MINTO ECOSYSTEMS AND VEGETATION BASELINE REPORT

YESAB PROJECT PROPOSAL PHASE V-VI

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Prepared for:

MINTO EXPLORATIONS LTD.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

Minto Explorations Ltd. (Minto) is preparing a proposal for assessment by Yukon Environmental and Socio-economic Assessment Board (YESAB) to expand their operations at the Minto Mine site to include mineral-rich deposits north (Minto North) and south (Area 2 Stage 3 and Ridgetop) of the current open pit mining. The expansion (Phase V/VI) will also include an expansion of the underground mining areas. In order to determine the effects that the proposed Phase V/VI development will have on local terrestrial ecosystems, further investigations are needed. Previous vegetative and soil studies conducted in the Minto area will serve as a base to update and enhance ecosystem information needed to satisfy YESAB requirements and to assist Capstone Management in minimizing possible impacts.

The first vegetative study done in the Minto mine area was conducted in 1994 by Hallam, Knight, and Piesold Ltd. (HKP), as part of the initial environmental evaluation (IEE). The focus of the HKP study was the entire Minto Creek watershed prior to mine development, a total area of 60 km^2. The information was gathered from aerial photographs, maps, and ground surveys. The report described ten different plant communities that existed within the study area and associated growth conditions.

More recently in 2007 to 2010 revegetation field tests were initiated and monitored to determine the best grass seed mix for the local growth conditions. The trials were set up in different locations around the mine site in a range of different aspects and slopes. Included in this study was the sampling of site soils and metal uptake by natural regenerating willows (*Salix sp.)* and Paper birch (*Betula papyrifera*) near trial plots. Control plots were also established near the Yukon River away from the access road that were beyond to runoff or dust generated by mine activities. Although this was not a comprehensive soil and vegetation sampling program, it did provide insight into the type of mineralization and nutrient content of local soils, plus potential metal accumulation in plant tissues.

In the intervening years the Minto area has been altered by the footprint of the present mine site, roads, further exploration, and three major fires. To update the information on the vegetation communities that surround the mine site, the 2010 vegetative study area was concentrated on a ~3 km radius around the present Minto mine footprint and encompassed a total of 3,626 hectares. Recent (2010) burn areas in the southeast quadrant were also measured and delineated (Figure 4). Plots were not established in proposed expansion or recent burns areas, but a reconnaissance was conducted to determine if there were any unique features or sensitive ecosystems within them.

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 into a final product. It was determined that an ecosystem mapping approach would best satisfy the informational needs for an evolving mining development and a forested landscape prone to frequent fire disturbances. Through ecosystem mapping protocols, changes in floristic coverage can be monitored by aerial photography and a framework of permanently established ground plots can monitor soil chemistry changes, successional growth, wildlife usage, and impact effects. This vegetation surveying and GIS ecosystem mapping project was undertaken by Access Consulting Group (ACG) with Horizon Ecosystem Consulting.

Thirty plots were visited, and site descriptions and floristic cover estimates were recorded. Notes were also taken between plots to clarify polygon boundaries Twenty-three plots are permanent plots that can be easily relocated and monitored for changes. In addition, seven plots outside the proposed mine expansion footprint

were selected as controls that represent different slope aspects and plant associations. These controls can be used to compare changes over time with respect to other sites closer to mine impacts.

Soils samples were taken from ten plots around the mine and analyzed for elemental metals, nutrients, cation exchange capacity, pH, and soil texture. These will inform future monitoring of plant growth/success and may be useful for comparison in future monitoring of effects from any downwind transportation of mineral dust from mining operations. In addition, grasses used in revegetation trials were sampled and analyzed for metal uptake. The soils that these grasses were growing in were also tested to determine which specific metals were being absorbed from the growth medium and stored in plant tissues. Data and observations over the lifetime of the mine are also useful in the development of a successful reclamation plan.

2 BIOPHYSICAL BACKGROUND

The Minto mine is located approximately 240 km north of Whitehorse, Yukon (Figure 1) and lies within the Boreal Cordillera ecozone and Yukon Plateau ecoregion (Smith et al. 2004). The Minto Mine is situated in the far western part of the Yukon Plateau ecoregion near the Dawson Range and adjacent to the Klondike Plateau ecoregion in the west. This area was part of the eastern extent of Beringia, which remained ice-free approximately twenty to fifteen thousand years ago (Smith et al. 2004). Endemic and rare plant species are associated with the Beringia area as it was a unique and isolated ecosystem; remnant species are possibly present, associated with grasslands on south-facing slopes or riparian/wetlands areas (Table 2-1).

Forest fires are frequent in this part of the Yukon Territory as it lies in the rain shadow of the St. Elias-Coast Mountains and receives less than 300 mm 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. Young mixed lodgepole pine and trembling aspen forests are the most common forest type, and willow species were ubiquitous in understory as well as in the main canopy of shrub dominate polygons. The study area is in the eastern part of the Dawson Range foothills with elevation range of 700 to 950 m; and the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed. As a result, discontinuous permafrost occurs on northern slopes and low lying areas where solar radiation is reduced.

Rare or Endangered Plants

Areas that were likely to be disturbed in the next year were checked for rare plant species. No plants that met this criteria, were found during a time limited search. Also these areas have already been disturbed by intense exploration activity. Rare plants are usually associated with riparian, grasslands and unique abiotic conditions, the areas surveyed were common White spruce/Aspen/Willow communities which are less likely to host rare plants. The following table is a list of endangered plants that may exist in the Minto area and the type of habitat preferred:

Table 2-1: Rare Plant Species Potentially Occurring in the Minto Area

Family	Species	Common Name	Habitat
Polypodiaceae	*Polypodium sibiricum*	wall fern	rocks & crevices
Ruppiacea	*Ruppia spiralis*	ditch grass	shallow water
Alismataceae	*Saggitaria cuneata*	arrowhead	shallow water
Poaceae	*Koeleria asiatica*	June grass	grassland
Poaceae	*Koelaria macrantha*	June grass	grassland
Poaceae	*Muhlenbergia richardsonis*	mat muhly	grassland
Poaceae	*Scolochloa festucaceae*	sprangletop	wetland
Poaceae	*Glyceria borealis*	Northern manna grass	wetland
Poaceae	*Helictotrichon hookeri*	spike oat	grassland
Cyperaceae	*Carex viridula* ssp. *viridula*	green sedge	wetland
Cyperaceae	*Trichophorum pumilum*	tufted bulrush	wetland
Iridacea	*Sisyrinchium montanum*	blue-eyed grass	grassland
Orchidaceae	*Cypripedium guttatum*	spotted lady's-slipper	open woods
Hydrophyllaceae	*Phacelia mollis*	scorpion weed	grassland

Family	Species	Common Name	Habitat
Apiaceae	*Cicuta maculata* var. *angustifolia*	spotted water-hemlock	wetland
Apiaceae	*Podistera yukonensis*	Yukon podistera	grassland
Apiaceae	*Sium suave*	water-parsnip	wetland
Santalaceae	*Comandra umbellate*	pale comandra	grassland
Violaceae	*Viola langsdorfii*	Alaska violet	forest edge
Caryophyllaceae	*Minuartia yukonensis*	Yukon sandwort	grassland
Caryophyllaceae	*Silene williamsii*	Campion	talus slope
Rosaceae	*Rosa woodsii*	western rose	grassland
Rosaceae	*Geum triflorum*	prairiesmoke	grassland
Asteraceae	*Haplopappus macleanii*	haplopappus	grassland
Asteraceae	*Antennaria microphylla*	rosy pussytoes	grassland
Asteraceae	*Artemisia laciniata*	wormwood	forest edge
Asteraceae	*Townsendia hookeri*	Easter daisy	grassland

Soils

The soils around the Minto mine were found to have elevated concentrations of copper, especially near waste rock piles. Chemical analysis of soils indicate that in general they are deficient in macronutrients (nitrogen, carbon, phosphate, and potassium), but have adequate micronutrients (copper, iron, manganese, molybdenum, and zinc). Soil samples have a pH range of 4.98 to 7.19, i.e., slightly acidic to slightly alkaline; no extremes were found.

3 METHODOLOGY

3.1 PHOTO INTERPRETATION

Aerial photos received from Geographic Air Surveys Ltd. were taken in the summer of 2009 and are at a scale of 1:10,000. Stereographic pairs were examined and delineated into polygons of vegetation cover types, based on the Vegetation Resource Inventory (VRI) photo interpretation procedures version 2.6 (2001). The elements considered for polygon delineation include: species composition, crown closure, stand structure, aspect, elevation, slope, tree age, height, and soil nutrient/moisture regimes.

Classification of vegetated polygons was based on protocol developed by Yukon Forest Management Branch (2005) and British Columbia Terrestrial Ecosystem Mapping Standards (1998). A polygon is considered vegetated when the total cover of trees, shrubs, herbs and bryoids is more than 5% of the total surface cover of the polygon. The polygon is considered forested if more than 10% of the cover is treed. Aside from the footprint of the existing mine, all the polygons identified within the study area were vegetated. In total, 99 polygons were delineated and interpreted. Tree and shrub polygons are labelled in decreasing order of crown closure, which is the highest proportion first, and the lowest proportion last, i.e. 60% aspen, 30% pine and 20% willow is represented as At6Pl3W2. The map polygons represent the spatial distribution of these vegetation communities within the study area.

3.2 MAPPING

Mapping was accomplished using ArcGIS 9.3 software and air photos combined with cadastral mine infrastructure data provided by Minto Explorations Ltd. The previously identified aerial photo polygons were then overlaid onto the base map (scanned and orthorectified in ArcGIS's ArcMap software). The delineated boundaries of forest cover were then traced and digitized using a tablet stylus, resulting in the creation of polygons. Each of these polygons has a unique identifying number, e.g. (M45). The estimated forest stand characteristics for each of these polygons were then attached to the shape file as attributes. The results from the field work were used to modify the vegetation map and improve accuracy in boundary location and species cover estimates. The attributes for the forest stand polygons that were visited in the field were updated and the raw data sheets are hyperlinked to these particular polygons. The UTM location of plots and types (field checked, permanent and controls) of plots are also indicated on maps (see TEM poster map). Although the initial map interpretation used the 2009 aerial imagery of the site, the map products in Figures 4-9 use more recent 2012 aerial imagery of the site.

3.3 PLOT SAMPLES

Thirty plots were visited to determine accuracy of photo interpretation, twenty-three of which are permanent plots. An aluminum stake with a metal identifier tag marks the plot centre. A radius of 11.29 m was measured and marked with flagging tape, resulting in a 400 m^2 area in which to gather information and measurements. These plots are GPS-referenced and designed to be easily relocated for future monitoring. At each plot, plant species were identified, percent cover was estimated, site attributes were recorded, and an overview photograph was taken. Summaries of surveyed sites are included in Appendix B and completed field data sheets were scanned and are available in digital format on request. This creates a set of permanent plots that can be monitored for floristic and soil chemistry changes over the lifetime of the mine and reclamation phase.

Understanding the conditions and natural secession in the immediate area can provide vital information for resource management, restoration planning, and restoration implementation.

Information recorded on plot data sheets includes (see Ecological Plot Survey Form Appendix C):

- Plant species
- Percent cover
- Coarse woody debris/snags estimates
- Site features
    - Surface shape
    - Plot position
    - Aspect
    - Elevation
    - Slope
    - Drainage
    - Soil moisture/nutrient regimes
    - Types of disturbances
    - Diagram of plot

The tree coverage is also divided by height on field cards as this helps determine the structural stage of each site/polygon. Tall trees (TT) are over 5m tall and little trees (LT) are less than 5m in height. Shrubs have four divisions: tall shrubs (TS) are 2m to 5m tall, medium shrubs (MS) are 0.5m to 2.0m tall, little shrubs (LS) are 0.1 to 0.5m, and ground shrubs (GS) are <0.1m tall.

Plant species that had 0.5% or greater coverage were identified and recorded on data sheets. Rare or uncommon species as well as uncommon ecosystems, i.e. wetlands and grasslands, were searched for within plots and between plots. No rare plants were found during the field investigations; although this does not mean that rare species do not exist within the study area, only that they were not located in the areas during the season that the field work was undertaken.

4 RESULTS

By integrating the aerial photo interpretation and vegetation survey information, an ecosystem map was produced and is presented in six distinct sheets in Figures 4 through 9 A large poster map can be generated to view the entire Minto ecosystems map using ArcGIS data. The map is the stratification of the landscape into polygons according to a combination of ecological features, primarily climate, soil, and vegetation. In general, an ecosystem map provides:

- a biological and ecological framework for land management;
- a means of integrating abiotic and biotic ecosystem components on one map;
- basic information on the distribution of ecosystems from which land management decisions can be based;
- a basis for rating values of resources or indicating sensitivities in the landscape;
- a historic record of ecological site conditions that can be used as a framework for monitoring ecosystem response to development, natural disturbances, or reclamation; and
- a demonstration tool for portraying ecosystem and landscape diversity (B.C. Resources Inventory Committee 1998).

On the ecosystem maps, each polygon is assigned a unique number, labelled by species in order of descending percent cover; with plot location and type also indicated. The photographs and summary information for each ecosystem plot can be found in Appendix B and located on the ecosystem map. The plot numbers are the same as the polygon in which the plots were established. The map and plot summaries are inventory of current vegetation communities and growth conditions to inform future reclamation efforts.

4.1 ACCURACY AND ERROR

Polygon boundaries are not exact, as stereo photographs are distorted because of lens curvature and transfer of photo boundaries from actual photos to GIS. Also, gradual change in slope and vegetation makes it difficult to determine a defining line between vegetative types. Error between polygon delineation is estimated to be ± 15 m.

Larger polygons have a higher degree of error as more micro-sites exist within the topography included in a larger area. Remnant patches of mature growth not burnt during recent fires may also be captured. Fire mosaics are complex and not easily delineated. As the study area has been disturbed by fires three times in the last thirty years (see Figure 3), polygons have a degree of variability arising from different successional stages. The accuracy of the polygon interpretation can be increased during monitoring visits as more ground calls can be made to verify polygon boundaries; and changes from mine expansion or other disturbances can be noted.

4.2 PLOT INFORMATION SUMMARY

Universal Transverse Mercator (UTM) locations for the 30 field plots, vegetation species percent cover, altitude, plot status, and soil sample assignment are presented in Table 4-1. See Plant List Appendix A for tree and shrub codes. Further details for each surveyed plot can be found in Appendix B.

Table 4-1: Plot Locations, Vegetation Type, and Status.

Plot#	Northing	Easting	Veg Type	Altitude (m)	Plot Status	Soil Sample
M01	6943349	383085.7	Sb_6W_4	904	permanent	n
M02	6943093	383078.0	$D_4W_4Ea_2$	910	permanent	n
M03	6943759	381970.3	W_6Es_4	841	permanent	n
M05	6944177	383095.4	$At_5W_3D_2$	943	visit	n
M07	6944289	381864.2	$At_5Pl_4W_1$	890	control	y
M17	6943539	384092.6	$Sb_7Sw_2W_1$	899	permanent	n
M18	6943302	383777.1	$Es_5S_3W_2$	892	visit	n
M19	6943678	384090.6	$W_8Ea_1Sw_1$	894	permanent	n
M20	6943683	384161.0	$W_5At_4Pl_1$	904	visit	n
M24	6943153	385352.9	Es_6W_4	872	permanent	n
M25	6943216	385545.4	Sb_9W_1	891	permanent	n
M26	6943242	385666.2	W_6D_4	890	permanent	n
M27	6943234	385742.5	$Pl_4AT_4W_2$	894	permanent	n
M28	6944384	386420.7	$Pl_7At_2W_1$	864	permanent	n
M29	6945182	386636.2	Sb_6Sw_4	798	control	y
M35	6943307	383641.8	At_8W_2	891	permanent	y
M36	6942781	383007.3	$At_5W_4D_1$	866	permanent	n
M51	6945428	382926.0	$Pl_6At_2W_2$	924	visit	n
M52	6945724	382846.6	$Pl_3G_3At_2W_2$	931	permanent	n
M54	6946246	384682.0	$Pl_4W_2Sw_2Ea_2$	929	control	y
M54A	6945971	383509.8	$W_5Pl_3D_2$	959	control	y
M54v	6946250	384116.2	$W_5Pl_3D_2$	912	visit	n
M56	6946205	384428.1	Sb_9w_1	921	visit	n
M76A	6948266	384025.0	$At_5G_3Pl_2$	837	control	y
M79v	6947061	384473.0	W_8Sb_2	801	visit	n
M80	6947083	384380.2	$Pl_5W_3At_2$	817	control	y
M84	6947320	385289.7	$At_5Pl_3G_2$	894	control	y
M90A	6947197	387045.2	$At_5Sw_3Pl_2$	792	permanent	y
M91	6947461	386101.7	$Pl_5Sw_4At_1$	817	permanent	n
M93	6947350	386696.1	$D_5W_4At_1$	816	control	y

4.3 AREA CALCULATIONS

The area covered per leading species within the study area was calculated in ArcGIS. The total area for each species was corrected by polygon composition within the forested portion of the study area for crown closure. This was performed in ArcMap and Microsoft office Excel 2007. The area covered per dominant plant species is calculated to show the relative abundance of each species within the study area and is presented in Table 4-2 below.

Table 4-2: Area of Individual Tree/Shrub Species Coverage as Leading (s1), Secondary (s2) and Tertiary (s3) Components of Polygons (Percent Cover per Individual Species for Entire Study Area).

Species	s1	s2	s3	Total Area (ha)	Percent Composition
At	198.08	91.90	47.01	337.00	24.59
D	37.29	15.89	19.69	76.23	5.56
Ea	20.85	13.90	12.28	47.03	3.43
Es	5.42	10.01	-	15.43	1.13
G	7.79	10.97	50.77	69.53	5.07
Pl	96.74	74.39	68.12	242.47	17.69
Sb	78.86	3.83	3.60	86.29	6.30
Sw	28.44	35.91	30.59	96.74	7.06
W	177.26	178.94	35.78	399.89	29.18

Total Forested Vegetation Coverage = 1370.62 ha

Area of species coverage = Species * percentage * cc * area of polygon

4.4 SOIL ANALYSIS

Ten soil samples were collected from the following plots: M07, M29, M35, M54, M54A, M76A, M80, M84, M85, M90A, and M93. The analysis was performed by Maxxam Analytics and Exova (see Appendix D).

In general, the cation exchange capacity (CEC) of the soils around the Minto mine site is low; however this is typical for coarse sandy silt soils, which are common throughout the study area. The soil analysis indicates positively charged mineral nutrients are not held on to by the soil particles therefore there is a reduced availability of nutrients for plant growth as there are less organics and clays in the soil matrix. Of the samples taken, plot M29 had the highest CEC at 19 cmol+/Kg, while the other plots were approximately 10 cmol/Kg or less.

Total Sulphur (S) was high across all soil samples. Sulphur is an essential plant nutrient necessary for protein synthesis and the formation of chlorophyll. Organic matter is the primary source of plant available SO4-S. Soils that are sandy, low in organic matter and found in upper to mid-slope positions are especially prone to sulphur deficiency since the small amount of SO4-S released from organic matter is susceptible to leaching loss. Also, organic sulphur is lost during forest fire events where it is volatized and released into the atmosphere. The higher concentration of inorganic sulphur found in soil samples is likely being contributed to by bedrock mineralization. The highest concentration of sulphur was found in plot M84 with 82 mg/kg, while the lowest concentration was the M93 plot sample at 36 mg/kg.

Most plots are low in nitrogen because of poor humus development, particularly in places where recent fires have burnt off forest floor organics.

Soil samples had a range of pH from 4.98 to 7.19, i.e., slightly acidic to slightly alkaline but no extremes were found. Soil analysis profiles for each of the 10 samples taken are in Appendix D; this information provides a baseline for comparison for future monitoring of soils

There was a high copper valuation found in the soil analysis for plot M84. This result was relayed to the site's geologist for interest's sake.

4.5 INCIDENTAL WILDLIFE OBSERVATIONS

Although wildlife observations were collected during the ecosystem survey, they were general, incidental, and confined to areas surveyed while establishing field plots. The reader is directed to the Baseline Wildlife Conditions report for a more comprehensive presentation of wildlife use around the Minto Project.

5 DISCUSSION

Most of the study area is regenerative young forest- or shrub-dominate ecosystems where tree and shrub species are at 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 (Table 4-2) at present. 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 ridgetops 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 (Table 4-2); and though none were found at the time of survey, this does not mean that none exist.

5.1 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. Vegetation associations have been developed based on the 1994 biophysical assessment (HKP, 1994) and data collect during this investigation. Plot descriptions are more detailed, but most polygons will fit in one of the following general forest types:

Trembling Aspen/Lodgepole Pine/White Spruce

This association is found in young successional forests on well-drained coarse soils, mesic to subxeric sites, along upper and middle slopes. Lodgepole pine (Pinus contorta latifolia) is more dominant on drier south-facing slopes and terraces. White spruce regeneration is commonly younger and growing in the understory. Ground cover is a mix of low growing shrubs such as lingonberry (Vaccinum vitis idaea), kinnikinick (Arctostaphylos uva-ursi), and bog blueberry (Vaccinum uliginosum). Prickly rose (Rosa acicularis) is often present in the understory as well. Earlier succession on the same site conditions has a higher component of shrub species including willow (Salix sp.), mountain alder (Alnus crispa crispa), and Alaskan birch (Betula neoalaskana). Herbaceous cover is sparse with scattered fireweed (Epilobium angustifolium), tall bluebells (Mertensia paniculata), and lupine (Lupinus arcticus). Lichens are well represented on drier sites.

Black Spruce/Labrador Tea/Sphagnum

This association is found along north-facing lower slopes and toes (cool sites), usually in sparse to open forests (< 50% crown cover). Common shrubs in this ecosystem include Labrador tea (*Ledum groenlandicum*), scrub birch (*Betula glandulosa*), willow (*Salix sp.),* and bog blueberry (*Vaccinum uliginosum*). Herbs commonly present are sweet coltsfoot (Petasites frigidus), cloudberry (Rubus chamaemorus), and horsetail (Equisetum sp.). Sites are poorly drained (hydric to mesic), with peat horizons over mineral soils

which are often associated with permafrost. These are mature to old forests (> 100 yrs) that have escaped repeated fires due to the high moisture content held in the organic layer.

White/Black Spruce

This association is typically located on south-facing lower slopes with willow species (Salix sp.) and Labrador tea (Ledum groenlandicum) in the understory. A thick carpet of feather moss and sphagnum covers the mineral soil. Ground cover shrubs include lingonberry (*Vaccinum vitis idaea*), bog blueberry (*Vaccinum uliginosum*), and crowberry (*Empetrum nigrum*). Herbs found were bastard toadflax (*Geocaulon lividum*) and horsetail (*Equisetum sp.).* Moisture regime is mesic to subhydric.

Willow/Trembling Aspen

This was the most common vegetation association in the study area, indicative of later regenerative growth (>10 years) after a fire event. Most trees and shrubs are less than 5 m tall; and the cover can be open to closed, as the canopy layer is of uniform height. Other species that may have been present include: Alder (*Alnus crispa*), Balsam poplar (*Populus balsamifera*), and Alaskan birch (*Betula neoalaskan*) on north-facing slopes. Lodgepole pine and white spruce may also be present in low numbers. The moisture regime ranges from subhygric to subxeric situated along mid slopes and terraces.

Willow/Scrub Birch

Willow (*Salix sp.)* and scrub birch (*Betula glandulosa*) occur in fluvial ecosystems adjacent to streams and fens, making them prone to flooding. 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/Grasslands

This association features sparse to open cover of trembling aspen (*Populus tremuloides*) with lodgepole pine (*Pinus contorta latifolia*) often present as a minor component. Found on steep south- and southwest-facing slopes, understory shrubs include prickly rose (*Rosa acicularis*), soapberry (*Shepherdia canadensis*), and kinnikinick (*Arctostaphylos uva-ursi*). Herb cover is diverse, with some common plants being purple reedgrass (*Calamagrostis purpurascens*), death camas (*Zygadenus elegans*), common yarrow (*Acillea millefolium*), goldenrod (*Solidago simplex*), pussytoes (*Antennaria sp.),* prickly saxifrage (*Saxifraga tricuspidata*), rough cinquefoil (*Potentilla norvegica*), and fireweed (*Epilobium angustifolia*).

Grasslands

This association is found on hillcrests and steep south-facing slopes as well as on shallow rocky soils that are nutrient-poor and very dry. An uncommon plant community was surveyed within the study area, (listed as "G" in Table 4-2, covering 7.79 ha). Purple reedgrass (*Calamagrostis purpurascens*) was most common, with scattered Rocky Mountain Fescue grass noted as well (*Festuca saximontana*). Similar herbs as mentioned above in trembling aspen (*Populus tremuloides*) and grassland communities were also found.

5.2 WILDFIRE HISTORY

Wildfire is a significant force in the vegetation successional systems of the area, given its semi-arid climate and forest types. As recently as 2010, forest fires have burned in the Minto mine vicinity. An orthorectified overview map with the known fire history is provided in Figure 3.

5.3 APPLICATION OF SURVEY NETWORK AND RESULTS

The ecosystem map was designed to be used as a land management and planning tool (Lipovsky 2005) . As the mine expands its footprint, the map can be referred to for a quick assessment of what type(s) of vegetation communities will be directly disturbed.

The ecosystem survey data can also be applied to future revegetation and reclamation efforts in the following ways:

- Early successional vegetation communities can be used as a template for developing revegetation prescriptions (YG, 2005)
- Certain plant communities can be easily found on the ecosystem map and accessed in the field.
- Control plots are established to compare vegetation growth with disturbed areas that have similar conditions.
- Plant seed and root stock resources can be quickly located and harvested.
- Natural soil conditions and nutrient cycling information can be used in designing soil covers needed in the reclamation phase.
- Improved understanding of types and extent of disturbance of natural ecosystems.
- Monitoring of invasive species by comparing species colonization in natural systems to revegetated sites.
- Topsoil salvage.
- High value wildlife habitat can be identified, , and protective measures put in place. .

5.4 AREAS OF CONCERN

In general, areas of concern are typically associated with ecosystems that are the least represented or uncommon within the larger regional landscape. It is more likely that rare or endangered species of plants and animals would occur in these underrepresented ecosystems. Within the scope of this study it was not possible to locate and identify all rare elements for protection; instead the best method would be to avoid disturbing these habitats/ecosystems during the expansion phase. If that is not possible, then it is recommended that a more focused survey be conducted in the immediate area proposed to be cleared, so salvaging attempts can be made or buffers used. Places identified during the study that have high wildlife value or are sensitive to disruption are listed below:

- Mature black spruce forest remnants: wildlife refuge (M17, M60, M56)
- Pine and spruce veterans that have survived successive fires: wildlife trees
- Ecosystems associated with rare and endemic plants, such as grasslands, wetlands, riparian zones and mature forests.
- Riparian areas have a high degree of plant diversity and are of high wildlife value - avoid disturbance (M01, M38, M03, M72, M78)

Conclusion

This report provides an updated inventory of vegetative ecosystems that exist within the Minto properties. Vegetative ecosystems were classified and mapped as polygons so different habitat types can be viewed in relationship to each other. The resulting ecosystem map and information on site conditions can be used as a planning and management tool.

This is an initial project; more information can be gathered to augment the usefulness of the ecosystem inventory and keep data current. Changes in the landscape will continue, due to ongoing mineral exploration and extraction, also reclamation and closure projects are scheduled to proceed. By maintaining a current ecosystem map these the different mine development and reclamation phases can be documented and effectively presented to a variety of audiences.

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FIGURES

MINTO MINE

MINTO EXPLORATIONS LTD.
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MINTO MINE PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

FIGURE 1
PROJECT LOCATION

ACCESS

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Study Area

MINTO MINE PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

FIGURE 2 - STUDY AREA

MARCH 2013

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 14th 2012.
Datum: NAD 83; Projection: UTM Zone 8N

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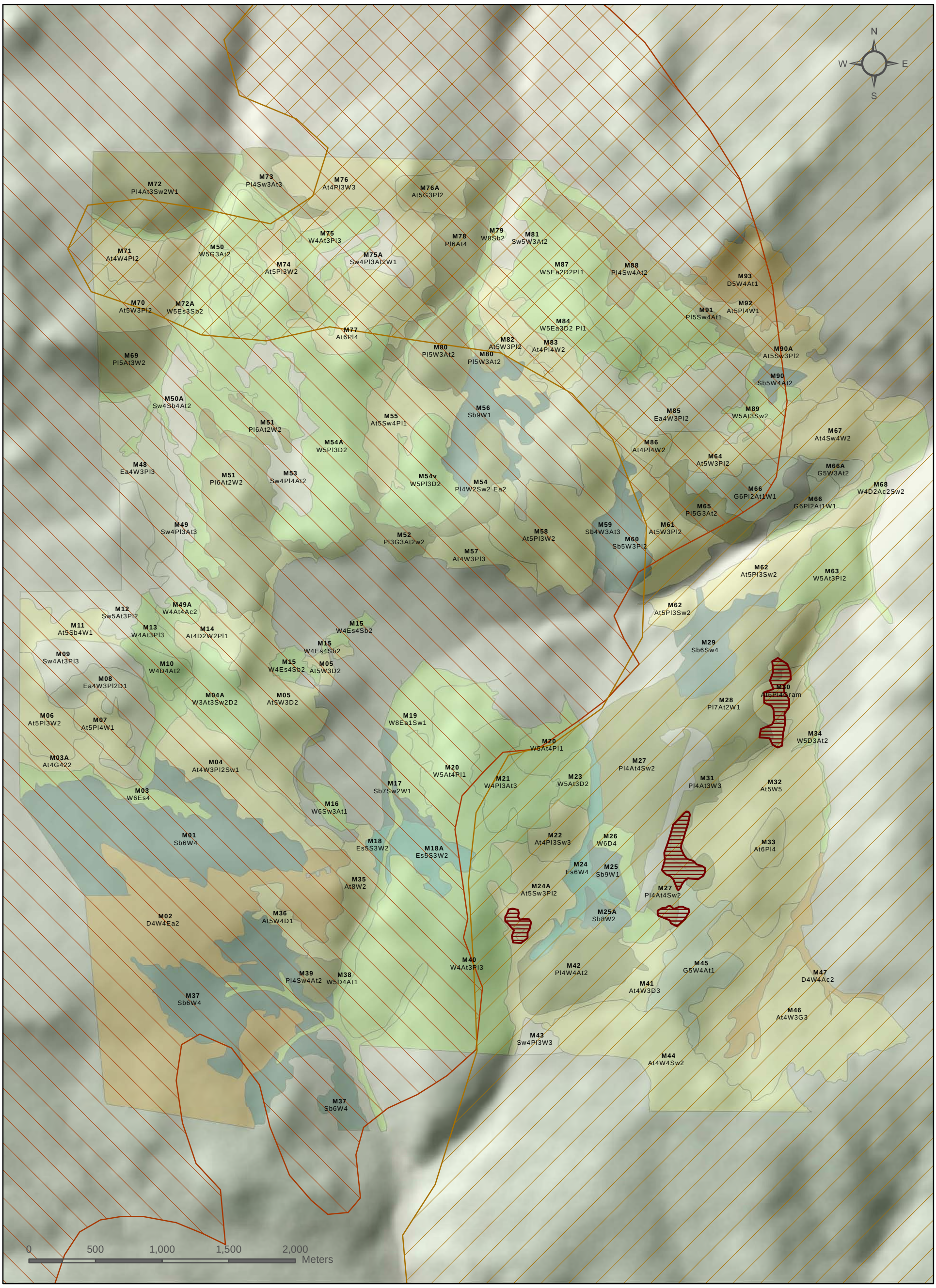

2010 Control Burn
1980
1995

Disturbed Area / Non-Vegetated
At - Trembling Aspen
D - Alder
Ea - Alaskan Birch

Es - Scrub Birch
G - Graminoids
Pl - Lodgepole Pine
Sb - Black Spruce

Sw - White Spruce
W - Willow

Fire history data compiled by Wildland Fire Management, Government of Yukon.Publication date 2005; Obtained from Yukon Geomatics. Map Datum: NAD 83; Map Projection: UTM Zone 8N

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MINTO MINE PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

FIGURE 3 - FIRE HISTORY

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382000 382500 383000 383500 384000 384500 385000

6948000 6947500 6947000 6946500 6946000

M72
Pl4At3Sw2W1

M73
Pl4Sw3At3

M76
At4Pl3W3

M76A

M76A
At5G3Pl2

N
W E
S

M88
Pl4Sw4At2

M81
Sw5W3At2

M87
W5Ea2D2Pl1

M75
W4At3Pl3

M75A
Sw4Pl3At2W1

M78
Pl6At4

M71
At4W4Pl2

M74
At5Pl3W2

M79
W8Sb2

M70
At5W3Pl2

M72A
W5Es3Sb2

M84
W5Ea3D2
Pl1

M77
At6Pl4

M82
At5W3Pl2

M83
At4Pl4W2

M69
Pl5At3W2

M80
Pl5W3At2

M80

M79v

M80
Pl5W3At2

M83
At4Pl4W2

M50A
Sw4Sb4At2

M54A
W5Pl3D2

M56
Sb9W1

M50
W5G3At2

M55
At5Sw4Pl1

M51
Pl6At2W2

M52
Pl3G3At2w2

M54v

M54
Pl4W2Sw2
Ea2

M54

M85
Ea4W3Pl2

M56

M48
Ea4W3Pl3

M49
Sw4Pl3At3

M51
Pl6At2W2

M53
Sw4Pl4At2

M54v
W5Pl3D2

M52
Pl3G3At2w2

M58
At5Pl3W2

M58
At5Pl3W2

M12
Sw5At3Pl2

M50
W5G3At2

M54A
W5Pl3D2

M54A

M52
Pl3G3At2w2

382000 382500 383000 383500 384000 384500 385000

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MINTO MINE
PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 4
NORTHWEST QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

2010 Control Burn Area

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0 50 100 200 300 400 500 Meters

Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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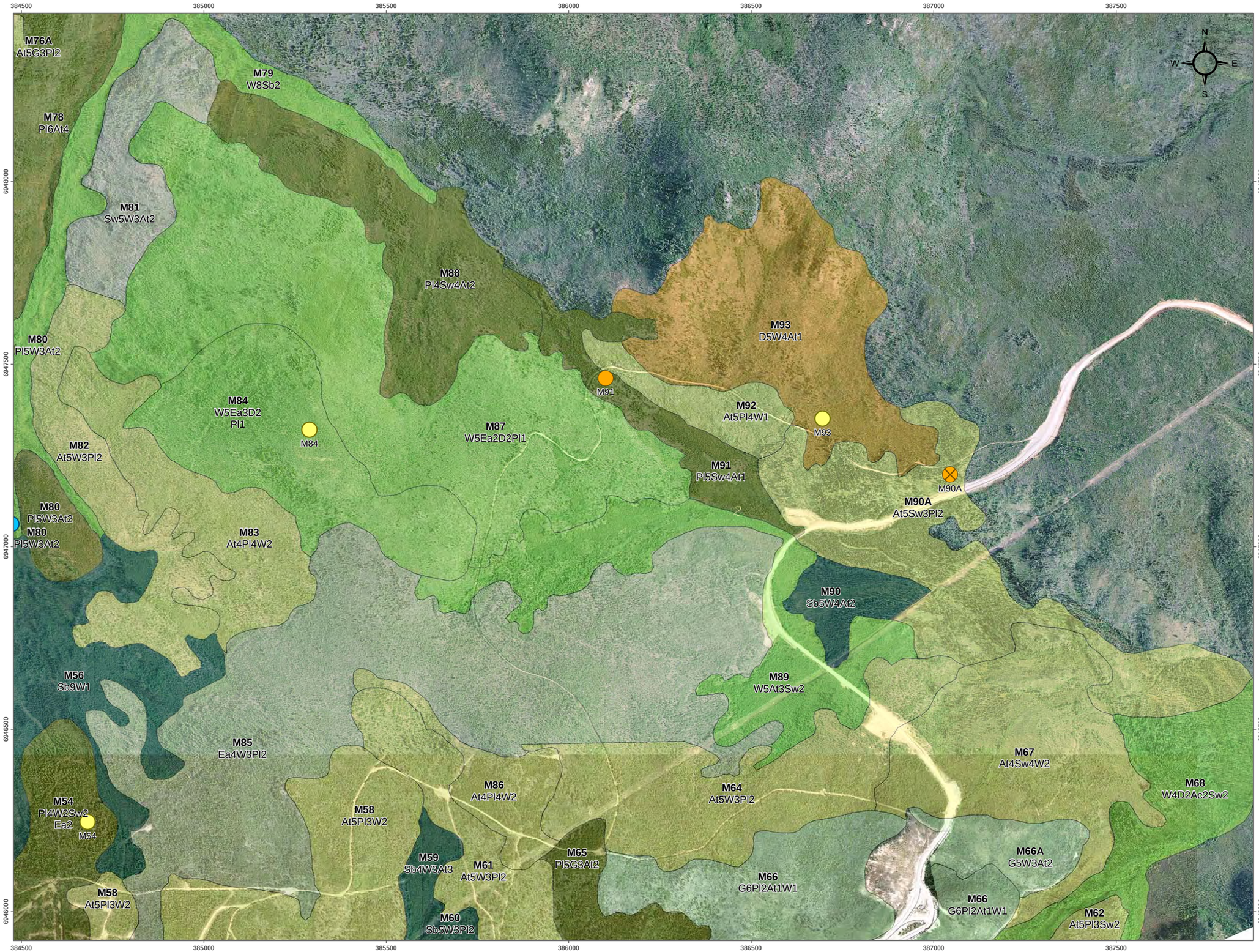

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MINTO MINE
PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 5
NORTHEAST QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

2010 Control Burn Area

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Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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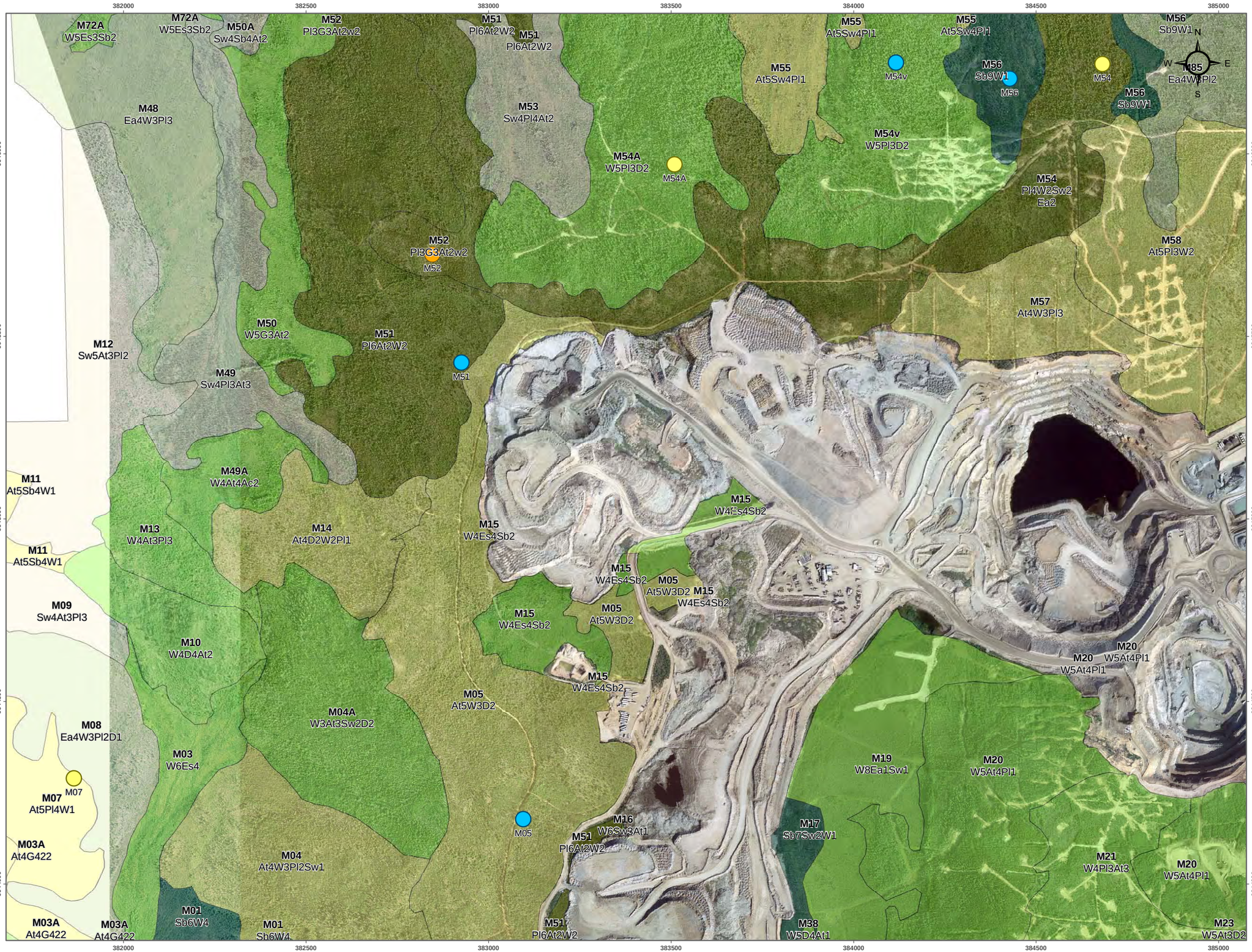

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PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 6
WEST CENTRE QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

2010 Control Burn Area

1:10,000 when printed on 11 by 17" paper

0 50 100 200 300 400 500 Meters

Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 7
EAST CENTRE QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

2010 Control Burn Area

1:10,000 when printed on 11 by 17" paper

0 50 100 200 300 400 500 Meters

Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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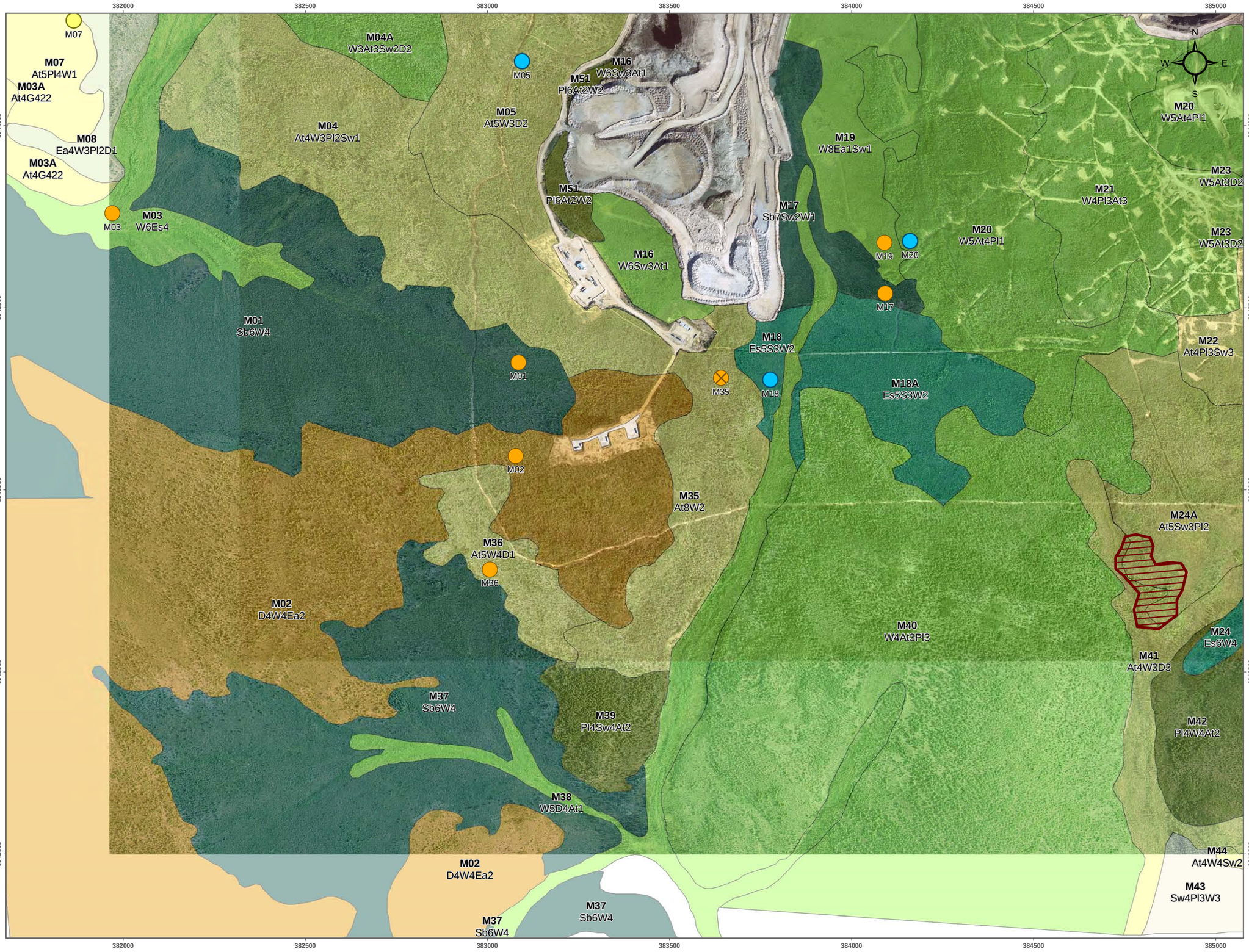

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BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 8
SOUTHWEST QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

- 2010 Control Burn Area

1:10,000 when printed on 11 by 17" paper

0 50 100 200 300 400 500 Meters

Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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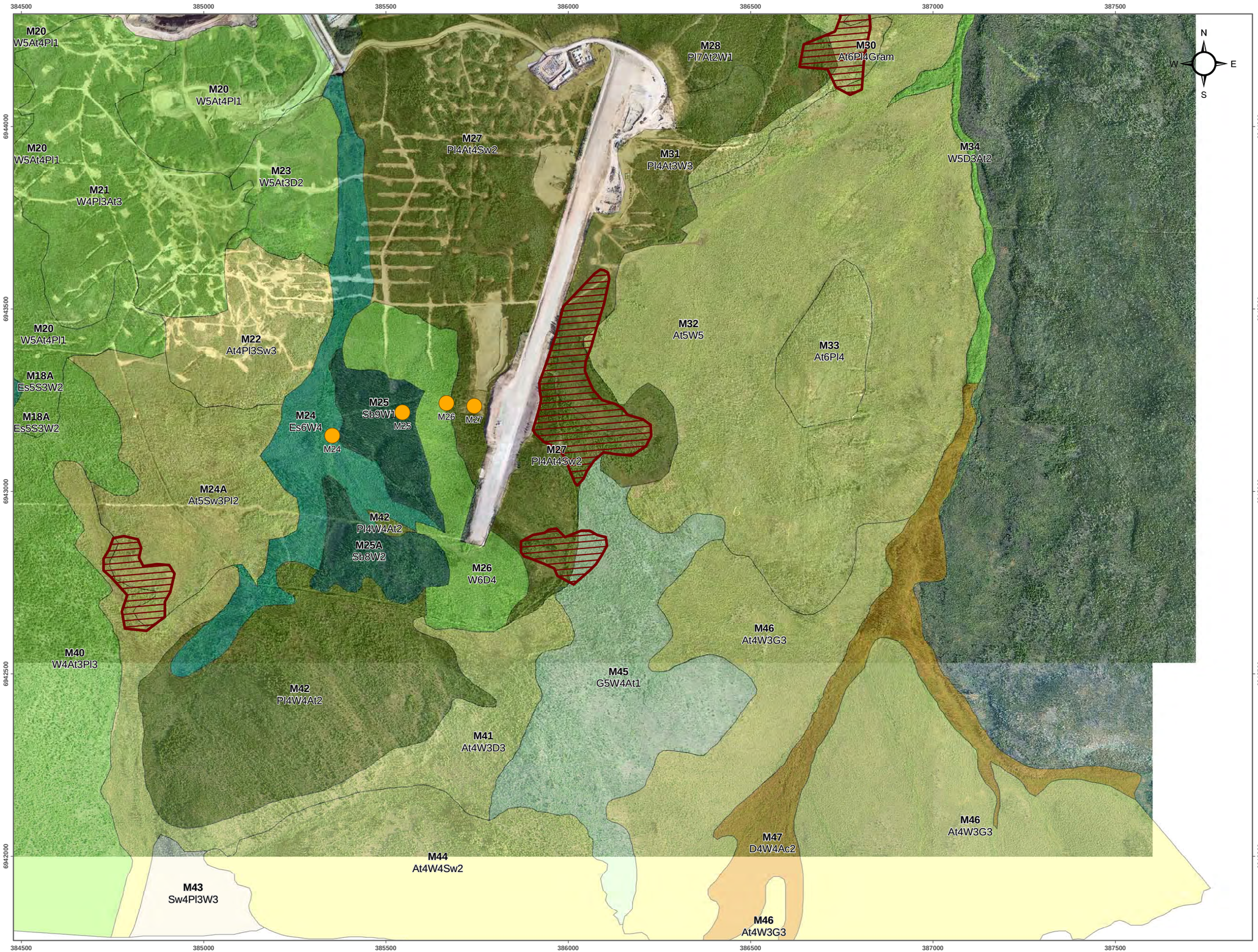

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MINTO MINE
PHASE V/VI EXPANSION

BASELINE VEGETATION CONDITIONS AND ECOSYSTEM MAPPING

ECOSYSTEM MAPPING - FIGURE 9
SOUTHEAST QUADRANT

SURVEY PLOTS

- Field Check
- Control Plot; Soil samples collected
- Permanent Plot
- Permanent Plot; Soil Sample Collected

LEADING SPECIES

- Non-Vegetated
- At - Trembling Aspen
- D - Alder
- Ea - Alaskan Birch
- Es - Scrub Birch
- G - Gramnoids
- Pl - Lodgepole Pine
- Sb - Black Spruce
- Sw - White Spruce
- W - Willow

2010 Control Burn Area

1:10,000 when printed on 11 by 17" paper

0 50 100 200 300 400 500 Meters

Aerial photography flight date: August 14th 2012. Ortho-rectification produced by Challenger Geomatics Ltd. Control burn area established from aerial imagery and field observations (gps points).

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APPENDIX A

PLANT LIST 2010

Trees (*Plant codes used on ecosystems map*)

Black spruce *Picea mariana (Sb)*

White spruce *Picea glauca (Sw)*

Lodgepole pine *Pinus contorta latifolia (Pl)*

Trembling aspen *Populus tremuloides (At)*

Balsam poplar *Populus balsamifera ssp. Balsamifera (Ac)*

Alaska paper birch *Betula neoalaskana (Ea)*

Shrubs

Green alder *Alnus crispa (D)*

Slide alder *Alnus viridis ssp. sinuata (Dg)*

Myrtle leaf willow *Salix myrtillifolia*

Scouler's willow *Salix scouleriana*

Bebb's willow *Salix bebbiana*

Grey-leaf willow *Salix glauca*

Willow spp. Salix ssp. *(W)*

Prickly rose *Rosa acicularis*

Scrub birch *Betula glandulosa var. Glandulosa (Es)*

Highbush-cranberry *Viburnum edule*

Shrubby cinquefoil *Potentilla fruticosa*

Labrador tea *Ledum groenlandicum*

Soapberry *Shepherdia canadensis*

Common Juniper *Juniperus communis*

Herbs

Mountain death-camas *(Zygadenus elegans)*

Arctic lupine (*Lupinus arcticus*)

Tall bluebells (*Mertensia paniculata*)

Cutleaf anemone (*Anemone multifida*)

Common horsetail (*Equisetum arvense*)

Woodland horsetail (*Equisetum sylvaticum*)

Dwarf scouring-rush (*Equisetum scirpoides*)

Bastard toadflax (Geocaulon lividum)

Twinflower (*Linnaea borealis*)

Cloudberry (*Rubus Chamaemorus*)

Bog blueberry (*Vaccininum uliginosum*)

Dwarf blueberry (*Vaccinum caespitosum*)

Lingonberry (*Vaccinium vitis-idaea*)

Clouldberry (*Rubus chamaemorous*)

Sweet coltsfoot (*Petasites frigidus*)

Bog cranberry (*Vaccinium oxycoccus*)

Kinniknick (*Arctostaphylos uva-ursi)*

Red bearberry (*Arctostaphylos rubra*)

Fireweed (*Epilobium angustifolium*)

Crowberry (*Empetrum nigrum*)

Pink wintergreen (*Pyrola asarifolia*)

One-sided wintergreen (*Orthilia secunda)*

Single delight (*Moneses uniflora*)

Northern Jacob's ladder *(Polemonium boreale)*

Pussytoes (*Antennaria sp.*)

Pasture sage (*Artemesia frigida*)

Graminoids

Water sedge (*Carex aquatilis*)

Cottongrass (*Eriophorum brachyantherum*)

Altai fescue (*Festuca altaica*)

Tufted hair grass (*Deschampsia caespitose*)

Bluejoint (*Calamagrostis canadensis*)

Purple reedgrass (*Calamagrostis purpurascens*)

Short awned foxtail (*Alopecurus aequalis*)

Polargrass (*Arctagrostis latifolia*)

Lichens

Green reindeer lichen (*Cladina mitis*)

Grey reindeer lichen (*Cladina rangiferina*)

Freckled lichen (*Peltigera aphthosa*)

Dog lichen (*Peltigera canina*)

Peltigera ssp.

Cladonia ssp

Mosses

Fire moss (*Ceratodon purpureus*)

Glow moss (*Aulacomnium palustre*)

Golden fuzzy fen moss *(Tomentypnum nitens)*

Step moss (*Hylocomium splendens*)

Red stem feather moss *(Pleurozium schreberi)*

Stiff-leaved polytrichum *(Polytrichuim alpinum)*

Juniper haircap moss (*Polytrichum juniperinum*)

Knight's plume (*Ptilium crista-castrensis*)

Dicranum sp.

APPENDIX B

SUMMARY PLOT DESCRIPTIONS

Plot M02.

Status: Permanent **Location**: UTM: 0383078E, 6943088N

Vegetation Plot Summary

Shrub species cover	$D_4W_4Ea_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	30
Succession Stage	Tall Shrub
Aspect (^{0})	232
Elevation (m)	902
Slope %	9
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	18/2

Site description: SW-facing gentle slope, fire regeneration 1995, most burnt spruce have fallen, Increased CWD. High diversity of shrub species, herb layer poorly developed 7% bare soil.

Plant community: Alder - Willow - Birch (trembling aspen, lodgepole pine)

Comments: Roads and transects through polygon. Moose/black bear tracks and scat.

Plot M03.

Status: Permanent **Location**: UTM: 0383968E, 6943755N

Vegetation Plot Summary

Shrub species cover	W_8Scrub $birch_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<2
Soil moisture and nutrient values (SMR/SNR)	7/C
Crown cover for polygon in %	15
Succession Stage	Middle Shrub
Aspect (^{0})	Level
Elevation (m)	841
Slope %	0
Meso slope position	Valley floor
Drainage	Poorly
Coarse woody debris%/Snags#	4/4

Site description: Riparian area - sedge fen with slow moving water. Fire regeneration 1995. Medium (0.5-2.0m) shrub cover. Organic substrate.

Plant community: Willow-Scrub birch-Carex

Comments: Heavy browsing on willow by moose. Many game trails in polygon - wildlife corridor.

Plot M07.

Status: Permanent ***(Control, soil sampled)*** **Location**: UTM: 0383864E, 6944289N

Vegetation Plot Summary

Shrub species cover	$At_5Pl_4W_1$
Age in years (dominant species)	20
Height in meters (avg dominant species)	8
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	40
Succession Stage	Young forest
Aspect (^{0})	204
Elevation (m)	890
Slope %	22
Meso slope position	Upper
Drainage	Well
Coarse woody debris%/Snags#	11/2

Site description: Southwest-facing open forest. Fire regeneration. Bare ground ~20% covered with leaf litter. Poorly developed herb layer, 6% grass (Calamagrostis purpurascens).

Plant community: Trembling Aspen – Pine - Bunchgrass

Comments: Selected control for mixed aspen/pine forest, southern aspect, outside of mine influences.

Plot M17.

Status: Permanent **Location**: UTM: 03840931E, 6943539N

Vegetation Plot Summary

Shrub species cover	$Sb_7Sw_2W_1$
Age in years (dominant species)	115
Height in meters (avg dominant species)	10
Soil moisture and nutrient values (SMR/SNR)	5/B
Crown cover for polygon in %	25
Succession Stage	Old forest
Aspect	290
Elevation	900m
Slope %	8
Meso slope position	Lower
Drainage	Imperfect
Coarse woody debris %/Snags #	3/2

Site description: Old black spruce open forest on organic substrate. Drainage/wetland bisects polygon, roads and over burden affecting north end of plot.

Plant community: Black Spruce - Labrador Tea – Coltsfoot - Stepmoss

Comments: Warblers, Grey Jays, Black-capped Chickadees and Dark-eyed Juncos sighted in plot.

Plot M18.

Status: Field Check **Location**: UTM: 0383777E, 69443302N

Vegetation Plot Summary

Shrub species cover	$Es_5S_3W_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<2
Soil moisture and nutrient values (SMR/SNR)	6/B
Crown cover for polygon in %	10% (50% shrub cover)
Succession Stage	Initiation
Aspect (^{0})	Level
Elevation (m)	892
Slope %	0
Meso slope position	Valley floor
Drainage	poorly
Coarse woody debris%/Snags#	2/3

Site description: Spruce - sphagnum bog, high spruce seedlings and Labrador tea cover, organic substrate.

Plant community: Scrub Birch – Spruce - Willow

Comments: Straddles Plot M038 which is a riparian/ wetland area on a watershed divide, diked only by dirt road. South mine expansion could have downstream effects.

Plot M19.

Status: Permanent **Location**: UTM: 0384091E, 6943678N

Vegetation Plot Summary

Shrub species cover	$W_8E_1S_1$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	5/B
Crown cover for polygon in %	40
Succession Stage	Tall Shrub
Aspect (^{0})	308
Elevation (m)	894
Slope %	6
Meso slope position	Lower
Drainage	Imperfect
Coarse woody debris %/Snags #	6/12

Site description: Burn regeneration, organic substrate. North end of polygon has overburden infill and roads, part of expansion foot print.

Plant community: Willow – Spruce – Labrador Tea

Comments: Moose tracks and scat in plot, signs of light browsing on willows.

Plot M20.

Status: Field Check **Location**: UTM: 0384161E, 6943683N

Vegetation Plot Summary

Shrub species cover	$W_5At_4Pl_1$
Age in years (dominant species)	20
Height in meters (avg dominant species)	9
Soil moisture and nutrient values (SMR/SNR)	4/C
Crown cover for polygon in %	60
Succession Stage	Fire regeneration – Pole sapling
Aspect	280 (W)
Elevation	900m
Slope %	18
Meso slope position	Middle
Drainage	well
Coarse woody debris	12/5

Site description: Polygon in expansion footprint, roads and trenches throughout polygon. CWD 12%, most burnt trees have fallen.

Plant community: Willow - Aspen – Pine - Soapberry - Lupine

Comments: Burn regeneration, closed canopy, poorly developed herb/moss layer

Plot M24.

Status: Permanent **Location**: UTM: 0385353E, 6943153N

Vegetation Plot Summary

Shrub species cover	Es_6W_4
Age in years (dominant species)	10
Height in meters (avg dominant species)	< 2.0
Soil moisture and nutrient values (SMR/SNR)	6/C
Crown cover for polygon in %	40
Succession Stage	Fire regeneration - Medium shrub
Aspect	Level
Elevation	872m
Slope %	0
Meso slope position	Valley floor
Drainage	Poorly (5% open running water)
Coarse woody debris%/ Snags#	4/16

Site description: Riparian floodplain with running stream on edge of plot, high variety of shrubs, herbs, graminoids and mosses. Used to be black spruce forest, numerous snags. Signs of moose (*Alces alces gigas*): browse, scat and game trails. Vole sighting, numerous rodent tunnels.

Plant community: Willow - Scrub Birch

Comments: High biodiversity area.

Plot M25.

Status: Permanent **Location**: UTM: 0385546E, 6943216N

Vegetation Plot Summary

Shrub species cover	Sb_9W_1
Age in years (dominant species)	120
Height in meters (avg dominant species)	10
Soil moisture and nutrient values (SMR/SNR)	4/B
Crown cover for polygon in %	20
Succession Stage	Old forest
Aspect	278 (W)
Elevation	880m
Slope %	16
Drainage	mw
Coarse woody debris % / Snags #	7/4

Site description: Lower moderate slope, Mature Sb open canopy. Hummocks of sphagnum with graminoids and horsetail. East of south ridge expansion.

Plant Community: Black Spruce - Labrador Tea - Feather Moss

Comments: Old growth spruce forest

Plot M26.

Status: Permanent **Location**: UTM: 0385666E, 6943242N

Vegetation Plot Summary

Tree species cover	W_6D_4
Age in years (dominant species)	15
Height in meters (avg dominant species)	< 3.0
Soil moisture and nutrient values (SMR/SNR)	5/B
Crown cover for polygon in %	20
Succession Stage	Fire regeneration - Medium shrub
Aspect	278^0 (W)
Elevation	890m
Slope %	14
Drainage	imperfect
Coarse woody debris % / snags #	8/12

Site description: Lower moderate slope, medium shrubs dominant (Labrador tea and willow). Hummocks of sphagnum with grass provide micro sites. East of south ridge expansion

Plant community: Willow - Alder - Labrador Tea

Comments: Recent burn regeneration, numerous Sb snags. Poor nutrient regime. 200m south of active excavations and roads. Sphagnum hummocks dried out; no canopy cover.

Plot M27.

Status: Permanent **Location:** UTM: 038574E, 6943233N

Vegetation Plot Summary

Tree species cover	$Pl_4At_4W_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	4.2
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	30
Successional Stage	Tall shrub (fire regeneration)
Aspect (degrees)	278 (W)
Elevation (meters)	890
Slope %	6
Drainage	Moderately well
Coarse Woody Debris %/ Snags #	10/2

Site description: Young seral upland forest with poorly developed herb and moss layer. Cryptogrammic soils with 15% leaf litter. Seedlings predominantly Sw.

Plant Community: Lodgepole Pine - Trembling Aspen - Willow

Comments: Large polygon with species variability – older Sw and At patches to north. Plot immediately west of airstrip.

Plot M28.

Status: Permanent **Location**: UTM: 0386421E, 69443841N

Vegetation Plot Summary

Shrub species cover	$Pl_7At_2W_1$
Age in years (dominant species)	15
Height in meters (avg dominant species)	6
Soil moisture and nutrient values (SMR/SNR)	4/B
Crown cover for polygon in %	40
Succession Stage	Young forest
Aspect (^{0})	338
Elevation (m)	864
Slope %	6
Meso slope position	Middle
Drainage	well
Coarse woody debris%/Snags#	3/3

Site description: . Most snags have fallen, high coarse woody debris content. Burn regeneration very few herbs.

Plant community: Pine - Aspen - Willow

Comments: Moose, mule deer and black bear tracks found nearby.

Plot M29.

Status: Permanent **Location**: UTM: 0386636E, 69475182N

Vegetation Plot Summary

Plant species cover	$Pl_5Sw_4At_1$
Age in years (dominant species)	130
Height in meters (avg dominant species)	15
Soil moisture and nutrient values (SMR/SNR)	6/B
Crown cover for polygon in %	30
Succession Stage	Old forest
Aspect (^{0})	348
Elevation (m)	798
Slope %	6
Meso slope position	Middle
Drainage	Poorly
Coarse woody debris%/Snags#	9/10

Site description: Old Black spruce forest, predominant low shrub Labador Tea (*Ledum groenlandicum*), ground cover Feathermoss/lichen. Permafrost close to surface, gleyed soils

Plant community: Black Spruce - Labrador Tea - Feathermoss

Comments: Plot ~ 50m from fire break NE of airstrip.

Plot M35.

Status: Permanent (*soil sampled)*

Location: UTM: 0383642E, 6943307N

Vegetation Plot Summary

Shrub species cover	At_5W_2
Age in years (dominant species)	15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	3/B
Crown cover for polygon in %	30
Succession Stage	Tall Shrub
Aspect (^{0})	160
Elevation (m)	891
Slope %	6
Meso slope position	Middle
Drainage	Well
Coarse woody debris %/Snags #	13/2

Site description: SE-facing gentle slope, fire regeneration 1995, poorly developed herb layer.

Plant community: Trembling Aspen - Willow (Pl, Ac)

Comments: North end of polygon in expansion footprint, overburden fill.

Plot M36.

Status: Permanent **Location**: UTM: 0383078E, 6943088N

Vegetation Plot Summary

Shrub species cover	$At_5W_4D_1$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	2/C
Crown cover for polygon in %	20
Succession Stage	Tall Shrub
Aspect (^{0})	248
Elevation (m)	866
Slope %	7
Meso slope position	Middle
Drainage	Rapid (high % coarse fragments)
Coarse woody debris%/Snags#	10/2

Site description: SW-facing gentle slope, fire regeneration 1995, most burnt spruce have fallen, Increased CWD. High diversity of shrub species, herb layer poorly developed, 15% bare soil.

Plant community: Trembling Aspen, Willow, Alder.

Comments: Recent road and transects.

Plot M51.

Status: Permanent **Location**: UTM: 0383510E, 6945971N

Vegetation Plot Summary

Shrub species cover	$Pl_6At_2W_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	4
Soil moisture and nutrient values (SMR/SNR)	3/B
Crown cover for polygon in %	50
Succession Stage	Young forest
Aspect (^{0})	Level
Elevation (m)	924
Slope %	0
Meso slope position	Level
Drainage	well
Coarse woody debris%/Snags#	14/4

Site description: North-facing slope with regenerating pine forest, ground cover mainly mosses, poorly developed herb layer.

Plant community: Pine - Aspen - Willow

Comments: Moose and grouse tracks and scat in plot.

Plot M52.

Status: Permanent **Location**: UTM: 0382849E, 6945724N

Vegetation Plot Summary

Shrub species cover	$W_5Pl_3At_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	2/B
Crown cover for polygon in %	15
Succession Stage	Young forest
Aspect (^{0})	139
Elevation (m)	931
Slope %	30
Meso slope position	Upper
Drainage	Rapid
Coarse woody debris%/Snags#	7/3

Site description: Southwest-facing steep slope with rocky sandy soils, cryptogrammic layer with bare patches ~ 70%. Purple reedgrass(*Calamagrostis purpurascens*) common in area.

Plant community: Willow - Pine - Aspen (grassland).

Comments: Approximately 2km NW of current mining footprint, possible control

Plot M54.

Status: Permanent (control, soil sampled) **Location**: UTM: 03838682E, 6946246N

Vegetation Plot Summary

Shrub species cover	$Ea_4W_2Pl_2(Sw)$
Age in years (dominant species)	22
Height in meters (avg dominant species)	8
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	30
Succession Stage	Young forest
Aspect (^{0})	004
Elevation (m)	929
Slope %	26
Meso slope position	Upper
Drainage	Well
Coarse woody debris%/Snags#	7/4

Site description: North-facing steep slope. High species diversity of shrubs and trees, herb layer poorly developed. A few scattered White spruce and seedlings.

Plant community: Alaskan Birch - Pine - Willow (Lichen)

Comments: Adjacent to northern mine expansion, disturbance in polygon.

Plot M54v.

Status: Field Check **Location**: UTM: 0384116E, 6946250N

Vegetation Plot Summary

Shrub species cover	$Pl_7Ea_2Sw_1$
Age in years (dominant species)	20
Height in meters (avg dominant species)	7
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	30
Succession Stage	Young forest
Aspect (^{0})	355
Elevation (m)	912
Slope %	17
Meso slope position	Middle
Drainage	well
Coarse woody debris%/Snags#	7/8

Site description: North-facing moderate slope. Seral Pl forest.

Plant community: Pine - Alaskan Birch - Lichen

Comments: Exploration and drilling within polygon, part of mine expansion footprint.

Plot M54A.

Status: Permanent **Location**: UTM: 0383510E, 6945971N

Vegetation Plot Summary

Shrub species cover	$W_5Pl_3D_2$
Age in years (dominant species)	20
Height in meters (avg dominant species)	7
Soil moisture and nutrient values (SMR/SNR)	2/B
Crown cover for polygon in %	50
Succession Stage	Young forest
Aspect (^{0})	278
Elevation (m)	959
Slope %	34
Meso slope position	Upper
Drainage	Rapid
Coarse woody debris%/Snags#	17/8

Site description: West-facing steep slope. Most snags have fallen, high coarse woody debris content.

Plant community: Willow - Pine - Alder

Comments: Mature white spruce also scattered through polygon.

Plot M56.

Status: Field Check **Location**: UTM: 0384428E, 6946205N

Vegetation Plot Summary

Shrub species cover	Sb_9W_1
Age in years (dominant species)	100
Height in meters (avg dominant species)	8
Soil moisture and nutrient values (SMR/SNR)	6/B
Crown cover for polygon in %	40
Succession Stage	Mature Forest
Aspect (^{0})	355
Elevation (m)	921
Slope %	16
Meso slope position	Lower
Drainage	Poorly
Coarse woody debris%/Snags#	3/8

Site description: North-facing moderate slope. Organic veneer on mineral soils.

Plant community: Black Spruce - Labrador Tea - Sphagnum

Comments: North and downstream of mine expansion. Voles, mice and moose sign.

Plot M76A.

Status: Permanent (Control and soil sample) **Location**: UTM: 0384025E, 6948266N

Vegetation Plot Summary

Shrub species cover	$At_5G_3Pl_2$
Age in years (dominant species)	<20
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	1/A
Crown cover for polygon in %	10
Succession Stage	Young forest/grassland
Aspect (^{0})	192
Elevation (m)	837
Slope %	28
Meso slope position	Upper
Drainage	Rapid
Coarse woody debris%/Snags#	3/0

Site description: South-facing steep slope with sandy rocky soils. Veteran pines and snags nearby.

Plant community: Aspen - Pine - Grass (*Calamagrostis purpurascens*)

Comments: Grassland ecosystem: soils and vegetation are sensitive to disturbances. Rare or uncommon plants are associated with this type of ecosystem, though none were found in this sample. Road access is~ 100m south. Exploration disturbance ~30m uphill.

Plot M79.

Status: field check **Location**: UTM: 038473E, 6947061N

Vegetation Plot Summary

Shrub species cover	W_8Sb_2
Age in years (dominant species)	80 (Sb)
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	6/B
Crown cover for polygon in %	10 (Sb)
Succession Stage	Medium shrub (W)/Mature forest (Sb)
Aspect (^{0})	333
Elevation (m)	801
Slope %	10
Meso slope position	Toe
Drainage	Poorly
Coarse woody debris%/Snags#	3/3

Site description: North draining riparian system that has not burned in the last 80+ years..

Plant community: Willow - Black Spruce - Sphagnum

Comments: Approximately 1 km downstream of northern mine expansion footprint, near water sampling station, helicopter access. Grizzly sow and cub seen at confluence with Yukon River.

Plot M80.

Status: Permanent (Control, soil sampled) **Location**: UTM: 0384380E, 6947083N

Vegetation Plot Summary

Shrub species cover	$Pl_5W_3At_2$
Age in years (dominant species)	15
Height in meters (avg dominant species)	5
Soil moisture and nutrient values (SMR/SNR)	3/B
Crown cover for polygon in %	40
Succession Stage	Young forest
Aspect (^{0})	140
Elevation (m)	817
Slope %	10
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	5/0

Site description: South east-facing slope, poorly developed herb layer, mainly moss/lichen with bare soil patches, about 10% exposed rocks.

Plant community: Pine - Willow - Aspen

Comments: Helicopter access

Plot M84.

Status: Permanent (Control and soil sample) **Location**: UTM: 0385289E, 6947320N

Vegetation Plot Summary

Shrub species cover	$W_5Ea_2D_2$ (Pl)
Age in years (dominant species)	<15
Height in meters (avg dominant species)	<5
Soil moisture and nutrient values (SMR/SNR)	4/C
Crown cover for polygon in %	40
Succession Stage	Regeneration
Aspect (^{0})	344
Elevation (m)	894
Slope %	13
Meso slope position	Upper
Drainage	Moderately well
Coarse woody debris%/Snags#	20/2

Site description: North-facing slope, shrub dominant. Most burnt snags have fallen, high coarse woody debris content. Poorly developed herb layer, 40% of ground cover is moss (*Polytrichum juniperinum*).

Plant community: Willow - Alaskan Birch - Alder

Comments: Helicopter access

Plot M90A.

Status: Permanent (soil sample) **Location**: UTM: 0387045E, 6947197N

Vegetation Plot Summary

Plant species cover	$At_5Sw_3Pl_2$
Age in years (dominant species)	75
Height in meters (avg dominant species)	10
Soil moisture and nutrient values (SMR/SNR)	3/C
Crown cover for polygon in %	40
Succession Stage	Mature forest
Aspect (^{0})	179
Elevation (m)	792
Slope %	22
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	2/1

Site description: South-facing slope ground cover predominantly kinnikinnick (*Arctostaphylos uva-ursi*) and grass (*Calamagrostis purpurascens*). Large canopy gaps with grassland attributes

Plant community: Aspen - White Spruce - Pine (grassland)

Comments: Minto Road just south of plot

Plot M91.

Status: Permanent **Location**: UTM: 0386102E, 6947461N

Vegetation Plot Summary

Plant species cover	$Pl_5Sw_4At_1$
Age in years (dominant species)	15
Height in meters (avg dominant species)	< 8
Soil moisture and nutrient values (SMR/SNR)	4/C
Crown cover for polygon in %	80
Succession Stage	Young forest
Aspect (^{0})	0
Elevation (m)	817
Slope %	Level
Meso slope position	Level
Drainage	Moderately well
Coarse woody debris%/Snags#	3/5

Site description: Terrace with thick young forest, low shrubs consist of bog cranberry (*Vaccinium uliginosum*) and Labrador tea (*Ledum groenlandicum*), ground cover moss/lichen. Poorly developed herb layer.

Plant community: Pine - White Spruce - Aspen

Comments: Road through polygon. Snags are from stand thinning.

Plot M93.

Status: Permanent (Control, soil sample) **Location**: UTM: 0386696E, 6947350N

Vegetation Plot Summary

Plant species cover	$D_4W_4Pl_1$
Age in years (dominant species)	10
Height in meters (avg dominant species)	>5
Soil moisture and nutrient values (SMR/SNR)	4/C
Crown cover for polygon in %	40
Succession Stage	Tall shrub
Aspect (^{0})	196
Elevation (m)	816
Slope %	6
Meso slope position	Middle
Drainage	Well
Coarse woody debris%/Snags#	10/5

Site description: South-facing slope regeneration shrub growth. Young trees (pine and White spruce) beginning to top shrub layer. White spruce scattered through polygon.

Plant community: Alder - Willow – Pine

Comments: Access road off Minto Road near 4km mark.

APPENDIX C

PLOT SURVEY FORM (SAMPLE)

Yukon Environment

Permanent

Ground Vegetation

Project: Minto Veg Survey Plot No. M024

Date (dd/mm/yy): 17/07/10

Wetland Type: Fen (Class / Form / Subform / Type / Subtype)

Plot Type: Eco 400m²

Observers: L. Knight, B. Ellert

Eco Type:

CNVC Type:

Coll	Strata	Genus	Species	%
	A1	PICE	MAR	2
	LT	PICE	MAR	4
	SD	PICE	MAR	1
	MS	BETU	GLA	25
	MS	SALI	GLA	3
✓	MS	SALI	UNK	10
	LS	PICE	GLA	.5
	LS	LEDU	GRO	3
	LS	POTE	FRU	1
	LS	SALE	MYR	1
	SD	BETU	NEO	0.1
	GS	ARCT	RUB	4
	GS	EMPE	NIG	15
	GS	VACC	VIT	1
	GS	VACC	ULI	.5

Coll	Strata	Genus	Species	%
	FB	EPIO	ANG	4
	FB	PETA	FRI	3
	FB	RUBU	CHA	4
	FB	EQUI	SYL	1
	FB	EQUI	SCR	0.5
	FB	STEL	BOR	0.1
✓	FB	RANU	LAP	0.1
	GR	CARE	AQU	3
	GR	POA	PAL	1
	GR	CALA	CAN	4
	BR	AULA	PAL	4
	BR	HYLO	SPL	6
✓	BR	SPHA	ROS	10
	BR	TOME	NIT	2
	LN	PELTIGERA		2
	BR	CERA	PUR	1
	BR	POLY	JUN	1
✓	GR	CARE	UNK	
	NVCWD	>7cm		3
	NVCWD	<7cm		1
	NVROCK			
	NVBARE			
	NVLITT	<2cm		
	NVWATE			5

Comments

Fen burned ~ few live trees
Shrub dominant MS
Scrub birch / Willow / moss
Very diverse
aquatic to Subhydric
Carex dominants in
open water area
Snags ~16

Strata		
TT	trees >5m	
A1	dominant trees - (tallest trees, veterans)	
A2	main tree canopy - (main layer of tree cover)	
A3	subcanopy - trees >5m that are lower than main canopy	
LT	trees < 5m	GR graminoids
TS	shrubs 2.0 - 5m	AQ aquatic
MS	shrubs 0.5 - 2.0m	BR bryophytes
LS	shrubs 0.1 - 0.5m	LN lichens
GS	ground shrubs < 0.1m	FG fungus
SD	seedlings < 0.5m	SN snag
FN	fern	NV non-vegetated
FB	forbs	

Ecological Moisture		
VX	0	Very Xeric
X	1	Xeric
SX	2	Subxeric
SM	3	Submesic
M	4	Mesic
SG	5	Subhygric
HG	(6)	Hygric
SD	(7)	Subhydric
HD	8	Hydric
F	9	Aquatic

Photos: 92, 93

Ecosystem Site Description

YUKON ENVIRONMENT PLOT DESCRIPTION

PLOT DATA

Plot No.	M024
Project:	Minto Veg Survey
Date (dd/mm/yy)	17/07/10
Start Time	24hh: mm:
End Time	24hh: mm:
Observers:	Lisa Knight, Brett Elliot

LOCATION

Ecoregion	YP-C
Airphoto Flight Line	0907039
Airphoto No.	018
NTS Map 250k/50k	115I / 11
Location:	Minto Mine Fen / Stream W of Airstrip

COORDINATES

	Deg	Min	Sec
UTM	385	353	E
	6943153		N
	Zone	North	East
UTM			
	Source	Precsn	Datum
Metadata			

CHARACTERISTICS

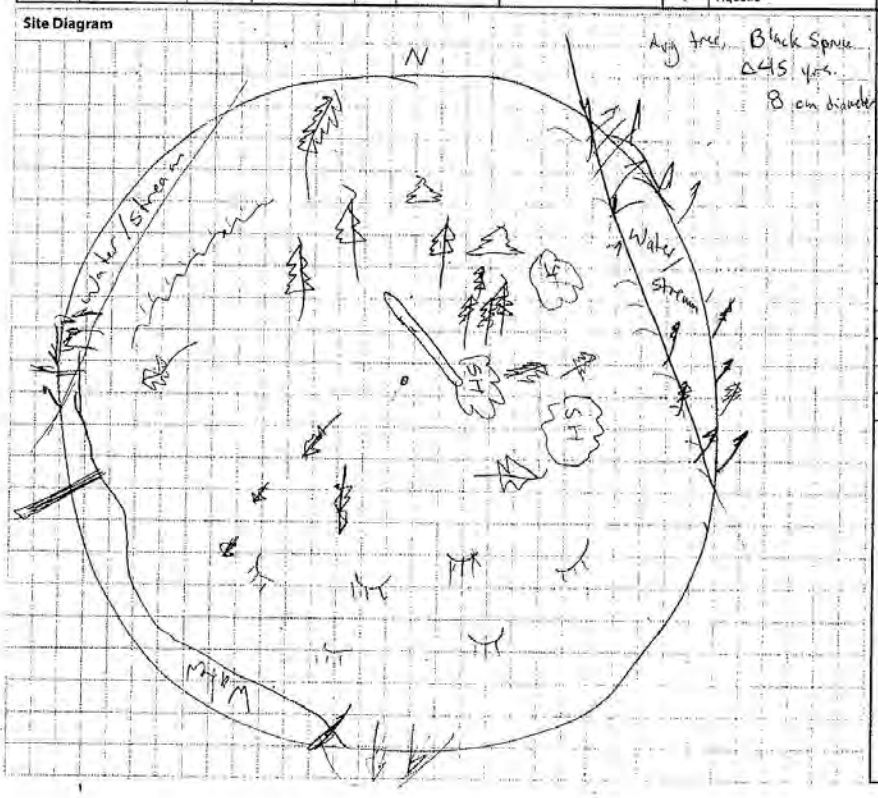
Elevation (m)	0872
Elevation Source	GPS
Aspect Macro (deg)	level
Aspect Meso (deg)	level
Slope (%)	0
Slope (deg)	0

Surface Shape		Microtopo Intensity			Perviousness	
(CV)	Concave	S	Smooth	no mounds	R	Rapidly
CX	Convex	M	Micro	<0.3m high	M	Moderately
ST	Straight	SL	Slight	0.3-1m / > 7m apart	(S)	Slowly
UN	Undulating	MD	Moderate	0.3-1m / 3-7m apart	**Soil Drainage**	
Microtopo Type		(ST)	Strong	0.3-1m / 1-3m apart	VR	Very Rapidly
CHA	Channelled	SV	Severe	0.3-1m / < 1m apart	R	Rapidly
DOM	Domed	E	Extreme	>1m / > 3m apart	W	Well
GUL	Gullied	U	Ultra	>1m / < 3m apart	MW	Moderately Well
(HMK)	Hummocked	**Plot Position Macro**		**Plot Position Meso**	I	Imperfectly
LOB	Lobed	A	Apex	C Crest	(P)	Poorly
MND	Mounded	F	Face	UP Upper Slope	VP	Very Poorly
NET	Netted	US	Upper Slope	MS Middle Slope	**Seepage**	
POL	Polygonal	MS	Mid Slope	LS Lower Slope	(P)	Present
RIB	Ribbed	LS	Lower Slope	T Toe	A	Absent
SMO	Smooth	(VF)	Valley Floor	(D) Depression		
TUS	Tussocked	P	Plain	L Level		

Flood Regime			
(A)	Annual	W	Winter
F	Frequent (every 2-5 years)	P	Permanent through growing season
O	Occasional (> 5 years)	(E)	Extended (<1 month not flooded)
R	Rare (extreme events)	M	Moderate (1-3 months flooded)
X	Never	T	Temporary (7-30 days)
		B	Brief (< 7 days)
		D	Diurnal

Ecological Moisture		Nutrient Regime	
0	Very Xeric	A	Very Poor
1	Xeric	(B)	Poor
2	Subxeric	C	Medium
3	Submesic	D	Rich
4	Mesic	E	Very Rich
5	Subhygric	F	Saline
6	Hygric	**Plot Disturbances**	
(7)	Subhydric		
(8)	Hydric		
9	Aquatic		

Site Diagram



Exposure Type	
AU	Aufeis
CA	Cold air Drainage
FR	Frost - Cold Air Accumulation
IN	Insolation
RN	Rain Shadow
SN	Snow Accumulation
WI	Wind
X	Other

Complex	
Complex #	
Component	

Photos 92, 93

Comments

wet / marshland

Very hummocky some depressions w standing water

CWD ~ 5%

Some standing Dead

Signs of moose scat

rodents trails + tunnels

APPENDIX D

SOIL ANALYSIS PROFILES

ACCESS CONSULTING GROUP

Maxxam Job #: B079893
Report Date: 2010/09/15

Your P.O. #: MN-110466
Sampler Initials: LK

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		W68609	W68610	W68611	W68612		
Sampling Date		2010/07/19	2010/07/22	2010/07/18	2010/07/20		
	Units	M07	M029	M035	M54A	RDL	QC Batch
Parameter							
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4091595
Elements							
Cation exchange capacity	cmol+/Kg	<10	19	12	<10	10	4248901

Maxxam ID		W68613	W68614	W68615	W68616	W68617	W68618		
Sampling Date		2010/07/21	2010/07/21	2010/07/21	2010/07/21	2010/07/22	2010/07/22		
	Units	M76A	M80	M85	M87	M90	M93	RDL	QC Batch
Parameter									
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4091595
Elements									
Cation exchange capacity	cmol+/Kg	<10	<10	<10	11	<10	11	10	4248901

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		W68609	W68610	W68611	W68612	W68613	W68614	W68615	W68616	W68617	W68618		
Sampling Date		2010/07/19	2010/07/22	2010/07/18	2010/07/20	2010/07/21	2010/07/21	2010/07/21	2010/07/21	2010/07/22	2010/07/22		
	Units	M07	M029	M035	M54A	M76A	M80	M85	M87	M90	M93	RDL	QC Batch
Total Metals by ICP													
Total Sulphur (S)	mg/kg	45	65	52	67	65	42	47	82	53	36	5	4255008

N/A = Not Applicable
RDL = Reportable Detection Limit

ACCESS CONSULTING GROUP

Maxxam Job #: B079893
Report Date: 2010/09/15

Your P.O. #: MN-110466
Sampler Initials: LK

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		W68618		
Sampling Date		2010/07/22		
	Units	M93	RDL	QC Batch
Misc. Inorganics				
Soluble (2:1) pH	pH Units	5.66	0.01	4244124
Total Metals by ICPMS				
Total Aluminum (Al)	mg/kg	12900	100	4244137
Total Antimony (Sb)	mg/kg	0.4	0.1	4244137
Total Arsenic (As)	mg/kg	5.1	0.2	4244137
Total Barium (Ba)	mg/kg	138	0.1	4244137
Total Beryllium (Be)	mg/kg	0.3	0.1	4244137
Total Bismuth (Bi)	mg/kg	<0.1	0.1	4244137
Total Cadmium (Cd)	mg/kg	<0.05	0.05	4244137
Total Calcium (Ca)	mg/kg	3150	100	4244137
Total Chromium (Cr)	mg/kg	26	1	4244137
Total Cobalt (Co)	mg/kg	6.5	0.3	4244137
Total Copper (Cu)	mg/kg	14.9	0.5	4244137
Total Iron (Fe)	mg/kg	20900	100	4244137
Total Lead (Pb)	mg/kg	5.7	0.1	4244137
Total Magnesium (Mg)	mg/kg	4740	100	4244137
Total Manganese (Mn)	mg/kg	219	0.2	4244137
Total Mercury (Hg)	mg/kg	<0.05	0.05	4244137
Total Molybdenum (Mo)	mg/kg	0.4	0.1	4244137
Total Nickel (Ni)	mg/kg	14.9	0.8	4244137
Total Phosphorus (P)	mg/kg	252	10	4244137
Total Potassium (K)	mg/kg	563	100	4244137
Total Selenium (Se)	mg/kg	<0.5	0.5	4244137
Total Silver (Ag)	mg/kg	<0.05	0.05	4244137
Total Sodium (Na)	mg/kg	<100	100	4244137
Total Strontium (Sr)	mg/kg	25.7	0.1	4244137
Total Thallium (Tl)	mg/kg	<0.05	0.05	4244137
Total Tin (Sn)	mg/kg	0.3	0.1	4244137
Total Titanium (Ti)	mg/kg	753	1	4244137
Total Vanadium (V)	mg/kg	52	2	4244137
Total Zinc (Zn)	mg/kg	43	1	4244137
Total Zirconium (Zr)	mg/kg	2.8	0.5	4244137

RDL = Reportable Detection Limit

Maxxam Job #: B079893
Report Date: 2010/09/15

ACCESS CONSULTING GROUP

Your P.O. #: MN-110486
Sampler Initials: LK

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL) Comments

Elements by ICP-AES (total): Sulphur reported as acid extractable.

ACCESS CONSULTING GROUP

Maxxam Job #: B079893
Report Date: 2010/09/15

Your P.O. #: MN-110466
Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4244124	Soluble (2:1) pH	2010/09/10			102	96 - 104			0.9	20		
4244137	Total Arsenic (As)	2010/09/10	101	75 - 125	97	75 - 125	<0.2	mg/kg	1.7	30	98	70 - 130
4244137	Total Beryllium (Be)	2010/09/10	100	75 - 125	95	75 - 125	<0.1	mg/kg	NC	30		
4244137	Total Cadmium (Cd)	2010/09/10	105	75 - 125	100	75 - 125	<0.05	mg/kg	NC	30	93	70 - 130
4244137	Total Chromium (Cr)	2010/09/10	100	75 - 125	96	75 - 125	<1	mg/kg	1.8	30	99	70 - 130
4244137	Total Cobalt (Co)	2010/09/10	100	75 - 125	96	75 - 125	<0.3	mg/kg	3.4	30	95	70 - 130
4244137	Total Copper (Cu)	2010/09/10	100	75 - 125	101	75 - 125	<0.5	mg/kg	1.9	30	90	70 - 130
4244137	Total Lead (Pb)	2010/09/10	101	75 - 125	99	75 - 125	<0.1	mg/kg	3.5	35	98	70 - 130
4244137	Total Mercury (Hg)	2010/09/10	85	75 - 125	85	75 - 125	<0.05	mg/kg	NC	35		
4244137	Total Nickel (Ni)	2010/09/10	99	75 - 125	98	75 - 125	<0.8	mg/kg	1.8	30	93	70 - 130
4244137	Total Selenium (Se)	2010/09/10	101	75 - 125	102	75 - 125	<0.5	mg/kg	NC	30		
4244137	Total Vanadium (V)	2010/09/10	NC	75 - 125	96	75 - 125	<2	mg/kg	0.9	30	101	70 - 130
4244137	Total Zinc (Zn)	2010/09/10	NC	75 - 125	105	75 - 125	<1	mg/kg	4.1	30	89	70 - 130
4244137	Total Aluminum (Al)	2010/09/10					<100	mg/kg	6.9	35	98	70 - 130
4244137	Total Antimony (Sb)	2010/09/10					<0.1	mg/kg	NC	30	107	70 - 130
4244137	Total Barium (Ba)	2010/09/10					<0.1	mg/kg	2.4	35	104	70 - 130
4244137	Total Calcium (Ca)	2010/09/10					<100	mg/kg	6.1	30	93	70 - 130
4244137	Total Iron (Fe)	2010/09/10					<100	mg/kg	2.6	30	95	70 - 130
4244137	Total Magnesium (Mg)	2010/09/10					<100	mg/kg	8.7	30	95	70 - 130
4244137	Total Manganese (Mn)	2010/09/10					<0.2	mg/kg	2.9	30	101	70 - 130
4244137	Total Molybdenum (Mo)	2010/09/10					<0.1	mg/kg	NC	35	103	70 - 130
4244137	Total Phosphorus (P)	2010/09/10					<10	mg/kg	4.3	30	90	70 - 130
4244137	Total Silver (Ag)	2010/09/10					<0.05	mg/kg	NC	35	78	70 - 130
4244137	Total Strontium (Sr)	2010/09/10					<0.1	mg/kg	3.7	35	96	70 - 130
4244137	Total Thallium (Tl)	2010/09/10					<0.05	mg/kg	NC	30	86	70 - 130
4244137	Total Titanium (Ti)	2010/09/10					<1	mg/kg	3.3	35	99	70 - 130
4244137	Total Bismuth (Bi)	2010/09/10					<0.1	mg/kg	NC	30		
4244137	Total Potassium (K)	2010/09/10					<100	mg/kg	1.1	35		
4244137	Total Sodium (Na)	2010/09/10					<100	mg/kg	NC	35		
4244137	Total Tin (Sn)	2010/09/10					<0.1	mg/kg	NC	35		
4244137	Total Zirconium (Zr)	2010/09/10					<0.5	mg/kg	NC	30		

ACCESS CONSULTING GROUP

Maxxam Job #: B079893
Report Date: 2010/09/15

Your P.O. #: MN-110466
Sampler Initials: LK

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4248901	Cation exchange capacity	2010/09/10							NC	35		
4255008	Total Sulphur (S)	2010/09/13					<5	mg/kg	7.8	30		

N/A = Not Applicable
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam Analytics Inc.
8577 Commerce Court
Burnaby, BC V5A 4N5
www.maxxamanalytics.com
Phone: (604) 444-4808
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Toll-free: 1-800-440-4808

08321901

CHAIN-OF CUSTODY RECORD AND ANALYSIS REQUEST

PAGE 1 OF 1

LAB USE ONLY — NAXXAM JOB #: B079893

ANALYSIS REQUEST

LAB USE ONLY — COC #:

COMPANY NAME: Access Consulting Group

CLIENT PROJECT #:

COMPANY ADDRESS:
#3 Calcite Business Center
151 Industrial Rd
Whitehorse, YT
Y1A 2V3

TEL: 867-668-6480
EMAIL: mduchamp@accessconsulting.ca
skeesey@accessconsulting.ca
kcruzone00@northwestel.net
FAX: 867-667-6606

SAMPLER NAME (PRINT): Lisa Knight, Brent Elliot

PROJECT MANAGER: Scott Keesey

LABORATORY CONTACT: Kimberley Mobbar

	FIELD SAMPLE ID	MATRIX: GROUNDWATER	SURFACE WATER	SOIL	SEDIMENT	DATE SAMPLED	TIME SAMPLED	# CONTAINERS	Calcium exchange rate (CEC)	Ca:Mg Ratio	% Organic Matter and TOC	Total Metals	Sulphur	pH
1	M87			X		18/07/2013		X	X	X	X	X	X	X
2	M89			X		22/07/2013		X	X	X	X	X	X	X
3	M85			X		19/07/2013		X	X	X	X	X	X	X
4	M84A			X		20/07/2013		X	X	X	X	X	X	X
5	M86A			X		21/07/2013		X	X	X	X	X	X	X
6	M88			X		21/07/2013		X	X	X	X	X	X	X
7	M95			X		21/07/2013		X	X	X	X	X	X	X
8	M97			X		21/07/2013		X	X	X	X	X	X	X
9	M90			X		22/07/2013		X	X	X	X	X	X	X
10	M93			X		22/07/2013		X	X	X	X	X	X	X
11														
12														

TAT (Turnaround Time)
TURNAROUND TIME MUST BE PRIOR APPROVED
* Some parameters require please contact laboratory
STANDARD: 5 BUSINESS DAYS
RUSH: 3 BUSINESS DAYS
RUSH: 2 BUSINESS DAYS
URGENT: 1 BUSINESS DAY
Specify 5 business days

PO NUMBER OR QUOTE NUMBER: MN-110498

ACCOUNTING CONTACT:

SPECIAL DETECTION LIMITS / CONTAMINANT TYPE:

SPECIAL REPORTING OR BILLING INSTRUCTIONS:

OF CONTAINERS:

COOLER: SEAL / ARRIVAL / TEMPERATURE (°C): 9/9/13

DUE DATE:

LOGIN CHECK:

RELINQUISHED BY: Paul Inglis — DATE: 24/09/2013 — TIME: 14:00 — RECEIVED BY:

RELINQUISHED BY: — DATE: — TIME: — RECEIVED BY:

RELINQUISHED BY: — DATE: 2/9/16 — TIME: 15:05 — RECEIVED BY LABORATORY: NICK SAMROE

CUSTODY RECORD

Exova
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Surrey, British Columbia
V3S 8P8, Canada

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W: www.exova.com

Exova

Analytical Report

Bill To:	Maxxam Analytics	Project:		Lot ID:	**760926**
Report To:	Maxxam Analytics	ID:		Control Number:	
	4606 Canada Way	Name:		Date Received:	Sep 3, 2010
	Burnaby, BC, Canada	Location:		Date Reported:	Sep 14, 2010
	V5G 1K5	LSD:		Report Number:	1355314
Attn:	Kimberley Webber	P.O.:	B079893		
Sampled By:		Acct code:			
Company:					

		Reference Number	760926-1	760926-2	760926-3	
		Sample Date	Aug 19, 2010	Aug 22, 2010	Aug 18, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	W68609-01R \ M07	W68610-01R \ M029	W68611-01R \ M035	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			40	15	>50	0.1
Nitrogen	Total	%	0.02	0.04	<0.01	0.01
Organic Matter	Total	%	1.25	1.35	1.08	
Carbon	Total Organic	%	0.62	0.68	0.54	0.02

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Analytical Report

Bill To:	Maxxam Analytics	Project:		Lot ID:	**760926**
Report To:	Maxxam Analytics	ID:		Control Number:	
	4606 Canada Way	Name:		Date Received:	Sep 3, 2010
	Burnaby, BC, Canada	Location:		Date Reported:	Sep 14, 2010
	V5G 1K5	LSD:		Report Number:	1355314
Attn:	Kimberley Webber	P.O.:	B079893		
Sampled By:		Acct code:			
Company:					

		Reference Number	760926-4	760926-5	760926-6	
		Sample Date	Aug 20, 2010	Aug 21, 2010	Aug 21, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	W68612-01R \ M54A	W68613-01R \ M76A	W68614-01R \ M80	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			45	25	31	0.1
Nitrogen	Total	%	0.04	0.05	0.04	0.01
Organic Matter	Total	%	3.98	2.38	2.22	
Carbon	Total Organic	%	1.99	1.19	1.11	0.02

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Analytical Report

Bill To:	Maxxam Analytics	Project:		Lot ID:	**760926**
Report To:	Maxxam Analytics	ID:		Control Number:	
	4606 Canada Way	Name:		Date Received:	Sep 3, 2010
	Burnaby, BC, Canada	Location:		Date Reported:	Sep 14, 2010
	V5G 1K5	LSD:		Report Number:	1355314
Attn:	Kimberley Webber	P.O.:	B079893		
Sampled By:		Acct code:			
Company:					

		Reference Number	760926-7	760926-8	760926-9	
		Sample Date	Aug 21, 2010	Aug 21, 2010	Aug 22, 2010	
		Sample Time	NA	NA	NA	
		Sample Location				
		Sample Description	W68615-01R \ M85	W68616-01R \ M87	W68617-01R \ M90	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			28	30	27	0.1
Nitrogen	Total	%	0.03	0.06	0.03	0.01
Organic Matter	Total	%	1.78	3.59	1.81	
Carbon	Total Organic	%	0.89	1.79	0.90	0.02

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Analytical Report

Bill To:	Maxxam Analytics	Project:		Lot ID:	**760926**
Report To:	Maxxam Analytics	ID:		Control Number:	
	4606 Canada Way	Name:		Date Received:	Sep 3, 2010
	Burnaby, BC, Canada	Location:		Date Reported:	Sep 14, 2010
	V5G 1K5	LSD:		Report Number:	1355314
Attn:	Kimberley Webber	P.O.:	B079893		
Sampled By:		Acct code:			
Company:					

		Reference Number	760926-10			
		Sample Date	Aug 22, 2010			
		Sample Time	NA			
		Sample Location				
		Sample Description	W68618-01R \ M93			
		Matrix	Soil			
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Classification						
C:N Ratio			28			0.1
Nitrogen	Total	%	0.02			0.01
Organic Matter	Total	%	1.15			
Carbon	Total Organic	%	0.57			0.02

Approved by:

Andrew Garrard, BSc
General Manager

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Methodology and Notes

Bill To:	Maxxam Analytics	Project:		Lot ID:	760926
Report To:	Maxxam Analytics	ID:		Control Number:	
	4606 Canada Way	Name:		Date Received:	Sep 3, 2010
	Burnaby, BC, Canada	Location:		Date Reported:	Sep 14, 2010
	V5G 1K5	LSD:		Report Number:	1355314
Attn:	Kimberley Webber	P.O.:	B079893		
Sampled By:		Acct code:			
Company:					

Method of Analysis

Method Name	Reference	Method	Date Analysis Started	Location
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	* Nitrogen-Total, Ch 37	09-Sep-10	Exova Surrey
Total Carbon, Nitrogen & Sulfur by Leco Combustion	SSSA Book Series 5	* Total Carbon, Organic Carbon, and Organic Matter, Ch 34	09-Sep-10	Exova Surrey

** Reference Method Modified*

Comments: