capstone
MINTO MINE

Site Characterization Plan

January 2018

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1 Introduction

As a requirement for Capstone Mining Corp's Quartz Mining Licence, a Site Characterization Plan has been developed. The Plan will outline the existing condition at the Minto Mine. Table 1-1 shows how sections of this plan correspond to the Plan Requirements Guidance for Quartz Mining Projects.

Table 1-1: Concordance with Plan Requirements

Section in Guidance Document		Corresponding Section(s) in this Plan	
4.1	Introduction	1	Introduction
4.2	Geology	2	Geology
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The Plan Requirements Guidance for Quartz Mining Projects references a concordance table outlining applicable proponent commitments and decision document conditions. As this plan describes the existing site conditions, none of the commitments made in the YESAB process or the conditions in the decision document are relevant to the understanding of this plan. Capstone's commitments and the conditions contained in the decision document are addressed in the appropriate documents that evaluate the potential environmental effects of the project and the issues raised in the evaluation process.

1.1 Site Overview

The Minto Mine is located on the west side of the Yukon River, approximately 240 km northwest of Whitehorse, Yukon (Figure 1-1) and is centered at 62°37'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). Highway 2 (North Klondike Highway) is located on the east side of the Yukon River; the mine can be accessed in the summer by barge crossing or in winter by the ice bridge crossing at Minto Landing.

Environmental conditions are summarized in Table 1-2 below.

Table 1-2: Summary of Environmental Conditions in the Minto Mine Area.

Project Area Attribute Description	Project Area Attribute Description
Region:	Yukon
Topographic map sheet:	NTS 115 I/10, 115 I/11
Geographic location name code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, McGinty Creek, and Minto Creek.
Ecoregion:	Yukon Plateau (Central) - Pelly River ecoregion.
Study area elevation:	Rolling hills above mine site at 1131 to 600 m at the Yukon River Valley bottom.
Site climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174mm.
Vegetation communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feather moss, sedge, sagewort, grassland, mixed forest (aspen, balsam, and sub-alpine). Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharp-tail grouse, waterfowl, raptors, and a variety of smaller birds.
Fish species:	In the Yukon River, Chinook, Coho, and chum salmon, rainbow trout, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin; In Big Creek, Chinook and chum salmon, Arctic grayling and whitefish species; In Wolverine Creek, Chinook salmon, Arctic grayling, and slimy sculpin; In Minto Creek (lower reaches only), Chinook salmon, slimy sculpin, round whitefish, Arctic grayling, longnose sucker, burbot; In McGinty Creek (lower reaches only), slimy sculpin, Arctic grayling

The Minto Mine property lies in the eastern portion of the Dawson Range, which is part of the Klondike Plateau Physiographic Region, an uplifted surface that has been dissected by erosion. The area was largely unglaciated during the last ice age and topography consists of deep and narrow valleys, rounded rolling hills, and ridges with relief of up to 600 m (2,000 ft.). The highest elevation on the property is 975 m (3,200 ft.) above sea level, compared to lower elevations in the region with elevations of 460 m (1,500 ft.) along the Yukon River.

The Minto Mine is near the height of land with relatively gentle slopes and smooth ridges that often have spines of bedrock outcrops (tors) at their crests left from long periods of weathering. Broad ridges are typically mantled with felsenmeer (fields of angular, frost-heaved, in situ rock fragments). Below the ridge crests, bedrock exposures are limited or negligible. The Project area lies in a zone of extensive discontinuous (50–90%) permafrost and is included in the western portion of the Yukon plateau central ecozone. North-facing slopes in the area are commonly underlain by permafrost. Valley-bottom deposits and upland soils usually contain ice-rich horizons. Well-drained uplands may have permafrost-free soils.

As the ecoregion is largely unglaciated, the dominant parent materials are stony residual materials along ridge tops and summits, coarse colluvium on upper slopes, and silty colluvium and loess, rich in organic matter, on lower slopes and floors of main valleys. Muck is usually capped with peat and underlain by permafrost. In the Minto Mine area, much of the colluvium on ridge slopes is coarse sand derived from decomposition of the largely granitic bedrock in the area. Overburden of relic soils that predate the last glaciation includes lacustrine deposits overlain by colluvium and organic silt in some upper valleys, some of which was exposed during excavation on the south side of the pit.

The mine development area is in the transition from the forested to non-forested (alpine) zone. Below the treeline (elev. ~1,000 m) the vegetation patterns reflect the discontinuous distribution of permafrost with stunted black spruce woodlands on cold, north-facing sites and mixed (aspen, white spruce, minor birch) forests on warm, south-facing slopes. The area has been burned over by several wild fires, the latest of which was in 2010 (Minto Landing to lower Minto Creek area). Many of the burnt trees have blown down and natural regeneration of pine and alder is occurring over much of the property and the Project area.

The climate of the region is continental with short, warm summers and very cold winters. Annual precipitation ranges from 300 to 500 mm. Mean annual temperatures are near –5°C with mean mid-winter temperatures of –23°C to –32°C, in July from +10°C to +15°C and extremes in the lower valleys ranging from –60°C to +35°C.

The area is drained by tributaries of the Yukon River. The rate of runoff is controlled by almost total vegetation ground cover and moderate slope gradients. Infiltration rate is expected to be high in areas of thicker colluvium. However, permafrost and seasonally frozen soils inhibit vertical percolation.

Topography in the Dawson Range is moderate and the active geomorphological processes in the study area are typically limited to include slow mass movement (solifluction) and some minor gully erosion. Although there are no reports of large-scale active natural landslides in the Minto Project area, smaller scale instabilities have recently been documented in the Minto Creek catchment area, downstream of the mine site. Substantial sediment loading in lower Minto Creek in the absence of effluent discharge from the site was observed throughout the open water months of 2011 (Appendix 1-3, *Minto Creek Water Quality Characterization*). This prompted a targeted water quality survey and an aerial investigation of the creek and tributaries in spring of 2012 in an attempt to identify the source(s) of the sediment. Two areas were identified in tributaries on the southern side of the Minto Creek catchment, below the area of control of the mine, where soil materials had slumped and transported a significant amount of material into the creek channel. Although ground investigations were not conducted, it is suspected that these instances may be related to thawing of frozen ground conditions, or may simply be small-scale instability of fine textured (lacustrine) soils.

1.2 Site Description

The Minto Mine is a high grade copper mine located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A approximately 240 km northwest of Whitehorse, Yukon Territory (Figure 1-1). It is owned and operated by the Minto Explorations Ltd. a wholly owned subsidiary of Capstone Mining Corporation. Development of the mine was initiated in 1997, commercial operations started in October 2007, and the currently anticipated operating life is to 2020 with permitted resources to 2022. The Minto Mine is permitted to conduct open pit and underground mining, and to mill the copper/gold/silver ore at a rate of 4,200 tonnes of per day. In 2016 (the most recent year of record), the Minto Mine produced 69.3 million pounds of copper from milling approximately 1.49 million tones or ore.

In addition to open pit mines, underground mines, and the mill, the Minto Mine site includes a number of waste rock dumps, a concentrate storage shed, a dry stack tailings storage facility (DSTSF), a water retention dam with a water storage pond (WSP), a water treatment plant, administrative offices, an airstrip, and a camp (Figure 1-2). Mill tailings are stored in the DSTSF and in mined-out open pits. Mine-impacted seepage from the DSTSF and under the Mill Valley Fill (MVF) is collected at the toe of the MVF in sump W62 and is pumped to the Main Pit (Figure 1-2). Non-impacted water and treated mine-impacted water are collected in the WSP (Figure 1-2). Effluent from the WSP is periodically discharged to Minto Creek under conditions specified in Water Use Licence (WUL) QZ14-031 (August 2015). Minto Creek, in turn, discharges to the Yukon River approximately 7.7 km south-east of the WSP (Figure 1-2).

MINTO MINE

CAPSTONE MINTO MINE - SITE CHARACTERIZATION PLAN

FIGURE 1-1
PROJECT LOCATION

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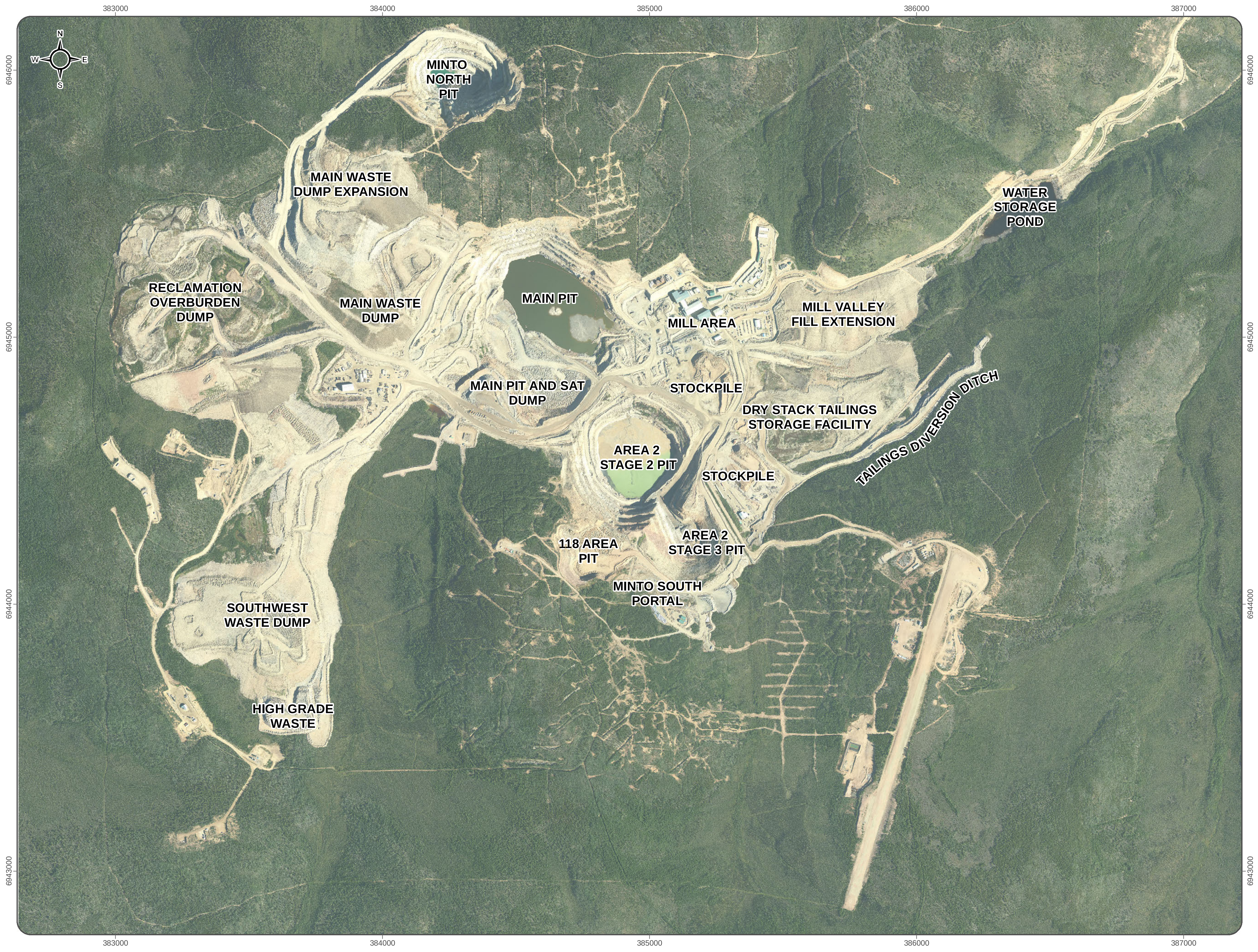

MINTO MINE

CAPSTONE MINTO MINE - SITE CHARACTERIZATION PLAN

FIGURE 1-2

MINE SITE LAYOUT

JANUARY 2018

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1:13,500 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

Alexco Environmental Group

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 9rd 2017

Datum: NAD 83 Projection: UTM Zone 8N

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2 Geology

2.1 Physiography

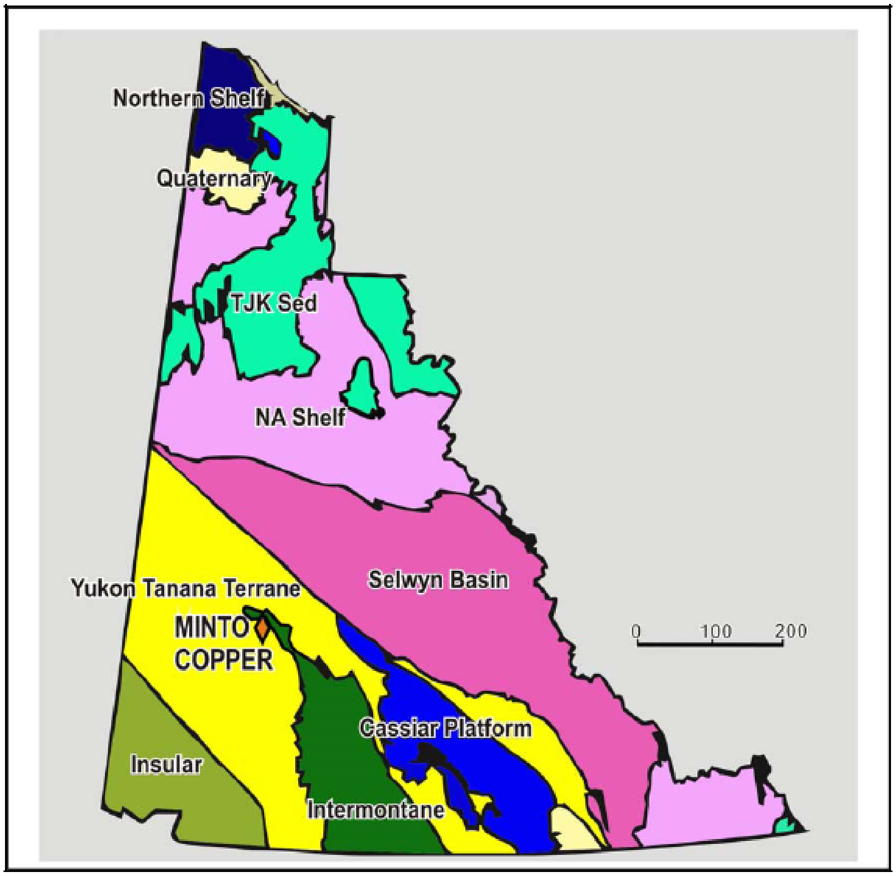
The property lies in the Dawson Range, part of the Klondike Plateau, an uplifted surface that has been dissected by erosion. Local topography consists of rounded rolling hills and ridges and broad valleys. The highest elevation on the property is approximately 1,000 m above sea level, compared to elevations of 460 m along the Yukon River. Slopes on the property are relatively gentle and do not present accessibility problems. Bedrock outcrops can often be found at the tops of hills and ridges. There are no risks of avalanche on the property.

Overburden is colluvium primarily comprised of granite-based sand from weathering of the granitic bedrock in the area and is generally thin but pervasive. It can reach plus 50 m in depth. Seams of clay and ice lenses are also present sporadically. South-facing slopes generally provide well-drained, sound foundation for buildings and roads. North-facing slopes in the area typically contain permafrost.

Vegetation in the area is sub-Arctic boreal forest made up of largely spruce and poplar trees. The area has experienced several wildfires over the years, the latest in 2010, and has no old-growth trees remaining. The fire in 2010 led to the partial evacuation of the camp and a short stoppage in production.

2.2 Bedrock Geology

The Minto Project is found in the north-northwest trending Carmacks Copper Belt along the eastern margin of the Yukon-Tanana Composite Terrain, which is comprised of several metamorphic assemblages and batholiths (). The Belt is host to several intrusion-related Cu-Au mineralized hydrothermal systems. The Yukon-Tanana Composite Terrain is the easternmost and largest of the pericratonic terrains accreted to the Paleozoic northwestern margin of North America (e.g., Colpron *et al.*, 2005). It is regarded to be the product of a continental arc and back-arc system, preserving meta-igneous and metasedimentary rocks of Permian age on top of a pre-Late Devonian metasedimentary basement (e.g., Piercey *et al*. 2002).



From: Yukon Geologic Survey "Maps Yukon" website (www.geology.gov.yk.ca)

Figure 2-1: Yukon Geology (from Yukon Geologic Survey "Maps Yukon" website (www.geology.gov.yk.ca).

The Minto Property and surrounding area are underlain by plutonic rocks of the Granite Mountain Batholith (Early Mesozoic Age) (Figure 2-2: Regional Geology) that have intruded into the Yukon-Tanana Composite Terrain. They vary in composition from quartz diorite and granodiorite to quartz monzonite. The batholith is unconformably overlain by clastic sedimentary rocks thought to be the Tantalus Formation and andesitic to basaltic volcanic rocks of the Carmacks Group, both of which are assigned a Late Cretaceous age. Immediately flanking the Granite Mountain Batholith, to the east, is a package of undated mafic volcanic rocks, outcropping on the shores of the Yukon River. The structural relationship between the batholith and the undated mafic volcanics is poorly understood because the contact zone is not exposed

Geobarometry and geothermometry data (Tafti and Mortensen, 2004) suggests that the Granite Mountain Batholith was emplaced at a depth of at least 9 km, while the presence of euhedral to subhedral epidote, interpreted by Tafti and Mortensen as magmatic in origin, suggests a deeper emplacement depth in the order of 18 to 20 km.

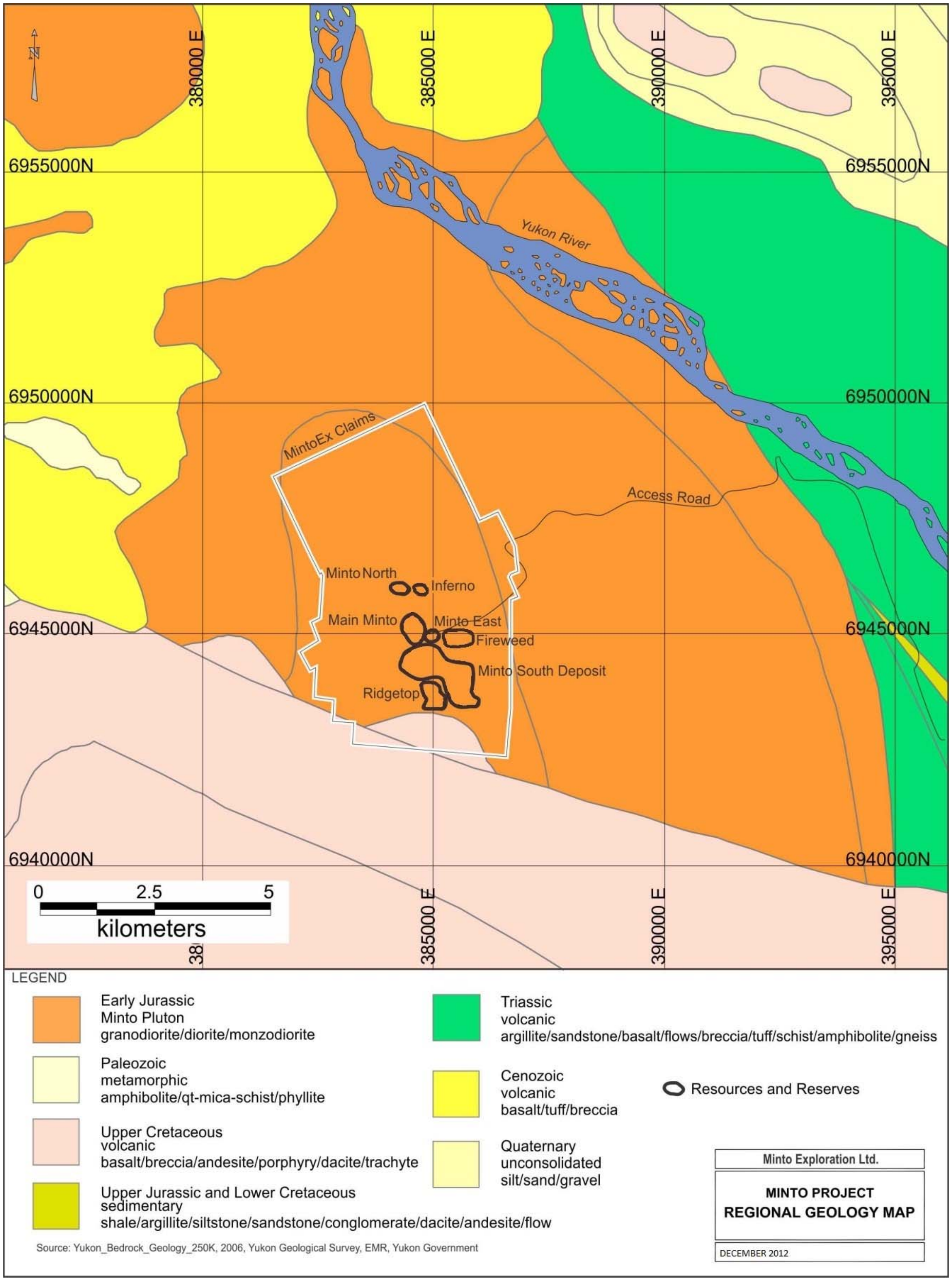


Figure 2-2: Regional Geology.

2.3 Property Geology and Lithological Description

Much of the geological understanding of the rock around the Minto deposits is based on observations from diamond drill core and extrapolation from regional observations. The reason for this is poor outcrop exposure (less than 5% coverage), as well as the deep weathering and oxidation of any existing exposed outcrop. The terrain was not glaciated during the last ice age event.

Five additional deposits of mineralization are reported in this document outside of the Minto Main Deposit; Minto South Deposit, Ridgetop, Minto North, Inferno, Fireweed, and Minto East (). For the purpose of this report Area 2, Area 118, Copper Keel, and Wildfire resource sub-domains are now considered continuous and reported as one deposit, namely Minto South Deposit (MSD) located immediately south of Main Minto. Names of these resource sub-domains are retained for ease of discussion when discussing regions within MSD. The Ridgetop deposit is located just over 300 m south of the Area 2/118 resource sub-domain, the Minto North and Inferno deposits are located about 700 m north of the Main Deposit, the Fireweed deposit is located just over 500m east of the south end of the Minto Main deposit, the Minto East deposit is located about 200 m east of the south end of the Minto Main deposit, while the Copper Keel and Wildfire sub-domains form a southeast extension from Area 2/118. Each of these deposits closely shares a similar style of mineralization of shallow dipping copper sulphide mineralized zones. The Main Minto deposit was exposed in the dormant open pit mine; similarly, this flat geometry is currently exposed in the Minto South Deposit (Area 2 resource sub-domain) starter pit. In addition to these mineral deposits which have NI 43-101 compliant mineral resources there are several significant mineral prospects. These deposits and prospects define a general north-northwest trend.

The hypogene copper sulphide mineralization at Minto is hosted wholly within the Minto pluton, which intrudes near the boundary between the Stikinia and Yukon-Tanana terrains, however since the contact is not exposed it is unclear if the pluton stitches the two terrains. The Minto pluton is predominantly of granodiorite composition. Hood *et al*. (2008) distinguish three varieties of the intrusive rocks in the pluton. The first variety is a megacrystic K-feldspar granodiorite. It gradually ranges in mineralogy to quartz diorite and rarely to quartz monzonite or granite, typically maintaining a massive igneous texture. An exception occurs locally where weakly to strongly foliated granodiorite is seen in distinct sub-parallel zones several meters to tens of meters thick.

A second variety of igneous rock is quartzofeldspathic gneiss with centimeter-thick compositional layering and folded by centimetre to decimetre-scale disharmonic, gentle to isoclinal folds (Hood et al., 2008). The third variety of intrusive is a biotite-rich gneiss. MintoEx geologists consider all units to be similar in origin and are variably deformed equivalents of the same intrusion.

Copper sulphide mineralization is found in the rocks that have a structurally imposed fabric, ranging from a weak foliation to strongly developed gneissic banding. For this reason, all core logging by the past and present operators separates the foliated to gneissic textured granodiorite as a distinctly discernible unit. It is generally believed by MintoEx geologists that the foliated granodiorite is just variably strained equivalents of the two primary granodiorite textures and not a separate lithology.

While this interpretation, based upon detailed observations from logging of tens of kilometers of drill core is highly likely but it still needs to be conclusively proven. Tafti & Mortensen (2004) noted that the relatively massive plutonic rocks have similar mineral and chemical composition as the foliated rocks. Research in collaboration with the Mineral Deposits Research Unit ("MDRU") of the University of British Columbia is on-going.

The contact relationship between the foliated deformation zones and the massive phases of granodiorite is generally very sharp. These contacts do not exhibit chilled margins and are considered by MintoEx geologists to be structural in nature, separating the variably strained equivalents of the same rock type. Tafti and Mortensen (2004) had interpreted the sharp contacts to be zones of deformed rock within the unfoliated rock (i.e. rafts or roof pendants). Supergene mineralization occurs proximal to near-surface extension of the primary mineralization and beneath the Cretaceous conglomerate.

Conglomerate and volcanic flows have been logged in drill core by past operators. New drilling has confirmed the presence of conglomerate, but not the volcanic flows. The latter cannot be confirmed by the authors as the drill core from historic campaigns was largely destroyed in forest fires and no new drilling has intersected such rocks. However, undated volcanic rocks are mapped by Hood, near the southwest margin of the property, south of a fault that is inferred from geophysics to separate them from the Jurassic Age intrusive rocks. The conglomerate has been dated (unpublished date pers. com. Dr. Maurice Colpron - Yukon Geological Survey) as Cretaceous Age. It is now recognized as an outcrop within a borrow pit exposure located west of the airstrip as well as in numerous recent drill holes. Observations of foliated and even copper mineralized cobbles in drilling indicate that "Minto-type" mineralization was exposed, eroded and reincorporated in sedimentary deposits by the Cretaceous Age.

Other rock types, albeit volumetrically insignificant, include dykes of simple quartz-feldspar pegmatite, aplite; and an aphanitic textured intermediate composition rock. Bodies of all of these units are relatively thin and rarely exceed the one meter core intersections. These dykes are relatively late, and observed contact relationships suggest they generally postdate the peak ductile deformation event; however some pegmatite and aplite bodies observed in a rock cut located north of the mill complex are openly folded.

It is unclear if this folding is contemporaneous with foliation development in the deformed rocks or post-dates the foliation development. Observations from drill core and open cut benches in the mine show examples where the foliation and the pegmatitic/aplitic intrusions are both folded, as well as examples where the intrusions are not folded, suggesting two populations of minor dykes.

2.4 Seismic Hazard

The tectonics and seismicity of southwestern Yukon are influenced primarily by the Pacific and North American lithospheric plate margins. In Yukon's St. Elias region, northwest British Columbia and southeast Alaska, the boundary of the two lithospheric plates changes from right lateral transform to subductive. Instead of sliding past each other, the Pacific Plate is forced beneath the stable North American plate resulting in the St. Elias region being uplifted. This transfer of force along the fault into uplift or mountain building dissipates tectonic energy, reducing seismic effects on the region northeast of and across the fault (SRK, 2013).

An assessment of peak ground acceleration was performed for the Minto project area using the 2015 National Building Code Seismic Hazard Calculation, and is shown in below. Additional details can be found in Appendix 1-1 Seismic Hazard Assessment for Minto, YT.

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

July 31, 2016

Site: 62.618 N, 137.241 W User File Reference: Minto Mine

Requested by: , Minto Explorations Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.154	0.229	**0.269**	0.246	**0.207**	**0.146**	**0.083**	**0.030**	**0.012**	**0.125**	**0.156**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.025	0.060	0.091
Sa(0.1)	0.034	0.086	0.134
Sa(0.2)	0.052	0.114	0.166
Sa(0.3)	0.060	0.118	0.163
Sa(0.5)	0.058	0.110	0.146
Sa(1.0)	0.047	0.085	0.109
Sa(2.0)	0.028	0.049	0.063
Sa(5.0)	0.0098	0.018	0.023
Sa(10.0)	0.0039	0.0068	0.0089
PGA	0.022	0.050	0.075
PGV	0.046	0.087	0.114

Figure 2-3: 2015 National Building Code Seismic Hazard Calculation for the Minto Mine

3 Meteorology

The existing meteorology of the Project area and the climate trends and projections of the Minto region of Yukon were first described in detail in EBA's report *Minto Mine – 2010 Climate Baseline Report* and subsequently in Access Consulting Group's (ACG) *Minto Climate Baseline Report* (2012) and Alexco Environmental Group's (AEG) *Minto Mine Site Characterization – Hydrometeorology* (2017) (Appendix 1-2). The meteorological data contained in the above reports were recorded by two on-site meteorological stations over a period of about twelve years. Snow depth and water equivalent data were provided from annual on-site snow surveys since 1994. Data used in climate trend analyses were sourced from regional monthly and annual records provided by the Meteorological Service of Canada and applied to the Project area. Future temperature and precipitation scenarios for the Minto Mine areas were obtained from a probabilistic analysis conducted by SRK (2016). Details of the data collection program and the procedures used for analysis are provided in the 2017 *Hydrometeorology Site Characterization Report* (Appendix 1-2).

The climate in the Minto region is subarctic continental characterized by long, cold winters and short, cool summers. The area experiences moderate precipitation in the form of rain and snow and a large range of temperatures on a yearly basis with a mean annual temperature below 0°C.

3.1 Summary of Site Meteorological Conditions (2005-2016)

Two meteorological stations installed at the property have recorded wind speed and direction, air temperature, relative humidity, barometric pressure, solar radiation and rainfall in one-hour intervals since September 7, 2005 for the HOBO and October 15, 2010 for the Campbell Scientific station. The Campbell Scientific weather station has been shown to provide more reliable data and as such, the HOBO station was decommissioned in the summer of 2014.

3.1.1 Wind

The HOBO anemometer was installed at a height of 3 meters and got damaged by strong winds in 2010. Based on data from the Campbell Scientific anemometer, which is installed at a height of 10 meters and is much less prone to icing than the HOBO anemometer, dominant winds at site originate from the South, Southeast and Northwest, with an average speed of 2.8 m/s and gusts up to 26.8 m/s.

3.1.2 Air Temperature

Summer is characterized by temperatures in the range of 10°C to 20°C. Winter is characterized by a much larger day-to-day variation in temperatures, typically between –10°C and –30°C. Diurnal variation in air temperatures tends to be less during the winter period than during the summer period. The transitions between winter and summer are characterized by a quick rise or fall in air temperatures. July has been the warmest month on average (14.5°C) while the coldest has been December (–17.7°C). The mean annual temperature for the period of record is -1.9°C for the HOBO station and -0.9°C for the Campbell Scientific station. Extremes ranged from -43.2°C to 30.3°C.

3.1.3 Relative Humidity

Relative humidity (RH) is highest during the winter months (typically in the range of 75% to 95%) and lowest during the spring and early summer, typically in the range of 40% to 60%. Relative humidity has a much larger day-to-day variability during the summer. The lowest recorded %RH was 10.25%. The highest was 100%. Annually, mean relative humidity is 70%.

3.1.4 Solar Radiation

As would be expected at a latitude of 62.6°N, a strong seasonal pattern is evident in solar radiation, with a maximum being received near the summer solstice in late June (daily maximums on the order of 750 W/m^2), and daily maximums slightly above zero around the winter solstice when the site experiences only about 3 hours of direct sunlight per day. Large fluctuations from the general trend during the summer are due to cloud cover. Mean annual solar radiation is 108 W/m^2 (averaged over the two meteorological stations).

On July 20, 2016, a second pyranometer was installed at the Campbell Scientific station to measure outgoing radiation. Data from August 2016 to December 2016 range from 5 w/m^2 to 34 W/m^2.

3.1.1 Barometric Pressure

Barometric pressure recorded on-site at 885 m elevation is converted into a meteorological standard sea level equivalent. Barometric pressure is slightly higher on average between May and August (above 1009 hPa), and lowest between September and April (below 1008 hPa). Mean annual sea-level equivalent barometric pressure is 1006.5 hPa (average of both meteorological stations).

3.1.2 Precipitation

3.1.2.1 Rainfall

The Minto Mine HOBO meteorological station has been recording rainfall on site since its installation in September 2005 until decommissioning in June 2014. Based on a cumulative of average monthly rainfall, 192.8 mm of rain is expected on average at site in a single year (AEG, 2017). August is the rainiest month with an average rainfall of 46.2 mm. The largest monthly rainfall total was 100.6 mm (August 2008). Rainfall has been recorded in every month of the year. Based on regional data, about 64% of total annual precipitation falls as rain (average proportion over the period of record for four regional stations). Applying this ratio to the average annual rainfall of 192.8 mm measured at the Minto Mine HOBO station would result in a total annual precipitation value of 303.2 mm.

3.1.2.2 Total Precipitation

The Campbell Scientific station was recording rainfall only from time of commissioning until October 14, 2011, when a snowfall conversion adaptor was installed on the tipping bucket to allow for measurement of total precipitation. On November 18, 2014, a Geonor T-200B vibrating wire all weather precipitation gauge was installed in addition to the existing tipping bucket and rainfall adaptor to improve accuracy and validate total precipitation measurements. Average annual total precipitation is 277.6 mm with the tipping bucket and snowfall adaptor and 248.5 mm with the total precipitation gauge. Both values are less than the estimated total of 303.2 mm based on the HOBO rainfall measurements and regional data. This could indicate potential undercatch of both the snowfall adaptor and total precipitation gauge, however, other factors such as wind or snow pillow formation can also play a role. More years of total precipitation data will allow a more meaningful comparison.

3.1.3 Snowpack

Annual snow surveys have been conducted in 1994, 1995, 1998, and annually from 2006 to 2016, at three locations in the Minto Creek catchment area and a fourth station was added in 2016. Based on the ten years of snow surveys, the average water-equivalent snow depth remaining on the first day of March and April is 86.3 mm and 86.7 mm, respectively. In four of the seven May surveys, the snowpack had melted entirely by May 1. In the three years where snow remained on the ground on May 1 (1995, 2006, and 2008), the mean snowpack had reduced to 10%, 27%, and 20%, respectively, of the peak measured snowpack in that year. The data indicates that the majority of runoff due to snowmelt occurs in April.

3.1.4 Evaporation

No evaporation records are available for the Minto Mine site. An evaporation pan was deployed on site during the summer of 2016, however, due to a system error, data are invalid. Starting in August 2012, the Campbell Scientific datalogger program incorporated an instruction for the calculation of potential evapotranspiration (PET) using the American Society of Civil Engineers (ASCE) standardized reference evapotranspiration equation (Penman-Monteith). The PET instruction uses temperature, relative humidity, wind speed, solar radiation, latitude, longitude and altitude to calculate an evaporation rate for a short grass crop. This provides an approximation of actual evaporation, which varies locally depending on surface type and micro topography. The average total annual PET is 428 mm which is similar to the estimated mean evaporation value of 400 mm/year based on regional data.

3.2 Regional Climate Trends

Long-term trends were evaluated by reviewing long-term records from stations in the region (regional analysis). Environment Canada meteorological stations used for this regional analysis were selected based on location/proximity and data availability.

3.2.1 Temperature

3.2.1.1 Past Trends

The annual mean temperature has been increasing at Pelly Ranch by 0.07°C per year on average over the 57-year period corresponding to a total average increase of 4.2°C from 1957 to 2014. For Carmacks, the average rate of increase of the annual mean temperature is slightly less at 0.05°C per year, resulting in an average increase of 2.5°C for the 52-year period. It is also important to note that the average annual minimum temperature has been increasing at a faster rate than the average annual maximum temperature at both stations, thus implying that the average diurnal range has also been decreasing. With respect to seasonality, January (winter) mean temperatures have experienced much higher rates of increase (0.15°C per year at Pelly Ranch and 0.22°C per year at Carmacks) than July (summer) mean temperatures (0.03°C per year at Pelly Ranch and 0.02°C per year at Carmacks). A close correlation between monthly average temperatures recorded at Minto and at Pelly ranch and Carmacks, as well as the proximity of the stations to the property, suggests that the long term trends would also be applicable to the Minto property. Winter temperatures at Minto however are approximately 3°C to 5°C higher due to a predominant Yukon winter temperature inversion of +8°C/ km up to an elevation of 1200 m (EBA, 2010).

3.2.1.2 Future Trends

Based on a probabilistic analysis conducted by SRK (2016), the mean annual temperature at Minto is expected to increase by about 3.3°C over the next century, with mean annual temperatures of -0.8°C, 0.2°C and 1.1°C in the 2020s, 2050s and 2080s, respectively. The intra-annual range between extreme maximum and extreme minimum temperatures is expected to decrease with time (SRK, 2016).

3.2.2 Precipitation

3.2.2.1 Past Trends

Environment Canada monthly precipitation records at Pelly Ranch and Carmacks show an increasing trend in total annual precipitation over the period of record, however the correlation is weak. The proportion of total precipitation falling as rain also displays an increasing trend over the period of record, but again, the correlation is weak.

3.2.2.2 Future Trends

Based on a probabilistic analysis conducted by SRK (2016), The total precipitation at Minto is forecasted to increase 67.9 mm (15%) during the mine life (2011 to 2040) and 199.3 mm (44%) by 2100 the total precipitation at Minto is forecasted to increase 67.9 mm (15%) during the mine life (2011 to 2040) and 199.3 mm (44%) by 2100. The simple daily precipitation intensity index (mean annual precipitation divided by the total number of wet days) is forecasted to increase by 6.6% during the mine life and by 25% in the next century. Snow accumulation appears to be increasing between December and March mainly by years 2100s.

4 Surface Water Hydrology

The baseline surface water hydrology of the Minto Creek watershed prior to mining activity was detailed in Clearwater Consultants Ltd. Memorandum CCL-MC6 *Minto Copper Project—Surface Water Hydrology Conditions* (CCL, 2010). CCL-MC6 also covered conditions during Mine Operations until 2009. A subsequent report was prepared by ACG to update CCL-MC6 by presenting those previous data, and data gathered since then until the end of the 2012 open water season (ACG, 2013). Additionally, this report included data since 2009 gathered in McGinty Creek, a catchment of similar size to Minto Creek, also draining into the Yukon River and located directly north of the Minto Creek catchment (Figure 4-1). An updated *Minto Mine Site Characterization – Hydrometeorology* report prepared by Alexco Environmental Group (2017) is presented in Appendix 1-2.

Hydrological data have been gathered by either ACG or Minto representatives. Data coverage from year to year varies, depending on when in situ dataloggers were installed and removed, and when instantaneous discharge measurements were taken. Instantaneous discharge is measured using the velocity-area method and a current meter. Solinst Water Leveloggers are used to collect continuous stage readings which are then corrected based on physical staff gauge measurements. The records are processed into continuous discharge based on the stage-discharge relationship. This relationship (stage and discharge) is established each season through rating measurements obtained during regular field visits to the sites.

The locations for which the greatest amount of data have been collected are stations W1, Minto Creek near the mouth (catchment area of 42 km^2); and W3, Minto Creek downstream of water storage pond dam (catchment area of 10.4 km^2 area). In 2010, another continuously monitored hydrometric site called MC1 was added, approximately 2 km upstream of W1. In 2011, data collection did not allow for processing of stage records into continuous discharge; however, improved monitoring allowed for successful processing in 2012.

In addition to Minto Creek, the catchment to the north has been monitored since 2009 to support development of the Minto North deposit, and is referred to as McGinty Creek. There are five stations on McGinty Creek at which discharge is measured. In 2009, four stations were established including MN-4.5, MN-2.5, MN-1.5 and MN-0.5; in 2011 a fifth site, MN-0.2, was added (Figure 4-1). Continuous hydrometric data has been collected at MN-4.5 since 2009, and additional continuous logging instruments were added to stations MN-2.5 and MN-0.5 in late 2012.

MINTO MINE

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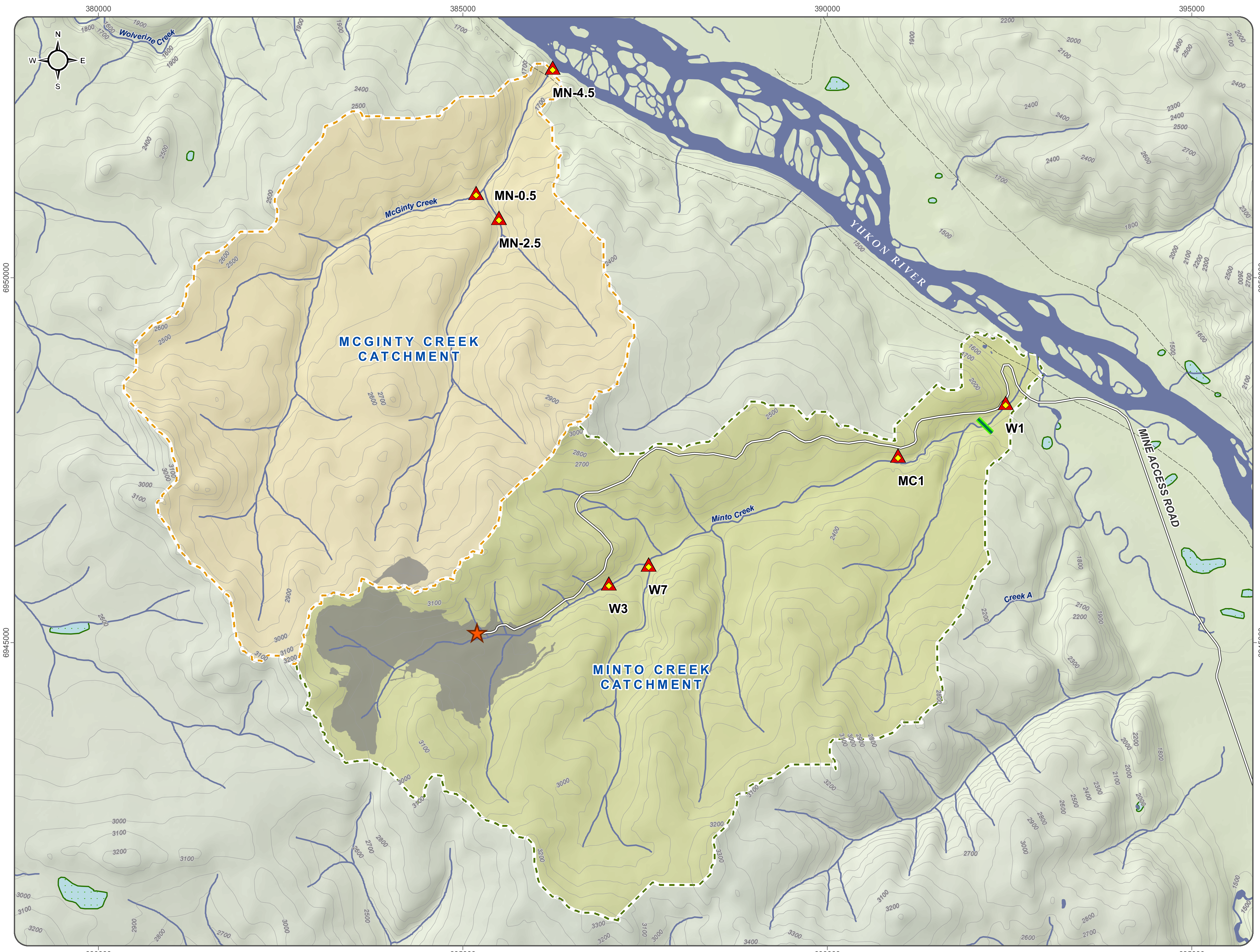
FIGURE 4-1
MINTO AND MCGINTY CREEK HYDROMETRIC MONITORING NETWORK AND CATCHMENT AREAS

JANUARY 2018



Water Quality and Hydrometric Monitoring Station
Observed Fish Barrier - Minto Creek
Mine Footprint
McGinty Creek Catchment
Minto Creek Catchment
Wetland
Minto Access Road
Contours (100ft)

1:50,000 *when printed on 11 x 17 inch paper*

0 500 1,000 1,500 2,000 Meters

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: amatlashevska;12/01/2018/11:24 AM*)

4.1 Minto Creek

Monitoring of hydrological parameters on Minto Creek began in 1993 and has continued intermittently at sites W1 and W3 (Figure 4-1). Monitoring has been more intensive since mine commissioning in 2007. W3 is an in-stream trapezoidal flume with a manufacturer-specified stage-discharge relationship. Both discharge and stage are read on an integrated gauge in the throat of the flume. A Solinst Levelogger record is calibrated with these field observations to process a continuous discharge record at this site. Flows at W3 are impacted by storage within, and discharge from the Water Storage Pond. Sites MC-1 and W1 are natural stream channels where manual velocity measurements are taken across the channel and discharge is calculated using the velocity area method. Continuous water levels from Solinst Leveloggers are processed into continuous discharge using these rating measurements. Updated mean monthly flows for W1 and W3 are presented in Table 4-1 and Table 4-2, respectively.

Table 4-1: Mean Monthly Discharge (m^3/s) on Minto Creek at Station W1.

	Apr	May	Jun	Jul	Aug	Sep	Oct
1993						0.069	
1994		0.312	0.058	0.095	0.007	0.073	
1995		0.027	0.001	0.091		0.133	
1996		0.031	0.024	0.324		0.146	
1997		1.447			0.265		
1998		0.161			0.003		
1999					0.033		
2000		1.004					
2001		0.467					
2002							
2003					0.129		
2004				0.118			
2005		0.097	0.012	0.127	0.209	0.219	0.134
2006	0.203	0.354	0.15	0.02	0.0068		0.031
2007	0.645	0.175	0.053	0.061	0.025	0.034	0.035
2008		0.117	0.015	0.026	0.184	0.184	0.026
2009		0.868	0.351	0.249	0.139	0.026	
2010	0.560	0.081	0.038	0.106	0.118	0.125	0.092
2011			0.229	0.200	0.200	0.082	
2012		0.269	0.073	0.052	0.051	0.078	0.056 [2]
2013		0.485 [1]	0.064	0.065	0.044	0.085	0.059 [2]
2014		0.138 [1]	0.022	0.020	0.014	0.031	0.025 [2]
2015		0.117	0.010	0.010	0.030	0.024	0.020 [1]
2016	0.252 [1]	0.047	0.020	0.017	0.024	0.043	0.026
Mean							
Pre-Mine 1993 to 2006	0.203	0.433	0.049	0.129	0.093	0.128	0.083
Mining Period 2007 to 2016	0.486	0.255	0.088	0.081	0.083	0.071	0.042
All Data 1993 to 2016	0.415	0.344	0.075	0.099	0.087	0.090	0.050

Notes: [1] Based on incomplete or derived data

[2] Based on multiple discrete measurements

Table 4-2: Mean Monthly[1] Discharge (m^3/s) on Minto Creek at Station W3.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993									0.028			
1994					0.101	0.028	0.039	0.011	0.028			
1995						0.004	0.017		0.027	0.008		
1996					0.013		0.087		0.021			
1997					0.554							
1998								0.006				
1999								0.006				
2000												
2001					0.160							
2002												
2003								0.037				
2004							0.026					
2005					0.046	0.008	0.014	0.017	0.022	0.020		
2006				0.018	0.128	0.042	0.006	0.015	0.009	0.010		
2007				0.001	0.012	0.009	0.006					
2008								0.064[2]	0.122[2]	0.003		
2009						0.026[2]	0.106[2]	0.092[2]	0.124[2]	0.110		
2010				0.002	0.004	0.005	0.034	0.071	0.086	0.070		
2011						0.005	0.005	0.006	0.005			
2012				0.004	0.020	0.003	0.004	0.004	0.004	0.004		
2013						<0.001	<0.001	0.002	0.003	0.003	0.003	0.006
2014	0.003	0.006	0.006	0.057	0.086	0.003	0.003	0.003	0.004	0.004	0.004	0.006
2015	0.004	0.002	0.001	0.075	0.052	0.003	0.003	0.004	0.004	0.004	0.004	0.003
2016				0.022	0.052	0.003	0.003	0.004	0.004	0.004	0.003	0.004
Mean												
Pre-Mine 1993 to 2006	-[3]	-[3]	-[3]	-[3]	0.167	0.02	0.032	0.015	0.023	0.013	-[3]	-[3]
Mining Period 2007 to 2016	0.004	0.004	0.004	0.027	0.038	0.007	0.021	0.028	0.040	0.025	0.004	0.005
All Data 1993 to 2016	0.004	0.004	0.004	0.026	0.102	0.012	0.025	0.023	0.033	0.022	0.004	0.005

[1]Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.

[2]Flows impacted by storage within, and emergency releases from, the Water Storage Pond in August and September 2008 and in June through October 2009.

[3]Insufficient data for calculation.

Table 4-3 shows the discharge data gathered to date at station MC-1 and Table 4-4 shows data available at station W7. Appendix 1-2 contains the associated baseline report and the available hydrographs from 2007-2012 for stations W1, W3, W7 and MC-1.

Table 4-3: Mean monthly discharge (m^3/s), Minto Creek at MC-1.

	Month					
Year	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2011					0.118	0.093
2012	0.179	0.065	0.052	0.041	0.108	-
2013	0.358	0.085	0.103	0.044	0.089	0.064 [2]
2014	0.187	0.028	0.031	0.036	0.028	0.033 [2]
2015	0.862 [2]	0.014	0.028	0.042	0.035	0.031 [1]
2016	-	0.029 [1]	0.036	0.048	0.076	-
Mean	**0.397**	**0.044**	**0.050**	**0.042**	**0.076**	**0.055**

Notes: [1] Based on incomplete or derived data

[2] Based on multiple discrete measurements

Table 4-4: Mean monthly discharge (m^3/s), Minto Creek at W7.

	Month					
Year	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2013			0.013	0.031	0.019	0.006
2014	0.112					
2015		0.006	0.004	0.011	0.011	0.029
2016		0.006	0.010	0.010	0.013	0.010

Notes: Based on discrete measurements only

4.2 McGinty Creek

McGinty Creek has two main sub-catchments that each have two water quality monitoring stations, one just above the confluence and one near the headwaters. MN-4.5 is located on the main stem below the confluence of the tributaries near the mouth; just above the Yukon River (Figure 4-1). MN-0.5 and MN-0.2 are the lower and upper stations on the west tributary, respectively. MN-2.5 and MN-1.5 are the lower and upper stations on the east tributary, respectively. Stations MN-0.2 and MN-1.5 are not set up with continuous loggers and generally exhibit very low flows. As such they are not included in the discussion below.

Table 4-5: Mean monthly discharge (m^3/s), McGinty Creek at MN-4.5.

	Month						
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2009	-	0.018 [1]	0.033	0.019	0.031	0.016	0.013 [1]
2010	-	0.028 [1]	0.051	0.079	0.047	0.034	-
2011	-	0.444	0.093	0.125	0.134	0.068	0.045 [1]

	Month						
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2012	0.212 [1]	0.230	0.180	0.082	0.053	0.109	-
2013	-	-	0.054 [1]	0.103	0.093	0.116	-
2014	-	0.230 [1]	0.041	0.037	0.026	0.046 [1]	-
2015	-	-	0.013	0.046	0.049	0.029	0.029 [1]
2016	-	0.017 [1]	0.015	0.026	0.028	0.028	0.010 [1]

Notes: [1] Based on incomplete or derived data

Table 4-6: Mean monthly discharge (m^3/s), McGinty Creek at MN-2.5.

	Month						
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2014 [1]	-	0.032	-	-	-	-	-
2015 [1]	-	0.015	0.003	0.011	0.038	0.010	0.010
2016 [1]	0.034	0.008	-	-	0.009	0.014	0.003

Notes: [1] Based on incomplete or derived data

Table 4-7: Mean monthly discharge (m^3/s), McGinty Creek at MN-0.5.

	Month						
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2014 [1]	-	0.045	-	-	-	-	-
2015 [1]	-	0.035	0.013	0.054	0.098	0.029	0.025
2016 [1]	-	0.028	0.016	0.010	0.016	0.035	0.018

Notes: [1] Based on incomplete or derived data

Hydrographs from 2009–2016 at MN-4.5, MN-2.5 and MN-0.5 are shown in the *Minto Mine Site Characterization – Hydrometeorology* report (Appendix 1-2).

5 Surface Water Quality

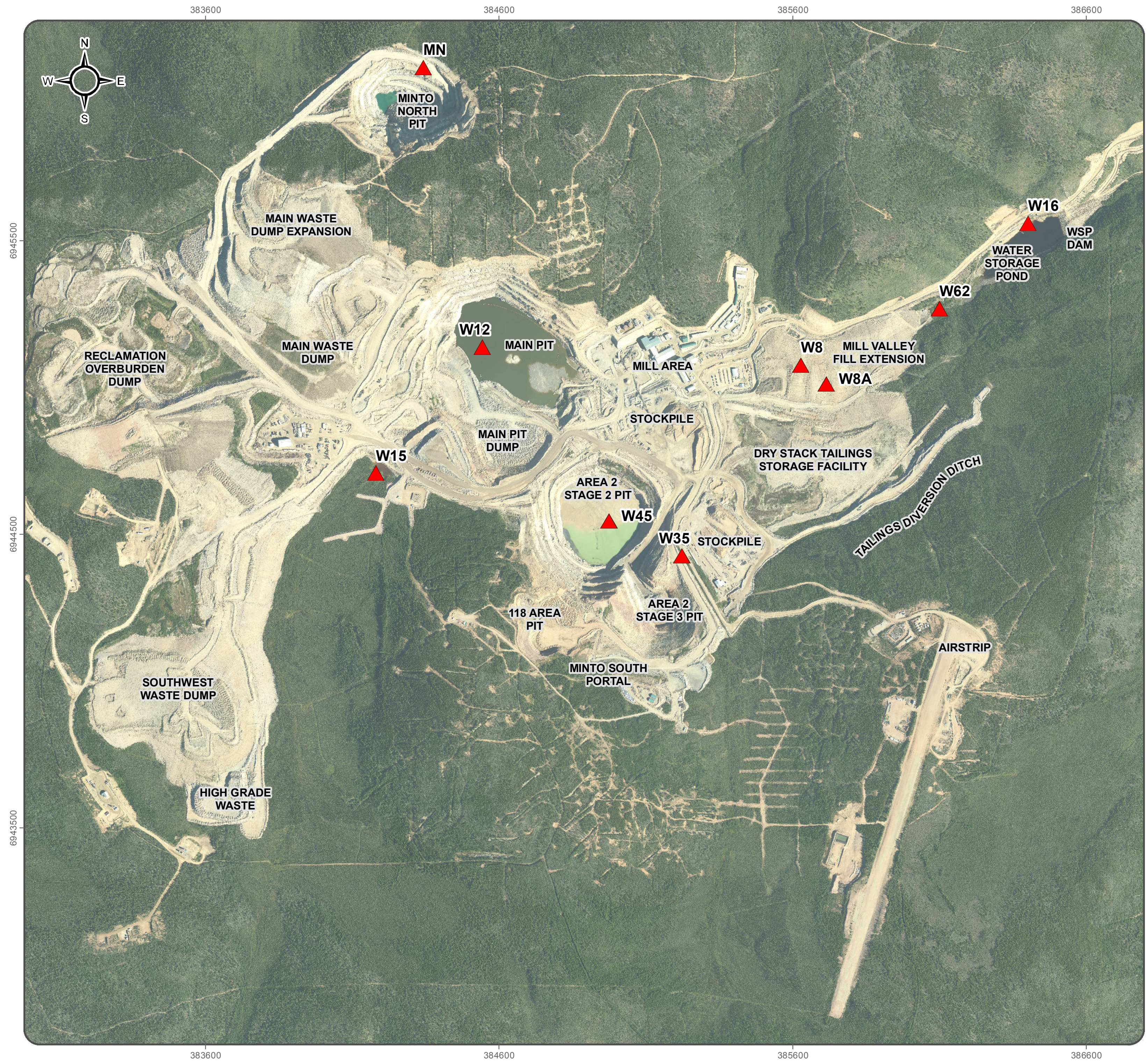
Surface water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects. Effects from mining activities can be observed for significant distances downstream and changes to water quality parameters have the potential to impact aquatic resources and to affect human use of water resources. Both Minto and McGinty Creeks are receiving environments for Minto Mine and have been monitored for water quality conditions, with more intensity and duration of sampling in Minto Creek as part of the initial baseline and more recently the intensive operational monitoring under the mine water quality monitoring programs (licenced and otherwise). A characterization report for water quality in these two watersheds has been developed with the intention of presenting either baseline or existing water quality conditions as the foundation of assessing potential effects from proposed mine expansion activities. Minto Creek and McGinty Creek have both been previously characterized in numerous reports. The *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017) included as Appendix 1-3 provides updates to the water quality characterization of both Minto and McGinty Creek stations and for key mine site water management and monitoring stations, and includes monitoring results to December 2016. Key findings from the characterization report are included below.

5.1 Minto Mine Site

The water quality for ten monitoring stations around the Minto Mine Site including W8, W8A, W12, W15, W16, W35, W35A, W35B, W45 and W62 is summarized in this section. For ease of discussion and presentation of results, these stations are divided into two groupings: the “upper mine site” and “lower mine site”. The Minto Mine Site stations and groupings are described in Table 5-1 and shown in Figure 5-1. Water quality is monitored at many more locations on the Minto site, but these ten stations are the most critical with respect to decisions regarding the conveyance, storage and treatment of site water.

Table 5-1: Minto Mine Monitoring Station Locations.

Station	Description / Location
Upper Mine Site	
W12	Main Pit
W15	Minto Creek, d/s of Southwest Waste Rock Dump
W35	South Diversion Ditch
W35A	North End of South Diversion Ditch
W35B	South End of South Diversion Ditch
W45	Area 2 Pit
Lower Mine Site	
W8	Dry Stack Tailings Storage Facility drainage, west
W8A	Dry Stack Tailings Storage Facility drainage, east
W16	Water Storage Pond
W62	Sump at toe of Mill Valley Fill Extension



MINTO MINE

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FIGURE 5-1

MINE SITE MONITORING STATION LOCATIONS

JANUARY 2018

capstone MINTO MINE

Surface Water Surveillance Program Monitoring Station Locations

1:18,000 *when printed on 8x11 inch paper*

0 100 200 300 400 500 Meters

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Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 3rd[th] 2017.

Datum: NAD 83 Projection: UTM Zone 8N

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The characteristics, trends and patterns associated with the geochemistry of surface waters at the Minto Mine Site are summarized below, while more details are available in *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017) included as Appendix 1-3.

- The pH of the waters was predominantly circumneutral to slightly alkaline;
- Although typically well oxygenated, lower levels of dissolved oxygen were often observed during winter, particularly for the pit lake locations, where ice cover limited the oxygenation of underlying waters;
- Nitrogen species concentrations were generally highest in the pit lake and DSTSF drainage sites, reflecting leaching of nitrogen residue from blasting activity. Nitrate-N levels showed marked seasonality at both the Minto Creek mine site location (W15) and the DSTSF drainage (W8 and W8A), but with different patterns. In Minto Creek, nitrate-N levels were highest in winter and lowest over summer, responding to nitrogen uptake demand by primary producers, whereas the opposite trend was noted in the DSTSF drainage;
- DOC concentrations were highest during spring snowmelt, likely due to snowmelt flushing the surrounding soils of labile organic matter that had accumulated through the previous summer and fall;
- Dissolved hardness concentrations were typically lowest in spring at the flowing water sites due to snowmelt dilution, and increased through the year, peaking in winter, suggestive of a marked groundwater component to hardness levels;
- Concentrations of dissolved iron, and to a lesser extent dissolved aluminum, often appeared higher than may be expected from equilibrium with their oxyhydroxide minerals under the prevalent oxidizing, circumneutral pH conditions. Complexation with dissolved organic matter likely maintains these elevated dissolved iron and aluminum levels;
- Dissolved copper concentrations were highest in the DSTSF drainage and tended to peak with freshet, suggestive of some association with DOC; and
- Dissolved concentrations of both selenium and molybdenum increased approximately four-fold in the pit lake sites over the past two to three years, alongside sulphate. Dissolved selenium exhibited strong seasonal cycling in both Minto Creek (W15) and the DSTSF drainage (W8A), but with offset patterns. In Minto Creek, selenium concentrations were lowest at freshet, then rose through the year, peaking in winter, suggestive of a strong groundwater contribution. The opposite pattern was observed at site W8A, where selenium levels oscillated on an annual basis between summer peaks and winter troughs.

5.2 Minto North Pit

The Minto North Pit is located at the northernmost tip of the mine site (Figure 5-1). Station MN was established with the initiation of the mining activities in the Minto North Pit (August 2015), and the monitoring results presented in the report for this station are all 'operational' results. Water quality data from the Minto North Pit are considered in isolation since the pit does not discharge at present and is not anticipated to discharge during the operational period.

The characteristics, trends and patterns associated with the geochemistry of Minto North Pit are summarized below, while more details are available in *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017) included as Appendix 1-3.

- Minto North Pit waters were circumneutral to mildly alkaline and well oxygenated over the one year of data collected to date;
- Field-measured conductivity and hardness were relatively high and showed no seasonal trends;
- Nitrogen species were very high in the Minto North Pit, likely due to nitrogen residue from blasting activities;
- Minto North Pit waters generally contained elevated dissolved copper, molybdenum, and selenium concentrations;
- The majority of dissolved silver and zinc measurements were below detection; and
- Dissolved aluminum, arsenic, cadmium, nickel, and iron concentrations were unremarkable although some sporadic spikes in iron levels were an order of magnitude higher than the median dissolved iron concentration.

5.3 Minto Creek

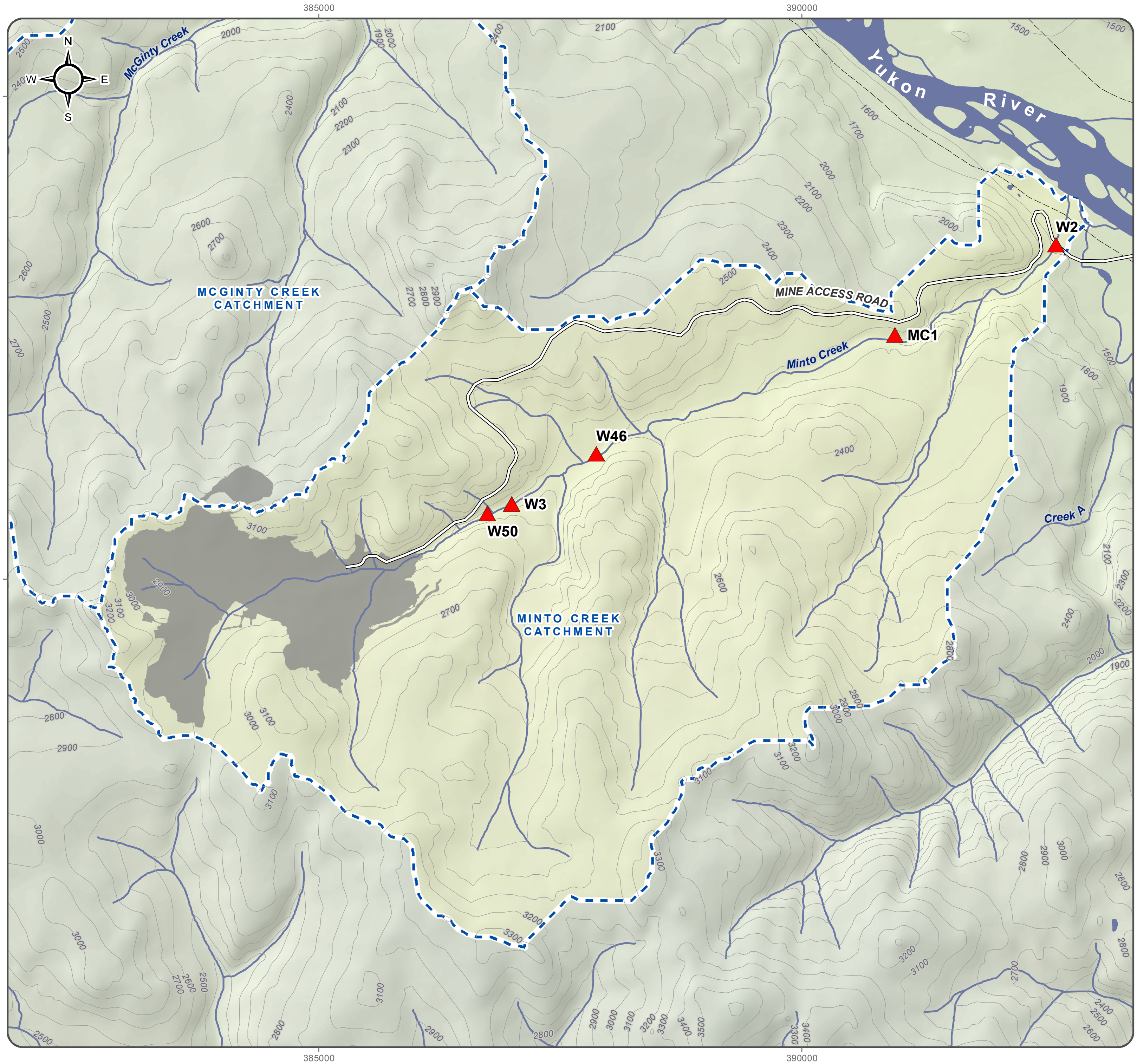
Several water quality stations are monitored on Minto Creek during the operational period. Data from four of these monitoring stations are provided in this report: W50, W3, MC1, and W2. These stations are described in Table 5-2 and their location shown in Figure 5-2. These stations are all on the 'mainstem' of Minto Creek.

Table 5-2: Minto Creek Monitoring Station Locations

Station	Description / Location
W50	Minto Creek, approximately 50m downstream of toe of WSP dam
W3	Downstream of Water Storage Pond dam, MMER Final Discharge Point (Flume) – Effluent
MC1	Receiving Environment station upstream of the canyon fish barrier on Minto Creek.
W2	Lower Minto-Creek at Road Crossing – Receiving Environment station in reach with documented fisheries usage.

W50 is located downstream of the inflow of the effluent discharge and is a point of compliance for effluent quality standards (EQSs) as outlined in WUL QZ14-031 (August 5th, 2015). EQSs are presented and discussed in further detail in Section 3.3 of Appendix 1-3 *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017). Station W3—located downstream of the Water Storage Pond dam—is the mine effluent monitoring and compliance point per the Metal Mining Effluent Regulations (MMER). Station W2 is the lowermost Minto Creek receiving environment monitoring location before the confluence with the Yukon River, and is the "WQO Station" designated in the Water Use Licence QZ94-031 during the period when flow is encountered at stations W15 and W35. Both W2 and W3 have been monitored regularly since 2005. Station MC1 in Minto Canyon serves as a comparison monitoring point between W3 and W2 and began regular monitoring in 2010.

Four additional stations (W6, W7, C4 and C10) situated on tributaries to Minto Creek are monitored regularly or semi-regularly. The data for these stations are not included in this reporting update as they were a component of the Minto Creek background water quality evaluation in 2016, and are included in Minnow Environmental Inc. (2016) (Appendix A of Appendix 1-3).



MINTO MINE

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FIGURE 5-2

MINTO CREEK MONITORING STATION LOCATIONS

JANUARY 2018

capstone MINTO MINE

Surface Water Surveillance Program Monitoring Station Locations

Catchment

Mine Footprint

Minto Access Road

Trail

1:55,000 ***when printed on 8x11 inch paper***

0 500 1,000 1,500 2,000

Meters

ALEXCO ENVIRONMENTAL GROUP

Datum: NAD 83 Projection: UTM Zone 8N

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5.3.1 Background Water Quality

In 2009, to support the redevelopment of the mine Water Management Plan, Minnow Environmental compiled Minto Creek water quality monitoring data into a pooled data set that reflected background (unimpacted by development activities) conditions. The mine water-quality monitoring program has continued to monitor stations within the operational area, downstream stations which are exposed to the influence of mine effluent discharge, and downstream stations which are not exposed to effluent. Data from these non-exposed stations are relevant the background water quality condition in Minto Creek, and were therefore added to the pre-existing 2009 background data set. New background data sets were developed for periods up to the end of 2010 and to the end of 2012. The background water quality data are also used in the water quality prediction work as the 'unimpacted' source term for undisturbed catchment areas.

5.3.2 Mainstem Minto Creek Water Quality

The characteristics, trends and patterns associated with the geochemistry of surface waters at the Minto Creek stations is summarized below, while more details are available in *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017) included as Appendix 1-3.

- The Minto Creek waters were typically circumneutral to slightly alkaline pH and well-oxygenated;

- Nitrogen species concentrations were generally higher during and following periods of mine discharge, likely due to blasting activity within the mine site. Aside from discharge periods, seasonal trends were observed, particularly for nitrate-N, with lower nitrate-N concentrations typically observed in summer months when primary producers that uptake nitrogen species would be most active;

- Concentrations of DOC at W3 were typically higher during April/May likely due to high flows caused by spring meltwater mobilizing organic carbon that had accumulated over the previous year. DOC concentrations also appeared to be higher during mine discharge periods, but as many of these periods occurred in early spring it is difficult to discern the effects of mine discharge on DOC. At downstream stations MC1 and W2, DOC concentrations were higher in mid to late summer and were generally lower in spring and winter;

- Hardness was often lowest in April and May and increased through the summer and fall suggesting dilution in spring, followed by a higher proportional contribution of groundwater to Minto Creek flow through summer, fall, and winter. This trend was more marked at W50 and downstream stations MC1 and W2, whereas W3 returned higher hardness concentrations with less seasonality;

- Dissolved aluminum concentrations were higher in the spring and decreased through the year, likely due to mobilization by high flows from spring meltwater and possibly complexation by DOC, which also peaked in spring;

- Dissolved arsenic and iron concentrations were typically higher at downstream stations MC1 and W2 than upstream stations and were highest in mid to late summer. A reasonable correlation with DOC concentrations suggests DOC likely enhances iron solubility at MC1 and W2;

- Since 2010, dissolved chromium, lead, silver and zinc has generally been closer to or below detection levels with and without mine discharge;

- Dissolved copper, molybdenum and selenium concentrations were higher during and following periods of mine discharge. Dissolved copper concentrations also appeared to vary seasonally with higher concentrations observed in the spring with higher flows from meltwater and were correlated with DOC concentrations. Dissolved molybdenum concentrations were consistently higher at W3 than W2 in pre-operations and during non-discharge periods.

5.4 McGinty Creek

McGinty Creek water quality was monitored monthly by ACG from May 2009 until July 2012 and has since been monitored monthly by Minto Mine Environment Department staff.

Water quality is monitored at five stations in the McGinty Creek watershed, described in and shown in . Water quality results for McGinty Creek stations are presented and discussed in two groups:

1. East arm of McGinty Creek (MN-1.5 and MN-2.5) and MN-4.5; and

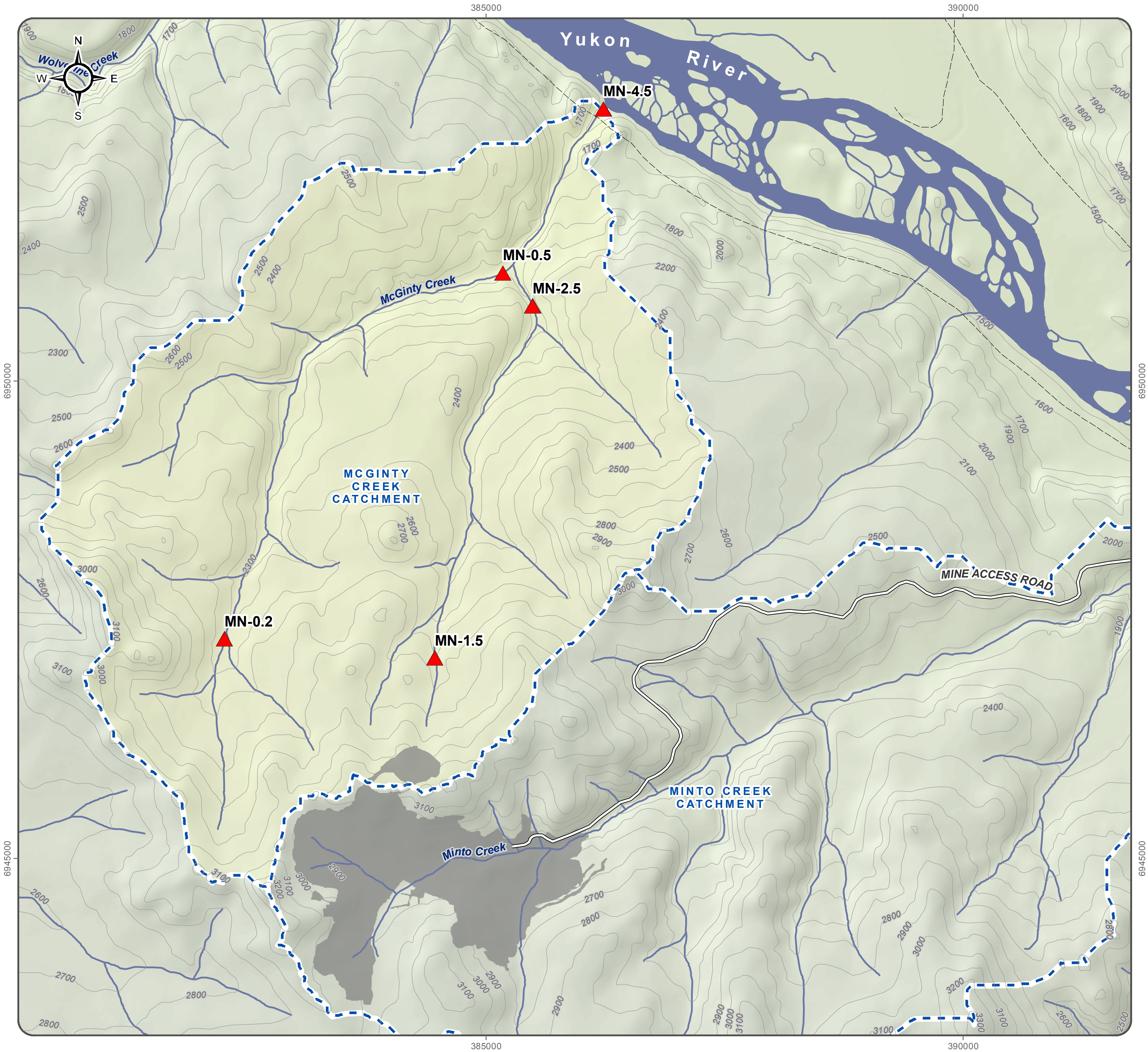
2. West arm of McGinty Creek (MN-0.2 and MN-0.5).

The east arm of McGinty Creek is considered the ‘exposure tributary’ as it originates downgradient of the Minto North deposit where the Minto North pit is located, while the west arm of McGinty Creek is considered the ‘reference tributary’.

Table 5-3: McGinty Creek Monitoring Station Locations.

Station	Description / Location
East Arm of McGinty Creek	
MN-1.5	Upper east arm of McGinty Creek downstream of the Minto North deposit
MN-2.5	East arm of McGinty Creek just upstream of confluence with the west arm
MN-4.5	Lower mainstem McGinty Creek near confluence with Yukon River
West Arm of McGinty Creek (Reference Stations)	
MN-0.2	Upper west arm of McGinty Creek
MN-0.5	West arm of McGinty Creek just upstream of the confluence with the east arm

Monitoring at the upper reference station MN-0.2 was suspended between June 2009 and April 2011, which explains in part the lower total number of samples collected at this station. Similar to Minto Creek, McGinty Creek typically freezes in the winter months with little to no flow observed at all monitoring stations.



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RECLAMATION AND CLOSURE PLAN

FIGURE 4-4

MCGINTY CREEK WATER QUALITY MONITORING STATION LOCATIONS

JANUARY 2018

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Surface Water Surveillance Program Monitoring Station Locations

Catchment

Mine Footprint

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Meters

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National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Datum: NAD 83 Projection: UTM Zone 8N

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The characteristics, trends and patterns associated with the geochemistry of surface waters at the and McGinty Creek stations is summarized below, while more details are available in *Minto and McGinty Creeks Water Quality Characterization report* (AEG, 2017) included as Appendix 1-3.

- Field pH was generally circumneutral to slightly alkaline and increased farther downstream in both arms of McGinty Creek;
- The waters were fairly well-oxygenated with occasional troughs of dissolved oxygen measured in winter months when ice cover likely inhibited ingress of oxygen to McGinty Creek;
- Nitrate-N concentrations were typically lower in April/May due likely to dilution from meltwater and higher values were typically observed in the winter when uptake by primary producers would have been lowest. Nitrite-N was predominantly below detection level in McGinty Creek;
- Concentrations of DOC were typically higher during April/May likely due to mobilization by high flows caused by spring meltwater. Higher concentrations were also commonly observed in mid to late summer;
- Dissolved hardness concentrations increased farther downstream and varied seasonally with lowest concentrations in the spring and increasing concentrations through to the winter, suggesting a significant proportion of hardness from baseflow that is diluted by spring meltwater;
- Dissolved aluminum concentrations were higher in the upstream stations of the east and west arms of McGinty Creek and were erratic, perhaps varying with precipitation events as concentrations were typically higher in April and May when higher flows caused by spring meltwater could mobilize aluminum. Complexation by DOC, which was highest during spring, may also have maintained elevated dissolved aluminum concentrations at this time;
- Dissolved arsenic and iron concentrations were higher in upstream stations of the east and west arm of McGinty Creek and often peaked in August or September. A negative correlation between iron and ORP suggests the presence of a groundwater seep with reducing conditions that could have provided elevated concentrations of iron to McGinty Creek. DOC could also be a factor in maintaining higher iron concentrations in solution;
- Dissolved cadmium and zinc concentrations appeared to decrease from 2010 to 2013 and have been fairly low throughout all McGinty Creek stations post-2013;
- Dissolved chromium concentrations were higher in upstream stations of the east and west arms of McGinty Creek;
- The upstream-most stations – MN-1.5 (east arm) and MN-0.2 (west arm reference tributary) – consistently returned higher dissolved copper concentrations in McGinty Creek. Generally,

concentrations were higher in April/May likely due to mobilization by the elevated DOC levels observed at this time of the year;

- Dissolved molybdenum concentrations typically increased moving downstream in McGinty Creek and varied seasonally such that lower concentrations were observed in the spring and higher concentrations were observed in the winter, suggestive of dilution of baseflow providing the bulk of molybdenum to McGinty Creek in the spring;

- Dissolved lead and silver concentrations have generally been close to or below their respective detection levels in McGinty Creek;

- Dissolved selenium concentrations in McGinty Creek were generally highest in the west arm (reference tributary) at MN-0.5, suggesting a significant proportion of loading occurs from the west arm to McGinty Creek downstream of MN-2.5 and upstream of MN-4.5.

6 Groundwater

Current groundwater conditions for the Minto Mine are presented in multiple reports. Groundwater conditions at the Minto site are monitored as part of the Minto Mine Groundwater Monitoring Plan (GMP, 2016-02), with monitoring data reviewed as part of the Operational Adaptive Management Plan (OAMP, 2017-02). The *Groundwater Characterization and Conceptual Model Update Report* (SRK 2018a) includes an assessment of data collected from groundwater wells in the area, results from the environmental tracer study and an assessment of potential transport of mine contact water across the site (see Appendix 1-4a). Updated conceptual models are presented for both the Minto Creek and McGinty Creek catchments. SRK (2018b) presents a summary of groundwater quality at OAMP monitoring stations that has reached thresholds defined in the OAMP (see Appendix 1-4b). The sum of this information is the basis for this section.

In the Minto Creek catchment, groundwater is fracture-controlled and, at the largest scale, groundwater flow follows topography, except where influenced by the Main and Area 2 open pits, and the Minto South Underground. These mine components create localized hydraulic sinks that overprint the topographic flow system. Locally, permafrost impedes downward infiltration of water from reaching the deeper groundwater system. Groundwater that does flow out of the mine footprint will move towards the Minto Creek valley and the Yukon River. Most of groundwater from the mine is expected to discharge to surface water by or within the Water Storage Pond. Any groundwater that does bypass the Water Storage Pond would be assumed to discharge to Minto Creek by surface water station MC1.

Seepage of contact groundwater from the open pits is interpreted to have remained within the mine footprint. OAMP events for groundwater quality are limited to SO_4, As, Cd and Se; other parameters have remained stable or not shown consistent changes sufficient to trigger the OAMP. As and Cd events have been inconsistent and, as of the last 2017 sampling round, did not exceed thresholds. Se exceedances have also been inconsistent and do not show consistent trends. SO_4 exceedances in groundwater at the mine property boundary are interpreted to not be related to mine seepage (Appendix 1-4a).

In the McGinty Creek catchment, the only current mine component is the Minto North open pit and related roadwork. In this catchment, groundwater is fracture-controlled and flow follows topography, with the Minto North open pit acting as a hydraulic sink; the open pit has not filled with water. Groundwater in this catchment that does not report to the open pit will move towards the Yukon River and is assumed to discharge to McGinty Creek.

There is interpreted to be no seepage of contact groundwater from the Minto North open pit as the pit is acting as a hydraulic sink. OAMP events for groundwater quality have occurred for As, Zn, Cd, NO_3 and SO_4. Zn and Cd events have been inconsistent. As and NO3 exceedances in groundwater have been consistent but are interpreted to be related to flushing of non-PAG haul road rock via precipitation. SO_4 exceedances of baseline concentrations have been ongoing, but concentrations are very low (<5 mg/L) and not considered significant.

7 Wildlife

Wildlife assessments were completed within, or near, the Project area between 1994 and 2017. This section summarizes the results of wildlife surveys conducted in the area to date, identifies species of concern, and lists ongoing and/or near-future surveys to be completed. The last update on the number and types of wildlife studies that have been conducted in the Minto Mine area was in a comprehensive 2010 report produced by EBA Engineering Consultants Ltd (EBA), titled *Minto Mine, Environment Baseline Report – Wildlife*.

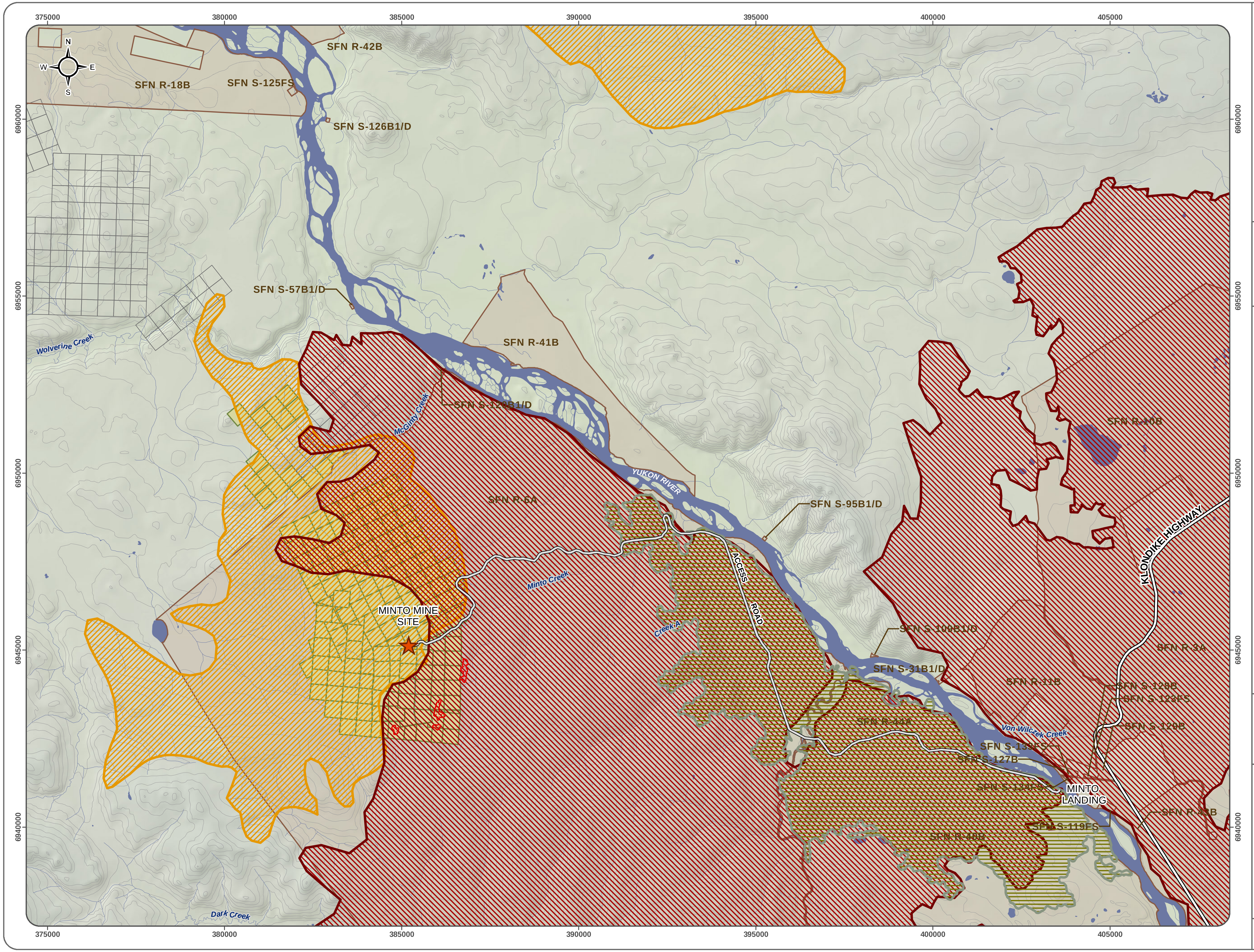
7.1 Environmental Setting

The Minto Mine is located within the Boreal Cordillera ecozone and in the western part of Yukon Plateau Central ecoregion (Smith et al., 2004). The Minto Mine is situated in the far western part of the Yukon Plateau-Central ecoregion near the Dawson Range and adjacent to the Klondike Plateau ecoregion in the west. The area was part of the eastern extent of Beringia, which remained ice-free approximately twenty to fifteen thousand years ago during the last maximum glacial period (Smith et al., 2004).

The Minto Mine is in the eastern part of the Dawson Range the local elevation ranges from 700 m to 950 m; the general landscape is composed of rounded mountains intersected by broad valleys and drainages that flow into the Yukon River. The access road starts on the western side of the Yukon River, at the barge landing site, continues north along the Yukon River and then turns southwest up the Minto Creek valley for 12 km to reach the Minto Mine site.

Forest fires are frequent in this region as less than 300 mm of precipitation falls per year due to the rain shadow formed by the St. Elias-Coast Mountains in the west. As a result, the study area around Minto Mine has experienced numerous fires over the last thirty years, rendering it into a complex mosaic of plant communities at various stages of succession. The oldest pertinent fire burned approximately 7,236 ha in 1980, the second and more extensive fire occurred in 1995 and burned approximately 55,521 ha (GYWFM, 2012). The 1995 burn occurred along the access road by the Yukon River barge landing and just west of the airstrip as shown in . The most recent fires occurred in 2010 and 2011, these small fires only consumed 17 hectares within the Minto claims, southeast of the airstrip.

The fire-disturbed areas are now regenerating and young forest or shrub ecosystems dominate the Minto area (Oswald and Brown, 1990). Willows (*Salix sp*.) and trembling aspen (*Populus tremuloides*) are the most represented species in crown cover at present. Lodge pole pine (*Pinus contorta latifolia*) is a later successional species and will gradually dominate well-drained mid and upper slopes. Shade-tolerant white spruce is the regenerating climax tree species currently found in the understory as seedlings. White spruce will eventually overgrow the pine and trembling aspen communities. Black spruce (*Picea mariana*) is also a climax species that is adapted to wetter, cooler sites, and is often the persistent species in white/black spruce-mixed areas along slope toes, valley bottoms and northern aspects. Small grasslands are scattered along dry crests and steep south-facing slopes, these locations do not retain enough moisture to sustain tree growth.



MINTO MINE

CAPSTONE MINTO MINE - SITE CHARACTERIZATION PLAN

FIGURE 7-1
FIRE HISTORY

JANUARY 2018

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- Minto Mine Site
- Control Burn 2010
- 1980 Fire
- 1995 Fire
- 2010 Fire
- Selkirk First Nation Settlement Lands
- MInto Exploration Ltd. Claims
- Other Claims
- Mine Access Road

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First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of 12 January 2018. Data obtained from Mineral Resources Branch, Energy Mines and Resources Department, Government of Yukon.
Site hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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The diversity of vegetative communities and successional stages around the Minto Mine provides a variety of habitat niches that support approximately 46 species of mammal (insectivores, bats, lagomorphs, rodents, carnivores, and ungulates), 60 species of birds, and one species of amphibian, the wood frog (*Rana sylvatica*). The list of mammals and bird species known to exist in the Minto area and/or the Yukon Plateau-Central ecoregion is included in EBA's 2010 baseline report.

7.2 Wildlife Baseline Assessments

lists the wildlife surveys and studies that have been conducted since 1994 in the Minto Mine area.

Table 7-1: Wildlife Surveys and Studies Undertaken in the Minto Project Area.

Dates	Type of Survey	Conducted By
Jan-March 2012	Late Winter Ungulate Studies	EDI, Environment Yukon
Fall 2012	Klaza Caribou Herd Study	Environment Yukon
March 2011	Late Winter Ungulate Study	Environment Yukon and EDI (on behalf of Casino Mining Corporation)
July 2010	Baseline Ecosystems and Vegetation Survey	Access Consulting Group
February 2010	Late Winter Moose Survey (Aerial)	Access Consulting Group
December 2010	Post-rut Moose Survey (Aerial)	Access Consulting Group
June 2009	Dall Sheep Survey (Aerial)	Environment Yukon
2007	Moose Survey	Environment Yukon
2003	Klaza Caribou Herd Survey	Environment Yukon
1994	Spring Wildlife Survey Spring Dall Sheep Survey Summer Raptor Survey Summer Wildlife Ground Pellet Survey	Hallam Knight Piesold Ltd.

The three most recent wildlife baseline studies were led by the Yukon Government (YG) and were not designed specifically for the Minto Mine project. These studies encompassed the large Carmacks West Moose Management Unit and the Klaza caribou herd range, for a total area of 6,430 km^2 which overlapped the Minto Mine site. The results from the YG surveys, when released, will provide more statistically sound estimates of moose and caribou population levels, gender ratios and recruitment success for the overall region. These values can then be used as means of gaging how Minto Mine area resident ungulate populations are faring. Also, the locations of sightings when mapped show distribution and can help detect high value habitat that may require protection if mine and road development increases substantially beyond the current footprint (which is not currently anticipated).

The 2010 Baseline Ecosystems and Vegetation Study (Access Consulting Group (ACG), 2010) was not primarily focused on wildlife; however, general wildlife observations were made during the vegetation survey, recorded on plot data sheets and wildlife mitigation recommendations were included in the report.

A wildlife log is maintained on site to track the animal sightings, details and behaviour in the site vicinity, and to monitor any human-wildlife interactions.

7.3 Wildlife Species of Conservation Concern in Yukon

The Minto Mine area and surrounding environment provide habitat for several species considered at risk by both the federal and territorial governments. lists species that have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or the Yukon Government as needing special attention and protective legislation, so that remaining populations are not unduly stressed. The list consists of species whose range overlaps the Minto Mine area.

Table 7-2: Wildlife Species of Conservation Concern in Yukon.

Species	Status*	Source
Little Brown Bat (*Myotis lucifugus)*	Endangered	COSEWIC (2012)
Common Nighthawk *(Chordeiles minor)*	Threatened	COSEWIC (2007)
Olive-sided Fly Catcher *(Contopus cooperi)*	Threatened	COSEWIC (2007)
Barn Swallow (*Hirundo rustica)*	Threatened	COSEWIC (2011)
Canada Warbler *(Wilsonia canadensis)*	Threatened	COSEWIC (2008)
Peregrine Falcon (*Falco peregrinus anatum - tundrius)*	Special concern	COSEWIC (2007), Yukon Wildlife Act (2002)
Short Eared Owl *(Asio flammeus)*	Special concern	COSEWIC (2008)
Wolverine *(Gulo gulo)*	Special concern	COSEWIC (2014)
Grizzly Bear *(Ursus arctos)*	Special concern	COSEWIC (2012)
Northern mountain population of woodlandCaribou *(Rangifer tarandus caribou)*	Special concern	COSEWIC (2014), SARA (2002)
Collared Pika *(Ochotona collaris)*	Special concern	COSEWIC (2011)
Rusty Blackbird *(Euphagus carolinus)*	Special concern	COSEWIC (2017)
Gyrfalcon (*Falco rusticolus)*	Specially protected	Yukon Wildlife Act (2002)
Trumpeter Swan *(Cygnus buccinator)*	Specially protected	Yukon Wildlife Act (2002)
Mule Deer *(Odocoileus hemionus)*	Specially protected	Yukon Wildlife Act (2002)
Cougar *(Puma concolor)*	Specially protected	Yukon Wildlife Act (2002)
Bank Swallow (*Riparia riparia*)	Conservation concern	Yukon Environment (2011)
Northern Shrike (Lanius excubitor)	Conservation concern	Yukon Environment (2011)
Mountain Goat *(Oreamnos americanus)*	Conservation concern	Yukon Environment (2011)

* Status designations by COSEWIC are defined as:
Extinct - A wildlife species that no longer exists.
Extirpated - A wildlife species that no longer exists in the wild in Canada, but exists elsewhere.

Endangered - A wildlife species facing imminent extirpation or extinction.
Threatened - A wildlife species that may become endangered if factors leading to its extirpation or extinction are not reversed.
Special Concern - A wildlife species that may become threatened or endangered because of its biological characteristics combined with environmental impacts.
The Yukon wildlife Act provides more legal protection for those wildlife species recognized as Specially Protected. Yukon Environment wildlife species of Conservation Concern are populations that are decreasing and require more monitoring.

There are currently eleven wildlife species in Yukon rated (in 2017) as threatened or of special concern by COSEWIC, of which ten species have ranges that could possibly encroach upon the area around Minto Mine. These include: grizzly bear (*Ursus arctos*), northern mountain woodland caribou (*Rangifer tarandus caribou*), wolverine (*Gulo gulo*), collared pika (*Ochotona collaris*), bank swallow (*Riparia riparia*), barn swallow (*Hirundo rustica*), rusty blackbird (*Euphagus carolinus*), olive-sided fly catcher (*Contopus cooperi*), common nighthawk (*Chordeiles minor*), short-eared owl (*Asio flammeus*), and peregrine falcon (*Falco peregrines anatum*).

One species, the little brown bat (*Myotis lucifugus*), has been classified by COSEWIC as an endangered species, which means they are in immediate danger of extinction or extirpation. Populations of these mammals have been seriously affected by a fungal infection known as White Nose Syndrome. The Minto Mine is within the northern extent of the summer range of the Little Brown Bat, although their existence within the area has not been verified.

The following sections provide brief descriptions of the most recent wildlife surveys conducted locally for Minto and surveys conducted by the Yukon Government that were larger in scale and included the Minto Mine area.

7.3.1 Moose

Current information regarding moose in the area came from two aerial surveys conducted by Environment Yukon and Environmental Dynamics Inc. (EDI) that covered a survey area that included the Minto Mine site. The average density of moose in the Yukon typically ranges from 100 to 250 moose/1,000km^2 (Yukon Government, 2017a). Estimates of moose in the Minto Mine area have ranged from 20 to 127 moose/1,000km^2 (EDI, 2013).

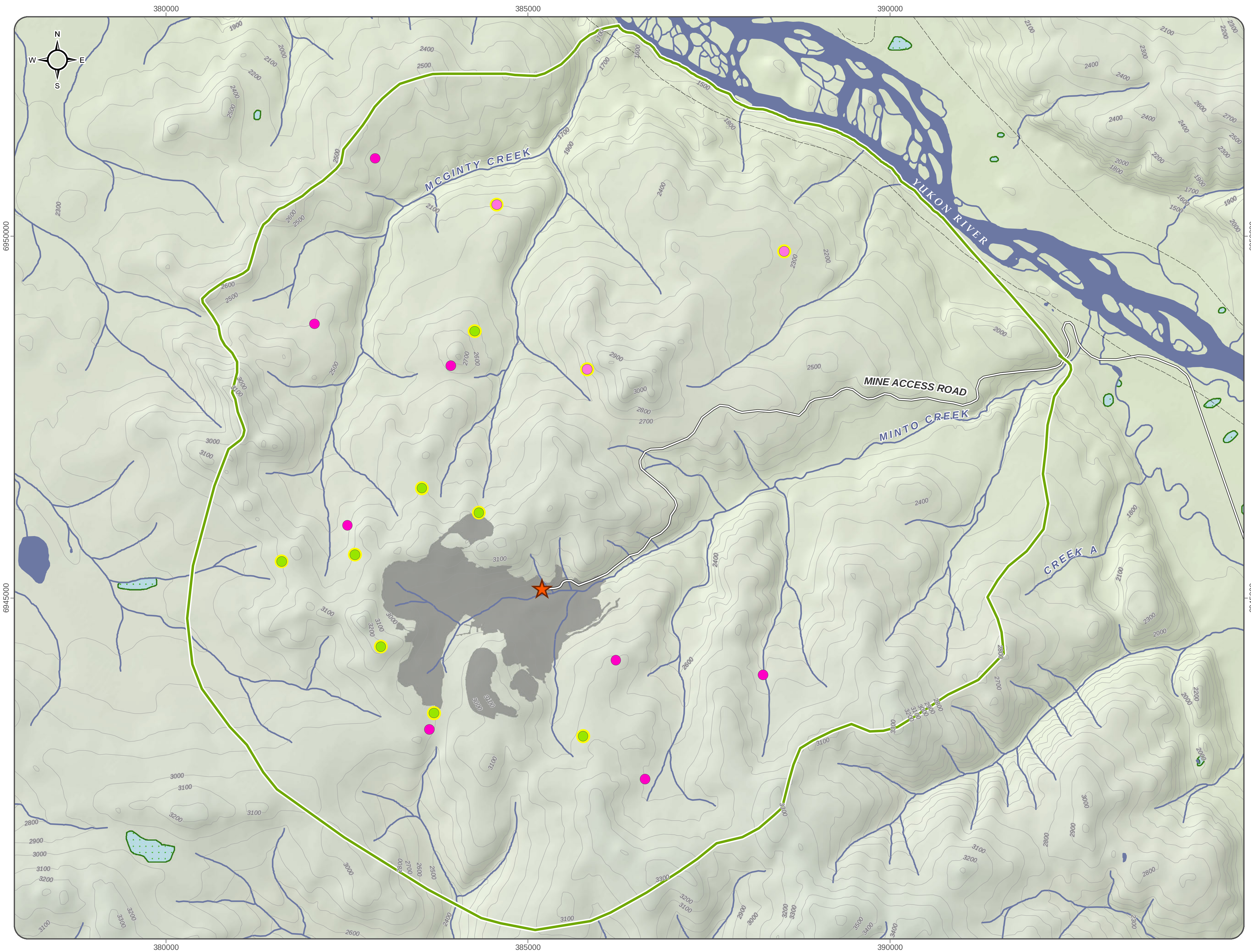
7.3.1.1 Aerial Moose Survey – Late Winter 2011/2012

This late winter aerial survey covered 6,400 km^2 west and northwest of Carmacks. During this survey, a total of 311 moose were observed. The 2011 map shows a cluster of moose observation points around the Minto Mine and in the southeast highlands, indicating that this area has a high density of moose in the late winter as compared to most of the Regional Survey Area (G. Pelchat, pers. comm.). Minto Mine vicinity has been subjected to numerous fires in the last thirty years and the vegetation cover is dominated by tall shrubs, attractive habitat for moose with plenty of browse and cover.

In addition, the Yukon River is approximately 10 km to the east. This large river corridor has ample shoreline and islands for moose calving and post-calving habitat. The Ingersoll Islands, located in the Yukon River downstream of the project site, are known to be used for calving during the spring and as rearing habitat during the summer (Magrum, 1994). The old burn areas in the Minto Creek Valley, the banks of the Yukon River, and the swamp lands below Minto Creek are often used by moose during the spring and summer (EBA, 2010b).

7.3.1.2 Aerial Moose Survey - Winter 2009/2010

Aerial moose surveys were completed on December 15, 2009 (post-rut) and February 23, 2010 (late winter) by ACG (2010). The total area surveyed was 112 km^2, specifically concentrating on the area around the Minto Mine and nearby drainages, see . Moose density for the post-rut survey was estimated to be 125 moose per 1,000 km^2. The average population density for calf-to-cow ratio estimated from this data was 25 calves and no sub adults for every 100 adult cows, and the estimated adult sex ratio was 50 mature bulls for 100 cows, which is considered fair compared to territorial averages.



MINTO MINE

CAPSTONE MINTO MINE - SITE CHARACTERIZATION PLAN

FIGURE 7-2

WINTER 2009/2010 AERIAL MOOSE SURVEY

JANUARY 2018

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- Moose Observation (15-Dec-2009)
- Moose Observation (23-Feb-2010)
- Moose Tracks (23-Feb-2010)
- Winter 2009/2010 Survey Boundary
- Wetland
- Minto Access Road
- Contours (100ft)

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Datum: NAD 83 Projection: UTM Zone 8N

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7.3.2 2007 Early Winter Moose Survey

The early winter 2007 moose survey for the Carmacks West Moose Management Unit (MMU) was conducted by Yukon Department of Environment. The densities are comparable, as there are similar habitat types in the MMU and its boundaries overlap the Minto Mine. The calculated moose density was 124 moose per 1,000 km^2 for the survey area.

This survey covered a much larger study area than the surveys conducted by ACG during the winter of 2009/2010, which were specifically focused on the area surrounding the Minto Mine site. However, during this survey in 2007, a total of 208 moose were observed during the survey, with a total population estimate of 520 moose for the study area. Survival rates for calves and yearlings were relatively low. The sex ratio of 75 bulls per 100 cows is considered to be a healthy sex ratio. The average sex ratio for other areas surveyed within Yukon is 68 bulls per 100 cows (O'Donoghue et al., 2008).

7.3.3 1994 Late Winter Moose Survey

Wildlife Resources surveys conducted in January 1994 by the Yukon Government estimated a moose density of 40 moose per 1,000 km^2 in the Minto area, which was lower then the 100 to 250 per 1,000 km^2 Yukon average (Yukon Government, 2017).

7.3.4 Caribou

The closest Woodland caribou ranges to the Minto Mine belong to the Klaza and the Tatchun herds. The Klaza herd appears to be the more stable of the two, and is the larger herd. Below is a brief summary of the herds' interactions with the Minto Mine area.

In 2005, the Klaza herd population was estimated at 650 and predicted to increase (Yukon Environment, 2005a). There are concerns for this caribou herd, as an increase in exploration projects and road development may cause negative impacts to the health of the Klaza caribou. The Klaza caribou range is west of the Minto Mine. As the area around the Minto Mine has experienced numerous fires recently, the habitat is of minimal value for caribou (Hegel, pers. comm.). Caribou prefer mature open forests where arboreal and ground lichen are plentiful. A Wildlife Key Area (WKA) for woodland caribou winter range was identified approximately 9 km to the east-northeast of the project area (Yukon Environment, 2010a). A fall (rut) count of Klaza caribou herd was conducted by Environment Yukon, EDI and Little Salmon Carmacks First Nation members in 2012. The herd is currently estimated to be approximately 1,180 caribou and is considered stable (Francis et al., 2016).

The Tatchun Caribou herd range is to the east of the Yukon River and does not overlap with the Minto Mine. In 2012, the population estimate for the Tachun herd was 500 animals.

MINTO MINE

CAPSTONE MINTO MINE - SITE CHARACTERIZATION PLAN

FIGURE 7-3

WILDLIFE KEY AREAS

JANUARY 2018

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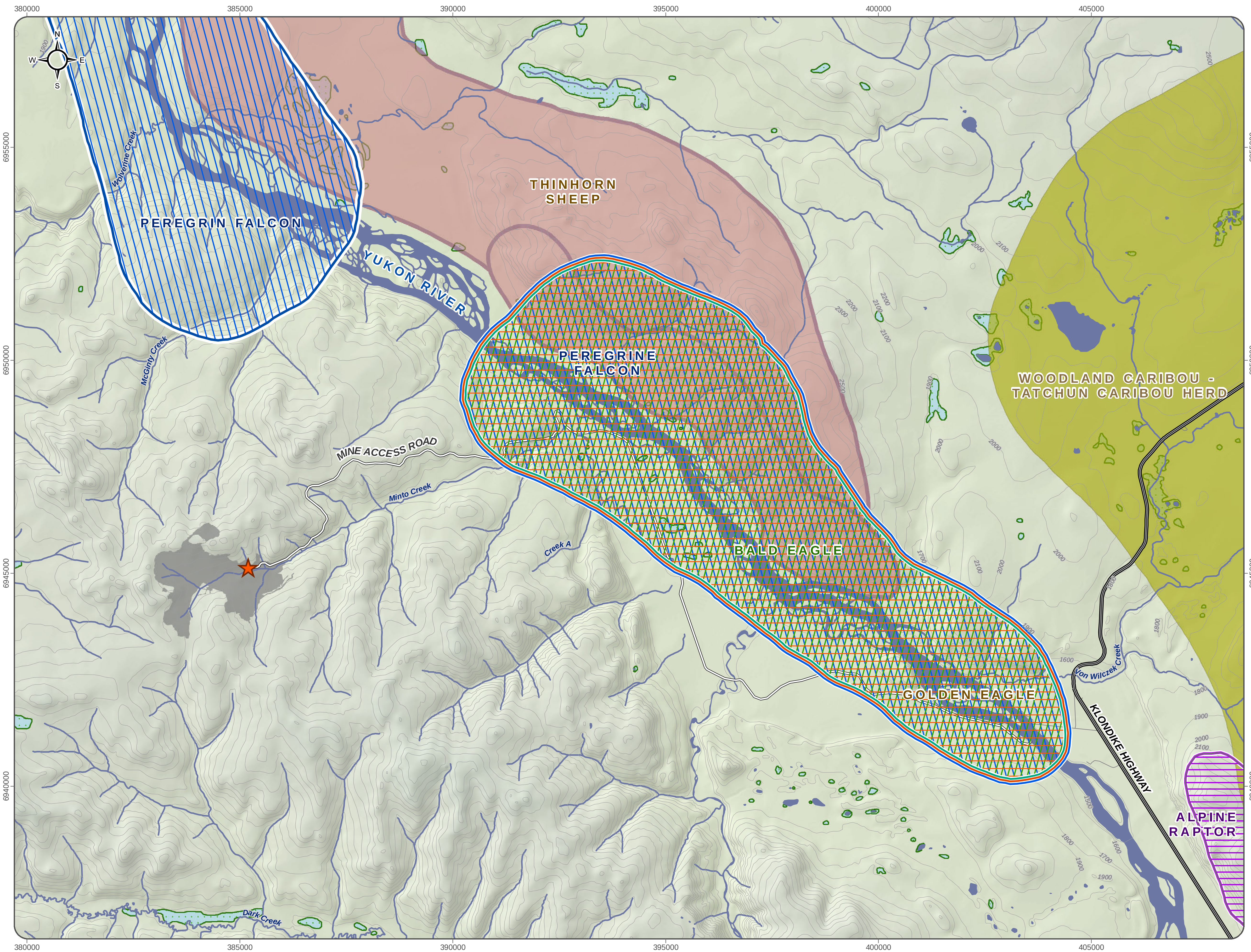

WILDLIFE KEY AREAS

- Golden Eagle
- Peregrine Falcon
- Bald Eagle
- Alpine Raptor
- Thinhorn Sheep
- Woodland Caribou

OTHER MAP FEATURES

- Minto Mine Site
- Mine Footprint
- Wetland
- Minto Access Road
- Contours (100ft)

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Datum: NAD 83 Projection: UTM Zone 8N

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7.3.5 Sheep

The Minto Bluffs along the Yukon River have been identified as an important Dall sheep area, see Figure 2, (O'Donoghue, 2009). Although the access road to the Minto Mine passes near sheep habitat, sheep habitat within the project area itself is limited and sheep are not expected to inhabit the project area for any extended length of time.

Between 2000 and 2017, sheep surveys of the Minto Bluffs resulted in observations of between 31 and 153 sheep annually, with the majority of observations being ewes, yearlings and lambs. During the 2016 survey, 153 sheep were observed, of which 59 were observed on the Minto Bluffs (which is located about 8 kilometres downstream and across the river from the Minto Mine site). This is the highest recorded observation for this area. Most sheep observed during these surveys have been located on the Minto Bluffs, Split Mountain, and Mount Hansen (O'Donoghue, 2009).

7.3.6 Carnivores, Fur Bearers and Small Mammals

Fur trapping and big game harvest statistics indicated the following species are expected to occur in the Minto Mine area: grizzly bear, black bear, coyote, gray wolf, red fox, wolverine, marten, least weasel, beaver, and lynx. Cougars may also have the potential to be found in the area as they are known to follow mule deer (Smith et al. 2004). Of the species listed above, the following species (or their sign) have been observed, on site: grizzly bear, black bear, gray wolf, lynx, river otter (HKP 1994, Capstone 2007-2008).

The territorial estimates for bear populations in Yukon are 6,000 to 7,000 grizzly bear and 10,000 black bear (Yukon Environment 2010b). The Yukon Government (2017b) has indicated that key habitat for black bears include seasonally concentrated feeding areas, such as south aspect slopes containing sagewort, bearberry, and grassland habitat. Summer and fall feeding habitats typically consist of those areas where berries grow. Black bears have been observed in the project area on many occasions (Wildlife log – Appendix 1-5).

Grizzly bears are known to use the Minto Mine area. Sightings and tracks were documented in the 2010 Baseline Ecosystems and Vegetation Report, and sightings have been reported by mine personnel (Appendix 1-5). Key habitat for grizzly bears includes areas where they concentrate seasonally, such as feeding areas, floodplains, and movement corridors. Important feeding habitat includes areas with profuse berries and areas where salmon spawn (Yukon Environment, 2017b). Although key habitat for grizzly bears has not been identified on site, they have been seen in the project area regularly since the commencement of mine operations. (ACG, 2010).

Wolverines have large territories where they hunt, scavenge and mate. While there is a moderate probability that they inhabit the area, because of their aversion to human activity and low population, they are not likely to be observed.

Small mammals common to the area include red squirrel, varying hare, fox, mink, weasel, vole, and shrew. The Minto Mine site is situated at the apex of five drainages that are part of the Yukon River watershed, so wildlife uses the area to access the valleys offering conduits from lowlands to highlands for seasonal foraging and hunting (ACG, 2010).

7.3.7 Birds

Five species of birds are considered to be of conservation concern: the peregrine falcon, short-eared owl, common nighthawk, olive-sided flycatcher, and rusty blackbird. Three of these species, the peregrine falcon, common nighthawk, and olive-sided flycatcher, have a moderate probability of occurrence at the Minto site. Suitable nesting habitat for the peregrine falcon is located in close proximity to the project site (see Figure 7-3), on the bluffs along the Yukon River (O'Donoghue, pers. comm.), and a historical record of nesting for this species was documented at the Pelly–Yukon River confluence (Mossop, pers. comm. as cited in HKP 1994). Common nighthawks are often found near open lodge pole pine forests, old burn areas and open mixed forests, and near wetlands or rivers (Sinclair et al., 2003) and many of these habitat types occur in the project area. The olive-sided flycatcher often occurs in black and white spruce, lodge pole pine, and mixed forests, from lowland areas to tree-line. The short-eared owl and rusty blackbird are considered to have a low probability of occurrence in the project area. The short-eared owl is often associated with open wetland and meadow, alpine, and alpine tundra habitat, which is limited within the project area. The rusty blackbird is also associated with wetland habitat (Sinclair et al., 2003), which is not abundant within the project area itself, but may occur along the margins of the Yukon River.

The rusty blackbird often nests at the edge of ponds/wetland complexes in boreal forests. They prefer lower elevations, but could feed and nest within the study area. Short-eared owls may travel through the area, but their typical habitat is in and near large meadows and agricultural fields and they may not be seen often because they are nocturnal. Peregrine falcons do not use the habitats in the Minto area; they nest and hunt near steep canyon walls along the Yukon River, approximately 20 km east.

7.3.7.1 Raptors

Although numerous raptor species have the potential to inhabit the project area, species that have been observed and documented in the Minto Mine area include the red-tailed hawk (HKP, 1994), peregrine falcon (Mossop, pers. comm. as cited in HKP 1994), and golden eagle (O'Donoghue, pers. comm.). It should be noted that only one aerial-based raptor survey was conducted as part of the Minto Mine baseline studies (HKP, 1994). High quality riparian cliff habitat for raptors exists along the Yukon River downstream of the Minto Mine access road. A WKA (wildlife key area) for golden eagle summer nesting habitat has been identified approximately 3 km to the east of the project area (Yukon Environment, 2010a) (Figure 7-3). This WKA is primarily associated with the steep bluffs along the Yukon River and includes a buffer area. No cliff-nesting raptor habitat has been identified within the Project area itself. The access road to the Minto Mine, however, runs adjacent to potential nesting areas for cliff-nesting raptors, such as the golden eagle and peregrine falcon.

7.3.7.2 Waterfowl

Key habitat for waterfowl includes wetlands that are used as staging areas in the spring and fall, and for breeding and molting in the summer. As suitably-sized wetlands are not found near the Minto Mine, waterfowl are not known to be present in large numbers or for extended periods. A key habitat area, Lhatsaw wetlands, lies approximately 30 km east of the project site and is used for nesting and molting in the summer (Yukon Environment, 2016). Waterfowl that may occasionally use the Minto Creek drainage include Canada goose, mallard, northern pintail, green-winged teal and American widgeon.

7.3.7.3 Game Species

Game birds that have been observed or that have the potential to occur in the study area include grouse (spruce, ruffed, sharp-tailed) and ptarmigan (willow, white-tailed, and rock). Of the species of grouse that live in Yukon, the sharp-tailed grouse is currently the only species of management concern. Sharp-tailed grouse have a limited distribution in Yukon due to the lack of suitable habitat. Gravel outwashes with fairly stable aspen parkland habitat and wet sedge-hummock meadows after fire are considered suitable habitat for this species. Sharp-tailed grouse have been observed in the Project area.

7.3.7.4 Amphibians

Of the five amphibian species known to occur in Yukon and northern British Columbia, only the wood frog (*Rana sylvatica*) is known to occur in the project area. This species is restricted to wetland areas and has not been surveyed for at the Minto site, although there have been some anecdotal observations. No reptiles are known to occur in Yukon.

7.4 SUMMARY

The frequent and often large fires that have occurred around the Minto Mine have created high quality habitat for moose. The numerous moose sightings and signs found in the area indicate that it is attractive and well-used by resident moose. Local aerial surveys completed in early (December 2009) and late winter (February 2010) indicated that the moose population in the area was below territorial average and recruitment may be low. However, the population has increased since the initial local survey was done in 1994. Then, the population was estimated at 40 moose per 1,000 km^2 during a government-supported count. Winter surveys in 2007 indicated a population of 125 per 1,000 km^2.

The Klaza woodland caribou herd range is located approximately 10 km west of the Minto Mine, where there is better winter habitat and mature open forests with ample growth of arboreal and ground lichens. The Minto Mine area does not provide good habitat for caribou, but they may travel through occasionally.

Current wildlife population estimates for caribou and moose conducted by Environment Yukon biologists are done over large regional study areas. Average population statistics, especially for moose, may not accurately reflect local habitat usage or seasonal variations, but can serve as a background comparison.

Dall sheep habitat is found along the steeper hillsides within the Yukon River corridor; the Minto Mine area does not contain the steep escape topography nor grasslands needed by these animals. The nearest population of Dall sheep is found at the Minto Bluffs approximately 10 km further down the Yukon River. The nearest disturbance is the access road, which is still approximately 10 km from sheep habitat.

Raptor inventories have been concentrated along the Yukon River corridor where steep slopes and cliffs provide nesting and perches for peregrine and golden eagles. Bald eagles commonly use large trees for nesting and are closely associated with riparian systems. Forest-dependent raptors such as northern goshawk and red-tailed hawks are likely nesting around the Minto Mine in mature forest areas.

Black and grizzly bears are known to use the area and may be attracted to food smells emanating from the camp and garbage disposal area. A waste management plan is in place to reduce attracting bears to camp and operation areas.

Large mammals such as moose, mule deer, timber wolves, grizzly bears, and black bears were found to be using riparian corridors, secondary access roads, and exploration transects as migration routes throughout the Minto mine study area (ACG 2010).

There is a dearth of information on other animals existing in the vicinity of Minto such as wolves, lynx, mule deer and bears.

8 Aquatic Resources

8.1 Overview

A complete report on Aquatic Resources is presented in the *Minto Mine Site Characterization – Aquatic Resources (AEG and Minnow, 2017)* (Appendix 1-6), which constitutes an update to the 2013 Aquatic Resources Baseline Report which was compiled by Access Consulting Group (ACG) and Minnow Environmental as part of the Phase V/VI Yukon Environmental and Socio-Economic Assessment Board (YESAB) Project Proposal. A summary of the key findings of the 2017 report is presented in the sections below.

The Minto Mine region includes the Yukon River and its smaller tributaries, including 7 km upstream to Big Creek and 13 km downstream to Wolverine Creek. The local study area of the Minto Mine centres on four small drainages that drain directly into the Yukon River: Minto Creek, Big Creek, an unnamed creek (referred to as Creek A) and McGinty Creek. The primary drainage is that of Minto Creek, which flows northeast from the existing mine site over approximately 17 km to the Yukon River, and covers an area of roughly 41 km^2. Big Creek flows to the northeast over about 97 km and is crossed by the Minto Project access road. Creek A flows to the north over about 7 km near the lower end of Minto Creek, drains an area of roughly 9 km^2, and is crossed by the Minto Project access road. The fourth drainage is that of McGinty Creek (formerly referred to as Unnamed Creek B), which is located to the north of Minto Creek and flows north-northeast nearly 9.5 km to the Yukon River confluence, and covers an area of about 34 km^2. Operational data was collected for Minto Mine's Annual WUL and through 3 Cycles of EEM.

8.2 Fish and Fish Habitat

8.2.1 Regional Overview (Yukon River)

A variety of resident and migratory fish species inhabit the Yukon River near Minto Mine. These include Chinook, Coho and chum salmon, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker, and slimy sculpin.

Previous studies on the Yukon River within the vicinity of Minto Mine have identified both spawning and rearing areas for salmon. Spawning shoals are present in the Ingersoll Islands (downstream of the Project area) as well as around islands upstream of Minto Mine, near Big Creek. These offer an extensive network of side channels and sloughs which provide good spawning gravel.

This portion of the Yukon River also provides rearing habitat for Chinook salmon, as evidenced by past studies in the Project area. Juvenile Chinook salmon (JCS) generally spend up to 1.5 years feeding and growing in fresh water tributaries prior to out-migrating to the ocean, and feed or stage in various tributaries to the Yukon River during this slow out-migration. Usage of the Project area tributaries by JCS is outlined further below.

8.2.2 Local Fish Habitat Investigations

8.2.2.1 Minto Creek

Fish and fish habitat studies of Minto Creek have been ongoing for many years, with contemporary studies including those from 1994 through to 2017 (see Table 8-1). A summary of effort and catches is presented in Table 8-2 while complete results can be found in Appendix 1-6. Generally, Minto Creek has been noted to provide only limited habitat to fish. Flows within the stream are quite variable on a yearly basis, with intermittent flows and extensive ice build-up during winter that limits the potential for overwintering habitat for fish. Also, the distribution of fish within Minto Creek has been observed to be limited to the lower 1.5 km of the watercourse, as there is a barrier and steep canyon upstream of that location. As noted above, Chinook salmon, slimy sculpin, Arctic grayling, longnose sucker, burbot, and round whitefish have been captured in Minto Creek; however, the latter have not been observed since the original baseline studies in 1994. Slimy sculpin have been observed consistently, but at a low density.

Table 8-1: Summary of Key Fish and Fish Habitat Studies, Minto Mine.

Year	Firm and Study Name	Scope of Studies
1994	Hallam Knight Piesold (HKP) – IEE for Minto Project Area (HKP 1994)	• Fisheries investigations on Minto Creek and Creek A. • Backpack electrofishing, minnow trapping. • Reach definition and description, identification of barriers to fish passage.
2006–2007	Access Consulting Group (ACG), R&D Environmental – Various Fisheries Investigations for Minto Explorations Ltd. (Minnow/ACG, 2007)	• Fisheries investigations in Minto Creek to support the permitting of the Minto Mine. • Backpack electrofishing, minnow trapping.
2008	ACG, Minnow Environmental – EEM Program, Cycle 1 (Minnow/ACG, 2009)	• Fisheries investigation of Minto Creek. • Backpack electrofishing and minnow trapping.
2009	ACG – Fish Relocation Program (ACG, 2009)	• Minnow trapping in Minto Creek and transfer of fish to the Yukon River.
2010	ACG – Fish Mark and Recapture Program (ACG, 2010)	• Minnow trapping in Minto Creek and marking of captured fish (release back into Minto Creek).
2009–2011	ACG, Minnow Environmental – EEM Program, Cycle 2 (Minnow/ACG, 2012)	• Integrated assessment of effluent sub-lethal toxicity, water quality, benthic invertebrate community condition, and fish health (hatchery-based exposure study).
2011–2012	ACG – Minto Creek Fisheries Monitoring Program (ACG, 2012/ ACG, 2013)	• Minnow trapping in Minto Creek.
2009–2011	ACG – Fisheries Monitoring Program in McGinty Creek	• Fisheries Investigation of McGinty Creek through Minnow trapping.
2012	ACG- Fisheries Monitoring in Minto Creek and Big Creek	• Fisheries investigation of Minto Creek and Big Creek through minnow trapping and backpack electrofishing
2013	ACG- Fisheries Monitoring in Minto Creek and Big Creek, EEM Program Cycle 3	• Fisheries investigation of Minto Creek and Big Creek through minnow trapping and backpack electrofishing

Year	Firm and Study Name	Scope of Studies
2014	ACG- Fisheries Monitoring in Minto Creek and Big Creek	• Fisheries investigation of Minto Creek and Big Creek through minnow trapping.
2015	ACG- Fisheries Monitoring in Minto Creek and Big Creek	• Fisheries investigation of Minto Creek and Big Creek through minnow trapping.
2016	Capstone- Fisheries Monitoring in Minto Creek and Big Creek	• Fisheries investigation of Minto Creek and Big Creek through minnow trapping.

Table 8-2: Summary of Fish captures in Minto Creek between 2008 and 2016.

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2008	Backpack Electrofishing	796 s	Catch	#	1	0
			CPUE	Fish/min	0.075	0
	Baited Gee Minnow Trapping	28.6 days	Catch	#	18	0
			CPUE	Fish/day	0.63	0
2009	Baited Gee Minnow Trapping	28.6 days	Catch	#	136	142
			CPUE	Fish/day	4.76	4.97
2010	Baited Gee Minnow Trapping	145.9 days	Catch	#	2293	2307
			CPUE	Fish/day	15.72	15.81
2011	Baited Gee Minnow Trapping	71 days	Catch	#	12	29
			CPUE	Fish/day	0.17	0.41
2012	Backpack Electrofishing	1051 s	Catch	#	0	4
			CPUE	Fish/min	0	0.23
	Baited Gee Minnow Trapping	43 days	Catch	#	3	6
			CPUE	Fish/day	0.07	0.14
2013	Backpack Electrofishing	3402 s	Catch	#	0	4
			CPUE	Fish/min	0	0.07
	Baited Gee Minnow Trapping	62.5 days	Catch	#	121	7
			CPUE	Fish/day	1.94	0.11
2014	Baited Gee Minnow Trapping	70.2 days	Catch	#	151	3
			CPUE	Fish/day	2.15	0.04
2015	Baited Gee Minnow Trapping	67.3 days	Catch	#	6	0
			CPUE	Fish/day	0.089	0
2016	Baited Gee Minnow Trapping	69.4 days	Catch	#	5	1
			CPUE	Fish/day	0.072	0.014

JCS presence in Minto creek was observed to be influenced by mine water discharge. During non-discharge periods, and prior to operations (baseline), numbers of JCS and other species of fish in the system were found to be very low. In contrast, during the two major discharge events (2009 and 2010), numbers of JCS were 20 to 30 times higher in the system (see Table 8-3 below), indicating that they may have been attracted into the system as a likely result of a more consistent temperature and flow regime associated with mine water discharge. Numbers of other species of fish during discharge events did not increase. It is important to note however that numbers of other species using the system has been consistently very low prior to mine development and during operations.

Table 8-3: Maximum Catch per Unit Effort (CPUE) of Juvenile Chinook Salmon in Minto Creek using baited Minnow traps 1994-2016.

Year	Month	JCS – CPUE (#fish/trap-day)*	Minto Creek Conditions
1994	September	0	Pre-development – no discharge
2008	September	0.9	Operational – no discharge
2009	September/October	20.0	Discharge
2010	August	30.0	Discharge
2011	September	0.43	No discharge – high TSS contribution from tributary
2012	September	0.19	No discharge – high TSS contribution from tributary
2013	October	5.01	Operational – no discharge
2014	September	5.05	Operational – no discharge
2015	July	0.30	Operational – no discharge
2016	July	0.301	Operational – no discharge

**CPUE calculated for actual 24-hr period (rather than nominal 24-hr period)*

Minto Creek does not provide preferred spawning habitat for fish because it completely freezes during winter months with no flow in lower Minto Creek. Accordingly, there is no evidence of spawning in Minto Creek (HKP 1994; R&D 2006, 2007), nor is there traditional knowledge indicating spawning occurring in the system (HKP 1994). Lower Minto Creek is also subject to low or zero flow conditions during periods in the summer when a portion (or all) of the flow sometimes infiltrates the ground, preventing the establishment of resident fish populations in this section of the stream. A natural barrier to fish passage exists at approximately km 1.2 upstream in Minto Creek from the Yukon River, therefore limiting fish use downstream of the barrier. This barrier is largely comprised of organic debris and can be considered temporary as it will likely degrade over time, although it has been consistently observed since it was first characterized in 2010. The canyon located upstream of the current barrier however is a permanent barrier to fish passage, due to its high gradient, thus limiting fish habitat to the lower 2.0 km of the system.

Water temperatures tend to remain cooler in Minto Creek than in the Yukon River until late June or early July. This likely deters fish, in particular JCS, from entering the system until creek temperatures equilibrate with the Yukon River. Minto Creek is subject to large diurnal fluctuations in temperature (up to 5°C or more) throughout the open water season. This daily variation is not ideal for fish and may limit their interest in using the creek for rearing.

Creek bottom substrate is comprised mostly of fines (silt/sand) with limited cobble/gravel sections which are more desirable for fish. In addition, significant input of suspended solids from a tributary in 2011 and 2012 may have further limited the use of the system by JCS during those years.

Bottom substrate at the mouth of Minto Creek and at the Yukon River confluence consists primarily of silt and mud which is not considered suitable substrate for salmonid spawning (grayling, salmon etc.). Aerial surveys for spawning fish were conducted in 2011, 2012, 2013 and 2014, and no adult fish were observed spawning in the vicinity of the Minto Creek/Yukon River confluence. No signs were present during the surveys that this area is used for spawning (such as redds or carcasses).

8.2.2.2 Big Creek

Starting in 2012, the compliance monitoring program included sampling efforts in Big Creek, which serves as a reference site. The same fish species as in Minto Creek were generally observed in Big Creek, and the CPUE has normally been slightly higher in Big Creek. Table 2-4 summarizes fish captures in Big Creek from 2012 to 2016.

Table 8-4: Summary of Fish captures in Big Creek in 2012 to 2016.

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2012	Backpack Electrofishing	273 s	Catch	#	1	23
			CPUE	Fish/min	0.22	5.05
	Baited Gee Minnow Trapping	11.8 days	Catch	#	7	2
			CPUE	Fish/day	0.59	0.17
2013	Backpack Electrofishing	911 s	Catch	#	0	27
			CPUE	Fish/min	0	1.78
	Baited Gee Minnow Trapping	14.8 days	Catch	#	19	2
			CPUE	Fish/day	1.28	0.14
2014	Baited Gee Minnow Trapping	16.4 days	Catch	#	96	3
			CPUE	Fish/day	5.86	0.18
2015		17.1 days	Catch	#	58	3

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
	Baited Gee Minnow Trapping		CPUE	Fish/day	3.39	0.18
2016	Baited Gee Minnow Trapping	15.0 days	Catch	#	51	9
			CPUE	Fish/day	3.40	0.60

8.2.2.3 Creek A

Creek A was investigated during the 1994 baseline study program at the Project site, at which time no fish were observed or captured (including a site at the road-crossing location). Creek A is not considered to offer high quality habitat for fish.

8.2.2.4 McGinty Creek

Arctic grayling and slimy sculpin were captured in McGinty Creek in 1994, through electrofishing and minnow trapping. Because substantial deadfall caused by a forest fire changed creek conditions, only minnow trapping was used in 2009–2011, yielding very low numbers of slimy sculpin. Since these captures were consistently made in close proximity to the Yukon River, these fish were presumed to be associated with the Yukon River, as opposed to McGinty Creek. These results are similar to those found in the 1994 survey, in that fish were only captured in close proximity to the Yukon River confluence. The physical nature of the McGinty Creek drainage is not conducive to a consistent year-round use by fish. Many factors, including gradient, discharge volume, depth, configuration, and paucity of an upstream reservoir, limit wintering habitat potential for fish. Also, several potential natural fish barriers were observed and documented in the lower reach of McGinty Creek.

8.2.3 Aquatic Environment and Habitat

8.2.3.1 Stream Sediments

Stream sediments were studied for particle size and metal concentrations in 1994, and annually since 2006. Sediment particle size distribution was notably different when comparing earlier sampling years to more recent years. The change in distribution from 1994–2009 compared to 2010–2016 reflects methodological changes that were implemented in 2010. Sediment metal concentrations were also complicated by the change in methodology. With this qualification in mind, concentrations of arsenic, copper, and occasionally chromium exceeded the interim sediment quality guideline (ISQG) levels over the years but not greater than the probable effect level (PEL). Copper was the only metal that consistently exceeded guideline levels every year, including during baseline sampling in 1994. This could indicate that there are naturally high levels of copper at the exposure area. Due to the predominantly erosional habitat in upper Minto Creek, there are relatively few areas where sediment is deposited and then only in small quantities that likely wash away each year during freshet. Therefore, elevated sediment copper in the upper reaches of Minto Creek may be of limited importance in terms of exposure and potential toxicity to biota.

Two sediment toxicity tests, a 10-day *Chironomus dilutus* survival and growth, and a 14-day *Hyalella azteca* survival and growth test, were performed in 2011, 2015, and 2016. Lower Minto Creek sediment did not result in any effects to survival or growth of either test organism relative to the laboratory control or the field reference sediment (lower Wolverine Creek).

Additional detailed results for sediment physical and chemical parameters are available in Appendix 1-6.

8.2.3.2 Benthic Invertebrate Community

Benthic macroinvertebrates (benthos) are non-backboned animals inhabiting the bottom substrates of aquatic habitats. The abundance, diversity, and taxonomic composition of benthos can be used as indicators of changing environmental conditions as their distribution and abundance can be influenced by a wide variety of physical parameters. Baseline and numerous other benthic invertebrate studies were undertaken in the Minto Mine area from 2006–2016.

Basic results of the 2008 and 2011 environmental effects monitoring (EEM) benthic analyses indicated that Minto Creek (treatment) had a significantly higher benthic invertebrate density and slightly lower number of taxa (not significant) compared to McGinty Creek (reference). The 2011 EEM benthic results show that Minto Creek had significantly higher number of taxa and higher density compared to both reference sites. Increased taxa, higher density, and lower evenness are indicative of a site that is experiencing nutrient enrichment. During the EEM investigation of cause (IOC) study (Phase 3), the benthic invertebrate community of the mine-exposed sites on upper Minto Creek was compared to the reference condition (defined by 12 reference areas) for four primary EEM metrics: density, taxon richness, Simpson's evenness and Bray-Curtis (BC) distance. Results are summarized in Appendix 1-6.

Under the terms of Minto's Water Use License #QZ06-006, benthic macroinvertebrate communities are required to be annually monitored in Minto Creek. Benthic invertebrate density at lower Minto Creek in 2016 was lower than in 2014 and 2015 but higher than in 2013. Number of taxa at lower Minto Creek in 2016 was within the historical range from 2006 onwards, but moderately lower than in 1994. Lastly, Simpson's Evenness was within the historical range documented after methodological change in 2011. Over the 2012-2016 period benthic invertebrate community metrics parameters were stable, any differences between this time period and earlier sampling was more likely due to a change in mesh size of the Hess sampler, with 2012 used as a bridge.

8.2.3.3 Periphyton

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. They can provide a valuable biological monitoring tool to assess potential impacts of nutrient enrichment and metal toxicity. Chlorophyll a is the primary photosynthetic pigment common to all algae. Determining chlorophyll a concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Periphyton was sampled in 1994 and 2011 to 2016, in Minto Creek (exposure) and Wolverine Creek (reference). Overall, the periphyton community of lower Minto Creek relative to lower Wolverine Creek had lower density and taxon richness. Temporal variability in periphyton community composition was evident among samples taken in 1994 and 2011-2016.

Concentrations of chlorophyll-a have been variable among areas over time. Significant differences between areas only occurred in 2014 and 2015. In 2016, concentrations were higher but as in previous years mean concentrations were below the British Columbia Water Quality Guideline (BCWQG) of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985).

9 Vegetation

The Minto Mine lies within the Boreal Cordillera ecozone and is situated in the far western part of the Yukon Plateau ecoregion, adjacent to the Klondike Plateau ecoregion in the west. This area was part of the eastern extent of Beringia, which remained ice-free approximately 15–20 thousand years ago. Endemic and rare plant species are associated with the Beringia area as it was a unique and isolated ecosystem. These remnant species are usually associated with grasslands and wetlands.

The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 950 m; the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed. Discontinuous permafrost occurs on northern slopes and low-lying areas where sunlight is reduced.

Forest fires are frequent in this part of Yukon as it lies in the rain shadow of the St. Elias–Coast Mountains and receives less than 300mm of precipitation per year (Smith et al. 2004). As a result, the study area around Minto Mine has experienced numerous fires over the last forty years, rendering it a complex mosaic of plant communities at various stages of succession.

Capstone has characterized the baseline vegetation conditions for the project area by commissioning a vegetation survey and mapping project in 2010 and a vegetation metal uptake program in 2016. The following subsections summarize vegetation surveys conducted in the Project area. For further detail, please see the *Minto Mine Site Characterization – Vegetation* (AEG, 2017) in Appendix 1-7.

9.1 Vegetation Baseline Survey and Ecosystem Mapping

A previous survey was conducted in 1994 by Hallam Knight Piesold (HKP), before any mine development had begun in the area. The 2010 baseline vegetation survey and mapping project was commissioned by Minto to capture the current biophysical conditions prior to expansion activities. The scope of the survey, mapping, and reporting includes classifying forest and vegetation types, identifying sensitive ecosystems, and compiling vegetation and some surficial soils information. In the intervening years between the 1994 and 2010 studies, the local landscape has been altered by the footprint of the current mine, further exploration and three major fires (See Fire History Map, of the *Minto Mine Site Characterization – Vegetation* (AEG, 2017*)*).

In the 2010 Vegetation Baseline Survey, different vegetation communities that exist within the study area were identified through aerial photo interpretation and delineated into polygons. Since most of the study area is regenerating from past fire disturbances, a mosaic of vegetation communities at different successional stages was delineated and classified. Thirty plots (23 of which are permanent plots) were visited to determine the accuracy of photo interpretation.

Most of the study area is regenerative young forest or shrub-dominated ecosystems where tree and shrub species are at a uniform height, as is common in fire disturbed areas (Oswald and Brown 1990). Willows and trembling aspen are the most represented species in crown cover at the time of the survey. Lodgepole pine is a later successional species and will gradually dominate mid and upper slopes that are well drained. Shade-tolerant white spruce was often found in the understory as seedlings and is a climax species that will eventually overgrow the pine and trembling aspen communities on northern aspects. Black spruce is also a climax species that is adapted to wetter, cooler sites, and is often the persistent species in white/black spruce mixed areas along slope toes and valley bottoms. Small areas of grasslands are scattered along dry crests and steep south facing slopes as these locations do not retain enough moisture to sustain tree growth and are more likely to contain rare or uncommon plants.

Most of the planned expansion is along ridge tops and mid slopes. The main vegetation types in these areas are upland willow species, trembling aspen, lodgepole pine, and associated understory growth. The potentially impacted polygons were surveyed for rare and endemic plants; and while none were found at the time of survey, does not mean that none exist.

The ecosystem map (Appendix 1-7) was designed to be used as a land management and planning tool. As the mine expands its footprint, the map can be referred to for a quick assessment of which type of vegetation communities will be directly disturbed and how much area is involved. Sensitive areas that should be avoided, if possible, include: riparian corridors, bog/wetlands, mature forests, and grasslands.

9.1.1 Vegetation Types

Vegetation types are based on reoccurring patterns of plant associations dictated by site attributes such as: moisture and nutrient availability, aspect, and elevation. Polygons were delineated based on tree/shrub composition, cover, and structural stage. Plot descriptions are more detailed, but most polygons will fit in one of the following general forest types:

Trembling Aspen/Lodgepole Pine

This association is found in early successional forests originating after fire disturbance, on mesic to subxeric sites. Lodgepole pine (*Pinus contorta latifolia*) is more dominant than trembling aspen (*Populus tremuloides)* on well-drained south facing slopes and terraces. Coarse soils are often exposed, and lichens are well represented in the ground cover. Typically, these sites have low growing shrubs such as lingonberry (*Vaccinum vitis idaea*), kinnikinnick (*Arctostaphylos uva-ursi*), and prickly rose (*Rosa acicularis*).

Black Spruce/Labrador Tea/Sphagnum

Found in low lying areas and north facing slopes (cool sites), usually sparse to open forests (<50% crown cover), common shrubs in this ecosystem include Labrador tea, scrub birch, willow, and bog blueberry. Herbs present were sweet coltsfoot (*Petasites frigidus*), cloudberry (*Rubus chamaemorus*), and horsetail (*Equisetum sp.)* Sites are poorly drained (hydric to mesic) with peat horizons over mineral soils, often associated with permafrost.

White/Black Spruce

This association is typically located on south facing lower slopes with upland willow species and Labrador tea. A thick carpet of feather mosses and sphagnum covers the mineral soil. Ground cover shrubs include lingonberry, bog blueberry, and crowberry.

Willow/Trembling Aspen

This was the most common vegetation association in study area, indicative of regenerative growth (>10yrs) after a fire event. Most trees and shrubs are less than 5 m tall; cover can be open to closed as the canopy layer is of uniform height. Other species that may be present include: Alder (*Alnus crispa*) and Alaskan birch (*Betula neoalaskan*) on north facing slopes. Lodgepole pine and white spruce are also present in the understory and will eventually overtop other competing species to form the dominant canopy as the forest matures. The moisture regime ranges from subhygric to subxeric.

Willow/Scrub Birch

Willow (*Salix sp.)* and scrub birch (*Betula glandulosa*) occur in fluvial ecosystems adjacent to streams and fens. Other shrubs present are bog blueberry (*Vaccinum uliginosum*), Labrador tea (*Ledum groenlandicum*), and shrubby cinquefoil (*Potentilla fruticosa*). Associated graminoids include water sedge (*Carex aquatilis*), bluejoint grass (*Calamagrostis canadensis*), and rushes (*Juncus sp*.). Sphagnum, feather, and glow mosses are common.

Trembling Aspen/Grassland

This association features sparse to open cover of trembling aspen (*Populus tremuloides*), often with lodgepole pine (*Pinus contorta latifolia*) present as a minor component. Found on steep south and southwest facing slopes, its understory shrubs include prickly rose (*Rosa acicularis*), soapberry (*Shepherdia canadensis*), kinnikinnick (*Arctostaphylos uva-ursi*), purple reedgrass (*Calamagrostis purpurascens*), Glaucous bluegrass (Poa glauca), Threadleaf sedge (Carex filifolia), Death camas (*Zygadenus elegans*), common yarrow (*Acillea millefolium*), pussytoes (*Antennaria sp*.), and prickly saxifrage (*Saxifraga tricuspidata*).

9.2 Vegetation Metal Uptake

The main objectives of the vegetation metal uptake program were to utilize previously established or documented conditions, monitoring results or predictive efforts, where appropriate and possible; establish a network of plots for monitoring both soil and vegetation metal concentrations; and, allow for an ongoing evaluation of the extent and degree that metals from mining activity is affecting vegetation in proximity to the project site.

These objectives were met for this first round of the program by establishing 16 exposure sites and five control sites that will be used for monitoring every three years. At each site between one and five vegetation samples were collected along with samples of each distinguishable soil horizon.

Results from the 2016 monitoring event present evidence that some metals are elevated in the certain plant species near the mine when compared to control sites. As no baseline vegetation metals samples were collected during the 2009-2010 ecosystem mapping program it cannot be determined that elevated metals were not present in the pre-mining condition.

Results between the rinsed and unrinsed samples were highly variable. Results for some metals were greater for rinsed samples then unrinsed, suggesting that rinsing was not always removing dust particulates. There appeared to be other processes involved since some metals increased after rinsing.

Lichen and willow samples showed significantly higher metals at exposure sites compared to control sites. Lichen species are known to be good indicators of airborne metals and range from being tolerant to sensitive to airborne metals, depending on the physiological form and species (Garty, 2000; Branquinho et al., 2000; Kabata-Pendias et al., 2011). Findings around the Minto site were that lichen samples accumulated more metals than the other plant species and had significantly elevated concentrations of arsenic, cadmium, iron, and lead compared to control sites.

Willows species are known to be accumulators of heavy metals (Kosvakinka and Quigley, 2004). In particular, willows are known to uptake cadmium and zinc from surrounding soils (Tlustos et al., 2007). Willows showed significantly higher arsenic, iron and lead concentrations in exposure than control sites. Conversely and contrary to expectations, willow samples at control sites appeared to have higher (but not significantly higher) concentrations of cadmium and zinc than exposure sites.

Horsetail and Labrador tea appeared to have similar responses, and were both significantly higher in copper and iron at exposure than control sites, but not for arsenic, iron, or lead.

Blueberry did not show any significant difference between control and exposure sites. This may have been due to the short exposure period when the plant is producing berries.

There were some interesting trends in other metals. Soil metals in general were higher at exposure than control sites. Iron concentrations increased significantly for all plant species other than blueberry. Iron is not a COPC, but it does indicate that there were generally higher levels of dust at the exposure than control sites. Zinc concentrations were not higher at exposure than control sites which indicates that zinc was not significantly picked up into plant tissue in the area surrounding the mine. CCME exceedances in soil were limited occuring in two of the 13 metals of interest with 5% of samples for arsenic and 25% of samples for copper exceeding the industrial guideline. When present, copper exceedances were often detected for the depth of the pit which reflects the mineralization of the area.

Large amounts of variation (noted by high standard deviations) are present within the data that were collected in 2016. The sources of variation are potentially attributed to natural variability in soil and plant tissue, plant species, source types and distance to exposure sample sites, field sampling conditions, and small sample size.

A main factor attributing to field variability for this sampling event was weather. The rain during the beginning of the sampling period could have affected the quantity of metals that were present on species that were more exposed compared to species in closed canopy conditions. There were scattered thunder showers for the remainder of the sampling period that could have affected parts of the study area. This variability is likely to persist through future sampling events as weather is unpredicatble and cannot always be avoided.

Variability attributed to sample size is reflected in the limited number of control sites and the number of target species present within each site. Blueberry sample size was limited for both control and exposure sites as they are less abundant across the landscape compared to the other species.

Laboratory variability was encounted by the nature of the selected lab’s data quality objective (DQO). The DQO implemented by the lab for tissue analysis was 40% repeatability. This threshold allows for 40% variation in concentrations between any duplicate samples. This threshold was set by that lab and is a factor of the natural variability that is present in vegetation tissue sampling. This variation is compounded when the lab homogonized, subsampled, and rinsed half of the samples for the purpose of quantifying external and internal metal concentrations. Large variation made comparisons between rinsed and unrinsed samples challanging when there were low metal concentations and minimal differences between subsamples. Additionaly, many of the results received were below the method detection limits. When this was the case, the value used to calculate statistics was half the detection limits. Including these halved detection limits is likely to have increased the variation and standard deviation for each variable.

Vegetation metal uptake surveys will continue on a three-year basis as a condition of the current licence to monitor trends and changes in metal concentrations in vegetation and soil.

10 Geochemistry and Geotechnical Information

10.1 Geochemistry

Minto conducted pre-production testing and continues to conduct operational monitoring. Detailed information on geochemistry can be found in Appendix 1-8 to this report.

The primary conclusions from the pre-production testing were that Main Pit and Minto North Pit waste rock was expected to be net acid neutralizing, and that the main acid neutralizing mineral was calcite (calcium carbonate, $CaCO_3$). The primary conclusions of preproduction testing for Area 2/ Area 118, Ridgetop, and proposed underground developments were that bulk granodiorite waste rock was expected to be net acid neutralizing, and that some mineralized waste rock was expected to have NP:AP values less than the threshold value of 3 specified by the water use license (YWB, 2015 and its predecessors).

Since mining commenced at Minto, operational ABA monitoring has been carried out on composite samples of blast hole cuttings from each waste blast. Waste rock monitoring reports have been prepared and submitted to regulators as part of the mine’s compliance reporting (initially semi-annually, now annually). The results show that Main Pit and Minto North Pit waste rock generally had low AP and NP:AP ratios greater than the threshold value of 3. Results for Area 2/ Area 118, Ridgetop, and proposed underground developments waste rock were mixed with most samples having NP:AP values greater than 3. There were sufficient samples with NP:AP less than 3 that Minto modified its waste rock management strategy to include segregation of NP:AP<3 materials. See Appendix 1-8 and Figure 10-1 for summary results of operational waste rock geochemistry monitoring.

No pre-production characterization tests were carried out on tailings from Main Pit ore. For the Phase IV and Phase V/VI deposits (Area 2, Area 118, Minto North, Ridgetop and Minto South underground), a range of preproduction tests were carried out on residues from locked cycle testing. Residues from metallurgical testing carried out on Area 2 and Area 118 ore samples were subjected to additional testing for purposes of ML/ARD characterization. Results of the pre-production testing on Phase IV and Phase V/VI tailings indicated that the material would be net acid neutralizing, and that risks of neutral pH metal leaching would be similar to those for Main Pit tailings produced from full-scale operations.

Operational monitoring of as-produced tailings has been carried out to track the ABA characteristics of the tailings produced over the operating period. Results of operational ABA monitoring of tailings produced to date confirm excess of neutralization potential (NP) over acid potential (AP), indicating that the tailings produced to date are net acid neutralizing. See Appendix 1-8 and Figure 10-2 for summary results of operational tailings geochemistry monitoring.

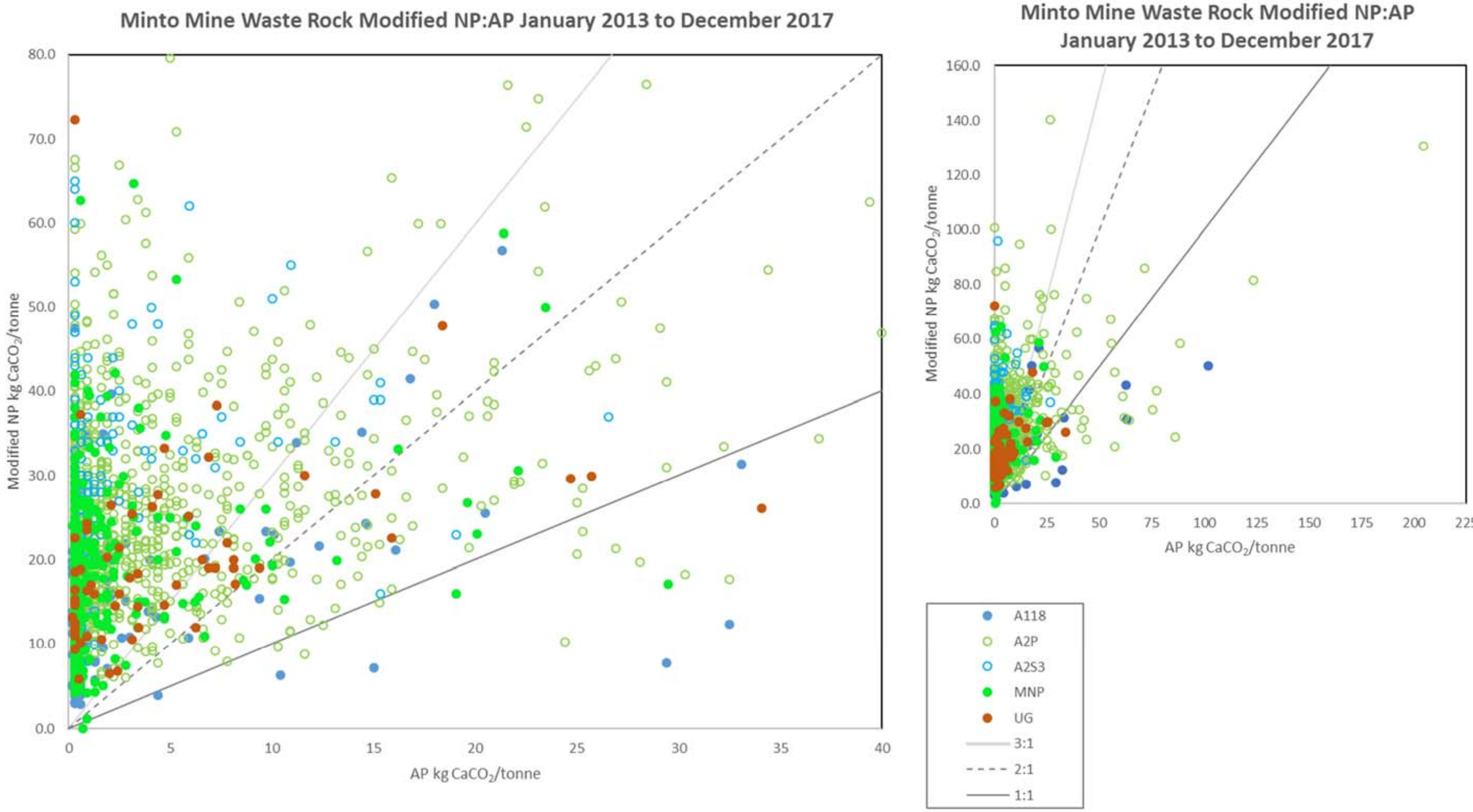

Figure 10-1: Minto Mine Waste Rock Modified NP:AP January 2013 to December 2017.

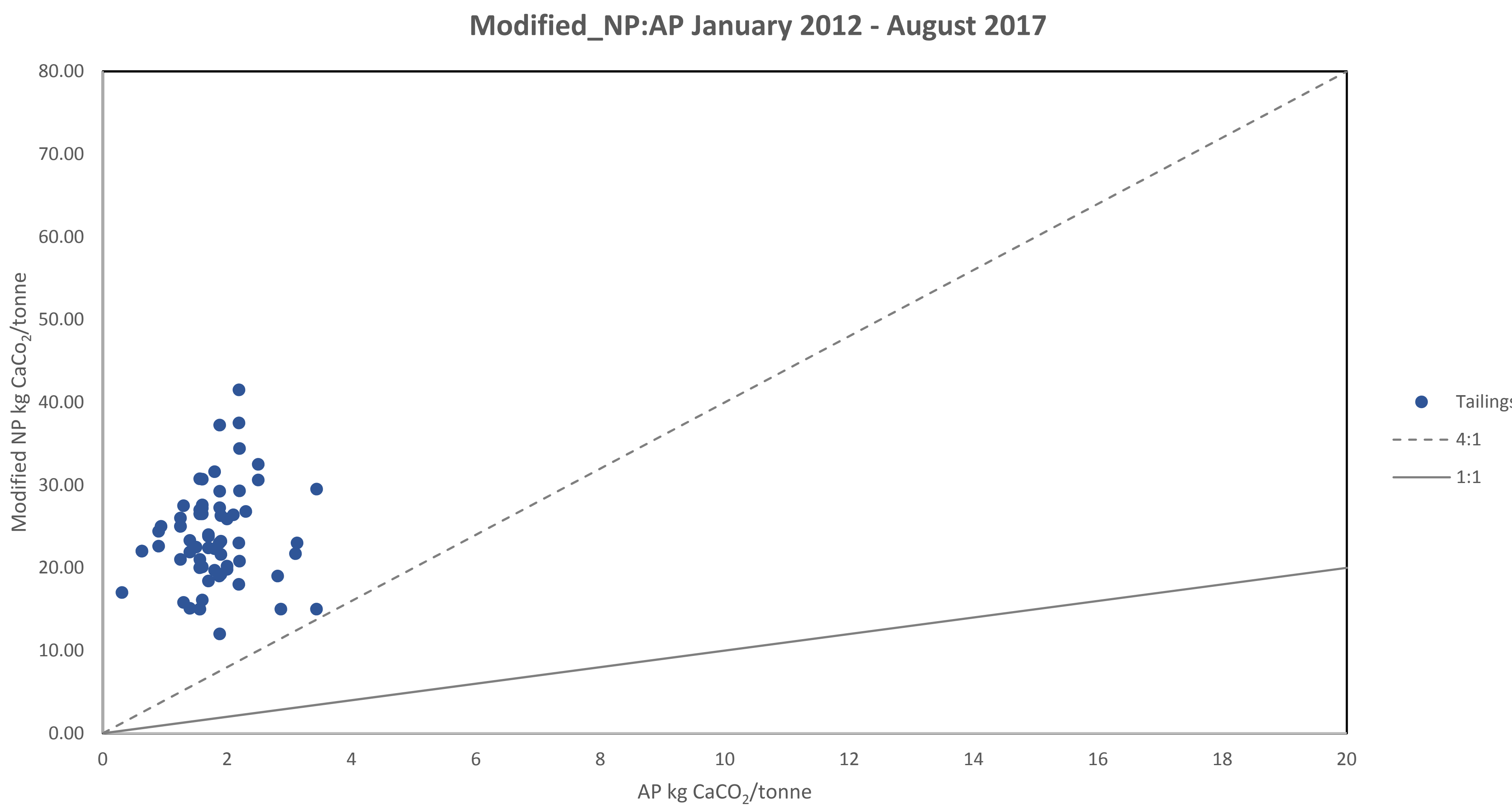

Figure 10-2: Modified NP:AP January 2012 – August 2017.

10.2 Geotechnical Information

The geotechnical stability of individual structures is addressed in geotechnical annual review reports. The site has in the past experienced slope instabilities and slow movements along a suspected shear zone underlying parts of some existing facilities; the physical monitoring program is carried out to monitor geotechnical performance of major site facilities, and review of monitoring results is an important component of the geotechnical annual inspections. The report documenting the most recent geotechnical annual review (SRK 2017) is attached as Appendix 1-9.

11 REFERENCES

Access Consulting Group (ACG). 2010. *Sherwood Copper Wildlife Survey*. Prepared for Capstone Mining Corporation.

Access Consulting Group (ACG). 2012. *Minto Climate Baseline Report.* YESAB Project Proposal Phase V/VI. Prepared for Minto Explorations Ltd. October 2012.

Access Consulting Group (ACG). 2013. *Surface Water Hydrology Baseline Conditions.* Minto Phase V/VI Expansion. Prepared for Minto Explorations Ltd. February 2013.

Access Consulting Group (ACG) and Minnow Environmental Inc. (Minnow). 2012. *Aquatic resources Baseline Report. YESAB Project Proposal Phase V/VI.* Prepared for Minto Explorations Ltd. November 2012.

Branquinho, C., F. Catarino, D.H. Brown. 2000. *Improving the Use of Lichens as Biomonitors of Atmospheric Metal Pollution.* In Biomonitoring of atmospheric pollution (with emphasis on trace elements) — BioMAP. Proceedings of an international workshop organized by the International Atomic Energy Agency in co-operation with the Instituto Tecnologico e Nuclear and held in Lisbon, Portugal, 21-24 September 1997.

BCMOE (British Columbia Ministry of Environment). 1985. *Water Quality Criteria for Nutrients and Algae: Technical Appendix.* Prepared by Richard Nordin, Water Quality Unit, Resource Quality Section, Water Management Branch. October 1985.

Capstone Mining Corporation. 2007. *Wildlife Log for the Minto Mine* (spreadsheet).

Capstone Mining Corporation. 2008. *Wildlife Log for the Minto Mine* (spreadsheet).

Clearwater Consultants Limited (CCL). 2010. *Memorandum CCL-MC6: Minto Copper Project – Surface Water Hydrology Conditions.* August 2010.

Colpron, M., Gladwin, K., Johnston, S.T., Mortensen, J.K. and Gehrels, G.E., 2005. *Geology and juxtaposition history of the Yukon-Tanana, Slide Mountain, and Cassiar terranes in the Glenlyon area of central Yukon.* Canadian Journal of Earth Sciences, 42, 1431-1448.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. Website accessed November 2012 at: http://www.cosewic.gc.ca/eng/sct1/index_e.cfm

EBA Engineering Consultants Ltd. (EBA). 2010a. *Minto Mine 2010. Climate Baseline Report*. Report prepared for Minto Exploration Inc. 14pp.

EBA Engineering Consultants Ltd.(EBA). 2010b. *Minto Mine Environmental Baseline Studies-Wildlife Report.* Prepared for Capstone Mining Corporation, August 2010.

Environmental Dynamics Inc. (EDI). 2013. *Casino Project: Wildlife Baseline Report.* Prepared for Casino Mining Corporation. October 2013.

Francis. Nishi. 2016. *A Range Assessment for the Klaza Caribou Herd in the Dawson Range of West-Central Yukon.* Prepared for Environment Yukon. Yukon Fish and Wildlife Branch Report MRC-16-01, Whitehorse, Yukon, Canada.

Garty, J. 2000. *Lichens as Environmental Biomonitors in Israel: Two Decades of Research.* In Biomonitoring of atmospheric pollution (with emphasis on trace elements) — BioMAP. Proceedings of an international workshop organized by the International Atomic Energy Agency in co-operation with the Instituto Tecnologico e Nuclear and held in Lisbon, Portugal, 21-24 September 1997.

Government of Canada. 2012. *Species at Risk Public Registry,* Available at http://www.sararegistry.gc.ca

Hallam, Knight, Piesold (HKP) Ltd. 1994. *Minto Explorations Limited, Minto Project: Volume II Environmental Settings.* Prepared for Minto Explorations Ltd.

Hood, S., Hickey, K., Colpron, M. and Mercer, B., 2008. *High-grade hydrothermal copper-gold mineralization in foliated granitoids at the Minto mine, central Yukon.* Yukon Exploration and Geology.

Kabata-Pendias, A. 2011. *Trace Elements in Soil* (4th ed.). Boca Raton, Florida: CRC Press.

Kellie, K.A. and R.A. DeLong. 2006. *Geospatial survey options manual.* Division of Wildlife Conservation, Alaska Department of Fish and Game, Fairbanks, Alaska, USA.

Kuzovkina Y.A., Knee M., Quigley M.F. 2004. *Cadmium and copper uptake and translocation of five Salix L. species.* International Journal of Phytoremediation, V.6(3): 269-287.

Little Salmon/Carmacks Fish and Wildlife Planning Team. 2011. Community based-fish and wildlife work plan for the Little Salmon/Carmacks First Nation Traditional Territory (2012 – 2017). Environment Yukon, Whitehorse (36 pages).

Magrum. 1994. An impact assessment of the Minto Project. Memo from the Selkirk First Nations to the Northern Affairs Program.

Minto Explorations Ltd. 1994. Initial Environmental Evaluation for the Minto Project.

O'Donoghue, M, R. Ward, S. Westover, A. Reyner, J. Bellmore. 2008. Carmacks West Moose Management Unit. Summary of Early-Winter 2007 Moose Survey. Yukon Fish and Wildlife Branch, Department of Environment.

O'Donoghue, M. 2009. Survey of Sheep along the Yukon River from Minto to Fort Selkirk and on Mount Hansen (GMS 3-20).

Oswald, E.T. and B.N. Brown. 1990. Vegetation Establishment During 5 Years Following Wildfire in Northern British Columbia and Southern Yukon Territory. Forestry Canada Pacific and Yukon Region Information Report BC-X-320.

Oswald, E.T. and J.P. Senyk. 1977. Ecoregions of Yukon Territory. Canadian Forestry Service and Environment Canada Report BC-X-164.

Piercey, S.J., Mortensen, J.K., Murphy, D.C., Paradis, S. and Creaser, R.A., 2002. Geochemisty and tectonic significance of alkali mafic magmatism in the Yukon-Tanana terrane, Finlayson Lake region, Yukon. Canadian Journal of Earth Sciences, 39(12), 1729-1744.

R&D Environmental. 2006. *Fisheries Assessment of Minto Creek, September 2006.* Prepared for the Access Consulting Group.

R&D Environmental. 2007. *Fisheries Assessment of Minto Creek, May, June and August 2007*. Prepared for the Access Consulting Group.

Sinclair, P.H., W.A. Nixon, C.D. Eckert, and N. L. Hughes (editors). 2003. *Birds of the Yukon Territory.* UBC Press, Vancouver, B.C.

Smith, C.A.S., J.C. Mielkle, and C.F. Roots (editors). 2004. *Ecoregions of the Yukon Territory: Biophysical properties of Yukon Landscapes.* Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia.

SRK Consulting Inc. 2013. *Freshet Geotechnical Site Inspection*, Minto Mine, YT.

SRK Consulting Inc. (SRK). 2016. *Climate Change Analysis, Minto Mine, Yukon.* Prepared for Minto Explorations Ltd. August 3, 2016.

Tafti, R. and Mortensen, J.K. 2004. *Early Jurassic porphyry (?) copper (-gold) deposits at Minto and Williams Creek, Carmacks Copper Belt, western Yukon.* Yukon Exploration and Geology 2003, D.S. Emond and L.L. Lewis (eds.), Yukon Geological Survey, 2004.

Tlustos, P., Szakova, J., Vyslouzilova, M., Pavlikova, D., Weger, J., Javorska, H. 2007. *Variation in the uptake of Arsenic, Cadmium, Lead and Zinc by different species of willows Salix spp. grown in contaminated soils.* Central European Journal of Biology 2: 254-275.

Yukon Bird Club. 2008. *Checklist of Yukon Birds.* Pamphlet produced with support from Yukon Environment and the Canadian Wildlife Service.

Yukon Environment. 2005a. Department of Environment Map ID ENV.009. *Status of Caribou in the Yukon.*

Yukon Environment. 2005b. *Yukon Amphibians.* Available at www.environmentyukon.gov.yk.ca/viewing

Yukon Environment. 2007. *Information for Decisions.* 2007 Fish and Wildlife Inventory Program Project Summaries.

Yukon Environment. 2010a. *Wildlife Key Areas. Produced by the Wildlife Key Area Inventory Program.* Environment Yukon, Habitat Programs.

Yukon Environment. 2010b. *Yukon Mammals.* Available at http://environmentyukon.gov.yk.ca/wildlifebiodiversity/mammals.php [accessed January 2010].

Yukon Environment, 2012. *Fish and Wildlife Branch 2012-2013 Project Summaries* http://www.env.gov.yk.ca/mapspublications/documents/Fish_Wildlife_Branch_projects_2012-2013.pdf

Yukon Environment. 2016. *Birds – Monitoring Breeding Waterfowl.* Yukon State of the Environment. Reporting on Environmental Indicators 2017. Available at: http://www.env.gov.yk.ca/publications-maps/report-fish-wildlife-waterfowl.php

Yukon Environment. 2017a. *Yukon Big Game Species.* Available at: http://www.env.gov.yk.ca/hunting-fishing-trapping/biggame.php

Yukon Environment. 2017b. *Yukon Mammals.* Available at: http://www.env.gov.yk.ca/animals-habitat/mammals.php

Yukon Government, Community Services, Protective Services Branch, Wildland Fire Management (GYWFM). 2012. *Yukon Fire History GIS Coverage and Metadata.* http://www.geomaticsyukon.ca/Yukon%20Coperate%20Spatial%20Data%20-%20page%202.html#Land_and_Natural_Resources_-_Fire

Yukon Government. 2009. *Yukon Species at Risk.* Available at http://www.environmentyukon.gov.yk.ca/wildlifebiodiversity/ [accessed on March 29, 2010].

Yukon Water Board (YWB). 2015. *QZ14-031-1 Type A Water Licence for a Quartz Mining Undertaking*, issued to Minto Explorations Ltd. August 5, 2015.