CopperFox Metals Inc.
Schaft Creek Project
British Columbia, Canada

Schaft Creek
Western Toad Baseline 2007

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EXECUTIVE SUMMARY

Executive Summary

The western toad (*Bufo boreas*) has declined across its range in British Columbia, Alberta and the north western United States. It is the only Canadian amphibian on the IUCN red list and federally, the western toad is a species of special concern under the Canadian Species at Risk Act. In British Columbia, the Western toad is yellow listed (secure but with conservation concern). Western toads undertake yearly migrations from hibernating sites to communal breeding ponds, and then to summer foraging sites, making them very susceptible to habitat fragmentation by roads and other barriers. Migrations occur over distances ranging from 1-5 km during a relatively short period of several days. During these migration periods, adult toads and juvenile 'toadlets' can experience heavy mortality on roads or may avoid roads altogether, thus being unable to reach breeding ponds. Wildlife underpasses (toad tunnels) can allow toads to safely cross roads and maintain habitat connectivity.

During August of 2007, the access road along Mess Creek, mine site and tailings impoundment options were surveyed from a helicopter to identify ponds that may be suitable as western toad breeding ponds. Following the helicopter reconnaissance survey, 49 wetlands were surveyed on the ground for adult toads and signs of toad breeding – tadpoles or metamorphosed toadlets. Since most female toads breed every 2-3 years, physical characteristics of wetlands were also recorded to predict the locations of breeding ponds that were unused in 2007. Toads do not appear to prefer specific wetland types (such as those defined by the Canadian Wetland Classification System) but rather appeared to choose sites based on specific features of wetlands, such as shallow water, muddy banks, low elevation, high water temperature and low numbers of adult Columbia spotted frogs (a potential predator on toad tadpoles). Five breeding ponds were found during the 2007 field surveys and no additional ponds were predicted to be breeding sites in alternate years. In total, two sections of the access road along Mess Creek were identified as locations for toad tunnels and associated fencing.

A potential monitoring program is outlined in order to annually document toad breeding and to identify potential hot spots along the road for breeding migration and toadlet crossing. Potential mitigation actions such as establishing toad tunnels and maintaining proper protocol for handling of amphibians and gear when visiting wetland sites is also briefly outlined.

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GLOSSARY AND ABBREVIATIONS

Glossary and Abbreviations

Abiotic Characteristic:
Refers to non-living chemical and physical properties that describe the terrestrial and aquatic environment around surveyed locations, such as temperature, weather, pH, or water flow.

Algae:
Group of simple plant-like organisms that are typically found in aquatic habitats and form a portion of tadpole diets

Biotic Characteristic:
Refers to biological properties that describe the terrestrial and aquatic environment around surveyed locations, such as species composition and vegetation structure.

Bufonid:
Toads belonging to the genus Bufo

Desiccation:
Refers to the drying out of a living organism

Detritus:
Particulate organic matter, often composed of dead plant and animal bodies or parts, that builds up at the bottom of waterbodies and forms a portion of tadpole diets.

Ecological Sinks:
Refers to habitat that does not provide the necessary requirements for a population of animals to be able to persist – resulting in a declining population which is only maintained through constant immigration.

Ephemeral:
Refers to a wetland, spring, stream, river, pond or lake that only exists for a short period following precipitation or snowmelt

Green List:
List of ecological communities and indigenous species that are not at risk in Alberta (generated by the Alberta Wildlife Management Division)

Hibernaculum:
The winter hibernating habitat or shelter of an animal (plural: hibernacula).

Hydroperiod:
The period of time during which a waterbody (*e.g.*, wetland) contains by water.

Lentic:
Still or non-moving waterbodies.

Metapopulation Dynamics:
Refers to a network of subpopulations that are found in discreet habitat patches and these patches may undergo extinctions and subsequent recolonizations in response to natural or anthropogenic changes, *e.g.*, toad breeding ponds, through migration of individuals between subpopulations

Metamorphosis:
Process wherein tadpoles undergo physiological and developmental changes to become toads, resulting in a shift from an aquatic to a terrestrial lifestyle.

Microsite:
A small area in which physical and biological conditions vary from that of the overall larger area, *e.g.*, a small ephemeral pond within a dry coniferous forest.

Parotoid Gland:
An external skin gland on the back, neck and shoulder of toads and some salamanders. It secretes an alkaloid milky substance to deter predators.

Ranid:
Frogs belonging to the genus Rana

Refugia:
An area that provides shelter and protection from the elements

Water Margin:
Refers to the edge of a waterbody (*i.e.*, where the bank meets water).

Yellow List:
List of ecological communities and indigenous species that are not at risk in British Columbia (generated by the British Columbia Conservation Data Centre).

1. INTRODUCTION

1. Introduction

The western toad (*Bufo boreas*) is an amphibian found throughout British Columbia, western Alberta, the western United States and southeast Alaska at low densities. Western toad population declines have been documented in southern BC and the southern Rocky Mountain states and concern has been raised over the status of this species in the remainder of its range (Pyare, 2005). Several causes have been proposed to explain population declines including introduced pathogens, habitat fragmentation and degradation from timber harvest and road construction.

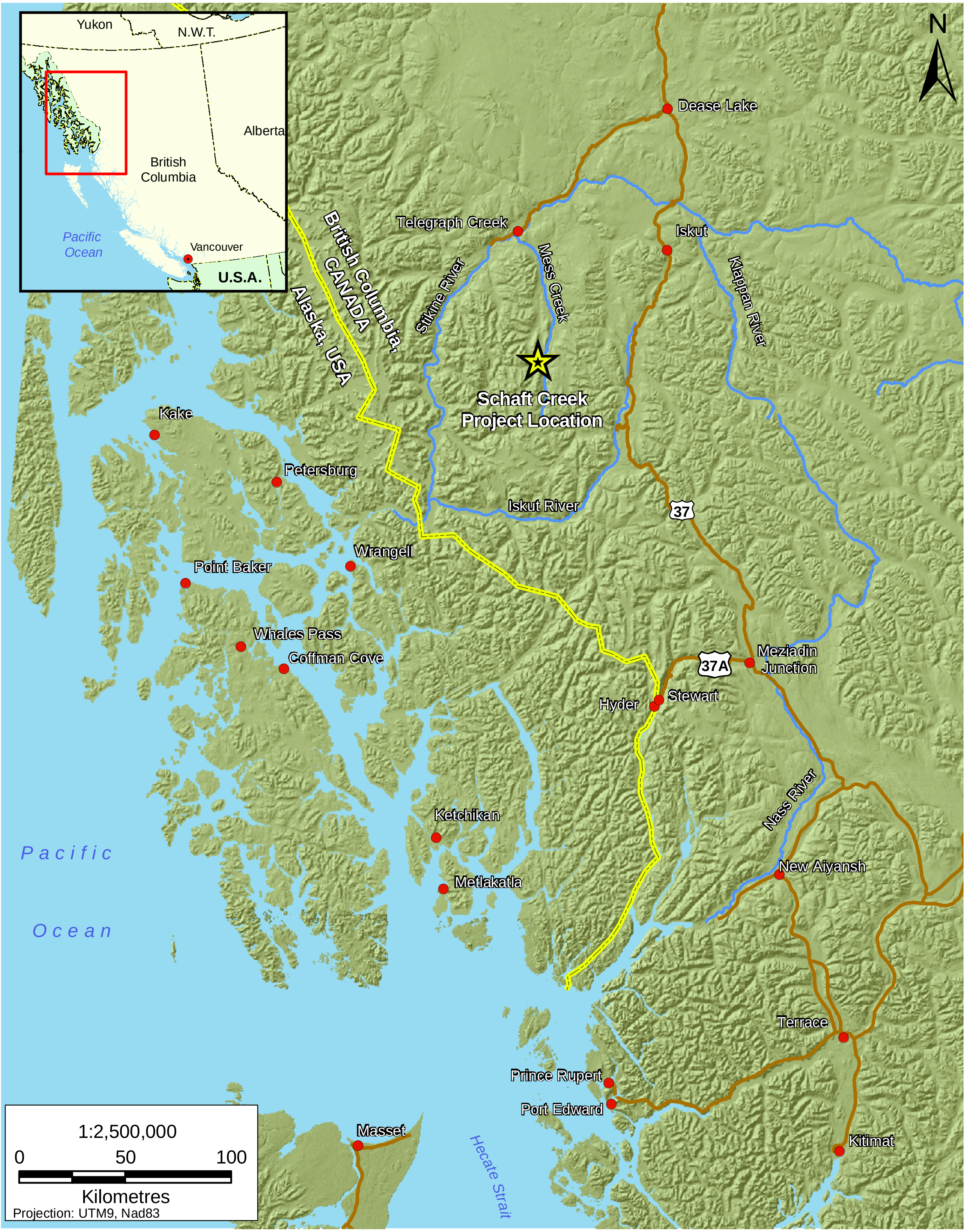
The western toad, like many amphibians, is subject to the introduced pathogen chytrid fungus (*Batrachochytrium dendrobatidis*). This fungus was likely introduced to North America with international trade in laboratory specimens of the African clawed frog (*Xenopus tropicalis*) in the 1930s (Weldon *et al.*, 2004). It has since spread across some continents and has caused many amphibian population declines and local extinctions in Canada, the United States, Australia and South America. Chytrid fungus has been identified as the proximate cause of the dramatic western toad decline in the southern Rocky Mountains (Lannoo, 2005), and may be implicated in population declines in southern British Columbia and the Alaskan panhandle (Govindarajulu, 2006; Pyare, 2006). Currently, the vector for chytrid transmission to new areas is unknown, although transmission by anglers and other people using wetlands is one possibility. This study investigates whether chytrid fungus is present in the Schaft Creek area and presents mitigation options for limiting the introduction and spread of this disease.

Unlike many other amphibians, toads migrate over relatively long distances each spring from their winter terrestrial hibernation sites to aquatic breeding sites, and then to forested feeding sites during the summer. Migrations are typically conducted over several days and a significant proportion of a local population can cross roads near breeding sites within a few hours of each other.

In order to minimize the potential effects of access road construction on western toad migration routes, a study was conducted during the summer of 2007 to identify current and potential toad breeding sites. These results were used to identify potential sites for amphibian underpasses, to facilitate safe movement of toads and maintain habitat connectivity.

1.1 Schaft Creek Project Summary

Copper Fox Metals Inc. (Copper Fox) is a Canadian mineral exploration and development company focused on developing the Schaft Creek deposit located in north-western British Columbia, approximately 60 km south of the village of Telegraph Creek Creek (Figure 1.1-1). The Schaft Creek deposit is a polymetallic (copper-gold-silver-molybdenum) deposit located in the Liard District of north-western British Columbia (Latitude 57^{o} 22’ 4.2’’; Longitude 130^{o}, 58’ 48.9”). The property is comprised of 40 mineral claims covering an area totalling approximately 20,932 ha within the Cassiar Iskut-Stikine Land and Resource Management Plan (Figure 1.1-2).



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Location Map for Schaft Creek Project

FIGURE 1.1-1

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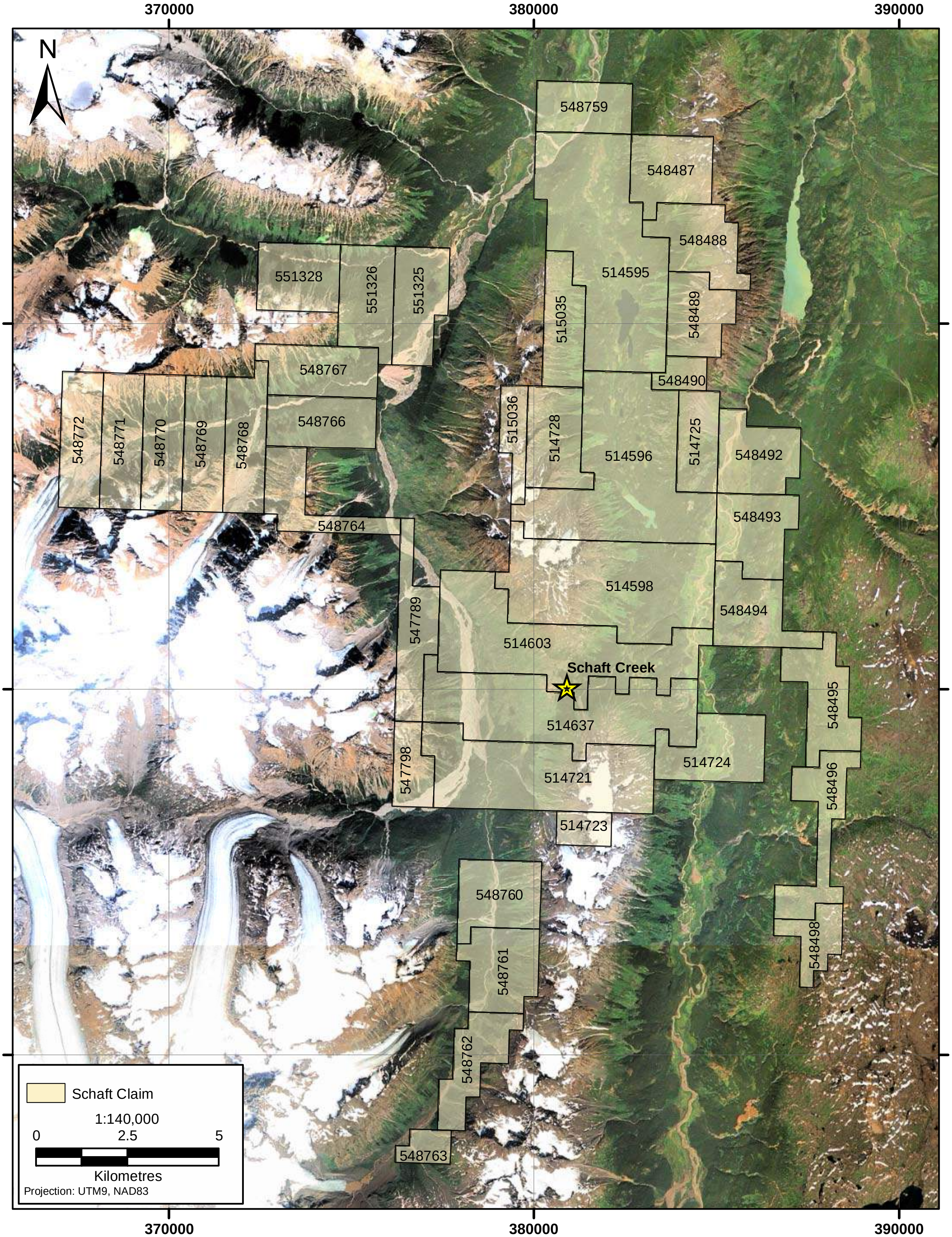

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Schaft Creek Project Mineral Claims

FIGURE 1.1-2

RTEC Rescan

The Schaft Creek Project is located within the traditional territory of the Tahltan Nation. Copper Fox has been in discussions with the Tahltan Central Council (TCC) and the Tahltan Heritage Resources Environmental Assessment Team (THREAT) since initiating exploration activities in 2005. Copper Fox has engaged in numerous agreements with the TCC including a Communications Agreement, Traditional Knowledge Agreement, Letter of Understanding with the Tahltan Nation Development Corporation (TNDC) and a THREAT Agreement. Copper Fox will continue to work together with the Tahltan Nation as work on the Schaft Creek Project continues.

The Schaft Creek deposit was discovered in 1957 and has since been investigated by prospecting, geological mapping, geophysical surveys as well as diamond and percussion drilling. Over 65,000 meters of drilling has been completed on the property as of end of 2007. Additional drilling is planned for 2008 to support future economic assessments of the property and an environmental assessment application.

The Schaft Creek Project entered the British Columbia environmental assessment process in August 2006. Although a formal federal decision has not yet been made, the Project will likely require federal approval as per the Canadian Environmental Assessment Act. Copper Fox has targeted the end of 2008 for submission of their Schaft Creek Environmental Assessment Application.

Copper Fox has recently released a scoping level engineering and economic report for Schaft Creek. The mine and associated infrastructure are presented in Figure 1.1-3. The current mine plan has ore milled from an open pit at a rate of 65,000 tonnes/day. The Schaft deposit will be mined with large truck/shovel operations and typical drill and blast techniques. An explosives manufacturing facility will be constructed on-site to support blasting activities. The mine plan includes 719 million tonnes of minable ore over a 31 year mine life. The Project is estimated to generate up to 1,200 jobs during the construction phase of the project and approximately 500 permanent jobs during the life of the mine.

Ore will be crushed, milled and filtered on-site to produce copper and molybdenum concentrates. The mill will include a typical comminution circuit (Semi-Autogenous Mill, Ball Mill and Pebble Crusher) followed by a flotation circuit and a copper circuit with thickener, filtration and concentrate loadout and shipping. The mill includes a designated molybdenum circuit with thickener, filtration circuit, drying and bagging. The filter plant will be located at the plant site. A tailings thickener and water reclaim system will be used to recycle process water. The circuit will have a design capacity of 70,652 tonnes per day and a nominal capacity of 65,000 tonnes per day (23,400,000 tonnes per year). The copper and molybdenum concentrates will be shipped via truck from the mill to the port of Stewart, BC.

Copper Fox will construct an access road from Highway 37 to the Schaft Creek property. Access to the property from Highway 37 will require approximately 105 km of new road. The first 65 km of the access road to the Schaft Creek property corresponds to the Galore Creek access road. NovaGold and Teck Cominco have currently put a hold on future construction efforts along their access road and the overall Galore Creek Project. Copper Fox will seek approval from the provincial government and NovaGold/Teck Cominco to construct the first 65 km of the Galore Creek access road should the status of the project not change.

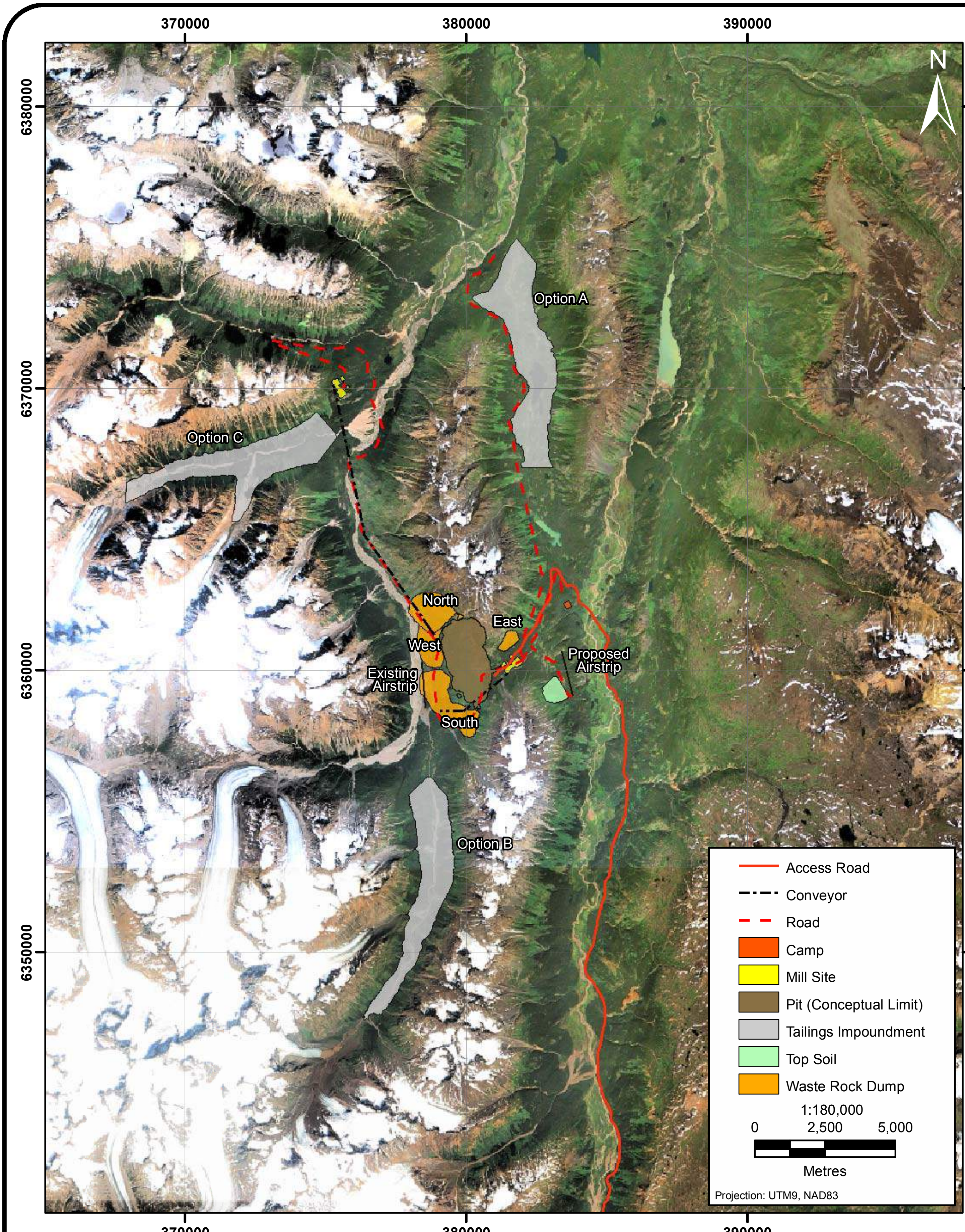

FIGURE 1.1-3

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Schaft Creek Project Mine and Associated Infrastructure

RTEC Rescan

The route of the final 40 km of access road has not been finalized. Copper Fox has completed initial investigations of a route along Mess Creek. An alternative route is also being considered that utilizes the plateau to the east of Mess Creek. Copper Fox is currently investigating the feasibility, as it relates to geohazards, of the two alignments. Both alignments include a 30 m bridge on Mess Creek. Mess Creek is considered navigable as per Transportation Canada criteria. Figure 1.1-4 presents the access road alignment that follows the Galore Creek road (65 km from Highway 37) and the Mess Creek alignment (40 km) to the Schaft Creek property.

Over the life of the mine, the Schaft Creek Project will generate over 700 million tonnes of tailings. There are three tailings facilities being considered (Figure 1.1-3). The three options will undergo an alternatives assessment that will include engineering, construction and operating costs, geotechnical, geohazards, environmental and social considerations.

The Project will generate over a billion tonnes of waste rock. Waste rock dumps are proposed around the perimeter of the pit (Figure 1.1-3). This includes the flat area between the proposed pit and Schaft Creek.

A detailed water management plan has yet to be developed for the Project. A water management plan will be included in the next level of economic assessment (pre-feasibility) and the next project description update. A waste water discharge is expected from the tailings facility, waste rock dumps and domestic waste water treatment plant. The management plan will detail the plans to minimize natural drainage into the tailings facility, the pit and the waste rock dumps. Pit water will be pumped to the tailings facility.

A new airfield will be constructed to the east of the pit (Figure 1.1-3). The Project will be a fly-in, fly-out operation. The new landing strip will be capable of handling a Boeing 737. Other facilities include a terminal building, fuelling, maintenance and control facilities.

A permanent camp will be constructed to support a staff of approximately 500 employees. Other facilities include truck shop, warehouse, administration, maintenance laboratory, explosives storage, water treatment facilities and potable water storage.

Copper Fox has targeted the end of 2008 for submission of their Environmental Assessment Application and full Feasibility Report. Screening of the EA Application plus the 180 day review period will result in project approval as early as July 2009. Copper Fox will likely seek concurrent permitting for strategic permits to facilitate the timely construction of key project components. Construction is estimated to take two and half years. Thus, production could begin by early 2012.

1.2 Project Objectives

Effectively managing the effects of the Project on western toad populations within the study area requires locating breeding sites and potential migration routes, installing safe wildlife passages underneath the access road to increase habitat connectivity, monitoring the use of these tunnels, and monitoring the prevalence of potential pathogens in the ecosystems. Specifically, the objectives of this report are to:

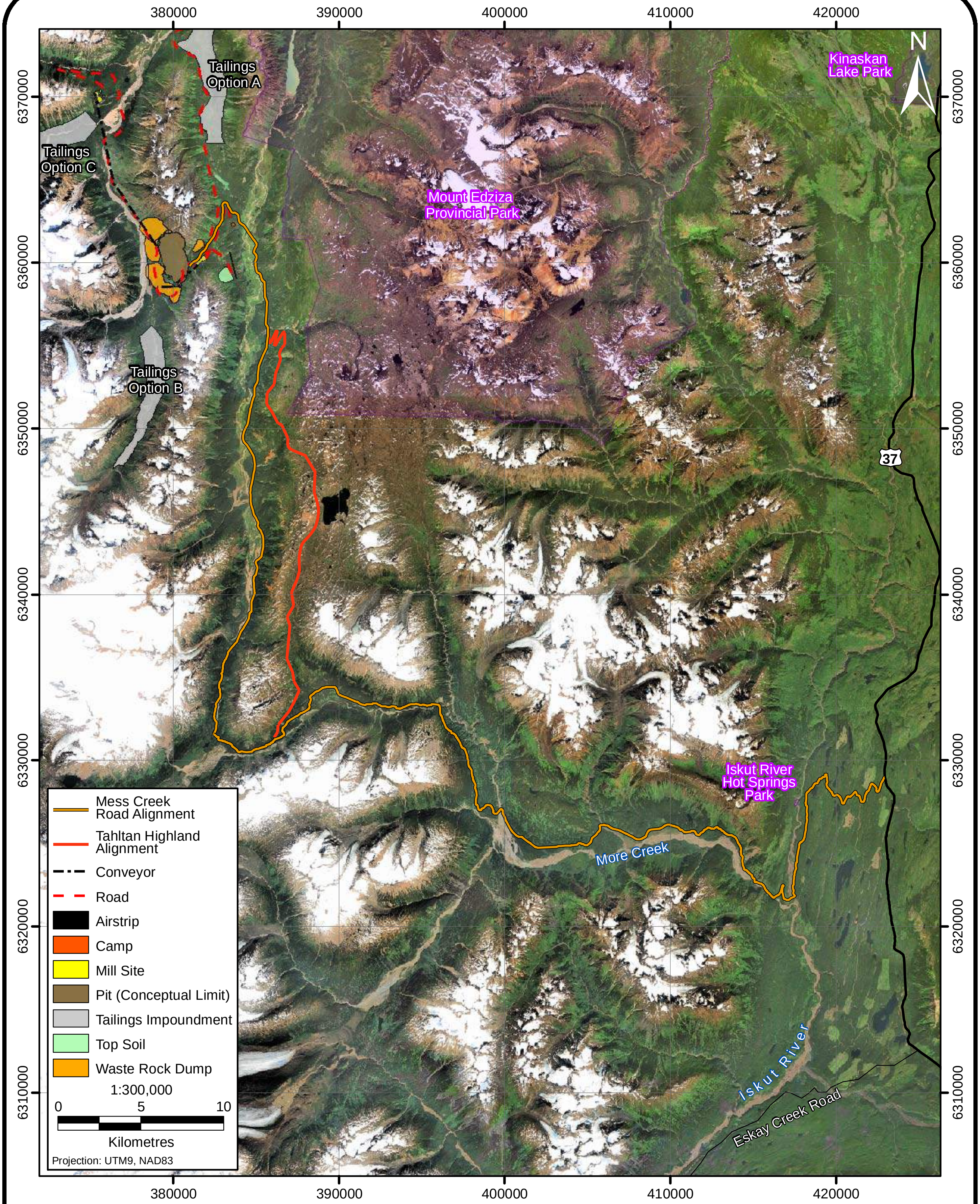

FIGURE 1.1-4

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Proposed Access Road Alignment for the Schaft Creek Project

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- identify ponds along the proposed road route, mine site, and tailings impoundments that are being used by western toad for breeding;
- suggest locations of ponds with similar characteristics which may be breeding sites in alternate years;
- recommend locations for toad tunnels and discuss appropriate features of construction design; and
- recommend appropriate monitoring techniques for future years.

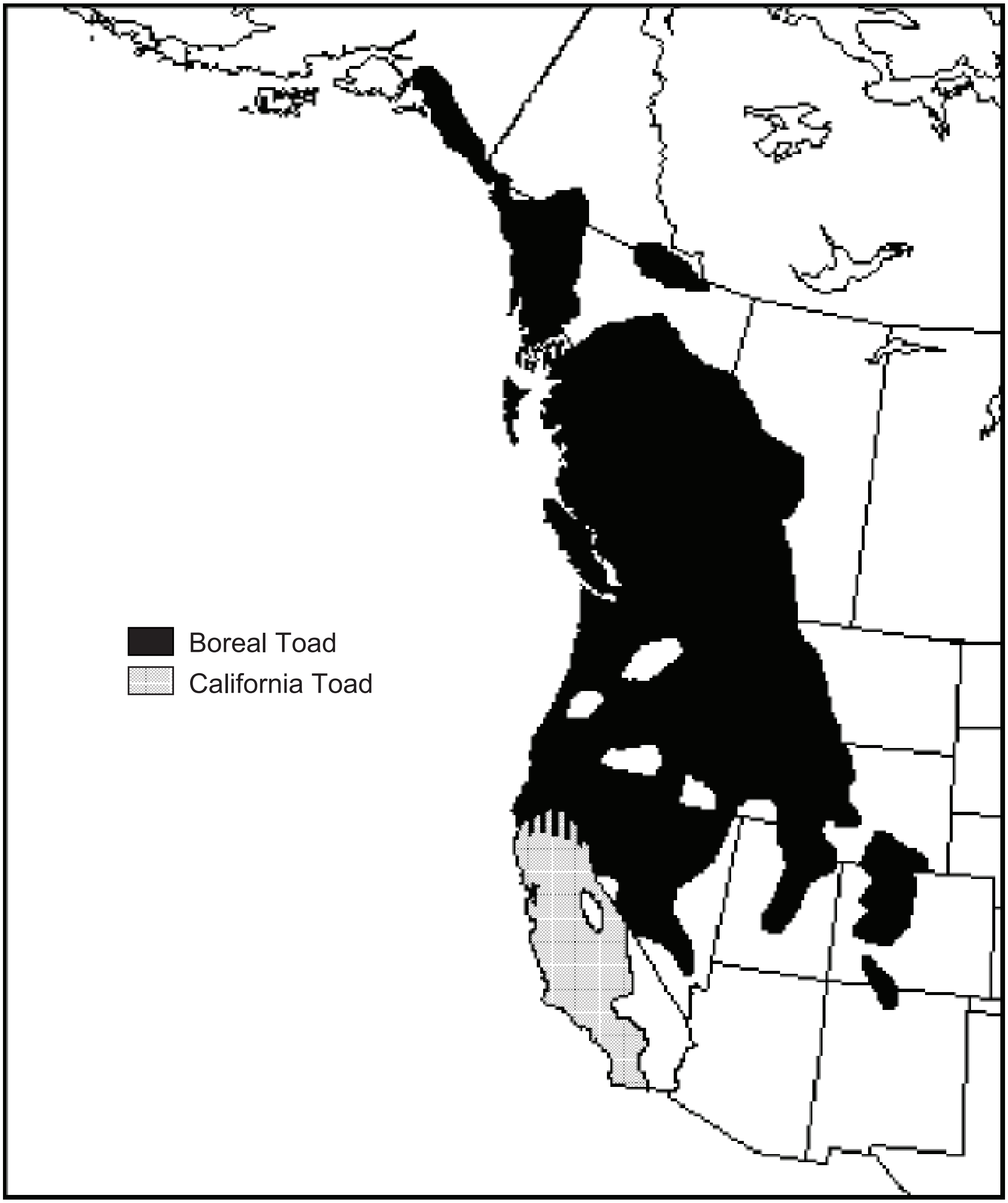
1.3 Description and Ecology of Western Toad

1.3.1 Distribution and Identification

Historically, western toads occurred throughout much of western North America (Lannoo, 2005). Their distribution has always been patchy and currently populations are widespread at low densities from central Alberta west to the Queen Charlotte Islands, and from the Yukon and southern Alaska to Wyoming and Colorado (Figure 1.3-1). Western toads are one of the few amphibian species to occupy alpine areas, found from sea level up to 3660 m (Wind and Dupuis, 2002). The extent of their current distribution in British Columbia is unknown, but the central and northern part of the province likely represent a stronghold for the species (Davis, 2002). There are two known subspecies of the western toad, the California toad (*Bufo boreas halophilus*) and the boreal toad (*B.b. boreas*). *B.b. boreas* is the subspecies found in the Schaft Creek area. The western toad can be identified by its dry, bumpy skin, lack of cranial crests, large, oval-shaped parotoid glands, horizontal pupils, and a cream-coloured or white dorsal stripe. There is a great deal of phenotypic plasticity, with individuals ranging in colour from olive-green, reddish-brown, to almost black (Plate 1.3-1). Males are 60-110 mm long while females are larger, up to 125 mm (Stebbins, 2003). Unlike other toads, males lack a vocal sack and do not signal breeding with a loud call. However, males will make a soft release call (a chirp) when grasped. Females are always silent.

1.3.2 Life history

Western toads require a variety of terrestrial and aquatic habitats to complete different stages of their life cycle: spring breeding, summer foraging, and winter hibernation. Toads are capable of moving over 5 km to breeding sites and occasional long distance excursions of up to 7.2 km have been noted (Davis, 2002). Male toads tend to have higher site fidelity than females, often staying within 300 m of breeding sites, whereas females may travel up to 2.5-4 km away (Loeffler, 2001). Males arrive at breeding sites before females and generally outnumber females at a ratio of 20:1 (AmphibiaWeb, 2006). Males sexually mature at 3-4 years of age and return to breeding sites annually. Females sexually mature at 5-6 years of age and may only breed every 2-3 years.



Source: COSEWIC (2002)

Note: Schematic indicates the range of the two subspecies, the Boreal toad (*B. b. boreas*) and the California toad (*B. b. halophilus*).

FIGURE 1.3-1

North American Distribution of the Western Toad

Plate 1.3-1. Western toads displaying some of the many phenotypes in this species. (Photo source A. Jacob)

The onset of breeding is thought to be linked to the timing of snow pack melt (Pyare, 2005) and the average daily minimum and maximum temperatures (Gyug, 1996). Western toads are explosive breeders, congregating in large numbers along the shallow margins of lentic or slow-moving aquatic breeding sites for a 1-2 week period. Males will clasp females in a breeding 'embrace' known as amplexus. The female winds a string of eggs around submerged vegetation in shallow water, often in locations that receive the most available sunlight (Plate 1.3-2; Davis, 2002). Up to 16,000 eggs can be laid by a female in a single breeding season which are then fertilized externally by the male (Davis, 2002; Davis and Gregory, 2003). Breeding habitat requires open water deep enough to prevent drying out prior to metamorphosis, but with sufficient shallow areas (<0.5 m) to support egg-laying. Breeding can take place in temporary ponds, including large puddles, roadside ditches, and irrigation ponds. However, ephemeral water bodies usually lack thermal and predatory cover for developing larvae and these habitats often function as "ecological sinks" in that they may dry up prior to tadpoles metamorphosing and cause subsequent tadpole mortality (Stevens *et al.*, 2006).

Plate 1.3-2. Western toad eggs, metamorphosing tadpoles, newly metamorphosed toadlet, and post-metamorphic toadlet aggregation.

Eggs develop into tadpoles which metamorphose into juvenile toads ('toadlets') in 2-3 months, depending on water temperature. Tadpoles are highly gregarious, forming large, slow-moving schools in shallow, warmer waters. They are mainly herbivorous, feeding upon filamentous algae and detritus. Toadlets also aggregate in large numbers and communally bask and feed at the water margin, a characteristic feature of western toads. Toadlets disperse to forested areas but do not appear to move more than 200-300 m from their natal site within the first year (Pyare, 2006). Adult toads disperse further into upland aquatic and terrestrial habitats, including forested areas, wet shrub lands, avalanche slopes, and subalpine meadows to forage for the summer months. Although terrestrial habitats are used up to 90% of the time (Davis, 2002), toads require frequent access to moist microsites to maintain internal water balance (AmphibiaWeb, 2006). Toads are thought to prey upon small invertebrates including crayfish, earthworms, slugs, spiders, ants and other arthropods (Lannoo, 2005).

Hibernation is usually terrestrial and may occur in communal hibernacula (Browne, 2006). During extreme temperatures (below 3°C and above 30°C) and at the onset of winter, western toads seek temporary refugia and hibernacula in rock-lined chambers near creeks, in abandoned small mammal burrows, in and under root systems of evergreen trees, and possibly in beaver dams (AmphibiaWeb, 2006). Hibernacula must be deep enough to prevent freezing and moist enough to prevent desiccation, often up to 1.3 m underground (Wind and Dupuis, 2002). Hibernation lasts 3-6 months, depending on elevation and latitude. Toadlets generally hibernate near their natal pond (Hammerson *et al.*, 2004; Pyare, 2006) and because of their small size can use small cracks in the substrate (A. Jacob, p*ersonal observation*) and other very tiny refugia. Toads are not freeze tolerant (AmphibiaWeb, 2006).

Mortality until the third year of life is estimated to be as high as 95-99%, due to dessication, ultraviolet radiation and predation (Keinath and Bennett, 2000). In areas infected with chytrid fungus, mortality may be as high as 100%. There is abundant evidence of drastic population declines and local extirpations of western toads throughout much of its southern range (Muths *et al.*, 2003). A smaller body of scientific studies, anecdotal evidence and traditional ecological knowledge point to similar trends in Alberta (Stevens *et al.*, 2006), southern British Columbia (Davis and Gregory, 2003) and southern Alaska (Pyare, 2006).

1.4 Threats to Western Toads

Globally, amphibian ranges and populations have been declining since the 1980s for variety of reasons (Davis, 2002; Wind and Dupuis, 2002; Lesbarrères *et al.*, 2004). The particular set of ecological characteristics of western toads makes them more vulnerable to threats than other amphibians. These characteristics include seasonal aggregations, metapopulation dynamics, fluctuations in breeding success, high turnover rates, migratory behaviour, physiological specialization, dependence on ephemeral pond habitats and toxicological sensivitity (Pyare, 2005).

Serious declines of western toads have been documented in relatively undisturbed areas of Oregon, Washington and Alaska. In British Columbia, declines are occurring on Vancouver Island and the southern mainland (Davis and Gregory, 2003). This section describes the anthropogenic and natural causes of toad mortality and likely causes for toad population decline.

1.4.1 Anthropogenic Effects

Human activities are likely responsible for most of the declines (Hels and Buchwald, 2001). Anthropogenic threats to western toads include habitat destruction, degradation and fragmentation (Hammerson, 1999), alteration of water tables, timber harvest, acid and mineral pollution from mine water drainage (Porter and Hakanson, 1976), introduction of invasive species (*e.g.*, bullfrogs) and road-related mortality (Davis, 2002; AmphibiaWeb, 2006).

Habitat fragmentation from road construction and the presence of vehicle traffic are the most significant anthropogenic threats to western toads within the study area. Roads create a significant barrier to movement (Carr and Fahrig, 2001) and even low traffic roads can cause considerable mortality, particularly during the breeding migration, resulting in population-level declines (Lesbarrères *et al.*, 2004).

On a landscape scale, western toads likely exist as a metapopulation – a group of small, linked populations – which are more susceptible to the effects of linear barriers. These low-density populations are characterized by repeated small-scale extirpations and immigration of new animals. With linear barriers and reduced immigration, areas are not re-colonized and population-level declines can occur over relatively large areas.

Roads may also become a population sink for the breeding efforts of toads. Water-filled ditches and wheel ruts warm up early in the spring and attract toads for breeding (Wind and Dupuis, 2002), but are normally unsuccessful because ditches and ruts dry out too early, are too warm and lack cover from predators (Stevens *et al.*, 2006). Toadlets can also become trapped in ditches and ruts deeper than 20 cm (A. Jacob, *personal observation*).

1.4.2 Predation Effects

Despite anti-predator defence mechanisms - a mild toxin released from the parotoid gland - a variety of avian, herpetile and mammalian fauna are predators of western toads. Persistent predation by ravens on adult toads during the breeding season appears to have contributed significantly to some population declines in Oregon (Keinath and Bennett, 2000). Columbia spotted frogs, a sympatric species within the study area, have been seen eating newly metamorphosed toadlets (BC Frogwatch, 2006). Various birds, animals and predaceous insects prey on other *Bufo* species, including ducks, corvids, raptors and passerine birds, bullfrogs, snakes, raccoons, skunks and foxes (Davis, 2002). Fish, including trout are reported to be tadpole predators (Davis, 2002). Any alteration in predator numbers due to habitat disturbance or from fish stocking may have an adverse effect on western toad populations.

1.4.3 Disease Effects

Disease, including the fungi *Saprolegnia ferax* associated with fish stocking and the highly infectious chytrid fungus *Batrachochytrium dendrobatidis*, has been implicated in amphibian declines. Chytrid fungus has caused the complete eradication of certain amphibian populations in the United States, Central and South America and Australia (Berger *et al.*, 1998), including western toads (Muths *et al.*, 2003; Scholl, 2005). Amphibians infected with chytrid fungus have been found in southern British Columbia, where populations are rapidly declining (Govindarajulu, 2006). Surveys conducted in the Alaskan panhandle in 2006 determined that chytrid fungus was present in 25% of survey sites (Pyare, 2006).

The chytrid fungus attacks the protein keratin in the skin of adult amphibians, causing skin thickening and interfering with water absorption, movement, and ion balance within the blood. It causes 90-100% mortality in some amphibian species, usually within 30 days of infection. Unlike many other fungal infections, chytrid fungus can live outside a host and remain dormant in the aquatic environment for a period of years. Toads may contract the fungus directly through contact with infected individuals (either during breeding congregations or through improper handling techniques) or indirectly with infected water bodies.

Research indicates that chytrid fungus may only be the proximal cause of amphibian decline. Anthropogenic effects, such as habitat degradation and fragmentation, likely stresses animals and reduces their immune responses, making them more susceptible to this pathogen (Carey, 1993).

1.5 Legal Status of Western Toad

The western toad is listed as a species of special concern on Schedule 1 of the Canadian Species at Risk Act (SARA), on the basis of rapid population declines in southern parts of the species range and the species' vulnerability to habitat deterioration (COSEWIC, 2002). It requires monitoring under section 79(2) of SARA. It is the only globally red-listed amphibian in Canada (Hammerson *et al.*, 2004). The IUCN listing is 'EN A1ce', meaning that it is considered endangered with a high risk of extinction in the wild, due to population reductions of 50% in the last 10 years as a result of declines in area or occupancy (COSEWIC, 2002). The western toad is yellow-listed 'secure but with conservation concern' within BC (BC Conservation Data Centre, 2006), and protected under the British Columbia Wildlife Act (1982).

The legal and conservation status of the western toad in Canada and the United States are listed in Table 1.5-1 below.

Table 1.5-1
Legal and Conservation Status of Western toad

Location	Natural Heritage Program Status[a]	Additional Status
Global	G4	IUCN Red List (EN A1ce)
Canada	N4	SARA Schedule 1 Special Concern
British Columbia	S4	Yellow list
Alberta	S4	Green list
Yukon	SNR	
United States	N4	
Alaska	S2	Non-game Wildlife
California	S5	
Colorado	S1	Endangered, USFS[b] Sensitive
Idaho	S4	USFWS[c] Species of Concern, USFS Sensitive
Montana	S2	Non-game Wildlife
Nevada	S4	
New Mexico	SH	Endangered, USFS Sensitive
Oregon	S3	Sensitive/Vulnerable
Utah	S2S3	Special Concern
Washington	S3S4	USFWS Species of Concern
Wyoming	S1	USFS Sensitive

[a] G = Global rank for species, S = State rank for species; NR = not reported, H = historical (possibly extirpated), 1 = critically imperiled, 2 = imperiled, 3 = rare, threatened or uncommon, 4 = not rare, apparently secure, 5 = widespread, abundant and secure (NatureServe, 2006). [b] United States Forest Service. [c] United States Fish and Wildlife Service.

2. METHODS

2. Methods

2.1 Study Area

The study area is located in north western British Columbia, approximately 1,050 km north of Vancouver and 150 km northeast of Wrangell, Alaska (Figure 2.1-1). The study focused on the proposed access road corridor from the proposed Galore Creek Road to the Schaft Creek Project Site, and the associated infrastructure at this site – tailings impoundments, airstrip, camp, *etc*. (Figure 2.1-1).

The area includes part of the watersheds of the Schaft and Mess creeks. It is transitional between coastal and interior influences. The sub-boreal interior and northern boreal mountains ecoprovinces are represented in the study area (Luttermerding *et al*., 1990). Two biogeoclimatic ecosystem classification (BEC) zones are represented, both within the Engelmann spruce subalpine fir (ESSF) zones: Engelmann Spruce - Subalpine Fir, Moist Cold (ESSFmc) and Engelmann Spruce - Subalpine Fir, Moist Cold Parkland (ESSFmcp)

The study area contained all of the five wetland types identified in Canadian Wetland Classification System (National Wetlands Working Group, 1997). Fens accounted for the majority of wetland type (53%), followed by bogs (15%), marshes (14%), shallow open water (9%), swamps (1%) and other (8%) (Table 2.3-1; Rescan, 2008).

Table 2.1-1
Schaft Creek Wetland Types

Wetland Class	Number	Percent
Fen	49	53
Bog	14	15
Marsh	13	14
Shallow Open Water	8	9
Other	7	8
Swamp	1	1
Total	**92**	

2.2 Previous Amphibian Studies in the Schaft Creek Area

No formal field surveys were conducted for herpetofauna within the study area before the summer of 2007. Amphibians were recorded as incidental wildlife observations during other field studies undertaken in summer 2005, 2006 and 2007 (Figure 2.2-1). Field studies included terrestrial ecosystem mapping (TEM), fisheries field studies, small mammal inventory, wetlands assessment and avian field studies. These investigations confirmed the presence of three amphibians in the study area: western toad (*Bufo boreas boreas*), Columbia spotted frog (*Rana luteiventris*) and long-toed salamander (*Ambystoma macrodactylum*).

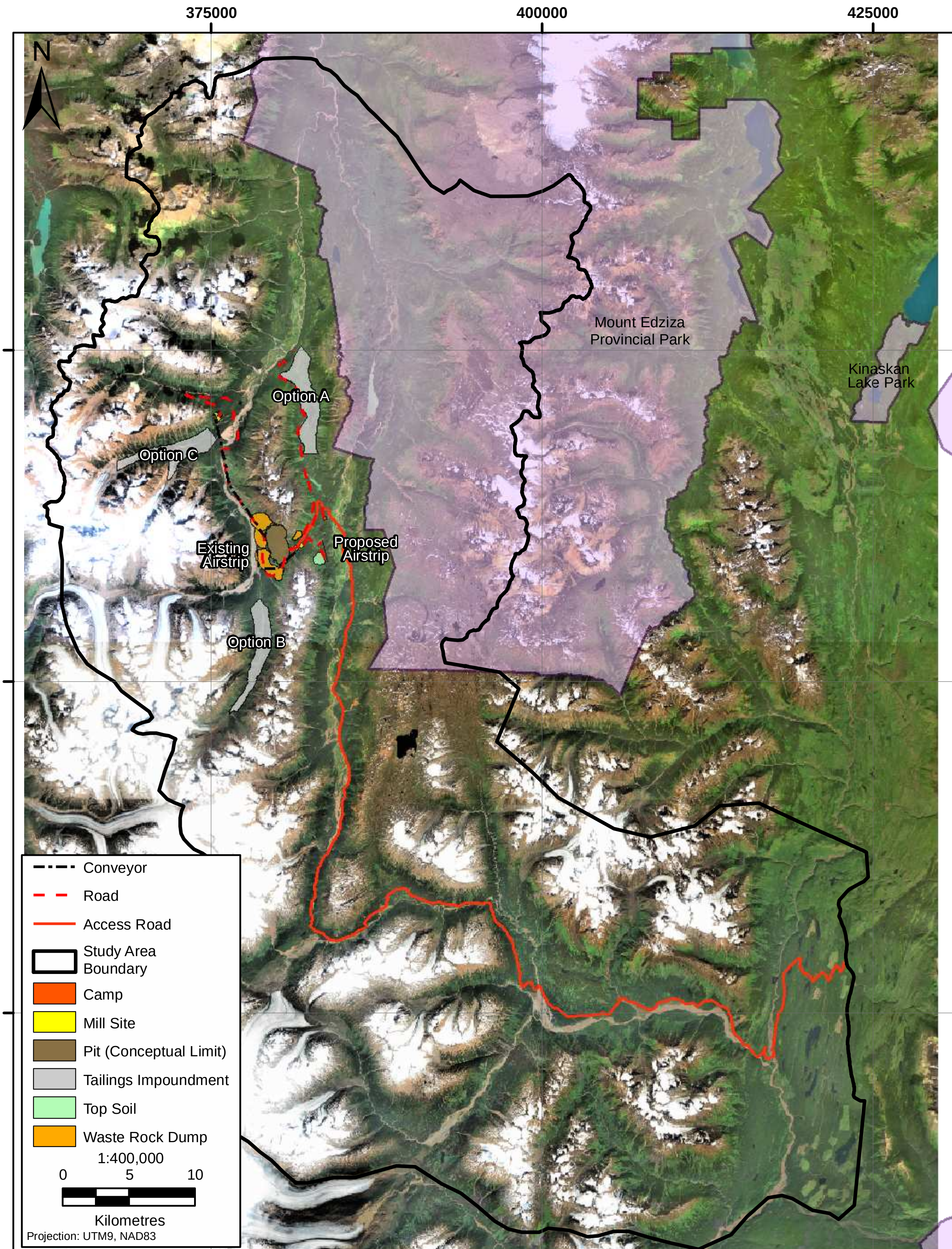


FIGURE 2.1-1

Schaft Amphibian Study Area, 2007

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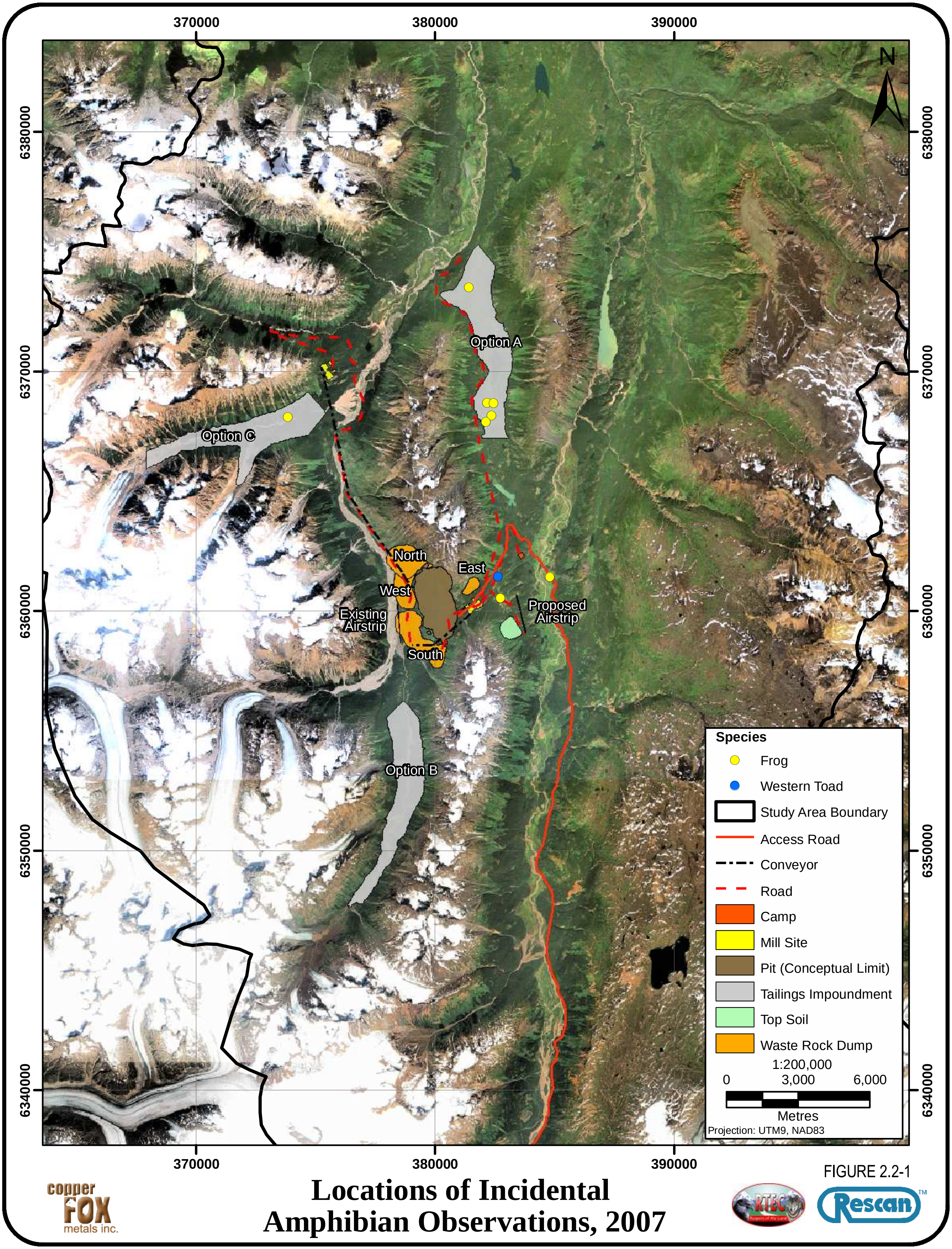

FIGURE 2.2-1

Locations of Incidental Amphibian Observations, 2007

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2.3 Survey Methodology

In order to identify potential breeding sites along the access road, potential breeding ponds were identified from aerial photographs and during an aerial survey on August 6, 2007. Potential breeding ponds were any water bodies in the study area with limited tree canopy, relatively shallow water, and a low level of water flow through the site (Pyare *et al*., 2005).

Wetlands and ponds were surveyed from August 7 to August 13, 2007. Sites were visited by helicopter, photographed, geo-referenced with GPS and searched for western toad breeding and adult occupancy. Incidental observations of Columbia spotted frog breeding, adults and long toed salamander were also recorded. Wetlands were classified according to provincial wetland indices for hydroperiod and vegetation associations (Section 2.3.1). Biotic and abiotic environmental and habitat characteristics were recorded at each site, including site characteristics that are or may be pertinent to toads (Section 2.3.2).

2.3.1 Wetland Characteristics

Wetlands were assigned to wetland classes based on the Canadian Wetland Classification System (National Wetlands Working Group, 1997) (Table 2.3-1) and other hydrodynamic and vegetative characteristics (MacKenzie and Moran, 2004) (Table 2.3-2). Aerial and ground photographs were taken for each site (Plate 2.3-1).

Table 2.3-1
Canadian Wetland Classification System

Wetland Type	Characteristics
Bog	Dense layer of peat; acidic; low nutrient content; water table at or near the surface; usually covered with mosses, shrubs and sedges; trees possibly present
Fen	Covered with peat; water table at or near the surface; higher nutrient content than bogs; trees and shrubs may be present; similar to bog but supports marshy vegetation (sedges, grasses, rushes)
Swamp	Stagnant or slow-flowing pool; high nutrient content; similar to marsh but characterized by dominance of trees or shrubbery (usually >30% cover)
Marsh	Periodically or permanently flooded; mosaic of emergent vegetation; usually high nutrient content; similar to swamp but <30% cover;
Shallow open water	Transitional between saturated/seasonally wet and aquatic ecosystems (*i.e.* lakes); include basins, pools and ponds, as well as wetlands found beside rivers, coastlines and shorelines; submerged vegetation; floating leaved plants

Table 2.3-2
Hydrodynamic and Vegetative Wetland Characteristics

Hydrodynamic Category*	Organic Matter Accumulation	Bryophytes	Water Regime
Stagnant (1)	Abundant	High	Surface saturation, minimal to no surface flooding
Sluggish (2)	Abundant	Abundant	Semi-permanent soil saturation
Mobile (3)	Abundant (deep)	Patchy cover	Adjacent to open water tracks, ponds, rivulets, or potholes with stable water regimes
Dynamic (4)	Low	Few	Wave-exposed shores or flood-plain back channels
Very dynamic (5)	None	None	Wave exposed shores, or directly adjacent to river flow

*** Numeric ratings correspond to Flow category in Appendix 2**

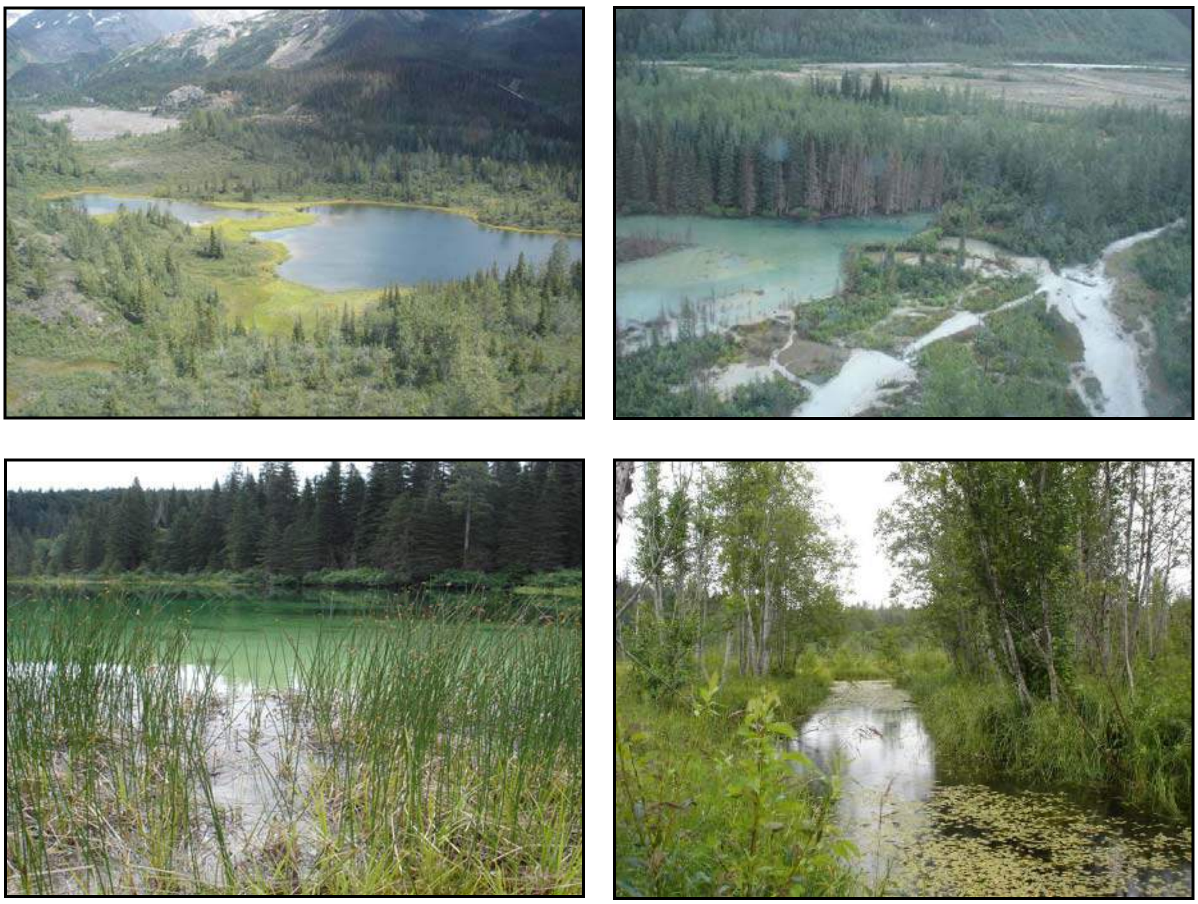

Plate 2.3-1. Wetland types in Schaft Creek study area. Clockwise from top left: small lakes with surrounding fen, shallow open water from river overflow/beaver pond, swamp and marsh.

2.3.2 Amphibian Habitat Assessments

Observers measured 18 qualitative and quantitative biotic and abiotic characteristics at each site (Table 2.3-3).

Table 2.3-3
Abiotic and Biotic Site Characteristics

Characteristic	Description
Site	
Location	UTM coordinates of site
Elevation	M above sea level
Observers	
Clouds	Clear and sunny, partially cloudy, or overcast
Rain	No rain, drizzle, or raining
Air Temperature	Measure air temperature
Water Temperature	Measure water temperature at a depth of 0.2 m, 0.5 m from shore
Size (m X m)	
Water Flow	1=stagnant, 2=sluggish, 3=mobile, 4=dynamic, 5=very dynamic
Water depth (m)	Measure water depth 0.50 m from edge
Substrate depth (m)	Measure substrate depth 0.50 m from edge
pH	Measure pH level
EC (µS)	Measure electrical conductivity level
Tannin	0=clear, 1=slightly stained brown, like weak tea (common in peatlands)
Biotic	
Wetland type	Assigned to one of the five major wetland types: bog, fen, marsh or shallow open water (MacKenzie and Moran, 2004)
Muddy substrate	Presence of a muddy bank or bottom
% Canopy	Estimate of the % of water body edge with canopy cover > 10m high
Canopy type	Forest, shrubs, open, *etc.*
Canopy open?	Wetland without surrounding canopy
Canopy set back?	Wetland with canopy, but canopy set back from pond at least the height of the canopy trees
Canopy dense, dark?	Canopy close to the wetland and casting a shadow on the water
Fish Present?	Yes, no, or unknown
Water Level Variable?	Whether or not the site has a variable water level (*i.e.,* evidence of flooding)
Edge Type	Proportion of water body edge in each type (A-E)
% mud	
% shrubs	
% gravel	
% sphagnum/bog	
% dense sedges/ aquatic veg	
% other	
Bank Slope	Proportion of water body edge with edge gradient, ranked on scale of 1-5
1 – mudflats	
2 – gentle slope	
3 – moderate slope	
4 – steep slope	
5 – drop off	
6 – other	
Vegetation type	Proportion of area (water body edge, aquatic survey area) with vegetation in each type
Emergent	Proportion of edge with emergent vegetation
Floating	Proportion of aquatic survey area with floating vegetation (*i.e.* lilypads, duckweed)
Submerged	Proportion of aquatic survey area with submerged vegetation

2.3.3 Amphibian Presence/Absence

Field methods were adapted from standard amphibian sampling techniques (Crump and Scott, 1994; Leonard *et al.*, 1997) and western toad monitoring programs in southeastern Alaska (Pyare *et al*., 2005). Observers searched shorelines, water bodies and terrestrial habitat adjacent to the pond margin using the Visual Encounter Survey (VES) technique and net sweeps to locate evidence of breeding (*i.e.*, adult breeding congregations, egg masses, tadpoles, emerging toadlets). Observers did not communicate with each other for the duration of the timed survey, and they independently recorded presence/absence data.

Amphibians were identified and classified into two broad life stages: breeding (egg mass, tadpole, metamorph, toadlet and yearling) or adult (>2 years of age). Photographs were taken whenever possible. Amphibians were handled using powder-free latex gloves to minimize the transference of pathogens (*i.e.,* chytrid fungus) and toxins (*i.e.,* insect repellent, hand moisturizers).

2.3.4 Disease Screening

All captured amphibians were screened for evidence of malformations and signs of disease, including:

- abnormal posture;
- abnormal behaviour (*i.e.* lethargy, lack of flee response); and
- abnormal appearance (*i.e.* thickened epidermis, sloughing of skin surface, abnormal mouth parts).

Disease screening techniques followed methodology developed by the Amphibian Research and Monitoring Initiative (Galvan, 2006; Pyare, 2006). Any dead amphibians, and up to 20 live tadpoles (<2% total abundance) were collected, euthanized and fixed with 50% alcohol for disease screening.

All adult toads, frogs and salamanders observed and caught were swabbed with cotton sterile swabs. The swabs dried at room temperature the same day and sent to the Abbotsford Animal Health Centre for chytrid analysis. The results of the disease screening will not be available until the spring or summer of 2008 and will comprise an addendum to this report.

3. RESULTS

3. Results

The following sections provide a general overview of survey results and description of the wetland types where toads and toad breeding were found, as well as identifiying the series of ponds where toad breeding was found and where habitat classification results indicate that toad breeding is likely.

3.1 Overview

Aerial reconnaissance of the Mess Creek road corridor, mine site and tailings impoundments identified a series of ponds for ground surveys (Figure 3.1-1). Ponds were excluded if they had high water flow, lacked a muddy bank, or were completely surrounded by trees – suggesting that water temperature would be too low for toads. Likely breeding sites were those ponds with open canopy, areas of muddy banks, shallow ponds, and ponds with a low rate of water flow (rated #1 hydrodynamic regime). Surveyors visited 49 sites between August 6 and 14, 2007. Amphibian sighting data are summarized in Table 3.1-1 and Figures 3.1-2 and 3.1-3, and listed in full in Appendix 1. Abiotic and biotic characteristics were measured at each site and are listed in Appendices 2 and 3, respectively.

Table 3.1-1
Summary of 2007 Amphibian Distribution

Species	Present in BEC zones (* indicates breeding)	% of Total Observations	Number of breeding sites (elevation range, m)	Number of sites with adults (elevation range, m)
Western toad (*Bufo b. boreas*)	ESSFmc*	6% Adult 10% Breeding	5 (732-783 m)	3 (732-1139 m)
Columbia spotted frog (*Rana luteiventris*)	ESSFmcp*, ESSFmc*	28% Adult 28% Breeding	14 (777-1171 m)	14 (747-1171 m)
Long-toed salamander (*Ambystoma macrodactylum*)	ESSFmcp	4% Adult	---	2 (948-997 m)

3.2 Canadian Wetland Classification of Survey Sites

Of the 49 wetlands surveyed in summer 2007, bogs, fens, and lakes accounted for the majority of wetland types (22% each), followed by shallow open water (18%) and beaver ponds (14%).

The three amphibian species detected in 2007 showed preferences for different habitat types (Table 3.2-1). Western toad breeding was observed at five sites, four of which were shallow open water and one site that was a beaver pond. Western toad adults were observed at four sites, in a fen, bog and shallow open water. Columbia spotted frog breeding was observed at 14 sites, predominantly fens and bogs. Columbia spotted frog adults were the most frequently observed species, observed at 14 sites, mostly fens and bogs. Adult long-toed salamanders were only found at two sites, one fen and one bog.

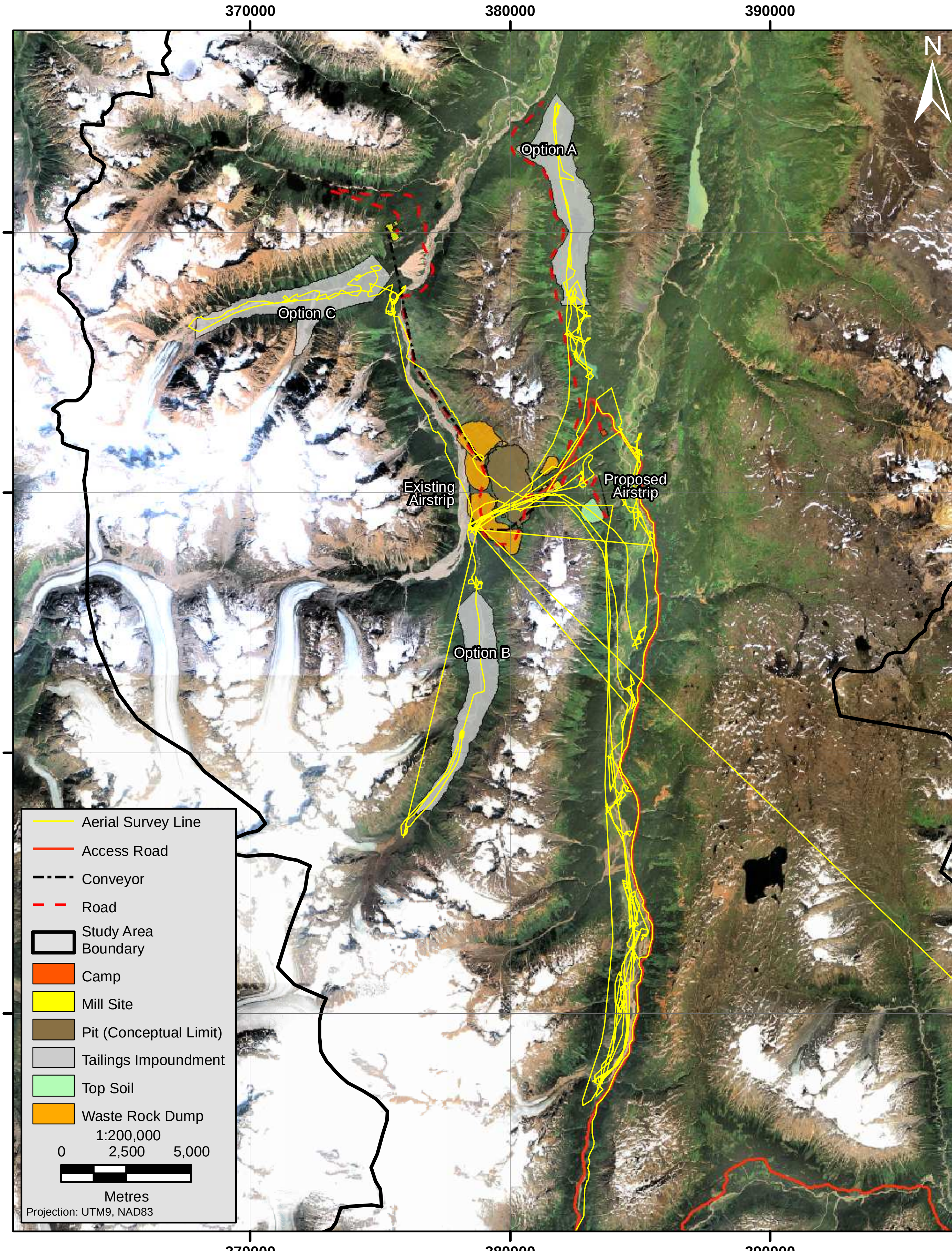

FIGURE 3.1-1

Aerial Survey Route of the Schaft Creek Study Area

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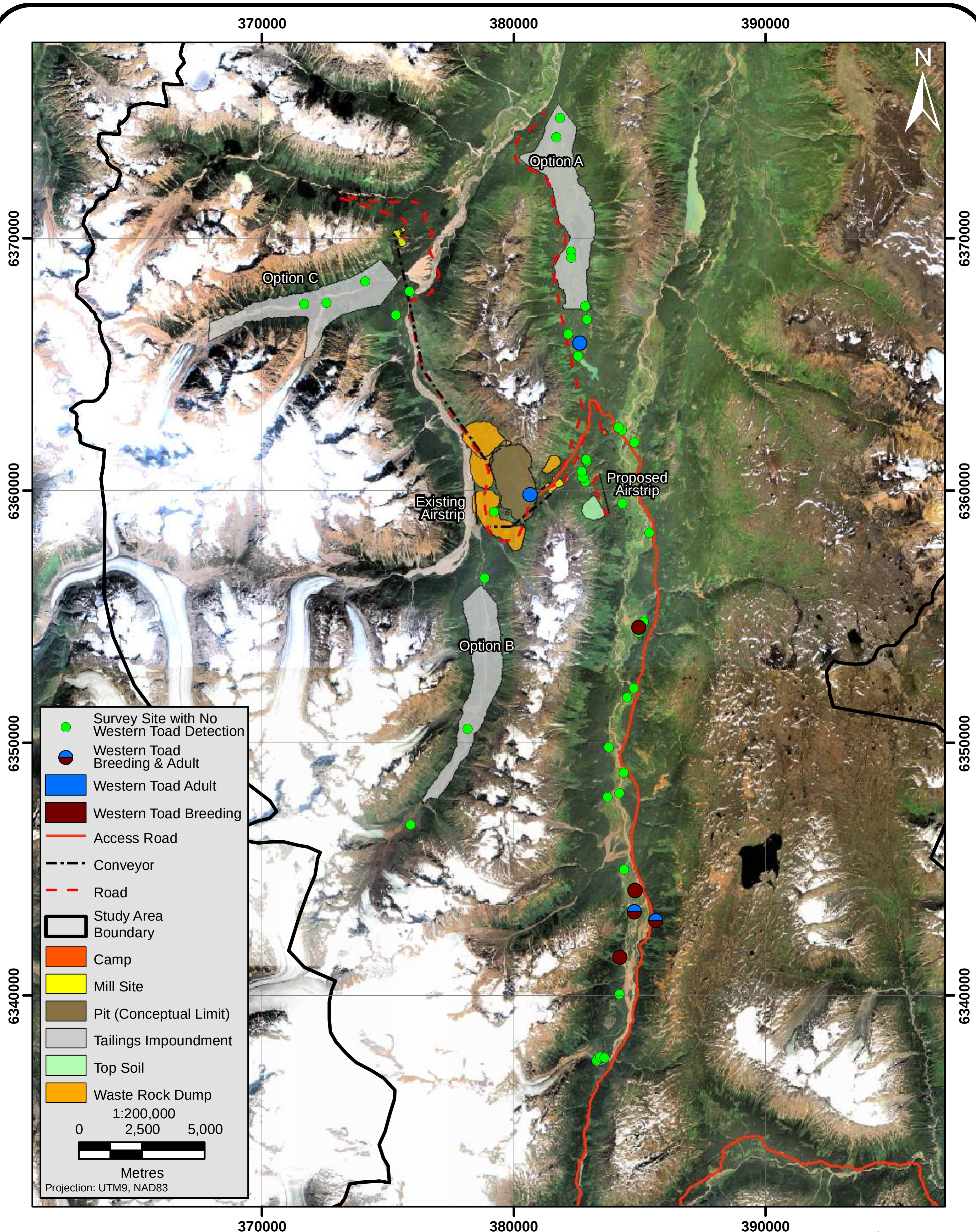

FIGURE 3.1-2

Survey Sightings of Western Toad, 2007

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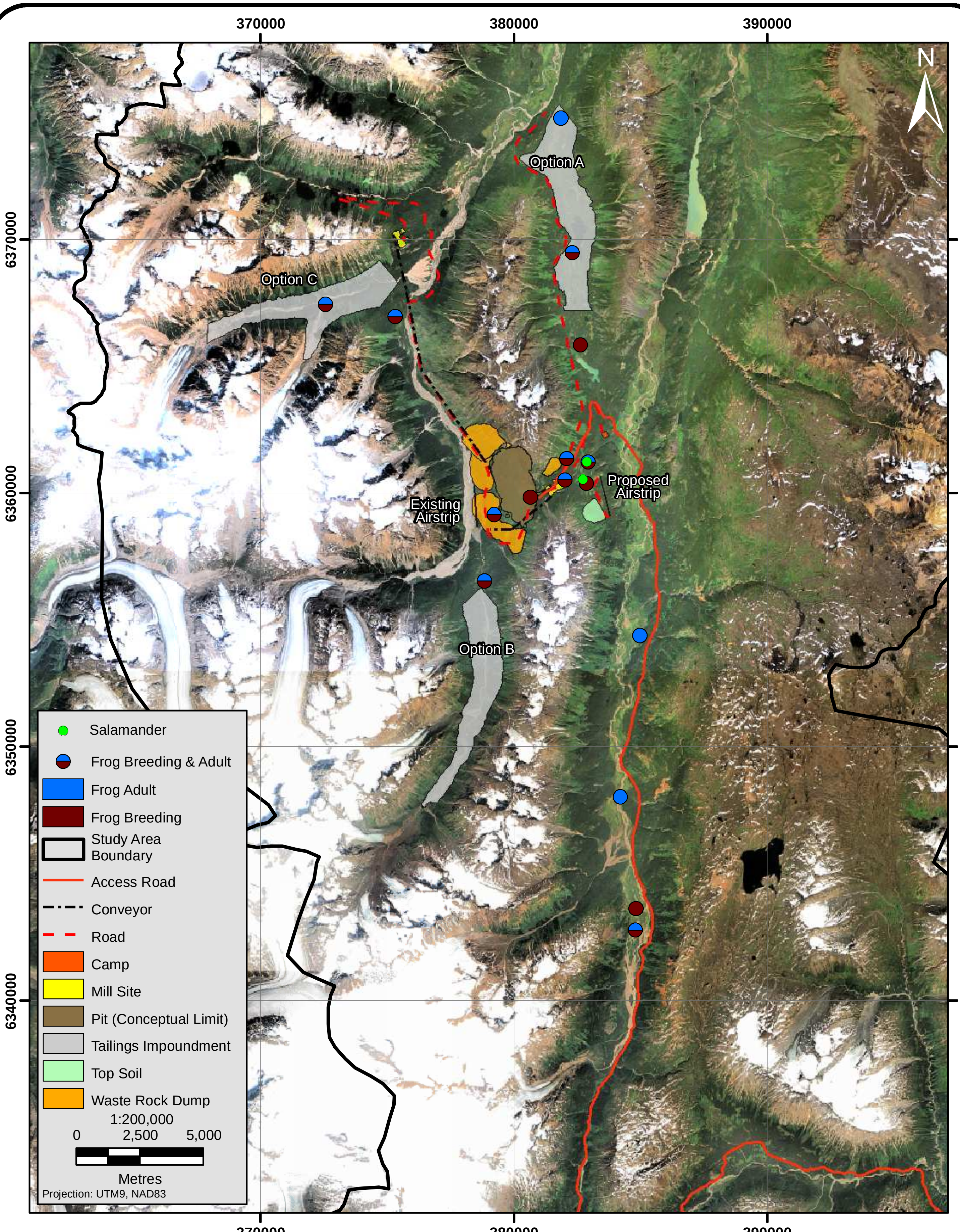

FIGURE 3.1-3

Survey Sightings of Other Amphibians, 2007

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Table 3.2-1
Amphibian Habitat Associations, 2007

Amphibian species	Wetland Type				
	Fen	Bog	Shallow open water	Lake	Beaver Pond
Western toad breeding					
Breeding			4 (8%)		1 (2%)
Adult	1 (2%)	2 (2%)	1 (2%)		
Columbia spotted frog					
Breeding	7 (14%)	5 (10%)	1 (2%)	1 (2%)	
Adult	9 (18%)	3 (6%)		1 (2%)	1 (2%)
Long-toed salamander					
Adult	1 (2%)	1 (2%)			

3.3 Disease Screening

The disease screening samples are currently being processed at the Abbotsford Animal Health Centre. The results of the disease screening will be available in the spring or summer 2008, as an addendum to this report.

3.4 Habitat Characteristics

Previous studies have loosely identified breeding habitat for western toads as shallow, slow-moving water, with emergent vegetation and warm water (Browne, 2006; Pyare, 2006). Table 3.4-1 lists the abiotic and biotic characteristics of surveyed ponds with and without toad breeding.

Results indicate that water temperature, shallow water depth, the presence of a muddy bank and a shallow sloping and muddy bank all increased the likelihood that toad breeding would occur. However, the presence of tannins and a shrubby bank reduced the chance of finding toads breeding at a particular pond.

The most biologically relevant variable to predict toad breeding is likely water temperature. Water temperature is higher in shallow water, areas with a shallow sloping bank, little vegetation and high quantities of mud (in such areas as mudflats that supply large areas of shallow water).

3.5 Actual and Potential Breeding Sites along the Road Alignment

Toad breeding was observed at sites 7, 13, 14, 15 and 22. Adult toads were found at sites 7, 22, 33 and 49. Breeding was not observed at sites 33 and 49. Finding adult toads is a poor indication that ponds are being used for breeding because adult toads can travel long distances during the summer period. Alternatively, breeding sites could potentially be nearby but may have been cryptic and difficult to observe. No breeding sites were found within the three tailings impoundment options.

Table 3.4-1
Habitat Characteristics of Ponds With and Without Western Toad Breeding

Habitat Variable	Sites with Toad Breeding (±SD)		Sites without Toad Breeding (±SD)		p-value
Elevation	2532	(73)	2792	(364)	0.120
Water Temperature	15.6	(0.89)	7.8	(1.7)	0.0003*
Water Depth	12	(4.5)	54	(36)	0.0007*
Substrate Depth	8.8	(12)	18	(15)	0.156
pH	6.2	(.36)	6.3	(0.52)	0.549
Electrical Conductivity	162	(72)	97	(65)	0.095
Tannins	0.4	(0.54)	0.34	(0.48)	0.001*
Hydrodynamic Category	1.2	(0.45)	0.68	(0.95)	0.065
Muddy Bank?	100%		28%		0.0009*
% Canopy	18	(19)	55	(44)	0.075
Edge Type					
% mud	55		11		0.0001*
% shrubs	30		37		0.0002*
% gravel	0		50		0.188
% sphagnum	0		90		0.081
% dense sedges	50		59		0.772
Bank Slope (1-5)	2.3		3.98		0.0036*
% Emergent Vegetation	48	(48)	34	(34)	0.592
% Floating Vegetation	0	(--)	45	(1.2)	0.341
% Submerged Vegetation	12	(21)	1	(2.9)	0.061

*** Statistically significant results using a rejection threshold defined by controlling the False Discovery Rate, using α=0.05 and methods in Benjamini and Hochberg, 1995.**

The primary concern for western toads related to development projects is removing breeding habitat and producing barriers between foraging and hibernating habitat in upland locations and lowland breeding sites. Research suggests that adult toads do not frequently cross large flowing rivers such as Mess Creek. Since the proposed road follows the east side of the river, the road may function as a barrier to toad movement when breeding ponds are on the east side of the river between the river and the road. Sites 7, 13, 14, and 22 should, therefore, be considered in subsequent management and monitoring programs.

Aerial and ground surveys of Mess Creek did not identify additional potential breeding sites along the eastern side of Mess Creek. Potential breeding sites were identified as being shallow, muddy, with slow flowing water and limited canopy.

4. DISCUSSION, MITIGATION, AND MANAGEMENT

4. Discussion, Mitigation, and Management

4.1 Discussion

Western toads within the Schaft Creek area showed a preference for breeding sites that were shallow open water wetlands that had higher water temperatures, were muddier, and had a shallow sloping bank as compared to sites that were not used for breeding. These site characteristics probably contribute to increasing the chance of successful recruitment of juveniles into the adult breeding population. Water temperature affects larval growth and differentiation rates and strongly determines developmental time to metamorphosis and metamorph (toadlet/froglet) body size (Smith-Gill and Berven 1979; Ultsch *et al*., 1999). The water temperature within a pond needs to be warm enough to allow for metamorphosis before the site desiccates or winter begins (Ultsch *et al*., 1999). Sites with colder water temperatures probably do not provide the conditions necessary for western toads to successfully metamorphose into toadlets prior to the onset of winter and are thus avoided for breeding.

The segregation of breeding sites between western toads and Columbia spotted frogs may be related to predator avoidance. Ranids are known to prey on toads and Columbia spotted frogs have been seen eating newly metamorphosed toadlets (BC Frogwatch, 2006). Ranid tadpoles are also know to depredate Bufonid eggs and hatchlings (Petranka *et al*. 1994).

The population dynamics of pond-breeding amphibians are greatly influenced by recruitment success from breeding sites with cycles of boom and bust whereby adult breeding populations increase following years of high recruitment rates (Berven, 1990; Semlitsch *et al*., 1996). Reports of catastrophic mortality and complete recruitment failure are not uncommon (Berven 1995; Ling *et al*., 1986; Petranka *et al*., 1998) and have been attributed to drought, disease and predation. It is therefore imperative to reduce any additional sources of mortality on amphibian populations as their dynamics typically are not stable. Potential sources of mortality and/or negative influences on western toad population size at Schaft Creek that are of concern are:

- decreased access to breeding sites;
- road-kill of adults migrating to and from breeding sites and toadlets dispersing away from aquatic sites; and
- the introduction of chytrid fungus to novel sites.

However, these potential threats can be mitigated through the construction of underpasses or toad tunnels along the road, monitoring the road for indications of migration/dispersal corridors and proper handling of amphibians and gear when visiting wetland sites.

4.2 Monitoring and Mitigation

Scholl (2005) identified three criteria for a population of western toads to be considered viable:

1. Documented breeding activity and recruitment to the population in at least four out of the past ten years. However, if breeding activity has not been documented in the past four years,

there must be reliable observations of toads, including at least one sub-adult age class, in the locality during at least two of those four years.

2. An average observed total of at least 20 breeding adults at the breeding locality, producing an average of at least four viable egg masses per year, and the number of breeding adults observed at the locality has remained stable or increased over a period of at least ten years, based on visual surveys.
3. The population faces no known significant and imminent threat to its habitat, health, and environmental conditions.

4.2.1 Monitoring at Known Breeding Sites and Identification of Other Breeding Sites

The sites where breeding has been confirmed should be monitored in order to verify that western toad breeding is still occurring. Additional breeding sites can be added by opportunistic sightings of toads and breeding during routine investigations by water quality, fisheries and wildlife biologists. Any new breeding sites should be added to the monitoring program. The percent of breeding sites used on an annual basis should be tracked in order to determine natural variation in annual breeding effort.

4.2.2 Monitoring Road Crossing

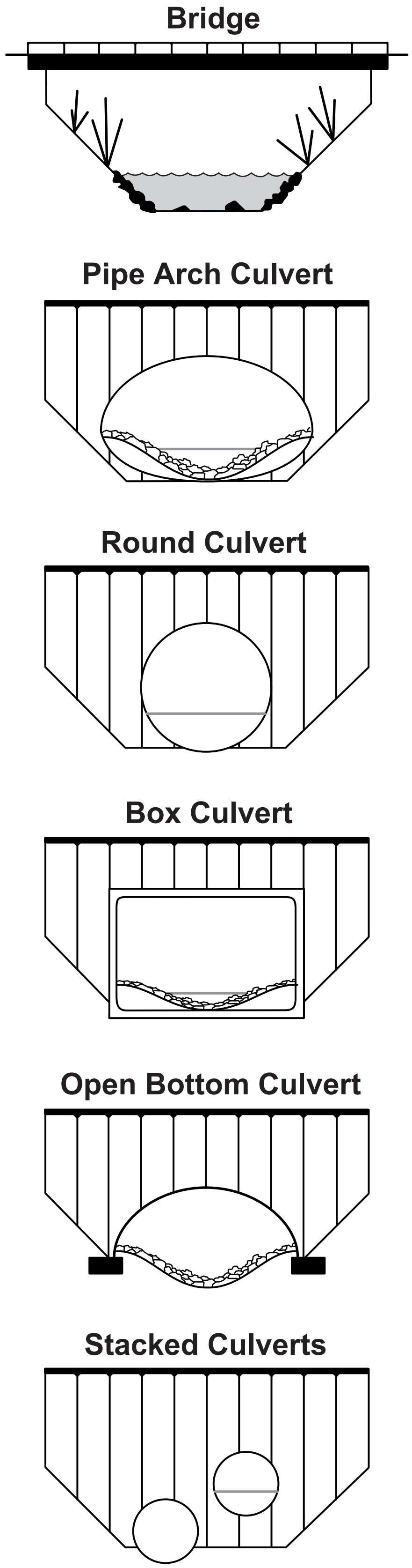
Night surveys are an effective and low-cost method of monitoring western toad migration patterns (Pyare, 2006). In this method, observers drive slowly (10-20 km/hr) along the road during the breeding period, using powerful headlights to watch for amphibian eye-shine reflected in the headlights. At a minimum, the number and location of adult toads should be recorded to determine migration routes. It is also possible for observers to sex and screen individual toads for disease or malformations. If areas along the road alignment are identified as hot spots for toad migration but are not close to known breeding sites, additional searches of nearby wetlands may be appropriate to determine the nearest breeding location. Similarly, if hot spots are identified later in the season along the road alignment for toadlet crossing then the location of their natal site should be confirmed.

4.2.3 Chytrid Fungus Mitigation

Wetland biologists and other personnel working in the Schaft Creek study area must be careful to ensure that they are not unwittingly transporting chytrid fungus spores into and out of the environment, or between infected and uninfected individuals. All equipment used in breeding sites, including hip waders, nets and boots, should be rinsed with a fungicide (*i.e.* Virkon™) before and after exposure to breeding sites. These measures are being implemented for amphibian monitoring projects by the United States Forest Service and Parks Canada (Pyare, 2006; Scrimgeour, 2006) and are now standard operating procedure within Rescan Environmental Services Ltd.

4.2.4 Toad Tunnels

Specialized wildlife underpasses systems and modified drainage culverts have successfully been used to facilitate safe movement of amphibians in fragmented landscapes (Langton, 1989; Fahrig *et al.*, 1995). In general, amphibians are more likely to use wide, short, well lit and ventilated tunnels that incorporate natural vegetation and substrate. Structures that help to maintain natural airflow, light and moisture and contain natural, permanent vegetation for predator avoidance are most effective. The position of "toad tunnels" must allow for movements of adults entering and leaving breeding ponds during the spring breeding season, and for the late summer/fall emigration of metamorphosed juveniles from ponds. The six types of stream crossing structures pictured in Figure 4.2-1 have varying degrees of utility as toad tunnels. The Bridge, Pipe Arch, and Box Culvert designs are considered the most suitable for western toads. Box culverts generally provide more room for travel than large pipes. Culverts are less expensive than expanded bridges, but are also less effective (Jackson and Griffin, 2000). Bridges that go over a seasonal or permanent stream and encompass a buffer zone of the stream bank are recommended for the Schaft Creek area.



Source: Fitzgibbon, 2001

Six types of stream crossing structures are considered. The bridge, pipe arch, box and open bottom culverts are most suitable for western toad management.

The bridge is preferred over the pipe arch, box or open bottom culverts. The bridge design should be used in place of conventional stream drainage culverts, and where topography and existing natural drainage require the road to be raised above ground (i.e. seasonal and permanent streams, water drainage and draws, depressions). This type of underpass maintains natural light, moisture, air and water temperatures and incorporates natural drainage, substrate and vegetation. The bottom of the bridge should be at least 1 m above the stream bank, and long enough to retain at least 1-2 m of natural vegetation and substrate on either side of the stream.

The pipe arch, box or open bottom culvert may be used where the road is not raised above ground and does not cross water draws or streams. These tunnels will facilitate the movement of amphibians migrating terrestrially, rather than along drainages. The culvert diameter should be as large as possible (minimum 1 m), have a raised non-metallic floor to prevent flooding and have associated drift fencing.

FIGURE 4.2-1

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Stream Crossing Structures

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APPENDIX 1
RESULTS OF AMPHIBIAN SURVEYS, SUMMER 2007

Appendix 1
Results of Amphibian Surveys, Summer 2007

Coding	Site #	Date	No. of Toads	No. of Toad Tadpoles	No. of Frogs	No. of Frog Tadpoles	Salamander	Toad Breeding Coding Variable	Time Searched	Notes
1	S 1	08-AUG-07 8:48:45						0	0.35	a fairly narrow overflow stream with imput out of a beaver dam, quite cold water and shaded
2	S 2	08-AUG-07 9:05:03						0	1.1	a beaver pond with inflow from mountain stream, cold water, heavy silt load and outflow into site #1
3	S 3	08-AUG-07 10:18:09						0	1.35	Large lake with small mudflats. Water quite cold.
4	S 4	08-AUG-07 12:44:45						0	1.25	Large lake with stream inflow and outflow and a large attached sedge wetland. Bank is typical sedge drop off. Water level variable.
5	S 5	08-AUG-07 14:19:44						0	1.05	Beaver pond with low water. Didn't see inflow or outflow but water shallow and cold, so likely flow-through present.
6	S 6	08-AUG-07 14:52:53						0	1.35	Beaver pond with quite cold water and high silt load, so relatively high flow-through.
7	S 7	08-AUG-07 15:36:07		2000				1	0.35	an overflow stream with very slow but consistent water flow, very warm water, and lots of muddy banks.
8	S 8	08-AUG-07 16:46:12			1			0	0.28	a blarge beaver pond with a large attached wetland of sedge clumps. Deep cold water and steep drop off from sedge clumps.
9	S 9	09-AUG-07 8:37:19						0	1.05	a medium beaver pond with low water and the bottom exposed as a series of mudflats. At normal water depth, no mudflats exist and shorline entirely made up of dense, deep sedge clumps.
10	S 10	09-AUG-07 10:01:25						0	1.25	a medium lake with mudflats around the inflow from a small and very cold stream. Poor habitat. Also surveyed during 2006 as part of Galore project.
11	S 11	09-AUG-07 11:45:15						0	0.55	a large stream with several defunct beaver dams and high flow through with deep channels. Not appropriate, but looked good from the air - with some mudflats.
12	S 12	09-AUG-07 12:57:21						0	0.45	a medium lake with mudflats on one side which were actually the exposed lake bottom. At regular water level, the entire shore would be sedges.
13	S 13	09-AUG-07 14:32:49		250		15		1	0.25	a weird open water area in an overflow stream with associated wetland. Open water is ~2-3 inches deep and looks like it is drying out. Tadpoles were very early development stage - both toad and frog.
14	S 14	09-AUG-07 15:14:51	1	2000	1	5		1	0.45	another weird open water area in an overflow stream/shallow running, but permanent stream through a sedge seep. May be associated with an overflow watercourse, but didn't see one.
15	S 15	09-AUG-07 16:33:38		10000				1	1.45	a large beaver dam with extensive mudflats at one end of the complex, warm water temps in the mudflats and lots of toad tadpoles.
16	S 16	10-AUG-07 8:31:59						0	0.25	a pond without flow. Sampled as part of 2006 Galore plan.
17	S 17	10-AUG-07 8:44:34						0	0.25	a small pond in the forest with a stony/forested bank. Also sampled as part of 2006 Galore plan.
18	S 18	10-AUG-07 8:54:21						0	0.25	a mediumpond in the forest with a stony/forested bank. Also sampled as part of 2006 Galore plan.
19	S 19	10-AUG-07 9:16:49						0	0.25	a mediumpond in the forest with a stony/forested bank. Also sampled as part of 2006 Galore plan.
20	S 20	10-AUG-07 10:01:24						0	0.45	a series of beaver ponds in the forest with a fast flowing large stream which overflows the blown-out dams yeilding a flooded forest, and fast flowing gravel stream.
21	S 21	10-AUG-07 11:25:42						0	1.15	a medium-sized, but slow moving channel which bisects an island in the main stream. It looked muddy and similar to S-7, but was deeper and faster flowing.
22	S 22	10-AUG-07 12:12:25	1	250				1	1.45	similar to S-7, but with more flow and the water looks as though it may dry out in some years.

(continued)

Appendix 1
Results of Amphibian Surveys, Summer 2007 (completed)

Coding	Site #	Date	No. of Toads	No. of Toad Tadpoles	No. of Frogs	No. of Frog Tadpoles	Salamander	Toad Breeding Coding Variable	Time Searched	Notes
23	S 23	10-AUG-07 13:52:53			1			0	0.45	large sedge wetland with open water and no mudflats. It looked shallow from the air, but rather deep and cold.
24	S 24	10-AUG-07 15:59:37						0	0.35	largish lake, but shallow. Open sedgy banks with little exposed sunny mudbanks - mostly sedgy, but not in clumps.
25	S 25	11-AUG-07 8:37:33			2			0	0.45	small series of bog ponds in large bog
26	S 26	11-AUG-07 9:25:47						0	0.45	small series of bog ponds in large bog
27	S 27	11-AUG-07 10:29:16			2	25		0	1.5	large lake
28	S 28	11-AUG-07 10:52:40						0	0.25	beaver pond/bog in forest
29	S 29	11-AUG-07 11:50:25						0	1.35	large lake
30	S 30	11-AUG-07 13:25:45						0	1.35	large lake
31	S 31	11-AUG-07 13:55:22						0	0.45	
32	S 32	11-AUG-07 14:54:14						0	1.5	large lake
33	S 33	11-AUG-07 15:30:40	1			2000		0	0.55	large bog pond with zillions of frog tadpoles.
34	S 34	12-AUG-07 8:33:35						0	0.25	small pond in alpine with nothing alive in it. Waaay too cold.
35	S 35	12-AUG-07 8:57:40						0	0.45	a freezing cold alpine bog
36	S 36	12-AUG-07 10:18:14			1	50		0	0.45	a shallow, but cold and frogless pond.
37	S 37	12-AUG-07 11:04:35						0	0.25	a stream through a gravel bar
38	S 38	12-AUG-07 12:10:30			2	500		0	0.45	a complex of bogs
39	S 39	12-AUG-07 13:16:08						0	0.45	bog
40	S 40	12-AUG-07 14:21:53						0	0.45	Lake
41	S 41	12-AUG-07 15:26:16			1	30		0	0.45	A series of fens ponds in an large open field.
42	S 42	12-AUG-07 16:00:13				5		0	0.45	a series of fen ponds in a large open area
43	S 43	12-AUG-07 16:18:40			1	25		0	0.45	a large fen pond
44	S 44	12-AUG-07 16:27:59			1		1	0	0.45	a large fen pond
45	S 45	12-AUG-07 16:50:01			1	5		0	0.45	a large fen pond
46	S 46	13-AUG-07 9:16:03			2	50		0	0.25	a large bog lake
47	S 47	13-AUG-07 9:30:44			3	25	1	0	0.45	a large bog lake
48	S 48	13-AUG-07 10:50:16			2	50		0	0.45	a large fen pond in an open grassland
49	S 49	13-AUG-07 11:35:18	1			200		0	1.5	a large bog lake
50	Alison	12-AUG-07 19:53:38						0		

APPENDIX 2
ABIOTIC CHARACTERISTICS OF AMPHIBIAN SURVEY SITES

Appendix 2
Abiotic Characteristics of Amphibian Survey Sites

Coding	Site #	Date	LAT	LONG	Y_PROJ	X_PROJ	ALTITUDE	Observer	Photo #'s	Weather	Rain	Air Temp	Water Temp	Size X	Size Y	Flow (1-5)	Water Depth	Substrate Depth	pH	EC	Tannin
1	S 1	08-AUG-07 8:48:45	57.38978737	-130.9248554	6362413.882	384303.4675	2342	GS, SL	934, 935, 936	Overcast	No Rain	9	6	350	4	2	15	5	7.8	250	0
2	S 2	08-AUG-07 9:05:03	57.39070276	-130.9272284	6362519.801	384163.7448	2387	GS, SL	937, 938, 939	Overcast	No Rain	9	4.5	150	100	2	35	10	7.2	270	0
3	S 3	08-AUG-07 10:18:09	57.3854442	-130.9162895	6361915.962	384804.6305	2373	GS, SL	942, 943, 944, 945, 946, 947	Party Cloudy	No Rain	14	7.8	1000	200	0	25	20	6.5	80	0
4	S 4	08-AUG-07 12:44:45	57.36366198	-130.9231151	6359503.275	384325.8235	2382	GS, SL	954, 955, 956, 957, 958, 959, 960, 961, 952	Party Cloudy	No Rain	15	7.5	400	200	0	25	10	6.4	75	0
5	S 5	08-AUG-07 14:19:44	57.35347252	-130.9049863	6358338.546	385384.329	2405	GS, SL	963, 964, 965, 966, 967	Party Cloudy	No Rain	14	7.9	250	100	0	10	5	6.7	80	0
6	S 6	08-AUG-07 14:52:53	57.32176211	-130.9069157	6354812.568	385169.3441	2441	GS, SL	968, 969, 970, 971, 972	Overcast	No Rain	12	6.5	250	250	1	30	2	6.3	50	0
7	S 7	08-AUG-07 15:36:07	57.31962514	-130.9102617	6354580.384	384961.2102	2401	GS, SL	977, 978, 979, 980, 981, 982, 9983, 984	Party Cloudy	No Rain	13	16	500	8	1	15	2	6	180	0
8	S 8	08-AUG-07 16:46:12	57.31787483	-130.9100423	6354385.212	384968.9504	2399	GS, SL	986, 987, 988	Party Cloudy	No Rain	14	6.5	600	250	0	25	10	6.2	120	0
9	S 9	09-AUG-07 8:37:19	57.29473424	-130.91653	6351820.767	384505.7684	2374	GS, SL	989, 990, 991, 992	Clear	No Rain	6.8	7.5	200	200	1	15	2	6.7	90	0
10	S 10	09-AUG-07 10:01:25	57.27679462	-130.9277108	6349843.214	383775.5548	2452	GS, SL	993, 994, 995	Clear	No Rain	12.6	6.8	800	200	1	35	10	6.4	40	0
11	S 11	09-AUG-07 11:45:15	57.26783009	-130.9173548	6348827.883	384371.7341	2501	GS, SL	996, 997, 998	Party Cloudy	No Rain	13.5	4.6	300	10	3	55	0	7.2	240	0
12	S 12	09-AUG-07 12:57:21	57.25908006	-130.9274944	6347871.321	383732.7874	2520	GS, SL	999, 1000, 1001, 1002	Party Cloudy	No Rain	14	7.8	600	250	0	20	5	6.5	40	0
13	S 13	09-AUG-07 14:32:49	57.22120676	-130.9075891	6343622.44	384815.2373	2558	GS, SL	1005, 1006	Party Cloudy	No Rain	14	17	15	20	1	5	2	5.8	220	1
14	S 14	09-AUG-07 15:14:51	57.21842154	-130.9078169	6343312.847	384792.802	2570	GS, SL	1009, 1010, 1011, 1012, 1013, 1014	Party Cloudy	No Rain	14	15	150	6	1	15	5	6.5	210	1
15	S 15	09-AUG-07 16:33:38	57.20203903	-130.9165277	6341504.345	384215.5752	2567	GS, SL	1016, 1017, 1018, 1019, 1020, 1021, 1022, 1055, 1056	Party Cloudy	No Rain	15	15	500	300	2	15	30	6.7	40	0
16	S 16	10-AUG-07 8:31:59	57.16528044	-130.929959	6337436.287	383288.4177	2859	GS, SL	1023, 1024, 1025	Overcast	No Rain	12.5	8.5	75	75	0	40	15	6.7	40	0
17	S 17	10-AUG-07 8:44:34	57.1657961	-130.9291234	6337492.246	383340.5652	2844	GS, SL	1026, 1027, 1028	Overcast	No Rain	12.5	7.2	35	55	0	40	15	6.7	40	0
18	S 18	10-AUG-07 8:54:21	57.16658827	-130.9275542	6337577.724	383437.9362	2831	GS, SL	1029, 1030, 1031	Overcast	No Rain	12.5	6.2	150	75	0	35	15	6.7	40	0
19	S 19	10-AUG-07 9:16:49	57.16626263	-130.9247256	6337536.65	383607.9335	2758	GS, SL	1032-1037	Overcast	No Rain	12	8.5	100	75	0	45	15	6.7	40	0
20	S 20	10-AUG-07 10:01:24	57.18905739	-130.916036	6340058.742	384204.65	2650	GS, SL	1038-1041	Overcast	No Rain	11	6.5	400	200	4	40	20	6.2	140	0
21	S 21	10-AUG-07 11:25:42	57.23332523	-130.9152222	6344984.079	384392.327	2556	GS, SL	1042-1045	Party Cloudy	No Rain	14	7.5	400	5	2	25	5	6.5	60	0
22	S 22	10-AUG-07 12:12:25	57.21543834	-130.9011632	6342969.604	385185.2738	2565	GS, SL	1057-1063	Party Cloudy	No Rain	14	15	400	10	1	10	5	6.2	160	0
23	S 23	10-AUG-07 13:52:53	57.2605857	-130.9198409	6348025.849	384199.0987	2469	GS, SL	1068-1071	Party Cloudy	No Rain	15	8.5	350	150	1	30	10	5.8	80	1
24	S 24	10-AUG-07 15:59:37	57.29806747	-130.9121545	6352184.323	384779.8278	2420	GS, SL	1077-1079	Party Cloudy	No Rain	12	8	500	250	1	40	10	6.4	55	0
25	S 25	11-AUG-07 8:37:33	57.50013303	-130.9716375	6374775.422	381848.3611	2624	GS, SL	1080-1082	Party Cloudy	No Rain	8.5	6.2	30	10	1	60	40	5.5	80	1
26	S 26	11-AUG-07 9:25:47	57.49322961	-130.973763	6374010.796	381698.6755	2630	GS, SL	1083, 1084	Party Cloudy	No Rain	8.5	6.2	50	20	1	60	40	6.1	40	1
27	S 27	11-AUG-07 10:29:16	57.45275566	-130.9616684	6369485.196	382293.3879	2743	GS, SL	1093-1097	Clear	No Rain	13	8.9	500	300	1	50	10	6.5	40	0
28	S 28	11-AUG-07 10:52:40	57.45060964	-130.9615312	6369246.115	382294.7243	2753	GS, SL	1098-1101	Clear	No Rain	13	6.5	50	70	2	50	25	6.8	80	0
29	S 29	11-AUG-07 11:50:25	57.42872223	-130.9498748	6366790.003	382924.175	2908	GS, SL	1103-1105	Party Cloudy	No Rain	13	8.5	1000	350	0	50	25	6.8	40	0
30	S 30	11-AUG-07 13:25:45	57.4333503	-130.9513147	6367307.569	382852.521	2885	GS, SL	none	Party Cloudy	No Rain	13	8.5	1000	350	0	50	25	6.8	40	0
31	S 31	11-AUG-07 13:55:22	57.42336997	-130.9621714	6366215.567	382168.7772	2800	GS, SL	1106-1108	Overcast	drizzle	8.5	6.8	250	350	2	75	0	6.4	80	0
32	S 32	11-AUG-07 14:54:14	57.41544312	-130.9551401	6365321.177	382565.5672	2771	GS, SL	1109-1113	Overcast	No Rain	9	6.9	1500	500	1	75	0	6.4	80	0
33	S 33	11-AUG-07 15:30:40	57.42019784	-130.9544994	6365849.25	382619.262	2867	GS, SL	1115-1119	Party Cloudy	No Rain	12	7.5	200	150	0	150	50	6.2	120	1
34	S 34	12-AUG-07 8:33:35	57.24704138	-131.0568746	6346759.831	375889.3995	3694	GS, SL	1139-1140	Party Cloudy	No Rain	2.5	5.2	5	9	0	35	0	6.8	20	0
35	S 35	12-AUG-07 8:57:40	57.28185117	-131.0211184	6350569.27	378161.5331	3463	GS, SL	1143, 1146, 1147	Party Cloudy	No Rain	3.5	6.2	50	75	1	150	50	6.2	80	1
36	S 36	12-AUG-07 10:18:14	57.33560985	-131.0128976	6356537.514	378833.983	3157	GS, SL	1153-1158	Party Cloudy	No Rain	8.5	11.2	150	50	1	150	25	6.3	120	1
37	S 37	12-AUG-07 11:04:35	57.43116329	-131.1373993	6367400.193	371675.3301	2907	GS, SL	1168, 1174, 1175	Party Cloudy	No Rain	6.8	12.4	150	4	2	15	0	6.8	240	1
38	S 38	12-AUG-07 12:10:30	57.43181532	-131.12276	6367445.213	372556.3398	2868	GS, SL	1176-1180	Overcast	No Rain	11.2	10.5	75	50	0	80	50	6.2	120	1
39	S 39	12-AUG-07 13:16:08	57.43986522	-131.0977144	6368294.416	374087.3706	2777	GS, SL	1183-1189	Party Cloudy	No Rain	13.8	9.6	150	75	0	150	50	5.9	110	1
40	S 40	12-AUG-07 14:21:53	57.43679141	-131.0681865	6367898.004	375849.0042	2509	GS, SL	1191-1192	Party Cloudy	No Rain	15.1	8.7	800	400	0	50	5	6.4	56	0
41	S 41	12-AUG-07 15:26:16	57.42822493	-131.0766463	6366960.105	375312.1326	2598	GS, SL	1195-1200	Overcast	No Rain	16.2	11.5	75	25	0	50	25	5.5	240	1
42	S 42	12-AUG-07 16:00:13	57.37106614	-130.9479661	6360369.854	382854.8989	3243	GS, SL	1201, 1202	Overcast	No Rain	16.1	10.6	15	10	0	80	30	5.2	85	1
43	S 43	12-AUG-07 16:18:40	57.37233575	-130.9490615	6360513.042	382793.0826	3251	GS, SL	1204, 1205	Overcast	No Rain	17	9.8	150	200	0	100	30	5.5	180	1
44	S 44	12-AUG-07 16:27:59	57.37266264	-130.9501957	6360551.378	382725.93	3267	GS, SL	1207, 1208	Overcast	No Rain	14	8.9	150	100	0	85	30	5.5	150	1
45	S 45	12-AUG-07 16:50:01	57.3746867	-130.9505733	6360777.297	382709.6876	3282	GS, SL	1209-1211	Overcast	No Rain	14	8.9	150	100	0	85	30	5.5	150	1
46	S 46	13-AUG-07 9:16:03	57.37837734	-130.9472246	6361182.278	382922.7806	3105	GS, SL	1215-1219	Overcast	No Rain	12	7.8	350	400	0	50	5	6.2	80	0
47	S 47	13-AUG-07 9:30:44	57.37896197	-130.9480119	6361248.7	382877.315	3110	GS, SL	1220-1223, 1235	Overcast	No Rain	12	7.8	350	400	0	50	5	6.2	80	0
48	S 48	13-AUG-07 10:50:16	57.35922142	-131.0079189	6359156.461	379211.1963	2873	GS, SL	1227-1229	Overcast	No Rain	12	7.8	150	100	0	35	40	5.9	65	1
49	S 49	13-AUG-07 11:35:18	57.36568605	-130.9844246	6359834.462	380645.2794	3836	GS, SL	1231-1234	Overcast	No Rain	12	7.8	400	250	0	35	40	5.9	65	0
50	Alison	12-AUG-07 19:53:38	57.46491496	-130.8587986	6370665.003	388502.0029	2852	GS, SL													

APPENDIX 3
BIOTIC CHARACTERISTICS OF AMPHIBIAN SURVEY SITES

Appendix 3
Biotic Characteristics of Amphibian Survey Sites

Coding	Site #	Habitat Type	Wetland Type	% Canopy	Canopy Type	Open and Sunny	Canopy Set Back	Dense, Dark Canopy	Fish Present?	Water Level Variable
1	S 1	Overflow stream	Shallow open Water	100	shrubs	0	1	0	no	yes, low
2	S 2	Beaver pond	Beaver pond	95	open	1	0	0	unk	no
3	S 3	Lake	Lake	80	open	1	0	0	unk	yes, low
4	S 4	Lake	Lake	0	open	1	0	0	unk	yes, low
5	S 5	Beaver pond	Beaver pond	100	open	1	0	0	unk	yes, low
6	S 6	Beaver pond	Beaver pond	50	forest	1	0	1	no	no
7	S 7	Overflow channel	Shallow open Water	35	shrubs	1	0	0	no	yes, low
8	S 8	Beaver pond	Beaver pond	100	open	1	0	0	unk	no
9	S 9	Beaver Pond	Beaver pond	80	open	1	0	0	no	yes, low
10	S 10	Lake	Lake	25	open	1	0	0	unk	no
11	S 11	large stream with damed areas	Shallow open Water	10	open	1	0	0	no	yes, low
12	S 12	lake	Lake	0	open	1	0	0	unk	yes, low
13	S 13	overflow wetland	Shallow open Water	0	open	1	0	0	no	yes, low
14	S 14	shallow stream and mudflats in a sedge seep	Shallow open Water	0	open	1	0	0	no	yes, low
15	S 15	beaver pond	Beaver pond	40	open	1	1	0	unk	no
16	S 16	pond	Bog	0	forest	0	0	1	no	no
17	S 17	small pond	Bog	100	forest	0	0	1	no	no
18	S 18	small pond	Bog	100	forest	0	0	1	no	no
19	S 19	small pond	Bog	100	forest	0	0	1	no	no
20	S 20	beaver pond/overflow system	Shallow open Water	100	forest	0	0	1	no	yes
21	S 21	secondary river channel/overflow channel	Shallow open Water	90	shrubs	0	1	0	unk	yes
22	S 22	very shallow and muddy overflow stream through an island in the main channel	Shallow open Water	15	shrubs	1	1	0	unk	yes
23	S 23	large open sedge wetland	Fen	25	forest	1	1	0	unk	no
24	S 24	lake - likely beaver origin	Lake	45	forest	1	0	0	unk	no
25	S 25	fen	Fen	0		1	0	0	unk	no
26	S 26	fen	Fen	0		1	0	0	unk	no
27	S 27	lake	Lake	90	forest	0	0	1	yes	no
28	S 28	beaver pond	Beaver pond	75	forest	0	0	1	unk	no
29	S 29	lake	Lake	100	forest	0	0	1	yes	no
30	S 30	lake	Lake	100	forest	0	0	1	yes	no
31	S 31	lake	Lake	80	forest	0	0	1	yes	no
32	S 32	lake	Lake	99	forest	0	0	1	yes	no
33	S 33	bog in forest	Bog	85	forest	0	0	1	unk	no
34	S 34	alpine pond	Shallow open Water	0		1	0	0	no	no
35	S 35	apline bog	Bog	25	forest	1	0	0	unk	no
36	S 36	bog	Fen	0		1	0	0	no	no
37	S 37	stream through a gravel bar	Shallow open Water	50	forest	1	0	0	no	yes
38	S 38	a complex of bogs	Bog	25	forest	1	1	0	no	no
39	S 39	bog	Bog	25	forest	1	1	0	no	no
40	S 40	Lake	Lake	75	forest	0	1	1	yes	no
41	S 41	A series of fens ponds in an large open field.	Fen	0		1	0	0	no	no
42	S 42	a series of fen ponds in a large open area	Fen	0		1	0	0	no	no
43	S 43	a large fen pond	Fen	0		1	0	0	unk	no
44	S 44	a large fen pond	Fen	50	forest	1	1	0	unk	no
45	S 45	a large fen pond	Fen	50	forest	1	1	0	unk	no
46	S 46	a large bog lake	Bog	100	forest	0	0	1	unk	no
47	S 47	a large bog lake	Bog	100	forest	0	0	1	unk	no
48	S 48	a large fen pond in an open grassland	Fen	0		1	0	0	no	no
49	S 49	a large bog lake	Bog	100	forest	0	0	1	unk	no
50	Alison									

(continued)

Appendix 3
Biotic Characteristics of Amphibian Survey Sites (continued)

Coding	Site #	Habitat Type	Wetland Type	Bank	% Mud	% Shrubs	% Gravel	% Shagnum/ Bog	% Dense Sedges/ Aquatic Vegetation	% Other
1	S 1	Overflow stream	Shallow open Water		10				90	
2	S 2	Beaver pond	Beaver pond		5				95	
3	S 3	Lake	Lake		2	50			48	
4	S 4	Lake	Lake		10		50		40	
5	S 5	Beaver pond	Beaver pond		5				95	
6	S 6	Beaver pond	Beaver pond		5				45	50 forest
7	S 7	Overflow channel	Shallow open Water		80	20				
8	S 8	Beaver pond	Beaver pond						75	25 forest
9	S 9	Beaver Pond	Beaver pond		10				65	25 forest
10	S 10	Lake	Lake		5				70	25 forest
11	S 11	large stream with damed areas	Shallow open Water		5		50		45	
12	S 12	lake	Lake		15				85	
13	S 13	overflow wetland	Shallow open Water		50				50	
14	S 14	shallow stream and mudflats in a sedge seep	Shallow open Water		50				50	
15	S 15	beaver pond	Beaver pond		10	55				35 forest
16	S 16	pond	Bog					75		25 forest
17	S 17	small pond	Bog				25			75 forest
18	S 18	small pond	Bog				25			75 forest
19	S 19	small pond	Bog				25			75 forest
20	S 20	beaver pond/overflow system	Shallow open Water				25	25		50 forest
21	S 21	secondary river channel/overflow channel	Shallow open Water		25	25	50			
22	S 22	very shallow and muddy overflow stream through an island in the main channel	Shallow open Water		85	15				
23	S 23	large open sedge wetland	Fen						100	
24	S 24	lake - likely beaver origin	Lake		2				53	45 forest
25	S 25	fen	Fen					75	25	
26	S 26	fen	Fen					75	25	
27	S 27	lake	Lake						10	90 forest
28	S 28	beaver pond	Beaver pond						100	
29	S 29	lake	Lake						50	50 forest
30	S 30	lake	Lake						50	50 forest
31	S 31	lake	Lake		50		25			25 forest
32	S 32	lake	Lake				100			
33	S 33	bog in forest	Bog					100		
34	S 34	alpine pond	Shallow open Water				100			
35	S 35	apline bog	Bog					100		
36	S 36	bog	Fen					100		
37	S 37	stream through a gravel bar	Shallow open Water				100			
38	S 38	a complex of bogs	Bog					100		
39	S 39	bog	Bog					100		
40	S 40	Lake	Lake						25	75 forest
41	S 41	A series of fens ponds in an large open field.	Fen					100		
42	S 42	a series of fen ponds in a large open area	Fen					100		
43	S 43	a large fen pond	Fen					100		
44	S 44	a large fen pond	Fen					100		
45	S 45	a large fen pond	Fen					100		
46	S 46	a large bog lake	Bog					100		
47	S 47	a large bog lake	Bog					100		
48	S 48	a large fen pond in an open grassland	Fen					100		
49	S 49	a large bog lake	Bog				25	75		
50	Alison									

(continued)

Appendix 3
Biotic Characteristics of Amphibian Survey Sites (completed)

Coding	Site #	Habitat Type	Wetland Type	Bank Slope	1 Mudflats	2 Gently Sloping	3 Moderate	4 Steep	5 Drop Off	Other	Emergent Veg % Shoreline	Species Emergent Veg	% Floating	% Submerged
1	S 1	Overflow stream	Shallow open Water		10	90					80	sedge	0	0
2	S 2	Beaver pond	Beaver pond		5				95		95	sedge	0	0
3	S 3	Lake	Lake		2		50	48			50	sedge	0	0
4	S 4	Lake	Lake		5			50	45		50	sedge	0	0
5	S 5	Beaver pond	Beaver pond		5	15		80			95	sedge	0	10
6	S 6	Beaver pond	Beaver pond		5				95		50	sedge	0	0
7	S 7	Overflow channel	Shallow open Water		20	60			20		20	sedge	0	0
8	S 8	Beaver pond	Beaver pond						100		100	sedge	5	0
9	S 9	Beaver Pond	Beaver pond		10				90		75	sedge	0	0
10	S 10	Lake	Lake		5				95		75	sedge	0	0
11	S 11	large stream with damed areas	Shallow open Water		5			95			25	sedge	0	0
12	S 12	lake	Lake		15			85			100	sedge	0	0
13	S 13	overflow wetland	Shallow open Water		50	50					100	sedge	0	50
14	S 14	shallow stream and mudflats in a sedge seep	Shallow open Water		50	50					100	sedge	0	10
15	S 15	beaver pond	Beaver pond		10		30		70		20	sedge	0	0
16	S 16	pond	Bog				50	50			20	sedge	0	0
17	S 17	small pond	Bog					100			0		0	0
18	S 18	small pond	Bog					100			0		0	0
19	S 19	small pond	Bog					100			0		0	0
20	S 20	beaver pond/overflow system	Shallow open Water				25	75			0		0	0
21	S 21	secondary river channel/overflow channel	Shallow open Water				25	75			0		0	0
22	S 22	very shallow and muddy overflow stream through an island in the main channel	Shallow open Water			85		15			0		0	0
23	S 23	large open sedge wetland	Fen						100		100	sedge	0	10
24	S 24	lake - likely beaver origin	Lake			50			50		55	sedge	0	0
25	S 25	fen	Fen				25		75		25	sedge	0	0
26	S 26	fen	Fen				25		75		25	sedge	0	0
27	S 27	lake	Lake					10	90		10	sedge	0	0
28	S 28	beaver pond	Beaver pond						100		80	sedge	0	0
29	S 29	lake	Lake						100		80	sedge	0	0
30	S 30	lake	Lake						100		80	sedge	0	0
31	S 31	lake	Lake			50		50			0		0	0
32	S 32	lake	Lake					100			5	sedge	0	0
33	S 33	bog in forest	Bog						100		0		0	0
34	S 34	alpine pond	Shallow open Water				100				10	rush	0	10
35	S 35	apline bog	Bog						100		20	sedge	0	0
36	S 36	bog	Fen						100		20	sedge	0	0
37	S 37	stream through a gravel bar	Shallow open Water			100					0		0	0
38	S 38	a complex of bogs	Bog						100		25	sedge	2	10
39	S 39	bog	Bog						100		5	sedge	0	0
40	S 40	Lake	Lake					25	75		25	sedge	2	2
41	S 41	A series of fens ponds in an large open field.	Fen			50			50		30	sedge	0	0
42	S 42	a series of fen ponds in a large open area	Fen						100		25	sedge	0	0
43	S 43	a large fen pond	Fen						100		25	sedge	0	0
44	S 44	a large fen pond	Fen						100		25	sedge	0	0
45	S 45	a large fen pond	Fen						100		25	sedge	5	0
46	S 46	a large bog lake	Bog						100		0		0	0
47	S 47	a large bog lake	Bog						100		0		2	0
48	S 48	a large fen pond in an open grassland	Fen						100		0		2	0
49	S 49	a large bog lake	Bog						100		0		2	0
50	Alison													