve assemblies), while habitat alteration occurs along the ROW or in temporary workspace where native vegetation is removed and replaced through reclamation efforts (see Section 13.7 for details). Of specific concern would be the potential loss through construction activities of an important localized habitat feature for a special status species.

Habitat availability can also be indirectly influenced by zones of sensory disturbance adjacent to physically altered areas created by human activities, where habitats become less attractive to wildlife because of increased disturbance or mortality risk. In addition, habitat availability can also be influenced through habitat fragmentation by a pipeline ROWs if/when it is of sufficient width to discourage crossing by wildlife (see Section 13.7).

13.9.2.1.2 Blockage of Wildlife Movement

Seasonal or daily movements of wildlife may be blocked or disrupted as a result of construction activities and, more specifically, the presence of vehicles and construction personnel in and around a pipeline development area. However, given the paralleling and sharing of workspace with existing ROWs for this Project, the short duration of activities in localized areas, the winter construction season when few animals are moving large distances, and mitigation measures to ensure passage of wildlife (see Section 13.7), the potential for wildlife movements to be significantly disrupted as a result of the Project is remote.

13.9.2.1.3 Direct and Indirect Wildlife Mortality

The Pipeline development could result in direct wildlife mortalities through collisions with project vehicles and unrestricted use of firearms by construction personnel. The new access afforded by pipeline ROWs can also increase the risk of hunting related mortalities and poaching of some species of wildlife. Further, direct and indirect mortality of wildlife could adversely affect trapping and traditional hunting but mitigation is possible.

13.9.2.1.4 Disruption of Petroleum Development

Nexen Canada operates an oilfield located next to the proposed Pipeline route and Nexen's ongoing development activities and infrastructure could be disrupted as a result of the proposed Ekwan Pipeline. Specifically, the Pipeline route may traverse two or three winter roads that provide access to and within the oilfield. In addition, the Pipeline construction could potentially disrupt future development within the oilfield during the winter of 2003/2004.

13.9.2.1.5 Loss of Merchantable Timber

The proposed Pipeline route does not pass through any designated commercial timber harvesting areas in British Columbia or Alberta, but it is estimated that less than 2000 M^3 of merchantable coniferous and deciduous timber could be removed during clearing of the Pipeline ROW, valve sites and temporary work space. The provincial forest management agencies have indicated that all merchantable timber logged during Project construction should be salvaged.

13.9.2.2 Key Impact Questions

Based on the discussion above, the following key questions will be the focus of the land and resource use component of the subsequent impact assessment.

Key Impact Issue	Assessment Approach
How will the Project affect habitat availability for wildlife?	Quantitative assessment of changes to high quality habitat within the mapped 2 km wide study corridor, incorporating disturbance levels of linear corridors (from Section 13.7).
How will the Project indirectly affect wildlife mortality risk?	Quantitative assessment of fragmentation effects on core security habitat for landscape level species within the 30 km wide study corridor, incorporating disturbance levels of linear corridors. (from Section 13.7)
How will the Project directly affect wildlife mortality risk?	Qualitative discussion of potential mortality of wildlife species of concern along the route due to collisions with project vehicles, and unrestricted use of firearms by project personnel (from Section 13.7).
How will Project effects on wildlife habitat availability and direct/indirect wildlife mortality risk affect trapping, traditional hunting, and guide outfitting hunting ?	From qualitative and quantitative assessment in Section 13.7 and qualitative information provided by affected trappers, guide outfitters and provincial wildlife management agencies.
How will the Project affect Nexen's oilfield development activities?	Quantitative assessment of issues and mitigation based on input received from Nexen, EnCana and project engineers
How will merchantable timber logged during Pipeline construction be disposed of?	Quantitative assessment of merchantable timber stands and information supplied by regional timber manufacturing industry

13.9.3 Study Areas

Due to the dependence of much of the land and resource use assessment on the results of the wildlife assessment, the wildlife study areas are used in this section. For the purposes of this section, the land and resource use LSA and RSA equate to the Project corridor and core security study area, respectively, in the wildlife section

The local study area (LSA) was defined as a 2 km-wide corridor along the preferred Pipeline route (Figure 13.7-1). The LSA was used to describe existing land and resource uses including trapping and traditional hunting, protected areas and petroleum development that could be directly affected by localized, project-specific effects.

The regional study area (RSA) was defined as a 30 km wide corridor along the preferred Pipeline route (Figure 13.7-1). The RSA reflected the general project setting and described land and resource use that could be indirectly affected (timber harvesting, guide outfitting, consumptive and non consumptive recreation) by the project or cumulatively affected (wildlife) as a result of pressures over and above that found in the LSA.

13.9.4 Assessment Scenarios

To assess Project effects on land and resource use the following assessment periods were used:

Baseline – this represents the existing condition of the land base and resource use under current baseline conditions (early February, 2003).

Construction – this represents the predicted condition of the land base and resource use at the time of construction (December 2003 to March 2004). By comparing construction to baseline conditions, the effects of construction activities on land and resource use, as well as those associated with other new (i.e., since baseline) unrelated activities within the study corridor, can be tracked from baseline conditions.

Operations - this represents the predicted condition of the land base and resource use during Operations (up to 25 years into the future from baseline). By comparing operations to baseline conditions, the effects of operational activities on land and resource use, as well as those associated with other new (i.e., since Baseline) unrelated activities within the study corridor, can be tracked from Baseline conditions.

A qualitative discussion on the implications of Project abandonment on land and resource use is also presented.

13.9.5 Proposed Mitigation

The following site-specific mitigation measures and general measures will be recommended as part of best available practices and have been factored into the assessment of residual effects on land and resource use. However, most of the site-specific mitigation details to be implemented by the Project to reduce impacts to wildlife will be developed after detailed wildlife habitat surveys are completed.

- berms, doglegs, and slash rollback along new ROW for access control
- avoidance of localized important habitats
- prohibiting hunting and trapping by construction workers while on the job and residing in camps in the Project area
  - directional drills at major creek crossings to limit the clearing of valuable wildlife habitat in riparian corridors and eliminate adverse effects on fish habitat
  - avoidance of sensitive wildlife seasons for clearing and construction activities
  - advance notification of Project construction schedule and Pipeline route to potentially affected trappers and guide outfitters

- routing deviations, road use/maintenance agreements, boring under winter roads, pipe coating and increased ground cover at and near Nexen Canada's oilfield
- salvage of merchantable timber from the Pipeline ROW and temporary work space

Clearing and development of the proposed ROW poses the risk of creating new access. Access proliferation is an important issue concerning caribou due to potential for access-induced mortalities from both humans and natural predators. Mitigation of the risks of mortality during construction or associated with operational personnel and activity can focus on timing and implementation of personnel codes of conduct (prohibiting hunting and trapping), whereas mortality risk associated with public access and natural predator activity must focus on curtailing the accessibility and use of the new ROW.

All critical wildlife features (dens, mineral licks) will be avoided by the Project through routing modifications, unless such modifications represent unacceptable risks or constraints to the Project. Where routing modifications are not possible, EnCana will provide a detailed alternative mitigation plan for the protection of such resources.

Extra workspace will not be developed where critical wildlife features are encountered by the ROW, unless such restrictions represent unacceptable risks or constraints to the Project.

For all wildlife species of concern, mitigation of potential direct project-related mortalities is focused on selection of timing windows for clearing that are outside vulnerable periods for wildlife and by implementing procedures that control the activities of project personnel and the general public that may lead to wildlife mortalities. Potential toxicity to wildlife due to hazardous materials spills will be mitigated by spill prevention and contingency response measures detailed in the EPP (Appendix 13D).

Implementation of these measures will minimize adverse effects on trappers and traditional hunters who depend on the wildlife resources in the LSA and RSA as a source of country food and income supplement. These wildlife protection measures will also benefit guide outfitters in Alberta.

Given that Nexen's oilfield operations are located next to the proposed Pipeline route and their ongoing development and production activities and infrastructure could be disrupted as a result of the proposed Ekwan Pipeline, a combination of mitigation measures may be implemented to minimize any adverse effects that could arise. Potential mitigation measures include: rerouting the Pipeline to reduce or eliminate access issues, road use and/or road maintenance agreements with Nexen, boring under winter roads instead of open cut, and increase depth of cover and pipe coating where winter road crossing(s) cannot be avoided.

Although no commercial timber harvesting operations are encountered along the Pipeline route, some merchantable coniferous and deciduous timber will be removed during clearing of the Pipeline ROW and valve sites. Provincial government agencies responsible for forest management and sustainability in British Columbia and Alberta have indicated that the merchantable timber must be salvaged for the forest products manufacturing industry in the regions. There are regional sawmills and wood fibre plants in both British Columbia and Alberta.

13.9.6 Residual Project Effects

13.9.6.1 Analytical Procedures

Quantitative and qualitative tools were used to measure project-specific effects for wildlife species of concern. Specifically, habitat analysis and core security habitat were used to analyze and evaluate project and cumulative environmental effects. Details on these two analytical techniques are provided in Section 13.7 and Appendix 13H-2

Three types of residual impacts (effects that remain after mitigation) through which Pipeline construction and operation can affect wildlife populations are reduced habitat availability, increased direct mortality risk, or indirect mortality risk. Project-specific effects on wildlife from these residual impacts were evaluated and described in Section 13.7 using three impact attributes: magnitude/extent, duration, and reversibility (see Table 13.7-2). These attributes assisted in determining the potential for project-specific impacts to contribute to cumulative effects.

The results of this analysis of project-specific effects for wildlife species of concern provided a basis for the determination of project-related effects on trapping, traditional hunting and guide outfitting. Because these resource uses rely on some wildlife species of concern, the results of wildlife assessment helped to validate residual effects on these resource uses.

13.9.6.2 Results

Potential effects on land and resource use are all predicted to be low in magnitude, with the exception of the potential effects on merchantable timber which is predicted to be moderate. Effects on merchantable timber are predicted to be long in duration but be reversible and do not have the potential to contribute measurably to cumulative effects. Other potential effects range from short to long in duration, but are all considered to be reversible and will not contribute measurably to cumulative effects. Table 13.9-1 presents a summary of findings for key issues.

Table 13.9-1 Summary of Project Effects for Land and Resource Use

Assessment Scenario	Issue	Magnitude/ Extent[1]	Duration[2]	Reversible/ Non-Reversible[3]	Potential for Measurable Contribution to Cumulative Effects[4]
Construction	Effects on furbearer habitat and mortality	Low	Short to long term	Reversible	No
	Effects on trapper harvest and income	Low	Short to long term	Reversible	No
	Effects on moose and caribou habitat and mortality	Low	Medium to long term	Reversible	No
	Effects on traditional hunting	Low	Medium to Long term	Reversible	No
	Effects on guide outfitting	Low	Medium to Long term	Reversible	No
	Effects on oilfield development activities	Low	Short to long term	Reversible	No
	Effects on merchantable timber	Moderate	Long term	Reversible	No
	Effects on consumptive and non consumptive recreation	Low	Medium to long term	Reversible	No
Operations	Effects on furbearer habitat and mortality	Low	Short to long term	Reversible	No
	Effects on trapper harvest and income	Low	Short to long term	Reversible	No
	Effects on moose and caribou habitat and mortality	Low	Medium to long term	Reversible	No
	Effects on traditional hunting	Low	Medium to Long term	Reversible	No
	Effects on guide outfitting	Low	Medium to Long term	Reversible	No
	Effects on oilfield development activities	Low	Short to long term	Reversible	No
	Effects on merchantable timber	Moderate	Long term	Reversible	No
	Effects on consumptive and non consumptive recreation	Low	Medium to long term	Reversible	No

Notes: [1] **Magnitude/Extent** – refers to the degree of change (or risk) to land use opportunities
Low or Moderate – possible effect on local (within two km) land use opportunities
High – possible effect on land use opportunities beyond 2 km-wide corridor

[2] **Duration** – refers to the length of time over which the project-related effect is measurable
Short term – less than one year
Medium term – greater than one year but not beyond life of project
Long term – beyond life of project

[3] **Reversibility** – refers to the potential for conditions to return to baseline conditions, in the absence of the project

Reversible – will likely revert to baseline conditions following end of project life or before

Non-reversible – unlikely to revert to baseline conditions following end of project life

[4] **Potential for Measurable Contribution to Cumulative Effects**

Yes – measurable contribution to CE within Regional Study Area

No – no measurable contribution to CE within the Regional Study Area

13.9.6.2.1 Furbearers

The marten was identified as the representative furbearer species of concern for the Project. The Project development (ROW clearing) will generally result in the localized conversion of a forest community to an early successional graminoid/forb and low shrub community in the short to medium term. While this conversion will locally reduce denning and escape cover for marten, it will also result in a foraging area for marten in close proximity to cover, once small mammals (e.g., voles, deer mice) reoccupy the ROW. Therefore, the ROW development will not represent a significant loss of marten habitat, either locally or regionally. Further, the proposed ROW will be 25 m in width, and even combined with existing linear corridors, will not be sufficiently wide to impair cross ROW movements.

The risk of significant construction-related noise disturbance (and reduced habitat availability) will be minimal for marten, other furbearers, and small mammals in the vicinity of the Project area. While small territorial animals such as marten and most other furbearers will avoid a ROW during actual construction, these animals will not significantly shift their territorial distributions in response to ROWs (Morgantini 1994; Eccles and Duncan 1987), particularly once vegetative cover has become re-established on the ROW. For beaver, wetland habitats will be avoided where possible, and impacts are therefore expected to be minor.

Limited high quality habitat for marten occurs in the LSA for spring, summer/fall, or winter range (see Table 13.7-7, Figures 13.7-19, 13.7-20, 13.7-21). Most marten habitat in the LSA was rated as either low or nil/very low quality during the three seasons (Appendix 13H-3). Therefore, it is expected that both the construction and operations phases of the Project will not affect habitat availability for marten within the LSA and are therefore not considered to contribute to cumulative effects.

At baseline, limited (13.4 percent) high quality habitat for beaver exists in close proximity to the proposed Pipeline (i.e., within a 60 m buffer around suitable wetland habitat) (Table 13.7-8). Both the construction and operations phase of the Project will reduce baseline high quality habitat for beaver by less than 1 percent (Table 13.7-8). In addition, less than one km of the Pipeline corridor alignment will directly intercept wetland types that may support beaver (see Section 13.6.1.3). Although long-term, these effects represent a low magnitude change in habitat availability, and are therefore not considered to contribute to cumulative effects.

Project-related mortality may occur as a result of collisions with project vehicles or direct destruction of roosts, or maternal dens for martens. Mortalities incurred from destruction of den sites and roosts are expected to be minimal as are mortality resulting from collisions with project vehicles. Therefore, project contributions are not expected to contribute to cumulative effects of mortality rates for marten.

13.9.6.2.2 Trapping

The wildlife assessment findings indicate that the minimal reduction in habitat availability and increased risk of project-related mortality during construction and Pipeline operations should not significantly affect the furbearers that reside in the LSA. As a result, the impact on trapper harvest and associated income should not be significant. This conclusion is consistent with feedback received from trappers in the affected trapping areas. None of the trappers interviewed expressed concern about potential project-related reduction in fur harvest (McCarthy 2003, pers. comm.; Capot Blanc 2003, pers. comm., Loe 2003, pers. comm.; J.B. Tally 2003, pers. comm.; Sutha 2003, pers. comm.; Denechoan Sr. 2003, pers. comm.; W. Tally 2003, pers. comm.)

Advance notification of construction schedule and Pipeline routing to all potentially affected trappers will provide an opportunity, as necessary, to relocate their traplines and equipment. Should relocation of trapline be required to prevent loss or destruction of traps, it is recommended that the trapper be compensated for their time and inconvenience.

Poaching of furbearer was identified as an issue by a FNFN trappers whose trapping area is located outside the LSA and RSA. The trapper felt that ever increasing industry-related access in the region was a contributing factor. Although there is no factual evidence that poaching is occurring on traplines in the region, this issue will be addressed by the Project through prohibition of hunting and trapping by construction workers and access control measures during Pipeline operations.

13.9.6.2.3 Caribou and Moose

Reduced Habitat Availability

Caribou and moose were identified as representative ungulate species of concern for the Project that are traditionally hunted by trappers and other members of the Fort Nelson First Nation and Dene Tha First Nation.

The caribou occupying a variety of habitat types within large territories, thus diminishing (but not precluding) the likelihood of significant effects on important localized habitats from oil and gas development (well site, access road and pipeline development). Caribou and moose may use the grass and shrub-dominated communities which will develop along most of the ROW as a forage source. Therefore, once reclaimed the ROW will provide a potential foraging area for these species in close proximity to escape cover. In general, direct Project effects to habitat will be too localized to result in significant reductions in habitat availability from physical habitat alteration.

New ROWs can lead to the fragmentation of caribou habitat but they represent only 33 percent of the total Pipeline ROW. While reclaimed ROWs *per se* do not represent an impediment to caribou movements, they may contribute to long term recreational activities or increased predator movements in otherwise remote, inaccessible habitat, resulting in the loss of core security habitat. This issue is dealt with in more detail under the discussion on direct and indirect mortality.

Construction activities may lead to sensory disturbance and reduced habitat availability for caribou and moose. However, there is no evidence to suggest that such short-term displacement persists or results in significant decreases in local animal numbers.

Currently the LSA provides little high quality habitat for either caribou or moose, largely due to the less productive habitat types of black spruce in the region. In addition, previous and ongoing human land use activities (primarily oil and gas development activities) have contributed to reductions in ungulate habitat availability in the LSA.

Potential changes in habitat availability were calculated for both caribou and moose during different seasons (Section 13.7). The construction phase of the proposed Project will not reduce baseline spring habitat availability for caribou within the LSA (see Tables 13.7-3). For moose the construction phase of the proposed Project will not reduce baseline spring high quality habitat within the LSA, but will reduce early winter range by 17.0 percent and late winter range by 15.6 percent (see Table 13.7-4). Because of the short term nature of construction effects, these effects are not considered to contribute to cumulative effects.

Including project effects during the operational phase, baseline high quality spring habitat for caribou within the LSA will increase by 2.4 percent (see Table 13.7-3). This positive change in habitat quality is due to the increase in sedge and grass habitat types along the cleared Pipeline ROW, which are preferred forage types for caribou during the spring. This long-term effect represents a positive change in habitat availability within the LSA, and is not considered to contribute to negative cumulative effects.

Including project effects during the operational phase, baseline spring high quality habitat for moose within the LSA will be increased by 2.0 percent and by 0.9 percent for summer /fall Early winter range will be reduced by 17.0 percent and late winter range will be reduced by 15.7 percent (see Table 13.7-4, Figures 13.7-6, 13.7-7, 13.7-8, 13.7-9). Although long-term, these effects represent a relatively low magnitude change in habitat availability. It is expected that access control measures implemented in the Hay River area will reduce the effect on high quality moose habitat. Therefore, changes to habitat availability for moose are not considered to contribute to cumulative effects.

Direct and Indirect Mortality

Direct project-related caribou or moose mortalities may occur during both construction and operations from collisions with project vehicles and from unrestricted use of firearms by project personnel. However, construction timing and adoption of personnel codes of conduct (firearm restrictions) will help mitigate these potential mortality risks that are directly related to the proposed Project. Of most concern is the potential for increased access into the area and associated increased risk of mortality. A potential increase in access along the Pipeline ROW may affect caribou and moose by increasing mortality from both natural predators (e.g., wolves) or hunting by humans.. The risk of access-induced caribou mortality associated with new ROW development was assessed using core security analyses and change in access use potential.

As described in Section 13.7.6.2.1.3, it was determined that during construction and operations, the Project will contribute incrementally to a loss in caribou core security habitat. However, relative to baseline conditions, these project effects will represent low-magnitude reductions for core security habitat. The project effects are expected to be medium-term in duration, as access control and revegetation of the Pipeline ROW will reduce both direct and indirect mortality risk. Therefore, change to core security habitat for caribou is not considered to contribute to cumulative effects.

The length of ROW representing improved access potential was calculated. The Project will increase the high potential use level to 83 km during construction, and then will subsequently return to 20.5 km at operations. Low use potential access will increase from 0 km at baseline to 62.5 km at operations. This increase is due to the conservative assumption that the Pipeline will represent low use after construction. It is expected that mitigation and specific access control measures will further reduce access along the Pipeline corridor, where large areas of the Pipeline will be inaccessible.

While the increase in high potential use access during construction may have implications on habitat fragmentation and increased mortality risk for ungulates, this impact will be short-term, and is therefore not considered to contribute to cumulative effects. Similarly, the conservative estimate of increase in low use access potential during operations is not considered to contribute to cumulative effects.

13.9.6.2.4 Traditional Hunting

Through implementation of firearms restrictions during Project construction and access controls on the ROW during Project operations, the likelihood of increased harvesting of moose and caribou by non-traditional hunters is low. Natural predators will not be deterred by access controls but given that the Project follows existing ROW for 76 percent of the route, the potential increase in moose and caribou mortality by natural predators should also be low in magnitude. As a result, it is concluded that project-related effects on traditional hunting in the LSA and RSA are not significant in the short or long term and therefore are not considered to contribute to cumulative effects.

13.9.6.2.5 Guide Outfitting

Taking into consideration the mitigation measures designed to minimize project-related effects on wildlife (construction timing, access controls, firearm restrictions) along with the fact that there are no guide outfitting allocations in the British Columbia portion of the Project and only five kilometres of the Pipeline extends into Alberta adjacent to an existing ROW, the impact on Alberta guide outfitters with allocations in WMU 536 will be negligible.

13.9.6.2.6 Nexen Oilfield Development

In recognition of potential project-related adverse effects on Nexen's current and future oilfield, a combination of mitigation measures are proposed including rerouting the Pipeline to reduce or eliminate access issues, road use and/or road maintenance agreements with Nexen, boring beneath winter roads, increasing the depth of cover and pipe coating at winter road crossing(s) that cannot be avoided. These mitigation options have been discussed with and are acceptable to Nexen Canada (Siemens 2003, pers. comm.).

13.9.6.2.7 Loss of Merchantable Timber

Although no commercial timber harvesting operations are encountered along the Pipeline route, some merchantable coniferous and deciduous timber will be logged during clearing of the Pipeline ROW and valve sites. EnCana has been directed by provincial forest management and sustainability agencies in British Columbia and Alberta to salvage merchantable timber that is removed and not needed for construction activities. Clearing contractors from British Columbia and Alberta will harvest and salvage merchantable timber for sale to forest products manufacturers in British Columbia and Alberta. As a result, there will be no project-related loss of merchantable timber.

13.9.7 Cumulative Effects Implications

The project effects on land and resource uses in the LSA and RSA are of a magnitude, duration and reversibility after mitigation that they are not considered to contribute to cumulative regional effects (Table 13.7-11 in Section 13.7.6.4 summarizes effects on wildlife species of concern).

13.9.7.1 Significance of Effects

The significance of impacts on land and resource use in the LSA and RSA was assessed by considering the nature of potential impacts, the mitigative strategies that are available for reducing or eliminating such impacts, and the nature and anticipated severity of residual impacts after mitigation. Significance was determined for impacts where project effects were expected to contribute cumulative effects.

After mitigation, the residual project-related effects on trapping, traditional hunting, guide outfitting, oil and gas exploration and development, protected areas, commercial timber harvesting, consumptive and non consumptive recreation will not be significant.

13.9.8 Follow Up and Monitoring

Habitat reclamation, following Pipeline construction (i.e., planting native shrubs and seeding with native seed mixes) and access control measures (i.e., gates, rollback, berms, and planting of native shrubs as visual barriers) are the primary mitigation options for ensuring that long-term negative impacts to wildlife (and trapping and traditional hunting which are dependant on the wildlife), are minimized. Effectiveness of these mitigation activities will be monitored as part of routine pipeline inspection. If revegetation activities in some areas of the Pipeline ROW fail, the necessary actions will be taken until functional plant communities are firmly established.

Since project effects on wildlife species of concern are not anticipated to significantly contribute to cumulative effects, long-term monitoring of these wildlife populations has not been proposed.

13.10 Traditional Land Use Study

The Project is located on the traditional territories of two First Nations: the Fort Nelson First Nation and the Dene Tha’ First Nation. Identifying traditional use sites within the LSA is a priority to interpreting the potential impacts of pipeline development to traditional resources. A full-scale traditional land use study (TLUS) of the traditional territory of the Dene Tha’, *The Dene Tha’ Traditional Land-Use and Occupancy Study* (1997), provides a basis for consultation with the Dene Tha’ relative to the proposed Project. During preliminary discussion with the Dene Tha’ Band Council it was suggested by council that the Dene Tha’ GPS technicians document any unrecorded heritage resource sites identified during field assessment to augment the existing TLUS.

The Fort Nelson First Nation does not currently have a TLUS. Traditional land use consultation will be route specific within the proposed study corridor and will deal with potential impact to environmental, socio-economic and heritage resources. The heritage resources survey crew assistants from the local First Nations will also act as consultants to traditional land use during the field study. Additionally, consultation with elders of the local First Nations and band members with knowledge of the study area will be undertaken to determine possible impacts and community values relative to newly identified heritage resource sites.

13.11 Heritage/Historical Resources

13.11.1 Baseline Setting

The Project study area is situated in two provincial jurisdictions, British Columbia and Alberta. The British Columbia portion consists of 78 km whereas the Alberta segment is represented by 5 km. It is necessary to conduct the heritage resources survey under two sets of heritage resources assessment guidelines.

13.11.1.1 Environmental Setting

13.11.1.1.1 Introduction

Precontact economic strategies as well as many aspects of the material culture of the human inhabitants were intimately related to the opportunities and constraints provided by their regional environment. In many respects, regional environment also strongly influenced where certain activities were conducted and consequently, where archaeological sites, testimony to precontact use and occupation are located. Terrain influenced many forms of human activity, directing travel, biasing routes of communication, enhancing or limiting resource procurement activities, and restricting human occupation areas to selected localities. As a result, human populations were not uniformly distributed across the landscape, but were clustered within the most suitable habitats.

13.11.1.1.2 Regional Environment

The Project study corridor is situated in the Taiga Plains Ecoprovince of the Sub-Arctic Ecodivision extending from the Fort Nelson River Basin to the border of the Northwest Territories. As part of the Boreal Forest Natural Region, long winters and short summers characterize the area. River areas are dominated by balsam poplar, while better-drained areas support white and black spruce, lodgepole pine and tamarack. Wetlands and muskeg are extensive due to poor drainage and bogs, fens, swamps, and marshes cover much of the area. The Taiga Plains Ecoprovince covers the northeastern portion of British Columbia, and is characterized as a large lowland dissected below the Alberta Plain by the Liard, Fort Nelson, and Petitot Rivers. Vegetation is dominated by the Boreal White and Black Spruce Zone that includes extensive black spruce bogs and wetlands (Alberta Environmental Protection 1994; Government of British Columbia 2003, Internet site). Soil materials in this area are derived from glacial, colluvial and alluvial deposits. Good forest growth is found in this area, particularly in soils of the alluvial flats, which are dominated by white spruce and balsam poplar. Above the river flood plains, black spruce and lodgepole pine are found in extensive pure and mixed stands (Rowe 1972).

13.11.1.1.3 Local Environment

The Taiga Plains Ecoprovince is divided into three Ecoregions with one Ecosection in British Columbia. The Hay River Lowland Ecoregion is a broad lowland area lying below the Alberta Plateau on its north and south sides. The Fort Nelson Lowland Ecosection is physiographically part of the Alberta Plateau on the south side but has a climatic association with the boreal climates of the lower, northern Interior plains (Government of British Columbia 2003, Internet site). The Wetland Mixedwood Subregion of the Boreal Forest in which the Project study area is located contains mainly organic and gleysolic soils. Vegetation contains peatlands, willow-sedge wetlands and upland black spruce forests.

13.11.1.2 Heritage Resource Context

13.11.1.2.1 Precontact Record

The Project area is part of a physiographic continuum with the southern Yukon. In this context, archaeological research in the southern Yukon is relevant to northeastern British Columbia. The earliest archaeological research in southwestern Yukon and northern British Columbia was conducted by Johnson and Raup (1964 and R. S. MacNeish (1964) in the 1940s. MacNeish's work continued into the 1650s and 1960s when a number of excavations were also completed in southwest Yukon, adjacent British Columbia and the western District of Mackenzie, Northwest Territories (MacNeish 1960). This work resulted in a sequence of cultural development spanning some 12,000 years. The initial sequence defined by MacNeish (1964) was re-examined and revised largely through academic research in the 1970s.

Although few archaeological sites with diagnostic artifacts have been identified in the northern interior of British Columbia, detailed archaeological studies have been completed at the Charlie Lake Site at Fort St. John (Fladmark et al. 1988) and at the Pink Mountain Site northwest of Fort St. John by Wilson (1989) relative to early Clovis materials. Evidence for early occupation recovered from the Charlie Lake Site includes Clovis projectile points radiocarbon dated to ca. 10,400 years ago (Fladmark et al. 1988). Approximately 150 kilometres northwest of Fort St. John, two Clovis point bases as well as Scottsbluff, Plainview, Lerma, and a later possible Salmon River projectile point and a microblade core were also recovered at the Pink Mountain Site (Wilson 1989). The Peace River – Grande Prairie region in Alberta is also known for its Paleo-Indian materials including Clovis, Alberta-Scottsbluff, Browns Valley-Frederick, and Plainview (Wormington and Forbis 1965; Magne 1986).

The archaeological sequence for the RSA is largely based on the cultural materials excavated north of the study area at Fisherman Lake, Northwest Territories (Fedirchuk 1970, 1973; Millar 1968, 1981). The earliest evidence of human occupation found at Fisherman Lake has been associated with the Cordilleran Tradition, characterized by leaf-shaped projectile points. Well documented and more widely found is the Northern Plano

Tradition (7000 - 4000 B.C.) viewed as a northerly expansion of plains hunters and characterized by large, lanceolate spear points comparable to Agate Basin types far to the south. Both the nature and precision of finishing technology varies between fine, parallel, ripple flaking to generalized, broad flaking. Notable in the associated assemblages is the presence of burins and gravers.

At approximately 4000 B.C., a significant change occurs in the assemblages from Fisherman Lake with the appearance of microblade technology. Sites of the Northwest Microblade Tradition are numerous in the locality. Other characteristic traits (in addition to microblade technology) include lanceolate, stemmed, and notched projectile points, scrapers made from large core remnants, side blades, burins, drills, gravers, and grooved sandstone abraders. Unique to this tradition is the presence of extensive workshops identified with the Julian Technology, a bifacial reduction procedure associated with a specific quality of chert, Julian Chert, occurring as erosional nodules. Although it represents a major lithic component of the archaeological materials at Fisherman Lake, the source of this characteristic chert has, to date, not been identified.

The succeeding components are viewed as representing the gradual development of the Athabaskan culture as observed among the Slavey people at the time of contact. Initially visible at approximately 2000 B.C., this tradition is characterized by a variety of tools and many notched forms of projectile points. Components relating to the contact period contain admixtures of European trade goods such as clay pipes and metal tools.

13.11.1.2.2 Proposed Model of Precontact Land Use

At the present time, the study region is occupied by the Fort Nelson First Nation and Dene Tha’ First Nation. Jenness (1977) describes population distribution in northern Canada at approximately 1725 A.D. He places the Chipewyan primarily to the east and north of Lake Athabasca. The Beaver inhabited the regions associated with Peace River whereas the Slavey occupied the lands between Great Slave Lake and Lake Athabasca and the lands west along the Mackenzie River. The Beaver and Slavey had been pushed westward during the protohistoric and early historic period.

Fedirchuk (n.d.) has developed a model of the economic pattern of the Slavey based on ethnographic literature and fieldwork among the Slavey peoples of Fisherman Lake adjacent to Fort Liard, Northwest Territories. Fish provided a mainstay, comprising approximately one-half of the diet (Honigmann 1946; Jenness 1977; Stafford 1959). The largest population gatherings occurred in the summers around a ‘fish lake’. The lakes acted as strategic locales for articulation with other groups and availability of resources. They also served as strategically located centers for mobilization, communication, and trade. Large camp size would have continued into early fall to take communal advantage of large schools of spawning whitefish.

Between July and September, fish weirs were constructed in shallow creeks and rivers. These semi-permanent ‘fish lake’ settlements were also used as a base for hunting parties and collection of roots and berries. Group size at this time was thought to consist of two nuclear families. Large game animals such as moose, bear, elk, woodland bison, and woodland caribou were utilized as well as smaller animals, mostly rabbit.

Honigmann (1946) was told that two or three families on Great Slave Lake could obtain four to five thousand whitefish in late October and early November. These were dried and cached for winter use. A variety of berries were collected in late summer and fall. Wild carrot, wild onion, wild rhubarb, and mushrooms were also utilized. Men were responsible for most of the hunting but women trapped for smaller mammals such as rabbit. Moose were taken by bow and arrow or by snares set along favoured runs bounded on both sides by fences of willows. Occasionally, natural features suitable for impoundment were used to trap moose. Bear and woodland bison might also be taken by spearing. Bear snares were set in berry patches.

During the height of the winter food became scarce and hunting was supplemented by fishing through the ice (VanStone 1974). Honigmann (1946:40) noted that the local group lived together during the winter at some fish lake and subsisted principally on the fish they could obtain through the ice. In the spring, a welcome addition to their diet was the returning migratory waterfowl. Later, the eggs of waterfowl provided a supplementary food source. Summer was marked by a return to the ‘fish lakes’ and re-establishment of kin ties. Woodland bison and moose were run down on snowshoes in spring, and were snared during summer and winter (Jenness 1977).

Weirs, traps, and nets were used for fishing. Lakes formed the pivotal points for human population movements particularly in winter and less ‘predictable’ times of seasonal scarcity of other resources throughout the year. Lakes were probably never completely abandoned by native populations at any time of the year. Early journals suggest that lakes were more intensively used by elderly natives whereas the younger, more able men tended to go on long extended hunts. The elderly exploited more dependable areas, basing themselves primarily on the lake fish resources but making sporadic and geographically more limited hunting excursions.

In this model, large multi-component base camps would be located along the edge of lakes, concentrated at good fisheries. These sites would contain a wide variety of tool types that are representative of the wide range of activities required for camp maintenance. Faunal remains in these sites would reflect year round utilization and provide evidence of secondary butchering. Sites radiating out from the base camps would be expected to contain a more restricted range of tool types indicative of task specific activities. Faunal material recovered at kill sites and hunting camps would bear evidence of primary butchering.

13.11.1.2.3 Historical Overview

Fort Nelson was founded in 1805 by the North West Company and named after Admiral Nelson, hero of the Battle of Trafalger. In 1813, the post was destroyed by local natives. It was abandoned until 1865 when it was rebuilt by the Hudson's Bay Company on a new location across the river and adjacent to the present town of Fort Nelson.

Establishment of posts in the northern interior of British Columbia largely post-dated the merger of the North West Company and the Hudson's Bay Company of 1821, for example, Fort Halkett (1829–1832; 1832–1875), Lower Post (1872–), and Dease Lake (1838–1839). These posts were short lived as the coastal Tlingit provided better and cheaper trade goods to the local inhabitants. Lower Post was founded as Liard Post by Robert Sylvester, a private trader, and was bought by the Hudson's Bay Company in 1876. Because of the confusion with Fort Liard on the Liard River in modern Northwest Territories, it came to be called Lower Post (Wright 1976: 171). With the loss of fur trade monopoly in 1858, the role of the fur trade in native life diminished. Subsequent devaluation of furs further limited the influence of the traders in the area.

Fort Nelson remained in relative isolation until the Klondike gold rush when the Edmonton Trail was promoted as a viable route to the Yukon. As gold fever swept North America, Edmonton attempted to capitalize on the gold rush by promoting an overland route to the Yukon originating in Edmonton. While the so-called Edmonton route suggested that a single well defined trail to the Klondike existed, it actually consisted of *a bewildering tangle of branching trails, none of them well defined*…(Berton 1972: 218). Two branches of the Edmonton trail led to Fort Nelson: one from Fort St. John and the other from Peace River Crossing (MacGregor 1970). The trails were opened by W.P. Taylor, hired by the town council of Edmonton to establish a roadway from the Peace River Crossing to Fort Nelson and then westward to Pelly River (Berton 1972: 222). Taylor began blazing the trail from Peace River Crossing on March 17, 1898 and reached Fort Nelson on April 8, 1898. From the confluence of the Sikanni Chief and the Fontas Rivers, the route followed an old 'Indian' trail along the high ground immediately east of the Fort Nelson River towards Fort Nelson.

On the return trip from the Yukon, Taylor stopped at Fort Nelson, but instead of returning along his earlier route to Peace River Crossing, he chose to establish a route southward to Fort St. John which he believed was the best route to Fort Nelson. However, few Klondikers used it. Most Klondikers heading for the Yukon via Fort Nelson went through Peace River Crossing. They soon realized that the Edmonton route consisted of little more than slash marks on trees. The route was virtually impassable and expedition after expedition met with disaster. While the Edmonton route had been promoted as the practical route to the gold fields, it would later be described as the *'worst trail of death'* in western Canadian history. In the words of one traveler, it was *'the most infernal swindle ever placed in front of the public'* (Weir 1988: 9-11). It was not until the 1920s that a well-established pack trail existed between Fort Nelson and Fort St. John. From Fort Nelson, the trail skirted the high ground along the Prophet River and crossed the Sikanni Chief River where it likely incorporated part of Taylor's earlier Klondike Trail. According to Young (1980: 33), the trail was blazed by Joe Apsassin, a Cree from the Blueberry Reserve and a white trapper named Glen Minaker in 1919–1920. Cornwallis King (1943: 42) recounted that the trail was cut by P.A. Godsell of the Hudson's Bay Company in 1925.

In the 1920s Fort Nelson was a small primitive, isolated community with less than 200 Indians and a handful of white men set in the middle of a vast uninhabited forest land (Young 1980: 31). It was not until the completion of the Alcan (Alaska) Highway in 1943, which ran from Dawson Creek to Fairbanks, Alaska, that Fort Nelson was effectively placed on a major communication route. Despite the traders, explorers, and scientists passing north and south of the study region, including the Yukon Expedition of geologists under the direction of George Dawson and accompanied by Richard McConnell and William Ogilvie in 1887, northern British Columbia remained isolated from historic developments. The need for a passable and affordable transportation link to the Klondike gold fields was recognized in the late 19th century. Despite several proposals put forth in the early 20th century to construct a road into the Yukon, it was not until World War II and the Japanese threat after the strike against Pearl Harbour that the commitment was made to construct a permanent road through northern British Columbia. The Northwest Staging Route, based on the air mail route between Edmonton and Whitehorse, was chosen for mobilization of construction personnel and equipment in the Canadian segment. For much of the route, traditional First Nation trails were followed and native guides used to survey the final route. Construction in this wilderness faced many challenges. For example, *...the men west of Fort Nelson faced both endless forest and bottomless muskeg, and progress was barely perceptible for weeks at a time* (Lundberg 1999: 20).

13.11.1.3 First Nations Consultation

The Fort Nelson First Nation and the Dene Tha' First Nation are identified as stakeholders in the proposed development area.

Consultation with the Fort Nelson First Nation and the Dene Tha' First Nation was initiated in November 2002 and continues in 2003 with an introduction to the Project and a proposed timeline for field assessments and construction. Consultation with the First Nations will be ongoing during construction, and band members will be involved in assisting with the field reconnaissance for heritage resources studies. Should significant heritage resource sites be identified during the assessment, First Nations members and elders in particular will be consulted.

13.11.1.4 Previous Studies

Other Archaeological Impact Assessments (AIA) have been conducted in the northeastern British Columbia and northwestern Alberta study region, primarily due to gas and oil exploration. In the study area, the west end of the Project will tie in with the EnCana Sierra gas plant, an area previously surveyed on behalf of AEC Oil & Gas Co, Ltd. (now EnCana Corporation) and included two pipelines, a compressor site and ancillary facilities (Wondrasek and McKillop 1999). Wondrasek (ibid.) found the area to be previously disturbed by road development, oil and gas development, and clearing, grading, and topsoil stripping incurred by the Sierra North and South Pipelines and Compressor site (Wondrasek and McKillop 1999). No new heritage resources sites were recorded during that survey.

In the Project area there is one study that parallels the proposed Project is the CU Power Rainbow Lake to Wescup (Fort Nelson) 144 kV Transmission Line Project (McCullough 1990). This transmission corridor extends east and west, and is south of the proposed Project and north of Ekwan Lake. The survey concentrated on the crossings of the Hay and Nelson Rivers with negative results. No heritage resource sites were identified and efforts to locate the historic Klondike Trail at the point that it crossed the transmission corridor were unsuccessful, possible due to overgrowth of forest cover. Overgrowth of historic trails hinders the identification of routes important to the heritage and development of local communities and can be addressed in many cases though consultation with community members.

Previous AIA's conducted adjacent to the study area surround the proposed Project. The Little Hay River Project for Wascana Energy Inc. (now known as Nexen Canada Ltd.) located east of Fort Nelson and west of Rainbow Lake Alberta, did not locate any heritage resources sites. It was suggested at that time that, *the majority of the proposed development was located in areas of low potential for archaeological resources. These included low, wet sections composed predominantly of black spruce and tamarack in muskeg areas* (Fedirchuk and Meyer 2000). The heritage resource survey of TransCanada's cancelled Liard Extension Pipeline Project to the north and northeast of the LSA yielded two cultural resource sites, one culturally modified tree site and two trail sites (Wondrasek and Green 1999a).

Other projects in the northeastern British Columbia and northwestern Alberta area include: the Maxhamish gas plant and Pipeline Projects (Wondrasek and Green 1999b, 1999c); the Ring Border Pedigree Gas Field for Canadian Hunter Exploration Ltd. (Bussey 1990, 1992); Summit Resources investigations in the Fort Nelson area (Bussey 1995); additional Canadian Hunter Exploration Ltd. developments (Bussey 1998); the Fort Nelson Timber Supply Area for Slocan Forest Products Ltd. (Prager 1997); and Ridington's investigations (2000).

Very few heritage resource sites were identified during these investigations. Few moderate to high potential areas for archaeological resources exist due to the low-lying wetland environment in the study area of all these projects. River crossings with elevated terraces or ridges and other elevated areas are considered to be high potential for heritage resources. While it is true that a high percentage of archaeological sites are located on these landforms, the opportunity for locating heritage resources in other areas does exist.

13.11.1.5 Site File Search

Information on the nature, contents, and locations of heritage sites was acquired through a site file search of the site survey records maintained by the Provincial Heritage Register of the Archaeology Branch of the Provincial Government of British Columbia. National Topographic Sheet (NTS) map sheets 94 I/9, 94 I/10, and 94 I/11 display the area through which the development zone passes. In Alberta the record review consists of a search of the Archaeological Site Inventory Data records maintained by the Historic Sites Service, Cultural Facilities and Historical Resources Division, Alberta Community Development for Townships 110 and 111 west of the sixth Meridian.

Three heritage sites have been recorded in the study area: IeRf-1, IeRg-1, and IeRh-1 (see Figure 13.11-1; Table 13.11-1). These precontact sites are located at the west end of the proposed Project and north of the existing gas plant facility where the proposed Pipeline will tie in. The sites consist of limited materials; a single piece of black chert shatter was recovered from IeRf-1 and a single quartzite secondary flake was identified from IeRg-1. Neither of these artifacts was identified in the field, but came from frozen sediments during laboratory analysis. No description is given for the surface lithics identified at IeRh-1. However, the true nature of these sites remains unknown, as no detailed assessment was undertaken due initially to poor weather conditions, and subsequently due to cancellation of the associated proposed Pipeline. No palaeontological sites are identified.

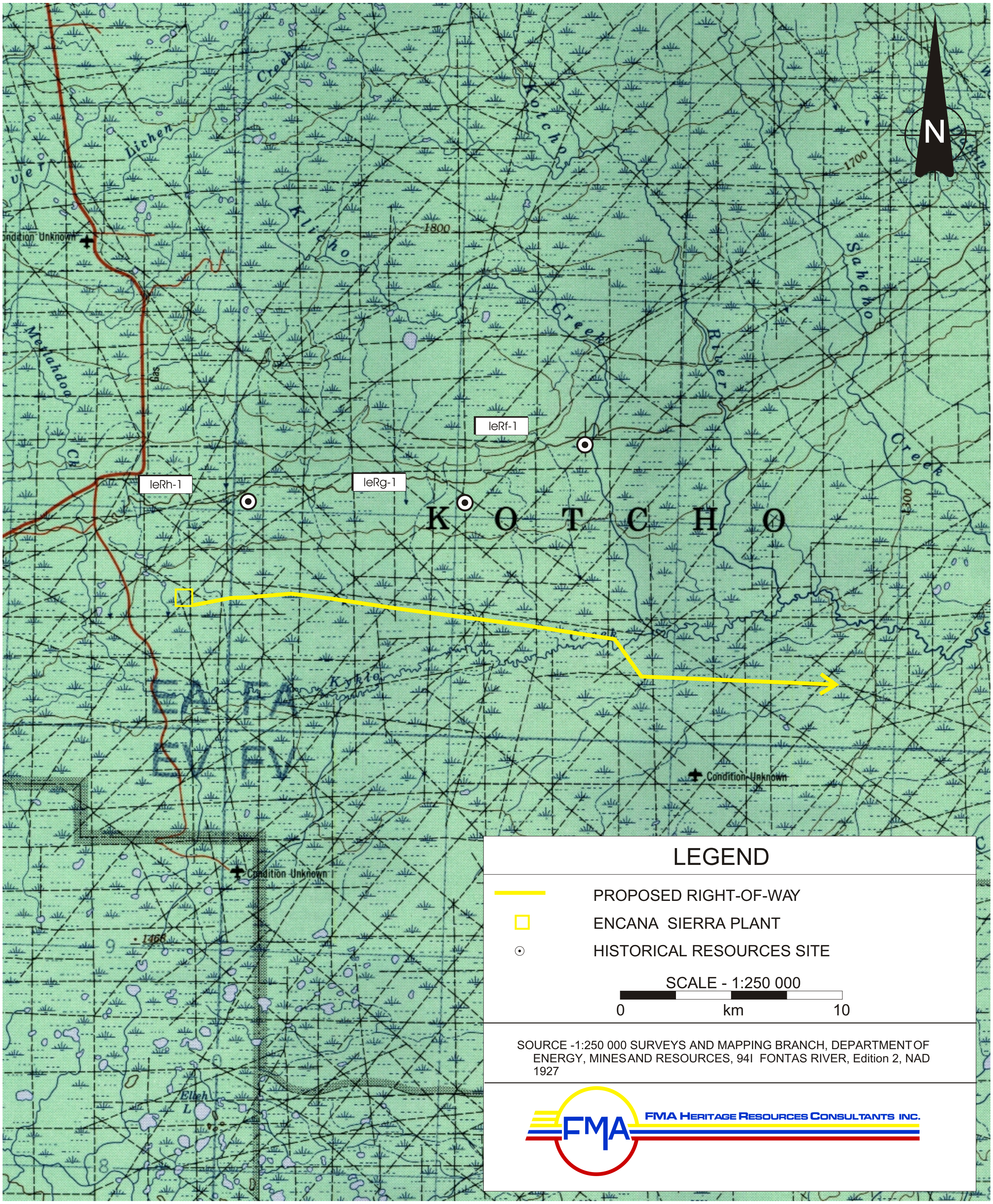
Due to the limited number of sites recorded in the area of the site file search and the lack of detailed assessment at the individual sites recorded, a generalized site distribution pattern cannot be extracted from the database and projected to the proposed development zones. The low density of the sites in the area of the site file search is unlikely to reflect a low potential for heritage resources. Rather, the recorded site distribution is a factor of the limited amount of field investigation conducted in the general region.

13.11.1.6 Field Survey Program

To verify elements of the baseline information discussed above, and to provide additional detail for the mitigation strategies discussed in the following sections, a heritage resources field survey program is planned in 2003. The results of this field survey described below will be submitted to the NEB upon finalization.

The heritage resources field survey to be conducted is detailed in Section 13.11.4 Proposed Assessment. Timing of this survey is weather dependent and thus may be delayed by snow or ice conditions.

A survey will be conducted by a field crew that includes two archaeological consultants and two members from each of the local First Nations. As heritage resource survey requires excavation by shovel of potential site locations, it is expected that the heritage resource survey will take place in late May or early June, 2003.



EKWAN PIPELINE PROJECT

Archaeological Sites

ENCANA

AXYS | Environmental Consulting Ltd

DRAFT DATE February 28, 2003		SCALE 1:250,000	
REVISION DATE February 28, 2003		PROJECT POG1045	FIGURE NO.
DRAWN LT&AB	CHECKED	APPROVED	VOL	13.11-1

Table 13.11-1 Summary of Previously Recorded Heritage Resource Sites

Site Number	Site Type	Site Context	Site Visibility	Geographical Setting	Association	NTS Map Reference	Location
IeRf-1	Lithic	undisturbed	subsurface	Kyklo Access road (PDR 178)	North Peace	94 I/11	58°7'46" 120°9'99"
IeRg-1	Lithic	undisturbed	subsurface	Kyklo Access road (PDR 178)	North Peace	94 I/11	58°7'28" 121°0'32"
IeRh-1	Lithics	n/a	surface	n/a*	n/a*	94 I/11	58°7'23" 121°2'38"

Note: * Information is not included on the site form, but location coordinates indicate the same general area as IeRf-1 and IeRg-1.

13.11.2 Results of Issues Scoping

13.11.2.1 Background

Heritage resources are defined by the British Columbia Heritage Conservation Act (1979) as *heritage objects* or *sites* that have *heritage value* to British Columbia, a community or an aboriginal people in which *heritage value* refers to the *historical, cultural, aesthetic, scientific or educational worth or usefulness of a site or object.* In Alberta, historical resources are protected under the *Alberta Historical Resources Act* (1980) and are defined as *precontact, historic, and palaeontological sites and their contents*. Cultural landscapes and traditional use sites are also encompassed within historical resources. As such, they include precontact archaeological sites and materials, historic and traditional sites and objects, as well as palaeontological remains. Precontact archaeological sites are comprised of artifacts, features, and residues of native origin. They predate the arrival of Europeans and are typically characterized by modified bone and stone implements, and stone structures. However, the identification of heritage sites without physical remains that are associated with traditional activity either in precontact or historic times recognizes an important component of heritage resources requiring consultation with members of local First Nations.

Historic sites represent heritage resources of a more recent nature and are characterized by structures, features, and objects of European influence and include First Nation sites and materials. These sites date back to contact with Europeans but also include remains of more recent activity (i.e., greater than 50 years). Historic sites that are less than 50 years old are generally associated with traditional land use and document continued use and occupation of an area to the present time. Cultural landscapes consisting of either natural or man-made features important to a societies' sense of place are also important heritage resources.

13.11.2.2 Nature of Heritage Resources

Heritage resources are non-renewable and are susceptible to alteration, damage, and destruction by construction and development activities. The value of heritage resources cannot be measured in terms of individual artifacts or biological specimens; their value lies in the integrated information which is derived from the relationship of the individual artifacts and fossil specimens, associated features, spatial relationships (distribution), and contextual situations. Interpretation of heritage resource materials, and the ability to interpret the significance of particular sites in a landscape, is based on an understanding of the nature of the relationship between individual archaeological and palaeontological materials as well as the sediments and strata within which they are contained. As such, removal or mixing of cultural or fossil bearing sediments results in the permanent loss of information basic to the understanding of these resources. As a result, heritage resources are increasingly susceptible to destruction and depletion through disturbance.

13.11.2.3 Project Effects Analysis

Heritage resources are non-renewable and are susceptible to alteration, damage, and destruction by development projects which modify the landscape. Three dimensions of impact are relevant to effects of development on heritage resources (Fedirchuk McCullough & Associates Ltd. 1983) (Table 13.11-2):

- scale of impact
- nature of impact
- degree of impact

13.11.2.3.1 Scale of Impact

Impact occurs on three levels of heritage resource phenomena: regional, local, and site data (Lenihan 1981). **Regional data** includes the archaeological, historical, and palaeontological resources within the region, the environmental context within which the sites occur; geological deposits, and soils; past and present ecological zones; vegetation and animal communities; archaeological and historical (traditional) settlement patterns; and the communication features linking prehistoric and historic sites into a regional network (e.g., river routes, portages, trails, and roads).

Local data consists of individual cultural/palaeontological sites or sites clusters; the information contained within the sites as they relate to stratigraphic and spatial relationships within the context of the regional data (e.g., standing buildings and building remains) and activity areas. **Site data** consists of the individual items or remains occurring at the sites (e.g., artifacts and features).

13.11.2.3.2 Nature of Impact

Potential impacts of the proposed Project on the three types of heritage resource phenomena may be primary, secondary or tertiary. Nature of impact must be viewed in terms of type of activities required for development of the project and post-construction activities. **Primary impacts** are predictable, planned disturbance factors necessitated by the objectives of the proposed Project. Relative to the Project, the primary impact zones are the Pipeline ROW and the locations of ancillary facilities (borrow areas, construction camps, access roads, shoo-flys and staging facilities), bank stabilization, and land reclamation programs. Primary impacts necessitated by the objectives of the proposed Project that could potentially affect archaeological resources include the compaction and displacement of sites occurring on or near the surface as a result of vehicular activity. The clearing of forested areas by mechanical means, particularly bulldozing, may also lead to disturbance of shallowly buried sites. Leveling of the development zones, in addition to potentially disturbing shallowly buried sites, may also impact deeply buried sites. Deeply buried sites may also be impacted during ditching operations, mining of borrow pits, construction of access roads, and associated facilities.

Table 13.11-2 Summary of Potential Development Impacts on Historical Resources

Phase	Activity	Nature of Impact	Potential Effect on Historical Resources
Exploration/Assessment/ Site Preparation	Vehicular traffic	Surface disturbance; removal of vegetation	Disturbance of surface cultural/fossil materials and contexts
	Soil testing	Disturbance of surface and subsurface sediments	Disturbance of surface and subsurface cultural/fossil materials and contexts
	Clearing of vegetation	Removal of forest cover	Disturbance of surface historical resource features (cairns, markers, tree blazes, trails, burials, etc.) and surface cultural/fossil materials and contexts in shallow sediments
		Soil compaction	Disturbance and compression of surface and subsurface deposits; possible breakage of individual cultural/fossil specimens
		Soil erosion	Disturbance of surface and subsurface cultural/fossil deposits; loss of exposed or intercepted historical resource sites
Construction/ Operation/ Closure	Grading/topsoil stripping/trenching Reclamation activities	Grading of landscapes	Disturbance of surface and shallowly buried historical resource deposits; loss of information about context, including provenience data for cultural/fossil materials; mixing of stratigraphic levels
		Excavation	Disturbance of surface and buried historical resource deposits; loss of information about context, including provenience data for cultural/fossil materials; mixing of stratigraphic levels; disturbance of traditional use sites of significance
		Soil compaction	Disturbance and compression of surface and subsurface deposits; possible breakage of individual cultural/fossil specimens
		Soil erosion	Disturbance of surface and subsurface cultural/fossil deposits; loss of exposed or intercepted historical resource sites
		Mixing of soil horizons	Loss of information about context, including provenience data for cultural/fossil materials
	Emergency fuel spills	Contamination of soils and vegetation	Contamination of surface and buried historical resource deposits and materials; destruction of ability to radiocarbon date cultural materials

Table 13.11-2 Summary of Potential Development Impacts on Historical Resources (cont'd)

Phase	Activity	Nature of Impact	Potential Effect on Historical Resources
Construction/ Operation/ Closure (cont'd)	Emergency fuel spills (cont'd)	Containment of contaminated soils and vegetation	Disturbance of surface and buried historical resource deposits; loss of information about context, including provenience data for cultural/fossil materials; mixing of stratigraphic levels
	Presence of roads, power and pipeline rights-of-way	Increased wind throw and erosion from tree and vegetation loss	Disturbance to surface and shallowly buried historical resource deposits; loss of contextual information about exposed or intercepted sites
		Improved access	Potential disturbance through vandalism or unauthorized collection of exposed or intercepted cultural/fossil deposits; increases non-aboriginal use of areas not previously affected by sport hunting/fishing
	Increased human traffic	Increased vehicular /foot traffic	Disturbance of surface and shallowly buried historical resource sites; loss of information about context, including provenience data for cultural/fossil materials; mixing of stratigraphic levels; increased potential for vandalism or unauthorized collection of historical resource materials

Source: Fedirchuk McCullough & Associates Ltd. 1997

Traditional land use, currently operative, could be impacted if the proposed Pipeline route intercepts or approaches areas of significance to First Nations peoples. Areas of significance are highly variable in definition, ranging from traplines to spiritual or sacred sites. Only through interviews with members of the local First Nation community can these areas be identified.

Blasting or ripping may occur during construction. Should palaeontological sites be present, they will be impacted by both blasting and ripping procedures. Potential unplanned impacts which could affect palaeontological resources include unauthorized collection of palaeontological specimens.

Secondary impacts are adverse effects on heritage resources which may occur during operationalization of the Project but may also occur during construction as a result of Project expansion and minor modifications to project design. Secondary impact zones include site areas immediately adjacent to the ROW, access roads, and facility locations.

Potentially, expansion of use areas associated with pipeline facilities and reclamation may disturb shallowly buried deposits situated immediately adjacent to the ROW and facilities. Mobilization of heavy equipment to aid in repair and clean-up of accidental spills/leaks can also potentially impact similarly located sites.

Tertiary impacts are not directly related to construction of the development facility. They are the result of project induced changes in land use. Tertiary effects involve the collection of artifacts by unauthorized individuals and vandalism. Tertiary impact zones include all site areas accessible via the ROW.

13.11.2.3.3 Degree of Impact

A **major impact** is defined as the loss of a significant proportion of data at the local or regional site level. With major impact, the interpretative capacity of the heritage resource following impact is minimal. **Moderate impact** is defined as the loss of a proportion of data at the local or regional site level with a significant proportion of data remaining unimpaired. After moderate impact, the interpretative capacity of the heritage resource is hindered by the loss of basic data about the past. **Minor impact** is defined as the loss of a minor proportion of data at the local or regional site level. After minor impact, the interpretative capacity of the heritage resource is virtually intact, limited only by the loss of minor items and features.

13.11.2.4 Lack of Previous Inventory

No previous inventory of heritage resources has been conducted along the proposed ROW and it is therefore not currently possible to evaluate the impacts of the Project on the heritage resources within the development zone. An assessment of the heritage resources is required.

13.11.3 Study Area

The LSA was used to complete the historical resources assessment. The LSA was defined as the 25-m wide ROW of the preferred route, including additional temporary workspace at stream crossings, heavy grade areas, timber decking sites, and facility/road crossings.

13.11.4 Proposed Assessment

13.11.4.1 Heritage Resource Program

A heritage resource program is designed to locate and assess the significance of heritage resource sites relative to project impacts, and to recommend mitigative strategies appropriate to the level of impact. For the proposed Project, the Heritage Resource Impact Assessment conducted will conform to all standard practices of both the British Columbia (Archaeology Branch) and Alberta (Alberta Community Development) jurisdictions. All studies will be conducted under provincially administered permits, and will consist of surface reconnaissance and subsurface investigations using controlled shovel testing. Laboratory and analytic studies will evaluate the sites and their significance. Previously recorded sites will be relocated if situated within the study corridor and the significance of both these and newly identified sites will be assessed in terms of context, contents and overall interpretive potential. The potential effects of the proposed Pipeline on the identified heritage resources will be evaluated relative to interpreted site significance, and mitigative recommendations will be made for each identified site.

A report will be submitted to Alberta Community Development and the Archaeological Branch (British Columbia) detailing the findings of the investigation. Review of these reports will result in the setting of final Provincial government requirements for the mitigation of the heritage resources identified.

13.11.4.1.1 Route Evaluation

Aerial reconnaissance by helicopter will be conducted over the proposed Project area in order to identify and assess the archaeological potential of remote areas of the Project based on topographic features. Consultation with members of the involved First Nations will also contribute to identification of potential areas of study not identified by physiographic associations.

The site file search, literature review, and the mapping data will be used to evaluate the corridor as to archaeological and historic site potential. Using recorded physiographic associations of archaeological sites on file with the British Columbia Heritage Branch, and recorded patterns of aboriginal land use, terrain features most commonly associated with precontact sites and documented historic use will be identified and targeted for examination. In addition, a variety of different environments with potential for sites of greater antiquity will also be targeted for inspection.

13.11.4.1.2 Ground Reconnaissance

The entire ROW will be assessed in the field to determine areas of medium to high potential for containing archaeological resources. All areas of medium to high archaeological potential within the proposed study corridor will be intensively examined using pedestrian traverses by two archaeologists and assistants from each of the two local First Nations. These areas include stream terraces/benches, pronounced topographic features such as summits and escarpments, well drained features in otherwise poorly drained terrain, areas providing exceptional views or outlook, and areas of specific resource procurement potential such as quarries and mineral licks. All fortuitous exposures will be examined for cultural materials; and shovel tests (each approximately 40 X 40 cm) will be judgmentally placed within the ROW in areas deemed to be of medium to high potential. The number of shovel tests excavated along the proposed ROW is at the discretion of the field archaeologist(s) depending on the nature of the topography on the ROW. Gravels, bedrock or C soil horizons are used as limits for the depth of the shovel tests.

Site identification includes examination for, and recording of, culturally modified trees (CMT) which may indicate precontact forest use such as bark stripping or tree felling. Indicators of trail blazing will be noted if there is a suggestion of substantive age (over 50 years old). In the event CMTs are identified, all CMT sites will be recorded using Level II Recording Techniques. This includes the completion of a Level II CMT Recording Form and the completion of a detailed site map showing the location of the individual CMTs. Tree cores will be collected from each site in order to date the activity. At CMT sites with over 5 modified trees, 20 percent of the trees will be cored for dating, to a maximum of 20 trees per site.

Subsurface testing will be undertaken at any sites identified to determine the nature of the site and the impact from development. Emphasis is placed on identifying site perimeters (both horizontal and vertical), site integrity, internal structure of the site, and scientific potential allowing for the formulation of recommendations for appropriate mitigation measures. In the event that shovel tests prove to be inadequate for establishing site significance (e.g., the deposits are very deep, or there is some question as to stratigraphic integrity or quality), evaluative tests will be excavated. Evaluative tests will be either 50 cm by one meter, or one meter by one meter square, depending upon the nature of the data required to provide thorough evaluation. Evaluative tests will be excavated by either shovel and/or trowel, depending on the nature, density, and distribution of cultural material and the resulting sediments would be screened through a six millimeter mesh hand screen. Either natural stratigraphic levels or arbitrary 10 cm levels will be used for vertical control, depending on the nature of the sediments and the cultural materials observed (i.e., should discernible stratigraphy be present, observable levels were to have been used for vertical control).

In the event that cultural material is observed on the surface or in exposures, a representative sample will be collected after the location is marked on an appropriate sketch plan. If the site consists of a limited number of artifacts (i.e., less than 10), all specimens will be collected. All formed tools and diagnostic artifacts will be collected. Detailed recording of site characteristics will be conducted, including observations of depth of surface cover, thickness of cultural deposit, sedimentary conditions, and cultural materials observed. A written and photographic documentation of stratigraphic conditions will be recorded. In general, observed cultural materials will be collected, bagged, and recorded as individual provenience locations and retained for analysis. All artifacts will be analyzed according to standard archaeological practice: lithic artifacts will be assigned to a specific artifact type and material type; tools will be measured and morphological attributes discussed in detail; where possible, cultural associations will be identified; faunal material will be assigned to class, genus, or species, element determined, and if possible, sided. If palaeontological specimens are observed, representative samples will be collected for identification by a palaeontologist and all palaeontological sites recorded.

Significance of all archaeological deposits identified is determined on the basis of scientific, public, ethnic and historic significance. These levels of significance will be evaluated in view of the undisturbed nature of the deposits, the ability of the deposits to yield information regarding temporal and/or cultural affiliations, the nature of the impacts experienced by the deposits, and the accumulated effect of impact to identified sites in view of their relationship to the provincial database. The specific selection of criteria used to evaluate a site’s significance conforms to those identified in Appendices D and E of the British Columbia *Archaeological Impact Assessment Guidelines* (1996). Classification of precontact and historic sites identified follows the British Columbia Archaeological Site Inventory Form Guide (1998) and the Provincial Museum of Alberta Archaeological Inventory Site Data Form Guide. The level of impact to heritage resources is identified with respect to the following criteria: the magnitude, severity, duration, range, diversity and frequency of the impact, as well as the cumulative effect and the rate of change.

13.11.4.1.3 Formulation of Recommendations

Site specific recommendations are formulated primarily on the basis of the level of available information and the perceived values within the context of the predicted impact. Due to the non-renewable and irreversible nature of historic resources, avoidance as a mitigation measure is recommended as the preferred option at sites with established heritage resource values. Sites of limited scientific and ethnic value (for example, isolated artifact finds or fossil fragments) are generally not recommended for further study and are not considered for avoidance mitigation as the data collected at the Heritage Resource Impact Assessment stage has effectively reduced or eliminated impact from the proposed development. Further study is recommended at sites which cannot be avoided and at which the data collected during the impact assessment stage are considered insufficient to mitigate effects from the proposed development.

13.11.4.1.4 Heritage Resource Values

Criteria for evaluating heritage resource values are provided in the *Archaeological Impact Assessment Guidelines* (Appendices D, E) (1996) developed by The British Columbia Archaeology Branch. Depending on the nature of the specific resource, the following criteria are used to assign heritage resource values to the sites identified during the field program.

13.11.4.1.4.1 Scientific Value

The potential of a site to enhance current understanding of cultural or natural history and development as well as its potential to shed light on current research problems are attributes of scientific value. Of prime importance to scientific value is site integrity, that is whether or not it has been disturbed. The frame of reference for evaluation of scientific value can consist of either the site, local or regional level, of scientific data. For example, because our knowledge of details of precontact lifestyle is incomplete, often dictated by vagaries of past human use and discard, as well as preservation, all three levels of data must be considered when determining scientific archaeological value. However, the first order of scientific evaluation occurs at the site level. Only after the potential of a site to provide substantive data has been established, are local and regional implications considered.

13.11.4.1.4.2 Public Value

Public or social value of historic and archaeological sites is evaluated from the perspective of their potential to contribute to public understanding or appreciation of past human lifestyles and their potential for development as interpretive or tourist facilities. Current use or visitation by the public, as well as public concern expressed at community consultation meetings are also considered in ascribing public value to a site.

13.11.4.1.4.3 Ethnic Value

Ethnic value is based either on the perceived value of a site to a particular ethnic group or on expressed importance to a particular group. Traditional land use sites are evaluated primarily from the perspective of ethnic value.

13.11.4.1.4.4 Historical Value

Historical value is relevant only to historic sites and is based on the association of a particular site with personages, themes or events that have important or lasting contributions to society on a local or regional level. Other factors considered include the presence of physical structural remains and the potential of the archaeological remains to provide information relating to consumption, provisioning, disposal, ethnic and social stratification, technological development, and economic transitions.

13.11.5 Mitigative Options

Primary impacts to heritage resource sites can be significantly reduced or eliminated by avoidance or adequate study. Avoidance is the preferred option when practical, as the archaeological excavation alternative amounts to the controlled destruction of the site's context in the recovery of its contents. *In-situ* Historical/Heritage Resource values are lost. Avoidance may be accomplished in linear disturbances, such as pipelines, through ROW relocation, offset, restriction of construction zones, and alteration of standard construction techniques, such as non-removal of top-soil from the proposed ROW, laying down of protective working surfaces or site flagging. Many of these options apply to surface or near-surface Historical/Heritage Resources which might be affected in ROW preparation and construction activities within the ROW. Options for significant Historical/Heritage Resources which lie buried below the surface and might be affected by ditching activities are limited to the relocation of the ditch line and the ROW outside the site area or area of significance. Where disturbance is unavoidable and avoidance is not a satisfactory or feasible option, mitigation by controlled archaeological excavation/collection from significant sites is the recommended procedure.

Adequate study generally involves scientific investigations which are designed to systematically explore and reconstruct the activities which were carried out at the sites. Investigations usually involve excavation of buried sites, detailed controlled collection of surface sites, detailed mapping, and photographic documentation. In some instances, however, photographic documentation, recording, and if necessary, the collection of specimens are deemed to be sufficient mitigative measures. Adverse secondary impacts which may occur during the construction phase can usually be effectively managed by close consultation between project planners and construction personnel.

Heritage/Historical Resources Impact Assessment and Mitigation studies will mitigate the effects which occur to significant Heritage/Historical Resources during construction, where avoidance is not feasible, through the conservation of the contexts and contents of affected significant sites.

13.11.6 Summary and Conclusions

Given the nature of archaeological resources in the Boreal Forest, and based on the results of previous studies, it is highly unlikely that the heritage resource sites identified cannot be mitigated through recording, collection, mitigation excavation or avoidance. A monitoring program of construction activities will be implemented as a discovery technique to ensure that any additional sites are mitigated appropriately.

13.12 Assessment of Upset Events

13.12.1 Background

Upset events represent unforeseen occurrences during the construction or operation of a facility that can have environmental implications. Section 16(1) of the *Canadian Environmental Assessment Act*, requires that Responsible Authorities consider the effects of potential upset events.

From a pipeline perspective, upset events can include a wide variety of possible scenarios. A pipeline rupture and explosion represents a 'worst case' scenario with potentially the greatest environmental implications, but it is a very low probability event. In addition, the environmental implications of such an event will vary widely, depending on the location, timing, and other factors surrounding the event. Therefore, there is little value in considering a scenario that is highly speculative and highly unlikely.

A more reasonable approach is to select events that reflects that actual setting and circumstances surrounding the Project, and has a reasonable probability of occurring. For this Project, two events are assessed: a failed HDD crossing of the Hay River and flaring of pipeline blowdown

13.12.2 Failed HDD Crossing

13.12.2.1 Assumptions

The following scenario has been considered:

- During the HDD crossing of the Hay, circulation will be lost, and drilling mud will migrate into the river channel at and adjacent to the drilling site.
- The river will be supporting under ice flows of approximately 1 - 2 m^3/sec. This is likely a overly conservative (high) estimate, considering that the river was frozen to its substrates in February 2003.
- An isolated trenched crossing will be employed as a back-up crossing technique.

The isolated trenched crossing technique will follow the procedures outlined in the Environmental Protection Plan and Watercourse Crossing Report (See Appendix 13D, Environmental Protection Plan)

13.12.2.2 Instream Habitat Alteration

Under this scenario, instream habitat conditions could be adversely influenced by:

- the deposition of drilling muds onto the stream substrates

- extensive grading of the banks to facilitate trenching and pipe lower-in
- instream trenching and associated sedimentation issues

Drilling Mud Issues. To limit the potential for mud introductions into the channel, downstream water clarity and substrate monitoring will be undertaken throughout the entire drilling procedure. Sudden increases in turbidity or drilling mud discoloration of substrate material will be immediately reported to the Environmental Inspector and HDD supervisor. Drilling shutdown criteria will be in place in the event of mud detection or circulation pressure losses, whichever comes first. Decisions to attempt a new drill path alignment or to abandon further drilling attempts will be based on the severity of mud detection and circulation pressure loss. Detailed criteria for abandonment are found in the Watercourse Crossing Report, Appendix 13D, Environmental Protection Plan.

With these contingency measures in place, mud introductions into the channel are expected to be minimal. In addition, preliminary habitat assessments at the site suggest that the reach near the crossing is dominated by low diversity run habitat with fine substrates and limited instream cover. Consequently, limited mud introductions into such a reach would likely have a limited effect the low quality habitat.

Bank and Bed Issues. If an isolated trenched crossing is required as a contingency plan, the location of the crossing will be finalized based on fisheries and habitat investigations to be undertaken in May 2003. If important habitat components (e.g., instream coarse woody debris cover, gravelly substrates) are identified in this reach of river, the crossing site would be adjusted to avoid these features and reduce the potential for a harmful alteration, disruption or destruction under Section 35(2) of the Fisheries Act. Based on current knowledge of the site, any adjustments to the location would be minor (i.e., less than 50 m), and would not have other significant environmental implications.

Considerable grading of the 5 m-high banks will be required for a trenched crossing. While a number of standard protection practices would be followed to limit material introductions into the channel (i.e., grading of bank material away from the channel into extra workspace, 15 m buffer of vegetation between channel and extra workspace), there will be a loss of vertical bank structure, particularly at the cutting bank on the east side of the channel. Consequently, restoration measures would focus on the reconstruction and stabilization of the cutting bank to prevent unnatural channel migration and bank erosion after construction. Given the lack of cobble or rock for gabion construction or armouring at the site, reconstruction measures would likely involve the installation of a buried log crib structure that would provide both vertical structure and bank stability. A preliminary geotechnical evaluation of the site has indicated that such a procedure would be effective, particularly given the low flow rates and limited erosion potential of the river.

Trenching in the river could potentially effect substrate characteristics through material mixing and instream sediment loading. It is anticipated that substrates will consist of fine fluvials to trench bottom. However, if different textured materials are encountered with depth, these materials will be stockpiled separately and backfilled into the trench in their natural sequence to minimize changes to substrate characteristics. Instream sedimentation will be controlled through the use of trench isolation dams (sheet piling) and pump around systems to maintain clean downstream water flows. Given the deep soft substrates of the river, defined channel and easily-managed, anticipated flows, it is reasonable to assume that a dam and pump system will be very effective in controlling downstream sedimentation. In addition, the sediment size of channel substrate at normal winter discharge is favourable to quick deposition in a relatively short distance downstream of each crossing, even if some material escapes the isolated area.

It is also expected that any trench dewatering undertaken within the isolated area can be effectively managed. On the east side of the river, there are several dry meander scars (see Appendix 13A, Environmental Alignment Sheets, Sheet 9) that are more than large enough to accommodate dewatering quantities. These features are ideal sediment deposition zones, and would prevent any sediment-ladened water from re-entering the river.

13.12.2.3 Alteration of Flow Patterns

Trenching activities in combination with inadequate dam and pump-around facilities could influence downstream flows. However, with an estimated 1 –2 m^3/sec of flow to manage, there is little potential for serious flow disruptions. A back-up pumping system with comparable capacity to the primary pumps would be present on site to accommodate any equipment failures.

13.12.2.4 Summary

In summary, it is not anticipated that a failed HDD crossing at the Hay would result in measurable, medium to long term effects on fish abundance/diversity or stream productive capacity. The low habitat quality afforded by the river, particularly during winter, coupled with more detailed habitat information to be collected this spring, and the ability to effectively manage a contingency crossing all point to the minimal effects of such an upset event.

13.12.3 Flaring of Pipeline Blowdown

There are no significant sources of pollutants associated with the normal operation of the Pipeline. In an emergency case however, some of the contents of the Pipeline (sweet, dry natural gas) may be flared. This scenario is expected to be a very rare occurrence.

Upset events occur when a portion of the gas in the Pipeline is burned off to the atmosphere to clear the Pipeline and/or relieve its pressure. Flaring would occur at either end of the Pipeline and result in combustion emissions comprised primarily of carbon dioxide, water vapour, nitrogen oxides, and trace amounts of hydrocarbon compounds. When operational, the total volume of gas in the Pipeline will be about 1.9 million m^3 (at standard conditions). During each event, one-third of the contents (630,000 m^3) would be flared resulting in approximately 622 kg of NO_X being emitted into the atmosphere.

Due to the transient and infrequent nature of the upset events, the potential effects to local and regional air quality are expected to be negligible.

13.13 References

13.13.1 Literature Cited

Agriculture and Agri-Food Canada. 1994. Soil Landscapes of Canada, British Columbia – North. Centre for Land and Biological Resources Research. Research Branch. Ottawa, ON. Map scale 1:1 000 000.

Alberta Environmental Protection (AEP). 1996. The Status of Alberta Wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division.

Alberta Environmental Protection (AEP). 1994. Natural Regions, Subregions and Natural History Regions, Subregions: A Classification of Protected Areas Management. Report 2. Edmonton, AB.

Alberta Legislature 1980. *Alberta Historical Resources Act*. Edmonton, AB.

Alberta Legislature 1996. Archaeological Impact Assessment Guidelines. Edmonton, AB.

Alberta Professional Outfitters Society. 2003. List of guide outfitters and their wildlife allocations in Wildlife Management Unit 536. Edmonton, AB.

Alberta Sustainable Resource Development. 2002. 2002 Alberta Guide to Sportfishing Regulations. Edmonton, AB.

Alberta Sustainable Resource Development. 2002. 2002 Alberta Guide to Hunting Regulations. Edmonton, AB.

Anon. 1981. Habitat suitability index models-a review copy: White Sucker. Habitat Evaluation Procedures Group. Western Energy and Land Use Team. U.S. Fish and Wildlife Service, Ft. Collins, CO 80526. 15 p.

Anon. 1995a. Home Oil Company Ltd. Shekilie River overview fisheries assessment. Prepared for Home Oil Company Ltd., Calgary, AB. by Diversified Environmental Services, Fort St. John, BC, 33p.

Anon. 1995b. Ish Energy Ltd. Descan pipeline project fisheries habitat assessment. Prepared for AXYS Environmental Consulting Ltd., Calgary, AB. by Diversified Environmental Services, Fort St. John, BC, 59+p.

Anon. 1995c. Novagas Clearinghouse Ltd. Midwinter pipeline project fisheries habitat assessment. Prepared for AXYS Environmental Consulting Ltd., Calgary, AB. by Diversified Environmental Services, Fort St. John, BC, 55+p.

Anon. 1995d. Novagas Clearinghouse Ltd. Pesh Creek pipeline project fisheries habitat assessment. Prepared for Home Oil Company Ltd., Calgary, AB. by Diversified Environmental Services, Fort St. John, BC, 18 p.

Anon. 2002. Encana Oil & Gas Partnership Fort Nelson Business Unit. Overview Fish and Fish Habitat Inventory Within the Watersheds of Gunnell, Elleh River and Gote Creeks, Kotcho River and Lower Shekilie River Western Tributaries. Vol 1 & 2. Prepared for Encana Oil & Gas Partnership Fort Nelson Business Unit. By EDI Environmental Dynamics Inc.

Antoniuk, T.M. 1994. Environmental protection strategies for development of the Monkman/Grizzly Valley gas fields. Prepared for Amoco Canada Petroleum Ltd., Norcen Energy Resources Ltd., Ocelot Energy Ltd., Petro-Canada Resources, Sceptre Resources, Ltd., Shell Canada Ltd., and Talisman Energy Inc. Prepared by Salmo Consulting Ltd. Calgary, AB. 472pp.

AXYS Environmental Consulting Ltd. (AXYS). 1995a. Nova Gas Mainline wildlife surveys. Unpublished data report.

AXYS Environmental Consulting Ltd. (AXYS). 1995b. Songbird and Waterfowl Surveys in the Kahntah River region of Northeastern British Columbia. Prepared for Home Oil Company Ltd. Calgary, AB.

AXYS Environmental Consulting Ltd. (AXYS). 1998. Addendum information to the Environmental Assessment and Mitigation Plan for the proposed Wildboy Pipeline. Prepared for Penn West Petroleum.

BC Ministry of Environment, Lands and Parks (MELP). 1995. BEI-based Wildlife Capability/Suitability Maps for Northeastern British Columbia. Map folio.

BC Ministry of Water Land and Air Protection. 2002. Hunting and Trapping Regulations Synopsis 2002–2003. Victoria, BC.

BC Ministry of Water, Land and Air Protection. 2002. Freshwater Fishing Regulations Synopsis 2002–2003. Victoria, BC.

BC Ministry of Water, Lands and Air Protection. 2002. Guide Outfitter Territories in Northeast BC. 2001. Victoria, BC.

BC Ministry of Water, Lands and Air Protection. 2002. Guide Outfitters in British Columbia. Victoria, BC.

Bailey, T.N., E.E. Bangs, M.F. Portner, J.C. Malloy and R.J. McAvinchey. 1986. An apparent over-exploited lynx population on the Kenai Peninsula, Alaska. *J. Wildl. Manage*. 50:279–290.

Baker, B.W., B.S. Cade, W.L. Mangus and J.L. McMillen. 1995. Spatial analysis of Sandhill Crane nesting habitat. *Journal of Wildlife Management* 59:752–759.

Banci, V. 1994. Wolverine. Pages 99-127 *in* L.F. Ruggiero, K. B. Aubry, S. W. Buskirk, L.J. Lyon and W. J. Zielinski (eds.), The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. USDA Forest Service Gen. Tech. Rep. RM-254.

Banfield, A.W. 1974. The Mammals of Canada. University of Toronto Press, Toronto, ON.

Barnes, D.M., and A.U. Mallik. 2001. Effects of beaver, *Castor canadensis*, herbivory on streamside vegetation in a northern Ontario watershed. *Canadian Field-Naturalist* 115:9–21.

Baydack, R.K., and D.A. Hein. 1987. Tolerance of sharp-tailed grouse to lek disturbance. Wildlife Society Bulletin 15:535–539.

Bellrose, F.C. 1976. Ducks, Geese and Swans of North America. Stackpole Books, Harrisburg, PA.

Benn, B. 1998. Grizzly bear mortality in the Central Rockies Ecosystem, Canada. Masters Degree Project, Faculty of Environmental Design, University of Calgary.

Benn, B. and S. Herrero. 2002. In press. Grizzly bear mortality and human access in Banff and Yoho National Parks, 1971-98. Ursus 13:0000-0000.

Bergerud, A.T. 1988. Caribou, wolves and man. Trends in Ecology and Evolution 3:68–72.

Bergerud, A.T. and W.B. Ballard. 1988. Wolf predation on caribou: the Nelchina herd case history, a different interpretation. *J. Wildl. Manage*. 52:344–357.

Berton, P. 1972. *The Last Great Gold Rush 1869–1899 Klondike*. McClelland and Stewart Limited. Toronto, ON.

Bodig, J. and B.A. Jayne. 1982. Mechanics of Wood and Wood Composites. Van Nostrand Reinhold Company Inc. New York.

Bowman, J.C. and J-F Robitaille. 1997. Winter habitat use of American marten, *Martes americana,* within second-growth forest in Ontario, Canada. *Wildl. Biol.* 3:97–105.

Boyce, M.S. 1981. Habitat ecology of an unexploited population of beavers in interior Alaska. Pages 155-186 *in* J.A. Chapman and D. Pursley (eds.). Worldwide Furbearer Conference Proceedings. Vol. I.

Boyd, M. 1978. Management of marten, fisher, and lynx in Saskatchewan - with special reference to the effects of forest harvesting in the mixed wood boreal forest. M.Sc. thesis. Univ. Calgary, Calgary, AB.

Bradshaw, C.J., D.M. Hebert, B. Rippin and S. Boutin. 1995. Winter peatland habitat selection by woodland caribou in northeastern Alberta. *Can. J. Zool.* 73:1567–1574.

Brand, C.J. and L.B. Keith. 1979. Lynx demography during a snowshoe hare decline in Alberta. *J. Wildl. Manage.* 43:827–849.

Brander, R.B. and D.J. Books. 1973. Return of the Fisher. Natural History 82:52–57.

British Columbia Legislature 1979. *Heritage Conservation Act*. Victoria, BC.

British Columbia Legislature 1998. *Archaeological Site inventory Guide*. Victoria, BC.

Brownell, V.R., and M.J. Oldham. 1985. Status report on the bald eagle, *Haliaeetus leucocephalus*, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Buehler, D. A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). In *The birds of North America, No. 506.* A. Ed., Poole and F. Gill. Philadelphia: The Academy of Natural Sciences. Washington, DC: The American Ornithologists' Union.

Bull, E.L. and T.W. Heater. 2000. Resting and denning sites of American martens in Northeastern Oregon. *Northwest Sci*. 74:179–185.

Bull, E.L., and J.A. Jackson. 1995. Pileated Woodpecker (*Dryocopus pileatus*). In *The birds of North America, No. 148*. Ed., A. Poole and F. Gill. Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Buskirk, S. W., L.F. Ruggiero, and C.J. Krebs. 2000. Habitat fragmentation and interspecific competition: implications for lynx conservation. In *Ecology and conservation of lynx in the United States*. Ed., L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey and J.R. Squires. University Press of Colorado, Boulder, CO.

Buskirk, S.W. 1984. Seasonal use of resting sites by marten in south-central Alaska. *J. Wildl. Manage*. 48:950–953.

Buskirk, S.W. and R.A. Powell. 1994. Habitat ecology of fishers and American martens. In *Martens, Sables, and Fishers: Biology and Conservation*. Ed., S.W. Buskirk, A.S. Harestad, and M.G. Raphael. Cornell University Press. Ithaca, NY.

Bussey, J. 1990. *Detailed Heritage Resource Overview Assessment Ring Border Pedigree Gas Field, northeastern British Columbia and northwestern Alberta*. Non-permit. Consultant's overview report on file, Heritage Resource Management Branch. Victoria, BC.

Bussey, J. 1992. *Heritage Resource Investigations in Northeastern BC for Canadian Hunter Exploration Ltd.* Permit 1992-4. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Bussey, J. 1995. *Archaeological Investigations in the Fort Nelson Area for Summit Resources Limited, 1995*. Permit 1995-013. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Bussey, J. 1998. *Archaeological Investigations for Canadian Hunter Exploration Ltd., 1998*. Permit 1998-115. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Caceres, M.C., and M.J. Pybus. 1997. Status of the northern long-eared bat (*Myotis septentionalis*) in Alberta. Alberta Wildlife Status Report No. 3. Alberta Environmental Protection, Wildlife Management Division, Edmonton, AB.

Cadman, M. D. 1994. Updated status report on the Short-eared Owl (*Asio flammeus*) in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Ottawa, ON.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C. McNall. 1990b. The birds of British Columbia. Volume 2. Nonpasserines: Diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, BC. 636pp.

Campbell, R.W., N.K. Dawe, I. M.cTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C. McNall. 1990a. The birds of British Columbia. Volume 1. Nonpasserines: Introduction and loons through waterfowl. Royal British Columbia Museum, Victoria, BC. 514pp.

Campbell, R.W., N.K. Dawe, I. M.cTaggart-Cowan, J.M. Cooper, G.W. Kaiser, M.C. McNall, and G.E. Smith. 1997. The birds of British Columbia. Volume 3. Passerines: flycatchers through vireos. Royal British Columbia Museum, Victoria, BC. 693pp.

Campbell, R.W., N.K. Dawe, I. M.cTaggart-Cowan, J.M. Cooper, G.W. Kaiser, A.C. Stewart, and M.C. McNall. 2001. The birds of British Columbia. Volume 4. Passerines: wood-warblers through old world sparrows. Royal British Columbia Museum, Victoria, BC. 739pp.

Carr, H.D. 1989. Distribution, numbers and mortality of grizzly bears in and around Kananaskis Country, Alberta. Alberta Fish and Wildlife Division, Wildlife Management Branch, Edmonton, AB. 49pp.

Casselman, J.M. and C.A. Lewis. 1996. Habitat requirements of northern pike (*Esox lucius*). Can. J. Fish. Aquat. Sci. Vol. 53 (Suppl. 1): 161-174.

Casselman, J.M. and C.A. Lewis. 1996. Habitat requirements of northern pike (*Esox lucius*). Can. J. Fish. Aquat. Sci. Vol. 53 (Suppl. 1): 161-174.

Clayton, D.A. 2000a. Space-use, diet, demographics, and topographic associations of lynx in the Southern Canadian Rocky Mountains: a study. In *Ecology and conservation of lynx in the United States*. Ed., L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey and J.R. Squires. University Press of Colorado, Boulder, CO.

Clayton, K.M. 2000b. Status of the short-eared owl (*Asio flammeus*) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 28, Edmonton, AB.

Clem, M.K. 1975. Interspecific relationships of fishers and martens in Ontario during winter. In *Proc. of Predator Symp., June 16-19*. Ed., R.L. Philips and C. Jonkel. University of Montana, Missoula.

Connelly, J.W., M.W. Gratson, and K.P. Reese. 1998. Sharp-tailed Grouse (Tympanuchus phasianellus). In *The birds of North America, No. 354*. Ed., A. Poole and F. Gill. Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Cooper, J., K.A. Enns, and M. Shepard. 1997b. Status report on the Philadelphia Vireo (*Vireo* philadelphicus) in British Columbia. BC Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC.

Cooper, J.M., K.A. Enns, and M.G. Shepard. 1997a. Status of the Cape May Warbler. BC Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC.

Coulter, M.W. 1966. Ecology and management of fishers in Maine. PhD. Thesis, State University Coll. Forest., Syracuse Univ., Syracuse, N.Y. 183 pp.

Craighead, F.C., Jr., and J.J. Craighead. 1970. Radio-tracking of grizzly bears in Yellowstone National Park, Wyoming, 1962. Pages 63-71 *in* National Geographic Society Research Reports, 1961-1962. National Geographic Society, Washington, DC.

Craighead, J.L. and J.A. Mitchell. 1982. Grizzly Bear (*Ursus arctos*). Pages 551-556 *in* J.A. Chapman and G.A. Feldhamer (eds.), Wild Mammals of North America - Biology, Management, and Economics, Johns Hopkins University Press.

Crampton, L.H., K.G. Poole, and C. Shurgot. 1997. Bat inventory of the Prophet River Territory in Northeastern British Columbia. Prepared for the BC Ministry of Environment, Lands and Parks, Fish and Wildlife Branch, Peace Subregion. Fort St. John, BC.

Cumming, H.G. 1992. Woodland Caribou: facts for forest managers. For. Chron. 68:481-492.

Dalle-Molle, J., and J.C. Van Horn. 1989. Bear/people conflict management in Denali National Park, Alaska. In *Bear-people conflict: Proceedings of a symposium on management strategies.* Yellowknife, NWT.

Dauphiné, T.C. 1989. Updated status report on the wolverine *Gulo gulo* in Canada. Report prepared for the Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Davis, M.H. 1983. Post-release movements of introduced marten. *J. Wildl. Manage*. 47:59–66.

deVos, A. 1951. Recent findings in fisher and marten ecology and management. In *Proceedings of the Trans North American Wildlife Conference*.

deVos, A. 1952. Ecology and management of the fisher in Ontario. Tech Bull. Ontario Dept. Lands and Forests, Wildl. Ser. 1. 90 pp.

Doerr, J.G. 1983. Home range size, movements and habitat use in two moose, *Alces alces*, populations in southeastern Alaska. *Can. Field-Nat*. 97:79–88.

Dyer, S.J. 1999. Movement and distribution of woodland caribou (*Rangifer tarandus caribou*) in response to industrial development in northeast Alberta. M.Sc. Thesis, University of Alberta, Edmonton, Alberta. 106pp.

Dzus, E. 2001. Status of the woodland caribou (*Rangifer tarandus caribou*) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 30, Edmonton, AB. 47pp.

Eccles, R., and J. Duncan. 1986. Wildlife monitoring studies along the Norman Wells-Zama oil pipeline, April 1985 - May 1986. Prepared by LGL Limited Environmental Research Associates for Interprovincial Pipeline (NW) Ltd. Calgary, AB.

Eccles, T.R., and J.A. Duncan. 1987. Wildlife monitoring studies along the Norman Wells-Zama oil pipeline, November 1984 - May 1987. Prepared by The Delta Environmental Management Group Ltd. for Interprovincial Pipeline (NW) Ltd., Calgary, AB.

Edmonds, E.J. 1988. Population status, distribution, and movements of woodland caribou in west central Alberta. *Can. J. Zool*. 66:817–826.

Edwards, E.A. 1982. Habitat suitability index models: Longnose Sucker. Habitat Evaluation Procedures Group. Western Energy and Land Use Team. U.S. Fish and Wildlife Service, Ft. Collins, CO 80526. 21 p.

Edwards, E.A. 1982. Habitat suitability index models: Longnose Sucker. Habitat Evaluation Procedures Group. Western Energy and Land Use Team. U.S. Fish and Wildlife Service, Ft. Collins, CO 80526. 21 p.

Enns, K.A. and C. Siddle. 1996. The distribution, abundance, and habitat requirements of selected passerine birds of the Boreal and Taiga Plains of British Columbia. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, BC.

Erskine, A.J. and G.S. Davidson. 1976. Birds in the Fort Nelson Lowlands of Northeastern British Columbia. *Syesis* 9:1–10.

Fedirchuk McCullough & Associates Ltd. 1983. *Corporate Field Manual*. On file, Fedirchuk McCullough & Associates Ltd. Calgary, AB.

Fedirchuk McCullough & Associates Ltd. 1997. *Fedirchuk McCullough & Associates Ltd. Report Guidelines*. On file, Fedirchuk McCullough & Associates Ltd. Calgary, AB.

Fedirchuk, G.J. 1970. *The Julian Site*, N.W.T. MA thesis, University of Calgary, Department of Archaeology. Calgary, AB.

Fedirchuk, G.J. 1973. *Progress Report: Saturation Archaeological Survey: Fisherman Lake Locality*. Unpublished manuscript on file, Archaeological Survey of Canada. Ottawa, ON.

Fedirchuk, G.J. and D. Meyer. 2000. *Post-Impact Archaeological Assessment, Wascana Energy Inc*. Winter 1999–2000 Drilling Program, Permit 2000-277. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Fenske-Crawford, T. J., and G. J. Niemi. 1997. Predation of artificial ground nests at two types of edges in a forest-dominated landscape. *Condor* 99:14–24.

Fladmark, K.R., J.C. Driver and D. Alexander. The Paleoindian Component at Charlie Lake Cave (HbRf 39), British Columbia. *American Antiquity*, Vol. 53, no. 2. Salt Lake City.

Forsey, E.S. and E.M. Baggs. 2001. Winter activity of mammals in riparian zones and adjacent forest prior to and following clear-cutting at Copper Lake, Newfoundland, Canada. *For. Ecol. Manage*. 145:163–171.

Fort Nelson LRMP Working Group. 1997. Fort Nelson Land and Resource Management Plan. B.C. Ministries of Forests; Energy and Mines; and Environment, Lands and Parks, Victoria, BC.

Fort Nelson LRMP Working Group. 1997. Recommended Fort Nelson Land and Resource Management Plan. Victoria, BC.

Fraker M.A., and J.E. Green. 1994. A review of information on the responses of moose and caribou to surface pipelines and potential mitigation measures. Draft final report. Prepared for Westcoast Energy Inc. by AXYS Environmental Consulting Inc., Vancouver, BC.

Fryxell, J.M., J.B. Falls, E.A. Falls, R.J. Brooks, L. Dix and M.A. Strickland. 1999. Density dependence, prey dependence, and population dynamics of martens in Ontario. *Ecology* 80:1311–1321.

Geen, G.H., T.G. Northcote, G.F. Hartman, and C.C. Lindsey. 1966. Life histories of two species of catostomid fishes in Sixteen Mile Lake, BC, with particular reference to inlet stream spawning. *J. Fish. Res. Board Can*. 23(11):1761–1788.

Geen, G.H., T.G. Northcote, G.F. Hartman, and C.C. Lindsey. 1966. Fife histories of two species of catostomid fishes in Sixteen Mile Lake, BC, with particular reference to inlet stream spawning. *J. Fish. Res. Board Can*. 23(11):1761–1788.

Gibeau, M.L., A.P. Clevenger, S. Herrero, and J. Wierzchowski. 2002. Grizzly bear response to human development and activities in the Bow River Watershed, AB. *Canada. Biol. Conserv*. 103:227–236.

Gibeau, M.L., and S. Herrero. 1998. Roads, rails and grizzly bears in the Bow River Valley, Alberta. In *Proceedings of the International Conference on Ecology and Transportation, Department of Transportation*. Talahassee, FL.

Gifford, D. 1978. Ethnoarchaeological Observations of Natural Processes Affecting Cultural Materials. In, *Explorations in ethnoarchaeology*, pp. 77–102. Ed., R.A. Gould, School of American Research. Santa Fe.

Godfrey, W.E. 1986. The Birds of Canada. National Museum of Canada. Bulletin No. 203. Biological Serial No. 73.

Hamer, D., S. Herrero, and R.T. Ogilvie. 1977. Ecological studies of the Banff National Park grizzly bear, Cuthead/Wigmore Region, 1976. Prepared by University of Calgary for Parks Canada, Calgary, AB. 234pp.

Hamilton, G.D., P.D. Drysdale and D.L. Evler. 1980. Effects of Cutover Width on Browse Utilization by Moose. In *Proceedings of the North American Moose Conference Workshop Vol. 11*.

Hargis C.D., J.A. Bissonette, and D.L. Turner. 1999. The influence of forest fragmentation and landscape pattern on American marten. *Journal of Applied Ecology* 36:157–172.

Hargis, C.D., and D.R. McCullough. 1984. Winter diet and habitat selection of marten in Yosemite National Park. *Journal of Wildlife Management* 48:140–146.

Hatler, D.F. 1989. A wolverine management strategy for British Columbia. Wildlife Bulletin No. B-60. BC Ministry of Environment, Wildlife Branch, Victoria, BC.

Hayes, M.L. 1956. Life History of two species of suckers in Shadow Mountain Reservoir Grand County, Colorado. M.S. Theses. Colorado A&M College, Ft. Collins. 126 pp.

Hayes, M.L. 1956. Life History of two species of suckers in Shadow Mountain Reservoir Grand County, Colorado. M.S. Theses. Colorado A&M College, Ft. Collins. 126 pp.

Henson, P. and T.A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. *Wildlife Society Bulletin* 19:248–257.

Herrero, S. 1985. Bear attacks, their causes and avoidance. Winchester Press, Piscataway. NJ. 287pp.

Herrero, S. 1989. The role of learning in some fatal grizzly bear attacks on people. In *Bear - people conflicts*. Proceedings of a symposium on management strategies. Northwest Territories Department of Renewable Resources. Yellowknife, NWT.

Hobson, K.A., and E. Bayne. 2000. Effects of forest fragmentation by agriculture on avian communities in the southern boreal mixedwood forest of western Canada. *Wilson Bulletin* 112:373–387.

Holt, D.W., and S.M. Leasure. 1993. Short-eared Owl (*Asio flammeus*). In *The birds of North America, No. 62*. Ed., A. Poole and F. Gill. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Honigmann, J.J. 1946. Ethnography and Acculturation of the Fort Nelson Slave. *Yale University, Publications in Anthropology.* No. 33.

Hornocker, M.G., and H.S. Hash. 1981. Ecology of wolverine in Northwestern Montana. *Canadian Journal of Zoology* 59:1286–1301.

Hudson's Bay Company. B.200/a/2. Journal of the Forks, 1823. Provincial Archives of Manitoba. Winnipeg, MB.

Hummel, M. and S. Pettigrew. 1991. Wild Hunters: Predators in Peril. Key Porter Books.

Ingram, R. 1973. Wolverine, fisher and marten in central Oregon. Oregon State Game Commission, Cen. Reg. Admin. Rep. 73-2.

Inskip, P. 1982. Habitat suitability index models: Northern pike. Habitat Evaluation Procedures Group. Western Energy and Land Use Team. U.S. Fish and Wildlife Service, Ft. Collins, CO 80526. 40 p.

Inskip, P. 1982. Habitat suitability index models: Northern pike. Habitat Evaluation Procedures Group. Western Energy and Land Use Team. U.S. Fish and Wildlife Service, Ft. Collins, CO 80526. 40 p.

Interagency Grizzly Bear Committee (IGBC). 1987. Grizzly Bear compendium. The National Wildlife Federation, Washington, DC. 540pp.

Iverson, G.C., P.A. Vohs and T.C. Tacha. 1987. Habitat use by mid-continent Sandhill Cranes during spring migration. *Journal of Wildlife Management* 51:448–458.

Jalkotzy, M.G., P.I. Ross, and M.D. Nasserden. 1997. The effects of linear developments on wildlife: a review of selected scientific literature. Prepared for the Canadian Association of Petroleum Producers by Arc Wildlife Services Ltd., Calgary, AB.

James, A.R. 1999. Effects of industrial development on the predator-prey relationship between wolves and caribou in Northeastern Alberta. Ph.D Thesis, University of Alberta, Edmonton, AB.

Jenkins, S.H. 1981. Problems, Progress, and Prospects in Studies of Food Selection by Beavers. In *Worldwide Furbearer Conference Proceedings, Vol. 1*. Ed., J.A. Chapman and D. Pursley.

Jenkins, S.H. and P.E. Busher. 1979. *Castor canadensis*. Mammalian Species 120:1–8.

Jenness, D. *The Indians of Canada*. National Museum of Canada, Bulletin 65. Ottawa, ON.

Johns, B.W. 1993. The influence of grove size on bird species richness in aspen parklands. *Wilson Bulletin* 105:256–264.

Johnson, F. and H.M. Raup. 1964. Investigations in Southwest Yukon: geobotanical and archeological reconnaissance. *Papers of the Robert S. Peabody Foundation for Archaeology*, Vol. 6(2), Andover.

Johnson, W.A., and A.W. Todd. 1985. Fisher behavior in proximity to human activity. *Canadian Field-Naturalist* 99:367–369.

Johnston N.T. and P.A. Slaney 1996. Fish habitat assessment procedures. Watershed Restoration Technical Circular No. 8. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests, Vancouver, BC.

Keith, L.B. 1972. Snowshoe Hare Populations and Forest Regeneration in Northern Alberta. Unpublished Report. Prepared for Alberta Forest Service.

Kelly, G.M. 1977. Fisher (*Martes pennanti*) Biology in White Mountain National Forest and Adjacent Areas. Ph.D. Thesis, University of Massachusetts, Amherst, MA.

Kessel, B. 1984. Migration of Sandhill Cranes, *Grus canadensis*, in east-central Alaska, with routes through Alaska and western Canada. *The Canadian Field Naturalist* 98:279–292.

King, W.C. Founding Fort Nelson as told to Mary Weeks. The Beaver, December, p. 42–43.

Koehler, G.M., W.R. Moore, and A.R. Taylor. 1975. Preserving the marten: management guidelines for western forests. Western Wildlands 2:31–36.

Krebs, J.A. and D. Lewis. 1999. Wolverine ecology and habitat use in the northern Columbia Mountains: progress report. Columbia Basin Fish and Wildlife Compensation Program.

Kyle, C.J. and C. Strobeck. 2001. Genetic structure of North American wolverine (*Gulo gulo*) populations. *Molecular Ecology* 10:337–347.

Lenihan, D.J. 1981. *The final report of the national reservoir inundation study.* United States Department of the Interior, National Park Service, Southwest Cultural Resource Center. Santa Fe.

Linnell, J.D.C., J.E. Swenson, R. Andersen, and B. Barnes. 2000. How vulnerable are denning bears to disturbance? *Wildlife Society Bulletin* 28:400–413.

MacGregor, J.G. 1970. The Klondike Rush through Edmonton 1897–1898. McClelland and Stewart Limited. Toronto, ON.

MacNeish, R.S. 1960. The Callison Site in the Light of Archaeological Survey of Southwest Yukon. *National Museum of Canada Bulletin* 162:1–51. Ottawa, ON.

Magne, M. *Archaeological Investigations in the Grande Prairie region of Northwestern Alberta, 1985*. Archaeological Survey of Alberta, Occasional Paper No. 29:185–199. Edmonton, AB.

McConnell, R.G. 1891. Report on an exploration in the Yukon and Mackenzie Basin, N.W.T. *Geological and Natural History Survey of Canada*, Annual Report 1888–1889, pt. D, n.s. Vol. IV: 24D-87D.

McCullough, E.J. 1990. *Archaeological Impact Assessment, CU Power Rainbow Lake – Wescup (Fort Nelson) 144 kV Transmission Line Project*. Permit 1990-92. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

McElhanney Associates. 2003. EnCana Corporation Ekwan Pipeline Map showing proposed pipeline route alternatives, permanent and seasonal road access and other land uses and dispositions in the project area. Fort St. John, BC.

McGillivray, W. B., and G. P. Semenchuk. 1998. Field guide to Alberta birds. Federation of Alberta Naturalists, Edmonton, AB.

McLellan, B.N., and D.M. Shackleton. 1989. Grizzly bears and resource-extraction industries: habitat displacement in response to seismic exploration, timber harvesting and road maintenance. *Journal of Applied Ecology* 26:371–380.

McPhail, J.D., D. O'Brien, and J. Degisi. 1998. Overview of the distribution and biology of fishes in the Hay River System, Northeastern British Columbia. Prepared for BC Environment, Fisheries Branch, Peace Subregion, Fort St John, BC.

Mech, L.D. and L.L. Rogers. 1977. Status, Distribution, and Movements of Martens in Northeastern Minnesota. USDA Forest Service Research Paper NC-143.

Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. BC Ministry of Forests, Victoria, BC.

Millar, J.F.V. 1968. *Archaeology of Fisherman Lake, Western District of Mackenzie, N.W.T.* Ph.D. dissertation, The University of Calgary, Department of Archaeology. Calgary, AB.

Millar, J.F.V. 1981. Interaction between the Mackenzie and Yukon basins during the early Holocene. In Networks of the past: regional interaction in archaeology. Proceedings of the Twelfth Annual Conference, Chacmool, *The Archaeological Association of the University of Calgary.* Edited by P. D. Francis, F. J. Kense, and P. G. Duke. Calgary. AB.

Mitchell, C.D. 1994. Trumpeter Swan (*Cygnus buccinator*). In *The birds of North America, No. 105*. Ed., A. Poole and F. Gill. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Morgantini, L.E. 1984. Pipelines and wildlife: a wildlife monitoring program during the construction of the Hanlan-Blackstone and the Brazeau pipelines. Prepared by Wildlife Resources Consultants Ltd. for Canterra Energy Ltd. 57pp.

Morrow, J.E. 1980. The Freshwater Fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, AK.

Moskoff, W., and S.K. Robinson. 1996. Philadelphia Vireo (*Vireo philadelphicus*). In *The birds of North America, No. 214*. Ed., A. Poole and F. Gill. Philadelphia: The

Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Mowat, G., K.G. Poole, and M. O'Donoghue. 2000. Ecology of lynx in northern Canada and Alaska. In *Ecology and conservation of lynx in the United States.* Ed., L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey and J.R. Squires. University Press of Colorado, Boulder, CO.

Murray, D.L., S. Boutin, and M. O'Donoghue. 1994. Winter habitat selection by lynx and coyotes in relation to snowshoe hare abundance. *Can. J. Zool.* 72:1444–1451.

Mytton, W.R. and L.B. Keith. 1981. Dynamics of moose populations near Rochester, Alberta, 1975–1978. *Can. Field-Nat.* 95:39–49.

Nagorsen, D.W. and R.M. Brigham. 1993. Bats of British Columbia. Royal British Columbia Museum Handbook, UBC Press, Vancouver, BC.

Nelson, J.S. and M.J. Paetz. 1970. The Fishes of Alberta. Government of Alberta, Queen's Printer, Edmonton, AB. First Edition.

Nelson, J.S. and M.J. Paetz. 1992. The Fishes of Alberta. University of Alberta Press, Edmonton, AB. Second Edition.

Nexen Canada Ltd. 2003. Hay 2002/2003 Project Access Map. Calgary, AB.

Nexen Canada Ltd. 2003. Hay Project Map showing all existing and proposed infrastructure and well sites. Calgary, AB.

Nexen Canada Ltd. 2003. Hay Project Map showing existing and proposed production Pads. Calgary, Alberta.

Nietfeld, M., J. Wilk, K. Woolnough, and B. Hoskan. 1984. Wildlife habitat requirement summaries for selected wildlife species in Alberta. Prepared by Alberta Fish and Wildlife Department.

Norton, M.R. 2001a. Status of the Bay-breasted Warbler (*Dendroica castanea*) in Alberta. Alberta Wildlife Status Report No. 32. Alberta Environmental Protection, Fisheries and Wildlife Management Division, Edmonton, AB.

Norton, M.R. 2001b. Status of the Cape May Warbler (*Dendroica tigrina*) in Alberta. Alberta Wildlife Status Report No. 33. Alberta Environmental Protection, Fisheries and Wildlife Management Division, Edmonton, AB.

Oberg, P., C. Rohner and F.K.A. Schmiegelow. 2002. Responses of mountain caribou to linear features in a west-central Alberta landscape. Proceedings of the Seventh Internation Symposium on Environmetnal Concerns in Rights-of-Way Management, 9-13 September 2000, Calgary, Alberta, Canada.

O'Donoghue, M., S. Boutin, C.J. Krebs and E.J. Hofer. 1997. Numerical responses of coyotes and lynx to the snowshoe hare cycle. *Oikos* 80:150–162.

Parker, G.R. 1981. Winter habitat use and hunting activities of lynx (*Lynx canadensis*) on Cape Breton Island, Nova Scotia. In *Worldwide Furbearer Conference, Vol. I, Frostburg, MD*. Ed., J.A. Chapman and D. Pursley.

Pierce, D.J. and J.M. Peek. 1984. Moose habitat use and selection patterns in north-central Idaho. *J. Wildl. Manage*. 48:1335–1343.

Poole, K.G. 1994. Characteristics of an unharvested lynx population during a snowshoe hare decline. *J. Wildl. Manage*. 58:608–618.

Poole, K.G. 1998. Beaver lodge survey of the Klua Lakes and Trutch Creek area, Prophet River Territory. Prophet River Wildlife Inventory Report No. 2. Prepared by Timberland Consultants Ltd., Fish and Wildlife Division for Prophet River Indian Band, Nelson, BC.

Poole, K.G., and D. Stanley. 1998. Furbearer track counts in the Prophet Territory, northeastern British Columbia. Prophet River Wildlife Inventory Report No. 6. Prepared for the Prophet River Indian Band, Fort Nelson, BC.

Poole, K.G., G. Mowat and D.A. Fear. 1999. Grizzly bear inventory of the Prophet River area, northeastern British Columbia. Prophet River Wildlife Inventory Report No. 10. Prepared for the Prophet River Indian Band, Fort Nelson, BC.

Poole, K.G., G. Mowat, D. Stanley, D.A. Fear and D. Pritchard. 1998. Moose inventory in the southeast Prophet River Territory, January 1998. Prophet River Wildlife Inventory Report No. 5. Prepared for the Prophet River Indian Band, Fort Nelson, BC.

Postovit, H.R., and B.C. Postovit. 1987. Mining and energy development. In *Proceedings of the western raptor management symposium and workshop, Boise, ID*.

Potvin F., R. Courtois, and L. Belanger. 1999. Short-term response of wildlife to clear-cutting in Quebec Boreal Forest: multiscale effects and management implications. *Canadian Journal of Forest Research* 29:1120–1127.

Powell, R.A. 1982. The Fisher Life History, Ecology, and Behavior. University of Minnesota Press, Minneapolis, MN.

Prager, G. 1997. Archaeological Assessments of Slocan Forest Products Ltd. Fort Nelson Timber Supply Area Developments, Final Report, 1997 Investigations. Permit 1997-067. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Pulliainen, E. 1968. Breeding biology of the wolverine (Gulo gulo L.) in Finland. *Annales Zoologica Fennici* 5:338–344.

Quimby, R. 1974. Grizzly bear. In *Mammal studies in northeastern Alaska with emphasis on the Canning River drainage*. Ed., R.D. Jakimchuk. Canadian Arctic Gas Study Ltd. Biological Report Series 24.

Quinlan, R.W., K. Wilson, W.A. Hunt, and J. Kerr. 1990. Habitat Requirements of Selected Wildlife Species in the Weldwood Forest Management Agreement Area. Prepared for the Weldwood Forest Management Agreement Area Integrated Resource Management Steering Committee.

Resource Inventory Committee (RIC). 1998. Standards for broad terrestrial ecosystem classification and mapping for British Columbia: classification and correlation of the broad habitat classes used in 1:250,000 ecological mapping. Version 2.0. BC Ministry of Environment, Lands and Parks, Victoria, BC. 225pp.

Resource Inventory Committee (RIC). 1999. British Columbia wildlife habitat rating standards. Version 2.0. BC Ministry of Environment, Lands and Parks, Victoria, BC. 100pp.

Rettie, J., T. Rock and F. Messier. 1998. Status of woodland caribou in Saskatchewan. *Rangifer* (Special Issue) 10:105–109.

Rettie, J.W. 1998. The ecology of woodland caribou in central Saskatchewan. Ph.D. Thesis, University of Saskatchewan. 159pp.

Rettie, J.W., and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Canadian Journal of Zoology* 76:251–259.

Rettie, J.W., and F. Messier. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. *Ecography* 23:466–478.

Ridington, A. 2000. Archaeological Impact Assessment, Petrochemical Developments in Blueberry River, Fort Nelson, Halfway River and Prophet River First Nation Asserted Territories: Archaeological Assessments permit Report, Permit 1999-306. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Riewe, R.R. 1980. Interactions between wildlife, trappers, hunters and seismic lines in the Mackenzie Valley Region, NWT, Canada. Environmental Studies No. 12, Northern Affairs Program, Dept. of Indian Affairs and Northern Development.

Risenhoover, K.L. 1989. Composition and quality of moose winter diets in interior Alaska. *J. Wildl. Manage*. 53:568–577.

Ritchie, R.J., and J.G. King. 2000. Tundra Swans. Pages 197-220 *in* J.C. Truett and S.R. Johnson (eds.). The natural history of an arctic oil field: development and the biota. Academic Press, San Diego, CA.

Robitaille, J.F. and K. Aubry. 2000. Occurrence and activity of American marten *Martes americana* in relation to roads and other routes. *Acta Theriologica* 45:137–143.

Rolley, R.E. and L.B. Keith. 1980. Moose population dynamics and winter habitat use at Rochester, Alberta, 1965-1979. *Canadian Field-Naturalist* 94:9–18.

Rowe, John 1972. Forest Regions of Canada. Rev. ed. *Canadian Forestry Service Publication* 1300. Ottawa, ON.

Rowell, P., and D.P. Stepinsky. 1997. Status of the Peregrine Falcon (*Falco peregrinus anatum*) in Alberta. Alberta Wildlife Status Report No. 8. Alberta Environmental Protection, Wildlife Management Division.

Ruggiero, L.F., K. B. Aubry, S. W. Buskirk, L.J. Lyon, and W. J. Zielinski. 1994. The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States. General Technical Report RM-254, USDA Forest Service.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 2000. The scientific basis for lynx conservation: qualified insights. Pages 443-454 *in* Ruggiero, L. F., Aubry, K. B., Buskirk, S. W., Koehler, G. M., Krebs, C. J., McKelvey, K. S., and Squires, J. R. (eds.), Ecology and Conservation of Lynx in the United States. University Press of Colorado, Boulder, CO.

Rusch, D.H., S. Destefano, M.C. Reynolds, and D. Lauten. 2000. Ruffed Grouse (*Bonasa umbellus*). *In* The birds of North America, No. 515. A. Poole and F. Gill (eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Savard, J.L., D. Bordage and A. Reed 1998. Surf Scoter (*Melanitta perspicillata*). *In* The birds of North America, No. 363. A. Poole and F. Gill (eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa, ON.

Seip, D.R. 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. *Can. J. Zoo*l. 70:1494–1503.

Semenchuk, G.P. 1992. *The Atlas of Breeding Birds of Alberta*. Federation of Alberta Naturalists.

Shackleton, D. 1999. Hoofed mammals. Royal British Columbia Museum Handbook. UBC Press, Vancouver, BC. 268pp.

Slocan Forest Products Ltd. 2003. Map of Fort Nelson Timber Supply Area 941.119 showing existing and proposed cut areas and access roads. Fort Nelson, BC.

Slough, B.G. 1988. The effects of changes in vegetation cover on furbearer populations and trapping activities in the Liard Valley. Yukon Department of Renewable Resources, Whitehorse, YK. 17pp.

Slough, B.G. 1989. Movements and habitat use by transplanted marten in the Yukon Territory. *J. Wildl. Manage*. 53:991–997.

Slough, B.G. and G. Mowat. 1996. Population dynamics of lynx in a refuge and interactions between harvested and unharvested populations. *J. Wildl. Manage*. 60:946–961.

Slough, B.G., and R.M. Sadleir. 1977. A land capability classification system for beaver (*Castor canadensis* Kuhl). *Canadian Journal of Zoology* 55:1324–1335.

Smith, K.G., E.J. Ficht, D. Hobson, T. Sorensen, and D. Hervieux. 2000. Winter distribution of woodland caribou in relation to clear-cut logging in West-Central Alberta. *Canadian Journal of Zoology* 78:1433–1440.

Soper, J.D. 1964. The Mammals of Alberta. The Queen's Printer, Edmonton, AB.

Soutière, E.C. 1979. Effects of timber harvesting on marten in Maine. *Journal of Wildlife Management* 43:850–860.

Speakman J.R., P.I. Webb, and P.A. Racey. 1991. Effects of disturbance on the energy expenditure of hibernating bats. *Journal of Applied Ecology* 28:1087–1104.

Stafford, H.E. 1959. *The Early Inhabitants of the Americas*. Vantage Press. New York.

Stevens, V. 1995. Wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds, and mammals in biogeoclimatic zones. BC Ministry of Forests, Research Branch and BC Ministry of Environment, Lands and Parks, Habitat Protection Branch, Victoria, BC. 288 pp.

Stevens, V. and S. Lofts. 1988. Wildlife Habitat Handbooks for the Southern Interior Ecoprovince - Volume 1: Species Notes for Mammals. B.C. Ministry of Environment, B.C. Ministry of Forests and Wildlife Habitat Canada.

Steventon, J.D., and J.T. Major. 1982. Marten use of habitat in commercially clear-cut forest. *Journal of Wildlife Management* 46:175–182.

Stuart-Smith, A.K., C.J. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. *J. Wildl. Manage*. 61:622–633.

Tacha, T.C., S. A. Nesbitt, and P. A. Vohs. 1992. Sandhill Crane (*Grus canadensis*). *In* The birds of North America, No. 31. A. Poole and F. Gill (eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Telfer, E.S. 1984. Circumpolar distribution and habitat requirements of moose (*Alces alces*). *In* R. Olson, R. Hastings and F. Geddes (eds.), Northern Ecology and Resource Management: Memorial Essays Honouring Don Gill. The University of Alberta Press, Edmonton, AB.

Terry, E.L., B.N. McClelland and G.S. Watts. 2000. Winter habitat ecology of mountain caribou in relation to forest management. *J. Applied Ecology* 37:589–602.

Thomas, D.W. 1995. Hibernating bats are sensitive to nontactile human disturbance. *Journal of Mammalogy* 76:940–946.

Todd, A.W. 1983. Dynamics and management of lynx populations in Alberta. Alberta Fish and Wildlife Division, Edmonton, AB. 23pp.

Todd, A.W. 1985. The Canada lynx: ecology and management. The Canadian Trapper 13:15–20.

Tolko Industries Ltd. 2003. General Development Plan: Harvest Activities Overview Map. High Level, AB.

Tolko Industries Ltd. 2003. Map: F14 General Development Plan 2002-2007. High Level, AB.

United States Environmental Protection Agency (USEPA). 1996a. Compilation of Air Pollutant Emission Factors, AP-42. 5th Edition. Volume I: Stationary Point and Area Sources. Chapter 3.3: Gasoline and Diesel Industrial Engines.

United States Environmental Protection Agency (USEPA). 1996b. Compilation of Air Pollutant Emission Factors, AP-42. 5th Edition. Volume I: Stationary Point and Area Sources. Chapter 13.1: Wildfires and Prescribed Burning.

United States Environmental Protection Agency (USEPA). 2000. Compilation of Air Pollutant Emission Factors, AP-42. 5th Edition. Volume II: Mobile Sources.

Valentine, K.W.G. 1971. Soils of the Fort Nelson Area of British Columbia. Research Branch. Canada Department of Agriculture. Report No. 12. Vancouver, BC.

van Zyll de Jong, C.G. 1985. Handbook of Canadian Mammals. National Museum of Natural Sciences, Ottawa, ON.

VanStone, J.W. 1974. Athapaskan adaptations: hunters and fisherman of the subarctic forests. Aldine. Chicago.

Vitt. D.H., L.A. Halsey, M.N. Thorman and T. Martin. 1998. Peatland Inventory of Alberta. Prepared for the Alberta Peat Task Force.

Vonhof M.J., and L.C. Wilkinson. 1999. Roosting habitat requirements of northern long-eared bats (*Myotis septentrionalis*) in the boreal forests of northeastern British

Columbia: Year 2. Prepared for the BC Ministry of Environment, Lands and Parks, Fort St. John, BC.

Walton, B.D. 1980. The reproductive biology, early life history and growth of white suckers, *Catostomus commersoni*, and long nose suckers, *C. catostomus*, in the Willow Creek – Chain Lakes System, Alberta. Fish Wildl. Div., Alberta. Fish Res. Rep. 23 180 pp.

Ward, D.H., R.A. Stehn, W.P. Erickson, and D.V. Derksen. 1999. Response of fall-staging Brant and Canada Geese to aircraft overflights in southwestern Alaska. Journal of Wildlife Management 63: 373-381.

Watson, J.W. 1993. Responses of nesting bald eagles to helicopter surveys. Wildlife Society Bulletin 21:171–178.

Weir, J. 1988. *Back door to the Klondike.* The Boston Mills Press. Erin, ON.

Westworth, D.A. 1980. Effects of seismic activity on the behaviour and activity of muskrats on the Mackenzie Delta. Prepared for the Department of Indian Affairs and Northern Development, Northern Affairs Program, Ottawa.

Wilkinson L.C., P.F. Garcia, and R.M. Barclay. 1999. Bat survey of the Liard River Watershed in Northern British Columbia. Prepared for the BC Ministry of Environment, Lands and Parks, Victoria, BC. 39pp.

Williams, J.M. 1996. Bay-breasted Warbler (*Dendroica castanea*). *In* The birds of North America, No. 206. A. Poole and F. Gill (eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Williams, R.D., and E.W. Colson. 1987. Raptor associations with linear rights-of-way. Pages 173-192 *in* Proceedings of the western raptor management symposium and workshop, Boise, ID.

Wilson, I.R. 1989. The Pink Mountain Site (HhRh 1): an Early Prehistoric campsite in northeastern B.C. *Canadian Journal of Archaeology*, Vol. 13:51–68.

Windberg, L.A., and L.B. Keith. 1978. Snowshoe hare populations in woodlot habitat. *Canadian Journal of Zoology* 56:1071–1080.

Wondrasek, R. and D. Green. 1999a. Archaeological Impact Assessment, Paramount Resources Ltd. Maxhamish Pipeline Project, Permit 1999-213. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Wondrasek, R. and D. Green. 1999b. Archaeological Impact Assessment, Paramount Resources Ltd. Maxhamish Gas Plant Project, Permit 1999-235. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Wondrasek, R. and D. Green. 1999c. Archaeological Impact Assessment, TransCanada's Liard Extension Pipeline Project, Permit 1999-345. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Wondrasek, R. and J. McKillop. 1999. Archaeological Impact Assessment, AEC Oil & Gas Co. Ltd. Sierra North and South Pipeline Project and Compressor Site, Permit 1999-159. Consultant's report on file, Heritage Resource Management Branch. Victoria, BC.

Wormington, H.M. and R.G. Forbis. 1965. An introduction to the archaeology of Alberta, Canada. Denver Museum of Natural History, Proceedings, 11.

Wright, J.V. 1976. Six chapters of Canada's prehistory. Canadian Prehistory Series, National Museum of Man. Ottawa, ON.

Young, G. *Fort Nelson Story.* D.W. Friesen & Sons Ltd., Cloverale, BC.

13.13.2 Personal Communications

Backmeyer, R. 2003. Senior Ecosystem Biologist, BC Ministry of Water, Land and Air Protection, Ecosystem Section, Fort St. John, BC.

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Capot Blanc, J. and J. Capot Blanc Jr. 2002. Registered trappers in BC trapping area 756T003, Fort Nelson First Nation.

Currie, C. 2003. Production Engineer, Conoco-Phillips. Calgary, Alberta.

Damant, L. 2002. Guides Officer, BC Ministry of Water, Land and Air Protection, Wildlife Allocations and Use Section. Victoria, BC.

Denechoan, H. 2003. Senior registered trapper in Alberta Registered Trapping Area No.88.

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Jenkins, L. 2003. Land Use Coordinator, Tolko Industries Ltd. High Level.

Kuhn, K. 2003. Senior Planning Forester, Slocan Forest Products Ltd. Fort Nelson.

Loe, K.T. 2002. Registered trapper in BC trapping area 756T013, Fort Nelson, BC.

McCarthy, C, N. McCarthy and D. McCarthy. Registered trappers in BC trapping area 765T002.

Murray. B. 2002. Fisheries Biologist, LGL Limited, Sidney, BC.

Norris, C. 2003. Forestry Officer, Alberta Sustainable Resource Development, Land and Forest Service. Rainbow Lake, Alberta.

Oberg. P. 2001. Wildlife Biologist, AXYS Environmental Consulting, Calgary, Alberta.

Siemens, W. 2003. Hay River Operations Manager, Nexen Canada Ltd. Calgary, Alberta.

Sutha, R. 2003. Junior registered trapper in BC trapping area 756T001.

Tally, J.B. 2003. Senior registered trapper in BC trapping area 756T001.

Tally, W. 2003. Junior registered trapper in Alberta Registered Trapping Area No. 88.

Thomas, A. 2003. Forester, BC Ministry of Forests, Fort Nelson District Forest. Fort Nelson.

Thornton, J. 2003. Biometrician, BC Ministry of Water, Land and Air Protection, Wildlife Branch. Victoria, BC.

Webster, B. 2003. Senior Wildlife Biologist, Ministry of Water, Land and Air Protection, Environmental Stewardship Division, Fort St. John, BC.

13.13.3 Internet Sites

B.C. Conservation Data Centre (CDC). 2002. BC Species Explorer. British Columbia Ministry of Sustainable Resource Management, Victoria, BC. Available at: http://srmapps.gov.bc.ca/apps/eswp/results.

Bayne, E. 2002. Bird responses to disturbances in the boreal. Integrated Landscape Management (ILM) Program. Obtained Online [http://www.biology.ualberta.ca/faculty/stan_boutin/ilm/?Page=1515] last updated: August 15, 2002.

Government of British Columbia. 1999. Ministry of Water, Land and Air Protection, BC Parks Conservation, Fort Nelson River. Available at: http://wlapwww.gov.bc.ca/bcparks/eco_reserve/fortnels_er.htm. Accessed: January 13, 2003.

Government of British Columbia. 2001a. Ministry of Sustainable Resource Management, Terrestrial Information Branch. An introduction to the ecoregions of British Columbia. Available at: http://srmwww.gov.bc.ca/rib/wis/eco/bcecode4.html. Accessed: January 13, 2003.

Government of British Columbia. 2001b. Ministry of Environment, Lands and Parks, BC Geographic Data, Geographical Names Database. Available at: http://www.gdbc.gov.bc.ca/bcnames/. Accessed: January 13, 2003.

Government of British Columbia. 2002. Ministry of Forests, Biogeoclimatic Ecosystem Classification. Available at: http://www.for.gov.bc.ca/hfd/pubs/docs/Bro/bro49.pdf. Accessed: January 13, 2003.

Government of British Columbia. 2003. An Introduction to the Ecoregions of British Columbia. Ministry of Sustainable Resource Management web site.

Government of Canada. 2003. Meteorological Service of Canada (MSC), Canadian Climate Normals for Fort Nelson, British Columbia (1971–2000). Available at: http://msc-smc.ec.gc.ca/climate/climate_normals/fort_nelson. Accessed: January 13, 2003.

Government of Canada. 2003. Natural Resources Canada (NRC), The Atlas of Canada. Available at: http://atlas.gc.ca/site/english/index.html. Accessed: January 13, 2003.

Government of the Northwest Territories. 2000. NWT Species 2000: General status ranks of wild species in the Northwest Territories [web version].

Santa Barbara County: Air Pollution Control District (SBC). (1997). Technical Information and References: Construction Equipment Emission Factors. www.sbcapcd.org/eng/tech/apcd-24.htm. Retrieved January 4, 2003.