Appendix V5-2A

2010 Thermistor Data Summary (Goose Property) Memorandum Report

an ERM company

Memorandum

DATE:	October 27, 2010
TO:	Elizabeth Sherlock, Environmental/Permitting Coordinator Dan Russell, Project Environmental Coordinator (Sabina Gold and Silver Corporation)
FROM:	Colin Fyfe, B.Eng. (Hons), Ph.D. (Rescan Hydrogeologist)
CC:	Deborah Muggli, M.Sc., Ph.D., R.P.Bio. (Project Manager) Gerry Papini, M.Sc., P.Geo. (Manager, Hydrogeology)
SUBJECT:	Thermistor Data Summary, Back River Project

1. Introduction

Two thermistor strings currently exist within the Goose Lake Property of the Back River Project. This memorandum provides a summary of the available data and its adequacy in characterizing the permafrost layer.

The thermistors were installed to characterize the permafrost layer beneath the property. One string is installed to approximately 7 m below ground surface (Goose Trench) while the second is installed to a depth of 300 mbgl (08GSE009). The data for the Goose Trench are anomalous and cannot be explained without further information on the history of this instrument. Figure 1 shows the locations of the thermistors and Table 1 summarizes the thermistor installation details.

The data presented in this memorandum was provided to Rescan Environmental Services Ltd. (Rescan) by Sabina Gold and Silver Corporation (Sabina) who have been collecting data since September 2007. The thermistor data has been collected manually. Measurements of thermistor resistance have been converted to temperature using a calibration curve provided by Sabina. Curves were fitted to the calibration data; the calibration fit was good.

2. Results

2.1 Goose Trench Thermistor

The Goose Trench thermistor was installed in 1997. Five datasets were provided by Sabina covering the period from September 20, 2007 to September 17, 2010 (Table 2). Four of the data sets were collected in August or September and one collected in May 2010. Node 3 of this thermistor is noted as non-functional.

Figure 2 is a time-series graph that shows the variation in temperature with depth. The data collected in August and September 2010 show the active layer (non-frozen ground conditions) to a depth of about 4.5 mbgl. The pre-2010 data suggest an active layer greater than 7 m.

Communications with Dan Russell, Project Environmental Coordinator (Sabina), has indicated that the area around the Goose Trench thermistor was reclaimed in August 2009 and resulted in increased depth of overburden at the site. The reclamation may explain the variability between the pre-2010 and 2010 data. The data from the uppermost node on this thermistor (1.2 m below the original ground surface) is suspect as it is thought to be measuring air temperatures (up to 19.7 degrees Celsius shown in Figure 2).

2.2 08GSE009 Thermistor

The 08GSE009 thermistor was installed in 2008. Since installation the thermistor has been read nine times from May 9, 2008 to September 17, 2010. The data are provided in Table 3 and Figures 3 through 6 present these data.

Figure 3 shows the equilibration of selected thermistor nodes with time. The selected thermistors are all installed at depths below the point of zero amplitude (the depth at which there is no seasonal temperature variation). The figure shows “freeze back” post-installation in June 10, 2008 and that the data from August 8, 2009 are suspect as they deviate by about one degree Celsius from the steady state temperatures at the individual nodes, which are not expected to vary with time. It was also noted that some of the data from August 8, 2009 was highlighted as questionable by field personnel. This data was subsequently excluded from the later figures.

Figure 4 shows the temperature to depth profile for the full 300 m installation depth of the thermistor string whereas Figure 5 shows the temperature trend observed in the upper 40 m of the thermistor profile. The point of zero amplitude is approximately 20 m below ground surface (Figure 5). Additional information showing seasonal fluxes would be required to better define this depth both spatially and with greater confidence.

Figure 6 shows the temperature trend observed in the upper 10 m of the thermistor profile. The three most recent data sets have been presented in these figures only. The profiles recorded in this thermistor are expected in a permafrost environment with an active layer (the surficial zone which experiences a freeze thaw cycle seasonally) of approximately 1 m and a permafrost layer beneath. The active layer is best illustrated in Figure 6 from which it can be seen that the near surface temperature is highly variable; as the depth increases, the variability decreases. The May 8, 2010 data shows sub-zero temperatures at surface. The later (August and September) data shows temperatures above freezing to a depth of approximately 1.25 m below ground surface. This information indicates an active layer of 1.25 m. There are no temporal data to accurately define the duration and maximum depth of the active layer.

The profiles show that the temperature trends towards zero with increasing depth as a result of the geothermal gradient. An estimation of the geothermal gradient was carried out by fitting a linear function to the lower 150 m of the thermistor string (4 data points) for September 17, 2010 (R^2 value of 0.977). The predicted depth for zero degrees Celsius in the bedrock is approximately 520 m below ground surface. This represents a simplification of the thermal gradient and is not necessarily the base of frozen ground and groundwater (e.g. high salinity could depress the freezing point).

3. <u>Conclusions, Limitations and Recommendations</u>

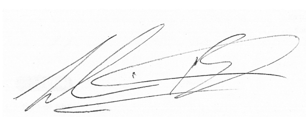
- The data for the Goose Trench thermistor are anomalous and may have been affected by site activities or instrument damage. The inferred 2010 permafrost depth of approximately 4.5 m below the original ground surface is greater than expected based on experience of permafrost depth at similar latitude at other locations. Further interpretation of the data and permafrost conditions may only be possible with more background and history for this instrument. Currently, the data are not considered reliable.

- The available data for the 08GSE009 thermistor string follows the typical trend observed in a permafrost environment. The active layer is approximately 1.25 m thick at the end of summer, the expected maximum and will vary through the annual freeze/thaw cycle.
- The thermistor string does not extend deep enough to directly measure the level where the temperature reaches zero degrees Celsius. Extrapolation of the data indicates that this point would be approximately 500 m below ground surface.
- The data available has been manually read. It is recommended that data loggers be installed at the two thermistor strings to better define the seasonal fluxes in sub-surface temperatures. This would allow the variations in the active layer and the point zero amplitude to be better, and more confidently, defined.

4. Closure

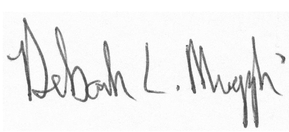
The contents herein reflect Rescans best understanding of the scope and the information available. This memorandum has been written for the sole use of our client, Rescan accepts no liability associated with third party use of the contents.

Prepared By:



Colin Fyfe, B.Eng (Hons), Ph.D.
Rescan - Environmental Engineering

Reviewed By:



Deborah Muggli, M.Sc., Ph.D., R.P.Bio. (Project Manager)

Tables

Table 1. Thermistor Details

Thermistor ID	Hole ID	Coordinates			Installation Hole Details			Installation Date	Installation Contractor	Thermistor String Manufacturer	Number of Thermistor Nodes	Comments
		Easting	Northing	Elevation (m-amsl)	Hole Strike	Hole Dip (Degrees from horizontal)	Depth of Installation					
Goose Trench	97GO-14	434055	7269263	282.6	44	45	7 m	1997	NA	RST Instruments	6	Thermistor string contains 6 nodes, but node 3 (3.7 m below ground surface) is not functional.
08GSE009	08GSE009	433904	7269461	285	44	56	300 m	2008	Dundee	RST Instruments	18	

Notes:
Coordinates are NAD 83, Zone 13
NA - Not Available/Not Applicable
m-amsl - metres above mean sea level

Table 2. Goose Trench Data

Thermistor Node	Node Length Along String (ft)	Node Depth Below Ground Surface (m)	September 20, 2007		August 8, 2009		May 8, 2010		August 30, 2010		September 17, 2010	
			Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)
1	-4	-1.2	8.18	-2.5	4.205	10.9	5.85	4.1	2.775	19.7	5.95	3.8
2	-8	-2.4	6.81	1.1	4.616	8.9	10.76	-7.7	5.442	5.6	6.45	2.2
3	-12	-3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	-16	-4.9	6.62	1.6	5.82	4.2	11.17	-8.4	7.47	-0.7	7.31	-0.3
5	-20	-6.1	6.89	0.8	6.62	1.6	11.07	-8.2	7.95	-1.9	7.75	-1.5
6	-24	-7.3	7.1	0.3	6.74	1.3	10.75	-7.7	8.29	-2.8	8.07	-2.2

Notes:
NA - Not Available/Not Applicable
ft - Feet
m - Metres
k-Ohms - Kilo Ohms
C - Celcius

Table 3A. 08GSE009 Data

Thermistor Node	Node Length Along String (m)	Node Depth Below Ground Surface (m)	May 9, 2008		May 11, 2008		May 13, 2008		May 19, 2008		June 10, 2008	
			Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)
1	-0.1	-0.1	7.51	-0.3	7.78	-0.9	8.32	-2.2	9.09	-3.9	7.85	-1.1
2	-0.6	-0.5	7.26	0.4	7.49	-0.2	8.02	-1.5	9.43	-4.6	8.98	-3.7
3	-1.2	-1	7.35	0.2	7.99	-1.5	8.75	-3.2	10.22	-6.2	9.71	-5.2
4	-1.8	-1.5	7.36	0.1	8.51	-2.7	9.93	-5.6	11.00	-7.5	10.35	-6.4
5	-2.4	-2	7.38	0.1	9.65	-5.1	10.76	-7.1	11.58	-8.5	10.90	-7.4
6	-6	-5	7.35	0.2	9.86	-5.5	10.72	-7.1	11.58	-8.5	11.83	-8.9
7	-9	-7.5	7.31	0.3	7.63	-0.6	9.27	-4.3	10.38	-6.5	11.13	-7.8
8	-12.1	-10	7.41	0.0	8.52	-2.7	8.96	-3.7	9.59	-5.0	10.40	-6.5
9	-18.1	-15	7.75	-0.9	8.90	-3.5	9.26	-4.3	9.66	-5.1	10.03	-5.8
10	-24.1	-20	8.16	-1.9	9.12	-4.0	9.46	-4.7	9.80	-5.4	10.06	-5.9
11	-36.2	-30	8.33	-2.3	9.28	-4.3	9.59	-5.0	9.90	-5.6	10.15	-6.0
12	-48.2	-40	8.50	-2.6	9.36	-4.5	9.65	-5.1	9.96	-5.7	10.20	-6.1
13	-84.4	-70	8.89	-3.5	9.56	-4.9	9.76	-5.3	9.99	-5.7	10.16	-6.1
14	-120.6	-100	8.69	-3.1	9.36	-4.5	9.66	-5.1	9.83	-5.4	10.06	-5.9
15	-189.2	-150	9.06	-3.9	9.46	-4.7	9.57	-4.9	9.70	-5.2	9.79	-5.4
16	-241.2	-200	8.85	-3.4	9.26	-4.3	9.36	-4.5	9.47	-4.7	9.53	-4.8
17	-301.6	-250	8.45	-2.5	8.93	-3.6	9.03	-3.8	9.12	-4.0	9.17	-4.1
18	-361.9	-300	7.89	-1.2	8.52	-2.7	8.62	-2.9	8.69	-3.1	8.73	-3.2

Notes:
NA - Not Available/Not Applicable
m - Metres
k-Ohms - Kilo Ohms
C - Celcius
Underline - Data noted as questionable by field personnel

Table 3B. 08GSE009 Data

Thermistor Node	Node Length Along String (m)	Node Depth Below Ground Surface (m)	August 8, 2009		May 8, 2010		August 30, 2010		September 17, 2010	
			Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)
1	-0.1	-0.1	6.18	3.6	12.35	-9.7	5.78	4.9	6.94	1.3
2	-0.6	-0.5	7.04	1.0	12.47	-9.9	6.49	2.6	6.95	1.3
3	-1.2	-1	7.74	-0.8	12.64	-10.1	7.32	0.2	7.31	0.3
4	-1.8	-1.5	8.28	-2.2	12.71	-10.2	7.75	-0.9	7.66	-0.6
5	-2.4	-2	9.19	-4.2	12.71	-10.2	8.14	-1.8	8.00	-1.5
6	-6	-5	7.81	-1.0	11.89	-9.0	9.81	-5.4	9.52	-4.8
7	-9	-7.5	11.23	-7.9	11.07	-7.7	10.50	-6.7	10.29	-6.3
8	-12.1	-10	10.83	-7.3	10.55	-6.8	10.78	-7.2	10.67	-7.0
9	-18.1	-15	10.67	-7.0	10.36	-6.4	10.53	-6.7	10.53	-6.7
10	-24.1	-20	9.33	-4.4	10.36	-6.4	10.40	-6.5	10.42	-6.5
11	-36.2	-30	10.40	-6.5	10.33	-6.4	10.33	-6.4	10.34	-6.4
12	-48.2	-40	10.59	-6.8	10.33	-6.4	10.34	-6.4	10.34	-6.4
13	-84.4	-70	10.60	-6.8	10.26	-6.2	10.26	-6.2	10.27	-6.3
14	-120.6	-100	10.44	-6.6	10.17	-6.1	10.16	-6.1	10.17	-6.1
15	-189.2	-150	9.90	-5.6	9.85	-5.5	9.87	-5.5	9.87	-5.5
16	-241.2	-200	9.86	-5.5	9.58	-4.9	9.62	-5.0	9.62	-5.0
17	-301.6	-250	9.63	-5.0	9.20	-4.2	9.25	-4.3	9.25	-4.3
18	-361.9	-300	9.22	-4.2	8.76	-3.2	8.79	-3.3	8.78	-3.3

Notes:
NA - Not Available/Not Applicable
m - Metres
k-Ohms - Kilo Ohms
C - Celcius
Underline - Data noted as questionable by field personnel

Figures

gis no.GOO-10-005 Job No. 833-002-03 October 26 2010

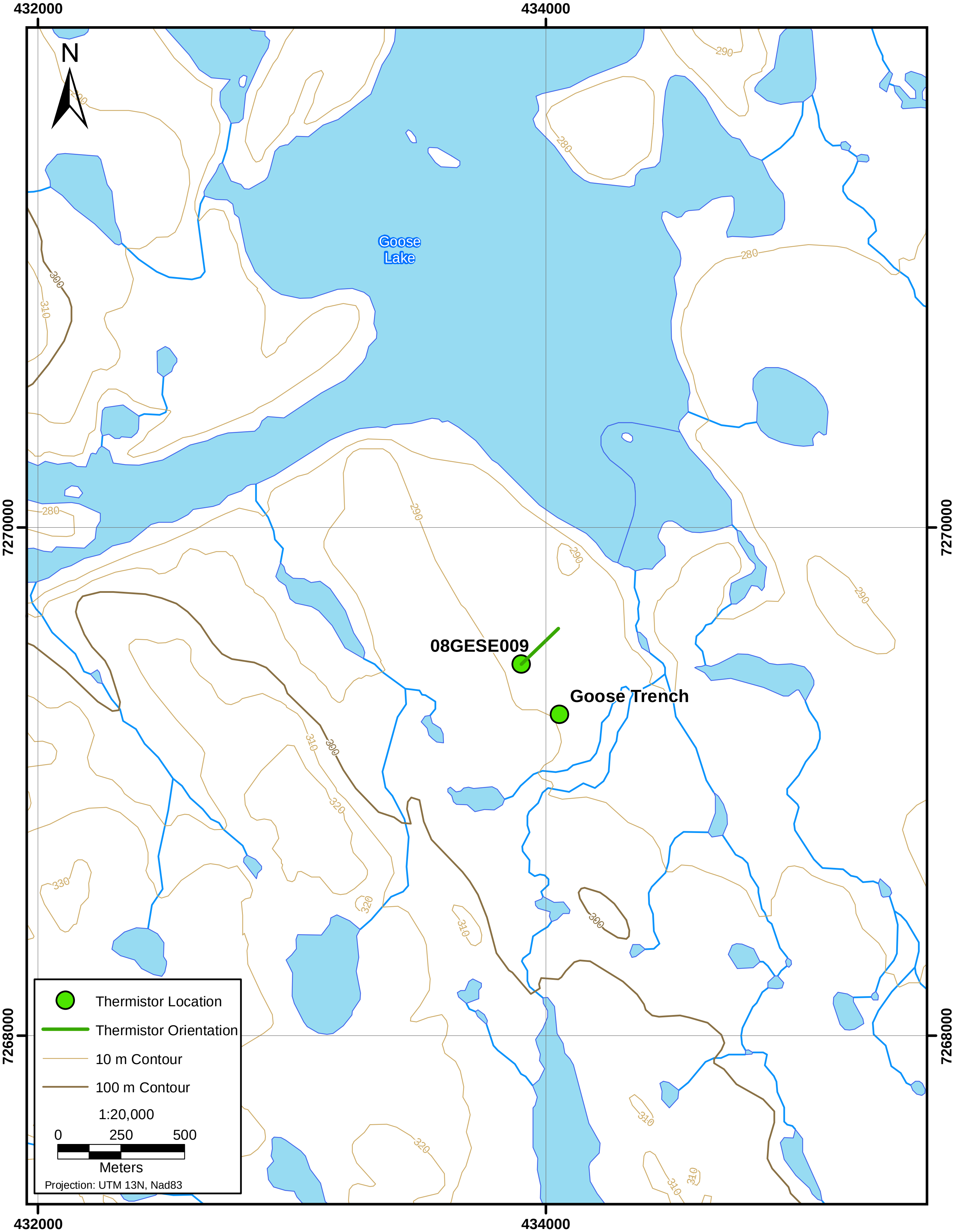


FIGURE 1

Thermistor Locations

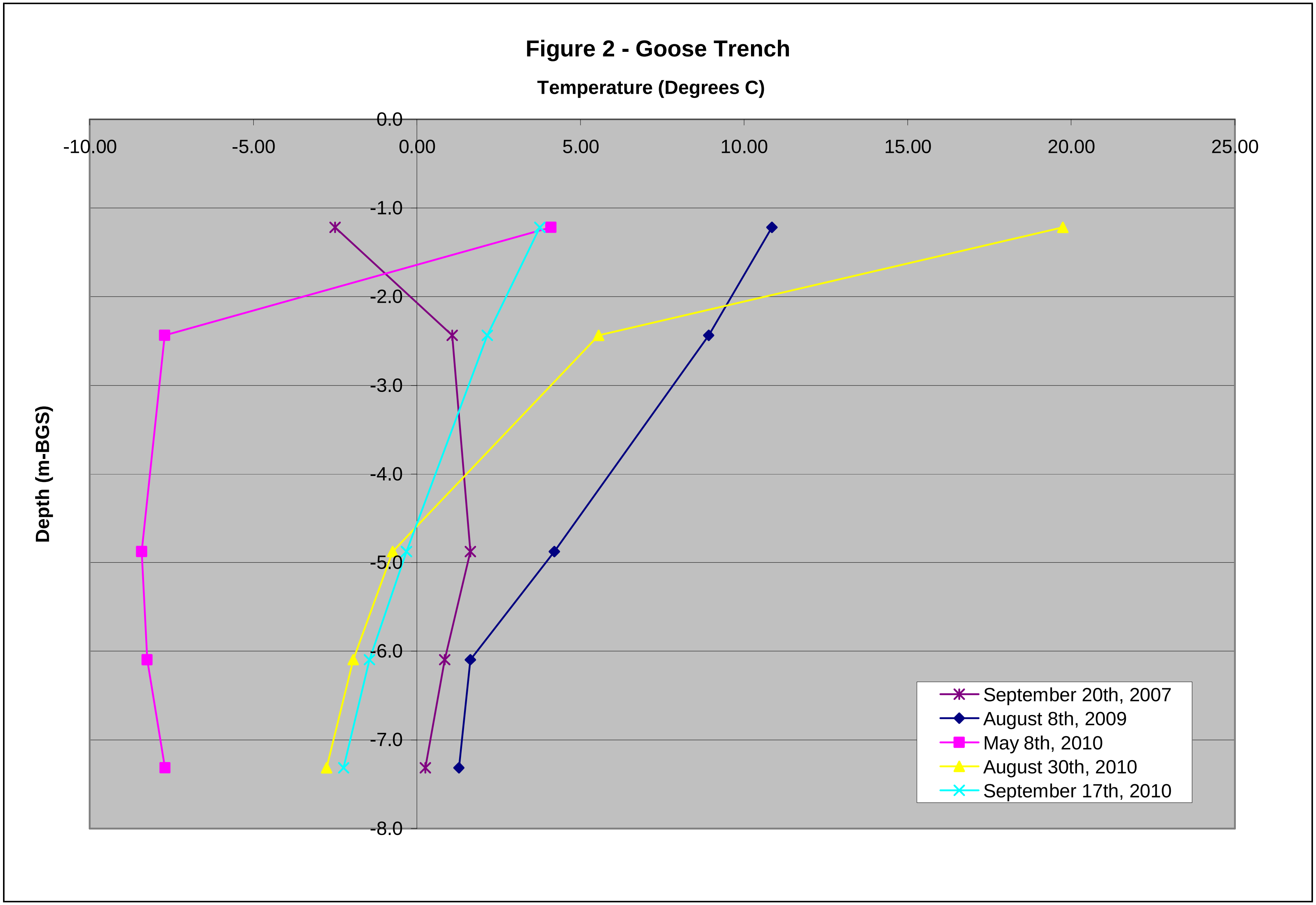


Figure 2 - Goose Trench
Temperature (Degrees C)
-10.00
-5.00
0.00
5.00
10.00
15.00
20.00
25.00
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
Depth (m-BGS)
September 20th, 2007
August 8th, 2009
May 8th, 2010
August 30th, 2010
September 17th, 2010

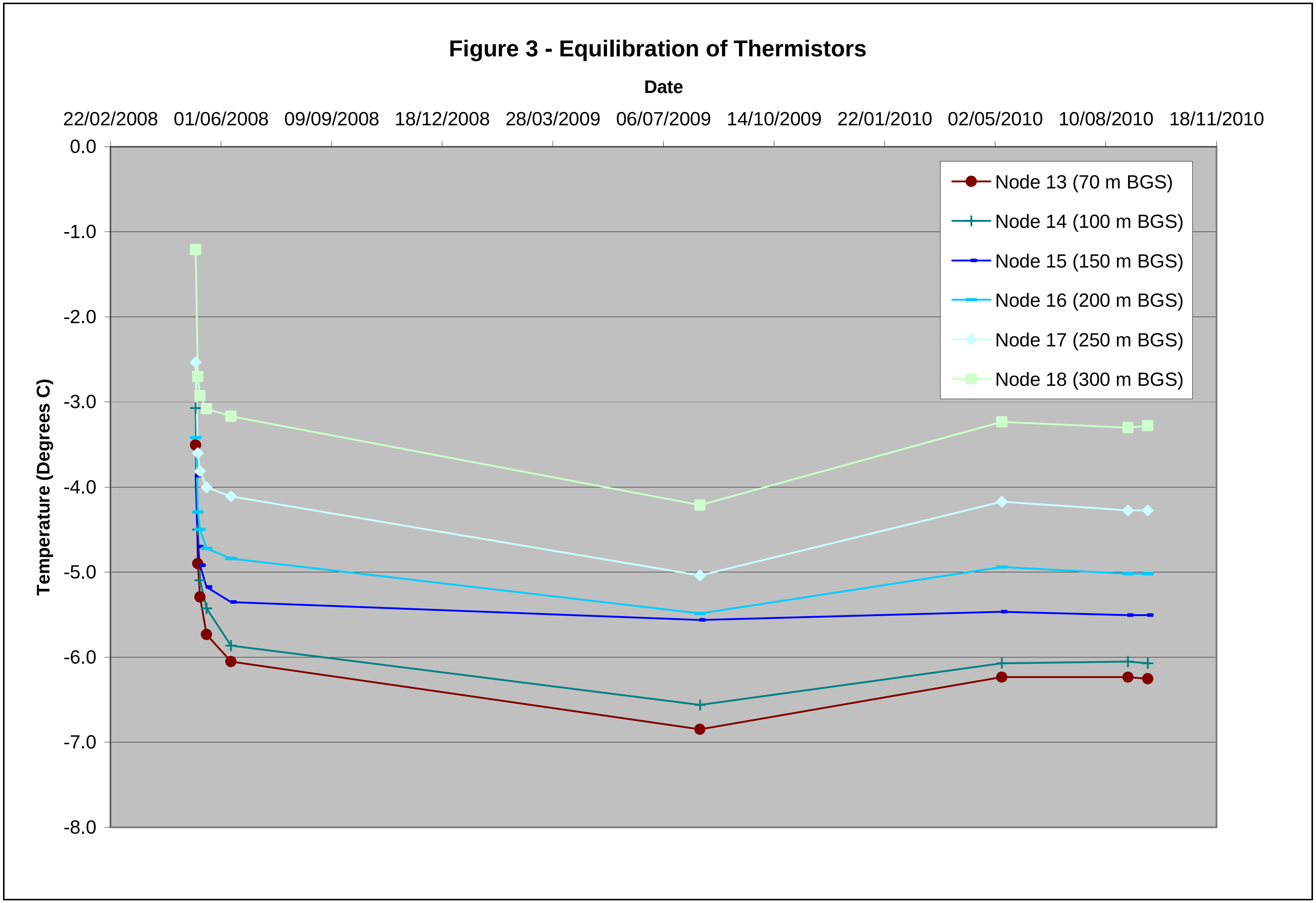


Figure 3 - Equilibration of Thermistors
Date
22/02/2008
01/06/2008
09/09/2008
18/12/2008
28/03/2009
06/07/2009
14/10/2009
22/01/2010
02/05/2010
10/08/2010
18/11/2010
Temperature (Degrees C)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
Node 13 (70 m BGS)
Node 14 (100 m BGS)
Node 15 (150 m BGS)
Node 16 (200 m BGS)
Node 17 (250 m BGS)
Node 18 (300 m BGS)

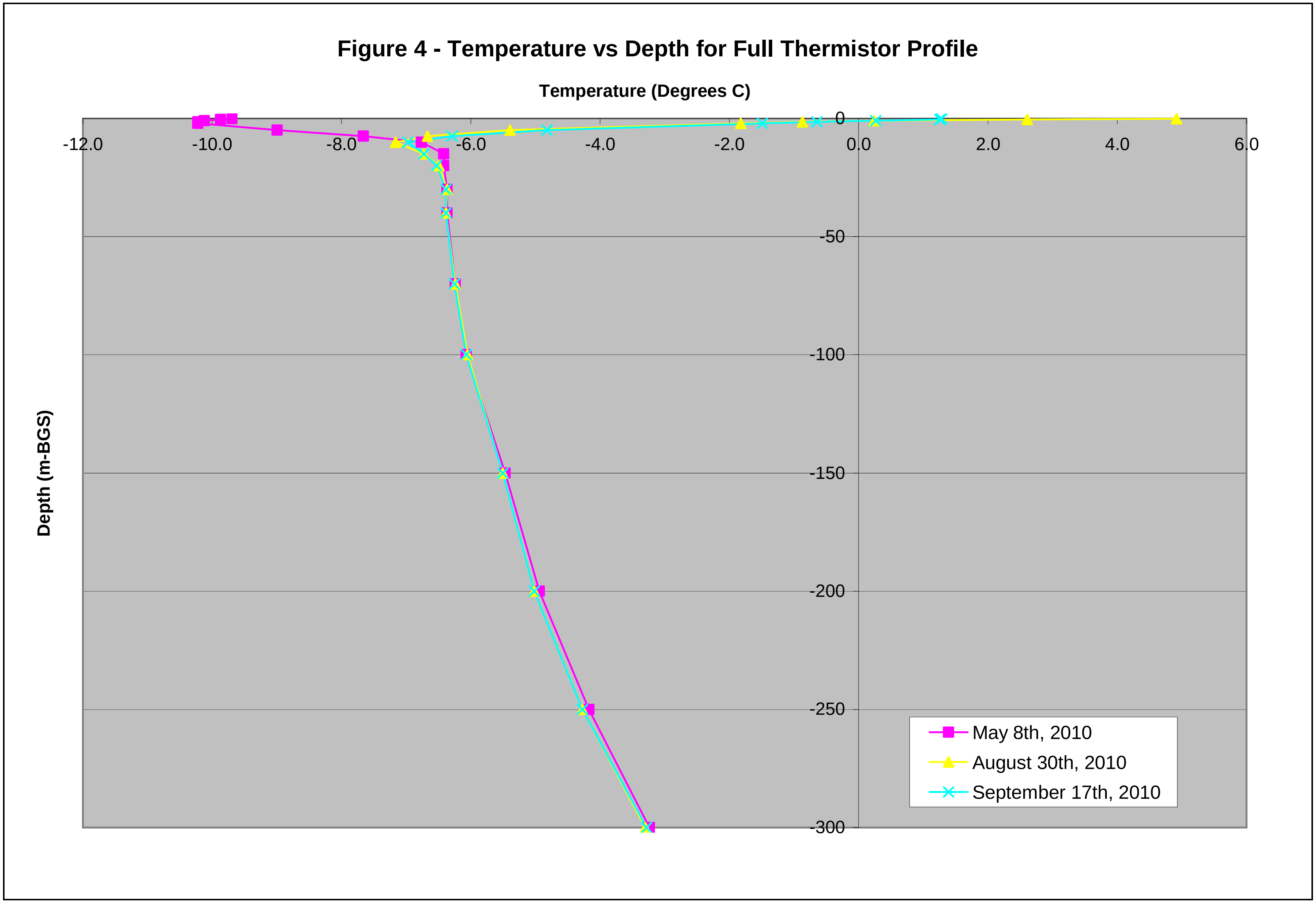


Figure 4 - Temperature vs Depth for Full Thermistor Profile
Temperature (Degrees C)
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
0
-50
-100
-150
-200
-250
-300
Depth (m-BGS)
May 8th, 2010
August 30th, 2010
September 17th, 2010

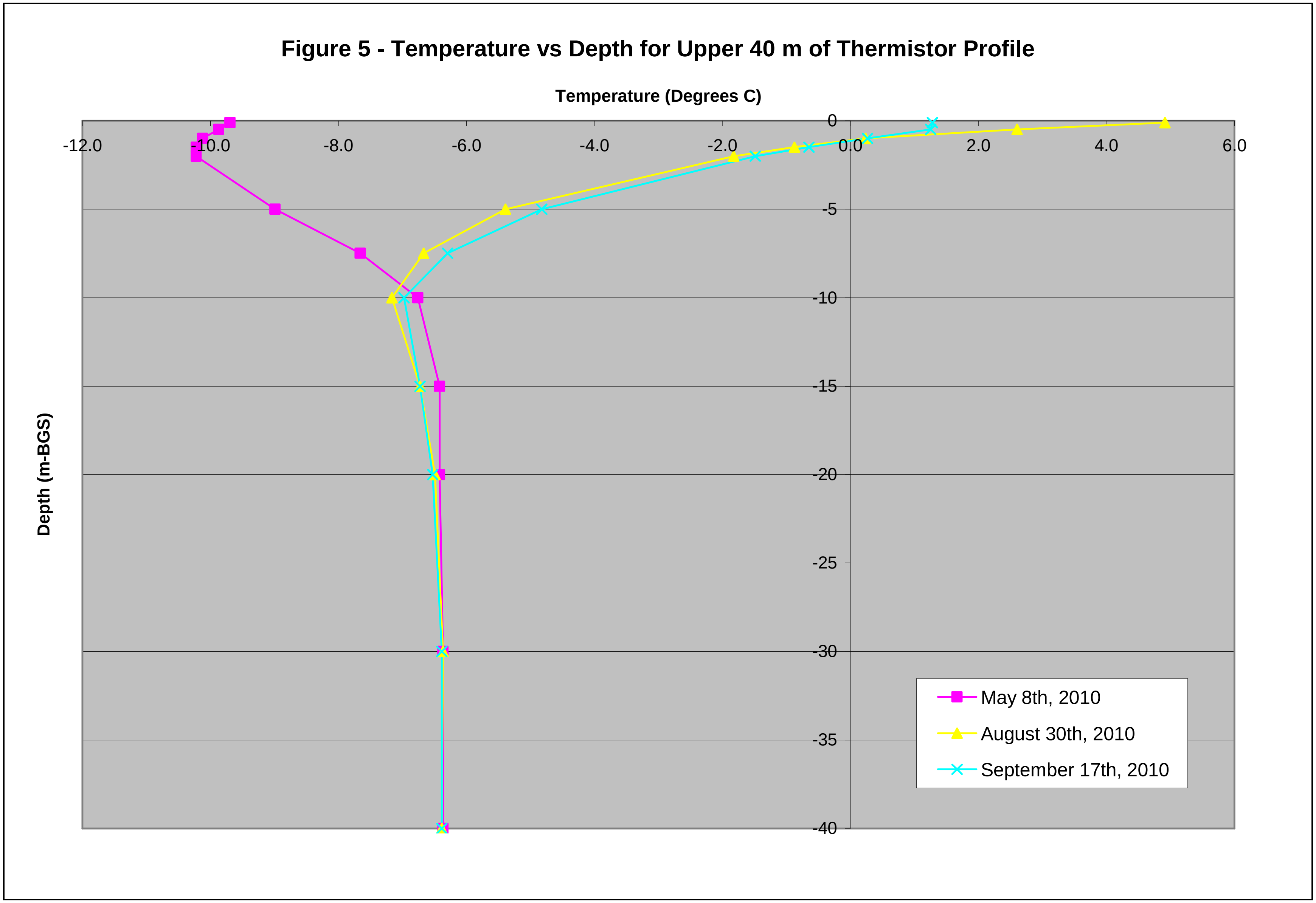


Figure 5 - Temperature vs Depth for Upper 40 m of Thermistor Profile
Temperature (Degrees C)
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
0
-5
-10
-15
-20
-25
-30
-35
-40
Depth (m-BGS)
May 8th, 2010
August 30th, 2010
September 17th, 2010

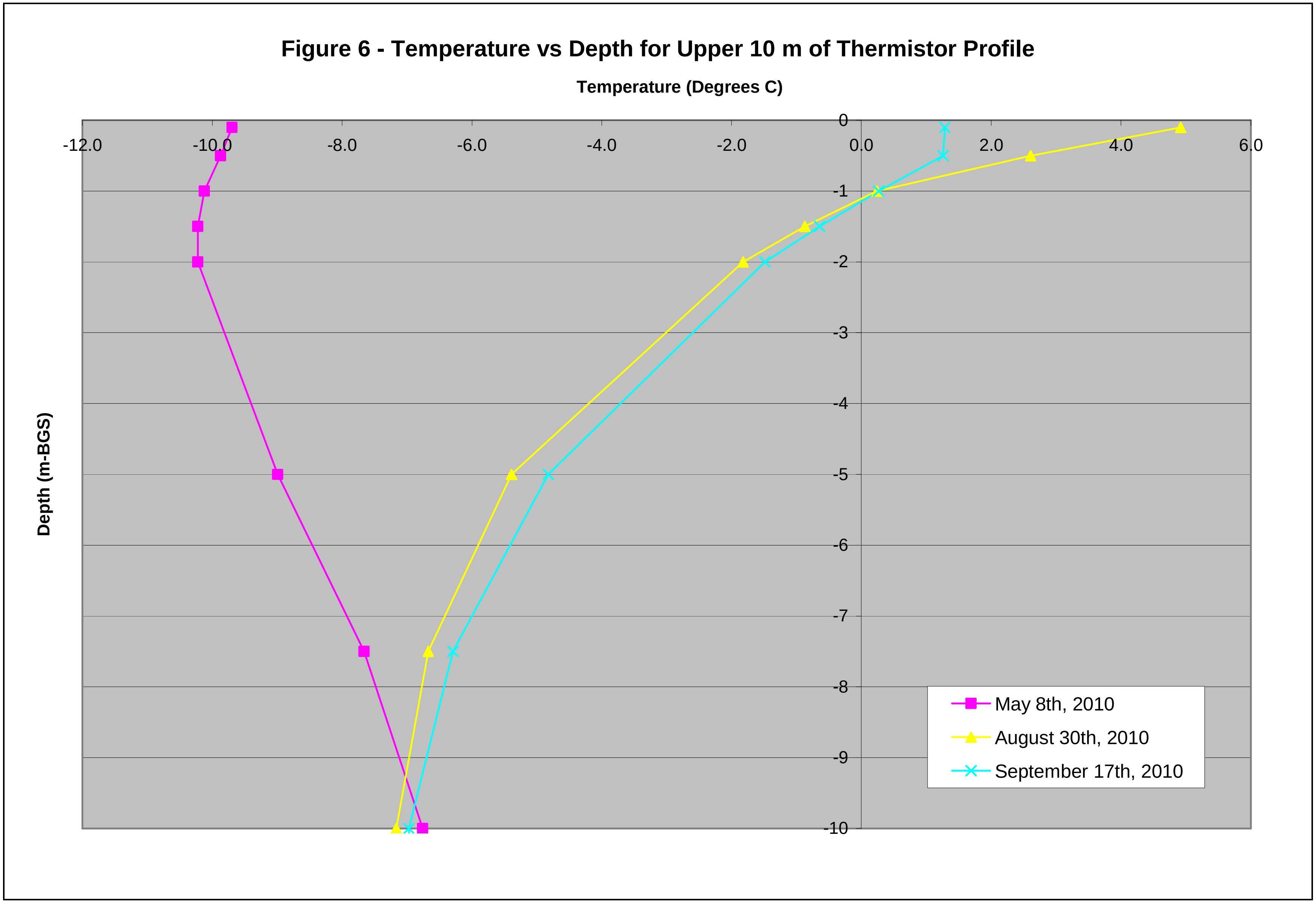


Figure 6 - Temperature vs Depth for Upper 10 m of Thermistor Profile
Temperature (Degrees C)
-12.0
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
Depth (m-BGS)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
May 8th, 2010
August 30th, 2010
September 17th, 2010

Appendix V5-2B

2012 Thermistor Data Summary (Goose Property) Memorandum Report

an ERM company

Memorandum

DATE: February 22, 2012

TO: Elizabeth Sherlock, Environmental/Permitting Coordinator
Sabina Gold and Silver Corporation

FROM: Deborah Muggli, M.Sc., Ph.D., R.P.Bio.; Project Manager
Gerry Papini, M.Sc., P.Geo.; Manager, Hydrogeology
Tyler Gale, M.A.Sc.; Rescan Hydrogeologist

SUBJECT: Thermistor Data Summary, Back River Project

1. Introduction

Three thermistor strings currently exist within the Goose Lake Property of the Back River Project. This memorandum provides a summary of the available data and a preliminary assessment of subsurface temperature conditions and permafrost depths.

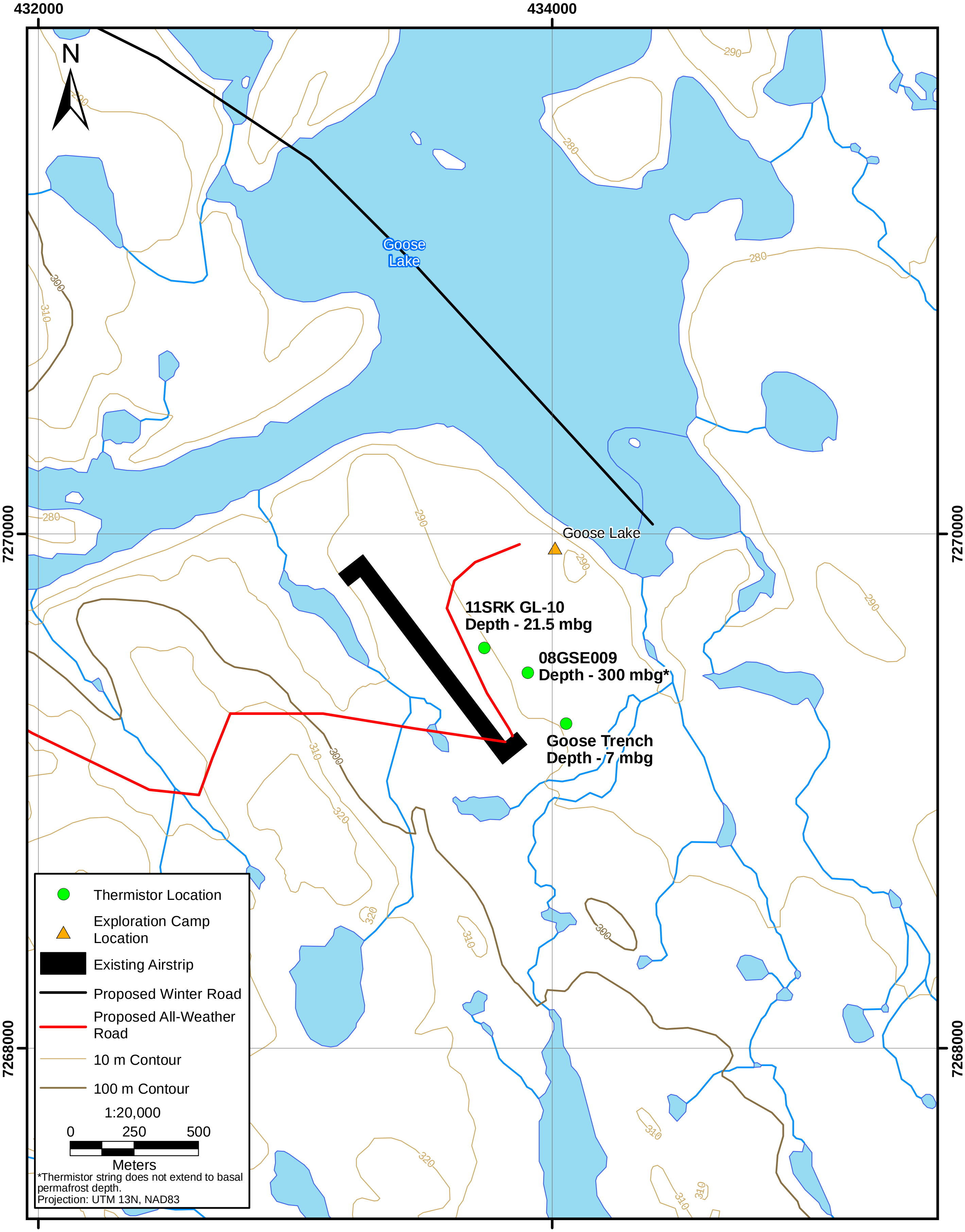
Thermistor string 08GSE009 is installed to a depth of 300 m below grade (mbg), with data collection commencing in 2008. 11SRK GL-10 is installed to 21.5 mbg, with data collection commencing in 2011. The Goose Trench thermistor string is installed to 7.0 mbg, with data collection commencing in 2007. Measurements prior to 2011 at the Goose Trench string indicated considerable temperature variability, which were attributed to disturbance of the adjacent trench. Data were not collected from the Goose Trench thermistor in 2011. Figure 1 shows the locations of the thermistors and Table 1 summarizes installation details.

Data loggers were installed at thermistor strings 08GSE009 and 11SRK GL-10 by Campbell Scientific Inc. in August 2011, establishing resistivity measurement records at 30 minute intervals. Data were downloaded from loggers in September 2011 by Rescan field staff. Resistivity measurements were conducted manually prior to 2011, and were provided to Rescan Environmental Services Ltd. (Rescan) by Sabina Gold and Silver Corporation (Sabina). Thermistor resistance measurements have been converted to temperature using the Steinhart-hart linearization scheme, with coefficients provided by the thermistor supplier (RST Instruments Ltd.).

2. Results

2.1 08GSE009 Thermistor String

The 08GSE009 thermistor was installed in 2008. Nine manual measurements were conducted between May 2008 and September 2010. Data logging with Campbell Scientific data loggers commenced August 17, 2011. A download was conducted September 15, 2011. Figures 2 through 10 present available data.



Sabina GOLD & SILVER CORP.

FIGURE 1

Thermistor String Locations

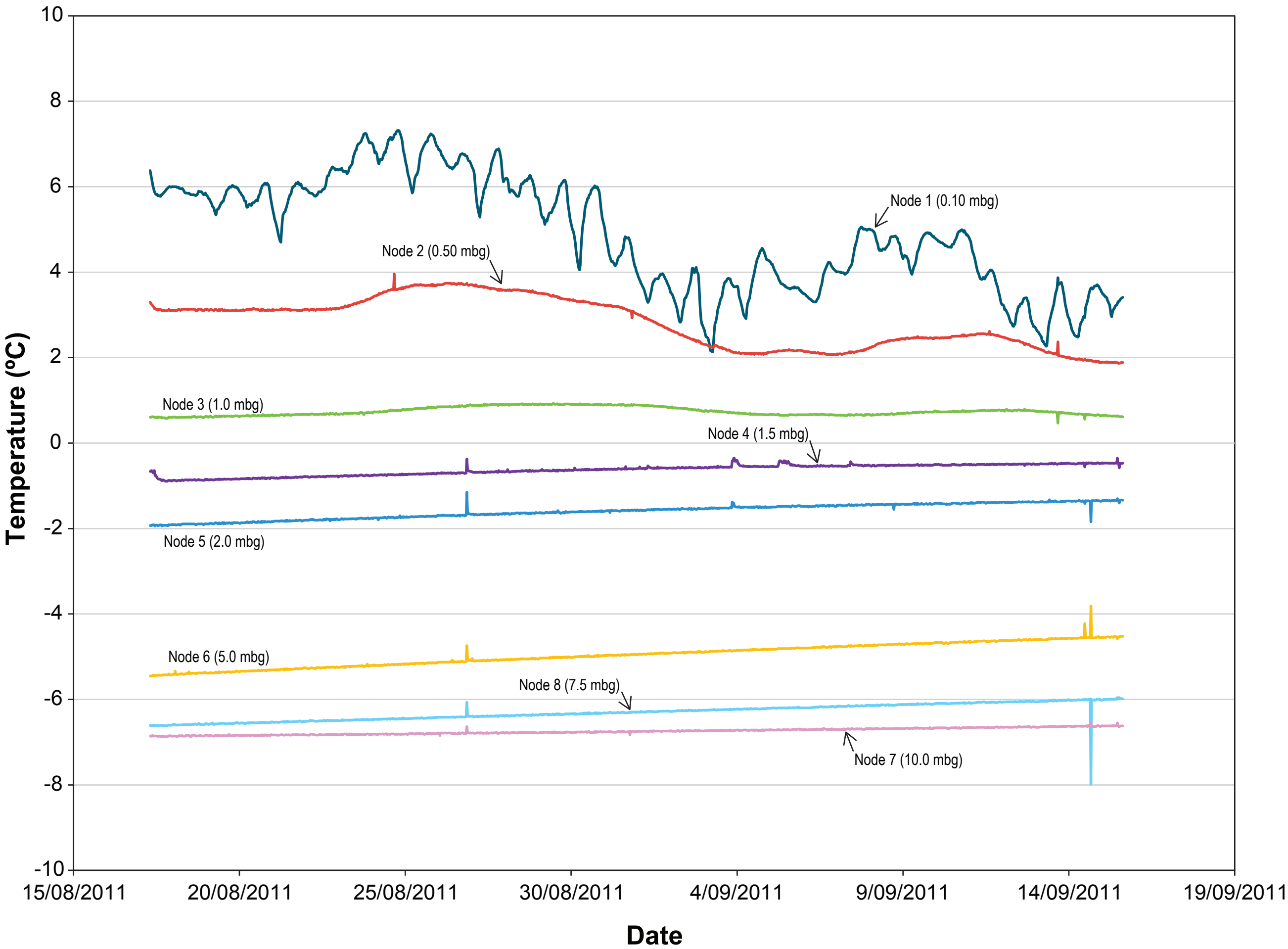
Rescan™

Table 1. Thermistor Details

Thermistor String ID	Hole ID	UTM Coordinates			Installation Hole Details		
		Easting	Northing	Ground Elevation (m-amsl)	Hole Strike	Hole Dip (Degrees from horizontal)	Depth of Installation
Goose Trench	97GO-14	434055	7269263	282.6	44	45	7 m
08GSE009	08GSE009	433904	7269461	285	44	56	300 m
11SRK GL-10	SRK-11-GL-DHTH	433734	7269557	293.89	-	90	21.5 m

Thermistor String ID	Hole ID	Installation Date	Installation Contractor	Thermistor String Manufacturer	Number of Thermistor Nodes	Comments
Goose Trench	97GO-14	1997	NA	RST Instruments	6	No 2011 data collection. Node 3 (3.7 m below ground surface) is not functional.
08GSE009	08GSE009	2008	Dundee	RST Instruments	18	
11SRK GL-10	SRK-11-GL-DHTH	2011	SRK	RST Instruments	10	

Notes:
Coordinates are NAD 83, Zone 13
NA - Not Available/Not Applicable
m-amsl - metres above mean sea level

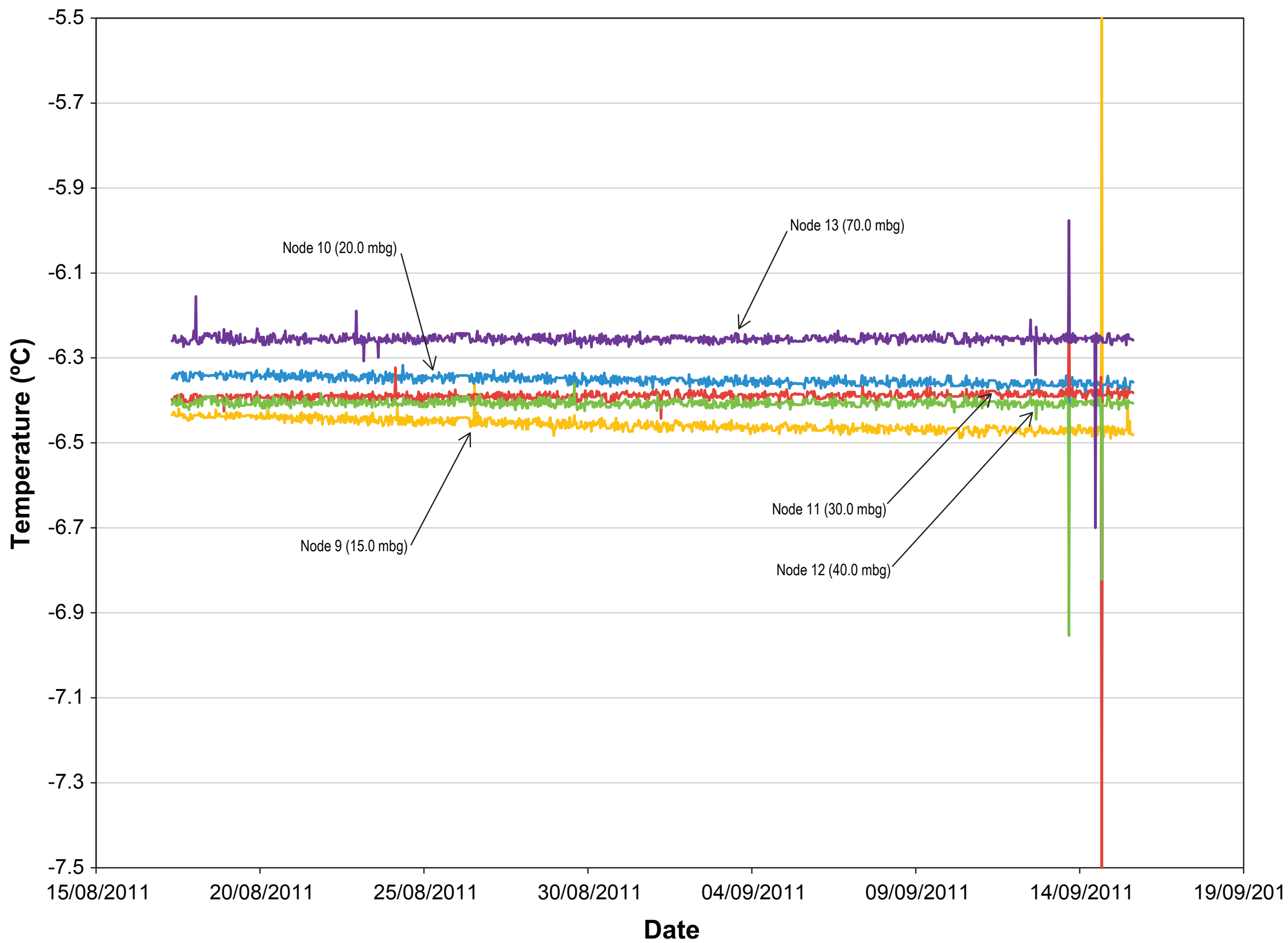


Sabina GOLD & SILVER CORP.

Logged Thermistor Timeseries for 08GSE009 String (Nodes 1 to 8)

Figure 2

Rescan Engineers & Scientists

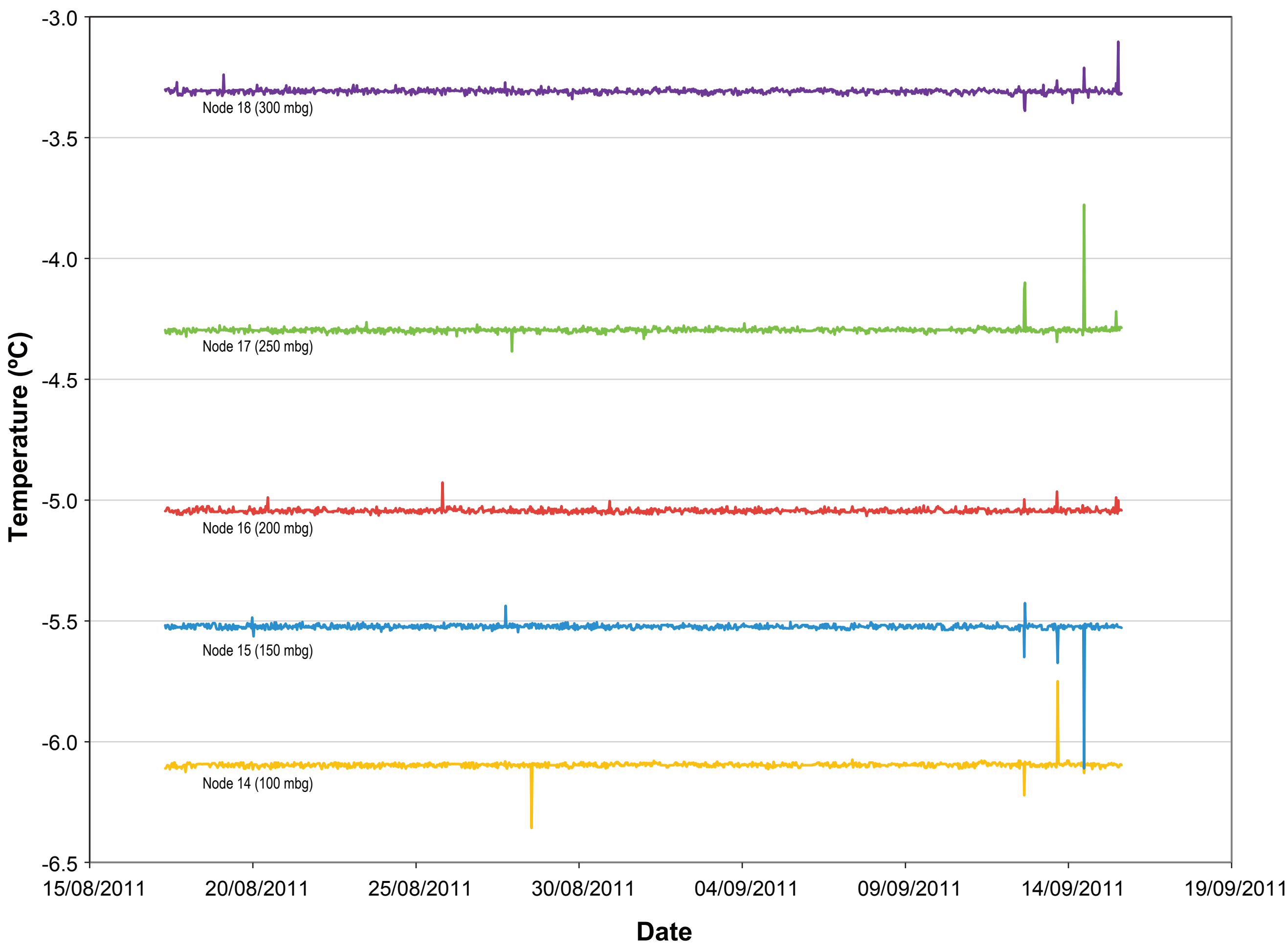


Sabina GOLD & SILVER CORP.

Logged Thermistor Timeseries for 08GSE009 String (Nodes 9 to 13)

Figure 3

Rescan Engineers & Scientists

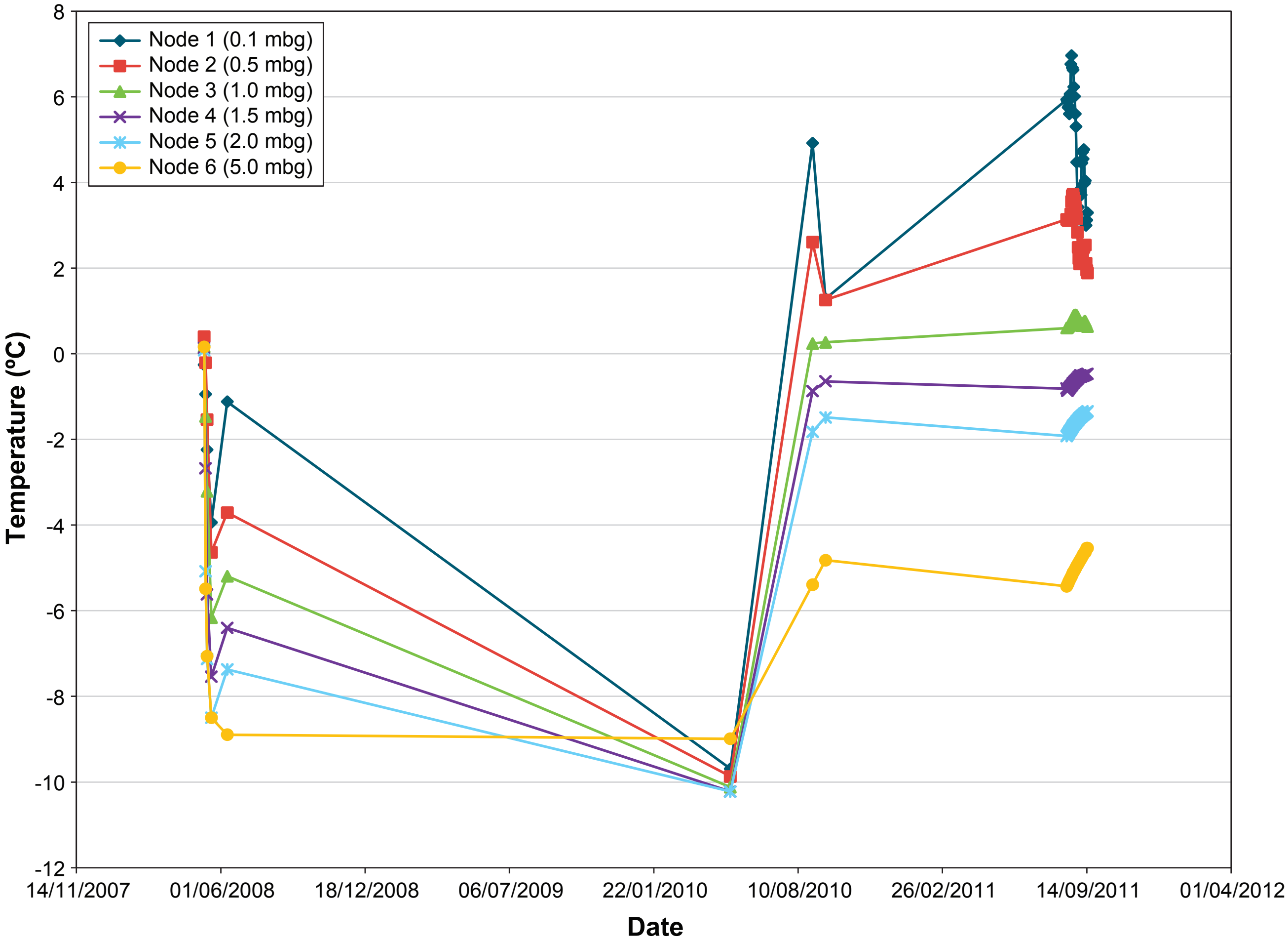


Sabina GOLD & SILVER CORP.

Logged Thermistor Timeseries for 08GSE009 String (Nodes 14 to 18)

Figure 4

Rescan Engineers & Scientists

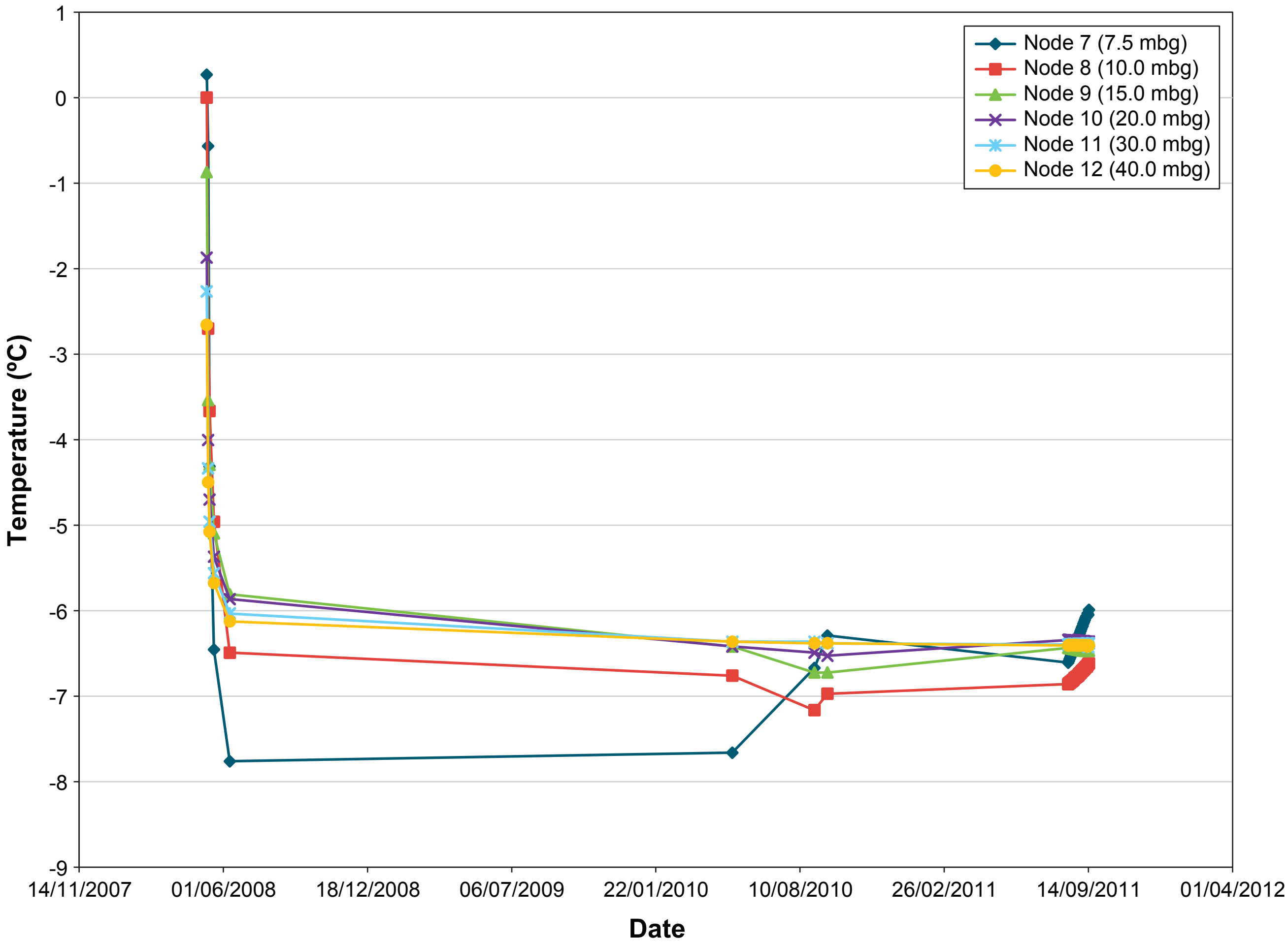


Sabina GOLD & SILVER CORP.

08GSE009 Thermistor String Data Records (Nodes 1 to 6)

Figure 5

Rescan Engineers & Scientists



Sabina GOLD & SILVER CORP.

08GSE009 Thermistor String Data Records (Nodes 7 to 12)

Figure 6

Rescan Engineers & Scientists

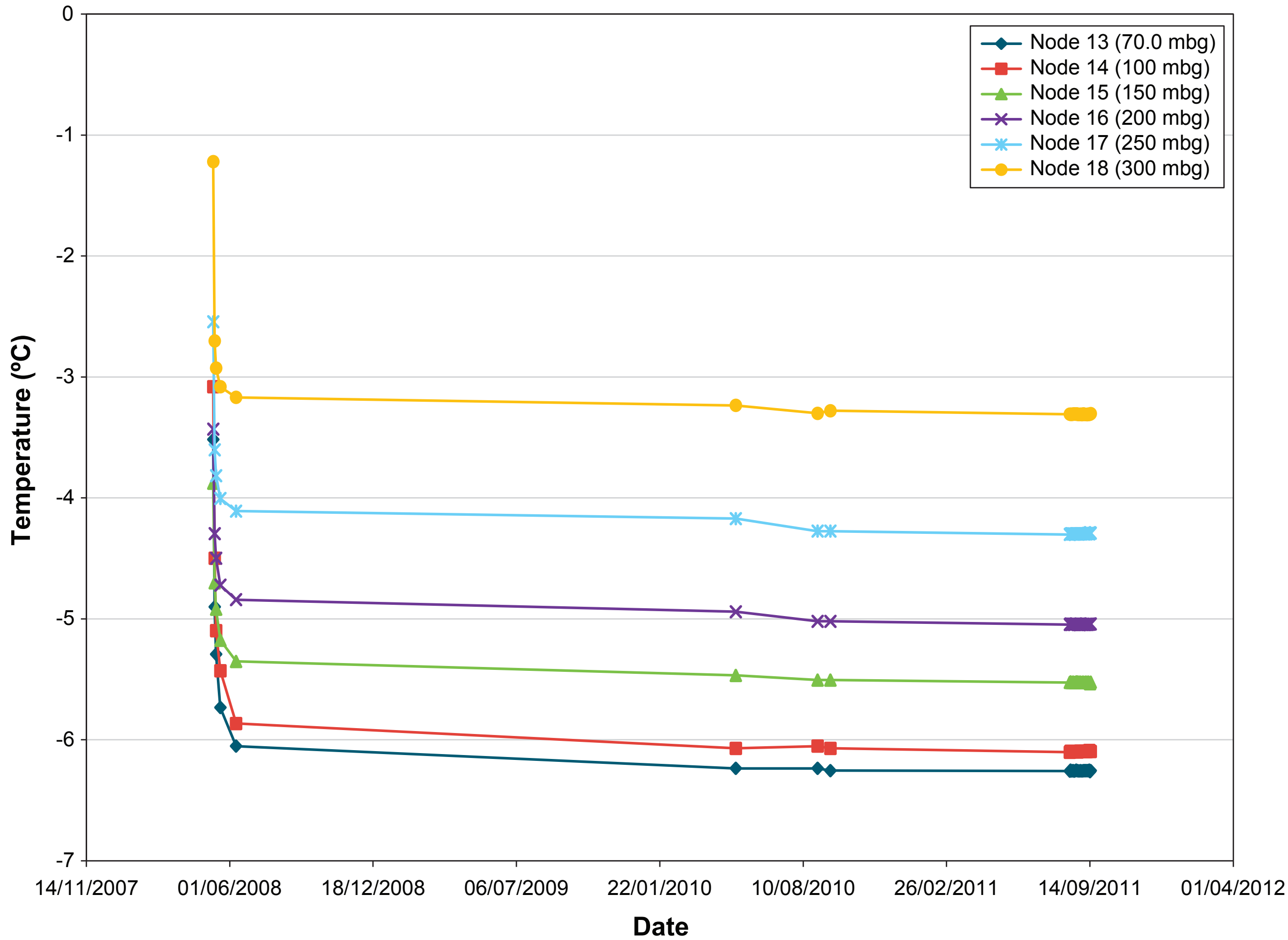


Figure 7

08GSE009 Thermistor String Data Records (Nodes 13 to 18)

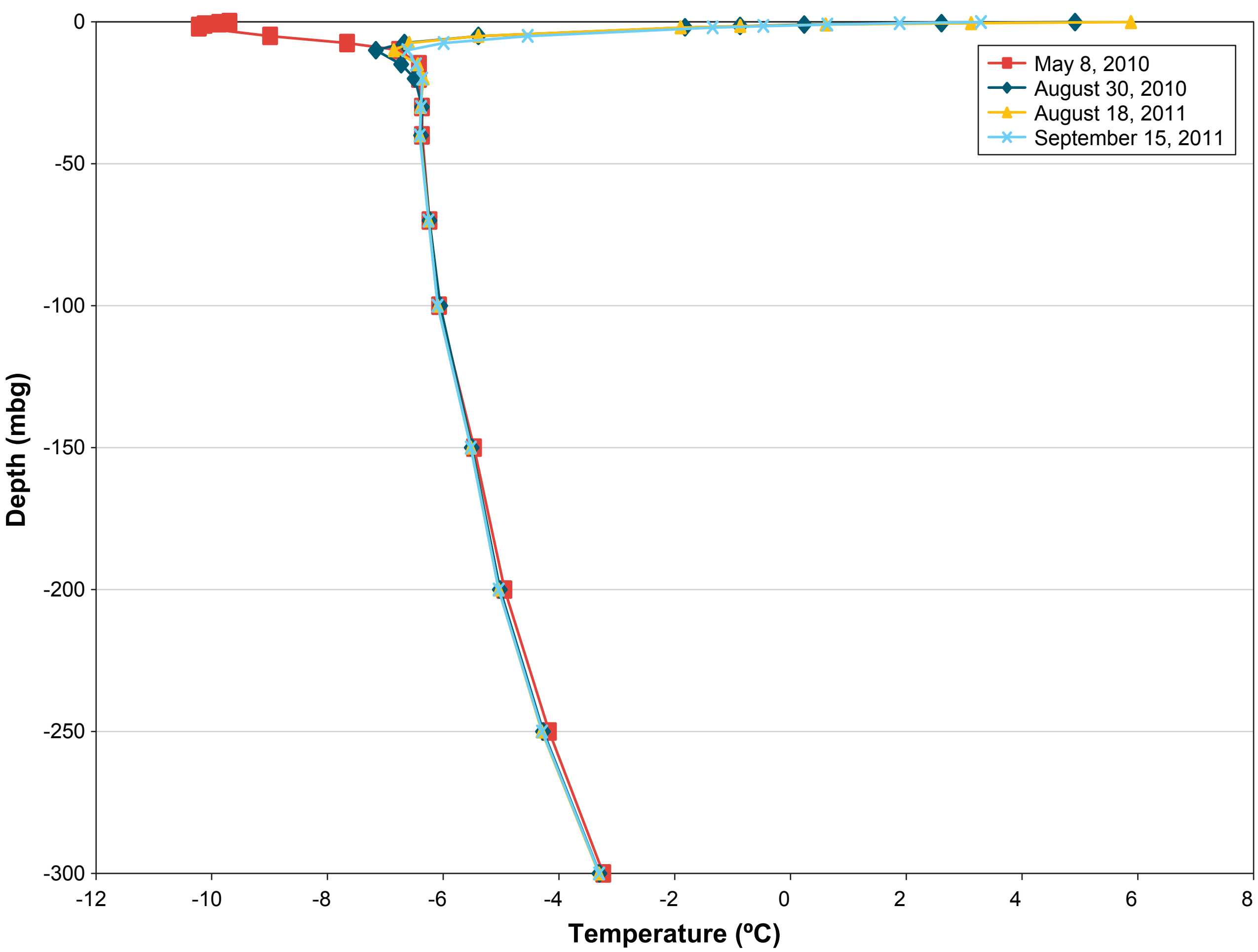


Figure 8

Temperature vs Depth
for Full Thermistor Profile

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

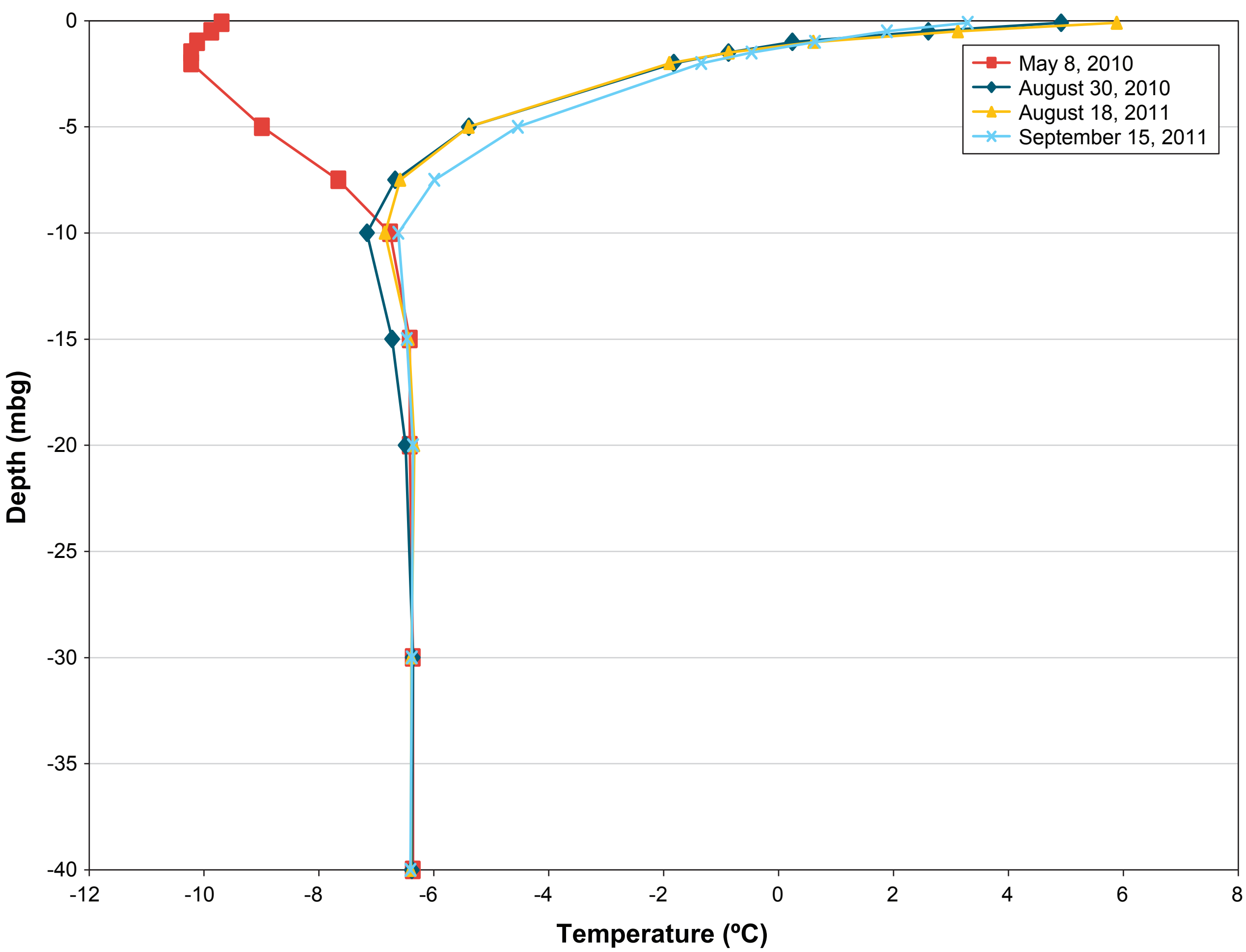


Figure 9

Temperature vs Depth for Upper 40 m of Thermistor Profile

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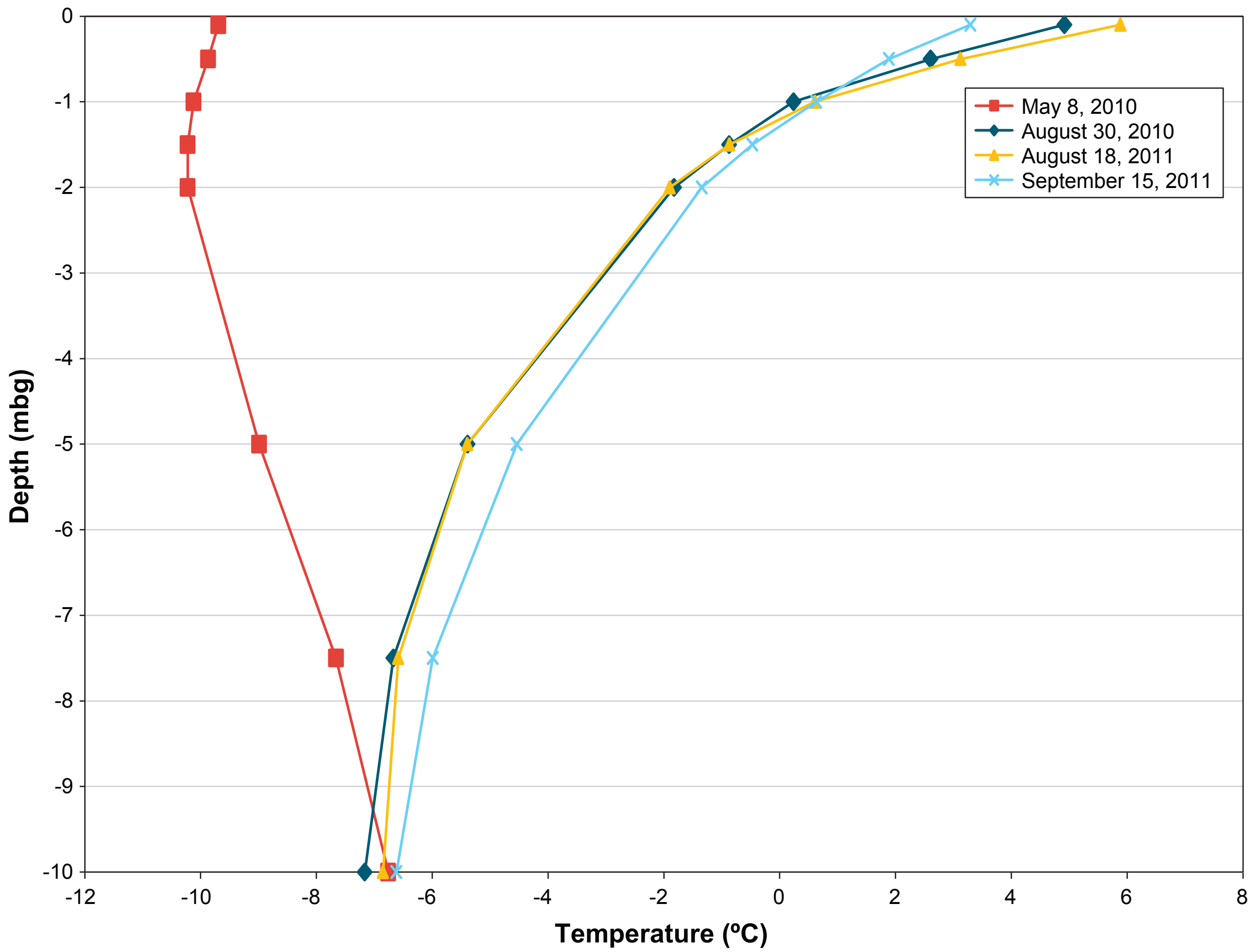

Sabina GOLD & SILVER CORP.

Figure 10

Temperature vs Depth for Upper 10 m of Thermistor Profile

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Logged data collected in 2011 (Figures 2, 3, and 4) recorded occasional anomalous data spikes. These are interpreted as instrument errors and disregarded with respect to subsurface temperature and permafrost characterisation. Diurnal variation is detected only at thermistor node 1 (0.1 mbg). Longer-term (wavelength of approximately two weeks) variability is detected as deep as node 3 (1.0 mbg). The warming trend logged at nodes 4 through 8 (1.5 to 10 mbg) is interpreted as seasonal variability, however a complete annual dataset would be required to confirm this interpretation. Temperatures varied less than 0.1 °C throughout the 30 days of logged data at all thermistors deeper than node 8.

Datasets integrating logger records and previous manual measurements were created (Figures 5, 6, and 7). Daily average values were used for logger records. Three years of stable temperature measurements at nodes 13 through 18 demonstrate freeze-back immediately following installation. These data were also used as justification to disregard 2009 manual measurements for temperature characterisation, as documented in the Rescan Memorandum dated October 27, 2010.

Temperature vs. depth profiles focussing on the full 300 m string (Figure 8), the top 40 m (Figure 9), and the top 10 m (Figure 10) were used to identify subsurface temperature trends and permafrost depths. Late summer ice depths recorded in 2010 and 2011 indicate an active layer (surficial zone which experiences a freeze-thaw cycle seasonally) at least 1.25 m deep. Logged data for the autumn months will lend to a more accurate assessment of active layer extents. The point of zero amplitude (depth at-which there is no seasonal temperature variation) is between 20 and 30 mbg. Temperature readings at node 10 (20 mbg) have fluctuated by 0.2 °C in 2010 and 2011 records. Temperature readings at node 11 (30 mbg) have varied by less than 0.1 °C.

Influence of the geothermal gradient on subsurface temperature becomes increasingly dominant at depths greater than 50 mbg, as indicated by a trend of increasing temperature with depth (Figure 8). An estimation of the geothermal gradient was conducted by fitting linear functions to the lower 200 m of the thermistor string (5 nodes) for measurements recorded May 8, 2010, September 17, 2010, August 18, 2011, and September 15, 2011 (R^2 values of 0.98 or greater for all four datasets). The predicted depth for zero degrees Celsius (maximum permafrost depth) is between 540 and 550 mbg. This represents a simplification of the thermal gradient and is not necessarily the base of frozen ground and groundwater (e.g. high salinity could depress the freezing point).

2.2 11SRK GL-10 Thermistor String

The 11SRK GL-10 thermistor string was installed in March 2011, with data logging commencing August 17, 2011. Data were downloaded September 15, 2011. Figures 11, 12, and 13 summarize available data.

A temperature vs. depth profile was used to identify subsurface temperature trends and depth to permafrost (Figure 11). Late summer ice depths recorded in 2011 indicate an active layer at least 1.25 m deep. Logged data for the autumn months will lend to a more accurate assessment of active layer extents. The point of zero amplitude appears to be approximately 15 mbg, as indicated by the static temperature recorded at this depth (variability less than 0.1 °C) to-date. Additional data documenting seasonal variability are required to accurately identify the point of zero amplitude.

2.3 Goose Trench Thermistor String

Data were not collected from the Goose Trench thermistor string in 2011. Previous results are included for reference (Table 2). Analyses involving the most recent data were reported in the Rescan memorandum dated October 27, 2010.

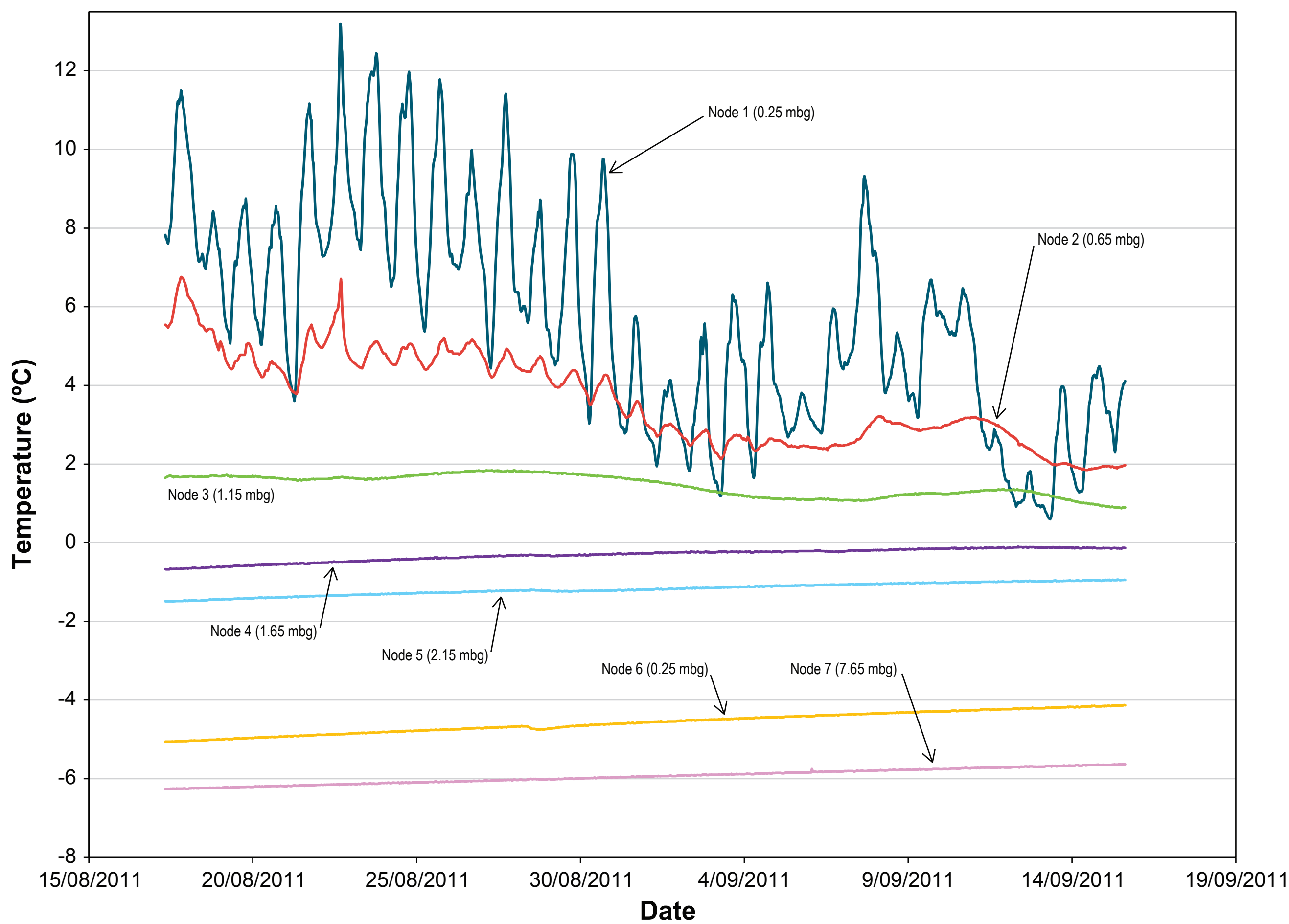

Figure 11

11SRK GL-10 Thermistor String Data Records (Nodes 1 to 7)

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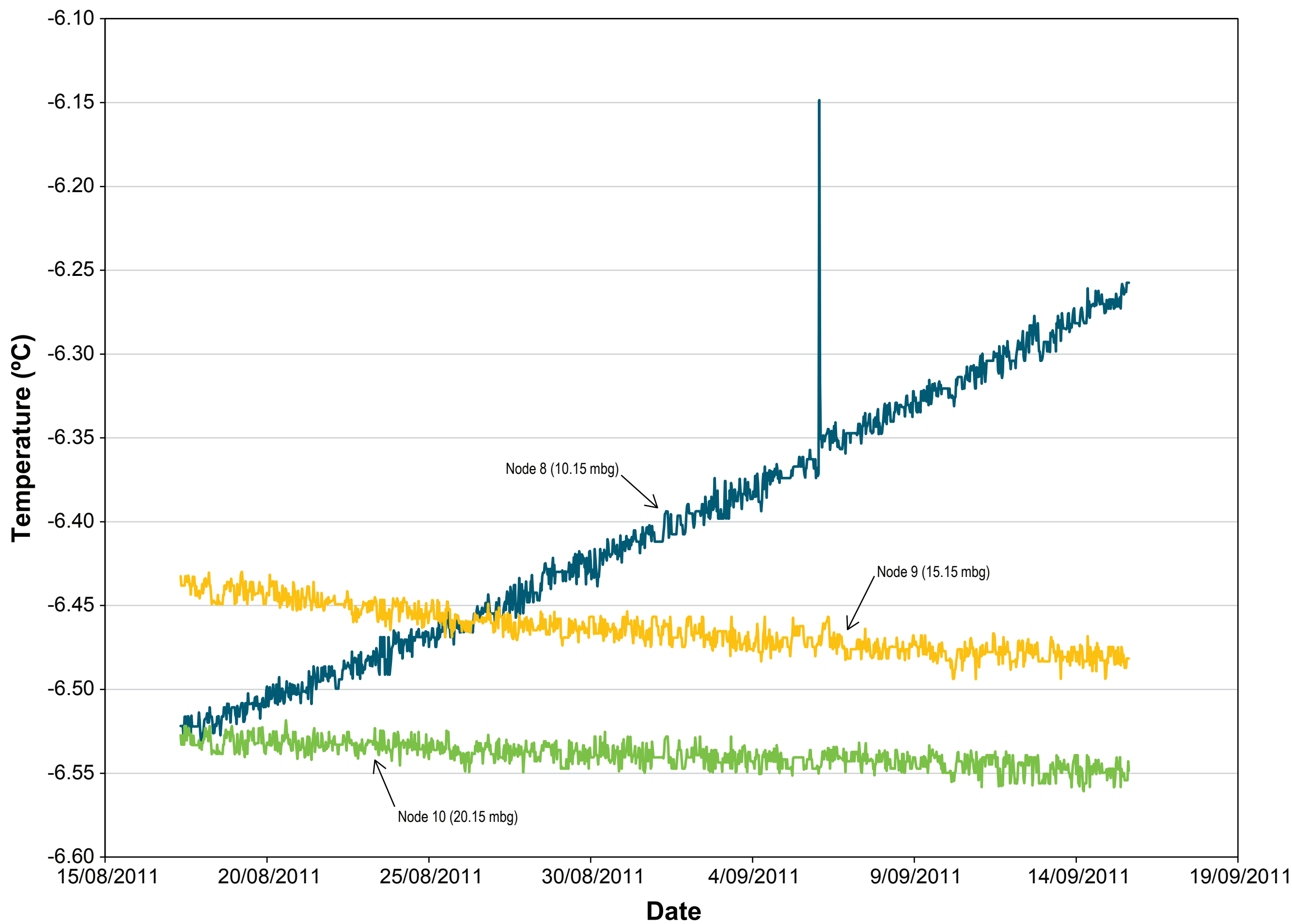
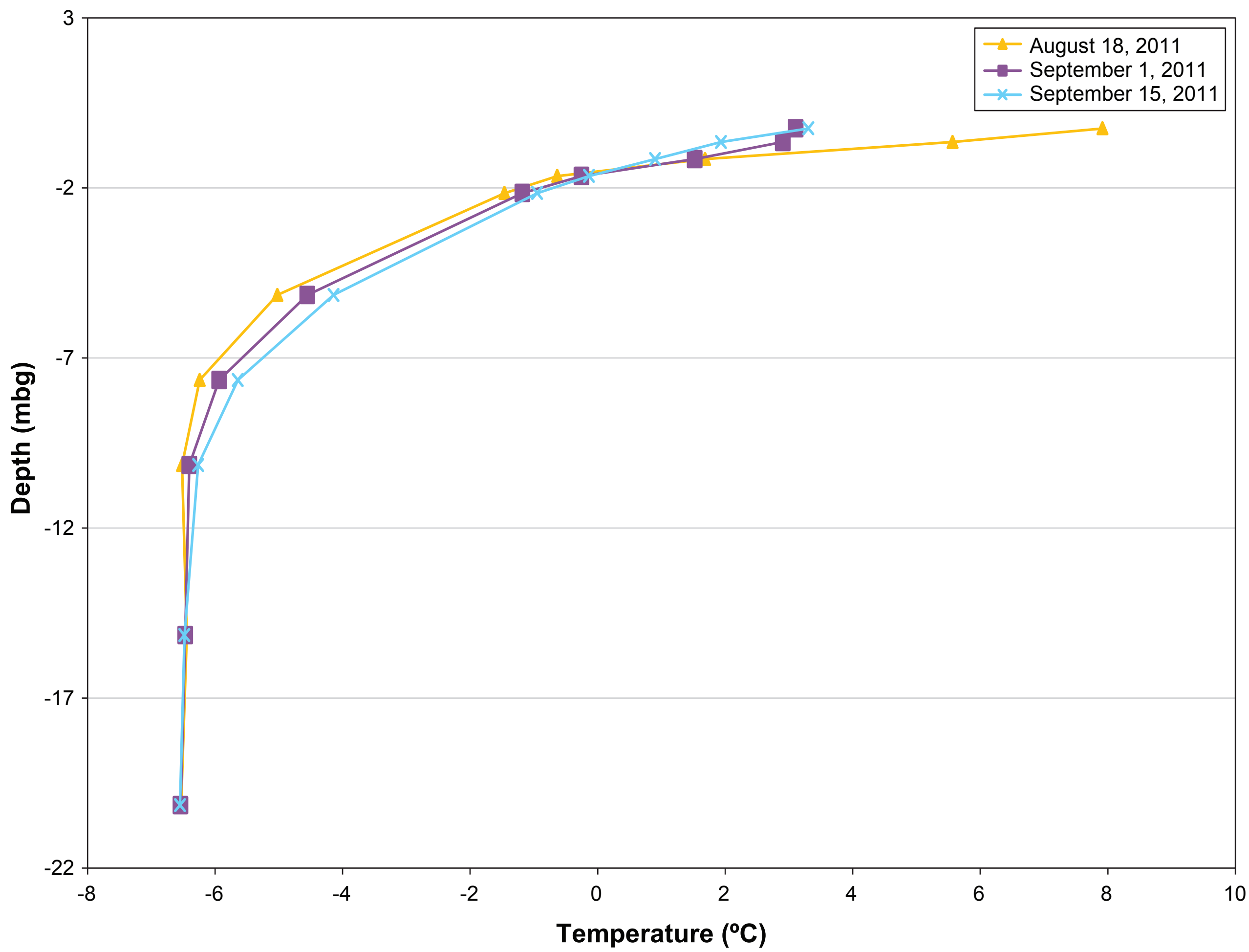


Sabina GOLD & SILVER CORP.

11SRK GL-10 Thermistor String Data Records (Nodes 8 to 10)

Figure 12

Rescan Engineers & Scientists



Sabina GOLD & SILVER CORP.

Temperature vs Depth for Full Thermistor string (11SRk GL-10)

Figure 13

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Table 2. Goose Trench Data

Thermistor Node	Node Length Along String (ft)	Node Depth Below Ground Surface (m)	September 20, 2007		August 8, 2009	
			Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)
1	-4	-1.2	8.18	-2.5	4.205	10.9
2	-8	-2.4	6.81	1.1	4.616	8.9
3	-12	-3.7	NA	NA	NA	NA
4	-16	-4.9	6.62	1.6	5.82	4.2
5	-20	-6.1	6.89	0.8	6.62	1.6
6	-24	-7.3	7.1	0.3	6.74	1.3

Thermistor Node	May 8, 2010		August 30, 2010		September 17, 2010	
	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)	Measured Resistance (k-Ohms)	Temperature (Degrees C)
1	5.85	4.1	2.775	19.7	5.95	3.8
2	10.76	-7.7	5.442	5.6	6.45	2.2
3	NA	NA	NA	NA	NA	NA
4	11.17	-8.4	7.47	-0.7	7.31	-0.3
5	11.07	-8.2	7.95	-1.9	7.75	-1.5
6	10.75	-7.7	8.29	-2.8	8.07	-2.2

Notes:
NA - Not Available/Not Applicable
ft - Feet
m - Metres
k-Ohms - Kilo Ohms
C - Celcius

3. Conclusions, Limitations and Recommendations

- Records for the 08GSE009 thermistor string follow the typical trend observed in a permafrost environment. Depth to ice is approximately 1.25 m in mid-September. This has been identified as a preliminary estimate of the active layer thickness at this location.
- Records for the 11SRK GL-10 thermistor string follow the typical trend observed in a permafrost environment. Depth to ice is approximately 1.65 m in mid-September. This has been identified as a preliminary estimate of the active layer thickness at this location.
- The 08GSE009 thermistor string does not extend deep enough to directly measure basal permafrost depth. Extrapolation of the data indicates that this point would be approximately 550 mbg.
- Data loggers installed at thermistor strings 08GSE009 and 11SRK GL-10 are collecting data at a frequency sufficient to characterise subsurface temperature and permafrost depth. Complete seasonal datasets will lend to accurate assessments when they become available. Occasional data spikes at the 08GSE009 thermistor string may become a hindrance if they increase in frequency.

Appendix V5-2C

2012-2013 Thermistor String Records Obtained at the Hackett River Project

an ERM company

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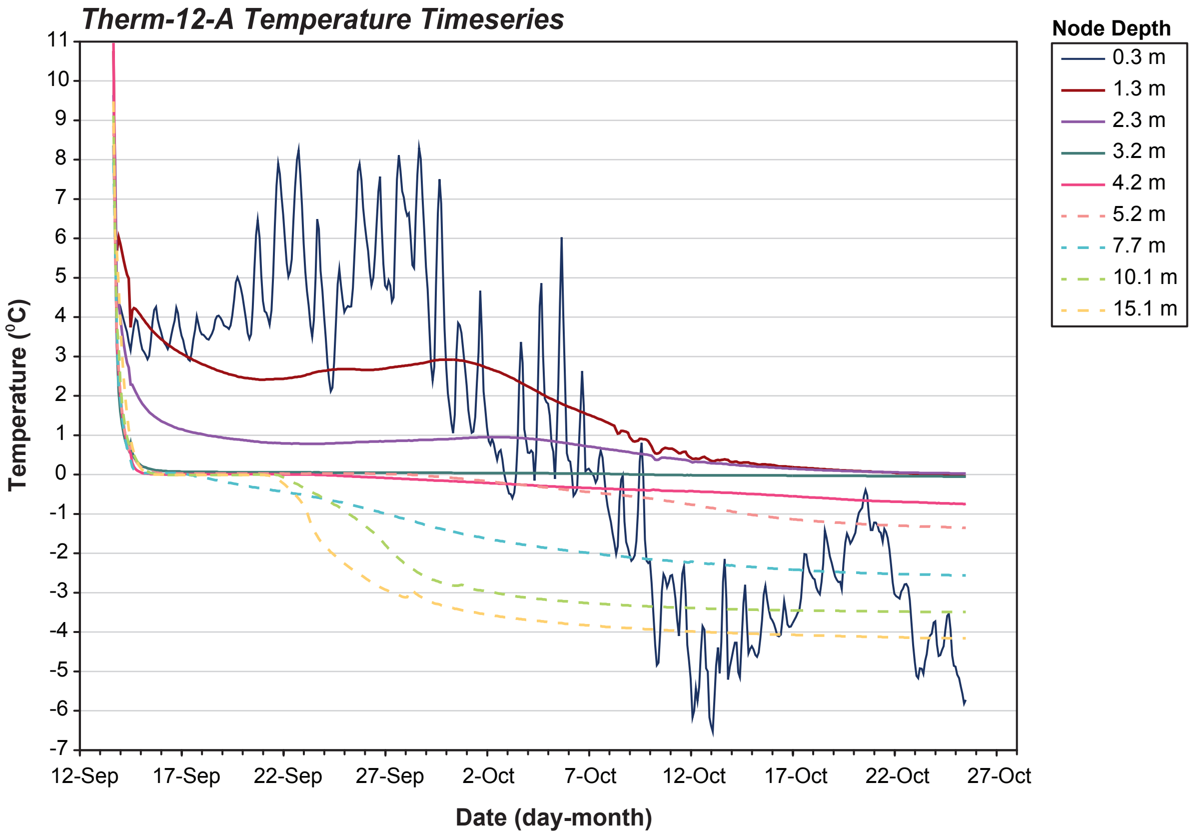
Figure V5-2C-1

Thermsitor String Locations at the Hackett River Exploration Site



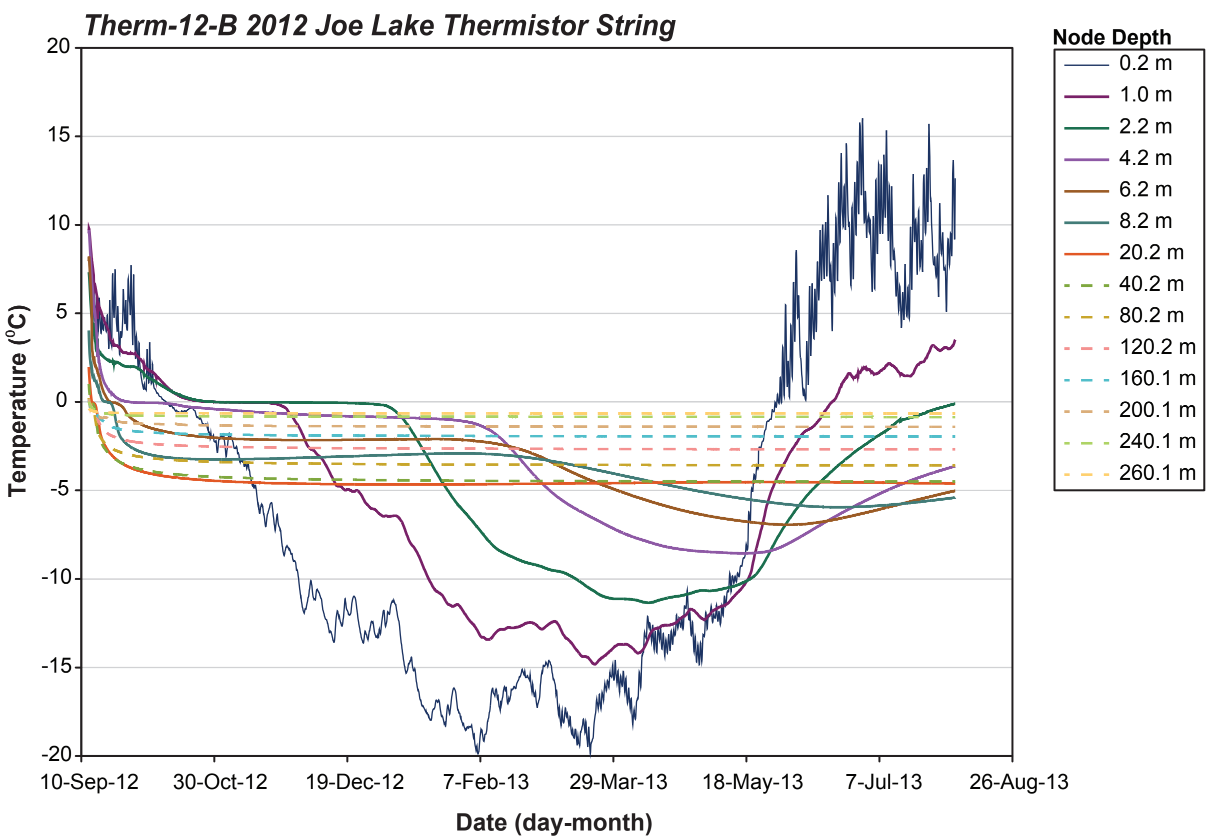


Figure V5-2C-2

Thermistor String Data Acquired at the Hackett River Exploration Project Site 2012-2013

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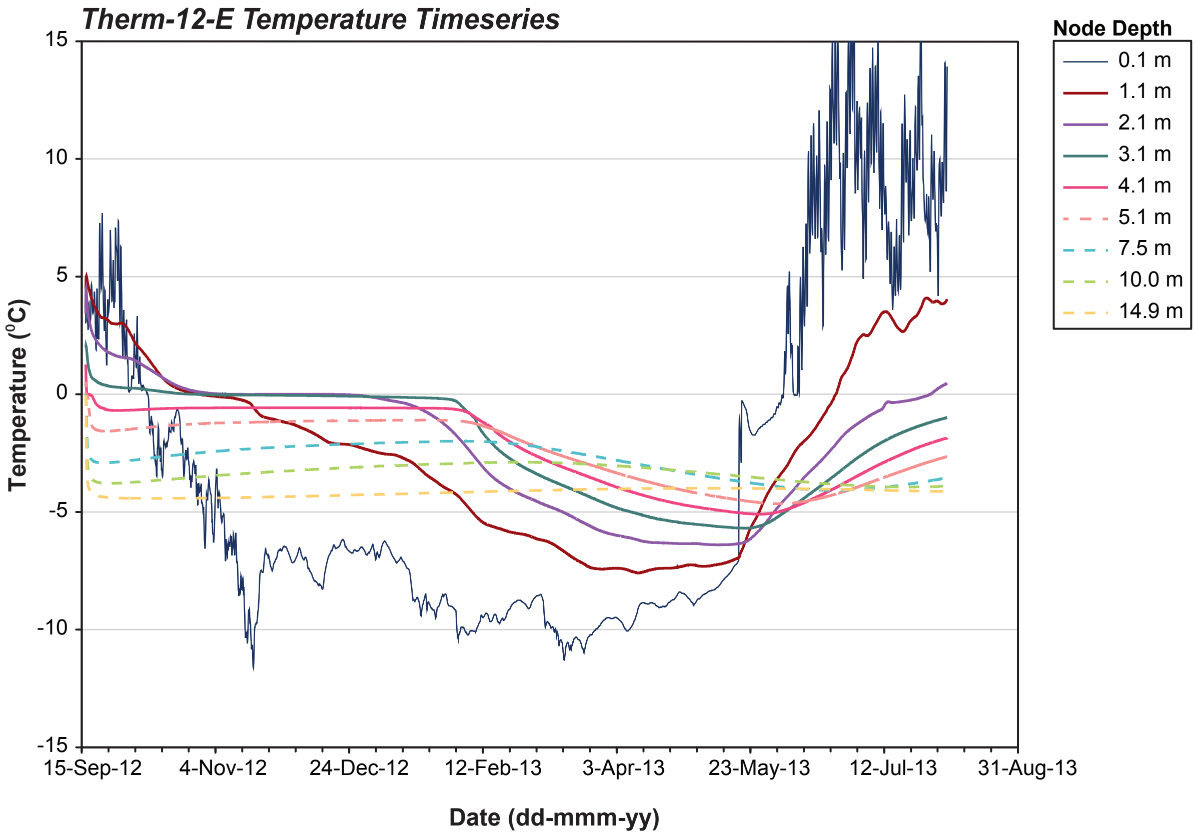

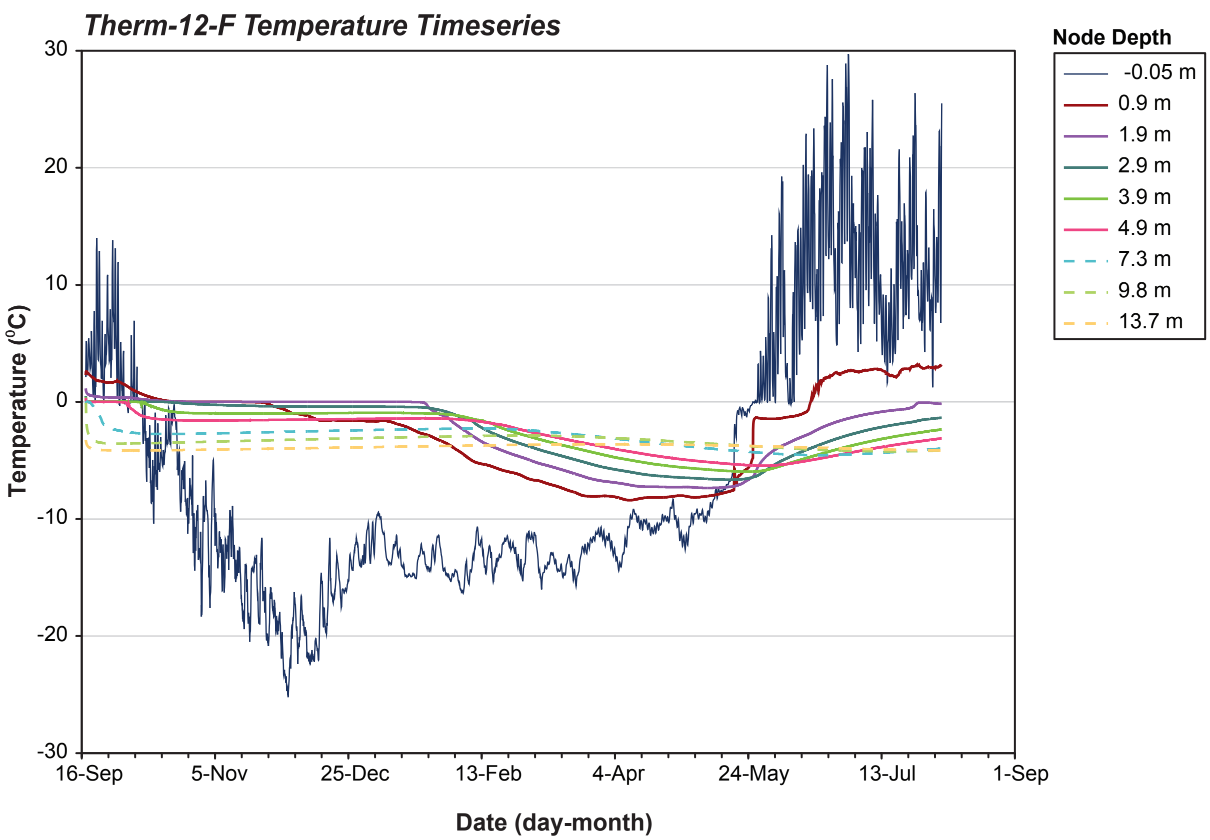

Figure V5-2C-3

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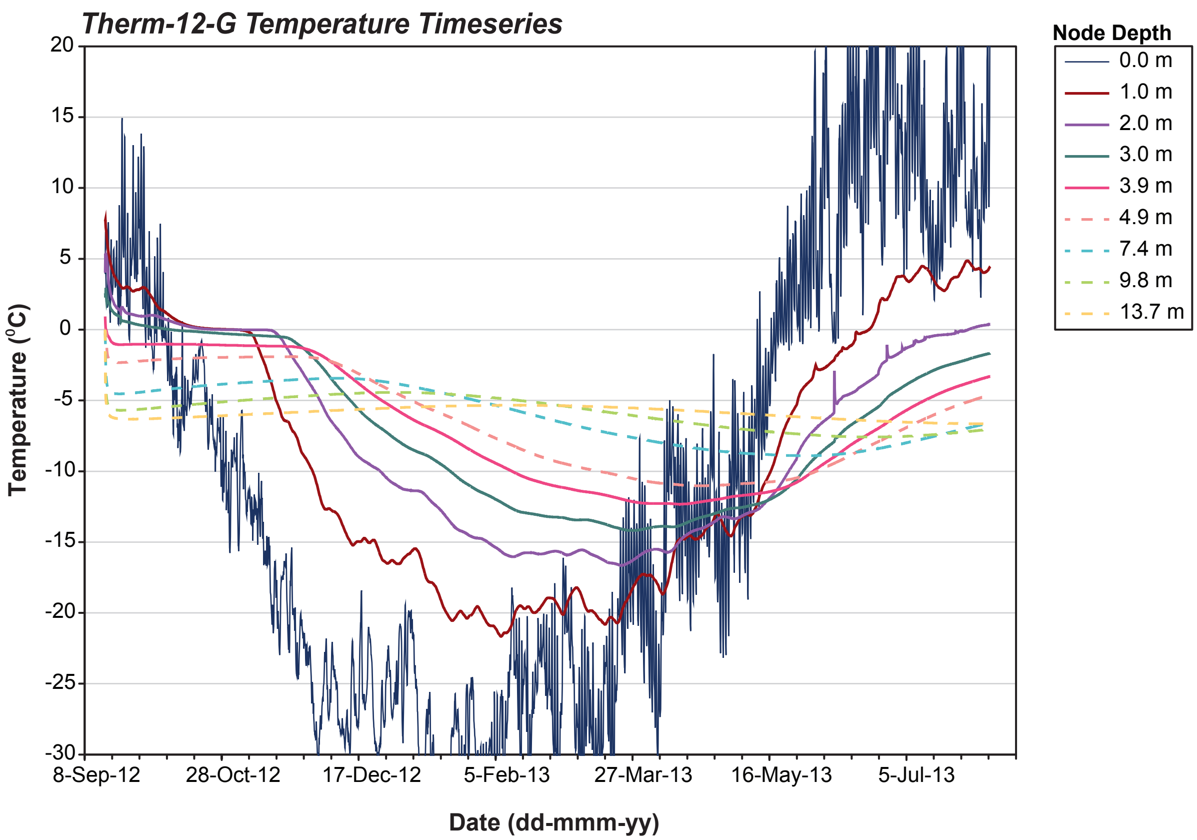
Thermistor String Data Acquired at the Hackett River Exploration Project Site 2012-2013

Rescan Engineers & Scientists



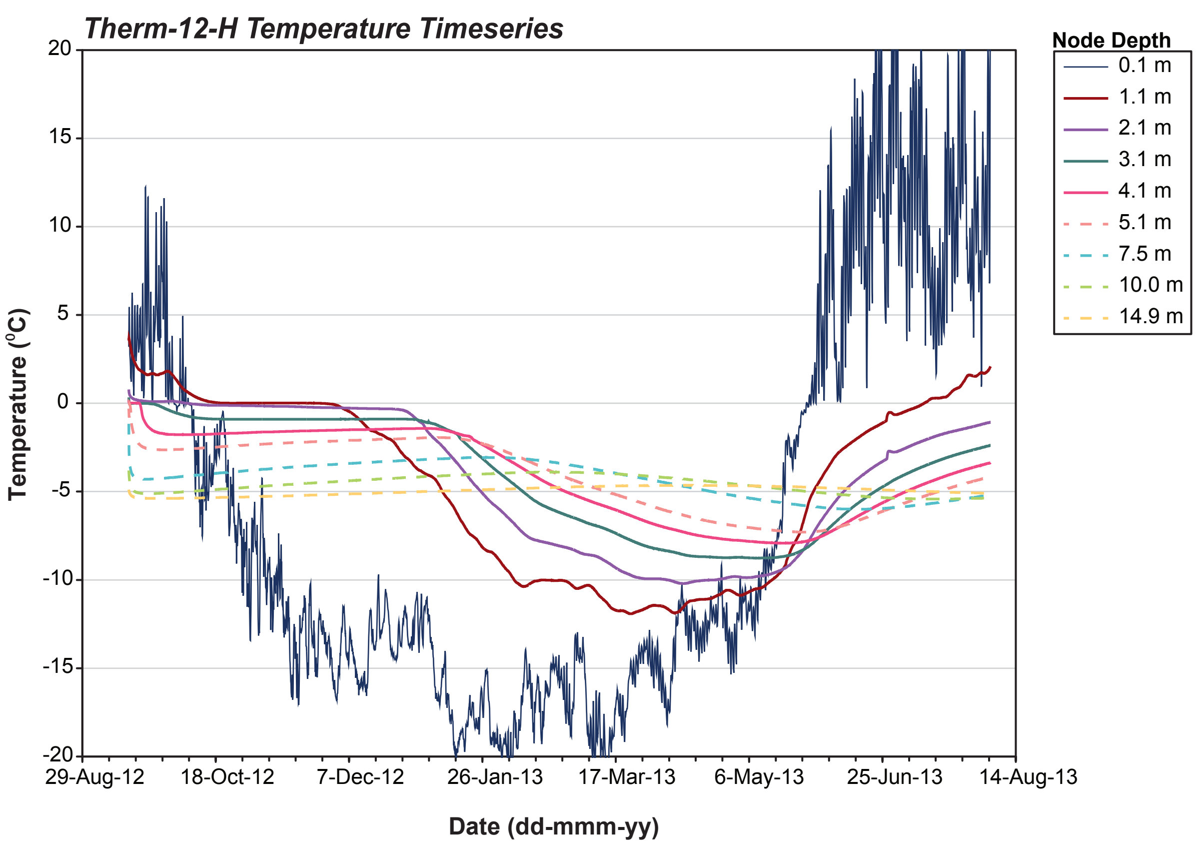
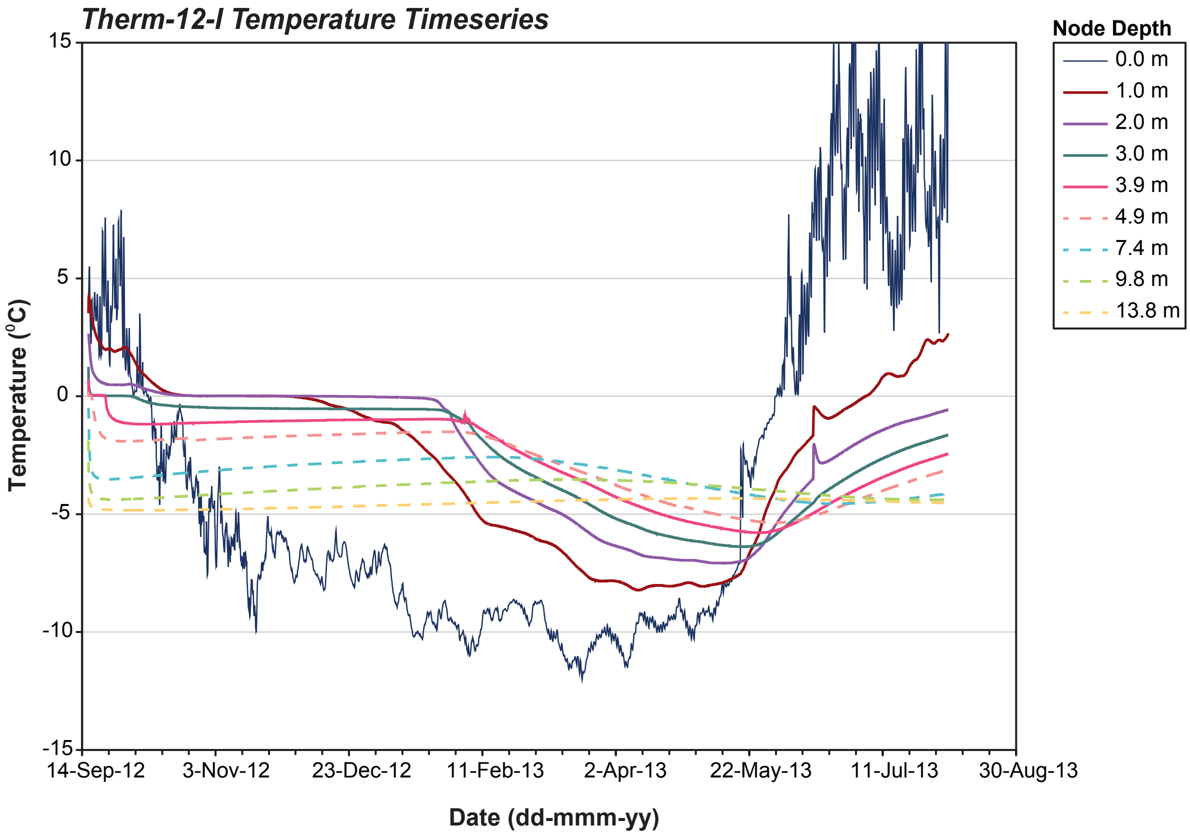


Figure V5-2C-4

Sabina GOLD & SILVER CORP.

Thermistor String Data Acquired at the Hackett River Exploration Project Site 2012-2013

Rescan Engineers & Scientists



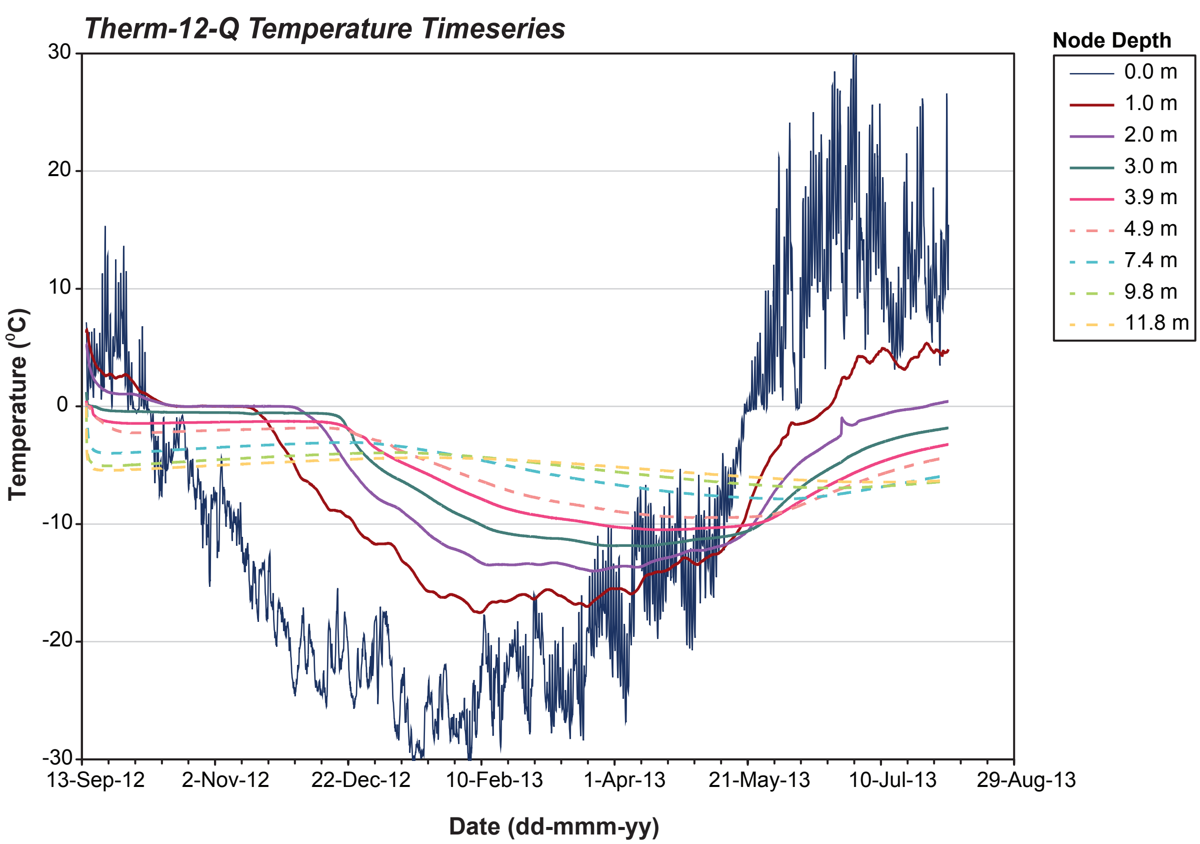


Figure V5-2C-5

Thermistor String Data Acquired at the Hackett River Exploration Project Site 2012-2013

Sabina GOLD & SILVER CORP.

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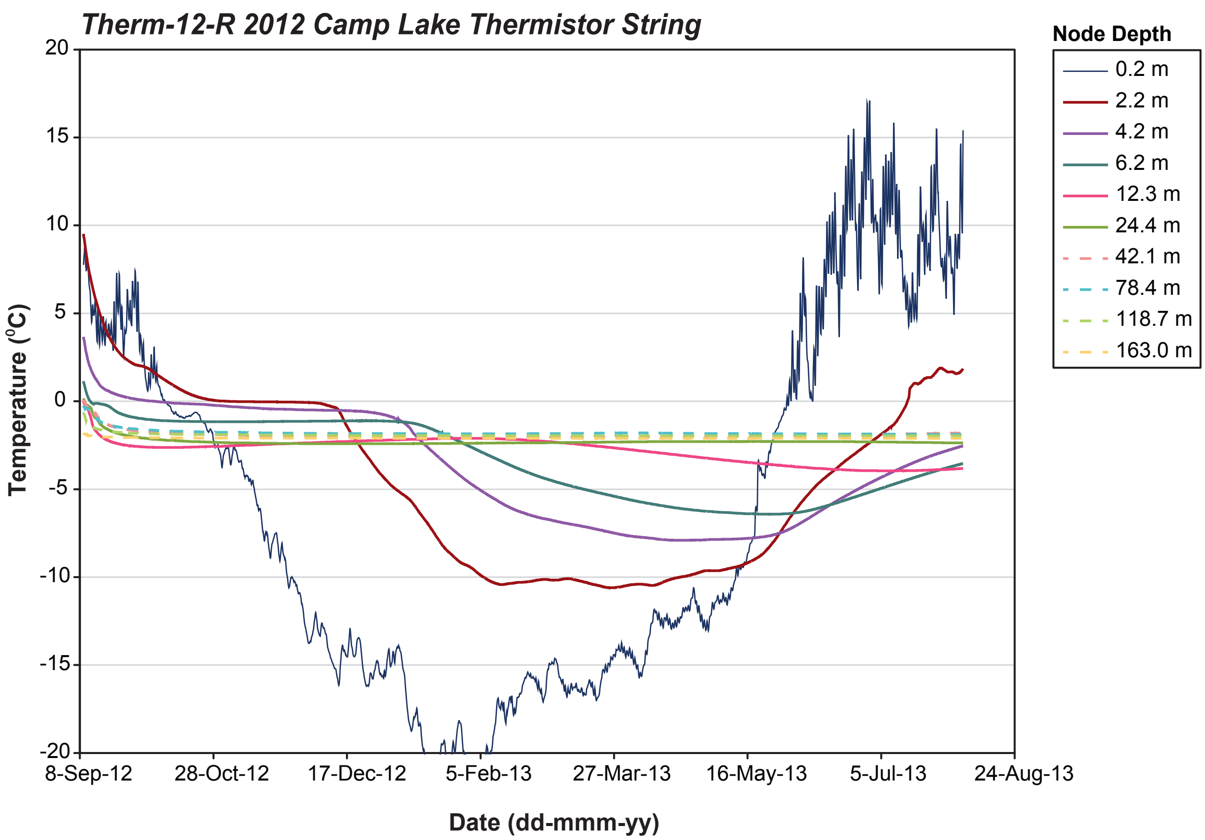

Figure V5-2C-6

Thermistor String Data Acquired at the Hackett River Exploration Project Site 2012-2013

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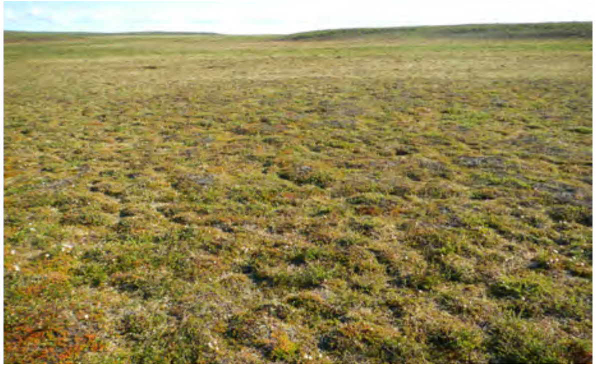
Appendix V5-3A

Back River Project: 2012 Terrain and Soils Baseline Report

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
2012 Terrain and Soils Baseline Report



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May 2013

BACK RIVER PROJECT
2012 TERRAIN AND SOILS BASELINE REPORT

May 2013
Project #0833-002-20

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

Rescan™
Engineers and Scientists

Executive Summary

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012.

For 2012, Sabina contracted Rescan Environmental Services (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. The 2012 baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, and the Marine Laydown Area. It was assumed that access from the Marine Laydown Area to George and Goose properties would be by winter road. This report presents the results from the Terrain and Soils portion of the 2012 baseline program.

A review of climatic data, regional maps, scientific papers, and reports describing environmental conditions in the region provided information necessary for the description of regional environmental conditions in the LSA. The temperature range in the LSA is typical of Arctic Canada (monthly means range between -26° and 15°C). Precipitation in the LSA is relatively low (ranges from 249.3 to 299.2 mm per year), with the majority occurring during the summer months. Permafrost reaching to a depth of several hundred meters occurs continuously throughout the LSA. Because permafrost restricts the downward flow of water, soils within the seepage areas are often waterlogged throughout the growing season. Annual freezing and thawing of these soils creates several phenomena, including patterned ground, solifluction, and thermokarst.

The bedrock is mostly composed of Precambrian igneous rocks, such as granite or gneiss. Less common, sedimentary rocks include coarse conglomerates and finer sandstones. A vast majority of the LSA is covered by a veneer of glacial till deposited over the bedrock by the last glacial ice sheet. Glacial till has been occasionally overlain by fine glaciolacustrine or coarse glaciomarine materials. Near Bathurst Inlet, coarse marine veneers deposited over till or bedrock form gentle slopes or undulating planes. A number of distinct landform types, including eskers, moraines, and boulder fields exist throughout the region.

Terrain maps including elevation data and stream networks were prepared at a 1:20,000 scale. The objective of mapping was to describe the terrain conditions at the LSA (138,712 ha) and to support planning of Project infrastructure. Terrain mapping was completed using PurVIEW and ArcMap software. The final terrain attributes were adjusted according to the data collected during field inspections conducted in the LSA in the summer of 2012.

The topography of the LSA is generally characterized by low relief. The land is dominated by gently undulating or rolling terrain and by plains. Slopes rarely exceed 7%. Smoothness of the landforms reflects the influence of local hydrological patterns associated with the impermeable permafrost layer. Kettle lakes connected by a complex network of streams cover 5.4% of the LSA. Lakes range in size from 0.51 ha to 628 ha, but most of them are small.

In general, the rates of soil development in the LSA are very slow. The soils that developed in non-stratified, compacted morainal surficial materials (till) occupy over half of the LSA. The typical soils include well to imperfectly drained Regosolic Static Cryosols, Brunisolic Eutric Turbic Cryosols and Regosolic Turbic Cryosols. Soil textures typically include sandy loams and loams. While soil erosion potential in this group is generally moderate to high, undisturbed soils rarely display evidence of significant erosion. Two distinct soil units have been differentiated according to parent material thickness: Morainal Blankets and Morainal Veneers.

Morainal Blankets are typically associated with lower elevations and lower slope positions and have slightly higher moisture regime indices and lower proportion of coarse fragments compared to Morainal Veneers. Both groups have similar textures, but significant proportion of soils that developed on Morainal Veneers are not suitable for salvage, mainly due to considerable surface stoniness or high coarse fragment content.

Rapidly to well-drained soils that developed on coarse glaciofluvial and eolian deposits cover 7.5% of the LSA. Typical soils for this unit include Regosolic Static Cryosol, Orthic Eutric Static Cryosol, and Orthic Regosol. These soils have weakly developed humic horizons and their nutrient regime is very poor to poor. Due to coarse texture, and often high proportion of coarse fragments, majority of soils in this unit are not suitable for salvage. Typical soil erosion potential is low to moderate.

Rapidly to moderately well-drained soils that developed in marine and glaciomarine materials (5.6% of the LSA) are geographically associated with Bathurst Inlet area. Soil textures typically include sands and sandy loams with low coarse fragment content. Erosion potential in this unit is generally low. The salvage suitability of most marine materials is poor due to coarse texture. The organic layer is typically very thin or absent. The typical soils include Regosolic Static Cryosols and Orthic Regosols.

Organic deposits cover 5.3% of the LSA and are distributed more or less evenly throughout the LSA, with the exception of southern part of the Goose Property, where they are less common. The organic layer is typically fibric or mesic and shallow (less than 1 m). Permafrost is typically found close to the surface and evidence of cryoturbation and thermokarst have been commonly recorded in this group. The typical soils include very poorly drained Terric Fibric Organic Cryosols, Terric Mesic Organic Cryosols, and poorly drained Regosolic Static Cryosols or Regosolic Turbic Cryosols. While most of soils in this unit are characterized by good salvage suitability, some may provide poor or unsuitable salvage material, mainly due to shallow bedrock or high stoniness. When undisturbed, this soil group does not display evidence of significant erosion; however, mineral soils underlying organic material contain a considerable proportion of fine sand and silt, and thus, may display moderate to high erosion potential if stockpiled.

Terrain polygons dominated by bedrock, weathered bedrock and colluvium comprise 4.9% of the LSA and commonly occupy crest to middle slope positions in higher elevations. Soil development is limited to non-occurring. The soils of this unit are mostly classified as Static Cryosols. If present, most soils are shallow and coarse with considerable coarse fragment content. Their erosion potential varies considerably. Nutrient regime is typically very poor and moisture regime is very xeric to mesic. Soils in this unit are generally not suitable for salvage due to their shallow nature, stoniness, and high coarse fragment content. Soils that developed on lacustrine or fluvial materials are poorly represented in the LSA.

Soil chemical analysis suggests that mineral soils are predominantly acidic (pH ranged from 4.5 to 6.8). At soil pH below 6 solubility of metal hydroxide minerals increases and more dissolved metals become potentially bio-available. While the pH of soil surficial horizons in the LSA is slightly below the optimal range (pH 6-8), no association between the spatial patterns of soil reaction and metal concentration have been observed. Soil pH tended to increase with soil depth but otherwise was similar throughout the LSA.

Soil metal concentrations in the Goose Property and Bathurst Inlet areas did not exceed CCME guidelines (CCME 2012), however, arsenic levels found in some samples collected within the George Property area and in some of the reference locations outside of the LSA exceeded the recommended CCME guideline industrial limit. In general, the George Property area had highest concentrations of all 19 metals sampled at 0-5 cm soil depth.

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BACK RIVER PROJECT
2012 TERRAIN AND SOILS BASELINE REPORT

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Glossary and Abbreviations

Engineers and Scientists

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

GLOSSARY

Ah	A soil horizon enriched with organic matter
Anion	An atom or molecule with a negative charge.
Blanket	A layer of unconsolidated material greater than 1 m thick deposited on the surface of the underlying material. While it conforms to the underlying topography, it masks minor irregularities in its surface.
Calcareous	Refers to soils that contain calcium carbonate, often with magnesium carbonate.
Canadian Council of Ministers of the Environment (CCME)	CCME is comprised of the environment ministers from the federal, provincial and territorial governments. These 14 ministers normally meet at least once a year to discuss national environmental priorities and determine work to be carried out under the auspices of CCME. The Council seeks to achieve positive environmental results, focusing on issues that are national in scope and that require collective attention by a number of governments.
Cation	An atom or molecule with a positive charge (contains more protons than electrons).
Coarse fragments	Mineral rock fragments found in the soil: gravel (2 - 64 mm), cobbles (65-250 mm) and boulders (> 250 mm).
Cryoturbation	Refers to the mixing of materials from various horizons of the soil due to freezing and thawing. (Also known as frost churning).
Drumlin	An elongated whale-shaped hill formed by glacial ice acting on underlying unconsolidated till or ground moraine
Edaphic	Features relating to soil, especially as it affects living organisms. Edaphic characteristics include factors such as moisture, acidity, aeration, and the availability of nutrients.
Eluviation	The transportation of soil particles and minerals in a lateral or downward direction from the upper horizons of soil.
Esker	A long winding ridge of stratified sand and gravel – formed by glacial melt water?
Fibric	A well-preserved organic material (or horizon) identifiable as to botanical origin, of which at least 40% remains fibrous after rubbing. Fibric material usually is classified on the von Post scale of decomposition as class 1 to class 4.
Fluvial	Refers to sediments deposited by streams or flowing water; it does not refer to deposition by waves or mass wasting processes such as mudflows.
Frost boils	Frost boils (also known as mud circles) are circular upwellings of soil created by frost heaving in arctic and alpine regions. They are typically 1 to 3 metres in diameter and are characterized by a bare soil surface with an elevated center.

Glaciofluvial	Deposits and landforms created by glacial rivers and streams.
Glaciolacustrine	Parent materials deposited in lakes associated with glacial melting. Most lacustrine parent materials in Canada were deposited in lakes that existed during the glacial periods and are called glaciolacustrine sediments. These sediments are typically well-sorted sands, silts, and clays. Well-sorted means that one particle size (e.g. clay) is dominant in the texture.
Gleyed soil / horizon	A soil having one or more neutral gray horizons as a result of water logging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent water logging.
Gleysol	Refers to soils formed under chronic reducing conditions inherent in poorly drained mineral soils and wet conditions, with a high water table and long periods of water saturation.
Gneiss	Coarse-grained metamorphic rock (i.e., rock altered by heat, pressure, and movement) comprised of quartz, feldspar, and mica.
Granite	Granite is a common and widely distributed type of igneous rock characterized by a medium to coarse grained texture. Granitic rock has been intruded into the continental crust during all geologic periods, although much of it underlies the sedimentary rocks since Precambrian age. Granitoid is a general, descriptive field term for light-coloured, coarse-grained igneous rocks.
Humic (organic material)	An organic material (or horizon) characterized by at an advanced stage of decomposition. It is very stable physically and chemically unless it is drained. The material's botanical origin is not identifiable and less than 10% of fibre remains after rubbing. Humic material usually is classified on the von Post scale of decomposition as class 7 or higher.
Humus	A mixture of organic debris in the soil; it is formed from plant and animal litter accumulated at the soil surface and roots. Dead organic material in the soil that undergoes continuous breakdown and change.
Hydric (moisture regime)	Water is removed from soil so slowly that water table is at or above soil surface all year. Typically results in development of organic or gleyed mineral soils.
Hydro-seeding	Hydro-seeding is a planting process which utilizes a slurry of seeds, mulch, fertilizer and tackifying agents. As an alternative to the traditional process of dry seed broadcasting, hydro-seeding promotes quick germination and inhibits soil erosion.
Hygric (moisture regime)	Water (usually from precipitation and seepage) removed slowly enough to keep soil wet for most of growing season. Permanent seepage and mottling are common.
Illuviation	Deposition of particles from one soil horizon to another, usually from an upper to a lower horizon, resulting in accumulations of clays, metals, and organic matter.
Lacustrine	Related to lakes; in soils, refers to deposits associated with lake level fluctuations, e.g., benches or terraces that mark former shorelines or lakebed materials exposed by an uplifting of the land.
Loam	Soil composed of a well-balanced mixture of sand, silt, and clay.

Mesic (moisture regime) Soil may remain moist for a significant, but sometimes short period of the year, as the available soil moisture reflects typical climatic inputs. Water (usually from precipitation) is removed somewhat slowly in relation to supply.

Mesic (organic material) An organic material (or horizon) partly altered physically and biochemically. It does not meet the requirements of either a fibric or a humic material, has a rubbed fibre content ranging from 10% to less than 40%. Mesic material usually is classified on the von Post scale of decomposition as class 5 or 6.

Moder An organic layer that develops on the soil surface and, as a result of activity of soil fauna (e.g., worms), becomes partially mixed with the top mineral horizons of the soil.

Mor An organic layer that develops on the soil surface and remains unmixed with the mineral horizons of the soil.

Moraine An accumulation of unconsolidated mineral debris (soil and rock), carried and deposited by glaciers.

Mottle Features that occur in grey coloured, gley soils when they are exposed to air resulting in the oxidation of Fe leaving reddish, yellow or orange patches in the soil profile.

Mud Mud is a liquid or semi-liquid mixture of water and some combination of soil, silt, and clay. Ancient mud deposits harden over geological time to form sedimentary rock such as shale or mudstone

Mudstone Mudstone is a fine grained (grain diameter is < 0.0625 mm) sedimentary rock whose original constituents were clays or muds.

Munsell colour system A system of specifying the degrees of hue, value, and chroma, the three variables of colour; commonly used for soils.

Nivation A collective name for several soil processes such as solifluction, mass wasting, erosion, weathering, and melt water flow beneath the snow patch.

Organic Cryosol Organic soil that has permafrost within 1 m of the surface.

Organic Deposit Surficial deposit composed largely of organic matter resulting from the accumulation of dead plant material. Organic deposits contain at least 30% organic matter by weight (17% or more organic carbon).

Orthic soil A category used by the Canadian System of Soil Classification to describe the central, most typical, concept of soils in a given soil subgroup.

Parent Material The natural material (mineral or organic) from which soil is formed.

Peat Peat is an accumulation of partially decayed organic matter formed under conditions of excess moisture from precipitation or slowly moving groundwater. Peat deposits form in wetlands dominated by Sphagnum and Carex species and are distributed primarily in the temperate zone of the northern hemisphere.

Permafrost Soil that stays at or below the freezing point of water (0 °C) continuously for two or more years. Overlying permafrost is a thin active layer of soil (typically 0.6 to 4 m thick) that seasonally thaws during the summer.

pH The pH is a measure of the hydrogen ion (H+) content of the soil. Term commonly used to describe soil reaction.

Quartz	Quartz is the second most abundant mineral in the Earth's continental crust, after feldspar. It is made up of a continuous framework of SiO4 silicon–oxygen crystals.
Reclamation	A process of converting disturbed land into useful landscapes that meet a variety of goals (typically, creating productive ecosystems). It includes material placement and stabilization, capping with soil/overburden, regrading, placing cover soils, and revegetation.
Regosol	Soils that have insufficient horizon development to meet the requirements of the other soil orders.
Rhizosphere	The layer of soil that is immediately adjacent to and affected by plant roots, where plants, soil, microorganisms, nutrients, and water interact.
Rolling landscape	Landscape composed of elongated rises and hollows with gentle slopes (5 to 25%) that extend in parallel forms in plain view.
Seepage	The movement of a liquid (e.g., water) through a porous medium (e.g., soil) beneath the ground surface. It typically occurs on slopes or if a water table there is perched above a non-permeable layer.
Shale	Shale is a fine-grained, clastic sedimentary rock that originated from mud. It is a mix of clay and tiny fragments of other minerals, especially quartz and calcite. Unlike Mudstone, Shale is characterized by parallel fissures less than one centimeter in thickness, which result in flaky appearance of the mineral
Silicate	An insoluble compound of silicon, oxygen, and a metal.
Soil horizon	is a layer of mineral or organic soil material approximately parallel to the land surface that has characteristics altered by processes of soil formation. It differs from adjacent horizons in properties such as color, structure, texture, and consistence and in chemical, biological, or mineralogical composition.
Soil reaction	An indicator of soil acidity or alkalinity measured on the pH scale; it affects the availability of nutrients and the reactivity of various substances in the soil.
Soil reactivity	The consistency and behaviour of a soil as affected by its water content. The Atterberg limits tests provide useful measures of soil engineering properties, which differ depending on soil physical state (solid, semi-solid, plastic or liquid).
Soil salvage	Conservation of valuable soil by stripping it off the surface when the site is first disturbed (e.g., before excavation of overburden). Salvaged soils are either stockpiled for future use or they are immediately used for covering reclaimed surfaces in a different location.
Solifluction	A type of mass wasting where waterlogged sediment moves slowly downslope, over impermeable material.
Static Cryosol	Mineral soils that have permafrost within 1 m of the surface but show little or no evidence of cryoturbation, such as disrupted, mixed or broken horizons, or displaced material.
Surface expression	Topography of a surficial material, which indicates the patterns of material deposition or reflect the surface configuration of the underlying material (e.g., when the surface material is draped over and owes its landform to the topography of an underlying substrate).

Texture (of mineral soil)	The solid material of mineral soil is composed of different size fractions of particles: gravel (> 2 mm in diameter), sand (2 mm to 53×10^{-6} m), silt (53 to 2×10^{-6} m), and clay (< 2×10^{-6} m). The soil texture is the particular mix of particle sizes found in any soil. In Canadian soils texture is almost entirely determined by the geomorphic processes responsible for depositing the original sediment.
Thermokarst	Land-surface configuration that results from the melting of ground ice in a region underlain by permafrost. In areas that have appreciable amounts of ice, small pits, valleys, and hummocks are formed when the ice melts and the ground settles unevenly.
Till (glacial till)	Till or glacial till is an unsorted, coarsely graded, and extremely heterogeneous sediment deposited directly by the glacier. It is mostly derived from the subglacial erosion of previous unconsolidated sediments. Its content may vary from clays to mixtures of clay, sand, gravel and boulders. An accumulation of till is called moraine.
Turbic Cryosol	Mineral soils that have permafrost within 2 m of the surface and show marked evidence of cryoturbation within the active layer, as indicated by disrupted, mixed or broken horizons, or displaced material.
Veneer	A layer of unconsolidated material 0.1 to 1 m thick deposited on the surface of the underlying material. It conforms closely to the underlying topography and is too thin to mask irregularities in its surface.
Xeric (moisture regime)	Soil is moist only during brief periods following precipitation. Due to coarse soil texture water is removed from the soil very rapidly in relation to supply.

ACRONYMS AND ABBREVIATIONS

AAFC	Agriculture and Agri-Food Canada
BC MOF	British Columbia Ministry of Forests
BC MELP	British Columbia Ministry of Environment, Lands, and Parks
C	Carbon
CCELC	Canada Committee on Ecological Land Classification
CCME	Canadian Council of Ministers of the Environment
LSA	Local study area
masl	Metres above sea level
QA	Quality assurance
QC	Quality control
UTM	Universal Transverse Mercator
WWF	World Wildlife Fund

1. Introduction

1. Introduction

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012 (Figure 1-1).

For 2012, Sabina contracted Rescan Environmental Services (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. The following components were included in the 2012 baseline program:

- Meteorology
- Air Quality and Dust
- Noise
- Hydrology and Bathymetry
- Freshwater Water Quality, Sediment Quality, Aquatic Biology
- Freshwater Fish and Fish Habitat
- Marine Water Quality, Sediment Quality, Aquatic Biology
- Marine Fish and Fish Habitat
- Wildlife (Terrestrial and Marine)
- Wildlife DNA Study (Grizzly Bear and Wolverine)
- Ecosystem Mapping
- Vegetation and Wetlands (including Rare Plants)
- Terrain and Soils
- Country Foods
- Archaeology
- Socio-Economics
- Land Use
- Metal Leaching/Acid Rock Drainage (ML/ARD)

The 2012 baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, and the Marine Laydown Area. It was assumed that access from the Marine Laydown Area to George and Goose properties would be by winter road, and that access between the George and Goose properties would also be by winter road.

This report presents the results from the Terrain and Soils portion of the 2012 baseline program. The purpose of the program was to characterize terrain and soils in the general area of the Project. The specific objectives of the program were to:

- gather relevant background environmental information from literature;

- map terrain and soils within the LSA;
- describe soil and terrain baseline conditions;
- characterize baseline soil metals; and
- assess the physical and chemical properties of the soils.

PROJECT # 0833-002-21 GIS # BAC-20-007 March 19 2013

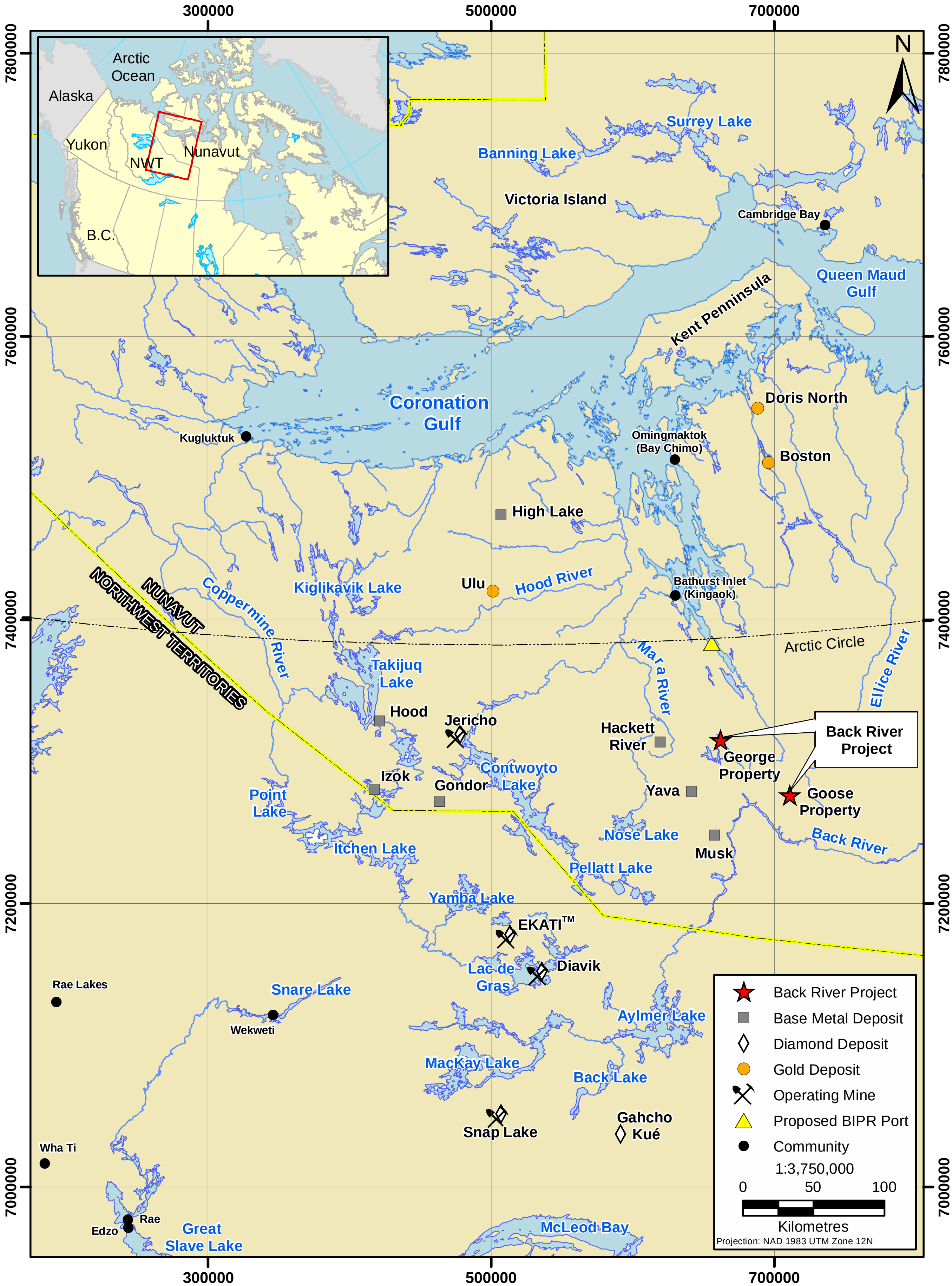

Figure 1-1

Sabina

Back River Project Location

Rescan Engineers & Scientists

2. Background Information

2. Background Information

This section is based on the review of climatic data, regional maps, scientific papers, and reports describing environmental conditions in the region.

2.1 CLIMATIC DATA

Observations indicated that air temperatures are very similar at George and Goose meteorological stations for the period 2006 to 2012 (Rescan 2012b). The temperature range in the LSA is typical of Arctic Canada. During the winter period (October to March) the mean monthly temperatures ranges between -26° and -16°C, while during the summer (June to September) it ranges between 7°C and 15°C. Precipitation in the LSA is relatively low (ranges from 249.3 to 299.2 mm per year), with the majority occurring during the summer months (Rescan 2012b).

2.2 GEOLOGY

The study area is located at the juncture of the Slave and Bear geological provinces. The bedrock is mostly composed of Precambrian igneous rocks, such as granite or gneiss. Less common, sedimentary rocks include coarse conglomerates and finer sandstones (SENES 2008).

Periodic changes in the global climate of the Quaternary period (about 2 million to 8.5 thousand years ago) induced four major glaciations. As a result, a vast majority of the LSA is now covered by a veneer of glacial till, an unsorted mixture of coarse angular to sub-angular rock fragments in a finer matrix of silty-clayey material, which has been deposited by the last glacial ice sheet. Drumlins, hills created by the movement of ice over till material, are also a common feature of the LSA. Glacial till has been occasionally overlain by glaciolacustrine or glaciomarine materials. Sandy or gravelly materials formed by melt-water streams remain in the area in form of elongated esker complexes deposited over glacial till or bedrock. Veneers or blankets of coarse marine deposits form gentle slopes or undulating planes over till or bedrock. The recession of the ice sheets was followed by isostatic uplift of the land that continues until present, at a rate of about 0.5 m per century (Prest 1970).

2.3 TOPOGRAPHY

The vast majority of the LSA is located in the Takijuq Lake Upland Ecoregion of the Southern Arctic Ecozone. The topography of the ecoregion is generally characterized by relatively low relief. The land is dominated by level or gently sloping plains and by rolling terrain, defined as a sequence of smooth, elongated rises and valleys that repeat in a wave-like pattern across the landscape. Slopes rarely exceed 7% and terrain elevation ranges between 300 and 700 masl (NRCan 2012). This smoothness of landforms reflects the effect of four glaciations and the influence of local hydrological patterns associated with the impermeable permafrost layer.

Uplands, which dominate the LSA, are typically covered by veneers of morainal materials deposited on Precambrian, sedimentary, metamorphic or intrusive rocks (Atlas of Canada 2012). Consequently, much of the upland surface is composed of sparsely vegetated, rocky outcrops, reminiscent of glacial scour along the Bathurst fault (Zoltai *et al.*, 1980).

Numerous small and medium size kettle lakes formed from large blocks of melting ice left by the last retreating ice sheet (about 8500 years ago) exist throughout the LSA. Lakes are usually connected by a complex network of streams. Wetlands occupy a relatively small portion of the area, covering only 5 to 10% of the Takijuq Lake Upland Ecoregion (NRCan 2012).

The northern extreme of the proposed winter road extends to the Bathurst Hills Ecoregion, where strong relief contrasts with the rest of the LSA. The deeply indented, rocky shoreline of Bathurst Inlet is surrounded by rugged ridges of massive granite rocks that reach about 610 masl (Ecological Framework of Canada 2012).

Several esker complexes, formed from sandy or gravelly materials deposited by sub-glacier melt-water streams over glacial till or bedrock, exist throughout the LSA. Drumlins, hills created by the movement of ice over till material, are also a common feature.

2.4 UNIQUE LANDFORMS

A number of unique landforms, including eskers, moraines, and boulder fields exist throughout the LSA. Several large eskers occur as elongated, sinuous ridges up to 100 m wide and several kilometres long. They were formed from sands, gravels, and cobbles deposited in the glacial melt water channels flowing below or within glaciers. Because of the general pervasiveness of boulder fields and shallow morainal material over bedrock, burrowing material is limited in the area; thus, eskers provide excellent denning. They also provide travel corridors and viewscapes for wildlife such as caribou, wolves, and grizzly bear. Furthermore, eskers have their own microclimate associated with drier, well-drained ground, which reduces insect abundance, providing further benefit to wildlife (Rescan 2007, SENES 2008).

Moraines are rocky ridges composed of unconsolidated, unsorted mineral debris deposited at the glacier edge. A large, over 200 km long glacial moraine extends in the eastern direction from the LSA (NRCan 2012).

In the Arctic, boulder fields are often derived from weathered bedrock, from which finer fractions have been removed by various periglacial processes (Sonesson 1985). Intense frost heaving also causes fracturing of bedrock and subsequent migration of large rock fragments to the surface. These phenomena created several boulder fields and belts in the LSA.

2.5 PERMAFROST AND RELATED FEATURES

Permafrost occurs continuously throughout the Southern Arctic Ecozone. It extends to depths of 90 m at Yellowknife, it reaches more than 270 m near Lac de Gras, and near Contwoyto Lake it is estimated to occur to a depth of about 540 m (Rescan 2012, 2013a, SENES 2008). Because permafrost restricts the downward flow of water, precipitation and melt water move horizontally, either as a surficial runoff or as shallow underground seepage within the active layer of the soil. Consequently, the soils within the seepage areas are often waterlogged throughout the growing season. Annual freezing and thawing of these soils creates several phenomena, including patterned ground, solifluction (slow downslope movement of waterlogged soil), and thermokarst.

Repeated freezing and thawing of the soil creates singular features on the ground surface. Frostboils (also known as mud boils or mud circles) are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heave and cryoturbation in permafrost areas. Common characteristics include an elevated center, a formation of an organic layer on the outer edge, and resistance of the soil surface to vegetation colonization. Extensive areas of patterned ground covered by frostboils are commonly found in the LSA.

Thermokarst typically occurs on the surface of wetlands as areas of irregular dry hummocks and wet hollows, which form in result of frost heaving and ice accumulation on the bottom of organic horizons. When they eventually thaw and collapse they form depressions, which further contribute to surface unevenness.

Massive ground ice of up to 10 m depth is a relic feature formed in late glacial or early postglacial times when sections of the retreating glaciers were rapidly buried, insulating them against melt. It has been reported in hummocky morainal deposits and eskers in the Contwoyto Lake and Lac de Gras areas (Wolfe 1998; Dredge et al. 1999), and is likely present in parts of the Takijuq Lake Upland where late glacial conditions allowed rapid cover of residual forms of glacial ice and frozen melt water, especially along the west side of Bathurst Inlet (Ecological Framework of Canada 2012).

2.6 SOIL DEVELOPMENT

Soil development is influenced by the interaction of factors associated with local climate, characteristics of surficial deposits (parent material), topography (especially how it affects hydrology), biotic influences, and time since disturbance. In general, the rates of soil development in the LSA are very slow, typically in the order of a few millimetres per century (SENES 2008). Only peat-derived organic materials accumulate considerably faster.

The LSA is underlined by continuous permafrost with sporadic occurrences of massive ground ice. Under harsh climatic conditions, soil development generally occurs only close to the ground surface. The frequent freeze-thaw cycles associated with cold environments also contribute to a suite of soil-forming processes. For example, in moist areas, annual frost heaving often causes soil movement (cryoturbation), which brings fresh mineral material to the surface creating “frostboils” and “patterned ground” phenomena. The presence of shallow permafrost and cryoturbation affect both the pedogenic process and soil classification. Therefore, most soils in the LSA have been classified as Cryosols, which are usually poorly developed (AAFC 1998).

Soil parent materials include till (mostly of silty loam texture with coarse fragments), glaciofluvial sandy deposits, and glaciolacustrine clays. The chemical characteristics of till usually reflect the chemistry of the rocks from which it originated. Veneers or blankets of morainal till may give rise to Static or Turbic Cryosols, depending on drainage regimes. Glaciofluvial deposits, due to their coarse texture, are rapidly drained and nutrient poor. Esker complexes present in the area typically give rise to Brunisolic Static Cryosols or Regosols. Glaciolacustrine sediments, however, are usually rich in clay minerals that contain more nutrients. These deposits may become parent materials for Brunisolic or Gleysolic Turbic Cryosols, depending on drainage (CCELC 1989).

In poorly drained areas, vegetation is often dominated by peatlands (CCELC 1989). Organic or Histic Cryosols develop as a result of the accumulation of organic matter in these ecosystems. The rate of water movement through these areas affects their acidity and fertility. More acidic and less fertile soils usually develop in areas dominated by *Sphagnum* moss associated with raised bogs. On long slopes and in lowlands dominated by fens and sage meadows, water movement gives rise to richer and less acidic soils.

3. Methodology

Engineers and Scientists

3. Methodology

3.1 STUDY AREA

The terrain and soil LSA is located in the West Kitikmeot region of Nunavut, approximately 40 to 120 km south of Bathurst Inlet. The LSA covers 147,263 ha and extends between Bathurst Inlet and the Goose and George Properties (Figure 3.1-1). The LSA boundaries were defined by several parameters, including a 1.0 km buffer around proposed Project infrastructure, the potential location of access roads, regional geomorphology, and the location of several archaeologically important sites. The same LSA was also used for the Ecosystem Mapping and Vegetation and Wetlands components of the program. The purpose of the LSA boundary is to establish an area where there exists the reasonable potential for direct or indirect impacts due to project activities, and allows for an environmental impact assessment to be conducted in a rigorous and comprehensive manner.

To enable reporting and discussion of geographic differences in ecosystem distributions, the LSA has been divided into the following four sub-areas (Figure 3.1-1):

- Goose Property Area
- George Property Area
- Marine Laydown Area
- Proposed Winter Road (to Bathurst Inlet)

3.2 REVIEW OF EXISTING INFORMATION

The initial stages of the Terrain and Soils Baseline Program involved a thorough review of climatic and geological data, regional maps, scientific papers, and professional reports describing environmental conditions in the region. This information guided field program methodology design and allowed for the interpretation of field data in a broader regional context.

3.3 TERRAIN MAPPING

Terrain mapping was completed using PurVIEW and ArcMap software, which enables users to view stereo pairs of digital air photos in three dimensions at variable scales. Terrain polygons were delineated based upon observable characteristics such as surficial material, surface expression, and geomorphological processes. Attributes were described using BC's Terrain System Classification (Howes and Kenk 1997) in the absence of a system for Nunavut and recorded in a database linked to the ArcGIS terrain shape file. The terrain maps were prepared at a 1:20,000 scale. The final terrain attributes were later adjusted according to the data collected during field inspections of terrain polygons.

3.4 TERRAIN AND SOILS FIELD PROGRAM

The Terrain and Soils Baseline Field Program was carried out between June 27 and August 9, 2012 by four teams consisting of a soil scientist, a vegetation ecologist, and an assistant. The survey involved the assessment of terrain and soils at 323 inspection sites (Figure 3.4-1).

The terrain was described based on British Columbia's Terrain System Classification (Howes and Kenk 1997) as no terrain classification system has been developed for the Nunavut. Soil inspection followed hand excavation of a soil pit to a depth of 100 cm, where possible. The soil and site characteristics were described in detail according to the methodology specified in the *Field Manual for Describing*

Terrestrial Ecosystems (BC MELP and BC MOF 1998) as there is no similar system developed for Nunavut. The following information was recorded at each site:

- location (UTM coordinates);
- slope (gradient, aspect, and position);
- elevation;
- micro-topography;
- surficial materials;
- surface expression; and
- geomorphologic processes.

Detailed soils information was recorded including:

- horizon designation, depth, and colour (according to Munsell colour chart);
- mottling characteristics;
- coarse fragment shape and content;
- humus order;
- soil texture;
- soil structure and consistence;
- root depth, size, and abundance;
- depth to permafrost;
- depth to water table;
- soil drainage;
- soil moisture and nutrient regime; and
- soil classification.

The soils were classified according to *The Canadian System of Soil Classification* (AAFC 1998). The detailed terrain and soil data have been entered into a Microsoft Access database. A summary of collected data is provided in Appendix 1.

3.5 SAMPLING AND LABORATORY ANALYSIS

3.5.1 Sampling

Soil samples were collected at 51 sites within the LSA and in 20 reference sites located at least 10 km outside of the LSA, but within the RSA (Figure 3.5-1). Where possible, the samples were collected at two depths: 0 to 5 cm and 50 to 60 cm (at several of the inspected sites, the mineral soils were shallow and only the upper soil layer(s) could be sampled). The 0 to 5 cm layer represents the organically enriched horizon and the surface layer where atmospherically deposited particulates (e.g., dust) could potentially accumulate. The 50 to 60 cm depth samples target subsoil conditions, which reflect parent material chemistry influenced by pedogenesis.

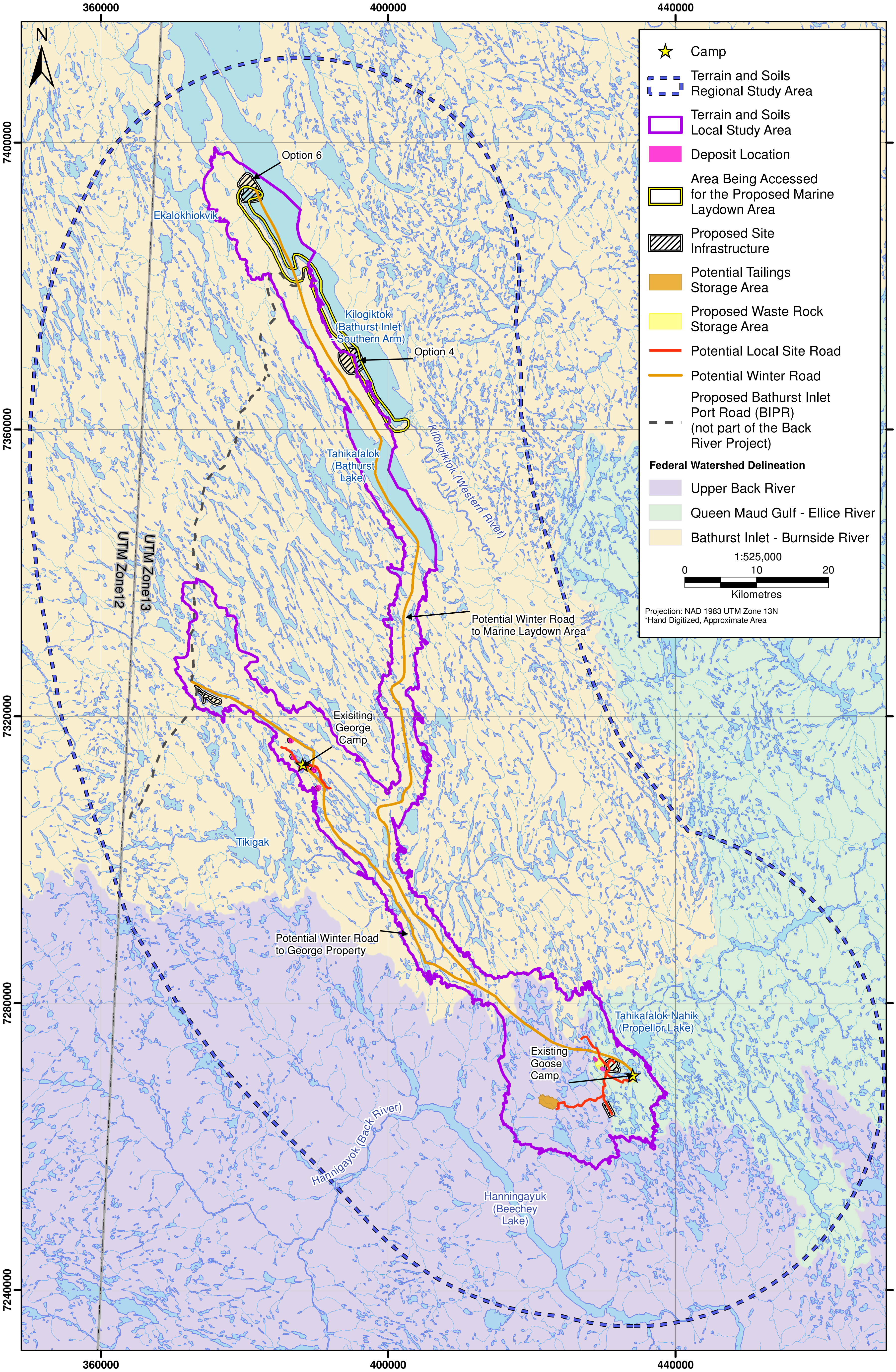

Figure 3.1-1

Terrain and Soils Local and Regional Study Areas, Back River Project

Sabina GOLD & SILVER CORP.

Rescan an ERM company

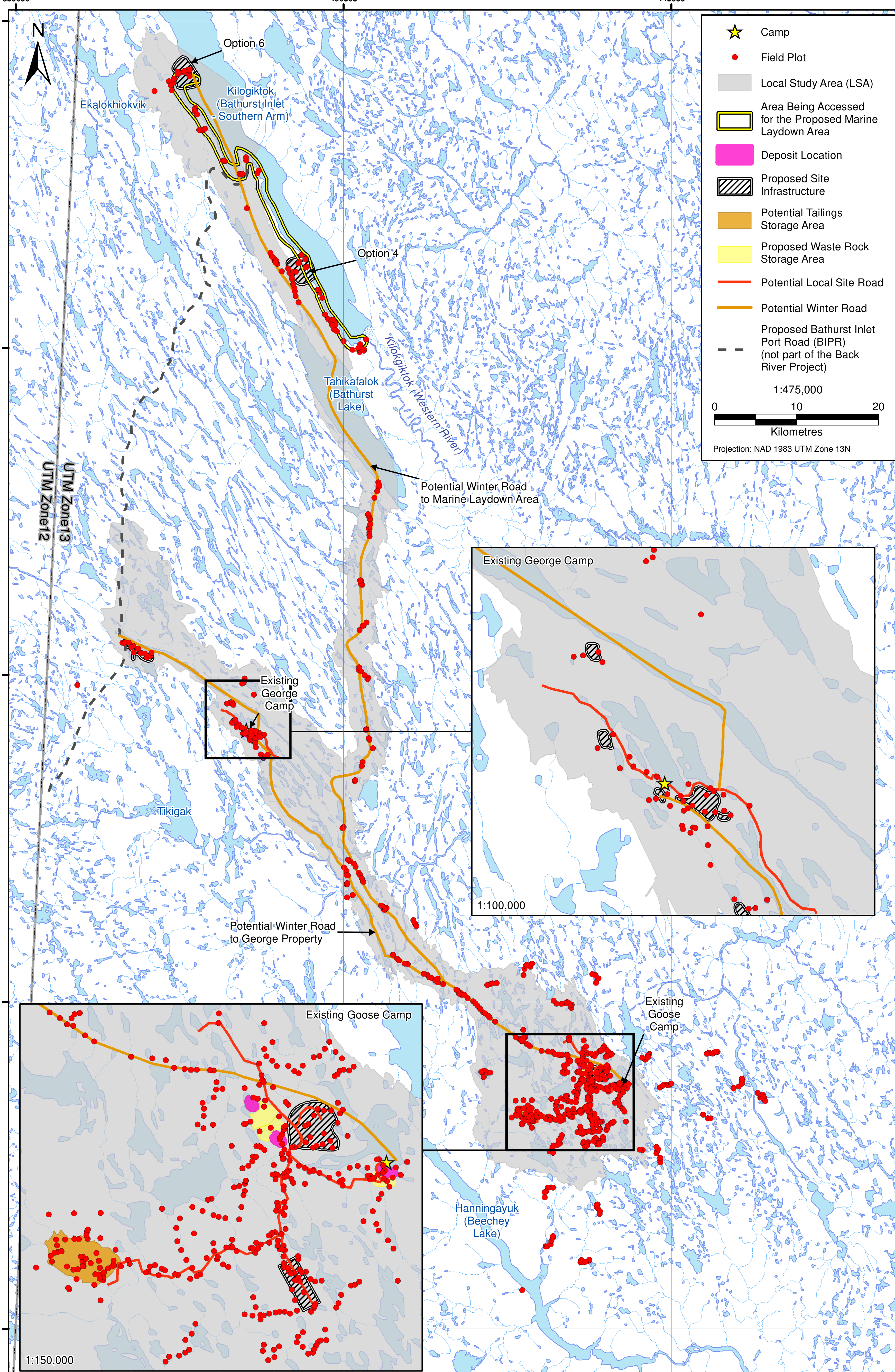

Figure 3.4-1

Distribution of Field Plot Locations, Back River Project

PROJECT #0194096-0020 GIS # BAC-17-020 May 22, 2013

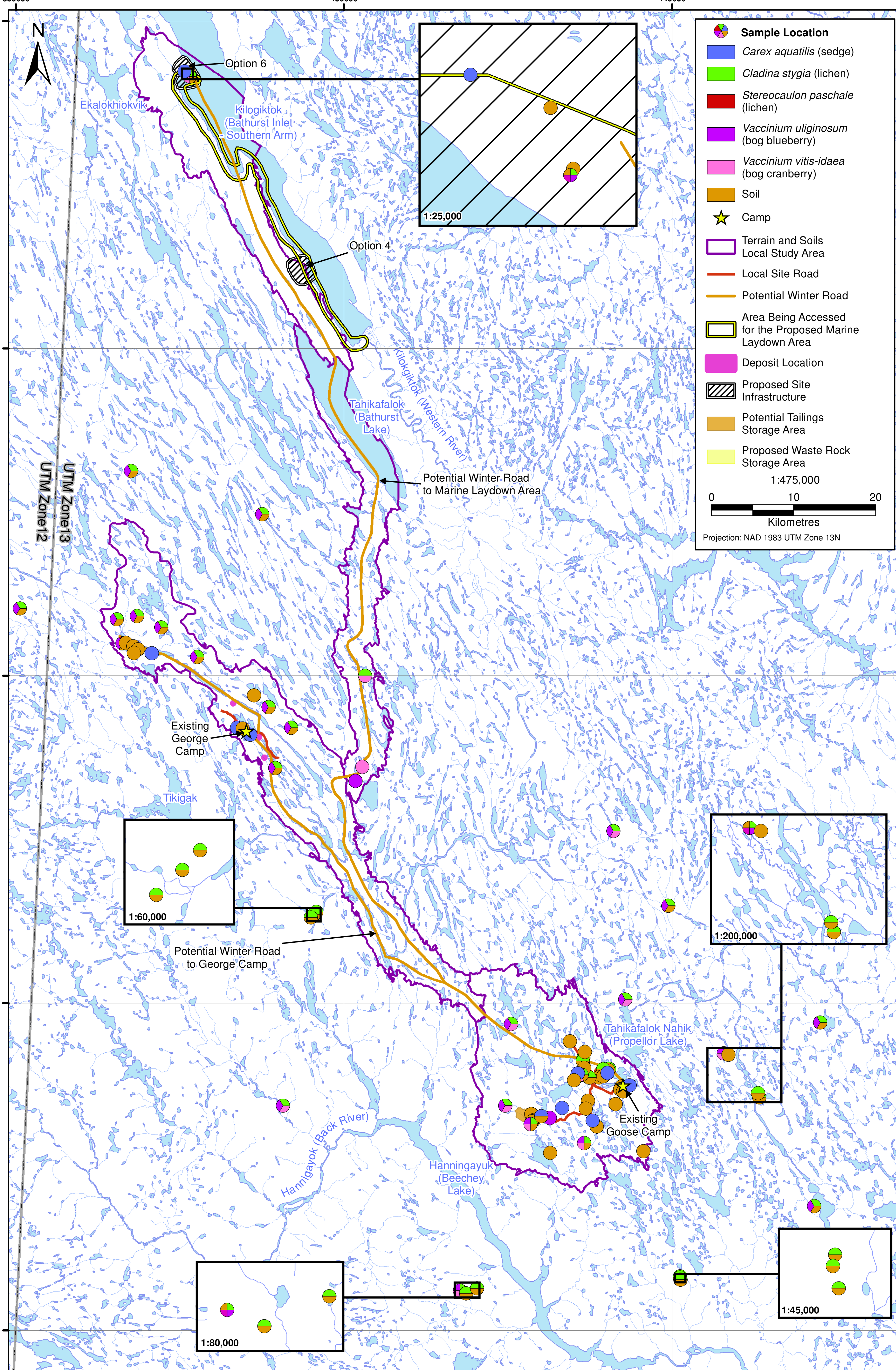

Figure 3.5-1

Soil and Vegetation Tissue Sampling Locations, Back River Project

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Tables 3.5-1, 3.5-2 and Figure 3.5-1 summarize information on the soil sampling sites, their locations and the plant tissues collected. A total of 73 soil samples were collected from the 51 sites in 2012. This included 53 samples from 0-5 cm soil depth and 20 samples from 50-60 cm soil depth. All soil samples were placed in clean, plastic, labelled bags and sent to ALS Environmental Laboratories for chemical analysis. A total of 73 soil samples were tested for soil reaction (pH) and metal concentrations. Thirty-three of the soil sampling sites were sampled in conjunction with the plant tissue sampling.

Table 3.5-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project

Sampling			Soil Depth		Tissue Collected *		
Site	Easting	Northing	5 cm	60 cm	Lichens	Berry	Sedge
Goose Property Area							
023	7266447	422831	1	1			
033	7265984	425094				*V. uliginosum*	
042	7262909	429287	1	1			
049	7264932	430824	1	1			
050	7265703	423118	1	1			
053	7265562	422916	1	1			
054	7265222	422747	1		*C. stygia*		
055	7269834	433891	1	1			
058	7269478	433685	1	1			
061	7271982	432331					
062	7271837	432216	1	1			
064	7271951	431608	1		*C. stygia*		
069	7270920	431080	1	1			
074	7271065	431606	1	1			
080	7270914	429917	1	1	*C. stygia*		
080-5-x	7270914	429917	1				
101	7273311	429202	1		*C. stygia*		
104	7272942	429119	1	1	*C. stygia*		
107	7272098	429293	1	1			
108	7271263	428967	1	1	*C. stygia*	*V.vitis-idaea, V. uliginosum*	
110	7269226	434037	1				
GB52	7267490	419663			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB45	7280456	434299			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB44	7277461	420373			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
422	7262909	429287			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
844	7262909	429287			*C. stygia*		
1083	7271263	428967			*S. paschale*		
2166	7271263	428967				*V. uliginosum*	
GB104	7267490	419663				*V. uliginosum*	
W002	7271477	432127					
W009	7271427	428525					
W019	7267199	426593					
W045	7265649	430329					

(continued)

Table 3.5-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project (continued)

Sampling Site	Easting	Northing	Soil Depth 5 cm	60 cm	Tissue Collected * Lichens	Berry	Sedge
Goose Property Area ***(cont'd)***							
W072	7269960	434814					
W086	7312809	388575					
W026	7266198	424046					*C.aquatilis*
W052	7274044	429382					*C.aquatilis*
W067	7267668	433128					*C.aquatilis*
W073	7261915	436508					*C.aquatilis*
W075	7261720	425138					*C.aquatilis*
W077	7270580	428052					*C.aquatilis*
W051	7268085	429763					*C.aquatilis*
W080	7267123	429480					*C.aquatilis*
W083	7275338	427543					*C.aquatilis*
Marine Laydown Area							
089	7393677	381049	1	1			
092	7393285	381195	1	1			
093	7393244	381176		1	*C. stygia*	*V.vitis-idaea, V. uliginosum*	
W106	7393890	380535					
George Property Area							
LBS10	7322310	382086	1		*C. stygia*	*V. uliginosum*	
LBS11	7316179	390788	1		*C. stygia*	*V. uliginosum*	
LBS12	7313663	393538	1		*C. stygia*	*V. uliginosum*	
LBS13	7308739	391616	1		*C. stygia*	*V. uliginosum*	
LBS26	7308739	391616			*C. stygia*		
234	7307153	401399				*V. uliginosum*	
W092	7313656	386945					
W134	7313564	387631					*C.aquatilis*
W135	7317620	389028					*C.aquatilis*
225						*V. uliginosum*	
Reference							
094	7323974	372980	1	1		*V. uliginosum*	
097	7324023	373388	1				
099	7323603	374310	1	1			
099-5-x	7323603	374310	1	1			
100	7323246	374885					
NE1	7268503	450632	1		*C. stygia*		
NE2	7269008	450497	1		*C. stygia*		
NE3	7273870	446315	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
NE4	7273709	446891	1				
NW1	7291155	396611	1		*C. stygia*		
NW2	7290851	396337	1		*C. stygia*		

(continued)

Table 3.5-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project (completed)

Sampling Site	Easting	Northing	Soil Depth		Tissue Collected *		
			5 cm	60 cm	Lichens	Berry	Sedge
Reference *(cont'd)*							
NW3	7290464	395934	1		*C. stygia*		
SE1	7246606	440991			*C. stygia*		
SE2	7246474	440965			*C. stygia*		
SE3	7246216	441032			*C. stygia*		
SE-3-X	7246216	441032	1				
SW1	7244864	414130	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
SW2	7244529	414894	1		*C. stygia*		
SW3	7245144	416228	1		*C. stygia*		
SW-3-x	7245144	416228	1				
GB47	7277634	458083					
GB50	7267480	392543			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB61	7255209	457340					
LBS1	7291904	439547	1		*C. stygia*	*V. uliginosum*	
LBS2	7277634	458083			*C. stygia*	*V. uliginosum*	
LBS3	7255209	457340			*C. stygia*	*V. uliginosum*	
LBS4	7327884	632234	1		*C. stygia*	*V. uliginosum*	
LBS5	7345042	374029	1		*C. stygia*	*V. uliginosum*	
LBS6	7339762	390032	1		*C. stygia*	*V. uliginosum*	
LBS7	7326911	372292	1		*C. stygia*	*V. uliginosum*	
LBS8	7327299	374755	1		*C. stygia*	*V. uliginosum*	
LBS9	7325922	377694	1		*C. stygia*	*V. uliginosum*	
206	7320003	402571	1		*C. stygia*	*V.vitis-idaea*	
233	7308877	402229	1			*V.vitis-idaea*	
Bearpost	7301041	432856	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
SW1-B					*C. stygia*		
NW4	7290851	396337			*C. stygia*		
SSE-3	7246216	441032			*C. stygia*		
NW6	7290464	395934			*C. stygia*		
542	7265222	422747			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
941					*S. paschale*		
W133	7322758	376543	1				
W128	7322794	374371					*C.aquatilis*
GB100	7267480	392543				*V. uliginosum*	

Notes:
Sampling site locations are listed using UTM coordinates. All sampling sites were from UTM Zone 13
C. stygia = Cladina stygia; S. paschale = Stereocaulon paschale; V. uliginosum = Vaccinium uliginosum; V. vitis-idaea = Vaccinium vitis-idaea; C. aquatilis = Carex aquatilis.

Table 3.5-2. Summary of the Soil Parameters, Detection Limits, and CCME Guideline Limits

Parameter	Detection Limits	CCME Industrial Guideline	Units
Aluminum (Al)	50	-	mg/kg
Antimony (Sb)	0.1	20	mg/kg
Arsenic (As)	0.05	12	mg/kg
Barium (Ba)	0.5	2,000	mg/kg
Beryllium (Be)	0.2	8	mg/kg
Bismuth (Bi)	0.2	-	mg/kg
Cadmium (Cd)	0.05	22	mg/kg
Calcium (Ca)	50	-	mg/kg
Chromium (Cr)	0.5	87	mg/kg
Cobalt (Co)	0.1	300	mg/kg
Copper (Cu)	0.5	91	mg/kg
Iron (Fe)	50	-	mg/kg
Lead (Pb)	0.5	600	mg/kg
Lithium (Li)	5	-	mg/kg
Magnesium (Mg)	20	-	mg/kg
Manganese (Mn)	1	-	mg/kg

Parameter	Detection Limits	CCME Industrial Guideline	Units
Mercury (Hg)	0.005	50	mg/kg
Molybdenum (Mo)	0.5	40	mg/kg
Nickel (Ni)	0.5	50	mg/kg
Phosphorus (P)	50	-	mg/kg
Potassium (K)	100	-	mg/kg
Selenium (Se)	0.2	2.9	mg/kg
Silver (Ag)	0.1	40	mg/kg
Sodium (Na)	100	-	mg/kg
Strontium (Sr)	0.5	-	mg/kg
Thallium (Tl)	0.05	1	mg/kg
Tin (Sn)	2	300	mg/kg
Titanium (Ti)	1	-	mg/kg
Uranium (U)	0.05	300	mg/kg
Vanadium (V)	0.2	130	mg/kg
Zinc (Zn)	1	360	mg/kg

3.5.2 Chemical Analyses

Samples were analyzed for soil reaction (pH) to help assess soil fertility, potential metal mobility, and to guide soil salvage and reclamation planning. Baseline soil analyses included testing for concentrations of 31 metals. Details of the analytical procedures and results are included in Appendix 3.

The interpretation of baseline data included comparing analytical results to the industrial guidelines provided for 19 of the metals in the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2012; Table 3.5-2).

3.5.3 Quality Assurance

The quality assurance (QA) and quality control (QC) measures completed for this report included a review of precision and accuracy, representativeness, and sample holding times. Precision and accuracy were controlled through an assessment of laboratory sample duplicate analysis. The laboratory's QA/QC procedures include replicate testing and instrument calibration verification. Sample results are not released unless all internal QA/QC data are acceptable. ALS Environmental laboratory's QA/QC results are included in Appendix 3.

Acceptable representativeness was achieved through use of the standard Rescan sampling procedures. All laboratory data were electronically transferred to tables (no manual entry) to prevent transcription error. All internal tables and figures were peer reviewed. Sample holding times for the analyses ensured that samples were analyzed before degradation of the sample occurred. The QA/QC procedures for collected data analyses and interpretation were followed.

Some of the characteristics assigned to terrain polygons were derived from the inspection point data (e.g., soil coarse fragment content). This was based on the assumption that the soil inspection data reflect the conditions found in the entire polygon well (the median area of a polygon is 10.7 ha, while the soil pit is representative of approximately 0.3 m^2). While considerable effort was made to conduct soil inspections in areas most representative of each polygon, the above assumption constitutes a source of potential error.

4. Results

4. Results

The following presents a summary of the topography and land forms in the area, along with the results of the soil field program. Complete terrain and soils maps are presented in Appendix 2.

4.1 TOPOGRAPHY AND LANDFORMS

The land is dominated by gently undulating landscapes (Plate 4.1-1), defined as a sequence of smooth, non-linear rises and hollows, and rolling topography (similarly smooth, but linear sequences of elongated rises and valleys that repeat in a wave-like pattern across the landscape). Together these two landforms comprise over 70% of the LSA. Plains occupy approximately 15% of the LSA. Slopes, ridges, and hummocky terrain are found on 2% of the LSA.

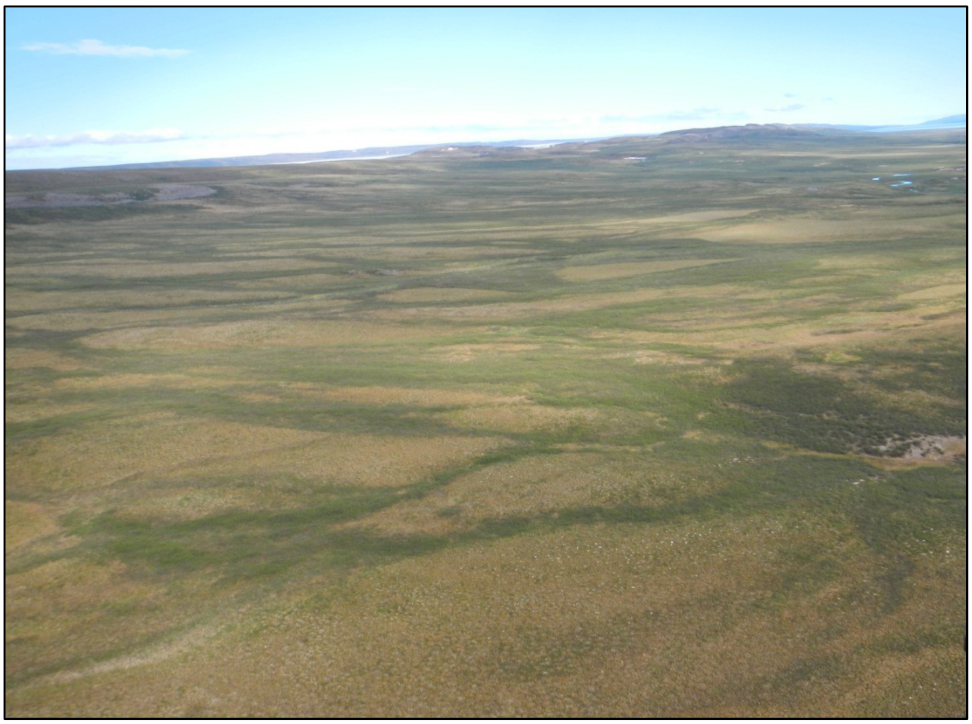

Plate 4.1-1. The study area is dominated by gently undulating and rolling landscapes. Near the Marine Laydown Area, June 2012.

Kettle lakes formed from large blocks of melting ice left by the last retreating ice sheet (about 8500 years ago) exist throughout the region. Lakes cover 5.4% of the LSA. They range in size from 0.51 ha to 628 ha, but most of them are small: the median lake size is only 3.03 ha. Lakes are usually connected by a complex network of streams.

Slopes are generally uniform and range between 0% and 20%, but over most of the land they rarely exceed 7%. Terrain elevation ranges between 300 and 700 masl. Smoothness of the landforms reflects the influence of local hydrological patterns associated with the impermeable permafrost layer.

A number of distinct landform types, including eskers, moraines, boulder fields, and wetlands exist throughout the region (Figure 4.1-1).

Several large eskers occur in the Project region as elongated, sinuous ridges up to 100 m wide and several kilometres long. They were formed from sands, gravels, and cobbles, and boulders deposited in the glacial melt water channels flowing below or within glaciers. Coarse fragment content within the top 1 m of deposit varies, in most instances, from 35% to 85%. The majority of eskers located within the LSA likely contain massive ice cores (Wolfe et al 1997, Dallimore and Wolfe 1988, Gowan and Dallimore 1990, Dallimore and Davis 1992, Moorman and Michel 2003, Robinbson et al. 2003, Macumber et al. 2011).

Besides being a unique geomorphological landscape feature, eskers provide several ecological functions. For example, the annual pattern of ground water flow within the esker active soil layer governs soil moisture and nutrient regimes in lower sections of eskers and adjacent ecosystems. Also, because burrowing material is limited in the areas dominated by boulder fields and shallow morainal veneers over bedrock, the unconsolidated, coarse mineral material of eskers provides excellent denning sites for wildlife.

Moraines are rocky ridges composed of unconsolidated, unsorted mineral debris deposited at the glacier edge. A large, over 200 km long glacial moraine extends in the eastern direction from the LSA (NRCan 2012) and can also be found in the region.

In the Arctic, boulder fields are often derived from weathered bedrock, from which finer fractions have been removed by various periglacial processes (e.g. solifluction) (Sonesson 1985). Intense frost heaving also causes fracturing of bedrock and subsequent migration of large rock fragments to the surface. These phenomena created several boulder fields and belts in the Project region.

Repeated freezing and thawing of the soil creates interesting features on the ground surface. Frostboils (also known as mud boils or mud circles) are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heave and cryoturbation in permafrost areas. Common characteristics include an elevated center, a formation of an organic layer on the outer edge, and resistance of the soil surface to vegetation colonization. Extensive areas of tundra “patterned ground” covered by frostboils are commonly found in the Project region.

Thermokarst typically occurs on the surface of wetlands as areas of very irregular hummocks and hollows, which form in result of frost heaving and ice accumulation on the bottom of organic horizons. When they eventually thaw and collapse they form depressions, which further contribute to surface unevenness.

Massive ground ice of up to 10 m depth is a relic feature formed in late glacial or early postglacial times and it has been reported in hummocky morainal deposits and eskers in the Contwoyto Lake and Lac de Gras areas (Wolfe 1998; Dredge et al. 1999). Massive ice is likely present in parts of the Takijuq Lake Upland where late glacial conditions allowed rapid cover of residual forms of glacial ice and frozen melt water, especially along the west side of Bathurst Inlet (Ecological Framework of Canada 2012).

4.2 SURFICIAL DEPOSITS

Since the last glaciation, hydrologic processes have played a major role in the redistribution of surficial deposits in the LSA. Water movements, aided by cryogenic processes, have contributed to considerable mixing of various deposits (e.g., angular coarse fragments typical of till are often intermixed with rounded glaciofluvial gravels). These processes make precise delineation of each deposit type difficult.

As indicated on the appended terrain maps (Appendix 2), morainal surficial materials dominate the LSA. Morainal till generally consists of well-compacted, non-stratified material composed of a mixture of sand, silt, and clay, and it contains a heterogeneous mixture of sub-rounded to angular coarse fragments of different sizes. Over half of the surficial materials of the LSA (71,825 ha) are of morainal origin (Figure 4.2-1 and Table 4.2-1).

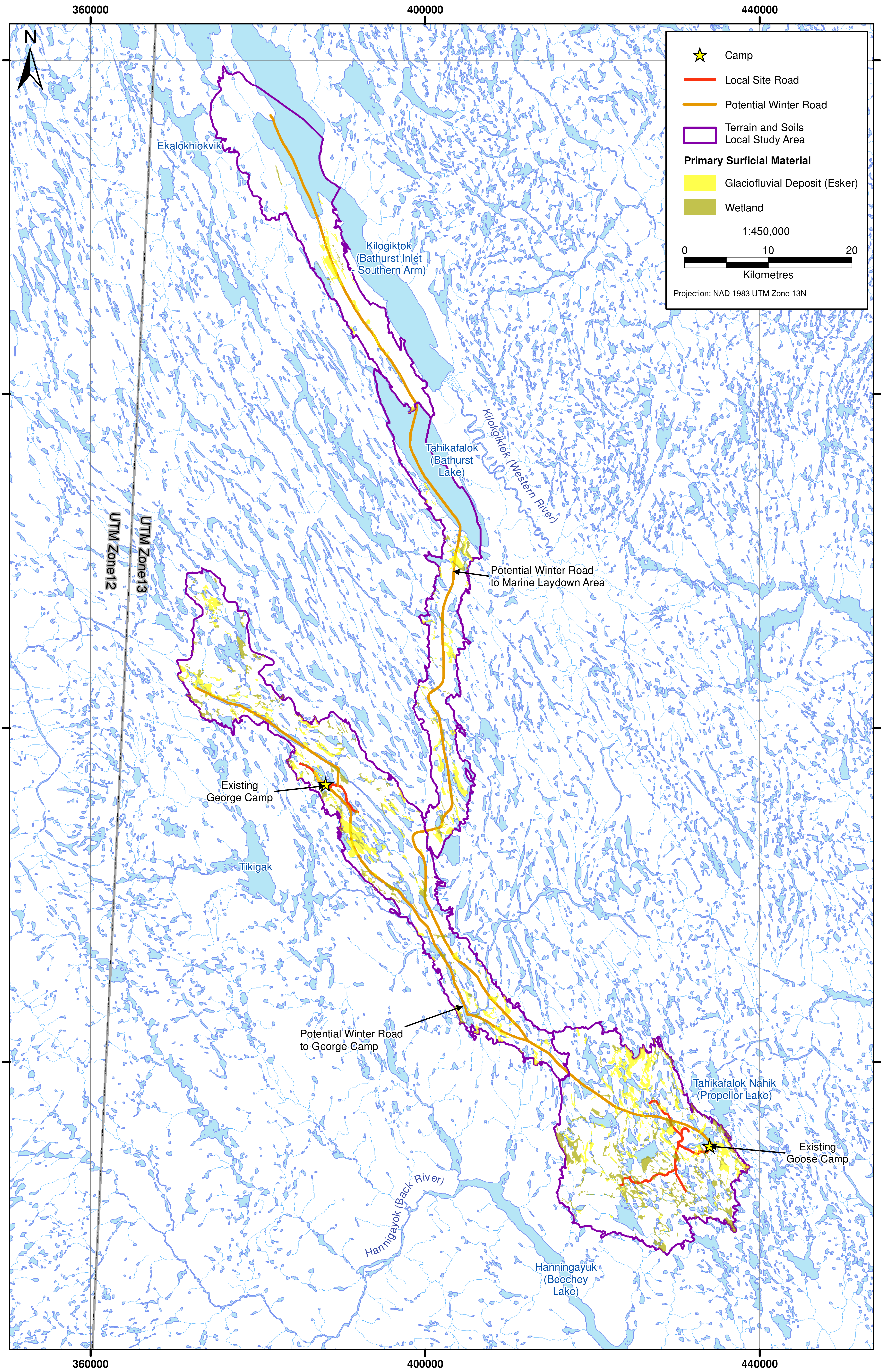

Figure 4.1-1

Distribution of Eskers and Wetlands in the Local Study Area, Back River Project

Figure 4.1-1

Sabina GOLD & SILVER CORP.

Rescan an ERM company

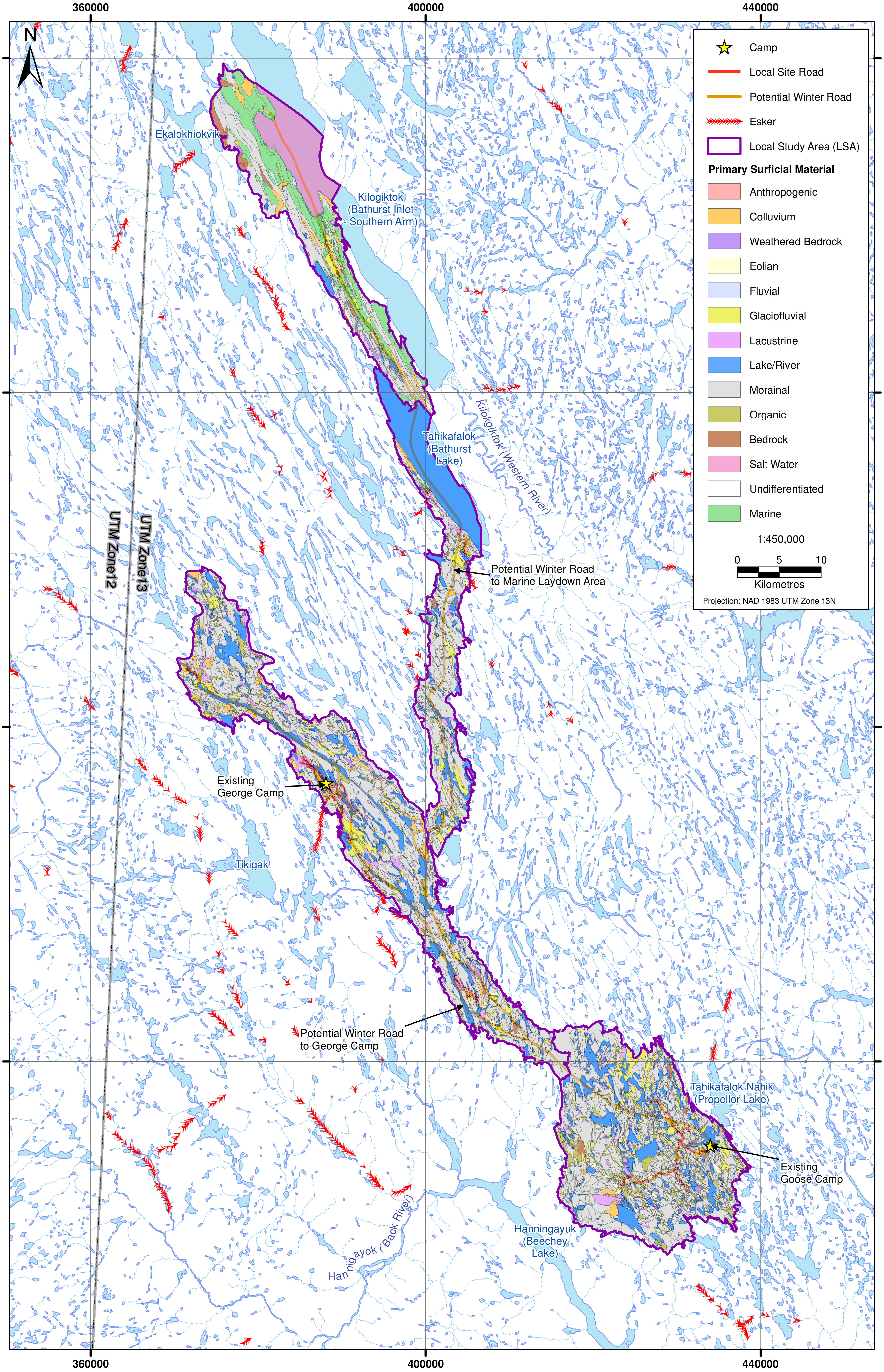

Figure 4.2-1

Sabina GOLD & SILVER CORP.

Distribution of Surficial Materials in the Local Study Area, Back River Project

Rescan an ERM company

Table 4.2-1. Distribution of Surficial Materials in the Local Study Area

Surficial Materials	George Area		Goose Area		Marine Laydown Area		Winter Access Road		LSA	
	ha	%	ha	%	ha	%	ha	%	ha	%
Anthropogenic	6.4	0.01	5.0	0.01	0.0	0.0	0.0	0.0	11.4	0.01
Bedrock	634.9	1.3	520.7	1.2	1428.5	5.5	202.8	0.9	2786.9	2.0
Colluvial	1717.2	3.6	432.0	1.0	1396.0	5.3	446.8	1.9	3992.0	2.9
Eolian	393.9	0.8	867.1	2.1	103.2	0.4	208.1	0.9	1572.4	1.1
Fluvial	260.8	0.6	300.6	0.7	225.8	0.9	109.2	0.5	896.5	0.6
Glaciofluvial	3423.7	7.3	3122.0	7.4	818.8	3.1	1449.1	6.2	8813.5	6.4
Lacustrine and Glaciolacustrine	1749.0	3.7	1075.3	2.6	33.7	0.1	473.4	2.0	3331.5	2.4
Marine and Glaciomarine	0.0	0.0	0.0	0.0	7698.5	29.4	30.0	0.1	7728.5	5.6
Morainal	28330.5	60.0	25379.7	60.6	7385.5	28.2	10729.4	45.9	71825.1	51.8
Organic	2857.2	6.1	3754.1	9.0	240.9	0.9	547.1	2.3	7399.3	5.3
Total Land Area	**39373.5**	**83.4**	**35456.6**	**84.6**	**19331.0**	**73.8**	**14196.0**	**60.7**	**108357.0**	**78.1**
Lakes and Ponds	7732.0	16.4	6405.7	15.3	642.7	2.5	9190.8	39.3	23971.2	17.3
Rivers and Streams	107.2	0.2	51.1	0.1	15.7	0.1	4.6	0.0	178.6	0.1
Salt Water	0.0	0.0	0.0	0.0	6205.5	23.7	0.0	0.0	6205.5	4.5
Total Area	**47212.7**	**100.0**	**41913.3**	**100.0**	**26194.9**	**100.0**	**23391.5**	**100.0**	**138712.4**	**100.0**

Glaciofluvial materials (recorded over 6.4% of the LSA land) have been deposited as eskers or veneers over morainal materials. They mainly consist of sands with a considerable component of rounded or sub-rounded coarse fragments (e.g., gravels, cobbles, boulders), which often display evidence of stratification.

Marine and glaciomarine deposits, characteristic of the Bathurst Inlet area, consist mainly of coarse sands with low proportion of coarse mineral fragments. These materials have been deposited by the sea over relatively large areas due to gradual exposure of sea shores during the postglacial isostatic rebound. Currently marine deposits cover 5.6% of the LSA.

Organic materials cover 5.3% of the LSA (7399 ha). They result from the accumulation of very slowly decomposing vegetation, typically in the wet lowlands and in areas of intense seepage. Organic deposits typically occur in the LSA in the form of poorly or moderately decomposed peat layers.

Glaciolacustrine and lacustrine deposits are similar in that both typically contain significant proportion of silt and clay and, generally, minimal proportions of coarse fragments. Coarse sediments may be occasionally found in beach areas and deltas, especially in shallow lakes fed by melt water, where more powerful currents prevent the settling of fine material (Embleton and King 1971). These materials are found in lowlands in 2.4% of the LSA.

Bedrock and weathered rock outcrops are one of the most prominent characteristics of the study area. Nevertheless, bedrock rarely extends over an area large enough to dominate the entire terrain polygon (median polygon size is 10.7 ha). Instead, it is often present close to the surface, covered with thin mineral or organic veneers. Bathurst Inlet area has the highest proportion of polygons dominated by exposed bedrock in the LSA. About 2% of the mapped polygon area in LSA is covered by large extents of exposed bedrock.

Associated colluvial materials are the products of bedrock mass-wasting typically occurring on steep slopes, and are rare in the region (2.9% of the LSA). Colluvial materials are generally course and contain high proportion of coarse mineral fragments.

Eolian parent materials are deposited by wind and consist primarily of sand or silt-sized particles. These materials tend to be extremely well-sorted and free of coarse fragments. Eolian deposits are found on only 1% of the LSA land (Table 4.2-1). They are typically located in the vicinity of glaciofluvial materials, inferring a common origin.

Despite the presence of many creeks, fluvial deposits have been found on only 0.6% of the LSA. These sediments generally contain a high proportion of gravel and sand; however, in areas where after a short period of intense activity during snow melt streams convert into seepage areas, fluvial materials contain a significant fraction of silt and clay. The gravels and cobbles are usually rounded.

A very small proportion of the LSA (0.01%) represents terrain modified by people (Table 4.2-1). Anthropogenic materials typically associated with mineral exploration represent a wide range of physical properties (e.g., morphological form, structure, and texture).

4.3 SOIL GROUPS

Since the mosaic of soil types in the LSA is diverse, soils have been grouped into Soil Groups according to soil main characteristics, such as dominant parent material, texture, and proportion of mineral coarse fragments.

4.3.1 Morainal Soil Group

The soils that developed in morainal surficial materials occupy approximately 71,825 ha or 52% of the LSA (Table 4.2-1). Morainal materials typically occur as veneers and blankets covering bedrock. The soils developed on these materials are mostly well drained Static Cryosols, moderately- to imperfectly drained Turbic Cryosols, or rapidly drained Regosols. Because of their significant area and considerable variation, two soil units have been differentiated according to parent material thickness: Morainal Blankets (more than 1 m thick) and Morainal Veneers (less than 1 m thick).

4.3.1.1 Morainal Blankets

This unit represents non-stratified, compacted morainal mantles and blankets typically occurring on plains and undulating and rolling terrain (Plate 4.3-1). They are typically associated with lower elevations and lower slope positions compared to Morainal veneers. Morainal blanket soils also have slightly higher moisture regime indices. These soils contain a low proportion of coarse fragments (typically less than 30%) mainly consisting of angular gravels and cobbles. Soil textures can vary widely (sandy loam to silty clay), but most typically include sandy loams and loams. Consequently, soil erosion potential in this unit is generally moderate to high. While slow mass movement, melt water channels, and seepage have been occasionally recorded, this type of soil usually does not display evidence of significant erosion if it is not disturbed. The typical soils include well to imperfectly drained Regosolic Static Cryosols, Brunisolic Eutric Turbic Cryosols and Regosolic Turbic Cryosols (Plate 4.3-2). The salvage suitability of this material is usually poor to fair, mainly due to coarse texture and considerable surface stoniness. The nutrient regime is usually poor and the average moisture regime is subhygric. The soils generally have a very thin organic layer. Typically, it is a mor, a form of humus that remains unmixed with the mineral horizons of the soil.

Plate 4.3-1. Morainal blankets are usually found on plains and on undulating and rolling terrain. Goose Property, July 2012.

Plate 4.3-2. Examples of soils developed on morainal parent material. Left: Brunisolic Eutric Turbic Cryosol; right: Regosolic Turbic Cryosol.

4.3.1.2 Morainal Veneers

The soils developed on non-stratified, compacted morainal veneers over bedrock, typically occurring in higher elevations on crests, upper and mid-slopes (Plate 4.3-3). Soil textures vary (loamy sand to silty loam), but most typically include sandy loams and loams. Most morainal veneer soils are rapidly to moderately well-drained. Compared to morainal blankets, these contain a slightly higher proportion of angular gravels and cobbles (commonly 30 to 60%).

Plate 4.3-3. Soils developed on morainal veneers are often found on upper and mid-slopes of undulating and rolling terrain. Goose Property, June 2012.

Soil erosion potential in this unit is generally moderate to high. Geomorphological processes controlled by the presence of permafrost are common. Undisturbed, these soils usually do not display evidence of significant erosion. The salvage suitability of most material ranges from poor to good; however, close to one third of soils in this unit are not suitable for salvage, mainly due to considerable surface stoniness or high coarse fragment content. The nutrient regime is usually poor, and the average moisture regime is mesic. The typical soils include well- to moderately well-drained Regosolic Static Cryosols and Regosolic Turbic Cryosols (Plate 4.3-4). The soils are generally covered by a very thin organic layer (mor).

4.3.2 Glaciofluvial and Eolian Soil Group

Glaciofluvial deposits are commonly found in the LSA in the form of eskers or sandy veneers over adjacent moraine (Plate 4.3-5). Eolian deposits are much less common, typically occur in the form of sandy veneers over moraine, and are spatially associated with eskers (Plate 4.3-6). For these reasons the two parent material types were combined into one soil unit. Together, glaciofluvial and eolian soil mapping units cover approximately 10,386 ha or 7.5% of the LSA. Their topography is typically undulating or rolling, and slopes range from 0% to 12%.

Plate 4.3-4. Regosolic Turbic Cryosol, left and Regosolic Static Cryosol, right. Some Morainal Veneer soils are not suitable for salvage due to coarse texture, excessive surface stoniness, shallow bedrock, or high coarse fragment content.

Typically soils are rapidly to well drained. Water table depths exceeded 1 m in most glaciofluvial sites. Permafrost was rarely found within 1 m below the surface. Soil texture typically ranges from coarse sand to sandy loam. The proportion of coarse fragments varies widely. Eolian soils usually have none, while glaciofluvial soils contain from zero up to 90% of rounded gravels, cobbles or boulders. Surface stoniness also ranges widely.

Glaciofluvial and eolian deposits generally have weakly developed humic horizons (LFH, Ah, or Ahe), except at sites where the water table (usually perched above permafrost) is present within a metre of the surface. If the humus layer develops at all, it is generally a mor. The nutrient regime characteristic of this soil unit sites is very poor to poor, while the moisture regime may range widely (from xeric to subhydric), which demonstrates the importance of frozen esker cores as reservoirs of slowly released water, which highlights their exceptionally high ecological value for vegetation and wildlife.

Typical soils for this unit include Regosolic Static Cryosol, Orthic Eutric Static Cryosol, and Orthic Regosol. The majority of soils in this unit are not suitable for salvage, mainly due to their texture, but often also due to high coarse fragment content and excessive stoniness (Plate 4.3-7). Typical soil erosion potential is low to moderate.

Plate 4.3-5. Undulating and rolling landscapes associated with glaciofluvial deposits. Goose Property, July 2012.

Plate 4.3-6. Eolian materials are often located in proximity to Glaciofluvial deposits. Goose Property, July 2012.

4.3.3 Marine and Glaciomarine Soil Groups

Soils developed in Marine and Glaciomarine materials (approximately 7728 ha or 5.6% of the LSA) are closely associated with the Bathurst Inlet area (Plate 4.3-8). Soil textures vary from coarse sands to silty clay loam, but most typically include sands and sandy loams with an average coarse fragment content of 13%. Most of these soils are very rapidly to moderately well-drained.

Plate 4.3-7. Deep, coarse textured Orthic Regosols typically develop on glaciofluvial deposits. Marine Laydown Area, June 2012.

Plate 4.3-8. Marine deposits at Bathurst Inlet. Marine Laydown Area, Option 4. June 2012.

Soil erosion potential in this unit is generally low. Typical geomorphological processes include seepage, washing and phenomena associated with permafrost. The salvage suitability of most marine materials is poor due to coarse texture. The nutrient regime is usually poor, and the average moisture regime is submesic. The typical soils include Regosolic Static Cryosols and Orthic Regosols (Plate 4.3-9). The organic layer (mor) is typically very thin or absent.

Plate 4.3-9. Regosolic Static Cryosol (left) and Orthic Regosol (right).

4.3.4 Organic Soil Groups

Organic deposits cover 5.3% of the LSA and are distributed more or less evenly throughout the LSA, with the exception of the southern part of the Goose property, where they are less common (Figure 4.2-1). Organic soil mapping units comprise soils that formed through the accumulation of organic materials, typically in poorly to very poorly drained areas. Thus, most organic soils occur predominantly in level areas distributed over the plain lowlands (Plate 4.3-10). Some organic soils, however, develop on gentle slopes in strong seepage areas.

This soil is characterized by poor to very poor drainage caused by continuous (although sometimes very slow) water movement. Permafrost is typically found close to the surface (average permafrost depth is 55 cm), and evidence of cryoturbation, seepage, and thermokarst have been commonly recorded.

Soil texture is fibric (poorly decomposed) or mesic (moderately decomposed) depending on water flow rate through the organic deposit. Coarse fragment content is minimal. Surficial stoniness and bedrock exposure are generally low; however, some exceptions have been observed. When undisturbed, this soil unit did not display evidence of significant erosion; however, mineral soils underlying organic material generally contain a considerable proportion of fine sand and silt and thus may display high erosion potential if stockpiled.

Plate 4.3.10. Organic soils are distributed over level areas of the plains. Goose Property, July 2012.

The typical soils include very poorly drained Terric Fibric Organic Cryosols, Terric Mesic Organic Cryosols, and poorly drained Regosolic Static Cryosols or Regosolic Turbic Cryosols (Plate 4.3-11). The nutrient regime is usually poor, and the moisture regime ranges from mesic to hydric.

While most of soils in this unit are characterized by good salvage suitability, some may provide poor or unsuitable salvage material, mainly due to shallow bedrock or high stoniness (Plate 4.3-12). When undisturbed, this soil group does not display evidence of significant erosion; however, mineral soils underlying organic material contain a considerable proportion of fine sand and silt and thus may display moderate to high erosion potential if stockpiled. Soil salvage suitability is highly variable and depends on the depth of bedrock and stoniness.

4.3.5 Bedrock, Weathered Bedrock and Colluvium Soil Group

While bedrock outcrops are common in the LSA, they cover only a fraction of terrain polygons and thus, are usually classified according to the polygon's dominant surficial material (Plate 4.3-13). Terrain polygons dominated by bedrock, weathered bedrock and colluvium comprise 4.9% of the LSA.

Weathered and/or exposed bedrock are commonly seen in higher elevations in crest to middle slope positions (Plate 4.3-14). Slopes of this mapping unit are variable. Soil development is limited to non-occurring. If present, most soils are shallow and coarse (e.g., sandy loam) with a median coarse fragment content of 27%. Their drainage and erosion potential vary considerably. Nutrient regime is typically very poor and moisture regime is very xeric to mesic. The soils of this unit are mostly classified as Static Cryosols. Soils in this unit are generally not suitable for salvage due to their shallow nature, stoniness, and high coarse fragment content.

Plate 4.3-11. Terric Fibric Organic Cryosol (permafrost is visible – left) and Terric Mesic Organic Cryosol, right.

4.3.6 Lacustrine and Glaciolacustrine Soil Groups

This unit represents both lacustrine and glaciolacustrine deposits, which were found in only 2.4% of the LSA. These soils typically form in lower slope positions and in level areas of plains (Plate 4.3-15). The average slope is less than 1%. They are generally imperfectly to poorly drained. The depth to the water table ranged from the surface to 52 cm, averaging only 15 cm. Consequently, evidence of gleying is common in lacustrine soils (Plate 4.3-16). Median depth to permafrost is 45 cm.

The texture of the lacustrine soils typically ranges from silty loam to silty clay. Rooting depth is often restricted by clay. Small amounts of coarse fragments occasionally present in these soils likely reflect the transport, mixing, and deposition of various mineral materials associated with spring melt water movement. No surficial stones were recorded in lacustrine sites. Soils were often covered by a thin layer of mesic peat. The typical nutrient regime of soils developed on lacustrine deposits is medium to poor, and the moisture regime ranges from subhigric to subhydric.

4.3.7 Fluvial Soil Groups

Fluvial soils are developed in parent materials that were transported and deposited by moving water (rivers and streams). In the LSA, fluvial materials occupy approximately 0.6% of the LSA (Table 4.1-3). The majority of the soils developed on fluvial deposits occur as very narrow bands on level to very gently sloping areas of plains (Plate 4.3-17) or as thin veneers covering rocky rubble on slopes along seasonally active ephemeral streams.

Plate 4.3-12. *Organic horizons are frequently shallow.*

Plate 4.3-13. Rock outcrops usually cover only a fraction of terrain polygons and thus, are usually classified according to the polygon's dominant surficial material. Goose Property, July 2012.

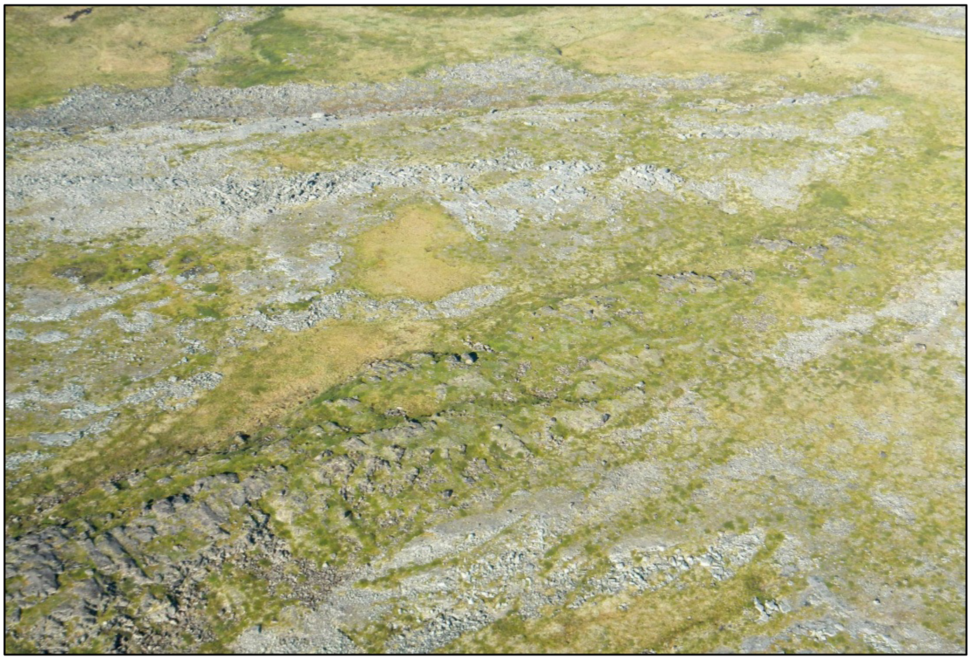

Plate 4.3-14. Rock outcrops and boulder fields appear over a prominent portion of the land surface, especially in the southern portion of the LSA. Goose Property, July 2012.

Plate 4.3-15. Lacustrine deposits occur in lower slope positions, as well as, in level areas of plains. July 2012, Goose Property.

Plate 4.3-16. Lacustrine and Glaciolacustrine soils are often poorly drained with the water table near the surface. July 2012, Goose Property.

Plate 4.3-17. Fluvial deposits formed on level areas of plains.

Soil textures of fluvial soils range from sand to loam. Fluvial soils commonly have layers that are well sorted by particle size. Coarse fragment content is variable, but it generally remains below 40%. Drainage varies from rapid to poor. On slopes the water table typically remains below the interface between the fluvial materials and the underlying rock rubble. Consequently, gleying is usually not strongly pronounced. Fluvial soils rarely displayed signs of cryoturbation. Permafrost typically lies below the rock rubble; however, its depth visibly decreases with distance from the watercourse.

Soil nutrient regime is usually medium, and soil moisture regimes range from mesic to hydric. Rooting depth is often restricted by the presence of either a lithic layer or clay pan. The typical humus form is mor; however, on plains it quickly phases into peat, and on slopes it has a highly variable thickness and a unique hummocky appearance. Typical fluvial soils include Regosolic Static Cryosol, Brunisolic Eutric Static Cryosol, and Orthic Regosol (Plate 4.3-18).

Plate 4.3-18. Typical Fluvial soils include Regosolic Static Cryosols.

Soil salvage suitability is often poor due to stoniness and coarse texture. Salvageable soil layer above the rock rubble is usually shallow (approximately 35 cm). When disturbed, mineral soil erosion potential can be high.

4.3.8 Anthropogenic Soil Groups

The anthropogenic mapping units represent areas altered by human activity, which comprise only 0.01% of the LSA land surface. This unit includes areas of compacted soil, roads, and camps. Soil drainage, texture, and erosion potential vary considerably. Soils in this unit are not suitable for salvage, mainly due to their compaction, coarse fragment content, and potential contamination.

4.4 SOILS

4.4.1 Soil Classification

Soil classification was based on soil inspections conducted during the field programs, which targeted approximately 15% of the LSA land surface. Soils of the inspected polygons were classified to Soil Great Groups (AAFC 1998). Soil classification for the remaining (not inspected) polygons was based on the analysis of similarities between terrain attributes (terrain labels derived during terrain photograph interpretation) of the inspected and non-inspected polygons. This approach allowed the remaining terrestrial polygons to be classified to Soil Great Groups with relatively high confidence.

Climate is the dominant factor of soil formation. The region in which the LSA is located is underlain by continuous permafrost with sporadic occurrences of massive ground ice (WWF 2002). Due to the ubiquitous presence of permafrost and cryoturbation, 92% of the soils were classified as Cryosols (Table 4.4-1). Non-Cryosolic soils were found in sites where the permafrost was deep and no evidence of cryoturbation was found. Permafrost presence within 1 m of the surface was assumed at sites where bedrock prevented excavation to a full 1 m depth.

Table 4.4-1. The Areas and Relative Proportion of Soil Great Groups in the LSA

Soil Great Group	Area (ha)	% of the Inspected Polygon Area
Eutric Brunisols	40	0.2
Orthic Gleysols	107	0.5
Orthic Regosols	1,461	6.8
Organic Cryosols	2,107	9.8
Static Cryosols	15,303	71.4
Turbic Cryosols	2,325	10.9
non-soils	74	0.3
Total Inspected Area	21,418	100

4.4.2 Soil Texture and Erosion Potential

Approximately 35% of the soils in the LSA are coarse textured (sands, and loamy sands). Soils in this textural range are generally associated with marine, glaciofluvial and eolian deposits. Moderately coarse soils (sandy loams, loams, silt loams,) were recorded in over 46% of surveyed areas and were mainly associated with morainal deposits; but they were also found in fluvial, some glaciofluvial, and sporadically, even in lacustrine deposits. Medium-textured, moderately fine, and fine soils (sandy clay loams clay loams, silty clay loams, and silty clays) were recorded in less than 8% of surveyed areas and were found mainly in lacustrine, glaciolacustrine, and under some shallow organic deposits (Table 4.4-2). Polygons dominated by organic deposits and exposed bedrock were found in the remaining 12% of the inspected land.

Table 4.4-2. The Areas and Relative Proportion of Soil Textures in the LSA and their Erosion Potential

Soil Texture	Area (ha)	% of the Inspected Polygon Area	Soil Erosion Potential
Sand	1,883	9	low
Loamy Sand	5,514	26	low
Sandy Loam	7,568	35	moderate
Loam	1,280	6	high
Silt Loam	956	4	high
Sandy Clay Loam	398	2	moderate
Clay Loam	276	1	high
Silty Clay Loam	734	3	high
Silty Clay	339	2	moderate
Bedrock	181	1	low
Organic	2,288	11	low
Total Inspected Area	21,418	100	

Note: Classification of soil textures to erosion potential groups was guided by soil erodibility estimates (K) based on approximately 1,600 samples analysed by the Ontario Institute of Pedology (Wall et al. 1997).

Soils in the LSA are constantly subjected to physical stresses associated with extremely low temperatures, freezing, and thawing (e.g., cryoturbation, solifluction, seepage, nivation, and thermokarst). These phenomena have been exerting a powerful effect on soil erosion processes for millennia. Consequently, it appears that today most soils in the LSA do not show evidence of significant erosion when undisturbed. This phenomenon is likely further augmented by the general gentleness of slopes and landforms in the LSA. Actively eroding areas tend to be relatively small, isolated, and associated with specific terrain morphology (e.g., lower sections of long slopes), recent changes in permafrost depth, or human activity.

The smoothness of landforms and slope gentleness, which characterize most of the terrain in the LSA suggest that the slope factors (steepness and length) have a limited and relatively uniform effect on soil erosion potential. In contrast, soil erodibility varies considerably according to texture. Consequently, soil texture is expected to play a major role in determining the erodibility of any excavated or stockpiled material.

Field data suggest that about 39% of the area inspected during the field programs has soils characterized by low erodibility, 46% by moderate erodibility, and 15% by high erodibility. Table 4.4-2 provides a general overview of the relationship between soil texture and its erosion potential.

4.4.3 Soil Chemical Analysis

The analyses of soil reaction (pH) and metal concentrations were carried out to assist in the assessment of soil capability for salvage and reclamation. The analyses will also help to gauge potential changes in soil chemistry during the Project life. The analytical results of the 73 soil samples are summarized in Appendix 3.

4.4.3.1 Soil Reaction (pH)

Soil acidity is generally affected by mineralogical composition of the parent material, soil moisture index, and organic acids produced by vegetation and decaying organic matter. The parent materials are derived from granitic Precambrian rocks and calcareous meta-sedimentary rocks. Therefore, the soil base saturation and acidity are expected to vary according to their parent material. In time, however, the initial distribution pattern of soil reaction may be modified by two processes. Leaching of basic cations may create a gradient of increasing pH down the soil profile and down the slope. In wetlands, a combined effect of high soil leaching potential and the influx of acids from *Sphagnum* moss may result in the acidification of soils.

The analysis of field results suggests that in the LSA mineral soils are predominantly acidic. The pH of mineral soils ranged from 4.5 to 6.8. Median pH values were: 5.86 in the Goose Property area, 5.84 in the George Property area, and 5.44 near Bathurst Inlet. Soil pH tended to increase with soil depth. None of the surficial deposits present in the LSA differed substantially from others in terms of soil acidity. Analytical details are provided in Appendix 3.

The highest nutrient availability and the greatest microbial activity generally occur in soils within the pH range of 6.0 to 7.5. With decreasing soil pH, solubility of metal hydroxide minerals increases and more dissolved metals become potentially bio-available. While the pH of soil surficial horizons in the LSA is slightly below the optimum range, no association between the spatial patterns of soil reaction and metal concentration have been observed.

4.4.3.2 Metals

Concentrations of 31 metals in the soil samples were determined by the laboratory ICP method. Summary statistics of metal concentrations in the 0 to 5 cm soil depth zone are presented in Table 4.4-3 and the data from the 50 to 60 cm depth zone are presented in Table 4.4-4. To calculate summary statistics for concentrations below the detection limit, one half of the detection limit was used. Two metals (antimony and tin) were below the detection limit in 100% of the samples collected at reference sites. Samples from the Marine Laydown area (0 to 5 cm depth) had nine metals (cadmium, bismuth, beryllium, molybdenum, selenium, silver, sodium, thallium and tin) that were below the detection limit for all samples. At 50 to 60 cm depth, five metals (cadmium, molybdenum, selenium, silver and tin) were below the detection limit for all samples.

Table 4.4-3. Summary Statistics for Soil Samples Collected from the 0 - 5 cm Depth Zone in 2012, Back River Project

Parameters	CCME [a]	DL	Maximum	Minimum	Median	Mean	SD
pH (1:2 soil:water)	-	0.1	6.83	4.48	5.58	5.54	0.53
Aluminum (Al)	-	50	31,800.00	674.00	5,400.00	6,846.68	4,595.77
Antimony (Sb)	20	0.1	0.10	0.05	0.05	0.06	0.07
Arsenic (As)	12	0.05	55.40	0.35	6.13	8.44	9.55
Barium (Ba)	2,000	0.5	149.00	5.39	22.40	27.13	25.63
Beryllium (Be)	8	0.2	2.32	0.10	0.10	0.18	0.31
Bismuth (Bi)	-	0.2	0.75	0.10	0.10	0.11	0.09
Cadmium (Cd)	22	0.05	0.22	0.03	0.03	0.04	0.03
Calcium (Ca)	-	50	4,070.00	100.00	1,440.00	1,388.28	678.30
Chromium (Cr)	87	0.5	50.20	1.27	18.50	21.13	10.83
Cobalt (Co)	300	0.1	22.40	0.25	4.46	5.26	3.55
Copper (Cu)	91	0.5	86.70	0.25	11.20	13.99	13.08
Iron (Fe)	-	50	36,300.00	1,320.00	11,000.00	12,079.06	5,708.37
Lead (Pb)	600	0.5	8.00	0.25	2.48	3.10	1.64
Lithium (Li)	-	5	39.40	2.50	9.90	12.43	7.58
Magnesium (Mg)	-	20	14,300.00	254.00	3,260.00	4,014.26	2,524.72
Manganese (Mn)	-	1	696.00	5.60	81.00	110.04	96.52
Mercury (Hg)	50	0.005	0.072	0.003	0.006	0.012	0.015
Molybdenum (Mo)	40	0.5	0.90	0.25	0.25	0.35	0.19
Nickel (Ni)	50	0.5	47.50	0.52	11.80	14.72	9.60
Phosphorus (P)	-	50	973.00	2.50	388.00	389.05	160.91
Potassium (K)	-	100	5,290.00	190.00	430.00	637.17	847.03
Selenium (Se)	2.9	0.2	0.35	0.10	0.10	0.11	0.05
Silver (Ag)	40	0.1	0.11	0.05	0.05	0.05	0.01
Sodium (Na)	-	100	180.00	50.00	50.00	69.06	33.93
Strontium (Sr)	-	0.5	73.40	2.51	7.29	9.36	10.27
Thallium (Tl)	1	0.05	0.23	0.03	0.03	0.04	0.04
Tin (Sn)	300	2	2.00	1.00	1.00	1.00	0.00
Titanium (Ti)	-	1	1,480.00	27.60	341.00	339.83	196.88

(continued)

Table 4.4-3. Summary Statistics for Soil Samples Collected from the 0 - 5 cm Depth Zone in 2012, Back River Project (completed)

Parameters	CCME [a]	DL	Maximum	Minimum	Median	Mean	SD
Uranium (U)	300	0.05	3.06	0.13	0.45	0.53	0.40
Vanadium (V)	130	0.2	51.80	1.79	21.40	22.69	8.67
Zinc (Zn)	360	1	72.70	1.30	17.10	20.30	13.10

Notes
All sampling sites were located within the local study area.
Except pH all units are mg/kg (ppm) unless otherwise indicated.
Shaded cells indicate concentrations greater than CCME guideline levels.
DL = detection limit. To calculate summary statistics for concentrations below the detection limit, one half of the detection limit was used.
a) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.

Table 4.4-4. Summary Statistics for Soil Samples Collected from the 50 - 60 cm Depth Zone in 2012, Back River Project

Parameters	CCME [a]	DL	Maximum	Minimum	Median	Mean	SD
pH (1:2 soil:water)	-	0.1	6.97	5.58	6.06	6.20	0.46
Aluminum (Al)	-	50	12,700.00	766.00	4,730.00	5,550.80	2,889.09
Antimony (Sb)	20	0.1	0.16	0.05	0.05	0.06	0.02
Arsenic (As)	12	0.05	16.30	0.40	4.39	5.78	4.44
Barium (Ba)	2,000	0.5	199.00	5.67	24.30	37.67	41.75
Beryllium (Be)	8	0.2	0.52	0.10	0.10	0.13	0.10
Bismuth (Bi)	-	0.2	0.21	0.10	0.10	0.11	0.03
Cadmium (Cd)	22	0.05	0.06	0.03	0.03	0.03	0.01
Calcium (Ca)	-	50	2,480.00	140.00	1,650.00	1,556.80	568.80
Chromium (Cr)	87	0.5	44.70	1.55	16.20	18.79	9.91
Cobalt (Co)	300	0.1	18.90	0.40	4.11	5.27	3.92
Copper (Cu)	91	0.5	41.00	0.25	11.30	13.06	9.00
Iron (Fe)	-	50	22,800.00	1,500.00	9,585.00	10,723.50	4,764.74
Lead (Pb)	600	0.5	5.19	0.25	2.36	2.52	1.18
Lithium (Li)	-	5	23.40	2.50	8.45	9.92	5.43
Magnesium (Mg)	-	20	7,540.00	423.00	2,940.00	3,373.90	1,878.96
Manganese (Mn)	-	1	312.00	8.70	81.00	99.52	65.03
Mercury (Hg)	50	0.005	0.013	0.003	0.003	0.004	0.003
Molybdenum (Mo)	40	0.5	0.89	0.25	0.25	0.30	0.16
Nickel (Ni)	50	0.5	45.30	0.89	10.85	13.67	9.59
Phosphorus (P)	-	50	592.00	53.00	421.00	392.15	126.31
Potassium (K)	-	100	2,740.00	190.00	470.00	615.00	528.29
Selenium (Se)	2.9	0.2	0.10	0.10	0.10	0.10	0.00
Silver (Ag)	40	0.1	0.05	0.05	0.05	0.05	0.00
Sodium (Na)	-	100	280.00	50.00	50.00	83.00	55.36
Strontium (Sr)	-	0.5	84.50	4.78	7.43	12.58	17.52

(continued)

Table 4.4-4. Summary Statistics for Soil Samples Collected from the 50 - 60 cm Depth Zone in 2012, Back River Project (completed)

Parameters	CCME [a]	DL	Maximum	Minimum	Median	Mean	SD
Thallium (Tl)	1	0.05	0.10	0.03	0.03	0.04	0.02
Tin (Sn)	300	2	2.00	1.00	1.00	1.00	0.00
Titanium (Ti)	-	1	508.00	22.00	326.50	310.13	115.57
Uranium (U)	300	0.05	1.14	0.14	0.41	0.50	0.24
Vanadium (V)	130	0.2	30.50	2.04	21.45	20.69	7.29
Zinc (Zn)	360	1	46.10	1.60	15.10	17.41	10.37

Notes
All sampling sites were located within the local study area.
Except pH all units are mg/kg (ppm) unless otherwise indicated.
Shaded cells indicate concentrations greater than CCME guideline levels.
DL = detection limit. To calculate summary statistics for concentrations below the detection limit, one half of the detection limit was used.
a) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial limits.

Soil metal concentrations were compared to the industrial limits of the CCME Guidelines for the Protection of Environmental and Human Health (CCME 2012). Concentrations of five metals were naturally greater than the guidelines in soil samples collected at the 0 – 5 cm depth (Table 4.4-5). Metal concentrations found in the soil samples collected at the Goose Property and Marine Laydown Areas did not exceed the CCME guidelines. At the George Property and at some of the reference locations (NW, SE) arsenic was the only metal found to be above the recommended CCME guidelines limit.

Table 4.4-5. Sampling Sites where Soil Arsenic (As) Concentrations were naturally higher than the CCME Guidelines, Back River Project

Site	Depth	Percent of Samples (%)	Number of Sites	Sampling Sites
George Property	5	29	4	099-5, LBS-10, LBS-11, LBS-13
	60	14	2	099-60, 100-60
Reference	5	29	5	NW2, NW3, SW1, SE2, SE3
	60	0.0	0	

Notes:
CCME-I = CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

5. Summary

5. Summary

The LSA has the terrain and soil characteristics typical of the Arctic tundra environment. The land is dominated by gently undulating landscapes and rolling topography. Steep slopes exceeding 16% are rare, and their presence is generally confined to the northern part of the LSA.

The soils in the LSA have been classified into nine soil mapping units. Over half of the surficial materials of the LSA are derived from moraine deposits. Marine deposits are common in the northern section of the LSA, near Bathurst Inlet. Organic materials are also common, covering about 5% of the LSA. Soils are predominately moderately coarse textured (sandy loams and loams). Currently most soils do not show evidence of significant erosion, unless vegetative cover has been disturbed or is absent. The LSA has about 29% of soils characterized by low erosion potential, 38% by moderate erosion potential, and 33% by high erosion potential.

As a result of low temperatures and the annual freeze-thaw cycles, pedogenesis is limited. Climate conditions limit the accumulation and decomposition of organic matter, especially in the drier upland soils. Due to the presence of permafrost and cryoturbation, 89% of the soils were classified as Cryosols. The remaining 11% of the soils were classified as Regosols and Brunisols.

The metal concentrations of soil samples were below CCME industrial guidelines (CCME 2012) except for arsenic, which exhibited naturally elevated concentrations within the George Property area and some reference areas (e.g., NW, SE).

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Appendix 1
Terrain and Soil Inspection Data Summary

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Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-001	Back River	28-Jun-12	SH	TG	13	7381742	389634	9	112	gentle	10	150	LO	PL	ST	hmk	3	B	20	80	0	0	0	0	-		999	999	None	R
2012-002	Back River	28-Jun-12	TG	SH	13	7381403	389466	5	107	moderate	13	250	LO	PL	ST		5	D	5	95	0	0	0	0	seepage	35	50	39		SC
2012-003	Back River	28-Jun-12	SH	TG	13	7371017	395388	13	60	v.gentle	5	>500	LVL	PL	ST		2	B	90	10	0	0	0	0	-		999	100	None	R
2012-004	Back River	29-Jun-12	SH	TG	13	7382978	388115	40	1	flat	0	200	LVL	PL			8	B	0	95	0	0	5	0	-		40	20	None	SC
2012-005	Back River	29-Jun-12	TG	SH	13	7383368	388071	16	30	v.gentle	4	100	MD	PL	ST		4	C	0	99	1	0	0	0	seepage	45	65	50	None	SC
2012-006	Back River	29-Jun-12	TG	SH	13	7319591	387901	433	218	gentle	7	500	MD	PL	ST		6	C	1	98	0	0	0	0	-		40		None	SC
2012-007	Back River	29-Jun-12	SH	TG	13	7319279	387822	417	-	flat	0	-	TOE	PL	CC		7	C	0	99	1	0	0	0	-		24	22	None	OC
2012-008	Back River	29-Jun-12	SH	TG	13	7319088	387789	419	20	v.gentle	4	300	MD	PL	ST		6	C	1	96	3	0	0	0	-		40	10	None	SC
2012-009	Back River	29-Jun-12	SH	TG	13	7318991	387618	429	77	gentle	7	-	UP				2	B	2	13	0	0	0	85	-		99			SC
2012-010	Back River	12-Jun-12	TG	SH	13	7318798	367492	430	-	flat	0	-	LVL	PL	ST		8	B	0	75	15	0	10	0	-		25	8		OC
2012-011	Back River	30-Jun-12	SH	TG	13	7369976	395496	10	75	moderate	14	150	MD	LO	ST		5	C	0	100	0	0	0	0	-		20			SC
2012-012	Back River	30-Jun-12	TG	SH	13	7369910	395359	30	76	gentle	9	500	MD	LO	CV	mnd	3	B	10	90	0	0	0	0	-		64		None	TC
2012-013	Back River	30-Jun-12	SH	TG	13	7362983	398864	21	70	gentle	6	150	MD	LO	ST		3	B	0	100	0	0	0	0	-		75	71	None	SC
2012-014	Back River	30-Jun-12	SH	TG	13	7275723	422195	318	288	v.gentle	2	-	LVL	PL	ST	hmk	4	C	5	83	12	0	0	0	-		65	60	None	SC
2012-015	Back River	30-Jun-12	SH	TG	13	7275676	421991	300	-	flat	0	-	LVL	PL	ST	hmk	8	B	0	98	0	0	2	0	-		30	0	None	OC
2012-016	Back River	30-Jun-12	SH	TG	13	7275522	421877	310	-	v.gentle	2	-			ST		4	B	1	97	2	0	0	0	-		60	20		SC
2012-017	Back River	30-Jun-12	SH	TG	13	7275285	421707	313	-	v.gentle	2	-	MD	PL			5	B	0	0	0	0	0	0	-		60	30	None	SC
2012-018	Back River	01-Jul-12	SH	TG	13	7265810	421948	287	-	flat	0	100	DP	PL		st. hmk	6	B	1	99	0	0	0	0	-		28	26	None	SC
2012-019	Back River	01-Jul-12	SH	TG	13	7265824	422122	286	-	flat	0	-	LVL	PL	ST	mc. Hmk	8	B	0	80	10	0	10	0	-		26	0	None	SC
2012-020	Back River	01-Jul-12	SH	TG	13	7265928	422338	292	-	flat	0	200	CR		CV		1	A	0	5	95	0	0	0	-		999	1	None	R
2012-021	Back River	01-Jul-12	SH	TG	13	7226019	422368	285	-	v.gentle	2	-	LVL	PL			4	B	1	99	0	0	0	0	seepage	6	55		None	SC
2012-022	Back River	01-Jul-12	SH	TG	14	7266223	422431	286	-	flat	0	-	LVL	PL			8	B									35	0	None	SC
2012-023	Back River	01-Jul-12	SH	TG	15	7266447	422831	293				-															52	50	None	SC
2012-024	Back River	01-Jul-12	SH	TG	16	7266149	422928	292				-															52	50	None	SC
2012-025	Back River	01-Jul-12	SH	TG	17	7265940	423032	285	-	flat	0	-	LVL	PL			8	B									35	0	None	SC
2012-026	Back River	01-Jul-12	SH	TG	18	7265857	423276	297	-	flat	0	-	CR	PL			3	B									67	63	None	SC
2012-027	Back River	01-Jul-12	SH	TG	19	7265947	423442	286	-	flat	0	-	LVL	PL			8	B									20	0	None	SC
2012-028	Back River	01-Jul-12	SH	TG	20	7265016	423569	288	200	v.gentle	2	-	LVL	PL			6	B							seepage	25	77	17	None	SC
2012-029	Back River	01-Jul-12	SH	TG	21	7265940	423774	293	-	v.gentle	4	200					6	B							seepage	0	67	0	None	SC
2012-030	Back River	01-Jul-12	SH	TG	22							-																	None	-
2012-031	Back River	01-Jul-12	SH	TG	13	7265739	424838	292	-	flat	0	-	LVL	PL	ST	mnd	5	B	4	95	1	0	0	0	-		60	55	None	SC
2012-032	Back River	02-Jul-12	SH	TG	13	7265924	424900	293	-	flat	0	-	LVL	PL	ST	mnd	7	B	1	99	0	0	0	0	-		65	8	None	SC
2012-033	Back River	02-Jul-12	SH	TG	13	7265984	425094	295	-	flat	0	-	LVL	PL	ST		4	B	4	94	2	0	0	0	-		72	55	None	SC
2012-034	Back River	02-Jul-12	SH	TG	13	7265843	425342	284	-	v.gentle	2	-	LVL	PL		hmk	8	B	0	85	0	0	15	0	-		61	0	None	SC
2012-035	Back River	02-Jul-12	SH	TG	13	7265775	425479	286	-	v.gentle	3	-	MD	PL	ST		6	C	1	94	2	0	3	0	-		60		None	SC
2012-036	Back River	02-Jul-12	TG	SH	13	7265595	425976	313	-	v.gentle	3	300	MD	PL	ST		3	B	8	89	3	0	0	0	-		60	60	None	SC
2012-037	Back River	02-Jul-12	TG	SH	13	7244777	421813	316	-	flat	0	-	LVL	PL	ST		6	B	0	85	15	0	0	0	seepage	30	75	30	Chem	SC
2012-038	Back River	02-Jul-12	TG	SH	13	7275285	421704	312	106	v.gentle	3	300	MD	PL	ST		6	B	2	91	7	0	0	0	seepage	30	75	30		SC
2012-039	Back River	02-Jul-12	TG	SH	13	7276619	421932	314	220	v.gentle	3	300	MD	PL	ST		6	C	1	99	0	0	0	0	seepage	25	60	27	None	SC
2012-040	Back River	03-Jul-12	SH	TG	13	7262843	429879	326	-	flat	0	-	LVL	PL	ST		4	B	8	90	2	0	0	0	-		65	65	None	SC
2012-041	Back River	03-Jul-12	TG	SH	13	7262710	429678	312	40	v.gentle	3	300	MD	PL					5	60	35	0	0	0	-		55	55	None	SC
2012-042	Back River	03-Sep-12	TG	SH	13	7262900	429287	308	90	v.gentle	2	300	LVL	PL					10	89	1	0	0	0	-		90	60	None	TC
2012-043	Back River	03-Jul-12	TG	SH	13	7262664	429249	312	270	v.gentle	2	200	LVL	PL	ST	mnd	6	B	2	97	1	0	0	0	seepage	20	45	20	None	SC
2012-044	Back River	03-Jul-12	TG	SH	13	7262310	429451	312	10	v.gentle	2	200	LVL	PL	ST		4	B	8	92	0	0	0	0	-		75	75	None	SC
2012-045	Back River	03-Jul-12	TG	SH	13	7262426	429694	327	240	gentle	7	150	UP	PL	CV		4	B	5	60	25	0	0	10	-		75		None	SC
2012-046	Back River	03-Jul-12	TG	SH	13	7264484	431275	322	-	flat	0	250	LVL	PL	ST	tus	8	B	0	90	0	0	10	0	-		35	0	None	OC
2012-047	Back River	03-Jul-12	SH	TG	13	7264319	431216	324	30	v.gentle	2	200	LVL	PL	ST	mnd	6	B	1	98	1	0	0	0	seepage	27	55	27	None	SC
2012-048	Back River	03-Jul-12	SH	TG	13	7264179	431109	323	-	flat	0	>500	LVL	PL			4	B	1	39	60	0	0	0	-		60	60	None	SC
2012-049	Back River	03-Jul-12	TG	SH	13	7264932	430824	337	-	flat	0	>500	LVL	PL					8	67	15	0	0	10	-		80			SC
2012-050	Back River	04-Jul-12	TG	SH	13	7265703	423118	272	-	flat	1	250	UP	PL	ST		4	B	20	80	0	0	0	0	-		90		None	SC
2012-051	Back River	04-Jul-12	SH	TG	13	7265544	423079	279	-	flat	0	-	LVL	PL	ST	hmk	8	B	0	100	0	0	0	0	-		28	10	None	OC
2012-052	Back River	04-Jul-12	SH	TG	13	7265400	423099	277	-	flat	0	-	LVL	PL	CC				15	65	0	0	20	0	-		52	50	None	SC
2012-053	Back River	04-Jul-12	SH	TG	13	7265620	422916	280	-	flat	0	-	LVL	PL	ST		4	B	2	98	0	0	0	0	-		85		None	SC
2012-054	Back River	04-Jul-12	TG	SH	13	7265222	422747	290	30	gentle	7	150	UP	PL			3	B	2	76	7	0	0	15	-		30	30	None	SC
2012-055	Back River	05-Jul-12	TG		13	7269834	433891	892	240	v.gentle	2	200	LO	PL					0	0	0	0	0	0	seepage		75		None	TC
2012-056	Back River	05-Jul-12	TG		13	7269632	433950		-	flat	0	-	LVL	PL					0	0	0	0	0	0	-		75		None	SC
2012-057	Back River	05-Jul-12	TG		13	7269550	433882	290	350	v.gentle	4	300	LO	PL					0	0	0	0	0	0	seepage	40	65	64	Comp,Chem	SC
2012-058	Back River	05-Jul-12	TG		13	7269478	433684	297	95	v.gentle	2	300	UP	PL					0	0	0	0	0	0	seepage	25	80		None	TC
2012-060	Back River	06-Jul-12	TG	NB	13	7269429	433389	289	-	flat	0	-	LVL	PL			8	C	0	0	0	0	0	0	-		21	0	None	OC
2012-061	Back River	06-Jul-12	TG	NB		7271982	432332	265	-	flat	0	-	LVL	PL	ST	hmk	4	B	0	100	0	0	0	0	-		100	100	None	TC

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoneiness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-001	P	r		N		XRF	R	25	< 3 %		Tun	gs	WG	b	j																
2012-002		m		P		XRF	R	20	< 3 %		Tun	s	WG	v			L	X		c			LG			j					
2012-003	P	w	X	N			N	20	< 3 %	NS	Tun	s	WG	v			L	X		c			LG			j					
2012-004	P	v	X	Z	40			20	< 3 %	NS	Tun	e	O	x			X			c	z	s	M			u					
2012-005	P	w	X	N			R	25	< 3 %	NS	Tun		M		j	m	L	X													
2012-006	P,L	i	X	P	7		R	25	< 3 %	NS	Tun	cz	M		j		L	X													
2012-007	G	p		W			P		< 3 %	NS	Wet	e	O	v			X						M			b	u				
2012-008	L	i		P	8		R		< 3 %	NS	Tun	czg	M		j		L														
2012-009	P	r-w	X									bcg	M	x									R			j					
2012-010	P	v		Z			P	40	< 3 %	NS	Wet	e	O	v			X						R			p					
2012-011	P	m	n	Z	20		R	25	< 3 %	NS	Tun	cgz	M	b	j		X														
2012-012	P	w	n	K	23		R		< 3 %	NS	Tun	zcg	M	b	j		X														
2012-013	P	r		N				25	< 3 %	NS	Tun	sg	W		t																
2012-014	p,g	m					R	0	> 50 %	stony	Tun	szc	M	b	p		X														
2012-015	GP	v		Z	30		P	50	< 3 %	NS	Wet	e	O	v	p		X														
2012-016	G	i		W	20						Tun	zgs	M	b	p		X														
2012-017		i		W	30				16-50%	stony		scg	M	b	j																
2012-018	G	p		P			R	25	< 3 %	NS	Wet	sz	L		p		X														
2012-019	G	v		P	12		P	25	< 3 %	NS	Wet	e	O	x						z	c		L			p					
2012-020	P	r					N	0	< 3 %	NS	Tun	sg	FG		m																
2012-021	G	i					R	25	< 3 %	NS	Tun	zc	M	b	j		L														
2012-022	G	v							< 3 %	NS	Wet	e	O	x									L			p					
2012-023	G	w				023-5, 023-50	R		3-15%		Tun	sz	M	b	p																
2012-024	G	w					R		3-15%		Tun	sz	M	b	u																
2012-025	G	v		Z	35		P	25	< 3 %		Wet	e	O	x									L			p					
2012-026	P	w					R		3-15%		Tun	zsg	M	v	m																
2012-027	G	v					P	35	< 3 %		Wet	e	O	v									M			m					
2012-028	G	w					R				Tun	szg	M	b	m		L														
2012-029	G	w		Z	65		R		< 3 %	NS	Tun	szg	M	b	m		L														
2012-030													M																		
2012-031	G	m		N			R	25	< 3 %	NS	Tun	zsg	M	b	p																
2012-032	G	v		W	15		P	25	< 3 %	NS	Wet	en	O	x			X			s	z	g	M			p					
2012-033	G	m					R	25	< 3 %	NS	Tun	szg	M		p		X														
2012-034		v		N			P		< 3 %	NS	Wet	e	O	v						z	s	g	M			p					
2012-035	G	i		L			R		3-15%		Tun	e	O	x			X			s	c		M			x	j		l		
2012-036	G	w					R		3-15%		Tun	gzs	M	v			X			b			R			j					
2012-037	G	p					R		16-50%	stony	Tun	zsb	M		p		L	X													
2012-038	G	i					R		16-50%	stony	Tun	szb	M	v			L	X		b			R			p					
2012-039	G	p		N			R	20	< 3 %	NS	Tun		M		p		L														
2012-040	G	w							16-50%	stony	Tun	gzs	M	b	p																
2012-041	G	w					R		16-50%	stony	Tun	gzs	M	v												p					
2012-042	G,L	i				042-5, 042-60	R	20	< 3 %	NS	Tun	gsz	M	b			L						R			p					
2012-043	G,L	i					R		< 3 %	NS	Tun	zsg	M	v			L						R			p					
2012-044	G	w					R	25	< 3 %	NS	Tun	zs	M	b	p																
2012-045	P	m					R		> 50 %	stony	Tun	zs	M	x			X						R			u					
2012-046	G	v		Z	30		P	50	< 3 %	NS	Wet	e	O	v	p		X														
2012-047	G,L	p					R	25	< 3 %	NS	Tun	zs	M	b	p		L	X													
2012-048	G,P	w					R		> 50 %	stony	Tun	szb	M	v			X						R			p					
2012-049	P	w					R		> 50 %	stony	Tun	zgs	M	v			X						R				p				
2012-050	P	w				050-5, 050-60	R	25	< 3 %	NS	Tun	s	M	b	m		X														
2012-051	G	v					P	50	< 3 %	NS	Wet	e	O	v	p		X														
2012-052		p		P	24		N		< 3 %	NS	Tun	sz	F	v			X			z			L			b	p				
2012-053	G	w		N			R	25	< 3 %	NS	Tun	zs	E	b	p		L														
2012-054	P					054-5	N		> 50 %	stony	Tun	s	E	x									R			u	j				
2012-055	G	i		Z	2	055-5, 055-60	R	25	< 3 %	NS	Tun	z	M	b	p		L														
2012-056	G	v		W	10		P	20	< 3 %	NS	Wet	e	O	x			L	X		z	s		M			b	p				
2012-057	G	w					R					kzs	M	b	p		L	X													
2012-058	G	m		N			R	25	< 3 %	NS	Tun	zs	M	b	p		L	X													
2012-060	G	v						50	< 3 %	NS	Wet	e	O	v	p																
2012-061	G	w		N			R	25	< 3 %	NS	Tun	gzs	M	b	p		Z														

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-062	Back River	06-Jul-12	TG	NB	13	7271837	432216	267	-	flat	0	-	LVL	PL			4	B	0	100	0	0	0	0	-		90	90	None	SC
2012-063	Back River	06-Jul-12	TG	NB	13	7271947	431879	279	70	gentle	8	250	MD	PL	ST	smo	4	B	0	100	0	0	0	0	-		82	82	None	TC
2012-064	Back River	06-Jul-12	SH	TG	13	7271951	431608	298	70	v.gentle	2	300	CR	PL	CV	rocky	3	B	0	0	30	0	0	0	-		40	40	None	SC
2012-065	Back River	06-Jul-12	TG	NB	13	7272015	431370	303	-	flat	0	-	UP	PL	ST		4	B	0	0	0	0	0	0	-		90		None	TC
2012-066	Back River	06-Jul-12	TG	NB	13	7271767	431222	308	100	v.gentle	2	-	UP	PL	ST	smo	3	B	0	0	0	0	0	0	-		75		None	SC
2012-068	Back River	06-Jul-12	TG	NB	13	7271362	430885	301	-	flat	0	-	LVL	PL					0	100	0	0	0	0	-		60	16	None	SC
2012-069	Back River	06-Jul-12	TG	NB	13	7270920	431079	310	180	v.gentle	3	300	UP	PL	ST	smo	4	B	0	85	15	0	0	0	-		65	65	None	TC
2012-070	Back River	06-Jul-12	NB	TG	13	7270513	431180	295	110	v.gentle	4	200	UP	PL			3	B	0	0	0	0	0	0	-		99		None	SC
2012-071	Back River	07-Jul-12	TG	NB	13	7270511	431928	298	192	moderate	12	300	MD	PL			2	B	1	0	55	0	2	0	-		99		None	SC
2012-072	Back River	07-Jul-12	TG	NB	13	7270780	431849	321	176	v.gentle	2	150	UP	PL			3	B	0	6	94	0	0	0	-		80	80	None	TC
2012-073	Back River	07-Jul-12	TG	NB	13	7270651	431555	306	170	moderate	11	70	MD	PL		hummocky	5	C	4	93	3	0	0	0	-		70		None	SC
2012-074	Back River	07-Jul-12	TG	NB	13	7271065	431606	321	1	flat	0	-	LVL	PL	ST	sl smk	4	C	15	85	0	0	0	0	-		92		None	SC
2012-075	Back River	07-Jul-12	TG	NB	13	7265496	430617	343	-	flat	0	-	LVL	PL	ST	smo	4	B	45	0	15	0	0	0	-		99		None	SC
2012-076	Back River	07-Jul-12	TG	NB	13	7265397	430489	345	-	flat	0	-	LVL	PL	ST	sl hmk	5	B	5	85	10	0	0	0	seepage	5	70		None	OC
2012-077	Back River	07-Jul-12	TG	NB	13	7265678	430390	341	-	flat	0	-	LVL	PL		sm mnds	5	B	8	0	0	0	0	0	seepage	5	77		None	SC
2012-078	Back River	07-Jul-12	TG	NB	13	7265739	430256	339	-	flat	0	-	LVL	PL			1	A	0	0	92	0	0	0	-		70		None	SC
2012-079	Back River	08-Jul-12	NB	TG	13	7270658	429998	302	90	gentle	9	50	UP	PL	angular	undulating rock	1	A	0	0	80	0	0	0	-		99		None	SC
2012-080	Back River	08-Jul-12	TG	NB	13	7270914	429917	308	-	flat	0	-	LVL	PL			5	B	0	10	0	0	0	0	-		90	65	Chem	TC
2012-081	Back River	08-Jul-12	TG	NB	13	7271046	429997	311	218	v.gentle	4	150	MD	PL		flat			4	0	0	0	0	0	-		90		Chem	TC
2012-082	Back River	05-Jul-12	TG	NB	13	7271214	430070	317	-	flat	0	-	LVL	PL	ST	rockt	3	B	3	0	30	0	0	0	-		99			SC
2012-083	Back River	08-Jul-12	TG	NB	13	7271312	430066	317	-	flat	0	-	LVL	PL		hmk	6	B	0	3	6	0	0	0	seepage		90	10	None	TC
2012-084	Back River	08-Jul-12	TG	NB	13	7271362	430132	324	-	flat	0	-	LVL	PL	ST	rocky	3	B	3	63	30	0	0	4	-		99		None	TC
2012-085	Back River	08-Jul-12	TG	NB	13	7266054	430064	346	-	flat	0	-	DP	PL	ST	hmk	6	B	0	3	10	0	2	0	-		80		None	SC
2012-086	Back River	08-Jul-12	TG	NB	13	7265883	430065	249	-	flat	0	-	LVL	PL	ST	rocky	3	B	0	65	35	0	4	0	-		99			SC
2012-087	Back River	08-Jul-12	TG	NB	13	7266588	429897	346	-	flat	0	-	LVL	PL	ST	Rocky	4	B	5	50	35	0	10	0	-		55	55	None	SC
2012-088	Back River	08-Jul-12	TG	NB	13	7266707	729914	343	-	flat	0	-	LVL	PL	CC	sl hmk			0	85	0	0	10	5	-			17	None	SC
2012-089	Back River	09-Jul-12	TG	NB	13	7393677	381049	63	-	flat	0	-	CR	PL	ST	smo	1	A	82	15	5	0	0	0	-		999	999	None	R
2012-090	Back River	09-Jul-12	TG	NB	13	7393641	380972	51	180	mod.steep	20	250	MD	MD	ST	und	4	C	0	100	0	0	0	0	-		31		None	SC
2012-091	Back River	09-Jul-12	TG	NB	13	7393570	381115	51	200	moderate	14	250	MD	MD	ST	smo	2	A	25	72	3	0	0	0	-		999	50		R
2012-092	Back River	09-Jul-12	NB	TG	13	7393285	381195	27	200	gentle	9	200	TOE	LO	ST	smo	3	B	5	95	0	0	0	0	-		65	65	None	SC
2012-093	Back River	09-Jul-12	TG	NB	13	7893244	381176		200	v.gentle	5	250	TOE	LO	ST	hmk	8	B	0	98	0	0	10	0	-		90	25	None	SC
2012-094	Back River	10-Jul-12	TG	NB	13	7323974	372980	461	70	v.gentle	5	200	UP	PL	ST	smo	4	B	5	94	5	0	0	0	-		78	78	None	TC
2012-095	Back River	10-Jul-12	TG	NB	13	7324007	373212	397	-	flat	0	-	TOE	PL		hmk	7	B	0	100	0	0	0	0	-		80	13	None	SC
2012-096	Back River	10-Jul-12	TG	NB	13	7323917	373236	396	-	flat	0	-	DP	PL	ST	smo	8	B	0	90	0	0	10	0	-		35		None	OC
2012-097	Back River	10-Jul-12	TG	NB	13	7324023	373388	402	-	flat	0	-	CR	PL			1	A	0	40	60	0	0	0	-		99		None	SC
2012-098	Back River	10-Jul-12	TG	NB	13	7323976	373752	393	20	v.gentle	2	250	LO	PL	CV	smo	5	B	15	75	20	0	5	0	seepage	25	80			SC
2012-099	Back River	10-Jul-12	TG	NB	13	7323603	374310	395	30	v.gentle	2	100	UP	PL	ST	smo	5	B	2	95	3	0	0	0	-		90	90	None	SC
2012-100	Back River	10-Jul-12	TG	NB	13	7323246	374885	400	10	gentle	6	300	MD	PL	ST	hmk			5	97	1	0	0	0	-		55	55	None	TC
2012-101	Back River	11-Jul-12	TG	NB	13	7273311	429202	319	110	v.gentle	4	250	MD	PL	ST	smo	4	B	3	97	1	0	0	0	-		75	75	None	TC
2012-102	Back River	11-Jul-12	TG	NB	13	7273128	429226	315	90	v.gentle	5	150	LO	PL	ST	hmk	6	C	0	100	0	0	0	0	seepage		65		None	TC
2012-103	Back River	11-Jul-12	TG	NB	13	7273045	429284	309	-	flat	0	-	LVL	PL	ST	hmk	7	B	0	100	0	0	0	0	seepage		60		None	SC
2012-104	Back River	10-Jul-12	TG	NB	13	7272942	429112	326	40	gentle	6	250	MD	PL	ST	smo	5	B	1	99	0	0	0	0	-		55	55	None	TC
2012-105	Back River	11-Jul-12	TG	NB	13	7272453	428880	315	190	v.gentle	5	90	MD	PL	ST	smo	5	B	5	95	0	0	0	0	-		65		Chem	TC
2012-106	Back River	11-Jul-12	NB	TG	13	7272338	429339	318	-	flat	0	-	LVL	PL	ST		1	A	0	50	50	0	0	0	-		99		None	Ox/R nonsoil
2012-107	Back River	11-Jul-12	TG	NB	13	7272098	429293	316	310	v.gentle	4	300	LO	PL	ST	hmk	5	B	0	0	0	0	0	0	seepage	10	90		None	TC
2012-108	Back River	11-Jul-12	TG	NB		7271263	426967	305	-	flat	0	-	LVL	PL	ST	hmk	5	B	2	98	0	0	0	0	seepage	30	105	30	None	TC
2012-109	Back River	12-Jul-12	TG		13	7265375	434451	270	-	flat	0	-	LVL	PL	ST	hmk	7	B	9	90	0	0	0	0	-		43	32	Chem	SC
2012-110	Back River	12-Jul-12	TG		13	7269226	434037	279	40	gentle	7	250	MD	PL	ST	mnd	4	B	10	89	0	0	0	0	-		85	85	Chem	TC
2012-111	Back River	12-Jul-12	TG		13	7269324	433904	278	20	v.gentle	4	300	MD	PL	ST	hmk	6	C	10	27	0	0	0	0	seepage	25	99		Chem	SC
2012-112	Back River	14-Jul-12	TG		13	7270528	430485	308	200	moderate	11	100	MD	PL			4	B	10	85	5	0	0	0	-		60	60	Chem	TC
2012-113	Back River	14-Jul-12	TG		13	7270537	430369	298	200	gentle	6	-					1	A	0	25	15	0	0	60	-		99		None	SC
2012-114	Back River	14-Jul-12	TG		13	7270441	430081	296	-	flat	0	-	LVL	PL	ST		6	C	0	60	20	0	0	20	seepage	17	99		None	SC
2012-115	Back River	14-Jul-12	TG		13	7270268	429982	299	-	v.gentle	2	-	LVL	PL			1	A	0	20	80	0	0	0	seepage		99		None	SC
2012-116	Back River	14-Jul-12	TG		13	7270094	430058	296	100	gentle	8	20	LO	PL	ST				2	97	1	0	0	0	-		90		None	TC
2012-117	Back River	14-Jul-12	TG		13	7269303	433365	284	60	v.gentle	3	-	LO	PL	ST	LV	4	B	6	94	0	0	0	0	-		85		None	TC
2012-121	Back River	15-Jul-12	NB		13	7266336	421073	289	-	v.gentle	2	300	LVL	PL	ST		4	B	0	60	40	0	0	0	-		40	40	None	SC
2012-122	Back River	15-Jul-12	NB		13	7265934	422301	289		-		-	CR	PL	CV	smo	1	A	95	5	0	0	0	0	-				None	R
2012-123	Back River	15-Aug-12	NB		13	7266308	422309	282		-		-	LVL	PL	ST	smo	7	B	0	90	0	0	10	0	-		27	21		SC
2012-124	Back River	15-Jul-12	NB		13	7267350	422500	322	-	flat	1	200	CR	PL	ST	smo	2	A	10	75	15	0	0	0	-		36			R
2012-126	Back River	24-Jul-12	JS	DM	13	7277631	418493	322	60	gentle	6	100	MD	PL	CC	mnd	2	B	0	78	22	0	0	0	seepage	8	51			SC

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoneniness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-062	G	w		N			R	25	< 3 %	NS	Tun	gzs	M	b	p																
2012-063	G	w		N			R	25	< 3 %	NS	Tun	gzs	M	b	p																
2012-064	P	r		L	20	064-5, 065 - LICH	R		16-50%	stony	Tun	zs	M	x									R			j					
2012-065	P,G	w		N				25	< 3 %	NS	Tun	gzs	M	b	p		X														
2012-066	G	m		N			R		> 50 %	stony	Tun	zks	M	v	u																
2012-068	G	v		N			P	50	< 3 %	NS	Wet	e	O	v	p																
2012-069	P	w		N			R		> 50 %	stony	Tun	gzs	M	v			Z						R			u					
2012-070	G	w					R		< 3 %	NS	Tun	gks	M	x									R			j	u				
2012-071	P	r		L	10		R	0	> 50 %	stony	Tun	e	O	x			X						R			u	j				
2012-072	G	w		N			N	25	< 3 %	NS	Tun	gzs	M	b	j		X														
2012-073	G	i		N			R	16	16-50%	stony	Tun	gzs	M	v			L	X					R			j					
2012-074	G	m		N			R	25	< 3 %	NS	Tun	gzs	M	b	p																
2012-075	G	w		N			R		> 50 %	stony	Tun	zgs	M	v			X						R			p					
2012-076	G	i		P	20		R		< 3 %	NS	Tun	gz	M	v			L	X					R			p					
2012-077	G	i		N			R		3-15%		Tun	gzs	M	v			L	X					R			p					
2012-078	P	r		L	20		P		> 50 %	stony	Other	e	O	x									R			p					
2012-079	P	x		L			R		> 50 %	stony	Other	b	R		u	j															
2012-080	G	m		N			R		< 3 %	NS	Tun	kgs	M	b	p		X														
2012-081	G	w		N	10 -20		R	25	< 3 %	NS	Tun	gs	M	b	j	p	X	C													
2012-082	P	r		L	10-20				> 50 %	stony	Tun	kgs	M	x									R			m					
2012-083	G	i		c,p	10		R		16-50%	stony	Wet	zs	M	x			L	X	C				R			m					
2012-084	G	w		N			R		16-50%	stony	Tun	bgs	M	x			X			b			R			m					
2012-085	G	p		N			P		3-15%		Wet	e	O	x			X						R			p					
2012-086	G	i					R					bzs	M	x			X						R				p				
2012-087	P	w		N			R		16-50%	stony	Tun	gzs	M	v			X						R								
2012-088	G	v		N			P		< 3 %	NS	Wet	e	O	x			X			b	z	s	M			p					
2012-089	P	x		N			N		3-15%		Other	gs	WG		u																
2012-090	G	w		Z	31		R	50	< 3 %	NS	Tun	s	WG	v			L	W					WG			u					
2012-091	G	r		N			N		3-15%		Tun	s	WG	v			W						R				j				
2012-092	G	r		N			R	25	< 3 %	NS	Tun	s	WG	v			W						R			g					
2012-093	G	v		N			P	50	< 3 %	NS	Wet	e	O	v	a		X			s	c		L			p					
2012-094	G	w		N			R	25	< 3 %	NS	Tun	gsz	M	b	m		X														
2012-095	G	p		N			P		< 3 %	NS	Wet	gs	M	b	p		X														
2012-096	G	v		N			P	40	< 3 %	NS	Wet	u	O	x			X			s			M			b	p				
2012-097	P	x		N			N		> 50 %	stony	Tun	bgs	M		m																
2012-098	G	i		N			R		16-50%	stony	Tun	ksz	M	b	u	p	L														
2012-099	G	m		N			R	20	< 3 %	NS	Tun	sz	M	b	m		X														
2012-100	G	m		N			R		3-15%		Tun	kgz	M	v			X						R			j					
2012-101	G	w		N			R	25	< 3 %	NS	Tun	gs	M	b	j		X														
2012-102	G	i		C			R		< 3 %	NS	Tun	zs	M	b	j		L														
2012-103	G	p		P	20		P	50	< 3 %	NS		e	O	v			L			g	s	z	M			b	p				
2012-104	G	m		N			R	25	< 3 %	NS	Tun	zs	M	b	j		X														
2012-105	G	m		N			R	30	< 3 %	NS	Tun	zs	M	b			X														
2012-106	P	x		L					> 50 %	stony	Other	eu	O	x									R			p					
2012-107	G	i		N		107-5, 107-60	R	25	< 3 %	NS	Tun	gzs	M	b	j		L	X													
2012-108	G	i					R	25	< 3 %	NS	Tun	gzs	M	b	p		L	X													
2012-109	G	v		N			P	50	< 3 %	NS	Wet	e	O	v			X						M			p					
2012-110	G	w		N			R	25	< 3 %	NS	Tun	gzs	M	b	j		X														
2012-111	G	i		N			P		< 3 %	NS	Tun	e	O	x			L	X		b	k	s	M			b	j				
2012-112	G	w		N			R		3-15%		Tun	gs	M	v			X						R			j					
2012-113	P	x		L	0-8		R		> 50 %	stony	Other	u	O	x									R			m					
2012-114	G	m		L			R		16-50%	stony	Tun	gzs	M	x			L	X		b			R			m					
2012-115	P	r		L	0-12		N		> 50 %	stony	Other	b	R		m		L														
2012-116	G			N			R	25	< 3 %	NS	Tun	gzs	M	b	j		X														
2012-117	G	m		N			R	25	< 3 %	NS	Tun	gzs	M																		
2012-121	G	w		N			R		16-50%	stony	Tun	ksz	M	v	m		x						R								
2012-122	P	x							< 3 %	NS	Other	zsg	FG		r																
2012-123	G	v		WZ	27			25	< 3 %	NS	Wet	e	O		p		X														
2012-124	P	r		L	36				16-50%	stony	Tun	zsg	M	v	m		X														
2012-126	P	m		Z	51				3-15%		Tun	sz	M	w			L	X													

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-127	Back River	24-Jul-12	JS	NB	13	7282888	411496	329	90	gentle	8	75	MD	UP	CV	smo	2	B	3	65	10	0	0	22	-		42		None	SC
2012-128	Back River	24-Jul-12	JS	NB	13	7282209	412158	310	280	v.gentle	5	150	LO	PL	ST	smo	4	B	0	97	3	0	0	0	-		51		None	
2012-129	Back River	24-Jul-12	NB	JS	13	7291394	405085	295	240	gentle	9	150	MD	MD	ST	smo	4	B	3	97	1	0	0	0	-		46		None	SC
2012-130	Back River	24-Jul-12	NB	JS	13	7291815	404568	296	-	flat	0	300	LVL	PL	ST	smo			5	85	5	0	0	5	-		57		None	SC
2012-131	Back River	24-Jul-12	JS	NB	13	7294438	400385	291	-	v.gentle	2	300	TOE	PL	ST	sl mnd			0	100	0	0	0	0	-		55		None	SC
2012-132	Back River	17-Jul-12	WB		13	7269058	432325	299	26	v.gentle	3	200	MD	PL	ST	st	3	B	2	97	1	0	0	0	-					
2012-133	Back River	17-Jul-12	WB		13	7269221	432224	297		moderate	14	30	CR	PL	CV	mnd	2	B	5	75	15	0	0	5	-				None	
2012-134	Back River	17-Jul-12	WB		13	7269358	431812	306	0	gentle	8	200	MD	PL	ST	mc	3	B	2	94	4	0	0	0	-				None	
2012-135	Back River	17-Jul-12	WB		13	7269546	431433	301	0	v.gentle	5	300	MD	PL	CV	mc	3	B	2	92	6	0	0	0	seepage	100			None	
2012-136	Back River	17-Jul-12	WB		13	7269655	431205	301	340	v.gentle	3	200	MD	PL	ST	st	6	C	0	100	0	0	0	0	seepage	10	10			
2012-137	Back River	17-Jul-12	WB		13	7269591	431048	305	120	v.gentle	4	50	UP	PL	CV	mc	2	B	8	59	30	0	0	3	-					
2012-138	Back River	17-Jul-12	WB		13	7269727	430878	303	310	v.gentle	3	100	UP	PL	CV	mc	3	C	5	80	15	0	0	0	-					
2012-139	Back River	18-Jul-12	WB	RM	13	7269820	430640	295	-	v.gentle	2	100	dp	PL	ST	st	6	D	1	98	0	0	0	0	seepage	30	110	40	None	
2012-140	Back River	18-Jul-12	WB	RM	13	7270023	430287	291	20	v.gentle	5	200	MD	PL	ST	mc	3	B	5	85	10	0	0	0	-					
2012-141	Back River	18-Jul-12	WB	RM	13	7270085	430017	302	10	v.gentle	5	400	MD	PL	ST	mc	3	B	1	98	1	0	0	0	-		85		None	
2012-142	Back River	18-Jul-12	WB	RM	13	7270286	429978	287	300	v.gentle	4	150	LO	PL	CC	st/mnd	2	C	0	50	50	0	0	0	-					
2012-143	Back River	18-Jul-12	WB	RM	13	7269628	430268	301	170	gentle	9	50	LO	PL	CV	mc/smt	3	B	2	97	1	0	0	0	-					
2012-144	Back River	18-Jul-12	WB	RM	13	7269301	430353	297	-	flat	0	-	LVL	PL	ST	mc/smo	5	C	0	100	0	0	0	0	-		60			
2012-145	Back River	18-Jul-12	WB	RM	13	7269579	430178	301	-	v.gentle	2	100	LVL	PL	ST	sl/hmk	5	C	3	96	0	0	0	0	seepage	20	70			
2012-146	Back River	18-Jul-12	WB	RM	13	7269514	430075	302	312	v.gentle	2	100	TOE	PL	CC	mc/hmk	7	D	0	60	10	0	30	0	seepage	10	100			TC
2012-147	Back River	19-Jul-12	WB	RM	13	7269850	429677	300	-	v.gentle	2	100	CR	PL	CV	no mounds	2	B	15	7	78	0	0	0	-				None	
2012-148	Back River	19-Jul-12	WB	RM	13	7269459	429827	305	-	flat	1	30	CR	PL	CV	mc/und	2	B	10	40	25	0	0	25	-					
2012-149	Back River	19-Jul-12	WB	RM	13	7269494	429735	299	240	gentle	10	50	UP	PL	CV	mc/mnd	2	B	5	80	15	0	0	0	-				None	TC
2012-150	Back River	19-Jul-12	WB	RM	13	7269481	429626	305	230	v.gentle	3	100	TOE	PL	CC	sl/hmk	4	C	2	96	2	0	0	0	-		33			SC
2012-151	Back River	19-Jul-12	WB	RM	13	7269372	430082	296	10	v.gentle	4	200	MD	PL	ST	mc/hmk	5	C	0	100	0	0	0	0	-					TC
2012-152	Back River	19-Jul-12	WB		13	7269291	429741	292	240	v.gentle	4	150	TOE	PL	ST	mc	3	B	0	40	60	0	0	0	-				None	TC
2012-153	Back River	19-Jul-12	WB	RM	13	7269024	430060	297	-	v.gentle	2	200	LVL	PL	ST	mc/mnd	3	B	10	55	35	0	0	0	-		50			TC
2012-154	Back River	19-Jul-12	WB	RM	13	7268899	430048	297	-	flat	0	-	dp	PL	ST		7	C	0	90	0	0	10	0	seepage	5	30	10		OC
2012-155	Back River	19-Jul-12	WB	RM	13	7268410	430083	309	-	v.gentle	2	300	dp	PL	ST	mc	7	C	0	100	0	0	0	0	seepage	20	70	40		TC
2012-156	Back River	19-Jul-12	WB	RM	13	7268202	430101	300	170	gentle	6	200	LO	PL	CV	mc/mnd	3	B	5	80	15	0	0	0	-					TC
2012-157	Back River	20-Jul-12	WB	RM	13	7268386	429804	309	-	v.gentle	2	60	LVL	PL	ST	mc	2	B	10	65	15	0	0	10	-					
2012-158	Back River	20-Jul-12	WB	RM	13	7268256	429836	309	-	flat	1	200	LVL	PL	CC	md/hmk	6	B	0	100	0	0	0	0	seepage	0	80	0		TC
2012-159	Back River	20-Jul-12	WB		13	7268045	429981	311	-	v.gentle	2	40	MD	PL	CV	mc/mnd	4	C	15	65	20	0	0	0	-					
2012-160	Back River	20-Jul-12	WB		13	7267911	430074	319	-	flat	1	50	UP	PL	CV	mc/mnd	2	B	10	65	15	0	0	10	-					
2012-161	Back River	20-Jul-12	WB	RM	13	7267178	429962	317	300	v.gentle	3	200	LO	PL	ST	md/hmk	5	D	0	99	1	0	0	0	seepage	25		25		TC
2012-162	Back River	20-Jul-12	WB	RM	13	7267249	429722	307	250	v.gentle	3	70	MD	PL	C	mc/mnd	3	B	10	70	15	0	0	5	-					TC
2012-163	Back River	20-Jul-12	WB	RM	13	7267150	429541	306	-	flat	0	200	LVL	PL	ST	md/hmk	6	C	0	96	2	0	2	0	seepage	0	90	0		SC
2012-164	Back River	20-Jul-12	WB	RM	13	7266843	429498	318	-	flat	0	-	LVL	PL	ST	mc/mnd	4	B	0	0	50	0	0	0	seepage	40				
2012-165	Back River	20-Jul-12	WB	RM	13	7266777	429170	315	-	flat	0	-	LVL	PL	ST	mc/mnd	4	C	5	90	5	0	0	0	-					TC
2012-166	Back River	21-Jul-12	WB	RM	13	7266844	428994	311	-	flat	0	-	dp	PL	ST	st/hmk	6	B	0	98	2	0	0	0	seepage	60	100	10		TC
2012-167	Back River	21-Jul-12	WB	RM	13	7266616	429060	319	-	flat	0	-	LVL	PL	ST	mc/mnd	3	B	15	65	20	0	0	0	-					
2012-168	Back River	21-Jul-12	WB	RM	13	7266449	428961	324	0	v.gentle	3	100	MD	PL	CV	mc/mnd	3	B	15	60	25	0	0	0	-					
2012-169	Back River	21-Jul-12	WB	RM	13	7266633	428786	322	-	flat	1	200	TOE	PL	ST	st/hmk	5	B	2	95	3	0	0	0	-		70			SC
2012-170	Back River	21-Jul-12	WB	RM	13	7266524	428234	323	310	v.gentle	5	150	LO	PL	ST	st/hmk	6	B	0	93	2	0	5	0	seepage	20		50		TC
2012-171	Back River	21-Jul-12	WB	RM	13	7266714	428033	309	-	v.gentle	2	100	LVL	PL	ST		7	C	0	45	0	0	55	0	seepage	0	75	0		SC
2012-172	Back River	21-Jul-12	WB	RM	13	7266659	427840	318	350	v.gentle	5	100	MD	PL	ST	mc/mnd	3	B	2	96	2	0	0	0	-					
2012-173	Back River	21-Jul-12	WB	RM	13	7265905	427912	317	315	v.gentle	3	300	MD	PL	ST	mc/mnd	3	B	10	88	2	0	0	0	-				None	
2012-174	Back River	21-Jul-12	WB	RM	13	7266006	427708	317	350	v.gentle	4	200	LO	PL	CC	mc/mnd	3	B	5	93	2	0	0	0	-					
2012-175	Back River	21-Jul-12	WB	RM	13	7266206	427476	312	-	v.gentle	2	200	TOE	PL	ST	mc/hmk	7	B	5	65	30	0	0	0	seepage	0	70	10		SC
2012-176	Back River	22-Jul-12	WB		13	7266523	427364	313	-	flat	1	50	LVL	PL	CV	mc/mnd	3	B	5	87	8	0	0	0	-					
2012-177	Back River	22-Jul-12	WB		13	7266245	427085	312	-	flat	0	-	LVL	PL	ST	T	2	B	10	20	70	0	0	0	-					
2012-178	Back River	22-Jul-12	WB		13	7265617	426843	328	-	flat	1	50	LVL	PL	ST		2	B	15	60	25	0	0	0	-					
2012-179	Back River	22-Jul-12	WB		13	7265548	426703	317	-	v.gentle	2	50	LVL	PL	ST	st/hmk	5	C	0	98	2	0	0	0	seepage	50	70			TC
2012-180	Back River	22-Jul-12	WB		13	7265449	426452	325	300	v.gentle	4	75	CR	PL	CV	mc/mnd	3	B	5	70	25	0	0	0	-					
2012-181	Back River	22-Jul-12	WB		13	7266175	426301	311	-	flat	1	50	LVL	PL	ST	mc/mnd	3	B	10	55	35	0	0	0	-					
2012-182	Back River	22-Jul-12	WB		13	7266919	429836	317	280	v.gentle	3	60	UP	PL	CV	mc/mnd	2	B	10	75	15	0	0	0	-					
2012-183	Back River	22-Jul-12	WB		13	7266729	429830	316	-	flat	1	100	dp	PL	ST	sl/hmk	7	B	0	100	0	0	0	0	seepage	0	90	10		SC
2012-184	Back River	22-Jul-12	WB		13	7266728	430051	323	230	gentle	6	50	CR	PL	CV	mc/mnd	3	B	10	70	20	0	0	0	-					
2012-185	Back River	22-Jul-12	WB		13	7266562	430103	320	320	v.gentle	4	100	UP	PL	ST	mc/mnd	5	C	5	75	20	0	0	0	seepage	60				TC
2012-186	Back River	23-Jul-12	WB		13	7266309	430043	321	-	flat	1	200	LVL	PL	CV	st/und	2	B	10	40	10	0	0	40	-					

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoneniness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-127	P	w		L	42		N		16-50%	stony	Tun	sz	M	v			X														
2012-128	P & G	m					N		< 3 %	NS	Tun	s	M	v			X														
2012-129	P	m		Z	14		N		16-50%	stony	Tun	szg	M	w			X														
2012-130	P	w		Z	57				16-50%	stony	Tun	gzs	M		p		X														
2012-131	P & G	m	F	Z	55		N	55	< 3 %	NS	Tun	s	L	b	p		X														
2012-132	P	r			40		R	40	< 3 %	NS	Tun	ps	FG		p																
2012-133	P	r		L	30		R	20	16-50%	stony	Tun	ps	M	w									R			u					
2012-134	P	r					R	25	3-15%		Tun	ys	M	b																	
2012-135	P	r	X		35		R	40	3-15%		Tun	gs	M	b			L						R			u					
2012-136	SP	i	X	Z	10		R	30	< 3 %	NS	Tun	u	O	v			L			g	s		M			b					
2012-137	P	r	X	L	45		N	20	16-50%	stony	Tun	gs	M	v									R			u					
2012-138	P	w					R	30	3-15%		Tun	ms	M	b																	
2012-139	S	i	A	W	110		R	40	< 3 %	NS	Tun	u	O	v			L			s			M			b					
2012-140	P	w	X				R	40	3-15%		Tun	s	M	b																	
2012-141	P	w	X	Z	85		R	40	< 3 %	NS	Tun	s	M	b									R			j					
2012-142	P	r	X	L	10		L	0	> 50 %	stony	Tun	bz	F	x						k	b		M			b					
2012-143	P	w	X				R	30	< 3 %	NS	Tun	s	M	b																	
2012-144	S	m	X	Z	60		R	20	< 3 %	NS	Tun	ms	M		j																
2012-145	P	l	X	Z	70		R	10	< 3 %	NS	Tun	ms	M		j		L														
2012-146	S	p	F	W	10		R	60	3-15%		Tun	u	O	v			L			k	s		M			b					
2012-147	P	r	X				N	10	16-50%	stony	Tun	psg	F		j																
2012-148	P	x	X	L	0-50		R	0	> 50 %	stony	Tun	sg	M	w									R			j					
2012-149	P	r		L	45		R	20	3-15%		Tun	gs	M	w									R			j					
2012-150	S	w		Z	33		R	20	< 3 %	NS	Tun	gs	M		j																
2012-151	P	w		N			R	30	< 3 %	NS	Tun	gs	M	b																	
2012-152	S	w		N			R	30	16-50%	stony	Tun	gsg	F	v						s	p		FG			p					
2012-153	P	w	X	Z	50		R	40	3-15%		Tun	s	M	b																	
2012-154	S	v		Z	30		R	0	< 3 %	NS	Tun	u	O	b			L														
2012-155	S	p		Z	70		R	15	< 3 %	NS	Tun	u	O	v			L			s			M			b					
2012-156	P	w	X	N			R	50	3-15%		Tun	s	M	b																	
2012-157	P	r	X	L	20		R	20	16-50%	stony	Tun	sm	M	w									R			u					
2012-158	S	p	A	W	0		R	0	< 3 %	NS	Tun	s	M	b			L														
2012-159	P	w	X	N			R	55	3-15%		Tun	gs	M	b									R			u					
2012-160	P	r	X	L	20		R	15	16-50%	stony	Tun	sm	M	w									R			u					
2012-161	S	i	A	L	30				< 3 %	NS	Tun	gm	F	v			L														
2012-162	P	r	X	L	35		R	15	16-50%	stony	Tun	sr	M	w																	
2012-163	S	p	A	W	0		R	0	< 3 %	NS	Tun	gs	M		j		L														
2012-164	P	w	X				R	15	> 50 %	stony	Tun	s	M	w			L														
2012-165	P	m	X				R		< 3 %	NS	Tun	ms	M		j																
2012-166	S	p		W	10		R	0	< 3 %	NS	Tun	pms	M	b			L														
2012-167	P	r					R	50	3-15%		Tun	ps	M	b																	
2012-168	P	r					R	46	16-50%	stony	Tun	gs	M	b																	
2012-169	S	p		Z	70		R	25	< 3 %	NS	Tun	ms	M	b																	
2012-170	S	p		W	50		R	25	< 3 %	NS	Tun	gms	M	b			L														
2012-171	S	v	A	W	0		R		< 3 %	NS	Tun	u	O	v			L			m	s		M			b					
2012-172	P	w	X				R	40	3-15%		Tun	gms	M	b																	
2012-173	P	r	X				R	50	< 3 %	NS	Tun	ms	M	b																	
2012-174	P	w	X	K			R	20	< 3 %	NS	Tun	s	M	b																	
2012-175	S	p		W	10		R		3-15%		Tun	u	O	v			L			z	r		D			w					
2012-176	P	r	X					50	3-15%		Tun	gs	M	b																	
2012-177	P	r	X	L	15		L		> 50 %	stony	Tun	ms	E	w																	
2012-178	P	r	X	L	50		L	30	3-15%		Tun	zg	M	w																	
2012-179	P	l	F	Z	70		R	40	< 3 %	NS	Tun	s	M	b			L														
2012-180	P	r					L	30	3-15%		Tun	gs	M	b																	
2012-181	P	w	X				L	30	3-15%		Tun	pzk	M	b																	
2012-182	P	r		L	35		L	25	3-15%		Tun	gs	M	v									R								
2012-183		p	A	W	10		R		< 3 %	NS	Tun	ms	M	b			L														
2012-184	P	w	X				R	45	3-15%		Tun	gms	M	b																	
2012-185	P	l					R	30	3-15%		Tun	gms	M	b			L														
2012-186	P	r	X	L	30		L	10	> 50 %	stony	Tun	ds	M	w																	

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-187	Back River	23-Jul-12	WB		13	7265925	430083	325	-	flat	1	30	LVL	PL	ST	mc/mnd	3	B	10	55	35	0	0	0	-					TC
2012-188	Back River	23-Jul-12	WB		13	7265867	430224	328	-	v.gentle	2	30	LVL	PL	CV	mc/mnd	3	B	30	60	10	0	0	0	-					
2012-189	Back River	23-Jul-12	WB		13	7265689	430465	332	-	v.gentle	2	100	LVL	PL	ST	mc/mnd	3	B	15	77	8	0	0	0	-					TC
2012-190	Back River	23-Jul-12	WB		13	7265708	430746	331	105	v.gentle	5	50	CR	PL	CV	st/und	1	B	10	35	15	0	0	40	-					
2012-191	Back River	23-Jul-12	WB		13	7265355	430680	328	-	flat	1	100	dp	PL	ST	st/hmk	5	B	0	95	5	0	0	0	seepage	10	60			SC
2012-192	Back River	23-Jul-12	WB		13	7266561	426101	306	340	v.gentle	3	70	LO	PL	ST	mc/mnd	3	B	10	75	15	0	0	0	-					TC
2012-193	Back River	23-Jul-12	WB		13	7266901	425954	298	-	v.gentle	2	400	MD	PL	ST	mc/hmk	5	C	0	98	2	0	0	0	seepage	20				G
2012-194	Back River	23-Jul-12	WB		13	7267418	425913	299	-	flat	1	500	LVL	PL	ST	st/hmk	6	C	0	100	0	0	0	0	seepage	0	70	0		SC
2012-195	Back River	23-Jul-12	WB		13	7268151	425365	295		gentle	10	25	CR	PL	CV		1	B	29	6	65	0	0	0	-					B
2012-196	Back River	24-Jul-12	DM	WB	13	7280889	414755	311	20	gentle	6	50	MD	PL	CV	mc/mnd	3	B	10	60	30	0	0	0	-					
2012-197	Back River	24-Jul-12	DM	WB	13	7281536	413770	305	-	v.gentle	4	40	CR	PL	CV	mc/mnd	3	B	20	55	25	0	0	0	-					
2012-198	Back River	24-Jul-12	WB		13	7290041	408517	315	210	gentle	10	100	UP	PL	CV	mc/mnd	2	B	15	5	60	0	0	20	-					
2012-199	Back River	24-Jul-12	WB		13	7289299	408885	285	200	moderate	15	75	MD	PL	CV	mc/mnd	3	B	10	55	35	0	0	0	-				None	
2012-200	Back River	13-Jul-12	NB		13	7312683	388237	354	-	v.gentle	2	150	LVL	PL	ST	smo	2	A	20	80	0	0	0	0	-		98		None	SC
2012-201	Back River	13-Jul-12	NB		13	7312696	388808	352	350	v.gentle	3	100	LVL	PL	ST	smo	3	B	0	90	10	0	0	0	-		41		None	SC
2012-202	Back River	14-Jul-12	NB		13	7326460	402785	384	50	flat	1	200		LO	ST	hmk	4	C	55	45	0	0	0	0	seepage	9	61		None	SC
2012-203	Back River	14-Jul-12	NB		13	7326009	402298	385	-	v.gentle	3	300	LVL	PL	ST	sl hmk	4	A	45	54	2	0	0	0	seepage	6	28			SC
2012-204	Back River	14-Jul-12	NB		13	7325514	401949	367	-	flat	1	100	TOE	LO	ST	sl hmk	7	C	0	98	0	0	2	0	-		38	33		OC
2012-205	Back River	14-Jul-12	NB		13	7320971	401898	358	-	flat	1	300	LVL	PL	ST	smo	3	C	45	45	10	0	0	0	-		16			SC
2012-206	Back River	14-Jul-12	NB		13	7320003	402571	360	-	flat	0	250	LVL	PL			3	C	45	55	5	0	0	0	seepage	7	73		None	SC
2012-212	Back River	16-Jul-12	NB		13	7331158	402114	293	-	v.gentle	3	300	LVL	PL	ST	smo	3	D	40	50	10	0	0	0	-		54	54		SC
2012-213	Back River	16-Aug-12	NB		13	7331599	402063	293	-	v.gentle	3	35	CR	PL	CV	smo	3	B	3	15	6	0	0	16	-		40			R
2012-214	Back River	16-Jul-12	NB	JS	13	7331581	401992	294	0	v.gentle	4	200	TOE	LO	ST	hmk	5	C	0	70	28	0	2	0	seepage	45	63	63	None	R
2012-215	Back River	16-Jul-12	NB		13	7336980	403159	274	-	flat	0	100	CR	PL	ST	smo	1	A	40	30	30	0	0	0	-		16			R
2012-216	Back River	16-Jul-12	NB		13	7338457	403253	218		-		-	LVL	PL	ST	smo	3	D	30	70	0	0	0	0	-		60			R
2012-217	Back River	16-Jul-12	NB		13	7339694	402987	208	25	gentle	10	100	MD	UP	ST	terraced	3	D	0	95	5	0	0	0	-		60			R
2012-218	Back River	17-Jul-12	NB		13	7313374	402793	363		-		300	LVL	PL	ST	smo	4	B	50	40	10	0	0	0	-		77			TC
2012-219	Back River	17-Jul-12	NB		13	7313324	402723	361		-		-	LVL	PL	ST	rocky			0	10	90	0	0	0	-			87		non soil
2012-220	Back River	17-Jul-12	NB		13	7312093	403144	373	-	v.gentle	4	300	LO	LO	ST	smo	4	C	20	77	3	0	0	0	seepage	29	56			R
2012-221	Back River	17-Jul-12	NB		13	7311068	403566	379	-	v.gentle	3	300	CR	PL	ST	smo	1	A	90	10	0	0	0	0	-					
2012-222	Back River	17-Jul-12	NB	JS	13	7343290	404272	113	20	v.gentle	3	300	MD	MD	ST	smo	5	C	2	98	0	0	0	0	seepage	18	69			R
2012-223	Back River	17-Jul-12	NB		13	7342512	404090	142	40	gentle	10	300	LO	UP	ST	smo	4	C	0	100	0	0	0	0	-					R
2012-224	Back River	17-Jul-12	NB		13	7341702	403750	161	100	v.gentle	4	300	LO	LO	ST	sl hmk	3	C	0	98	2	0	0	0	-		43			R
2012-225	Back River	17-Jul-12	NB		13	7314172	386369	386	-	v.gentle	2	300	CR	PL	ST	smo			30	35	20	0	0	15	-		44		None	R
2012-226	Back River	18-Jul-12	NB		13	7312832	387696	343	220	v.gentle	3	50	LVL	PL	ST	smo	3	B	55	35	10	0	0	0	-		14		Chem	R
2012-227	Back River	18-Jul-12	NB	JS	13	7312866	387874	323	-	flat	0	100	LVL	LO	ST	hmk	7	C	0	100	0	0	0	0	-		59		Chem	SC
2012-228	Back River	18-Jul-12	NB		13	7312534	389125	353	-	flat	0	300	CR	UP		smo	4	C	20	65	15	0	0	0	-		49		None	SC
2012-229	Back River	18-Jul-12	NB		13	7312559	389625	348	-	v.gentle	3	300	LVL	PL	ST	hmk	7	C	0	100	15	0	2	0	seepage	15		19		OC
2012-230	Back River	18-Jul-12	NB		13	7312973	389607	354	345	v.gentle	5	50	MD	MD		hmk	2	B	0	60	10	0	0	30	-		32		None	SC
2012-231	Back River	18-Jul-12	NB		13	7313064	389360	336	330	gentle	6	200	MD	MD	ST	smo	7	C	0	100	0	0	0	0	seepage	8	34		Chem	SC
2012-232	Back River	18-Jul-12	NB		13	7309350	402300	407	280	v.gentle	5	100	LVL	PL	ST	smo	3	B	5	60	35	0	0	0	-		53		None	SC
2012-233	Back River	18-Jul-12	JS	NB	13	7308877	402229	413	-	flat	1	150	LVL	PL	ST	sl hmk	6	B	0	95	0	0	5	0	seepage	11	36	33	None	SC
2012-234	Back River	19-Jul-12	NB	SB	13	7307153	401399	417	110	v.gentle	4	100	CR	PL	ST	smo	1	B	80	20	0	0	0	0	-				None	R
2012-235	Back River	19-Jul-12	NB	SB	13	7297397	400533	298	1	flat	0	300	LVL	PL	ST	smo	1	A	15	80	5	0	0	0	-		23		None	SC
2012-236	Back River	19-Jul-12	NB	SB	13	7296930	401245	328	1	flat	1	150	CR	PL	ST	smo	3	C	5	55	3	0	0	37	-		85		None	SC
2012-237	Back River	19-Jul-12	NB	SB	13	7296580	401464		1	v.gentle	2	100	LVL	PL	ST	smo	8	C	0	99	0	0	1	0	-		70	14	None	SC
2012-238	Back River	19-Jul-12	NB	JS	13	7295568	402004	301	120	gentle	7	300	MD	MD	ST		4	B	5	90	5	0	0	0	-		52		None	SC
2012-239	Back River	19-Jul-12	NB	SB	13	7295164	402206	287	-	v.gentle	4	300	LVL	PL	ST	hmk	7	A	0	5	0	0	95	0	seepage		47	29	None	SC
2012-240	Back River	19-Jul-12	NB	DM	13	7301268	399843	323	162	v.gentle	3	300	TOE	LO	ST	hmk			0	100	0	0	0	0	-		23	3	None	SC
2012-241	Back River	20-Jul-12	DM	SB	13	7394062	380983	15	1	flat	1	150	MD	PL	ST	mnd	2	A	0	95	5	0	0	0	-			53	None	R
2012-242	Back River	20-Jul-12	NB	JS	13	7393901	380520	20	210	gentle	6	300	MD	MD	ST	smo	4	B	0	100	0	0	0	0	-		33		None	SC
2012-243	Back River	20-Jul-12	NB	DM	13	7393830	379730	5	-	flat	1	100	LVL	PL	ST	smo	4	B	0	100	0	0	0	0	seepage	50	60	50		OC
2012-244	Back River	21-Jul-12	NB	DM	13	7389061	381838	2	-	flat	1	300	LVL	PL	ST	smo	5	B	0	100	0	0	0	0	seepage	42	83			SC
2012-245	Back River	21-Jul-12	NB	DM	13	7388956	381876	5	340	v.gentle	2	300	LVL	PL	ST	mnd	3	B	0	100	0	0	0	0	-		42			SC
2012-246	Back River	20-Jul-12	NB	SB	13	7393700	379901	3	-	flat	0	300	LVL	PL	ST	smo			0	100	0	0	0	0	-		28	14		G
2012-247	Back River	20-Jul-12	NB	DM	13	7392672	378679	5	-	flat	0	-	LVL	PL	ST	mnd	6	D	0	100	0	0	0	0	-		33	33		SC
2012-248	Back River	20-Jul-12	NB	SB	13	7392172	378895	10	44	v.gentle	4	150	UP	PL	CV	mnd	3	B	2	95	3	0	0	0	-		45			SC
2012-249	Back River	20-Jul-12	NB	SB	13	7386710	382773	32	62	gentle	6	200	MD	MD	ST	mnd	3	C	0	100	0	0	0	0	-		21			R
2012-250	Back River	21-Jul-12	JS	DM	13	7388604	382116	3	270	gentle	6	50	UP	UP	ST	smo	3	B	2	98	0	0	0	0	-					
2012-251	Back River	21-Jul-12	JS	DM	13	7382963	385245	16	314	v.gentle	5	50	MD	LO	ST	mnd	4	B	10	90	0	0	0	0	-		68			SC

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoneniness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-187	P	w	X				R	40	> 50 %	stony	Tun	gms	M	w																	
2012-188	P	w	X				R	50	3-15%		Tun	gs	M	b																	
2012-189	P	w	X				R	50	< 3 %	NS	Tun	gs	M	b																	
2012-190	P	x	X	L	20		N	0	> 50 %	stony	Tun	z	E	w									R								
2012-191	S	I	A	Z	60		L	20	< 3 %	NS	Tun	ms	M	b			L														
2012-192	P	w					R	35	3-15%			ms	M	b																	
2012-193	P	I					R	20	< 3 %	NS	Tun	s	M	b			L														
2012-194	S	p	A	W	0		R	20	< 3 %	NS	Tun	u	O	x			L			p	m	s	M			b					
2012-195	P	r	X				N		> 50 %	stony	Tun	spg	F		j		D														
2012-196	P	w	X				R	20	3-15%		Tun	gs	M	b																	
2012-197	P	w					R		3-15%		Tun	mgs	M	b																	
2012-198	P	r	X	L	60		N	20	> 50 %	stony	Tun	gs	M	w			D														
2012-199	P	w	X				N	25	3-15%		Tun	mgs	M	b																	
2012-200	P	r		Z	98		N		< 3 %	NS	Other	s	FG		r																
2012-201	P	w		Z	41		R		3-15%		Tun	gs	M	w			X														
2012-202	P	m		Z	61		N		16-50%	stony	Tun	gs	M	b			L	C	X												
2012-203	P	m		Z	0				3-15%		Tun	gs	M	b	j		L	X													
2012-204	G	p		WZ	38				< 3 %	NS	Tun	h	O	b			L	X													
2012-205	P	w		Z	16				16-50%	stony	Tun	gs	M	b	j		X														
2012-206	P	w				BMz + Cz			3-15%		Tun	s	M				L	X													
2012-212	P	w		N			R		16-50%	stony	Tun	sg	M	b	p		X														
2012-213	P	w		N			R		16-50%	stony	Tun	zg	M		m		X														
2012-214	G & P	i		W	63		R		16-50%	stony	Tun	sg	M	b	j		L	X													
2012-215	P	r		L	16				> 50 %	stony	Tun	gs	M	v			X														
2012-216	P	w					L		3-15%		Tun	gs	M	b	p		X														
2012-217	P	w					R		3-15%		Tun	szg	M	w	j		X														
2012-218	P	m							16-50%	stony	Tun	gs	M		p		X														
2012-219	G	r		L	0				> 50 %	stony	Other		M	b			U														
2012-220	P	w							3-15%		Tun	zgs	M	b			L	X													
2012-221	P								16-50%	stony		egs	M	b	m		X														
2012-222	P	i					R	70	< 3 %	NS	Tun	gs	M	b	j	p	L														
2012-223	P	m					L		3-15%		Tun	hcs	O	b	j																
2012-224	P	w					L	0	3-15%		Tun	gs	M	b			X														
2012-225	P	w		N					16-50%	stony	Tun	sgz	M	v	m		X														
2012-226	P	w		L	14		L		> 50 %	stony	Tun	gzs	M	v	m		X														
2012-227	G	p		Z			L	50	< 3 %	NS	Tun	z	L		p		X														
2012-228	P	w		L	49		L	49	3-15%		Tun	s	M	w	m		N														
2012-229	G	v		W, Z	19			25	< 3 %	NS	Tun	e	O	b			L	X													
2012-230	P	w		L	32		L		3-15%		Tun	gz	M	w			Z														
2012-231	G	p		K	34		L	34	< 3 %	NS	Tun	zsg	L	vw			L	X													
2012-232	P	w		L	53		L	50	16-50%	stony	Tun	gs	M	v			X														
2012-233	G	i		Z	36		N	19	< 3 %	NS	Tun	e	O	v			L	X													
2012-234	P	x		N			N		< 3 %	NS	Tun	gs	FG		r		N														
2012-235	P	r		L	23		L		16-50%	stony	Tun	gs	M	v			X														
2012-236	P	w		N			L		16-50%	stony	Tun	zgs	M	w	r		X														
2012-237	G	v		W	14			60	< 3 %	NS	Wet	e	O		p		X														
2012-238	P	w		N			L	40	3-15%		Tun	gs	C	b	j		S														
2012-239	G	p		Z	47			40	3-15%		Tun	e	O	v			L			s			L			p			L	X	
2012-240	G	v		Z				20	< 3 %	NS	Wet	e	O	v			L			s			L			b			X		
2012-241	P, G	m		W	53		L		< 3 %	NS	Tun	gs	W	b	j		W														
2012-242	P	m		Z	33		R	30	< 3 %	NS	Tun	cz	M	b			X														
2012-243	P	i	A	X				60	< 3 %	NS	Tun	zc	W		p		L	W								x					
2012-244	G	I		Z		42			< 3 %	NS	Tun	z	W		p		L	W													
2012-245	P	m		Z	41		R		< 3 %	NS	Tun	cz	W	b	p		X														
2012-246	G	p		W	14		R		< 3 %	NS	Tun	s	W	v	p		W			z			W			v	p				
2012-247	G	I		W	33		R		< 3 %	NS	Tun	s	W		p		W														
2012-248	P	w		N			D		3-15%		Tun	gs	M	b			X														
2012-249	P	w		L	21		R		3-15%		Tun	gs	W	v			W														
2012-250	P	w		Z	41							sr	W	v	j		W			s			W			b	j		W		
2012-251	P	mw		68	z		R		< 3 %	NS	Tun	z	W	v			X			s			W			b			X		

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-252	Back River	21-Jul-12	NB	DM	13	7382930	385382	5	-	flat	0	300	LVL	PL	ST	smo	7	C	0	100	0	0	0	0	-		98	2		
2012-253	Back River	21-Jul-12	NB	DM	13	7377134	388191	30		flat		300	LVL	PL	ST	smo			5	95	0	0	0	0	-		77			
2012-254	Back River	22-Jul-12	NB	DM	13	7316563	385997	416	60	v.gentle	3	300	LVL	MD		sl mnd	3	A	2	38	30			30	seepage	7	80			SC
2012-255	Back River	21-Jul-12	DM		13	0	0		20	gentle	9	100	MD	LO		sl mnd	2	A	0	60	40	0	0	0	-		85			SC
2012-256	Back River	22-Jul-12	JS	NB	13	7316532	385756	393	245	moderate	12	300	MD	MD	CV	smo but rocky			15	40	15	0	0	30	-		99			SC
2012-257	Back River	22-Jul-12	NB	DM	13	7381303	387300	4	-	flat	0	300	LVL	PL	ST	smo			45	55	0	0	0	0	-		130			R
2012-258	Back River	22-Jul-12	NB	DM	13	7381247	387451	5	250	flat	1	300	LVL	PL	ST	smo	3	B	0	100	0	0	0	0	-		56			
2012-259	Back River	22-Jul-12	NB		13	7381330	387626	4	250	flat	1	300	LVL	PL					0	0	0	0	0	0	-		87	87		G
2012-260	Back River	22-Jul-12	NB		13	7370890	395331	19	106	-		300	LVL	PL	ST	smo	2	A	0	0	0	0	0	0	-					
2012-261	Back River	23-Jul-12	NB		13	7363221	398837	12	82	v.gentle	4	250	MD	LO	ST	hmk	5	C	0	100	0	0	0	0	-		91			SC
2012-262	Back River	23-Jul-12	NB		13	7362909	398999	15	80	gentle	10	250			ST	sl smk			0	100	0	0	0	0	-		99			SC
2012-263	Back River	23-Jul-12	NB	DM	13	7359770	401974	5	1	flat	0	250	LVL	PL	ST		5	B	0	100	0	0	0	0	-		103			SC
2012-264	Back River	23-Jul-12	JS	SB	13	7359715	402456	14	-	flat	0	300	LVL	PL	MC	smo	4	B	15	20	0	0	0	0	-		67	60		SC
2012-265	Back River	23-Jul-12	JS	SB	13	7359875	402475	10	-	flat	0	300	LVL	PL	MC	hmk	5	C	10	10	0	0	0	0	-		50	38		TC
2012-267	Back River	23-Jul-12	JS	SB	13	7359885	402248	8	-	flat	0	300	LVL	PL					45	0	0	0	0	0	-		99	59		SC
2012-268	Back River	23-Jul-12	JS	SB	13	7371661	391069	87	-	flat	1	200	UP	MD					15	25	0	0	0	0	-		63			SC
2012-269	Back River	23-Jul-12	JS	SB	13	7370751	391747	103	250	gentle	8	300	MD	MD					0	0	0	0	0	0	seepage	9	32			SC
2012-272	Back River	23-Jul-12	NB	DM	13	7370512	391714	43	236	moderate	12	75	MD	MD			3	B	5	95	0	0	0	0	-		85			SC
2012-273	Back River	27-Jul-12	KG	SH	13	7264743	428876	331	-	v.gentle	4	150	MD	PL	ST	mnd	3	B	5	80	15	0	0	0	seepage	30				TC
2012-274	Back River	23-Jul-12	DM		13	7363239	398460	60	82	gentle	9	100	MD	MD	CC	sl mnd	3	B	5	85	10	0	0	0	-		80			SC
2012-275	Back River	23-Jul-12	DM	SB	13	7362922	398589	60	88	gentle	8	100	MD	MD	CV	sl mnd	3	B	0	95	5	0	0	0	-		100			SC
2012-278	Back River	23-Jul-12	JS	NB	13	7363494	398683	12	64	v.gentle	3	300	DP	LO	ST		7	C	0	100	0	0	0	0	-		82	14		SC
2012-279	Back River	23-Jul-12	NB	DM	13	7371211	391266	36	240	gentle	8	200	LO	LO	ST	sl smk	3	B	3	97	0	0	0	0	-		50			SC
2012-287	Back River	27-Jul-12	SH	KG	13	7264358	428969	319	-	flat	0	-	LVL	PL	ST	hmk	6	B	0	96	0	0	4	0	seepage	12	90	10		SC
2012-288	Back River	27-Jul-12	SH	KG	13	7264077	428543	314	222	v.gentle	2	300	LO	PL	CV	mnd	5	C	1	98	1	0	0	0	-		90			SC
2012-289	Back River	27-Jul-12	KG	SH	13	7264030	428849	323		-		-	LO	PL	CV		3	B	5	85	10	0	0	0	-		100			TC
2012-290	Back River	27-Jul-12	SH	KG	13	7264039	429283	323	-	v.gentle	3	250	LO	PL	ST	mnd	5	C	2	98	0	0	0	0	-		80			SC
2012-291	Back River	27-Jul-12	SH	KG	13	7264175	429898	326	-	v.gentle	2	500	MD	PL	ST	hmk	6	C	5	89	6	0	0	0	seepage	0				TC
2012-292	Back River	28-Jul-12	SH	KG	13	7263382	430796		-	flat	0	-	LVL	PL	ST		3	B	8	90	2	0	0	0	-		90			TC
2012-293	Back River	28-Jul-12	SH	KG	13	7263000	430558	315	-	v.gentle	2	-	LO	PL			6	C	3	96	1	0	0	0	seepage		90			TC
2012-294	Back River	28-Jul-12	SH	KG	13	7262732	431230	320		-		-	LVL	PL	ST	hmk	7	B	6	87	7	0	0	0	seepage	0				TC
2012-295	Back River	28-Jul-12	SH	KG	13	7263492	431658	336	-	v.gentle	3	200	MD	PL	ST		4	B	3	97	0	0	0	0	-		100			TC
2012-296	Back River	29-Jul-12	SH	KG	13	7273347	432124	280		-		-	LVL	PL					0	0	0	0	0	0	seepage	0	63	55		SC
2012-297	Back River	29-Jul-12	SH	KG	13	7273644	432752	304	24	gentle	9	100	UP	PL	CV		3	B	5	70	10	0	0	15	-		100			TC
2012-298	Back River	29-Jul-12	SH	KG	13	7274061	431431	270		-		-	LVL	PL	ST		3	B	6	90	4	0	0	0	-		100			TC
2012-299	Back River	29-Jul-12	SH	KG	13	7273674	430226	303	-	v.gentle	3	250	MD	PL	ST	mnd	4	C	10	89	1	0	0	0	-		100			TC
2012-300	Back River	29-Jul-12	SH	KG	13	7274325	429304	327	136	gentle	6	200	MD	PL	ST		4	B	10	89	1	0	0	0	-		100			SC
2012-301	Back River	24-Jul-12	WB	RM	13	7294554	400439	273	-	v.gentle	2	40	UP	PL	CC	mnd	2	B	5	60	25	0	0	10	-					
2012-302	Back River	25-Jul-12	WB	RM	13	7296472	400043	279	-	flat	0	40	LVL	PL	ST	hmk	7	C	0	80	0	0	20	0	seepage	0	50	0		SC
2012-303	Back River	25-Jul-12	WB	RM	13	7295507	400520	289	45	v.gentle	5	250	TOE	PL	ST	mnd	3	B	15	55	30	0	0	0	-					
2012-304	Back River	25-Jul-12	WB	RM	13	7293092	401091	279	-	flat	0	-	LVL	PL	ST		2	B	5	85	10	0	0	0	-					
2012-305	Back River	25-Jul-12	WB	RM	13	7285792	406018	273	-	flat	0	-	LVL	PL	CV		0	A	0	10	80	0	0	10	-					
2012-306	Back River	25-Jul-12	WB	RM	13	7284731	407461	277	320	v.gentle	3	100	MD	PL	CC	mnd	4	C	5	60	35	0	0	0	-					
2012-307	Back River	25-Jul-12	WB	RM	13	7283458	409812	300	-	v.gentle	2	50	MD	PL	ST	mnd	3	B	10	75	15	0	0	0	-			7		
2012-308	Back River	26-Jul-12	WB	RM	13	7267016	422981	284	-	v.gentle	2	50	LVL	PL	ST	mnd	3	B	10	75	15	0	0	0	-					
2012-309	Back River	26-Jul-12	RM		13	7266991	421985	281	-	v.gentle	2	200	LVL	PL	ST	mnd	3	B	5	55	35	0	0	5	-					
2012-310	Back River	26-Jul-12	WB	RM	13	7266742	421318	279	-	flat	0	-	LVL	PL	ST	mnd	5	C	2	93	5	0	0	0	-		80			SC
2012-311	Back River	26-Jul-12	WB	RM	13	7265435	422067	276	0	v.gentle	5	10	LO	PL	CC	mnd	3	B	10	75	15	0	0	0	-					
2012-312	Back River	26-Jul-12	WB	RM	13	7267996	422996	287	32	v.gentle	5	150	MD	PL	ST	mnd	4	C	10	65	25	0	0	0	-		60			TC
2012-313	Back River	26-Jul-12	WB	RM	13	7267983	421976	307	-	flat	0	-	LVL	PL	CV	mnd	3	B	15	60	25	0	0	0	-					TC
2012-314	Back River	26-Jul-12	WB	RM	13	7267936	420993	293	-	flat	1	100	LVL	PL	ST	hmk	6	C	0	97	3	0	0	0	seepage	10	90	40		TC
2012-315	Back River	27-Jul-12	WB	RM	13	7267745	428334	309	-	flat	0	-	LVL	PL	ST	mnd	2	B	5	65	30	0	0	0	-					TC
2012-316	Back River	27-Jul-12	WB	RM	13	7268681	428501	296	270	v.gentle	5	200	LO	PL	ST	mnd	3	B	5	60	35	0	0	0	-					
2012-317	Back River	27-Jul-12	WB	RM	13	7269819	428692	289	-	flat	1	50	LVL	PL	ST	mnd	4	C	20	70	10	0	0	0	-					TC
2012-318	Back River	28-Jul-12	WB	RM	13	7265097	421745	310	-	flat	0	-	LVL	PL	ST	mnd	4	C	10	60	30	0	0	0	-					TC
2012-319	Back River	28-Jul-12	WB	RM	13	7273602	425832	310	-	v.gentle	3	150	MD	PL	ST	mnd	4	C	3	95	2	0	0	0	-					TC
2012-320	Back River	28-Jul-12	WB	RM	13	7274860	422401	306	-	v.gentle	2	100	LVL	PL	ST	mnd	4	C	25	65	10	0	0	0	-		90			TC
2012-321	Back River	29-Jul-12	WB	RM	13	7281001	414110	293	-	v.gentle	2	100	LVL	PL	ST	mnd	5	C	5	85	10	0	0	0	seepage	50		60		TC
2012-322	Back River	29-Jul-12	WB	RM	13	7279162	416673	321	250	v.gentle	4	100	MD	PL	ST	mnd	2	B	15	60	25	0	0	0	-					
2012-323	Back River	29-Jul-12	WB	RM	13	7278140	417830	309	245	v.gentle	3	250	LO	PL	ST	hmk	6	C	0	100	0	0	0	0	seepage	10		20		SC

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoniness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-252	G	v		Z	98		R		< 3 %	NS	Wet	csz	W	b	p		X														
2012-253	P	r		Z	77				< 3 %	NS		gs	F		pt																
2012-254	P	m							> 50 %	stony	Tun	r	D				L														
2012-255	P	w							> 50 %	stony	Tun	r	D																		
2012-256	P	r					R		3-15%			zsg	M	v	m		X														
2012-257	P	r		N					< 3 %	NS		s	W	b	p		W														
2012-258	P	r		Z	56				< 3 %	NS	Tun	s	W	b	p		W														
2012-259	G	p							< 3 %	NS		cz	W	b	p		W														
2012-260	P	r							3-15%		Tun	s	W	b	p		W														
2012-261	P	l		Z	91				< 3 %	NS	Tun	s	W	b	j		W														
2012-262	P	m					N		< 3 %	NS	Tun	s	W	b	j		W														
2012-263	P	i	A					40	< 3 %	NS	Tun	zc	W		p																
2012-264	G	m		W	60				< 3 %	NS		s	W	b	p		W														
2012-265	G	l		W	38				< 3 %	NS	Tun	s	W	b	p		W														
2012-267	P	m		W	59				< 3 %	NS	Other	s	W	b	p		W														
2012-268	P	w		Z	63			50	< 3 %	NS	Tun	s	F		t		X														
2012-269	G	i		Z	32			30	< 3 %	NS	Tun	sz	F		t		L	X													
2012-272	G	w							16-50%	stony	Tun	sz	FG																		
2012-273	P	w	X				R	50	3-15%		Tun	gs	M	b			L	Z													
2012-274	P	w							16-50%	stony	Tun	r	W	v									D								
2012-275	P/G	w							16-50%	stony	Tun	vs	W	b																	
2012-278	G	p		Z	82				< 3 %	NS	Wet	gs	W	b	j		W														
2012-279	G	m		Z					3-15%		Tun	s	W	b																	
2012-287	G	i		W	10				< 3 %	NS	Tun	u	O	x			L			g	s		M			b			x		
2012-288	G	i			25				< 3 %	NS	Tun	gs	M	b			X														
2012-289	P	w		L					3-15%		Tun	x	M	v									D			u					
2012-290	G	i		W					< 3 %	NS	Tun, Wet	u	O	x						s			M			b			x		
2012-291	G	i		W					< 3 %	NS		s	M	b			L														
2012-292	P	w		Z	90				< 3 %	NS	Tun	gs	M	b			Z	X		x			D			u					
2012-293	G			Z	90				< 3 %	NS	Tun	gs	M	b			L														
2012-294	G	p		L, W	0				3-15%		Tun	u	O	x			L			x			D			p					
2012-295	P	w							< 3 %	NS	Tun	gs	M	b	j																
2012-296	G	p		W					< 3 %	NS	Tun	u	O	v			L			g	s		M			p			x		
2012-297	P	w		L	40				3-15%		Tun	x	M	w			Z						R			j					
2012-298	P	w							3-15%			gs	M	b	p		Z														
2012-299	P	w							< 3 %	NS	Tun	gs	M	b	j																
2012-300	P	w							< 3 %	NS	Tun	gs	M	b	j																
2012-301	P	r	X	L			R	25	3-15%		Tun	z	E	x						m	s		M			w					
2012-302	G	p	A	W	10		R	0	< 3 %	NS	Tun	z	LG				L														
2012-303	P	w	X					40	3-15%		Tun	gs	M	b																	
2012-304	P	r					R		< 3 %	NS	Tun	z	E	x						s	g		M			b					
2012-305	P	x	X	L	10		N	0	> 50 %	stony	Tun	x	D	x																	
2012-306	P	w	X					15	3-15%		Tun	sg	M	b																	
2012-307	P	w	X				R	20	3-15%		Tun	mgs	M	b																	
2012-308	P	w	X				R	50	3-15%		Tun	s	M	v						p	s		M			p					
2012-309	P	w	X	L	50		R	32	16-50%	stony	Tun	mgs	M	w									R								
2012-310	P	m		Z	80		R	45	< 3 %	NS	Tun	s	FG		p																
2012-311	P	r					R	26	16-50%	stony	Tun	sx	M	b																	
2012-312	P	m	X	Z	60		R	30	16-50%	stony	Tun	gs	M	b			X														
2012-313	P	w					R	20	3-15%		Tun	sx	M	b			X														
2012-314	G	i		Z	90		R	20	< 3 %	NS	Tun	ps	M	b			L	X													
2012-315	P	r		L	50		R	40	16-50%	stony	Tun	mgs	M	v			C														
2012-316	P						R	35	3-15%		Tun	s	M	b																	
2012-317	P	w	X				R	35	< 3 %	NS	Tun	ms	M	b			X	C													
2012-318	P	m	X				R	40	16-50%	stony	Tun	gs	M	w			C	X													
2012-319	P	m					R	40	< 3 %	NS	Tun	gsm	M	b			C														
2012-320	P	w	X				R	45	< 3 %	NS	Tun	ms	M	b			C														
2012-321	P	m	X	W	60		R	50	3-15%		Tun	gs	M	b			L	C													
2012-322	P	r	X	L	38		R		16-50%	stony	Tun	mrs	M	w																	
2012-323	G	l	X	W	20		R		< 3 %	NS	Tun	gs	M	b			L	X													

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Project	Date	Surveyor1	Surveyor2	UTM	Northing	Easting	Elevation	Aspect	Slope	Slope%	Slope Length	Slope Position	Slope Position (Macro)	Surface Shape	Microtopography	Soil Moisture	Soil Nutrients	Cover Bare Min Soil	Cover Organic Matter	Cover Rock	Cover CWD	Cover Water	Cover Bedrock	Soil Seepage Check	Seepage Depth	Permafrost Depth	Water Table	Disturbance	Soil Class Site
2012-501	Back River	30-Jul-12	KG	SH	13	7269761	438981	303		-		-	LVL	PL			3	B	6	78	15	0	0	1	-		100			SC
2012-502	Back River	30-Jul-12	KG	SH	13	7273959	445412	270		-		-	LVL	PL	ST		3	B	2	83	15	0	0	0	-		100			TC
2012-503	Back River	30-Jul-12	KG	SH	13	7273277	437185	279		-		-	LVL	PL	ST	mnd	6	B	1	98	1	0	0	0	-		30			TC
2012-504	Back River	30-Jul-12	KG	SH	13	7273204	436458	279		-		-	LVL	PL			3	B	11	80	8	0	0	1	-					TC
2012-506	Back River	31-Jul-12	KG	SH	13	7255183	430896	301		-		-	LVL	PL	ST		5	B	0	100	0	0	0	0	-		76			TC
2012-507	Back River	31-Jul-12	KG	SH	13	7254088	431255	315		-		-	LVL	PL	ST		3	B	12	81	7	0	0	0	-					SC
2012-508	Back River	31-Jul-12	KG	SH	13	7257297	425568	276	114	v.gentle	5	300	LO	PL	ST		5	C	2	98	0	0	0	0	-					TC
2012-509	Back River	01-Aug-12	KG	SH	13	7272782	427686	293		-		-			ST		3	B	7	93	0	0	0	0	-		100			TC
2012-510	Back River	01-Aug-12	KG	SH	13	7272248	426928	337	344	v.gentle	5	200	UP	PL	CV		3	B	15	83	2	0	0	0	-					SC
2012-511	Back River	01-Aug-12	KG	SH	13	7269989	428847	298		-		-	LVL	PL	ST	st.hmk	7	B	3	96	1	0	0	0	seepage	27	75			TC
2012-512	Back River	03-Aug-12	KG	SH	13	7266620	434285	312	-	v.gentle	3	200	LVL	PL	ST		4	B	1	99	0	0	0	0	seepage	75	85			TC
2012-513	Back River	04-Aug-12	KG	SH	13	7282349	430812	311	-	v.gentle	2	-	LVL	PL	ST		3	B	8	85	7	0	0	0	-		100			TC
2012-514	Back River	04-Aug-12	KG	SH	13	7282094	417529	340	-	v.gentle	3	-	LVL	PL	ST		4	B	10	70	20	0	0	0	seepage	20	55			TC
2012-515	Back River	05-Aug-12	KG	SH	13	7248460	429002	295		-		-	TOE	PL	ST		6	B	0	100	0	0	0	0	seepage	26	26			SC
2012-516	Back River	05-Aug-12	KG	SH	13	7248228	429548		256	v.gentle	5	100	UP	PL	ST		2	B	2	85	10	0	0	3	-					SC
2012-517	Back River	05-Aug-12	KG	SH	13	7260985	438666	306		-		-	LVL	PL	ST		2	B	15	82	3	0	0	0	-					TC
2012-518	Back River	06-Aug-12	KG	SH	13	7268889	450589	236	58	moderate	11	50	UP	PL	ST		2	B	40	60	0	0	0	0	-					R
2012-519	Back River	06-Aug-12	KG	SH	13	7270005	448628	280	44	gentle	7	-	MD	PL	ST		2	B	10	78	12	0	0	0	-					SC
2012-520	Back River	06-Aug-12	KG	SH	13	7265760	444788	323	-	flat	0	-	LVL	PL	ST	st.hmk	5	B	0	100	0	0	0	0	seepage	55	84			TC
2012-521	Back River	07-Aug-12	KG	SH	13	7271447	416805	331	224	gentle	8	20	UP	PL	ST		3	B	8	90	2	0	0	0	-					SC
2012-057	Back River	05-Jul-12	TG		13	7269550	433882	290	350	v.gentle	4	300	LO	PL					0	0	0	0	0	0	-		65	64	Comp,Chem	SC

Appendix 1. Terrain and Soil Inspection Data Summary

Plot	Water Source	Soil Drainage	Flooding Regime	Root Restriction	Root Restriction Depth	Soil Samples	Humus Form	Salvage Depth	Surface Stoniness	Stoniness	Landuse	Surface Texture	Surf Mat	Surf Ex Thick	Surf Ex Topo	Surf Ex Topo2	Geo-Process(1)	Geo-Process(2)	Geo-Process(3)	Sub-Surface Texture1	Sub-Surface Texture2	Sub-Surface Texture3	Sub-Surf Mat1	Sub-Surf Mat2	Sub-Surf Mat3	Sub-Surf Ex1	Sub-Surf Ex2	Sub-Surf Ex3	Sub_Surf Geo_Pr1	Sub-Surf Geo-Pr2	Sub-Surf Geo-Pr3
2012-501	P	r-w		L					3-15%		Tun	r	M	w	h		Z														
2012-502	P	r-w							3-15%		Tun	ds	M	w	u																
2012-503	G	p	Inactive	Z	30				< 3 %	NS	Wet	u	O	x						s			F			p			x		
2012-504	P	w							3-15%		Tun	ds	M		u		Z														
2012-506	G	m		Z	76				< 3 %	NS	Tun	s	FG		p		L														
2012-507	P	w		K	12				3-15%		Tun	gs	M		u		Z														
2012-508	P	w-m		K					< 3 %	NS	Tun	sz	M	b	j		W														
2012-509	P	w		K	0				< 3 %	NS	Tun	s	M		u		S	Z													
2012-510	P	w							< 3 %	NS	Tun	ks	M		j		Z														
2012-511	G	p							< 3 %	NS		s	M		u		L	X													
2012-512	P								< 3 %	NS	Tun	gs	M		j		L	X													
2012-513	P	w		L	36				3-15%		Tun	ds	M	w			Z			d			D			u					
2012-514	G	i							16-50%	stony	Tun	gs	M	w			L			d			D			u			z		
2012-515	G	i							< 3 %	NS	Wet	u	O	v			L			c	z		F			p					
2012-516	P	w		L	41				3-15%		Tun	gs	M	w						d			D			j					
2012-517	P	w							3-15%		Tun	ds	M	v																	
2012-518	P	x-r	X						< 3 %	NS		s	FG		m																
2012-519	P	x-r	X						3-15%		Tun	ks	M		j																
2012-520	G	i		W	50				< 3 %	NS	Tun	gs	M		p		L														
2012-521	P	w	X						< 3 %	NS	Tun	sz	M		j		Z														
2012-057	G	w					R	0				kzs	M	b	p		L	X													

Appendix 2

Terrain Maps of the Local Study Area

Included on CD

Appendix 3
Analytical Results of Soil Sampling

Rescan™ Engineers and Scientists

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
Date: 31-Jul-12

RESULTS OF ANALYSIS

Sample ID	023-5	023-60	042-5	042-60	049-5
Date Sampled	1-Jul-12	1-Jul-12	1-Jul-12	3-Jul-12	3-Jul-12
ALS Sample ID	L1178856-1	L1178856-2	L1178856-3	L1178856-4	L1178856-5
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.86	5.72	5.93	6.00	5.86
Metals					
Aluminum (Al)	3020	3880	6360	5900	5400
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	5.53	4.62	8.76	10.3	7.03
Barium (Ba)	15.5	19.7	23.3	23.2	25.1
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1310	1100	1620	1630	1690
Chromium (Cr)	10.4	12.5	22.0	20.4	18.5
Cobalt (Co)	2.71	2.70	5.15	6.26	5.84
Copper (Cu)	6.46	13.3	15.2	16.7	14.2
Iron (Fe)	6870	7070	11500	11400	11000
Lead (Pb)	1.54	1.92	2.48	2.63	2.78
Lithium (Li)	6.0	5.3	11.8	11.1	9.4
Magnesium (Mg)	1720	1570	4320	3970	3150
Manganese (Mn)	51.6	45.1	97.7	99.1	96.2
Mercury (Hg)	<0.0050	0.0067	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	7.38	10.9	15.7	16.5	14.8
Phosphorus (P)	344	354	445	445	479
Potassium (K)	280	260	550	520	400
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	100	<100	100
Strontium (Sr)	5.59	5.55	5.62	5.76	6.03
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	228	219	285	305	341
Uranium (U)	0.274	0.471	0.421	0.487	0.433
Vanadium (V)	14.2	15.6	19.7	20.7	21.4
Zinc (Zn)	9.0	9.3	20.8	19.5	16.4

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
Date: 31-Jul-12

RESULTS OF ANALYSIS

Sample ID	049-60	050-5	050-60	053-5	053-60
Date Sampled	3-Jul-12	4-Jul-12	4-Jul-12	4-Jul-12	4-Jul-12
ALS Sample ID	L1178856-6	L1178856-7	L1178856-8	L1178856-9	L1178856-10
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.72	6.16	6.64	5.93	6.79
Metals					
Aluminum (Al)	5840	3960	3610	7070	8160
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	6.72	7.00	7.90	6.29	7.08
Barium (Ba)	22.7	24.2	24.1	62.4	74.7
Beryllium (Be)	<0.20	<0.20	<0.20	0.22	0.26
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1750	1470	1370	2290	2220
Chromium (Cr)	19.4	13.5	13.0	24.8	26.4
Cobalt (Co)	4.82	4.46	3.90	6.42	6.12
Copper (Cu)	17.3	7.72	7.69	11.1	11.5
Iron (Fe)	11000	7830	7600	13600	14900
Lead (Pb)	2.79	1.94	1.60	3.28	3.77
Lithium (Li)	8.6	6.9	7.0	10.7	12.6
Magnesium (Mg)	3160	2110	2240	4100	4310
Manganese (Mn)	88.2	70.6	70.1	125	131
Mercury (Hg)	0.0125	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	12.2	9.58	9.50	14.4	15.0
Phosphorus (P)	592	378	318	571	519
Potassium (K)	440	450	430	730	870
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	130	130
Strontium (Sr)	6.95	7.44	5.60	20.2	21.5
Thallium (Tl)	<0.050	<0.050	<0.050	0.054	0.069
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	324	282	258	507	446
Uranium (U)	0.541	0.487	0.366	0.826	0.924
Vanadium (V)	21.5	16.6	15.8	29.0	30.1
Zinc (Zn)	15.7	10.0	10.6	18.5	20.3

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
Date: 31-Jul-12

RESULTS OF ANALYSIS

Sample ID	054-5	055-5	055-60	058-5	058-60
Date Sampled	4-Jul-12	5-Jul-12	5-Jul-12	5-Jul-12	5-Jul-12
ALS Sample ID	L1178856-11	L1178856-12	L1178856-13	L1178856-14	L1178856-15
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.18	6.31	5.85	6.21	6.56
Metals					
Aluminum (Al)	4480	3880	3730	4080	4190
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	5.65	2.41	2.83	2.44	2.56
Barium (Ba)	31.1	23.6	23.8	28.7	31.4
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	911	1870	1730	1830	1930
Chromium (Cr)	15.0	13.7	12.7	14.9	15.7
Cobalt (Co)	2.97	3.35	3.26	3.52	3.92
Copper (Cu)	9.37	9.75	10.4	10.3	11.1
Iron (Fe)	9060	7760	8570	9040	9510
Lead (Pb)	4.06	2.09	2.05	2.08	2.31
Lithium (Li)	6.3	6.4	6.1	6.8	7.0
Magnesium (Mg)	2100	2330	2150	2460	2710
Manganese (Mn)	58.4	63.9	66.0	75.4	75.5
Mercury (Hg)	0.0097	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	10.7	8.74	8.51	8.80	9.79
Phosphorus (P)	184	439	413	428	418
Potassium (K)	190	370	420	470	470
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	120	110	<100	180	120
Strontium (Sr)	5.76	8.99	7.47	8.42	8.08
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	238	315	317	386	419
Uranium (U)	0.482	0.372	0.381	0.427	0.592
Vanadium (V)	19.6	21.4	20.5	22.6	23.3
Zinc (Zn)	12.3	11.8	12.0	12.0	13.1

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
Date: 31-Jul-12

RESULTS OF ANALYSIS

Sample ID	**062-5**	**062-60**	**064-5**	**069-5**	**069-60**
Date Sampled	**6-Jul-12**	**6-Jul-12**	**6-Jul-12**	**6-Jul-12**	**6-Jul-12**
ALS Sample ID	**L1178856-16**	**L1178856-17**	**L1178856-18**	**L1178856-19**	**L1178856-20**
Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Physical Tests					
pH (1:2 soil:water)	6.01	6.84	5.42	5.83	6.07
Metals					
Aluminum (Al)	3870	4260	3980	4260	4730
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	2.37	2.13	1.89	3.29	4.97
Barium (Ba)	23.3	23.6	20.2	20.2	23.2
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1820	2010	1300	1440	1620
Chromium (Cr)	13.4	15.3	13.1	13.1	17.5
Cobalt (Co)	3.34	3.64	3.02	4.24	5.20
Copper (Cu)	7.27	7.15	7.42	9.74	12.3
Iron (Fe)	8110	9260	8180	8510	9970
Lead (Pb)	1.96	1.77	2.07	1.96	2.11
Lithium (Li)	6.1	7.4	6.9	7.3	7.7
Magnesium (Mg)	2170	2740	2080	2630	2950
Manganese (Mn)	65.5	82.3	63.5	71.3	83.6
Mercury (Hg)	<0.0050	<0.0050	0.0078	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	8.09	8.53	6.66	9.66	13.6
Phosphorus (P)	435	453	305	388	418
Potassium (K)	380	510	370	430	470
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	110	110	<100	<100	<100
Strontium (Sr)	8.67	8.55	6.99	5.29	7.07
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	356	347	306	271	323
Uranium (U)	0.380	0.364	0.334	0.403	0.326
Vanadium (V)	20.9	21.4	20.3	18.7	21.1
Zinc (Zn)	11.1	13.4	11.5	12.5	14.8

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
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RESULTS OF ANALYSIS

Sample ID	074-5	074-60	080-5	080-60	080-5-X
Date Sampled	7-Jul-12	7-Jul-12	8-Jul-12	8-Jul-12	8-Jul-12
ALS Sample ID	L1178856-21	L1178856-22	L1178856-23	L1178856-24	L1178856-25
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	6.83	6.54	4.73	5.58	4.73
Metals					
Aluminum (Al)	4430	3850	4650	5110	4600
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	3.07	2.72	4.84	3.63	4.30
Barium (Ba)	28.5	23.9	21.3	30.8	23.6
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1820	1930	1390	1490	1100
Chromium (Cr)	15.3	14.8	13.0	15.8	12.8
Cobalt (Co)	4.61	3.45	3.25	4.30	2.99
Copper (Cu)	10.2	8.68	5.29	10.7	6.66
Iron (Fe)	9980	8630	9280	9520	8340
Lead (Pb)	2.08	1.88	2.27	2.14	2.33
Lithium (Li)	7.6	6.7	8.4	9.6	7.3
Magnesium (Mg)	2800	2300	3120	3160	3100
Manganese (Mn)	81.0	71.2	71.3	72.9	63.3
Mercury (Hg)	<0.0050	<0.0050	0.0052	<0.0050	0.0064
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	10.4	8.45	8.02	10.8	7.19
Phosphorus (P)	442	485	325	358	209
Potassium (K)	540	430	340	420	410
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	120	110	<100	<100	<100
Strontium (Sr)	8.21	8.07	7.55	7.38	6.65
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	351	350	398	374	415
Uranium (U)	0.355	0.397	0.244	0.314	0.330
Vanadium (V)	22.7	21.3	21.7	21.6	19.9
Zinc (Zn)	14.2	11.7	13.9	15.4	13.6

Appendix 3. Data

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Date Received: 16-Jul-12 14:07
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RESULTS OF ANALYSIS

Sample ID	089-5	089-60	092-5	092-60	093-60
Date Sampled	9-Jul-12	9-Jul-12	9-Jul-12	9-Jul-12	9-Jul-12
ALS Sample ID	L1178856-29	L1178856-30	L1178856-26	L1178856-27	L1178856-28
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.76	5.82	5.12	6.05	6.97
Metals					
Aluminum (Al)	1570	1420	674	766	12700
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	0.16
Arsenic (As)	0.870	0.990	0.352	0.395	3.86
Barium (Ba)	25.2	199	5.39	5.67	80.0
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	0.52
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	0.21
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	144	196	100	140	2480
Chromium (Cr)	2.61	2.69	1.27	1.55	28.5
Cobalt (Co)	0.75	0.66	0.25	0.40	7.65
Copper (Cu)	0.55	<0.50	<0.50	<0.50	16.4
Iron (Fe)	3650	4280	1320	1500	17700
Lead (Pb)	0.91	0.94	<0.50	<0.50	5.19
Lithium (Li)	<5.0	<5.0	<5.0	<5.0	19.3
Magnesium (Mg)	535	445	254	423	7040
Manganese (Mn)	28.5	36.8	5.6	8.7	184
Mercury (Hg)	0.0057	<0.0050	<0.0050	<0.0050	0.0051
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	1.30	1.24	0.52	0.89	18.8
Phosphorus (P)	109	104	<50	53	424
Potassium (K)	520	570	220	190	2740
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	<100	280
Strontium (Sr)	73.4	84.5	11.7	12.3	20.9
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	0.099
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	28.0	22.0	27.6	31.5	508
Uranium (U)	0.276	0.316	0.134	0.144	1.14
Vanadium (V)	3.36	3.61	1.79	2.04	30.3
Zinc (Zn)	3.2	2.7	1.3	1.6	31.8

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RESULTS OF ANALYSIS

Sample ID	094-5	094-60	097-5	099-5	099-60
Date Sampled	10-Jul-12	10-Jul-12	10-Jul-12	10-Jul-12	10-Jul-12
ALS Sample ID	L1178856-31	L1178856-32	L1178856-33	L1178856-34	L1178856-35
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.58	6.14	5.46	6.11	6.83
Metals					
Aluminum (Al)	7880	7620	9520	7720	8420
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	6.85	5.51	11.4	14.2	16.2
Barium (Ba)	20.5	24.5	15.2	16.5	18.2
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1030	1230	603	1270	1670
Chromium (Cr)	30.2	28.8	35.8	29.1	32.5
Cobalt (Co)	5.44	7.56	5.29	9.56	9.85
Copper (Cu)	13.7	17.2	11.2	22.1	26.9
Iron (Fe)	13700	13000	17400	15700	17200
Lead (Pb)	3.12	2.85	3.52	3.47	3.74
Lithium (Li)	15.5	14.6	16.4	17.1	18.0
Magnesium (Mg)	5200	4960	5190	5060	5630
Manganese (Mn)	117	133	130	156	170
Mercury (Hg)	<0.0050	<0.0050	0.0305	0.0068	0.0080
Molybdenum (Mo)	<0.50	<0.50	0.70	0.58	0.58
Nickel (Ni)	20.6	22.2	17.9	25.1	26.0
Phosphorus (P)	311	322	156	387	435
Potassium (K)	670	880	470	390	470
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	<100	<100
Strontium (Sr)	4.13	4.78	5.20	5.75	6.72
Thallium (Tl)	0.050	0.055	0.062	0.069	0.067
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	348	329	481	230	289
Uranium (U)	0.524	0.515	0.468	0.605	0.782
Vanadium (V)	23.8	22.3	33.5	21.2	24.1
Zinc (Zn)	22.8	23.4	27.2	32.0	32.4

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RESULTS OF ANALYSIS

Sample ID	099-5-X	100-60	101-5	104-5	104-60
Date Sampled	10-Jul-12	10-Jul-12	10-Jul-12	11-Jul-12	11-Jul-12
ALS Sample ID	L1178856-36	L1178856-37	L1178856-38	L1178856-39	L1178856-40
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	6.02	6.38	5.76	5.60	6.04
Metals					
Aluminum (Al)	8300	10900	5240	4720	4730
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	15.8	16.3	4.72	4.78	4.15
Barium (Ba)	18.2	24.8	28.7	23.5	25.0
Beryllium (Be)	<0.20	0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	0.21	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	0.059	<0.050	<0.050	<0.050
Calcium (Ca)	1360	1560	1930	1460	1710
Chromium (Cr)	33.2	44.7	19.1	13.9	14.6
Cobalt (Co)	10.6	18.9	5.32	3.05	3.36
Copper (Cu)	23.2	41.0	16.7	11.9	7.79
Iron (Fe)	17300	22800	11200	8850	8710
Lead (Pb)	3.52	4.94	2.62	2.16	2.55
Lithium (Li)	17.7	23.4	9.1	8.5	8.4
Magnesium (Mg)	5690	7540	3260	2670	2750
Manganese (Mn)	178	312	102	67.3	74.2
Mercury (Hg)	0.0062	0.0054	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	0.58	0.89	<0.50	<0.50	<0.50
Nickel (Ni)	27.3	45.3	14.1	9.11	9.89
Phosphorus (P)	417	460	428	282	354
Potassium (K)	440	770	520	390	420
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	100	130	<100	110
Strontium (Sr)	6.12	7.70	8.72	7.12	8.13
Thallium (Tl)	0.070	0.076	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	294	307	401	325	338
Uranium (U)	0.608	0.796	0.368	0.354	0.377
Vanadium (V)	23.3	30.5	25.0	21.2	20.8
Zinc (Zn)	36.1	46.1	17.4	12.6	14.4

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RESULTS OF ANALYSIS

Sample ID	107-5	107-60	108-5	108-60	110-5
Date Sampled	11-Jul-12	11-Jul-12	11-Jul-12	11-Jul-12	12-Jul-12
ALS Sample ID	L1178856-41	L1178856-42	L1178856-43	L1178856-44	L1178856-45
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.48	5.67	5.69	5.73	6.04
Metals					
Aluminum (Al)	4830	4720	6950	6480	3680
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	1.69	3.27	7.80	9.56	1.42
Barium (Ba)	24.8	27.6	29.8	27.5	27.0
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1970	1610	1960	1760	1620
Chromium (Cr)	14.6	16.6	23.2	22.4	15.3
Cobalt (Co)	3.02	3.88	4.84	5.62	3.59
Copper (Cu)	8.54	7.39	17.2	17.2	6.92
Iron (Fe)	7180	9650	11500	12200	8420
Lead (Pb)	2.40	2.40	2.98	2.61	2.14
Lithium (Li)	8.4	8.5	12.2	12.0	6.1
Magnesium (Mg)	2710	2930	4620	4500	2520
Manganese (Mn)	74.4	79.7	97.2	107	69.7
Mercury (Hg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	9.05	9.52	15.2	15.7	11.8
Phosphorus (P)	492	434	480	484	365
Potassium (K)	440	490	550	530	410
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	110	<100	<100	100	<100
Strontium (Sr)	8.77	7.26	8.37	7.34	8.99
Thallium (Tl)	<0.050	<0.050	0.058	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	369	329	395	367	288
Uranium (U)	0.370	0.349	0.553	0.424	0.384
Vanadium (V)	18.3	22.8	26.3	24.5	20.5
Zinc (Zn)	14.6	16.1	22.5	23.8	10.2

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RESULTS OF ANALYSIS

Sample ID	NW1	NW2	NW3	SW1	SW2
Date Sampled	4-Jul-12	4-Jul-12	4-Jul-12	12-Jul-12	12-Jul-12
ALS Sample ID	L1178856-46	L1178856-47	L1178856-48	L1178856-49	L1178856-50
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	4.49	4.90	5.46	5.32	5.54
Metals					
Aluminum (Al)	7920	10300	14600	11100	9500
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	10.8	19.4	15.9	14.3	12.0
Barium (Ba)	11.3	14.6	18.5	57.0	20.0
Beryllium (Be)	<0.20	<0.20	0.30	0.32	0.28
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	0.224	0.060	<0.050	0.080	0.051
Calcium (Ca)	463	1110	1620	2130	1840
Chromium (Cr)	25.6	41.1	50.2	42.2	31.7
Cobalt (Co)	5.25	5.98	10.6	11.4	6.98
Copper (Cu)	18.8	17.5	39.9	36.4	21.9
Iron (Fe)	11400	19100	23800	17300	16200
Lead (Pb)	6.53	6.03	6.73	6.55	8.00
Lithium (Li)	6.5	18.3	30.7	23.0	23.4
Magnesium (Mg)	2430	6850	9420	7530	5820
Manganese (Mn)	61.5	167	236	146	141
Mercury (Hg)	0.0720	0.0168	0.0088	0.0088	0.0126
Molybdenum (Mo)	0.72	0.83	0.57	0.90	0.57
Nickel (Ni)	20.3	20.7	37.6	38.1	24.7
Phosphorus (P)	606	424	497	714	579
Potassium (K)	470	460	440	1640	570
Selenium (Se)	0.35	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	0.11	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	150	<100
Strontium (Sr)	6.11	7.34	7.18	8.39	7.29
Thallium (Tl)	<0.050	<0.050	0.054	0.142	0.058
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	200	432	437	614	382
Uranium (U)	0.693	0.666	0.706	1.10	0.838
Vanadium (V)	14.3	30.6	34.1	37.5	27.5
Zinc (Zn)	19.7	33.3	54.3	42.6	30.1

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RESULTS OF ANALYSIS

Sample ID	SW3	SW-3-X	NE1	NE2	NE3
Date Sampled	12-Jul-12	12-Jul-12	14-Jul-12	14-Jul-12	14-Jul-12
ALS Sample ID	L1178856-51	L1178856-52	L1178856-53	L1178856-54	L1178856-55
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	5.51	5.64	4.85	6.20	5.35
Metals					
Aluminum (Al)	7970	7500	1750	5100	2730
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	6.13	5.67	0.588	0.721	1.35
Barium (Ba)	28.2	26.3	15.0	28.0	13.0
Beryllium (Be)	0.26	0.26	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	1830	1700	388	1160	585
Chromium (Cr)	26.7	24.3	8.03	13.5	7.94
Cobalt (Co)	5.68	5.16	0.76	3.92	1.58
Copper (Cu)	19.6	17.9	1.58	5.70	2.17
Iron (Fe)	14000	12900	5580	9910	7060
Lead (Pb)	4.23	4.07	1.72	2.54	1.58
Lithium (Li)	20.1	19.0	<5.0	10.4	<5.0
Magnesium (Mg)	4950	4480	557	3820	1060
Manganese (Mn)	125	116	27.0	105	36.9
Mercury (Hg)	<0.0050	<0.0050	0.0168	0.0099	0.0278
Molybdenum (Mo)	0.57	0.56	<0.50	<0.50	<0.50
Nickel (Ni)	16.6	14.7	1.60	8.72	3.23
Phosphorus (P)	525	456	170	268	222
Potassium (K)	950	920	390	640	350
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	120	100	<100	<100	<100
Strontium (Sr)	6.89	6.99	8.79	7.54	36.0
Thallium (Tl)	0.074	0.068	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	446	405	203	349	145
Uranium (U)	0.773	0.797	0.355	0.221	0.254
Vanadium (V)	26.4	24.3	17.1	22.3	16.9
Zinc (Zn)	24.3	22.3	5.0	19.5	6.2

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RESULTS OF ANALYSIS

Sample ID	**NE4**	**SE1**	**SE2**	**SE3**	**SE-3-X**
Date Sampled	**15-Jul-12**	**14-Jul-12**	**14-Jul-12**	**14-Jul-12**	**14-Jul-12**
ALS Sample ID	**L1178856-56**	**L1178856-57**	**L1178856-58**	**L1178856-59**	**L1178856-60**
Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Physical Tests					
pH (1:2 soil:water)	5.71	4.73	5.19	5.77	5.83
Metals					
Aluminum (Al)	5050	7470	12300	9790	9440
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	1.07	9.30	20.4	22.9	22.8
Barium (Ba)	16.3	34.9	13.2	20.9	19.2
Beryllium (Be)	<0.20	<0.20	0.25	0.26	0.25
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	0.054	0.079	0.056	0.053	0.053
Calcium (Ca)	1450	504	1410	1580	1480
Chromium (Cr)	14.6	24.4	31.5	31.4	30.0
Cobalt (Co)	4.07	3.28	7.43	9.28	8.99
Copper (Cu)	16.0	5.31	23.7	25.3	24.7
Iron (Fe)	12300	14100	18400	18400	18100
Lead (Pb)	2.17	2.93	4.77	3.96	3.96
Lithium (Li)	8.2	10.0	20.2	20.9	20.3
Magnesium (Mg)	3430	3380	4620	5870	5730
Manganese (Mn)	72.9	74.9	111	133	130
Mercury (Hg)	0.0173	0.0689	0.0276	0.0103	0.0101
Molybdenum (Mo)	<0.50	<0.50	0.68	0.54	0.54
Nickel (Ni)	6.98	11.7	26.6	27.6	27.2
Phosphorus (P)	418	414	442	424	384
Potassium (K)	390	410	260	450	390
Selenium (Se)	<0.20	<0.20	0.28	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	<100	<100
Strontium (Sr)	12.0	7.11	8.93	8.71	8.97
Thallium (Tl)	<0.050	<0.050	<0.050	0.052	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	357	284	410	420	432
Uranium (U)	0.341	0.444	0.601	0.568	0.574
Vanadium (V)	39.0	27.0	31.4	33.1	32.4
Zinc (Zn)	12.2	19.1	23.6	26.9	25.9

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
Date: 31-Jul-12

RESULTS OF ANALYSIS

Sample ID	LBS-1	LBS-2	LBS-3	LBS-4	LBS-5
Date Sampled	2-Aug-12	2-Aug-12	2-Aug-12	2-Aug-12	2-Aug-12
ALS Sample ID	L1190635-1	L1190635-2	L1190635-3	L1190635-4	L1190635-5
Matrix	Soil	Soil	Soil	Soil	Soil
Physical Tests					
pH (1:2 soil:water)	4.64	5.68	4.92	5.12	5.44
Metals					
Aluminum (Al)	13400	3790	5080	5720	4860
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	0.939	0.753	0.462	2.88	6.31
Barium (Ba)	143	26.9	25.4	26.7	13.9
Beryllium (Be)	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth (Bi)	<0.20	<0.20	<0.20	0.22	<0.20
Cadmium (Cd)	0.065	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	2780	1630	933	878	776
Chromium (Cr)	17.5	13.8	10.6	22.7	13.8
Cobalt (Co)	7.65	2.71	2.78	2.77	3.05
Copper (Cu)	1.58	6.52	5.08	15.7	7.49
Iron (Fe)	19400	8410	7630	7950	8250
Lead (Pb)	2.29	2.30	2.15	2.35	1.70
Lithium (Li)	23.0	7.4	11.2	9.4	8.0
Magnesium (Mg)	10500	2030	3460	3140	2550
Manganese (Mn)	192	61.2	69.2	67.9	80.4
Mercury (Hg)	0.0136	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	17.5	5.58	7.10	10.3	8.57
Phosphorus (P)	973	464	266	351	314
Potassium (K)	4050	670	370	930	250
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	130	<100	<100	<100	<100
Strontium (Sr)	15.1	7.11	6.38	2.91	3.64
Thallium (Tl)	0.110	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	1480	374	435	260	215
Uranium (U)	0.288	0.343	0.264	0.502	0.558
Vanadium (V)	51.8	20.8	17.5	16.8	11.4
Zinc (Zn)	49.5	11.9	17.1	13.5	12.1

Appendix 3. Data

Project: 0833-002-20 Back River
ALS File No.: L1178856
Date Received: 16-Jul-12 14:07
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RESULTS OF ANALYSIS

Sample ID	**LBS-6**	**LBS-7**	**LBS-8**	**LBS-9**	**LBS-10**
Date Sampled	**2-Aug-12**	**2-Aug-12**	**3-Aug-12**	**3-Aug-12**	**3-Aug-12**
ALS Sample ID	**L1190635-6**	**L1190635-7**	**L1190635-8**	**L1190635-9**	**L1190635-10**
Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
Physical Tests					
pH (1:2 soil:water)	4.94	5.68	5.42	5.15	6.50
Metals					
Aluminum (Al)	3580	9070	4970	6290	10100
Antimony (Sb)	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	2.04	6.55	6.42	9.51	14.4
Barium (Ba)	15.0	22.4	11.7	14.1	18.8
Beryllium (Be)	0.22	<0.20	<0.20	<0.20	0.24
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	<0.050	<0.050	<0.050	<0.050	<0.050
Calcium (Ca)	568	1760	806	1070	1990
Chromium (Cr)	8.51	32.6	16.0	18.7	33.7
Cobalt (Co)	2.71	4.66	3.47	4.28	8.91
Copper (Cu)	3.54	12.3	9.45	12.1	12.0
Iron (Fe)	7920	12800	8800	10000	18900
Lead (Pb)	1.13	3.02	2.05	2.40	3.36
Lithium (Li)	5.7	18.0	9.9	11.0	20.7
Magnesium (Mg)	1840	5300	2730	3240	6730
Manganese (Mn)	56.7	121	69.7	88.5	280
Mercury (Hg)	0.0211	0.0109	<0.0050	0.0214	0.0182
Molybdenum (Mo)	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel (Ni)	6.35	17.3	10.5	12.2	20.2
Phosphorus (P)	205	448	305	372	259
Potassium (K)	320	520	260	280	380
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100	<100	<100
Strontium (Sr)	2.51	7.39	4.70	5.49	7.76
Thallium (Tl)	<0.050	<0.050	<0.050	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	202	398	217	236	221
Uranium (U)	0.489	0.652	0.401	0.452	0.652
Vanadium (V)	12.3	21.7	12.3	14.6	22.2
Zinc (Zn)	7.3	24.3	13.3	16.9	33.8

Appendix 3. Data

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Date Received: 16-Jul-12 14:07
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RESULTS OF ANALYSIS

Sample ID	LBS-11	LBS-12	LBS-13
Date Sampled	3-Aug-12	3-Aug-12	3-Aug-12
ALS Sample ID	L1190635-11	L1190635-12	L1190635-13
Matrix	Soil	Soil	Soil
Physical Tests			
pH (1:2 soil:water)	6.40	4.48	5.28
Metals			
Aluminum (Al)	31800	7590	8980
Antimony (Sb)	0.52	<0.10	0.14
Arsenic (As)	55.4	10.7	33.0
Barium (Ba)	149	15.5	13.1
Beryllium (Be)	2.32	0.21	<0.20
Bismuth (Bi)	0.75	<0.20	<0.20
Cadmium (Cd)	0.112	<0.050	0.053
Calcium (Ca)	4070	630	1130
Chromium (Cr)	44.2	18.6	34.2
Cobalt (Co)	22.4	5.83	9.43
Copper (Cu)	86.7	13.3	16.1
Iron (Fe)	36300	14100	15900
Lead (Pb)	7.18	3.99	4.45
Lithium (Li)	39.4	13.9	21.2
Magnesium (Mg)	14300	4990	6100
Manganese (Mn)	696	130	156
Mercury (Hg)	0.0553	0.0200	0.0059
Molybdenum (Mo)	0.70	<0.50	<0.50
Nickel (Ni)	47.5	14.7	23.8
Phosphorus (P)	724	254	340
Potassium (K)	5290	420	370
Selenium (Se)	0.29	<0.20	<0.20
Silver (Ag)	<0.10	<0.10	<0.10
Sodium (Na)	<100	<100	<100
Strontium (Sr)	17.2	3.59	4.27
Thallium (Tl)	0.231	<0.050	<0.050
Tin (Sn)	<2.0	<2.0	<2.0
Titanium (Ti)	72.5	182	337
Uranium (U)	3.06	0.512	0.446
Vanadium (V)	38.2	18.7	23.2
Zinc (Zn)	72.7	21.9	29.1

	Minimum	Median	Mean	Maximum
Physical Tests				
pH (1:2 soil:water)	4.48	5.72	5.72	6.97
Metals				
Aluminum (Al)	674.00	5110.00	6491.64	31800.00
Antimony (Sb)	0.14	0.16	0.27	0.52
Arsenic (As)	0.35	5.53	7.71	**55.40**
Barium (Ba)	5.39	23.60	30.01	199.00
Beryllium (Be)	0.20	0.26	0.40	2.32
Bismuth (Bi)	0.21	0.22	0.35	0.75
Cadmium (Cd)	0.05	0.06	0.08	0.22
Calcium (Ca)	100.00	1490.00	1434.45	4070.00
Chromium (Cr)	1.27	17.50	20.49	50.20
Cobalt (Co)	0.25	4.30	5.26	22.40
Copper (Cu)	0.55	11.70	14.31	86.70
Iron (Fe)	1320.00	9980.00	11707.67	36300.00
Lead (Pb)	0.91	2.48	3.02	8.00
Lithium (Li)	5.30	9.90	12.57	39.40
Magnesium (Mg)	254.00	3160.00	3838.82	14300.00
Manganese (Mn)	5.60	81.00	107.16	696.00
Mercury (Hg)	0.01	0.01	0.02	0.07
Molybdenum (Mo)	0.54	0.58	0.66	0.90
Nickel (Ni)	0.52	11.70	14.43	47.50
Phosphorus (P)	53.00	417.50	395.28	973.00
Potassium (K)	190.00	440.00	631.10	5290.00
Selenium (Se)	0.28	0.29	0.31	0.35
Silver (Ag)	0.11	0.11	0.11	0.11
Sodium (Na)	100.00	115.00	125.91	280.00
Strontium (Sr)	2.51	7.34	10.24	84.50
Thallium (Tl)	0.05	0.07	0.08	0.23
Tin (Sn)	0.00	1.00	1.00	2.00
Titanium (Ti)	22.00	329.00	331.69	1480.00
Uranium (U)	0.13	0.44	0.52	3.06
Vanadium (V)	1.79	21.40	22.14	51.80
Zinc (Zn)	1.30	16.10	19.51	72.70

Metals	Detection Limits	CCME Industrial Guideline	Units
Aluminum (Al)	50	-	mg/kg
Antimony (Sb)	0.1	20	mg/kg
Arsenic (As)	0.05	12	mg/kg
Barium (Ba)	0.5	2,000	mg/kg
Beryllium (Be)	0.2	8	mg/kg
Bismuth (Bi)	0.2	-	mg/kg
Cadmium (Cd)	0.05	22	mg/kg
Calcium (Ca)	50	-	mg/kg
Chromium (Cr)	0.5	87	mg/kg
Cobalt (Co)	0.1	300	mg/kg
Copper (Cu)	0.5	91	mg/kg
Iron (Fe)	50	-	mg/kg
Lead (Pb)	0.5	600	mg/kg
Lithium (Li)	5	-	mg/kg
Magnesium (Mg)	20	-	mg/kg
Manganese (Mn)	1	-	mg/kg
Mercury (Hg)	0.005	50	mg/kg
Molybdenum (Mo)	0.5	40	mg/kg
Nickel (Ni)	0.5	50	mg/kg
Phosphorus (P)	50	-	mg/kg
Potassium (K)	100	-	mg/kg
Selenium (Se)	0.2	2.9	mg/kg
Silver (Ag)	0.1	40	mg/kg
Sodium (Na)	100	-	mg/kg
Strontium (Sr)	0.5	-	mg/kg
Thallium (Tl)	0.05	1	mg/kg
Tin (Sn)	2	300	mg/kg
Titanium (Ti)	1	-	mg/kg
Uranium (U)	0.05	300	mg/kg
Vanadium (V)	0.2	130	mg/kg
Zinc (Zn)	1	360	mg/kg

Appendix 3. Method

Soil pH:

This method determines the pH of soil, using a 1:2 soil:water extract of the soil (by weight) using deionized water. Soil pH is a measure of the relative acidity or alkalinity of the soil solution that is in equilibrium with the solid soil particles. It is a measure of the intensity of acidity or alkalinity, but does not indicate the relative buffering capacity of the soil. It is best applicable to soils with a pH ranging from 4.0 to 9.0. The results obtained by this method differ from the saturated paste method, the resulting reading is 0.25 pH units higher than that obtained using the saturated paste method.

CCME Metals:

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is dried at 40 C, then ground to < 2 mm particle size using a stainless steel flail grinder. A representative portion is digested with concentrated nitric and hydrochloric acids for 2 hours in an open vessel digestor at 95 degrees. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Appendix 3. Results

Project 0833-002-20 BACK RIVER
ALS File No. L1178856
Date Received 16-Jul-12 14:07
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QUALITY CONTROL RESULTS

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Result	Target	Units	%	Limits
Metals									
Soil	CRM	Aluminum (Al)	WG1513596-5	VA-CANMET-TILL1	17900	18200	mg/kg	98.2	70-130
Soil	CRM	Antimony (Sb)	WG1513596-5	VA-CANMET-TILL1	6.14	6.27	mg/kg	97.9	70-130
Soil	CRM	Arsenic (As)	WG1513596-5	VA-CANMET-TILL1	16.6	15.4	mg/kg	107.7	70-130
Soil	CRM	Barium (Ba)	WG1513596-5	VA-CANMET-TILL1	85.8	80.6	mg/kg	106.4	70-130
Soil	CRM	Beryllium (Be)	WG1513596-5	VA-CANMET-TILL1	0.50	0.54	mg/kg	0.50	.34-.74
Soil	CRM	Cadmium (Cd)	WG1513596-5	VA-CANMET-TILL1	0.228	0.231	mg/kg	98.7	70-130
Soil	CRM	Calcium (Ca)	WG1513596-5	VA-CANMET-TILL1	3520	3320	mg/kg	106.1	70-130
Soil	CRM	Chromium (Cr)	WG1513596-5	VA-CANMET-TILL1	29.0	27.2	mg/kg	106.6	70-130
Soil	CRM	Cobalt (Co)	WG1513596-5	VA-CANMET-TILL1	12.8	12.5	mg/kg	102.8	70-130
Soil	CRM	Copper (Cu)	WG1513596-5	VA-CANMET-TILL1	44.4	44.9	mg/kg	98.9	70-130
Soil	CRM	Iron (Fe)	WG1513596-5	VA-CANMET-TILL1	33000	33300	mg/kg	99.1	70-130
Soil	CRM	Lead (Pb)	WG1513596-5	VA-CANMET-TILL1	13.6	14.4	mg/kg	94.8	70-130
Soil	CRM	Lithium (Li)	WG1513596-5	VA-CANMET-TILL1	10.1	9.8	mg/kg	102.9	70-130
Soil	CRM	Magnesium (Mg)	WG1513596-5	VA-CANMET-TILL1	6130	5830	mg/kg	105.2	70-130
Soil	CRM	Manganese (Mn)	WG1513596-5	VA-CANMET-TILL1	1160	1100	mg/kg	105.0	70-130
Soil	CRM	Mercury (Hg)	WG1513596-5	VA-CANMET-TILL1	0.0924	0.0980	mg/kg	94.3	70-130
Soil	CRM	Molybdenum (Mo)	WG1513596-5	VA-CANMET-TILL1	0.68	0.74	mg/kg	0.68	.24-1.24
Soil	CRM	Nickel (Ni)	WG1513596-5	VA-CANMET-TILL1	18.0	17.4	mg/kg	103.5	70-130
Soil	CRM	Phosphorus (P)	WG1513596-5	VA-CANMET-TILL1	798	796	mg/kg	100.2	70-130
Soil	CRM	Potassium (K)	WG1513596-5	VA-CANMET-TILL1	650	620	mg/kg	105.1	70-130
Soil	CRM	Selenium (Se)	WG1513596-5	VA-CANMET-TILL1	0.32	0.32	mg/kg	0.32	.12-.52
Soil	CRM	Silver (Ag)	WG1513596-5	VA-CANMET-TILL1	0.24	0.22	mg/kg	0.24	.12-.32
Soil	CRM	Sodium (Na)	WG1513596-5	VA-CANMET-TILL1	330	340	mg/kg	98.2	70-130
Soil	CRM	Strontium (Sr)	WG1513596-5	VA-CANMET-TILL1	11.9	11.6	mg/kg	102.9	70-130
Soil	CRM	Thallium (Tl)	WG1513596-5	VA-CANMET-TILL1	0.129	0.125	mg/kg	0.129	.075-.175
Soil	CRM	Titanium (Ti)	WG1513596-5	VA-CANMET-TILL1	889	764	mg/kg	116.4	70-130
Soil	CRM	Uranium (U)	WG1513596-5	VA-CANMET-TILL1	0.865	0.800	mg/kg	108.2	70-130
Soil	CRM	Vanadium (V)	WG1513596-5	VA-CANMET-TILL1	58.6	54.9	mg/kg	106.8	70-130
Soil	CRM	Zinc (Zn)	WG1513596-5	VA-CANMET-TILL1	68.4	67.5	mg/kg	101.3	70-130
Soil	CRM	Aluminum (Al)	WG1513596-6	VA-NRC-PACS2	17400	17500	mg/kg	99.7	70-130
Soil	CRM	Antimony (Sb)	WG1513596-6	VA-NRC-PACS2	9.31	9.79	mg/kg	95.1	70-130
Soil	CRM	Arsenic (As)	WG1513596-6	VA-NRC-PACS2	24.6	23.3	mg/kg	105.5	70-130
Soil	CRM	Barium (Ba)	WG1513596-6	VA-NRC-PACS2	374	294	mg/kg	127.2	70-130
Soil	CRM	Beryllium (Be)	WG1513596-6	VA-NRC-PACS2	0.40	0.41	mg/kg	0.40	.21-.61
Soil	CRM	Bismuth (Bi)	WG1513596-6	VA-NRC-PACS2	0.35	0.35	mg/kg	0.35	.15-.55
Soil	CRM	Cadmium (Cd)	WG1513596-6	VA-NRC-PACS2	2.20	1.98	mg/kg	111.2	70-130
Soil	CRM	Calcium (Ca)	WG1513596-6	VA-NRC-PACS2	8000	7790	mg/kg	102.7	70-130
Soil	CRM	Chromium (Cr)	WG1513596-6	VA-NRC-PACS2	49.1	48.1	mg/kg	102.0	70-130
Soil	CRM	Cobalt (Co)	WG1513596-6	VA-NRC-PACS2	8.53	8.75	mg/kg	97.5	70-130
Soil	CRM	Copper (Cu)	WG1513596-6	VA-NRC-PACS2	284	297	mg/kg	95.6	70-130
Soil	CRM	Iron (Fe)	WG1513596-6	VA-NRC-PACS2	30700	31200	mg/kg	98.5	70-130
Soil	CRM	Lead (Pb)	WG1513596-6	VA-NRC-PACS2	169	167	mg/kg	101.5	70-130
Soil	CRM	Lithium (Li)	WG1513596-6	VA-NRC-PACS2	22.2	25.8	mg/kg	85.9	70-130
Soil	CRM	Magnesium (Mg)	WG1513596-6	VA-NRC-PACS2	9960	9900	mg/kg	100.6	70-130
Soil	CRM	Manganese (Mn)	WG1513596-6	VA-NRC-PACS2	249	253	mg/kg	98.4	70-130
Soil	CRM	Mercury (Hg)	WG1513596-6	VA-NRC-PACS2	3.21	2.88	mg/kg	111.5	70-130
Soil	CRM	Molybdenum (Mo)	WG1513596-6	VA-NRC-PACS2	4.83	4.57	mg/kg	105.8	70-130
Soil	CRM	Nickel (Ni)	WG1513596-6	VA-NRC-PACS2	30.7	31.6	mg/kg	97.3	70-130
Soil	CRM	Phosphorus (P)	WG1513596-6	VA-NRC-PACS2	863	838	mg/kg	103.0	70-130
Soil	CRM	Potassium (K)	WG1513596-6	VA-NRC-PACS2	3010	3230	mg/kg	93.3	70-130
Soil	CRM	Selenium (Se)	WG1513596-6	VA-NRC-PACS2	0.90	0.92	mg/kg	98.2	70-130
Soil	CRM	Silver (Ag)	WG1513596-6	VA-NRC-PACS2	1.18	1.12	mg/kg	105.2	70-130
Soil	CRM	Sodium (Na)	WG1513596-6	VA-NRC-PACS2	17200	18600	mg/kg	92.3	70-130
Soil	CRM	Strontium (Sr)	WG1513596-6	VA-NRC-PACS2	71.4	68.0	mg/kg	105.0	70-130
Soil	CRM	Thallium (Tl)	WG1513596-6	VA-NRC-PACS2	0.413	0.412	mg/kg	100.3	70-130
Soil	CRM	Tin (Sn)	WG1513596-6	VA-NRC-PACS2	19.6	19.1	mg/kg	102.9	70-130

Appendix 3. Results

Project 0833-002-20 BACK RIVER
ALS File No. L1178856
Date Received 16-Jul-12 14:07
Date 31-Jul-12

QUALITY CONTROL RESULTS

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Result	Target	Units	%	Limits
Soil	CRM	Titanium (Ti)	WG1513596-6	VA-NRC-PACS2	1090	900	mg/kg	120.7	70-130
Soil	CRM	Uranium (U)	WG1513596-6	VA-NRC-PACS2	1.53	1.64	mg/kg	93.3	70-130
Soil	CRM	Vanadium (V)	WG1513596-6	VA-NRC-PACS2	78.7	74.4	mg/kg	105.8	70-130
Soil	CRM	Zinc (Zn)	WG1513596-6	VA-NRC-PACS2	343	337	mg/kg	101.8	70-130
Soil	CRM	Aluminum (Al)	WG1513702-5	VA-CANMET-TILL1	18300	18200	mg/kg	100.6	70-130
Soil	CRM	Antimony (Sb)	WG1513702-5	VA-CANMET-TILL1	6.41	6.27	mg/kg	102.3	70-130
Soil	CRM	Arsenic (As)	WG1513702-5	VA-CANMET-TILL1	16.4	15.4	mg/kg	106.6	70-130
Soil	CRM	Barium (Ba)	WG1513702-5	VA-CANMET-TILL1	83.8	80.6	mg/kg	104.0	70-130
Soil	CRM	Beryllium (Be)	WG1513702-5	VA-CANMET-TILL1	0.53	0.54	mg/kg	0.53	.34-.74
Soil	CRM	Cadmium (Cd)	WG1513702-5	VA-CANMET-TILL1	0.244	0.231	mg/kg	105.5	70-130
Soil	CRM	Calcium (Ca)	WG1513702-5	VA-CANMET-TILL1	3950	3320	mg/kg	119.0	70-130
Soil	CRM	Chromium (Cr)	WG1513702-5	VA-CANMET-TILL1	29.1	27.2	mg/kg	106.9	70-130
Soil	CRM	Cobalt (Co)	WG1513702-5	VA-CANMET-TILL1	13.1	12.5	mg/kg	104.5	70-130
Soil	CRM	Copper (Cu)	WG1513702-5	VA-CANMET-TILL1	44.9	44.9	mg/kg	99.9	70-130
Soil	CRM	Iron (Fe)	WG1513702-5	VA-CANMET-TILL1	33100	33300	mg/kg	99.3	70-130
Soil	CRM	Lead (Pb)	WG1513702-5	VA-CANMET-TILL1	14.0	14.4	mg/kg	96.9	70-130
Soil	CRM	Lithium (Li)	WG1513702-5	VA-CANMET-TILL1	10.3	9.8	mg/kg	105.2	70-130
Soil	CRM	Magnesium (Mg)	WG1513702-5	VA-CANMET-TILL1	6440	5830	mg/kg	110.4	70-130
Soil	CRM	Manganese (Mn)	WG1513702-5	VA-CANMET-TILL1	1160	1100	mg/kg	105.8	70-130
Soil	CRM	Mercury (Hg)	WG1513702-5	VA-CANMET-TILL1	0.0858	0.0980	mg/kg	87.5	70-130
Soil	CRM	Molybdenum (Mo)	WG1513702-5	VA-CANMET-TILL1	0.74	0.74	mg/kg	0.74	.24-1.24
Soil	CRM	Nickel (Ni)	WG1513702-5	VA-CANMET-TILL1	18.7	17.4	mg/kg	107.2	70-130
Soil	CRM	Phosphorus (P)	WG1513702-5	VA-CANMET-TILL1	819	796	mg/kg	102.9	70-130
Soil	CRM	Potassium (K)	WG1513702-5	VA-CANMET-TILL1	710	620	mg/kg	115.1	70-130
Soil	CRM	Selenium (Se)	WG1513702-5	VA-CANMET-TILL1	0.29	0.32	mg/kg	0.29	.12-.52
Soil	CRM	Silver (Ag)	WG1513702-5	VA-CANMET-TILL1	0.22	0.22	mg/kg	0.22	.12-.32
Soil	CRM	Sodium (Na)	WG1513702-5	VA-CANMET-TILL1	430	340	mg/kg	126.6	70-130
Soil	CRM	Strontium (Sr)	WG1513702-5	VA-CANMET-TILL1	13.2	11.6	mg/kg	113.6	70-130
Soil	CRM	Thallium (Tl)	WG1513702-5	VA-CANMET-TILL1	0.137	0.125	mg/kg	0.137	.075-.175
Soil	CRM	Titanium (Ti)	WG1513702-5	VA-CANMET-TILL1	985	764	mg/kg	129.0	70-130
Soil	CRM	Uranium (U)	WG1513702-5	VA-CANMET-TILL1	0.874	0.800	mg/kg	109.2	70-130
Soil	CRM	Vanadium (V)	WG1513702-5	VA-CANMET-TILL1	60.8	54.9	mg/kg	110.7	70-130
Soil	CRM	Zinc (Zn)	WG1513702-5	VA-CANMET-TILL1	73.2	67.5	mg/kg	108.4	70-130
Soil	CRM	Aluminum (Al)	WG1513702-6	VA-NRC-PACS2	17600	17500	mg/kg	100.3	70-130
Soil	CRM	Antimony (Sb)	WG1513702-6	VA-NRC-PACS2	9.39	9.79	mg/kg	96.0	70-130
Soil	CRM	Arsenic (As)	WG1513702-6	VA-NRC-PACS2	23.1	23.3	mg/kg	99.0	70-130
Soil	CRM	Barium (Ba)	WG1513702-6	VA-NRC-PACS2	362	294	mg/kg	123.3	70-130
Soil	CRM	Beryllium (Be)	WG1513702-6	VA-NRC-PACS2	0.39	0.41	mg/kg	0.39	.21-.61
Soil	CRM	Bismuth (Bi)	WG1513702-6	VA-NRC-PACS2	0.35	0.35	mg/kg	0.35	.15-.55
Soil	CRM	Cadmium (Cd)	WG1513702-6	VA-NRC-PACS2	2.04	1.98	mg/kg	103.0	70-130
Soil	CRM	Calcium (Ca)	WG1513702-6	VA-NRC-PACS2	7900	7790	mg/kg	101.4	70-130
Soil	CRM	Chromium (Cr)	WG1513702-6	VA-NRC-PACS2	45.4	48.1	mg/kg	94.5	70-130
Soil	CRM	Cobalt (Co)	WG1513702-6	VA-NRC-PACS2	7.96	8.75	mg/kg	91.0	70-130
Soil	CRM	Copper (Cu)	WG1513702-6	VA-NRC-PACS2	268	297	mg/kg	90.4	70-130
Soil	CRM	Iron (Fe)	WG1513702-6	VA-NRC-PACS2	28400	31200	mg/kg	91.1	70-130
Soil	CRM	Lead (Pb)	WG1513702-6	VA-NRC-PACS2	161	167	mg/kg	96.5	70-130
Soil	CRM	Lithium (Li)	WG1513702-6	VA-NRC-PACS2	22.6	25.8	mg/kg	87.8	70-130
Soil	CRM	Magnesium (Mg)	WG1513702-6	VA-NRC-PACS2	9420	9900	mg/kg	95.1	70-130
Soil	CRM	Manganese (Mn)	WG1513702-6	VA-NRC-PACS2	239	253	mg/kg	94.3	70-130
Soil	CRM	Mercury (Hg)	WG1513702-6	VA-NRC-PACS2	3.10	2.88	mg/kg	107.5	70-130
Soil	CRM	Molybdenum (Mo)	WG1513702-6	VA-NRC-PACS2	4.83	4.57	mg/kg	105.7	70-130
Soil	CRM	Nickel (Ni)	WG1513702-6	VA-NRC-PACS2	29.6	31.6	mg/kg	93.6	70-130
Soil	CRM	Phosphorus (P)	WG1513702-6	VA-NRC-PACS2	778	838	mg/kg	92.9	70-130
Soil	CRM	Potassium (K)	WG1513702-6	VA-NRC-PACS2	2950	3230	mg/kg	91.2	70-130
Soil	CRM	Selenium (Se)	WG1513702-6	VA-NRC-PACS2	0.90	0.92	mg/kg	97.5	70-130
Soil	CRM	Silver (Ag)	WG1513702-6	VA-NRC-PACS2	1.13	1.12	mg/kg	101.1	70-130
Soil	CRM	Sodium (Na)	WG1513702-6	VA-NRC-PACS2	16200	18600	mg/kg	87.1	70-130

Appendix 3. Results

Project 0833-002-20 BACK RIVER
ALS File No. L1178856
Date Received 16-Jul-12 14:07
Date 31-Jul-12

QUALITY CONTROL RESULTS

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Result	Target	Units	%	Limits
Soil	CRM	Strontium (Sr)	WG1513702-6	VA-NRC-PACS2	71.3	68.0	mg/kg	104.9	70-130
Soil	CRM	Thallium (Tl)	WG1513702-6	VA-NRC-PACS2	0.401	0.412	mg/kg	97.4	70-130
Soil	CRM	Tin (Sn)	WG1513702-6	VA-NRC-PACS2	18.1	19.1	mg/kg	94.5	70-130
Soil	CRM	Titanium (Ti)	WG1513702-6	VA-NRC-PACS2	1030	900	mg/kg	114.6	70-130
Soil	CRM	Uranium (U)	WG1513702-6	VA-NRC-PACS2	1.49	1.64	mg/kg	90.7	70-130
Soil	CRM	Vanadium (V)	WG1513702-6	VA-NRC-PACS2	74.2	74.4	mg/kg	99.7	70-130
Soil	CRM	Zinc (Zn)	WG1513702-6	VA-NRC-PACS2	322	337	mg/kg	95.5	70-130
Soil	MB	Aluminum (Al)	WG1513596-1		<50	<50	mg/kg	-	50
Soil	MB	Antimony (Sb)	WG1513596-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Arsenic (As)	WG1513596-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Barium (Ba)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Beryllium (Be)	WG1513596-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Bismuth (Bi)	WG1513596-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Cadmium (Cd)	WG1513596-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Calcium (Ca)	WG1513596-1		<50	<50	mg/kg	-	50
Soil	MB	Chromium (Cr)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Cobalt (Co)	WG1513596-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Copper (Cu)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Iron (Fe)	WG1513596-1		<50	<50	mg/kg	-	50
Soil	MB	Lead (Pb)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Lithium (Li)	WG1513596-1		<5.0	<5	mg/kg	-	5
Soil	MB	Magnesium (Mg)	WG1513596-1		<20	<20	mg/kg	-	20
Soil	MB	Manganese (Mn)	WG1513596-1		<1.0	<1	mg/kg	-	1
Soil	MB	Mercury (Hg)	WG1513596-1		<0.0050	<0.005	mg/kg	-	0.005
Soil	MB	Molybdenum (Mo)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Nickel (Ni)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Phosphorus (P)	WG1513596-1		<50	<50	mg/kg	-	50
Soil	MB	Potassium (K)	WG1513596-1		<100	<100	mg/kg	-	100
Soil	MB	Selenium (Se)	WG1513596-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Silver (Ag)	WG1513596-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Sodium (Na)	WG1513596-1		<100	<100	mg/kg	-	100
Soil	MB	Strontium (Sr)	WG1513596-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Thallium (Tl)	WG1513596-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Tin (Sn)	WG1513596-1		<2.0	<2	mg/kg	-	2
Soil	MB	Titanium (Ti)	WG1513596-1		<1.0	<1	mg/kg	-	1
Soil	MB	Uranium (U)	WG1513596-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Vanadium (V)	WG1513596-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Zinc (Zn)	WG1513596-1		<1.0	<1	mg/kg	-	1
Soil	MB	Aluminum (Al)	WG1513596-2		<50	<50	mg/kg	-	50
Soil	MB	Antimony (Sb)	WG1513596-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Arsenic (As)	WG1513596-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Barium (Ba)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Beryllium (Be)	WG1513596-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Bismuth (Bi)	WG1513596-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Cadmium (Cd)	WG1513596-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Calcium (Ca)	WG1513596-2		<50	<50	mg/kg	-	50
Soil	MB	Chromium (Cr)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Cobalt (Co)	WG1513596-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Copper (Cu)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Iron (Fe)	WG1513596-2		<50	<50	mg/kg	-	50
Soil	MB	Lead (Pb)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Lithium (Li)	WG1513596-2		<5.0	<5	mg/kg	-	5
Soil	MB	Magnesium (Mg)	WG1513596-2		<20	<20	mg/kg	-	20
Soil	MB	Manganese (Mn)	WG1513596-2		<1.0	<1	mg/kg	-	1
Soil	MB	Mercury (Hg)	WG1513596-2		<0.0050	<0.005	mg/kg	-	0.005
Soil	MB	Molybdenum (Mo)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Nickel (Ni)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5

Appendix 3. Results

Project 0833-002-20 BACK RIVER
ALS File No. L1178856
Date Received 16-Jul-12 14:07
Date 31-Jul-12

QUALITY CONTROL RESULTS

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Result	Target	Units	%	Limits
Soil	MB	Phosphorus (P)	WG1513596-2		<50	<50	mg/kg	-	50
Soil	MB	Potassium (K)	WG1513596-2		<100	<100	mg/kg	-	100
Soil	MB	Selenium (Se)	WG1513596-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Silver (Ag)	WG1513596-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Sodium (Na)	WG1513596-2		<100	<100	mg/kg	-	100
Soil	MB	Strontium (Sr)	WG1513596-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Thallium (Tl)	WG1513596-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Tin (Sn)	WG1513596-2		<2.0	<2	mg/kg	-	2
Soil	MB	Titanium (Ti)	WG1513596-2		<1.0	<1	mg/kg	-	1
Soil	MB	Uranium (U)	WG1513596-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Vanadium (V)	WG1513596-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Zinc (Zn)	WG1513596-2		<1.0	<1	mg/kg	-	1
Soil	MB	Aluminum (Al)	WG1513702-1		<50	<50	mg/kg	-	50
Soil	MB	Antimony (Sb)	WG1513702-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Arsenic (As)	WG1513702-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Barium (Ba)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Beryllium (Be)	WG1513702-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Bismuth (Bi)	WG1513702-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Cadmium (Cd)	WG1513702-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Calcium (Ca)	WG1513702-1		<50	<50	mg/kg	-	50
Soil	MB	Chromium (Cr)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Cobalt (Co)	WG1513702-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Copper (Cu)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Iron (Fe)	WG1513702-1		<50	<50	mg/kg	-	50
Soil	MB	Lead (Pb)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Lithium (Li)	WG1513702-1		<5.0	<5	mg/kg	-	5
Soil	MB	Magnesium (Mg)	WG1513702-1		<20	<20	mg/kg	-	20
Soil	MB	Manganese (Mn)	WG1513702-1		<1.0	<1	mg/kg	-	1
Soil	MB	Mercury (Hg)	WG1513702-1		<0.0050	<0.005	mg/kg	-	0.005
Soil	MB	Molybdenum (Mo)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Nickel (Ni)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Phosphorus (P)	WG1513702-1		<50	<50	mg/kg	-	50
Soil	MB	Potassium (K)	WG1513702-1		<100	<100	mg/kg	-	100
Soil	MB	Selenium (Se)	WG1513702-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Silver (Ag)	WG1513702-1		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Sodium (Na)	WG1513702-1		<100	<100	mg/kg	-	100
Soil	MB	Strontium (Sr)	WG1513702-1		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Thallium (Tl)	WG1513702-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Tin (Sn)	WG1513702-1		<2.0	<2	mg/kg	-	2
Soil	MB	Titanium (Ti)	WG1513702-1		<1.0	<1	mg/kg	-	1
Soil	MB	Uranium (U)	WG1513702-1		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Vanadium (V)	WG1513702-1		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Zinc (Zn)	WG1513702-1		<1.0	<1	mg/kg	-	1
Soil	MB	Aluminum (Al)	WG1513702-2		<50	<50	mg/kg	-	50
Soil	MB	Antimony (Sb)	WG1513702-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Arsenic (As)	WG1513702-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Barium (Ba)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Beryllium (Be)	WG1513702-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Bismuth (Bi)	WG1513702-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Cadmium (Cd)	WG1513702-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Calcium (Ca)	WG1513702-2		<50	<50	mg/kg	-	50
Soil	MB	Chromium (Cr)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Cobalt (Co)	WG1513702-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Copper (Cu)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Iron (Fe)	WG1513702-2		<50	<50	mg/kg	-	50
Soil	MB	Lead (Pb)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Lithium (Li)	WG1513702-2		<5.0	<5	mg/kg	-	5

Appendix 3. Results

Project 0833-002-20 BACK RIVER
ALS File No. L1178856
Date Received 16-Jul-12 14:07
Date 31-Jul-12

QUALITY CONTROL RESULTS

Matrix	QC Type	Analyte	QC Spl. No.	Reference	Result	Target	Units	%	Limits
Soil	MB	Magnesium (Mg)	WG1513702-2		<20	<20	mg/kg	-	20
Soil	MB	Manganese (Mn)	WG1513702-2		<1.0	<1	mg/kg	-	1
Soil	MB	Mercury (Hg)	WG1513702-2		<0.0050	<0.005	mg/kg	-	0.005
Soil	MB	Molybdenum (Mo)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Nickel (Ni)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Phosphorus (P)	WG1513702-2		<50	<50	mg/kg	-	50
Soil	MB	Potassium (K)	WG1513702-2		<100	<100	mg/kg	-	100
Soil	MB	Selenium (Se)	WG1513702-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Silver (Ag)	WG1513702-2		<0.10	<0.1	mg/kg	-	0.1
Soil	MB	Sodium (Na)	WG1513702-2		<100	<100	mg/kg	-	100
Soil	MB	Strontium (Sr)	WG1513702-2		<0.50	<0.5	mg/kg	-	0.5
Soil	MB	Thallium (Tl)	WG1513702-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Tin (Sn)	WG1513702-2		<2.0	<2	mg/kg	-	2
Soil	MB	Titanium (Ti)	WG1513702-2		<1.0	<1	mg/kg	-	1
Soil	MB	Uranium (U)	WG1513702-2		<0.050	<0.05	mg/kg	-	0.05
Soil	MB	Vanadium (V)	WG1513702-2		<0.20	<0.2	mg/kg	-	0.2
Soil	MB	Zinc (Zn)	WG1513702-2		<1.0	<1	mg/kg	-	1

Appendix V5-3B

Back River Project: 2013 Terrain Maps

Rescan™
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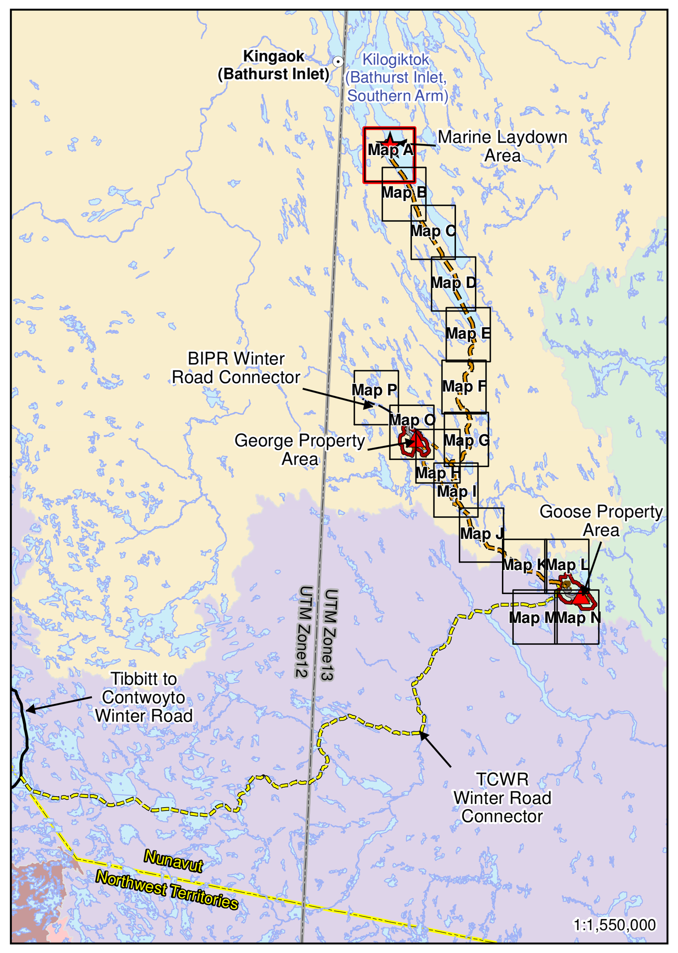

Terrain Polygon Label Code

Decile, Surficial Material, Geomorphological Process, Secondary Surficial Texture, Secondary Surface Expression

7zsMbu-X 3gsFGam

Primary Surficial Texture, Surface Expression, Decile, Secondary Surficial Material

Surficial Material

A - Anthropogenic - Artificial materials, or geological materials so modified by human activity that their original physical properties (e.g. structure, cohesion, consolidation) have been drastically altered.

C - Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture

D - Weathered Bedrock - Bedrock decomposed or disintegrated in situ by processes of mechanical and/or chemical weathering.

E - Eolian - Materials transported and deposited by wind action.

F - Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks

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M - Morainal - High to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface

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OW - Open water

R - Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10cm thick) of unconsolidated or organic materials.

RI - River

U - Undifferentiated

W - Marine

Surface Expression

a - moderate slope
b - blanket
c - cone
d - depression(s)
f - fan
h - hummock(s)
j - gentle slope
k - moderately steep slope
m - rolling
p - plain
r - ridge(s)
s - steep slope
t - terrace
u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map A

Figure V5-3B-1

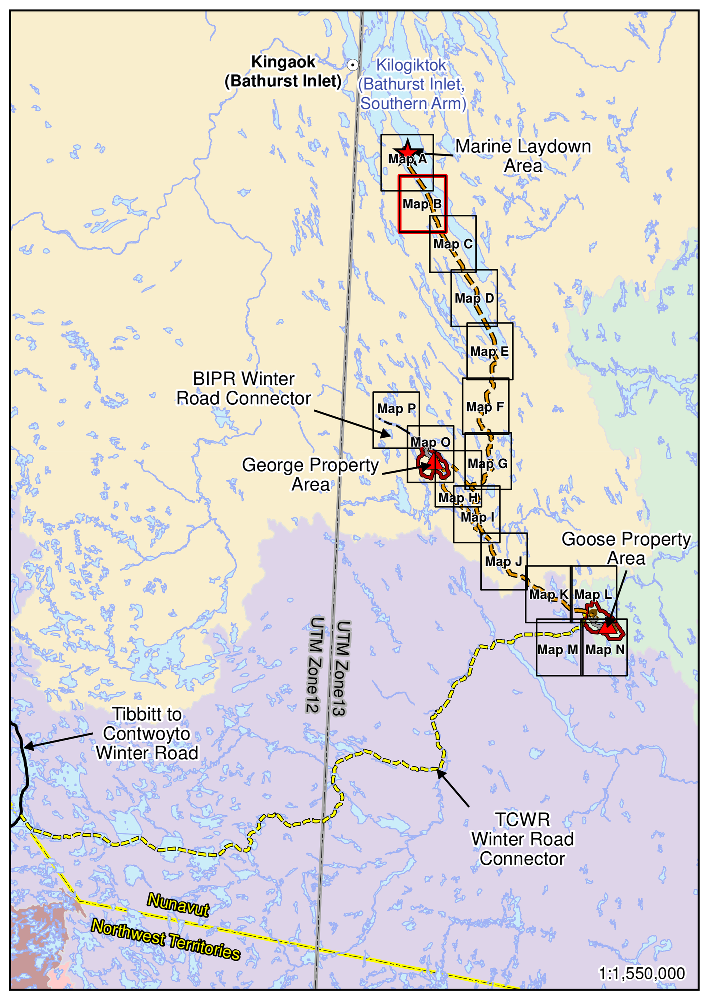
Terrain Polygon	BIPR Winter Road Connector
Existing Exploration Camp	Haul and Access Road
Marine Laydown Area	Proposed Infrastructure
TCWR Winter Road Connector	Potential Development Area (PDA)
Winter Road	**Federal Watershed Delineation**
Winter Road, George Tie-In Option 1	Bathurst Inlet - Burnside River
	Upper Back River
Winter Road, George Tie-In Option 2	Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

Sabina Rescan



Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- Decile
- Primary Surficial Texture
- Surficial Material
- Surface Expression
- Geomorphological Process
- Decile
- Secondary Surficial Texture
- Secondary Surficial Material
- Secondary Surface Expression

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u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
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L - Surface Seepage
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R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map B

Figure V5-3B-2

- Esker
- Terrain Polygon
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

Federal Watershed Delineation

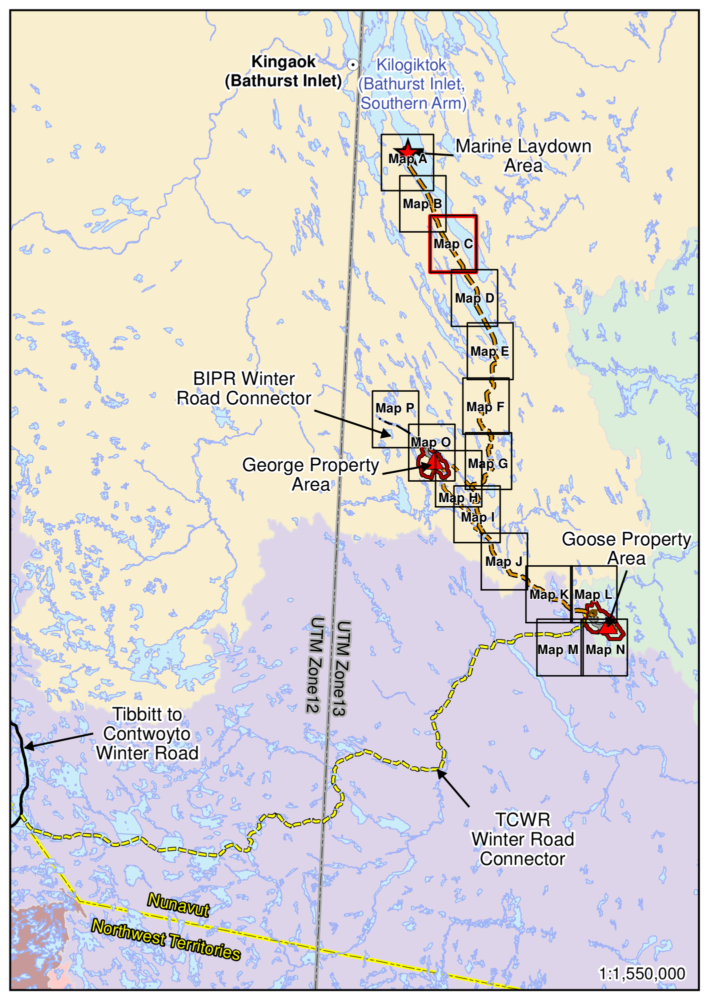
- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028b
Date: November 15 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N



Terrain Polygon Label Code

7zsMbu-X 3gsFGam

Decile; Primary Surficial Texture; Surficial Material; Surface Expression; Geomorphological Process; Decile; Secondary Surficial Texture; Secondary Surficial Material; Secondary Surface Expression

Surficial Material

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u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map C

Figure V5-3B-3

Esker
Terrain Polygon
Existing Exploration Camp
Marine Laydown Area
TCWR Winter Road Connector
Winter Road
Winter Road, George Tie-In Option 1
Winter Road, George Tie-In Option 2
BIPR Winter Road Connector
Haul and Access Road
Proposed Infrastructure
Potential Development Area (PDA)

Federal Watershed Delineation

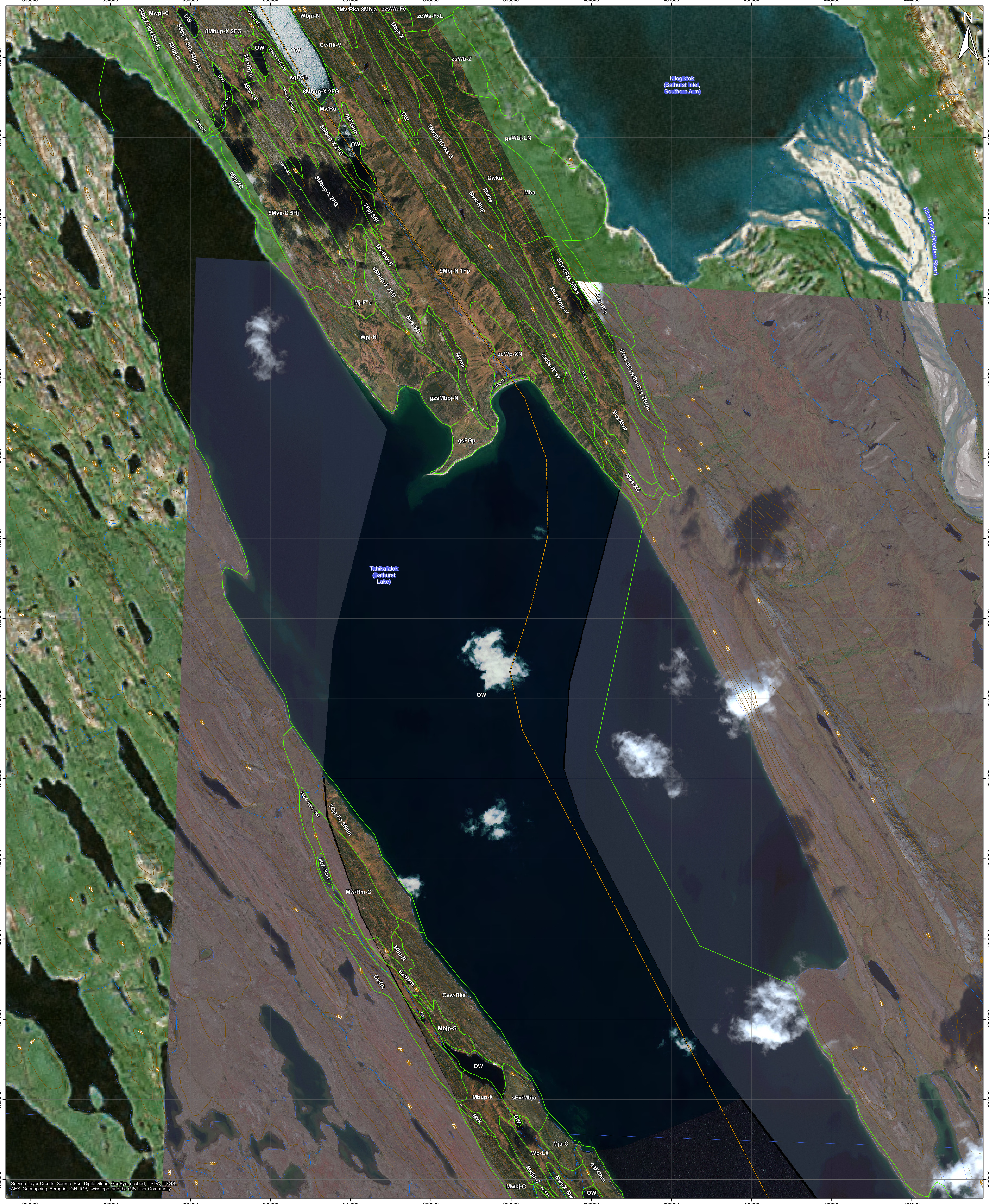
Bathurst Inlet - Burnside River
Upper Back River
Queen Maud Gulf - Ellice River

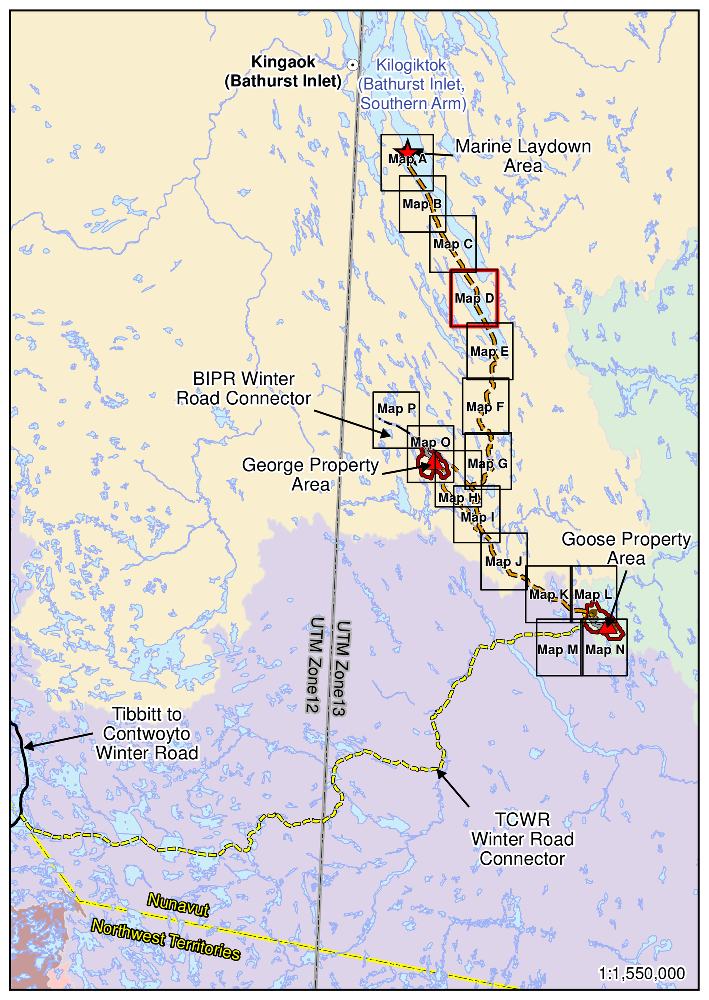
1:20,000

0 1,000 2,000
Metres

GIS # BAC-17-028c
Date: November 15 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

Sabina GOLD & SILVER CORP.
Rescan an ERM company





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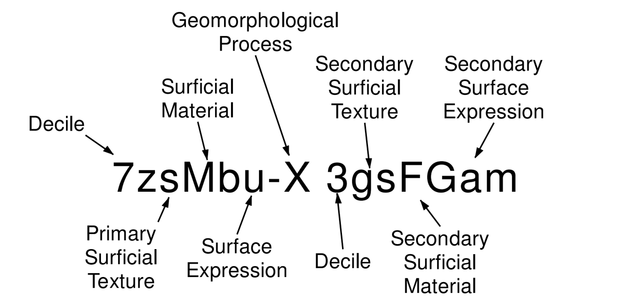

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Geomorphological Process Class

C - Cryoturbation
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E - Channeled by Meltwater
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J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map D

Figure V5-3B-4

- Esker
- Terrain Polygon
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

Federal Watershed Delineation

- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000
Metres

GIS # BAC-17-028d
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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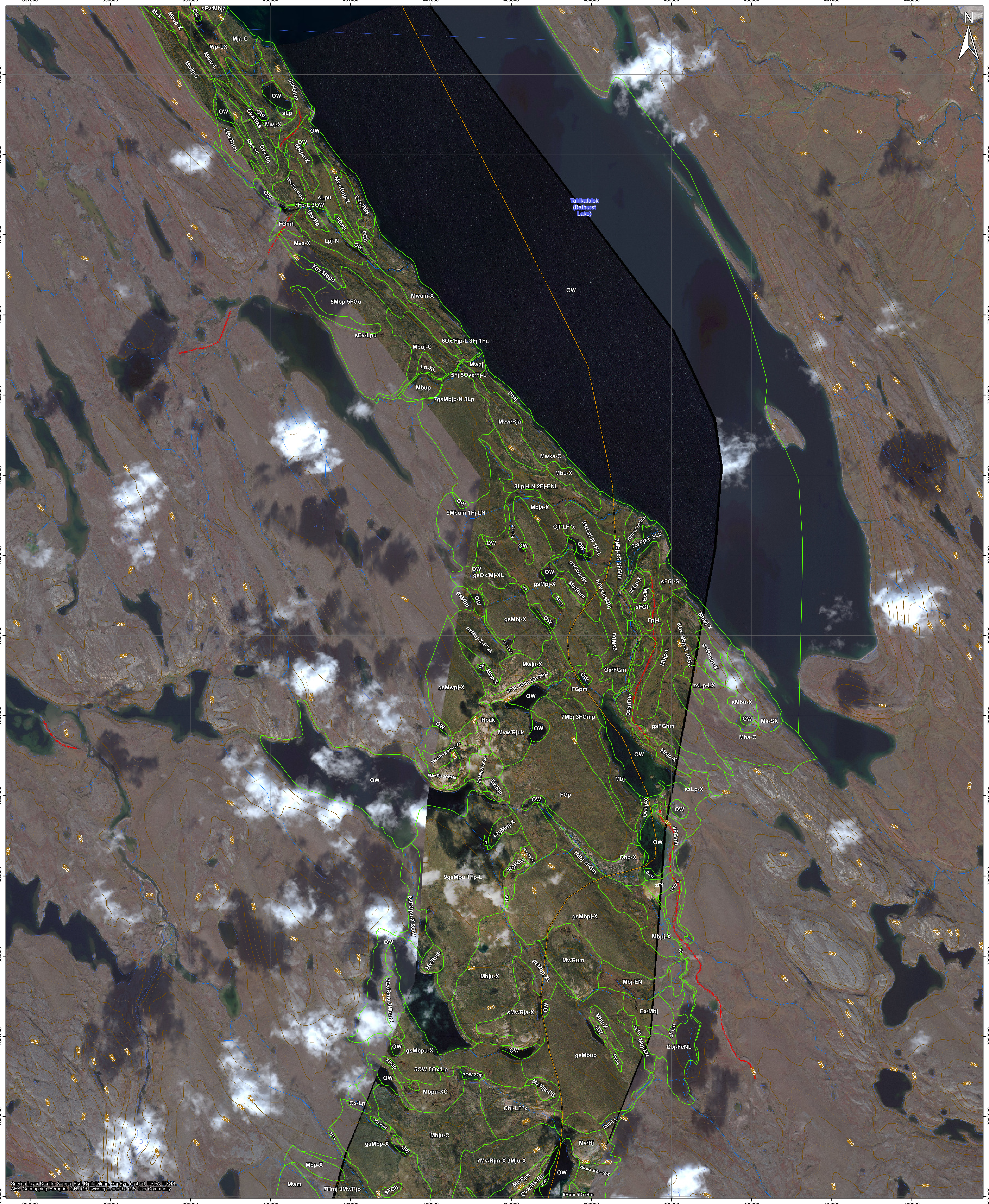

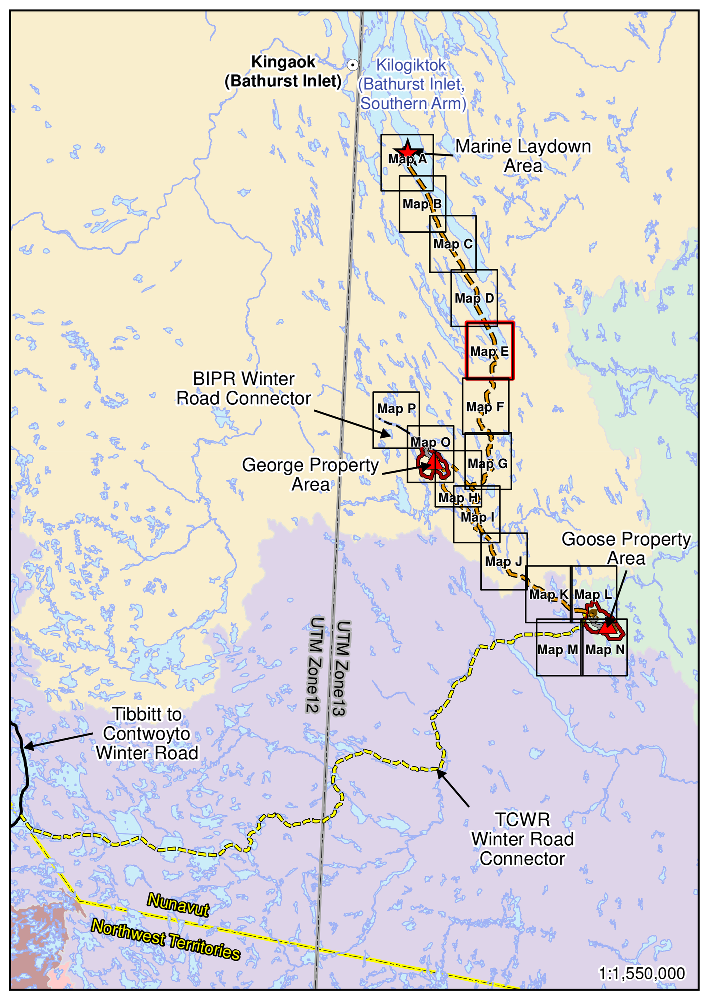

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

Decile; Primary Surficial Texture; Surficial Material; Surface Expression; Geomorphological Process; Decile; Secondary Surficial Texture; Secondary Surficial Material; Secondary Surface Expression

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Texture

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r - rubble
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u - mesic
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Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map E

Figure V5-3B-5

Esker	BIPR Winter Road Connector
Terrain Polygon	Haul and Access Road
Existing Exploration Camp	Proposed Infrastructure
Marine Laydown Area	Potential Development Area (PDA)
TCWR Winter Road Connector	**Federal Watershed Delineation**
Winter Road	Bathurst Inlet - Burnside River
Winter Road, George Tie-In Option 1	Upper Back River
Winter Road, George Tie-In Option 2	Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028e
Date: November 15 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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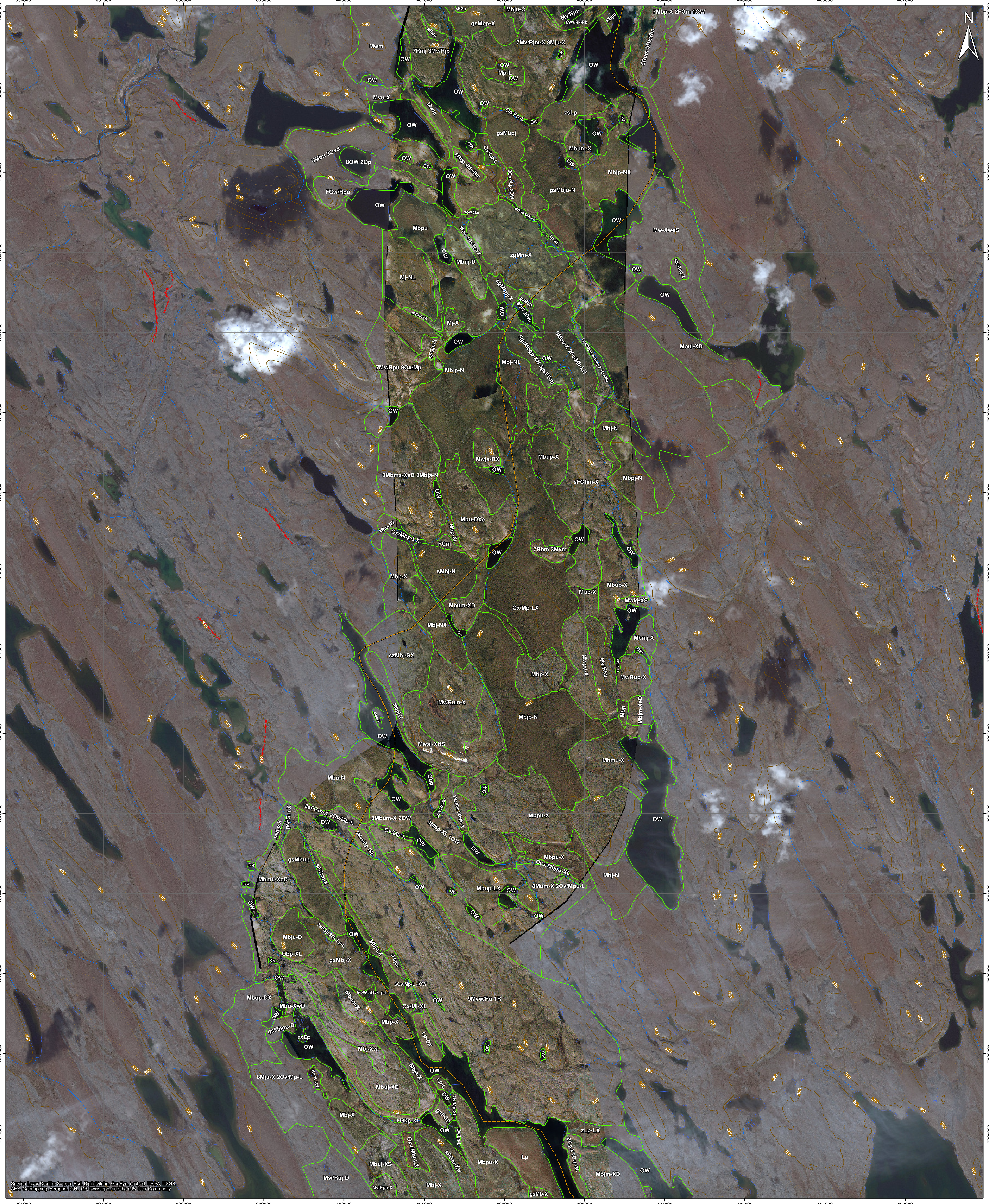
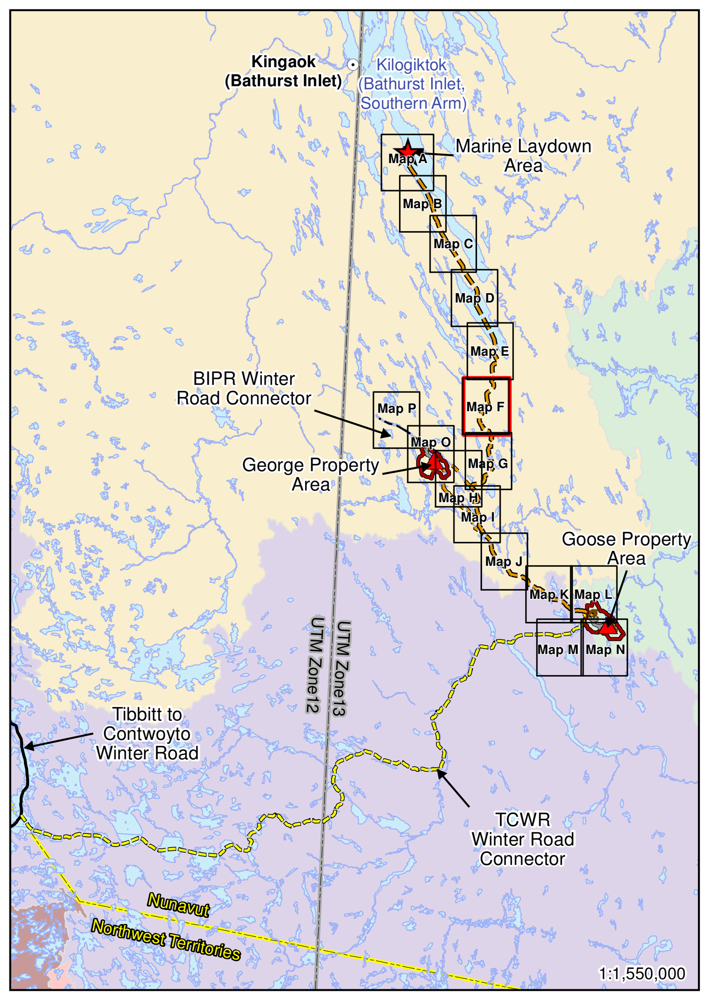
Rescan an ERM company





Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- Decile (7)
- Primary Surficial Texture (zs)
- Surficial Material (M)
- Surface Expression (bu)
- Geomorphological Process (X)
- Decile (3)
- Secondary Surficial Texture (gs)
- Secondary Surficial Material (FG)
- Secondary Surface Expression (am)

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Geomorphological Process Class

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N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map F

Figure V5-3B-6

Esker
Terrain Polygon
Existing Exploration Camp
Marine Laydown Area
TCWR Winter Road Connector
Winter Road
Winter Road, George Tie-In Option 1
Winter Road, George Tie-In Option 2
BIPR Winter Road Connector
Haul and Access Road
Proposed Infrastructure
Potential Development Area (PDA)

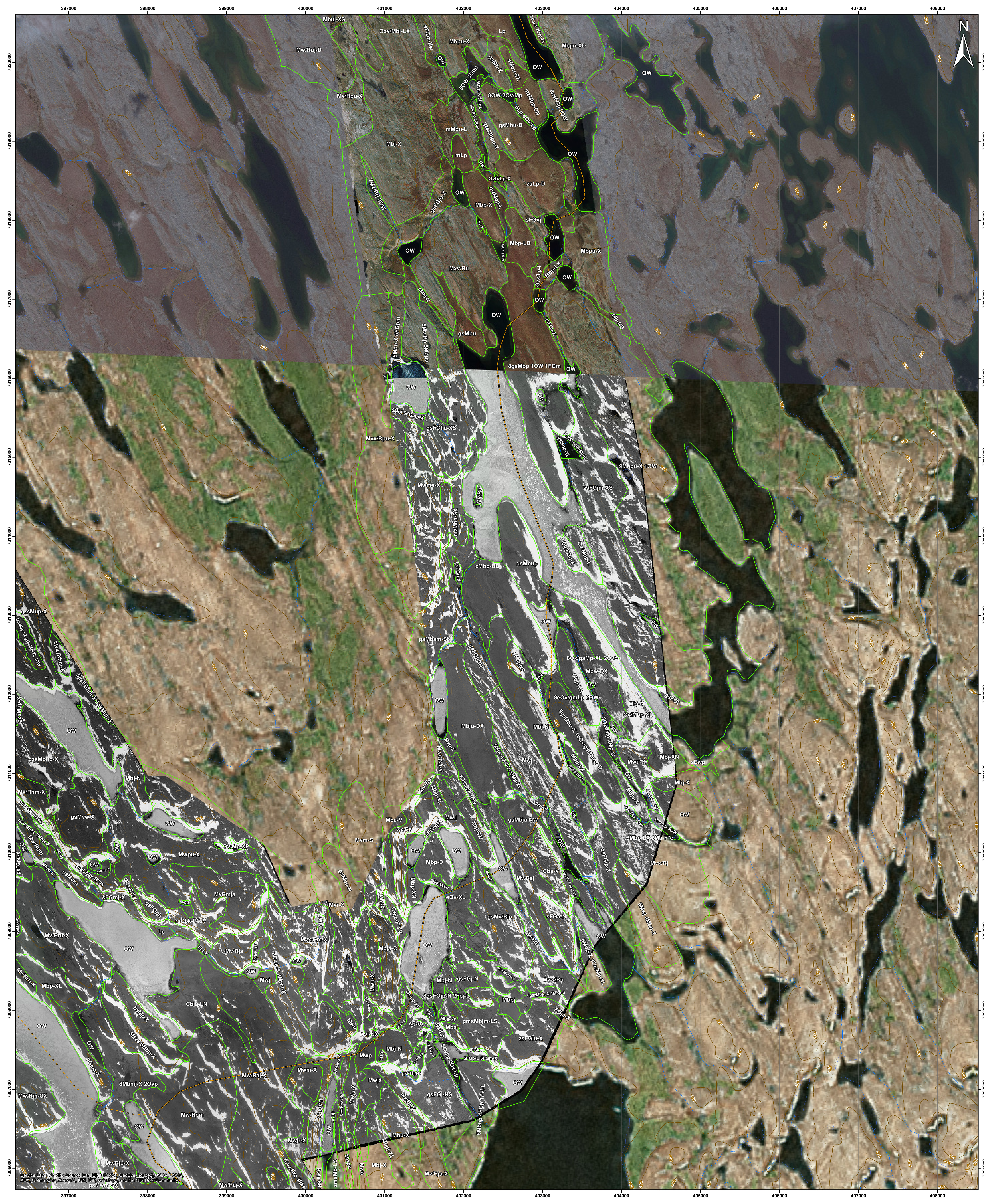
Federal Watershed Delineation

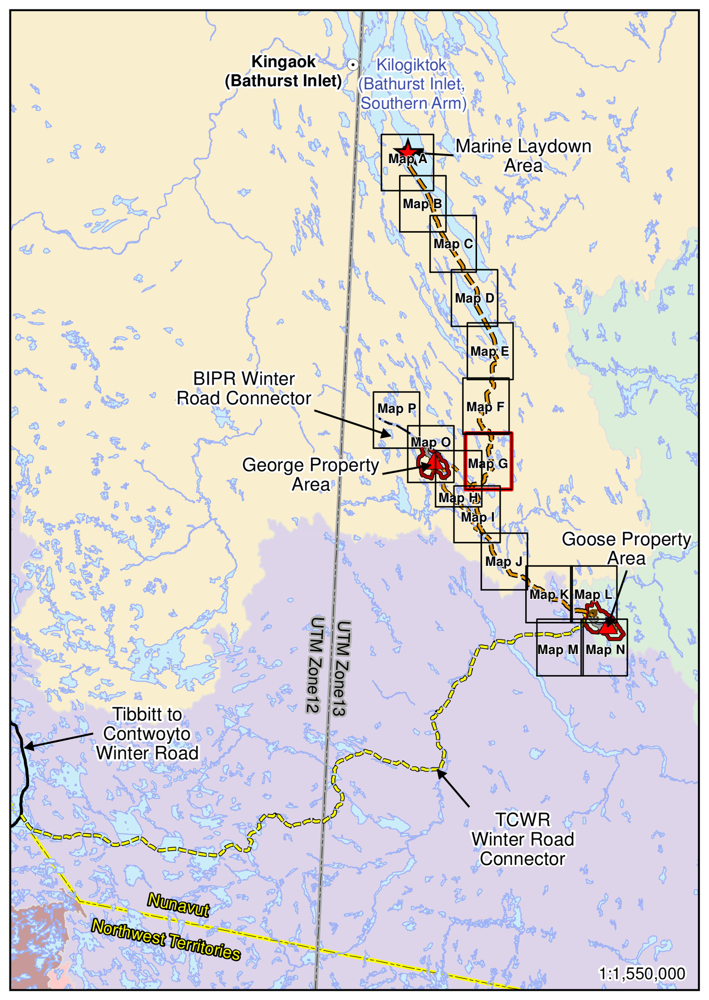
Bathurst Inlet - Burnside River
Upper Back River
Queen Maud Gulf - Ellice River

1:20,000
0 1,000 2,000
Metres

GIS # BAC-17-028f
Date: November 15 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

Sabina GOLD & SILVER CORP.
Rescan an ERM company





Terrain Polygon Label Code

7zsMbu-X 3gsFGam

Decile; Primary Surficial Texture; Surficial Material; Geomorphological Process; Surface Expression; Decile; Secondary Surficial Texture; Secondary Surficial Material; Secondary Surface Expression

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- r - rubble
- s - sand
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- z - silt

Geomorphological Process Class

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- D - Deflation
- E - Channeled by Meltwater
- F - Slow mass movements
- H - Kettle
- J - Anastomosing Channel
- L - Surface Seepage
- N - Nivation
- R - Rapid Mass Movement
- S - Solifluction
- V - Gully Erosion
- W- Washing
- X - Permafrost Processes
- Z - General Periglacial Processes

Back River Project: Terrain Map
Map G

Figure V5-3B-7

- Terrain Polygon
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

Federal Watershed Delineation

- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028g
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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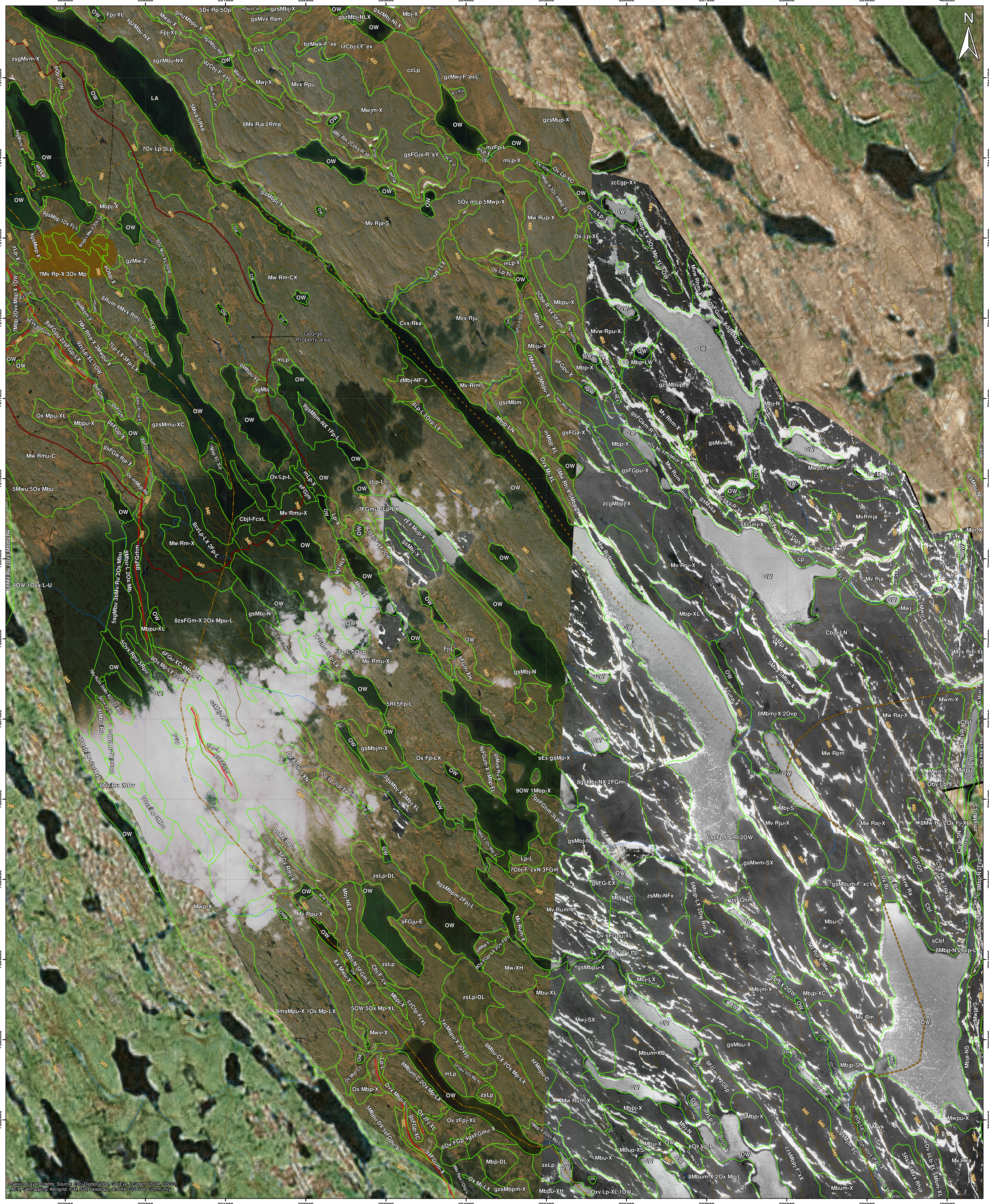

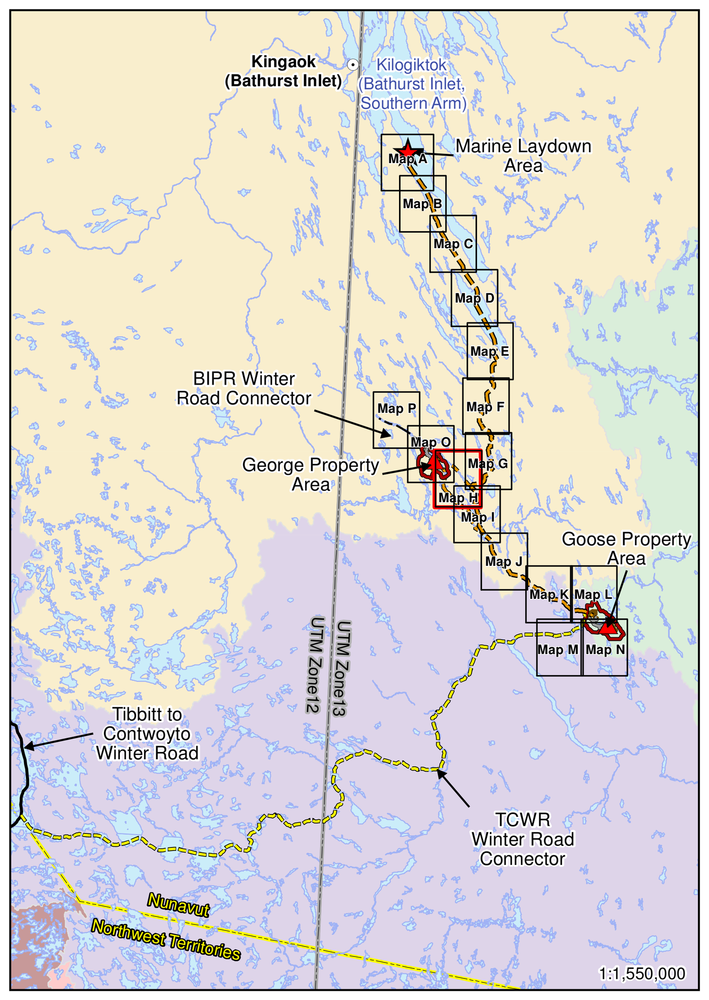

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- 7 – Decile
- zs – Primary Surficial Texture
- M – Surficial Material
- bu – Surface Expression
- X – Geomorphological Process
- 3 – Decile
- gs – Secondary Surficial Texture
- FG – Secondary Surficial Material
- am – Secondary Surface Expression

Surficial Material

A - Anthropogenic - Artificial materials, or geological materials so modified by human activity that their original physical properties (e.g. structure, cohesion, consolidation) have been drastically altered.

C - Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture

D - Weathered Bedrock - Bedrock decomposed or disintegrated in situ by processes of mechanical and/or chemical weathering.

E - Eolian - Materials transported and deposited by wind action.

F - Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks

FG -Glaciofluvial - Very high coarse fragment content, rounded particles, sandy to coarse loamy texture, commonly associated with morainal materials, often as a moderately thick capping in recent deposits

L - Lacustrine - Sediments settled from suspension and underwater gravity flows, such as turbidity currents, in bodies of standing fresh water, or sediments accumulated at their margins through the action of waves.

M - Morainal - High to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface

O - Organic - Very dark, moderately decomposed organic material, often less than 1 m thick

OW - Open water

R - Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10cm thick) of unconsolidated or organic materials.

RI - River

U - Undifferentiated

W - Marine

Surface Expression

a - moderate slope
b - blanket
c - cone
d - depression(s)
f - fan
h - hummock(s)
j - gentle slope
k - moderately steep slope
m - rolling
p - plain
r - ridge(s)
s - steep slope
t - terrace
u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map H

Figure V5-3B-8

Terrain Polygon
Existing Exploration Camp
Marine Laydown Area
TCWR Winter Road Connector
Winter Road
Winter Road, George Tie-In Option 1
Winter Road, George Tie-In Option 2
BIPR Winter Road Connector
Haul and Access Road
Proposed Infrastructure
Potential Development Area (PDA)

Federal Watershed Delineation

Bathurst Inlet - Burnside River
Upper Back River
Queen Maud Gulf - Ellice River

1:20,000
0 1,000 2,000
Metres

GIS # BAC-17-028h
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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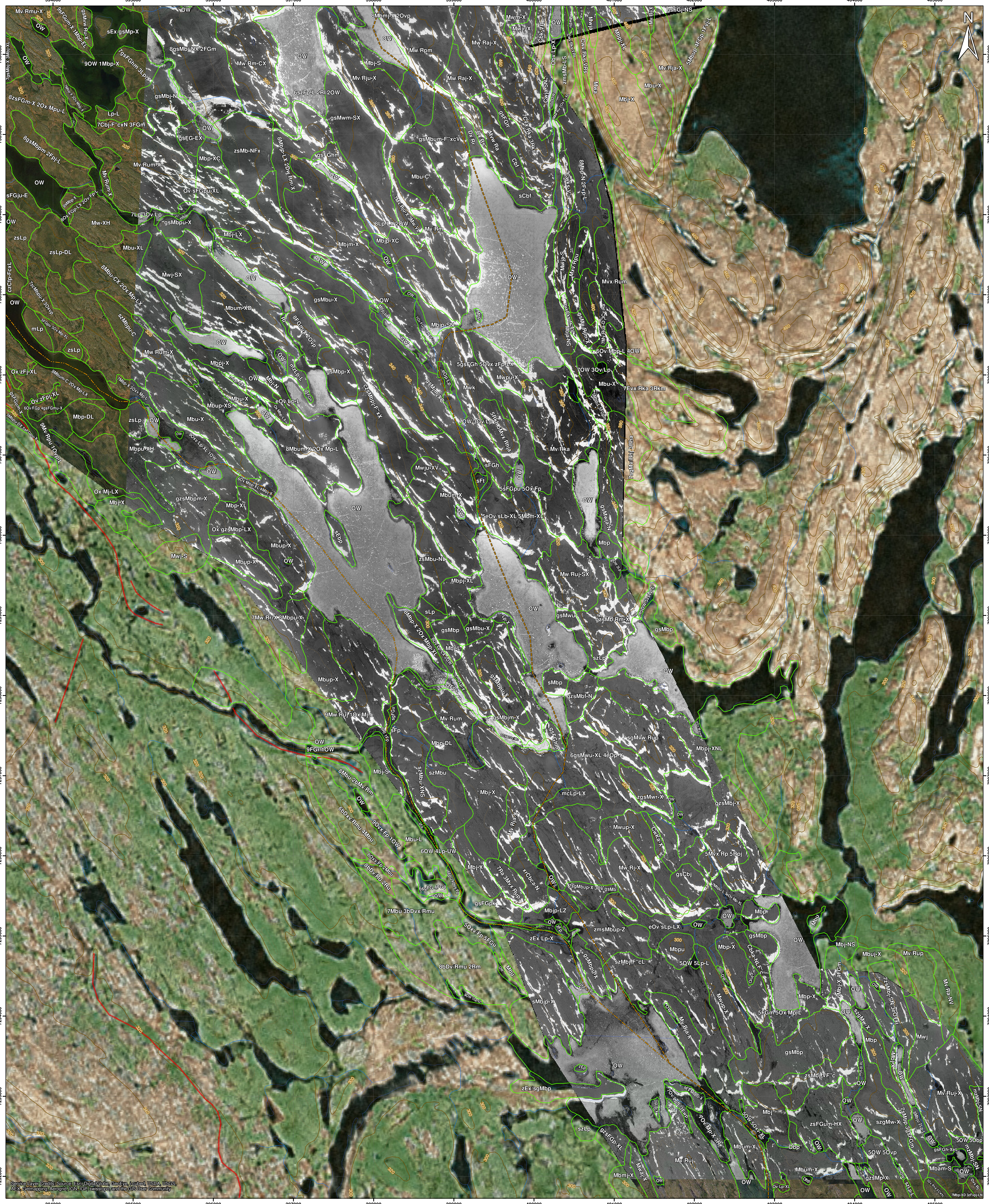
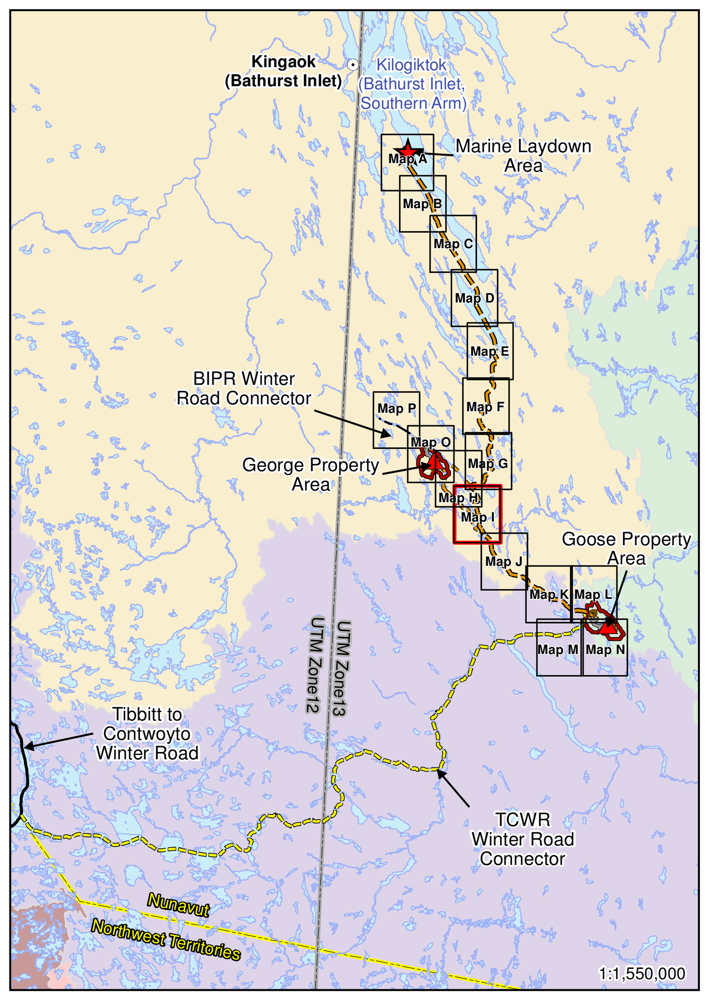
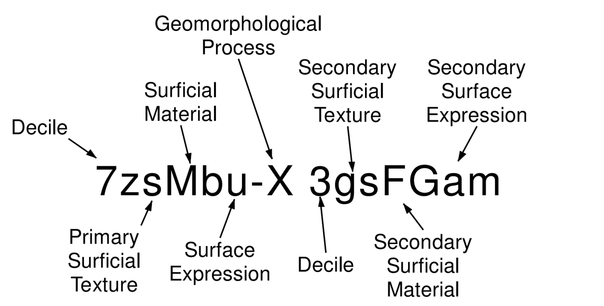




Terrain Polygon Label Code



Surficial Material

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Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map I

Figure V5-3B-9

Terrain Polygon	BIPR Winter Road Connector
Existing Exploration Camp	Haul and Access Road
Marine Laydown Area	Proposed Infrastructure
TCWR Winter Road Connector	Potential Development Area (PDA)
Winter Road	**Federal Watershed Delineation**
Winter Road, George Tie-In Option 1	Bathurst Inlet - Burnside River
Winter Road, George Tie-In Option 2	Upper Back River
	Queen Maud Gulf - Ellice River

1:20,000
0 1,000 2,000
Metres

GIS # BAC-17-028i
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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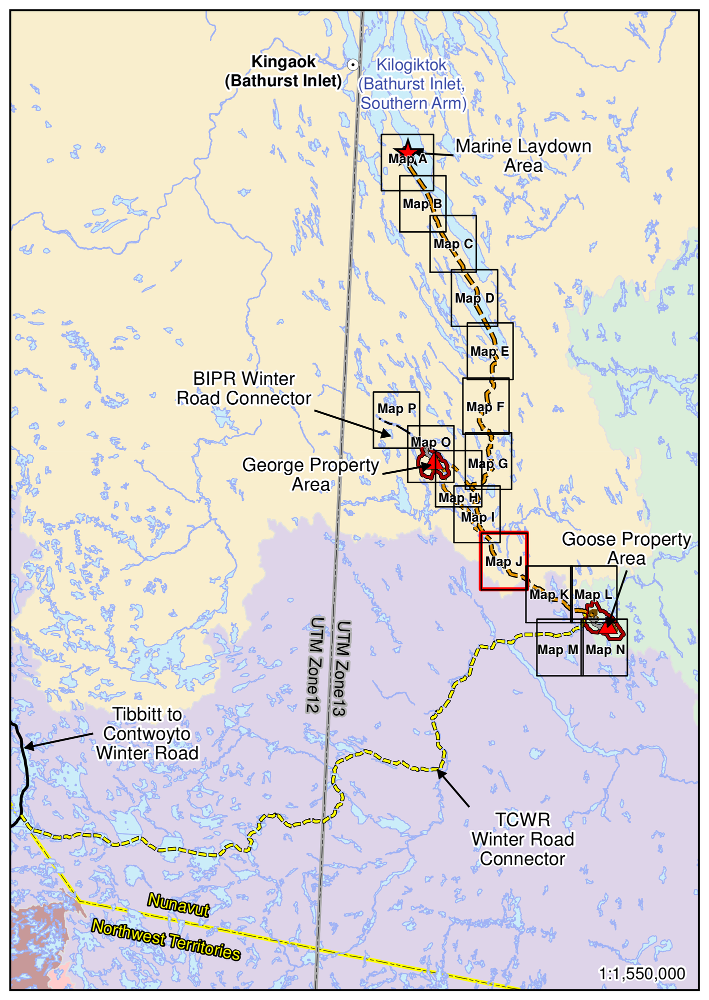

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- Decile (7)
- Primary Surficial Texture (zs)
- Surficial Material (M)
- Surface Expression (bu)
- Geomorphological Process (X)
- Decile (3)
- Secondary Surficial Texture (gs)
- Secondary Surficial Material (FG)
- Secondary Surface Expression (am)

Surficial Material

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U - Undifferentiated

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s - steep slope
t - terrace
u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map J

Figure V5-3B-10

	Terrain Polygon		BIPR Winter Road Connector
	Existing Exploration Camp		Haul and Access Road
	Marine Laydown Area		Proposed Infrastructure
	TCWR Winter Road Connector		Potential Development Area (PDA)
	Winter Road		**Federal Watershed Delineation**
	Winter Road, George Tie-In Option 1		Bathurst Inlet - Burnside River
	Winter Road, George Tie-In Option 2		Upper Back River
			Queen Maud Gulf - Ellice River

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0 1,000 2,000

Metres

GIS # BAC-17-028j
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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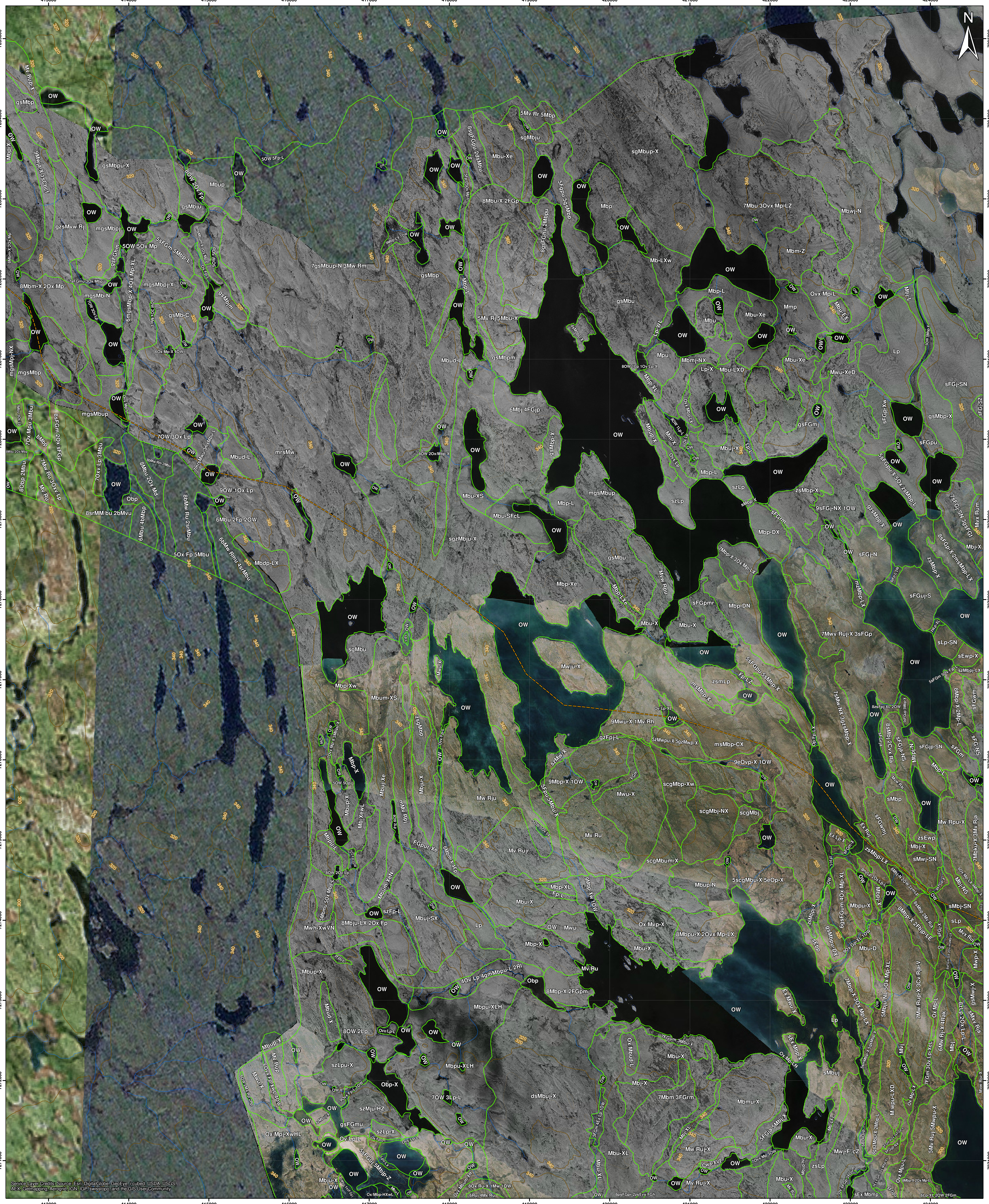

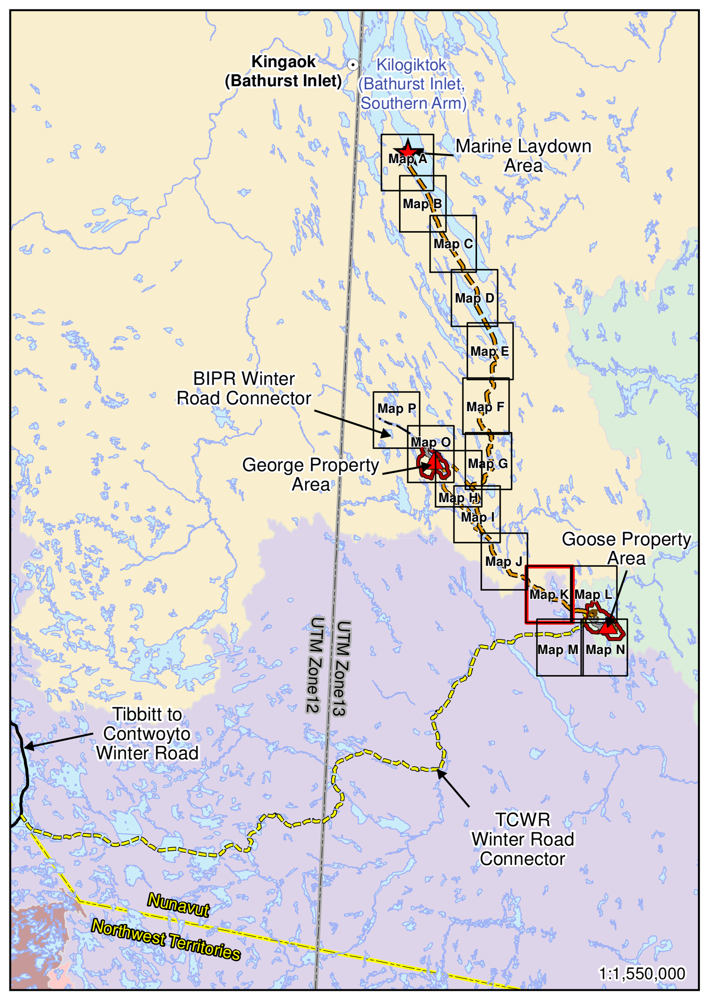

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- 7 – Decile
- z – Primary Surficial Texture
- s – Primary Surficial Texture
- M – Surficial Material
- bu – Surface Expression
- X – Geomorphological Process
- 3 – Decile
- gs – Secondary Surficial Texture
- FG – Secondary Surficial Material
- am – Secondary Surface Expression

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Texture

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p - pebbles
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Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
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J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map K

Figure V5-3B-11

Terrain Polygon	BIPR Winter Road Connector
Existing Exploration Camp	Haul and Access Road
Marine Laydown Area	Proposed Infrastructure
TCWR Winter Road Connector	Potential Development Area (PDA)
Winter Road	**Federal Watershed Delineation**
Winter Road, George Tie-In Option 1	Bathurst Inlet - Burnside River
Winter Road, George Tie-In Option 2	Upper Back River
	Queen Maud Gulf - Ellice River

1:20,000

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Metres

GIS # BAC-17-028k
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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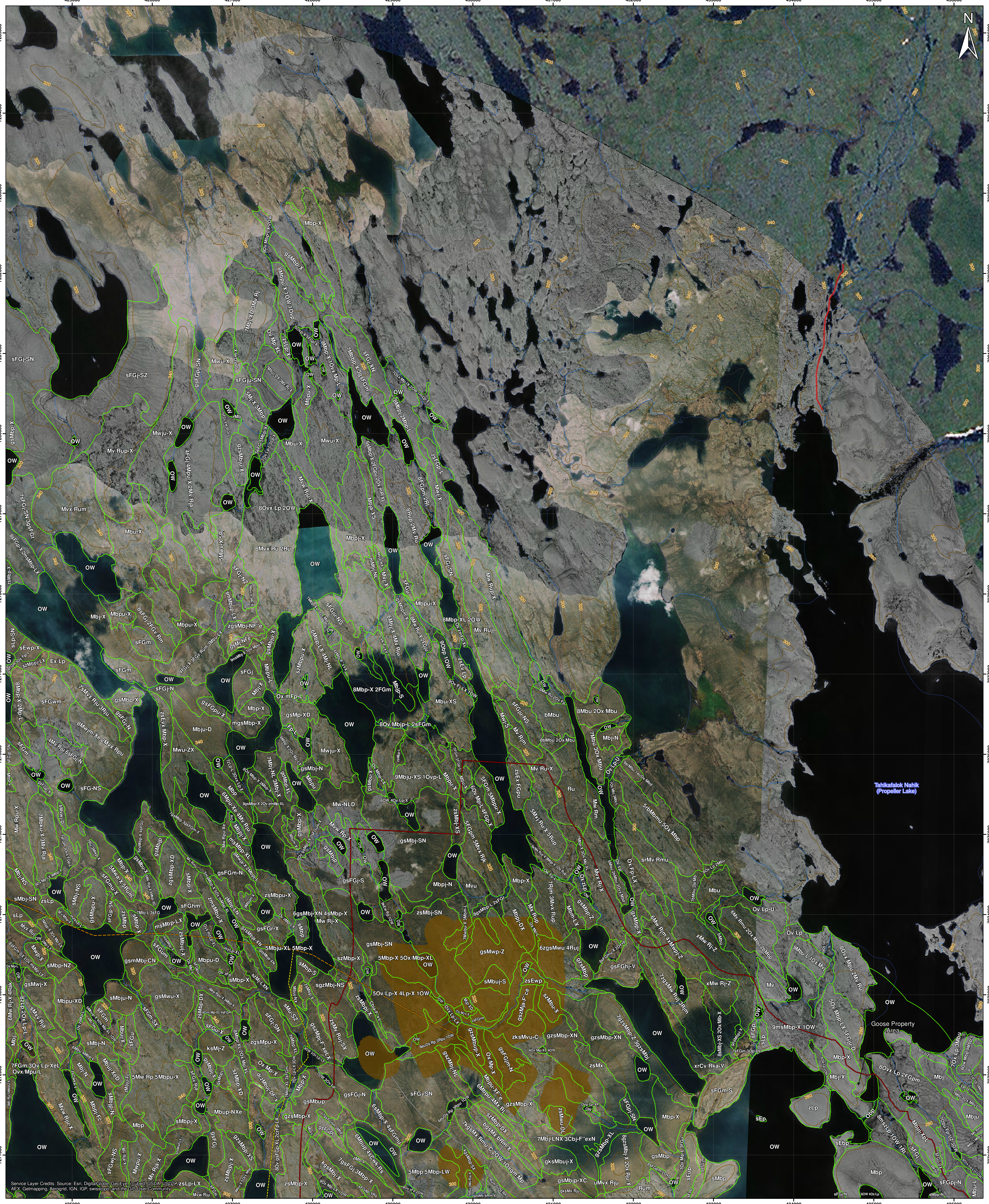
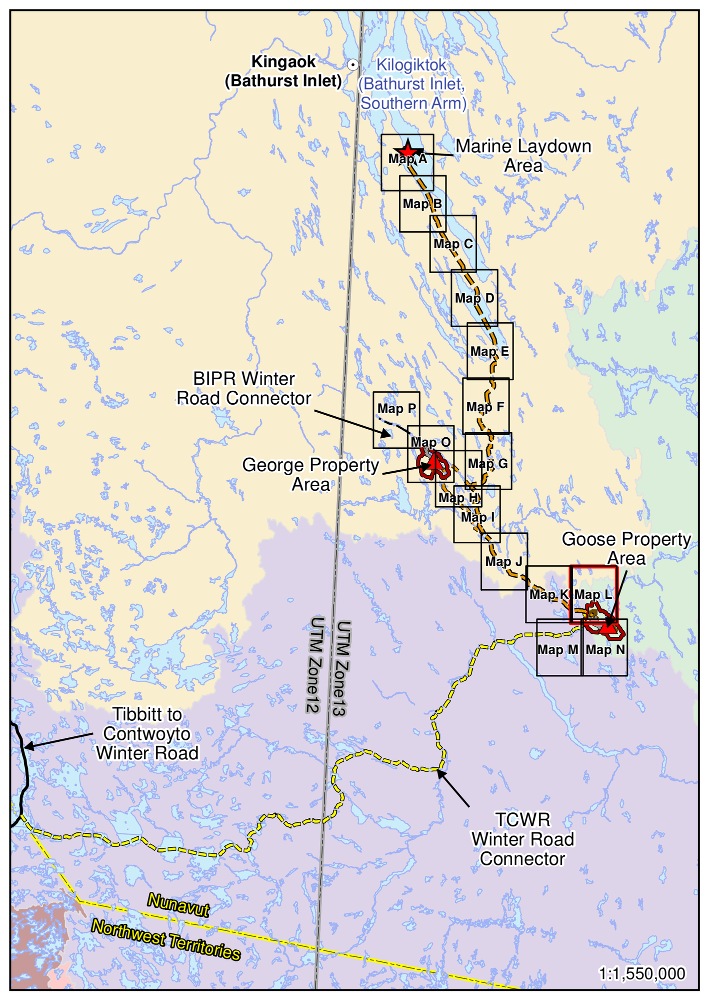
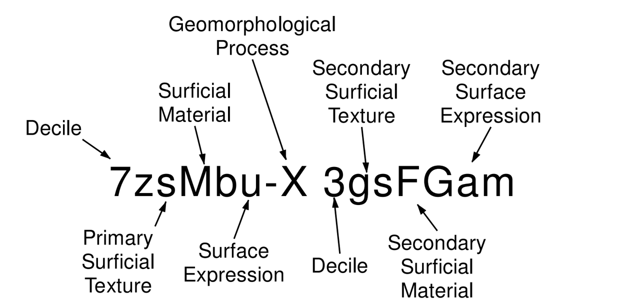




Terrain Polygon Label Code



Surficial Material

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v - veneer
x - thin veneer

Texture

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g - gravel
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p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map L

Figure V5-3B-12

Esker
Terrain Polygon
Existing Exploration Camp
Marine Laydown Area
TCWR Winter Road Connector
Winter Road
Winter Road, George Tie-In Option 1
Winter Road, George Tie-In Option 2
BIPR Winter Road Connector
Haul and Access Road
Proposed Infrastructure
Potential Development Area (PDA)

Federal Watershed Delineation

Bathurst Inlet - Burnside River
Upper Back River
Queen Maud Gulf - Ellice River

1:20,000

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Metres

GIS # BAC-17-028l
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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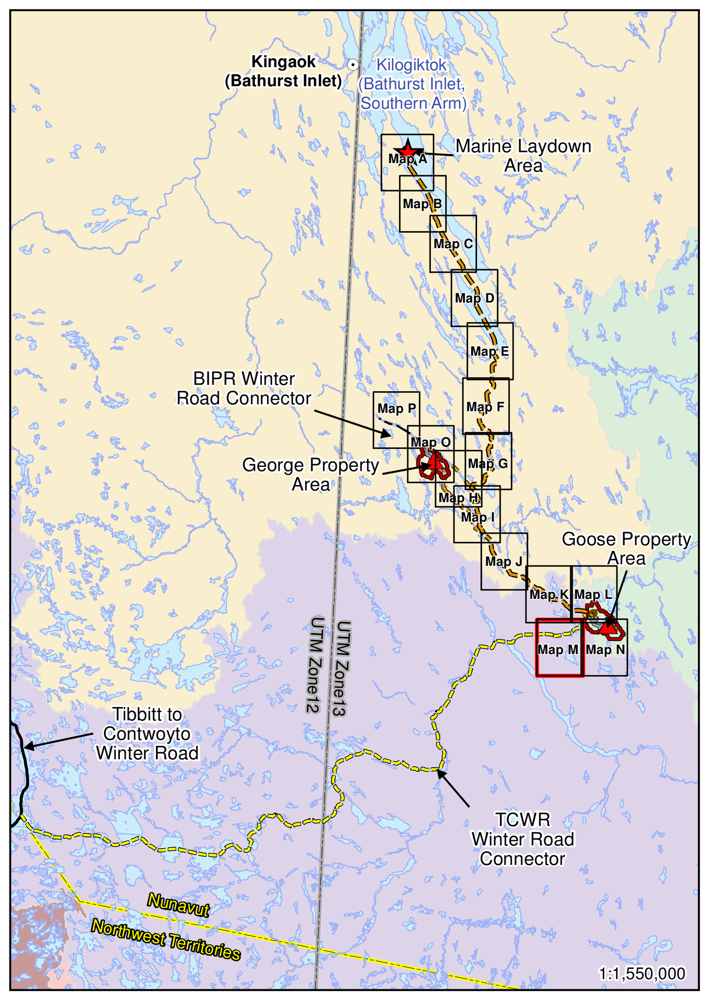

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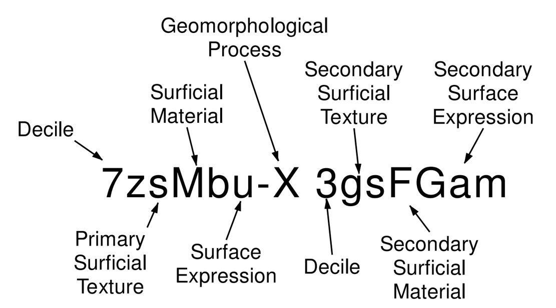

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Geomorphological Process Class

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S - Solifluction
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W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map M

Figure V5-3B-13

Esker		BIPR Winter Road Connector	
Terrain Polygon		Haul and Access Road	
Existing Exploration Camp		Proposed Infrastructure	
Marine Laydown Area		Potential Development Area (PDA)	
TCWR Winter Road Connector		**Federal Watershed Delineation**	
Winter Road		Bathurst Inlet - Burnside River	
Winter Road, George Tie-In Option 1		Upper Back River	
Winter Road, George Tie-In Option 2		Queen Maud Gulf - Ellice River	

1:20,000

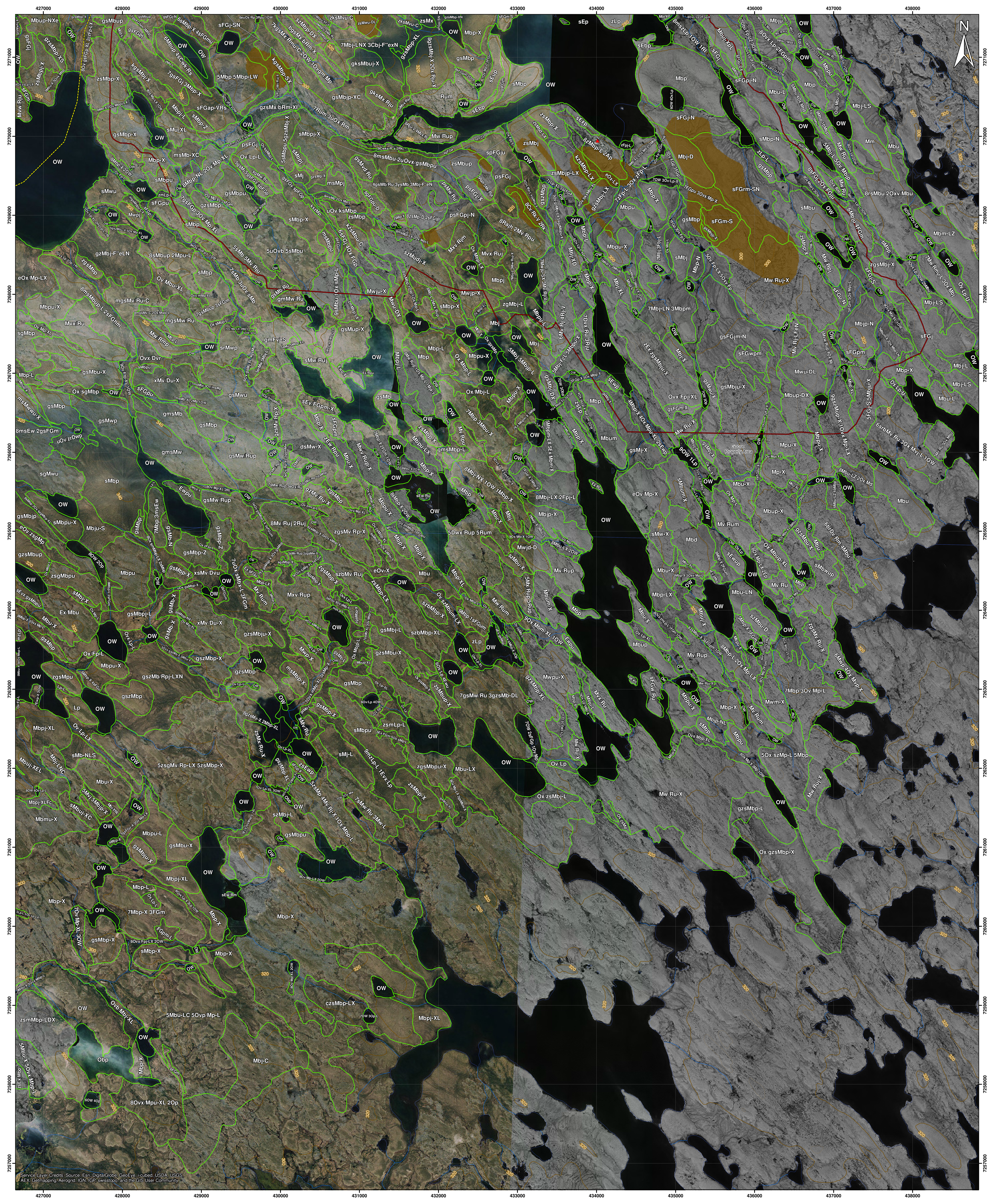
0 1,000 2,000

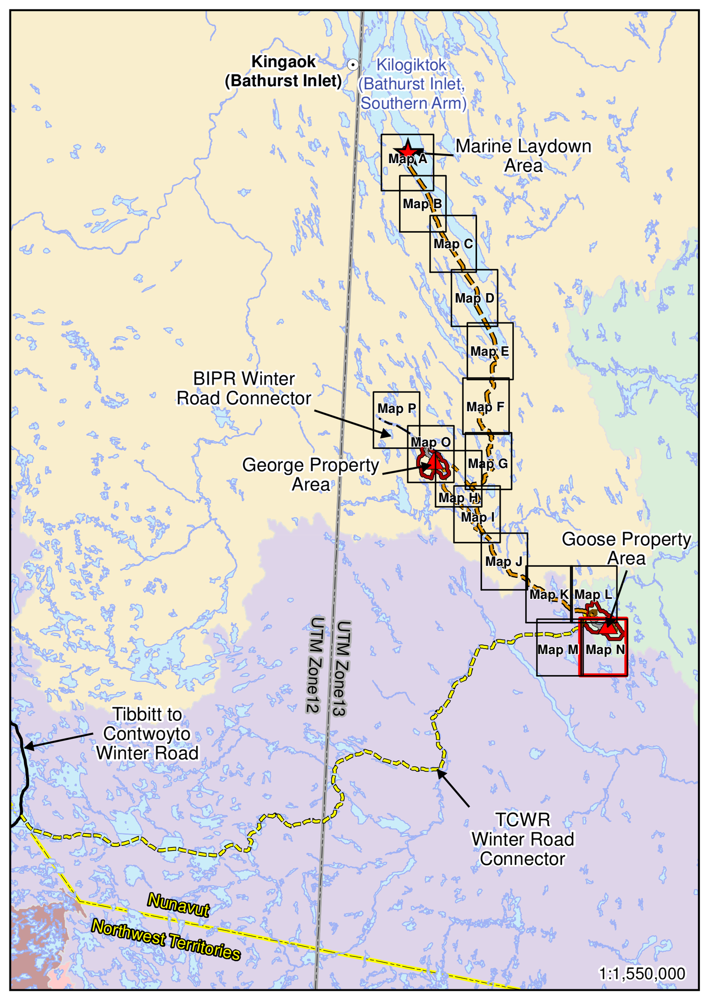
Metres

GIS # BAC-17-028m
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

Sabina GOLD & SILVER CORP.

Rescan an ERM company





Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- 7 – Decile
- zs – Primary Surficial Texture
- M – Surficial Material
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- X – Geomorphological Process
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Geomorphological Process Class

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X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map N

Figure V5-3B-14

Terrain Polygon	BIPR Winter Road Connector
Existing Exploration Camp	Haul and Access Road
Marine Laydown Area	Proposed Infrastructure
TCWR Winter Road Connector	Potential Development Area (PDA)
Winter Road	**Federal Watershed Delineation**
Winter Road, George Tie-In Option 1	Bathurst Inlet - Burnside River
Winter Road, George Tie-In Option 2	Upper Back River
	Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028n
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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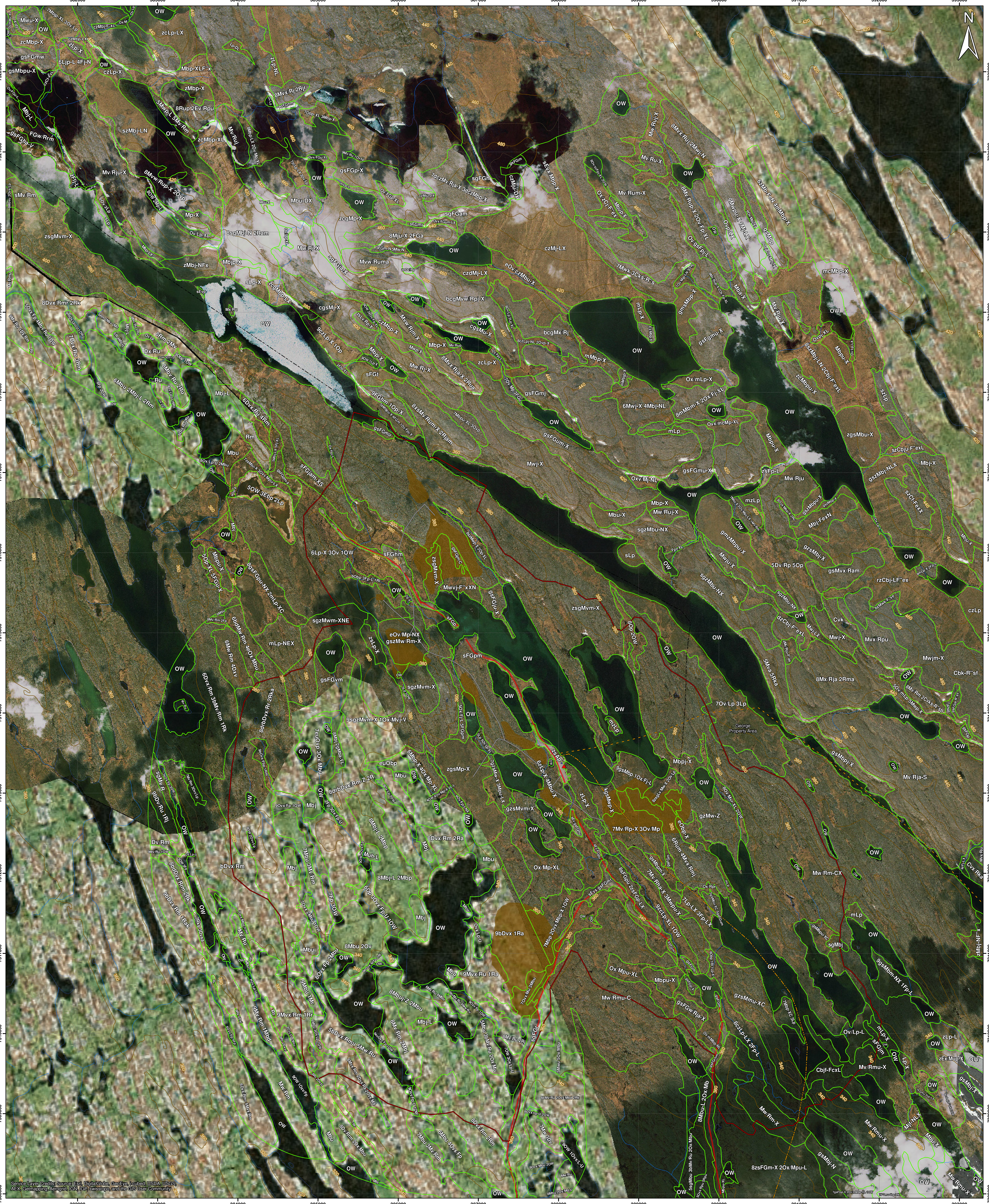

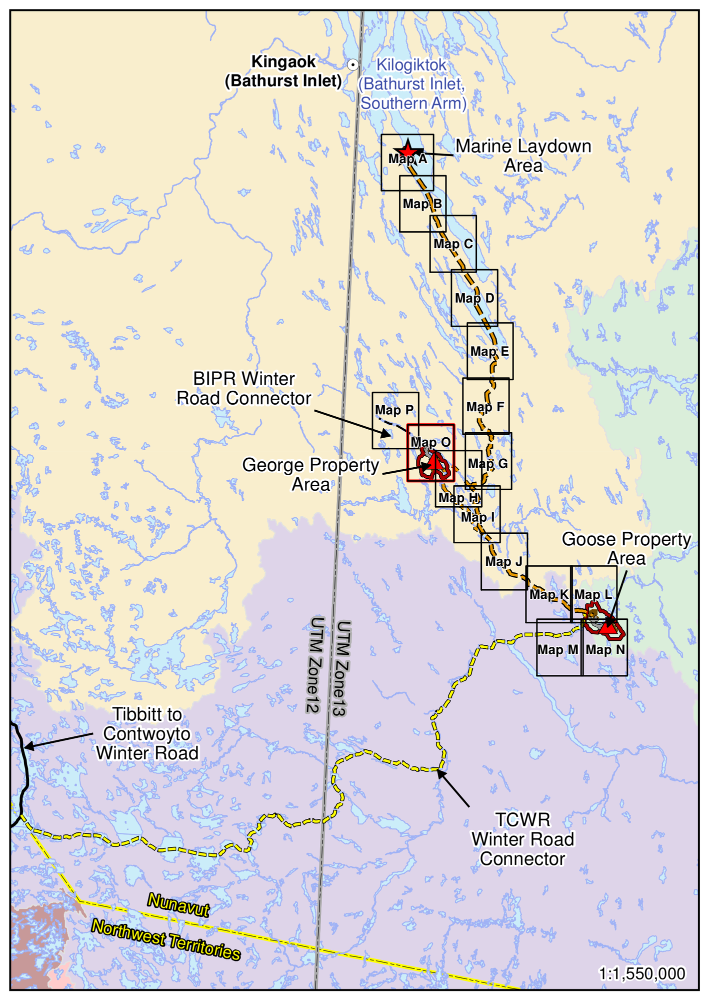

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- Decile (7)
- Primary Surficial Texture (zs)
- Surficial Material (M)
- Surface Expression (bu)
- Geomorphological Process (X)
- Decile (3)
- Secondary Surficial Texture (gs)
- Secondary Surficial Material (FG)
- Secondary Surface Expression (am)

Surficial Material

A - Anthropogenic - Artificial materials, or geological materials so modified by human activity that their original physical properties (e.g. structure, cohesion, consolidation) have been drastically altered.

C - Colluvium - Very high coarse fragment content, angular particles, sand to coarse loamy texture

D - Weathered Bedrock - Bedrock decomposed or disintegrated in situ by processes of mechanical and/or chemical weathering.

E - Eolian - Materials transported and deposited by wind action.

F - Fluvial - Very high coarse fragment content, rounded particles, sandy texture; loose, often stratified associated with active creeks

FG -Glaciofluvial - Very high coarse fragment content, rounded particles, sandy to coarse loamy texture, commonly associated with morainal materials, often as a moderately thick capping in recent deposits

L - Lacustrine - Sediments settled from suspension and underwater gravity flows, such as turbidity currents, in bodies of standing fresh water, or sediments accumulated at their margins through the action of waves.

M - Morainal - High to very high, coarse fragment content, mixed particles, sandy to fine loamy texture; commonly compact subsurface

O - Organic - Very dark, moderately decomposed organic material, often less than 1 m thick

OW - Open water

R - Bedrock - Bedrock outcrops and rock covered by a thin mantle (up to 10cm thick) of unconsolidated or organic materials.

RI - River

U - Undifferentiated

W - Marine

Surface Expression

a - moderate slope
b - blanket
c - cone
d - depression(s)
f - fan
h - hummock(s)
j - gentle slope
k - moderately steep slope
m - rolling
p - plain
r - ridge(s)
s - steep slope
t - terrace
u - undulating
w - mantle
v - veneer
x - thin veneer

Texture

a - blocks
b - boulder
c - clay
d - mixed fragments
e - fibric
g - gravel
k - cobbles
m - mud
p - pebbles
r - rubble
s - sand
u - mesic
z - silt

Geomorphological Process Class

C - Cryoturbation
D - Deflation
E - Channeled by Meltwater
F - Slow mass movements
H - Kettle
J - Anastomosing Channel
L - Surface Seepage
N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map
Map O

Figure V5-3B-15

- Terrain Polygon
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

Federal Watershed Delineation

- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028o
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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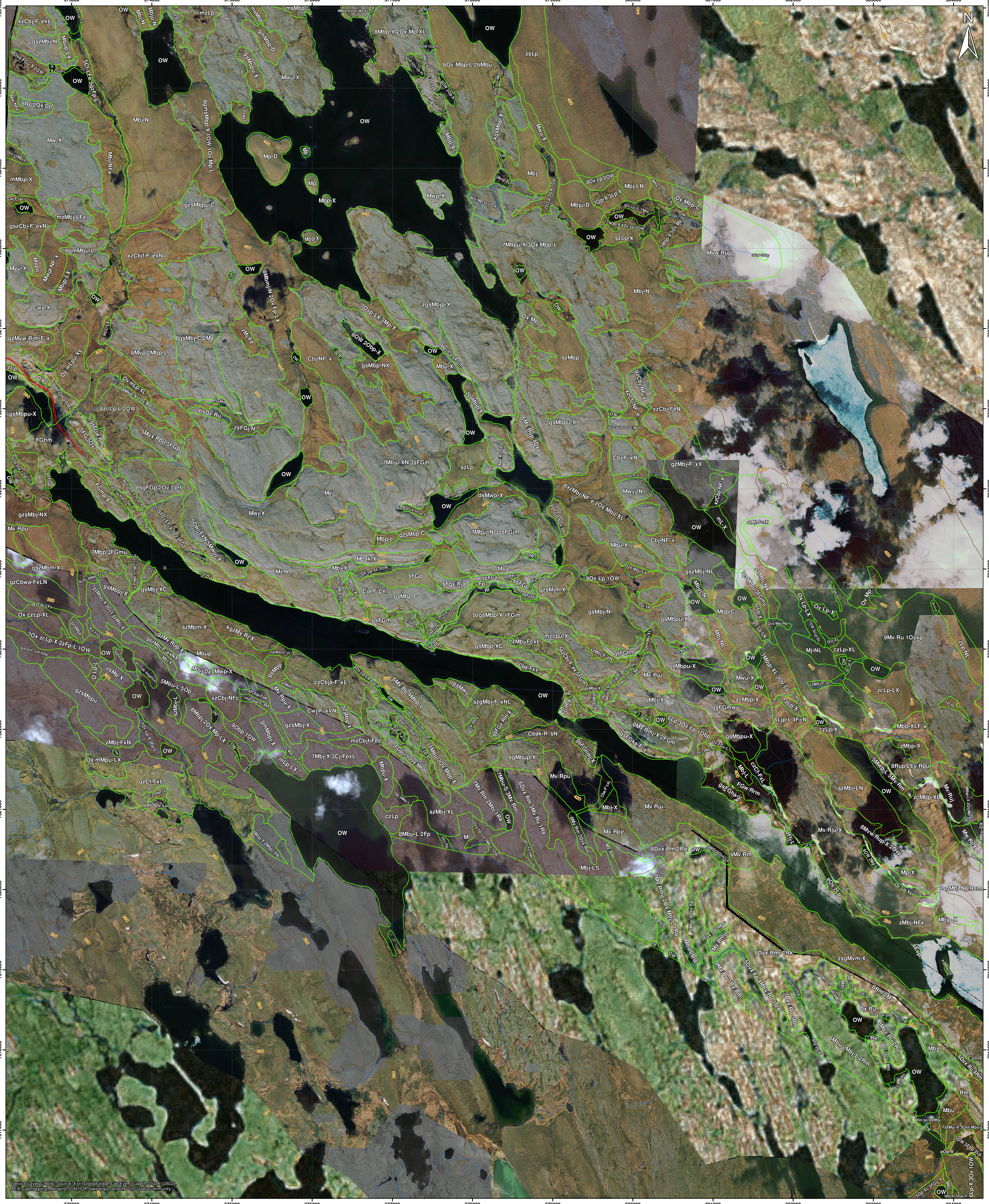

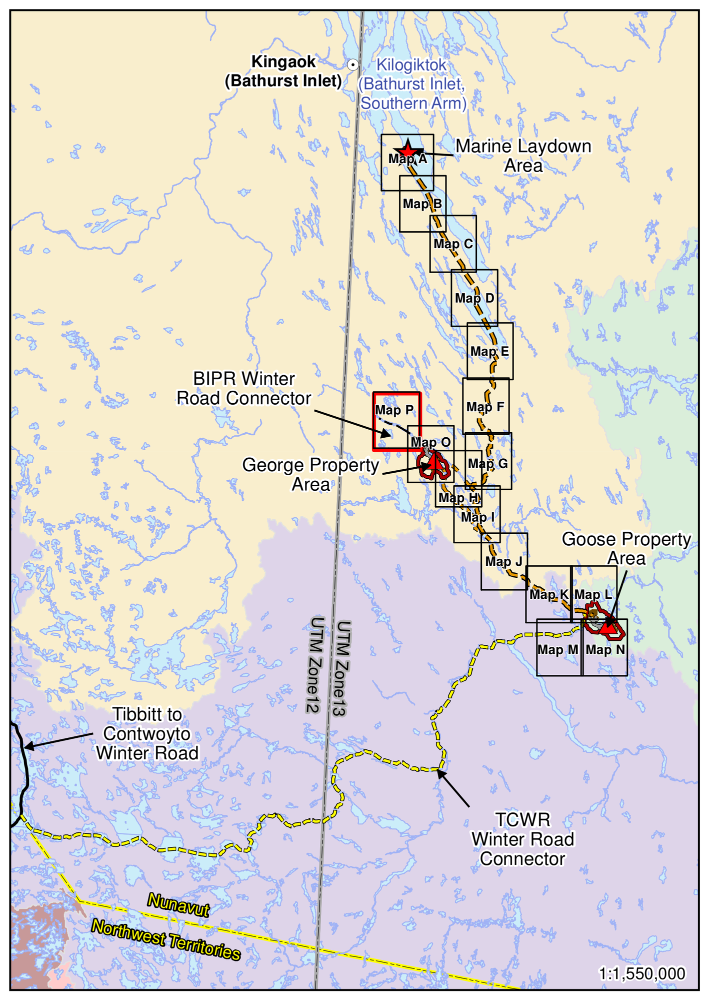

Terrain Polygon Label Code

7zsMbu-X 3gsFGam

- Decile
- Primary Surficial Texture
- Surficial Material
- Surface Expression
- Geomorphological Process
- Decile
- Secondary Surficial Texture
- Secondary Surficial Material
- Secondary Surface Expression

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D - Weathered Bedrock - Bedrock decomposed or disintegrated in situ by processes of mechanical and/or chemical weathering.

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N - Nivation
R - Rapid Mass Movement
S - Solifluction
V - Gully Erosion
W- Washing
X - Permafrost Processes
Z - General Periglacial Processes

Back River Project: Terrain Map Map P

Figure V5-3B-16

- Terrain Polygon
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

Federal Watershed Delineation

- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

1:20,000

0 1,000 2,000

Metres

GIS # BAC-17-028p
Date: November 18 2013
Project #: 0194096-0040
Projection: NAD 1983 UTM Zone 13N

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Appendix V5-4A

2012 Ecosystems and Vegetation Baseline Report

an ERM company

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
2012 Ecosystems and Vegetation Baseline Report




Rescan™ Environmental Services Ltd.
Rescan Building, Sixth Floor - 1111 West Hastings Street
Vancouver, BC Canada V6E 2J3
Tel: (604) 689-9460 Fax: (604) 687-4277

April 2013

BACK RIVER PROJECT
2012 ECOSYSTEMS AND VEGETATION BASELINE REPORT

April 2013
Project #833-002-19

Citation:

Rescan. 2013. *Back River Project: 2012 Ecosystems and Vegetation Baseline Report*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.

Prepared for:

Sabina GOLD & SILVER CORP.

Sabina Gold & Silver Corp.

Prepared by:

Rescan™ Engineers and Scientists

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

Rescan™
Engineers and Scientists

Executive Summary

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. The 2012 baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, the Marine Laydown Area, and a system of proposed winter and all season roads.

In 2012, baseline studies were initiated to inventory and describe the full range and type of ecosystems and vegetation, rare and invasive plants, in the Project area. This report presents the results of the studies including terrestrial ecosystem classification and mapping, sensitive ecosystems, rare plant surveys, invasive plant surveys, plant tissue collection for baseline metals analysis, and an analysis of the potential carbon storage of wetlands.

Field surveys were completed during the summer of 2012 to characterize the full range of ecosystems that occur in the Project area. The collected data was then used to create a project specific ecosystem classification system to enable ecosystem mapping of the approximately 140,000 hectare Local Study Area (LSA). The classification system includes detailed descriptions of 11 sparsely-vegetated ecosystems, 20 vegetated ecosystems, and 6 non-vegetated ecosystems. Vegetated ecosystems comprise approximately 70 % of the LSA, 8 % of which are wetland ecosystems. The most common ecosystem class mapped within the LSA was tundra, with the mesic dwarf-shrub tundra (TL), the dry-sparse tundra (TH), and the shrubby tundra (TS) vegetation associations comprising greater than 50 % of the LSA. While a formal system for tracking sensitive ecosystems does not presently exist in Nunavut, seventeen ecosystems are considered sensitive, primarily due to their importance as wildlife habitat or heightened sensitivity to disturbance. Of the mapped sensitive ecosystems, representing approximately 14 % of the total LSA, nearly half were mapped within the George Property Area.

Rare plant surveys, conducted in 2012, contributed significantly to the available scientific data of distribution and occurrence of rare plants in western Nunavut. A total of 90 rare species were found in the Project area, including 41 vascular plants, 31 lichens, and 18 mosses. The area around Bathurst Inlet had the highest concentration of rare plant occurrences. None of the rare species are currently listed under the *Species at Risk Act* or by the *Committee on the Status of Endangered Wildlife in Canada*. In total, 236 tracked species observations were recorded. No invasive species were found in the LSA.

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Rescan™ Engineers and Scientists

BACK RIVER PROJECT

2012 ECOSYSTEMS AND VEGETATION BASELINE REPORT

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Glossary and Abbreviations

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Aeolian	Medium to fine sand and silt that has been transported and deposited by wind action.
Alluvial	Pertaining to the loose, unconsolidated sediments that have been eroded, deposited, and reshaped by water in some form in a non-marine setting. Generally not applied to deposits when the particular mode of deposition via water is identifiable.
Attribute	Any feature of a vegetation association that is not represented by the site series/vegetation association, site modifier or structural stage. Attributes may either be recorded from fieldwork or inferred by extrapolating features from similar vegetation associations.
Colluvium	Material that has accumulated in a given location as a direct result of gravity-induced movement.
COSEWIC (Committee on the Status of Endangered Wildlife in Canada)	A committee that produces the official list of Canada's endangered species.
Ecosystem (terrestrial)	A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
Edaphic	Pertaining to soil characteristics, and specifically how these affect living organisms.
ELC	Ecological Land Classification
Floodplain	Area of unconsolidated, river-borne sediment in a river valley; subject to periodic flooding.
Fen	Peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone. They are dominated by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses.
Fibric	Poorly decomposed peat with large amounts of well-preserved fibre readily identifiable as to botanical origin.
Fluvial	Material, generally sand, gravel or silt, which is transported and deposited by streams and rivers.
Forb	Non-graminoid herbaceous plants.
Habitat	Land and water surface used by wildlife. This may include biotic and abiotic aspects such as vegetation, exposed bedrock, water and topography.
HDI	Hydrodynamic Index

Hectare	10,000 m^2 or 0.01 km^2 or 2.47 acres.
Herb	A plant - annual, biennial or perennial - with stems that die back to the ground at the end of the growing season.
Hydric	A qualitative measure of soil moisture that indicates water being removed so slowly that a water table is at or above soil surface during the entire growing season. Organic and gleyed mineral soils are present.
Hydrophilic	Substances that have an affinity for water often because of the formation of hydrogen bonds.
Hygric	A qualitative measure of soil moisture regime that indicates wetter than mesic conditions. Saturation of the soil is limited so that anaerobic soil conditions are transient in the rooting zone.
Hydrodynamic index	And index measuring the magnitude of water vertical fluctuation and lateral flow.
LSA	Local Study Area
Marsh	A shallowly flooded mineral wetland dominated by emergent grass-like vegetation.
Mesic	1. Organic material in an intermediate stage of decomposition where some fibers can be identified as to botanical origin. 2. Medium soil moisture regime where a site has neither excess soil moisture nor a moisture deficit.
Moisture Regime	Indicates the available moisture for plant growth in terms of the soil's ability to hold, lose, or receive water. Described as moisture classes from Very Xeric (0) to Hydric (8). (B.C. MELP and B.C. MoF 1998).
Morainal	Material deposited directly by glacial ice. Highly variable material that that has not been modified by other transportation agents.
NGSWG	National General Status Working Group (NGSWG
Nutrient Regime	Indicates the available nutrient supply for plant growth. Nutrient regime is based on a number of environmental and biotic factors, and is described as classes from Oligotrophic (A) to Hypereutrophic (F) (BC MELP and BC MoFR, 1998).
NWT GSRP	Northwest Territories General Status Ranking Program. The program that integrates knowledge from relevant agencies regarding statue of species within the NWT.
Palsa	Palsas are low, often oval, frost heaves occurring in polar and subpolar climates, which contain permanently frozen ice lenses.
Peatland	Organic wetlands containing at least 40 cm of peat accumulation on which organic soils (excluding folisols) develop (Warner and Rubec 1997).
Periglacial process	Freezing and thawing processes that drastically modify the ground surface.
Physiognomy	General appearance of an object without reference to its implied characteristics.

Polygon	Delineations that represent discrete areas on a map, bounded by a line on all sides.
Presence/absence surveys	Surveys which rely on visual observations to confirm the presence of the target. These cannot be used in isolation from other statistical techniques to determine the size or absence of a population. They can only be used to confirm the presence of a target species.
Riparian Ecosystem	Ecosystems whose structure and species composition is strongly influenced by regular flooding.
SARA	Species At Risk Act
SMR	Soil Moisture Regime
SNR	Soil Nutrient Regime
Structural Stage	Describes the existing dominant stand appearance or physiognomy for a land area. Structural stages range from non-vegetated to old forest.
Submesic	A qualitative measure of soil moisture regime that indicates soil conditions drier than mesic. Water is removed from the soil at a faster rate than supply.
Topography	The configuration of a surface, including its relief and the position of its natural and man-made features.
Tundra	An area with permafrost soils which causes trees to be excluded from the landscape due to the edaphic conditions of the rooting zone within the soil.
UTM	Universal Transverse Mercator
Vegetation association	Defines all sites capable of supporting similar plant communities.
VM	Very Moist SMR
VW	Very Wet SMR
Wetland	Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrotrophic vegetation and various kinds of biological activity which are adapted to a wetland environment (National Wetlands Working Group 1988).
W	Wet SMR
WKSS	West Kitikmeot/Slave Study

1. Introduction

1. Introduction

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corp. (Sabina) located in the West Kitikmeot region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012 (Figure 1-1).

For 2012, Sabina contracted Rescan Environmental Services (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. The following components were included in the 2012 baseline program:

- Meteorology
- Air Quality & Dust
- Noise
- Hydrology & Bathymetry
- Freshwater Water Quality, Sediment Quality, Aquatic Biology
- Freshwater Fish & Fish Habitat
- Marine Water Quality, Sediment Quality, Aquatic Biology
- Marine Fish & Fish Habitat
- Wildlife (Terrestrial & Marine)
- Wildlife DNA Study (Grizzly Bear & Wolverine)
- Ecosystem Mapping
- Vegetation & Wetlands (including Rare Plants)
- Soils & Terrain
- Country Foods
- Archaeology
- Socio-Economics
- Land Use
- Metal Leaching/Acid Rock Drainage (ML/ARD)

The 2012 baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, and the Marine Laydown Area. It was assumed that access from the Marine Laydown Area to George and Goose properties would be by winter road, as would access between the George and Goose properties.

This report presents the results from the Ecosystems and Vegetation portion of the 2012 baseline program. These studies were initiated to inventory and describe the full range and type of ecosystems and vegetation in the Project area. This report presents the results of the studies including ecosystem classification and mapping, sensitive ecosystems, rare plant surveys, invasive plant surveys, plant tissue collection for baseline metals analysis, and an analysis of the potential carbon storage of wetlands.

PROJECT # 0833-002-21 GIS # BAC-20-007 March 19 2013

Figure 1-1

Back River Project Location

Sabina

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Chapter 2 of this report presents the methodology, Chapter 3 the results, and a summary is provided in Chapter 4. All raw data collected are included as appendices.

The specific objectives of this report are to:

- Describe the terrestrial and wetland ecosystems and their distributions within the Local Study Area (LSA);
- Identify and describe any plants tracked by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the Northwest Territories General Status Ranking Program (GSRP), and the Species At Risk Act (SARA) that occur in the LSA;
- Identify the presence and location of any plants considered invasive within Nunavut;
- Describe baseline metal concentrations in plant collections from the Project area;
- Describe the functions of identified ecosystems;
- Calculate the carbon storage potential of wetlands in the LSA; and
- Provide land cover and vegetation data for the wildlife habitat suitability modelling.

2. Methodology

2. Methodology

2.1 SPATIAL BOUNDARIES

Figure 2.1-1 depicts the local study area (LSA) and regional study area (RSA) boundaries for the ecosystems and vegetation baseline work.

The LSA was created using a combination of sub-watershed boundaries and buffers (1 km for roads and 2 km for all other infrastructure) around the proposed Project components, including potential infrastructure and access roads. Subwatersheds were used when the size of the watershed provided a reasonable area surrounding the Project components.

To enable reporting and discussion of geographic differences in ecosystem distributions, the LSA has been divided into the following four sub-areas (Figure 2.1-2):

- Goose Property Area;
- George Property Area;
- Marine Laydown Area; and
- Proposed Winter Road (to Bathurst Inlet).

The RSA was the same RSA used for wildlife baseline work, and generally included a 30 km buffer around the proposed infrastructure (Figure 2.1-1).

2.2 TERRESTRIAL ECOSYSTEM MAPPING

This section presents the methodology used to characterize ecosystems in the Project area. Terrestrial Ecosystem Mapping (TEM) involves the delineation and classification of both surficial materials and vegetated ecosystems. Terrain mapping is used as the base layer for the completion of ecosystem mapping. Initial mapping involves polygon delineation and the assigning of general attributes to the individual polygons. Detailed attributes are subsequently assigned using the field data collected from ground plots.

Mapping was completed at 1:5000 scale using 1984 1:20 000 black and white airphotos from the National Air Photo Library. Air photos were acquired in a digital format and aerial triangulation was completed to develop models for use in PurVIEW, a softcopy system. This system enables 3D stereo mapping within ESRI ArcGIS 9.3 where users can work with multiple types and sources of data (such as watercourse, contours, and geology data) to interpret and map air photos, at various scales. A Digital Elevation Model (DEM), created from the Digital Topographic Maps of Canada, was used to provide a control on the vertical plane (z-axis) to enable on-screen digitizing of polygons that are photogrammetrically accurate. Colour satellite imagery from (composite image from 2006 to 2011) was also used to assist with classification and to identify any recent disturbances. Mapping procedures generally followed the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998a) where applicable.

2.2.1 Preliminary Terrain and Soils Mapping

Preliminary terrain mapping was completed during the spring and early summer of 2012. Terrain mapping is the identification of homogeneous terrain units based on surficial material, geomorphology and landform. Terrain mapping forms the basis for the surficial material mapping within the LSA.

Terrain polygons are delineated based upon observable landscape characteristics such as surficial material, terrain texture, surface expression, and geomorphic processes. Attributes were described using British Columbia's Terrain System Classification for British Columbia (Howes and Kenk 1997), and recorded in a database linked to the ArcGIS terrain shapefile.

Soils mapping was conducted according to the Canadian System of Soil Classification (Soils Classification Working Group 1998). It is largely an interpretive exercise based upon field data, terrain attributes, and local climate, and is completed primarily to identify sensitive soils and to support soil salvage and reclamation plans. Additional information can be found in the 2012 Terrain and Soils Baseline Report (Rescan 2013d).

Since a formal system of ecosystem classification does not exist for the Canadian Arctic, a preliminary classification system was developed for the Project. This system involved incorporating data from a number of other studies that have previously developed site level ecosystem classification systems to delineate mappable ecological units with consistent vegetation associations, soil properties, and subject to a similar climate. These include the following ecological land classification (ELC) projects:

- Ecosystem classification in the Lac de Gras area (BHP 1995);
- Ecosystem classification in the Hope Bay Belt (Burt 2003) (Golder Associates 2009);
- Vegetation Classification for the West Kitikmeot/Slave Study Region (1997-2001) (Matthews, Epp, and Smith 2001);
- EBA Engineering for the Tibbett to Contwoyto Winter Road (TCWR; (EBA 2002); and
- Ecosystem Classification of the Bathurst Port and Inlet Road Project (Rescan 2010).

Eight broad ecosystem classes were deemed likely to be present within the LSA, including tundra, freshwater, marine, wetland, bedrock, riparian, esker and disturbed/barren classes. Wetland and riparian ecosystems were defined according to (MacKenzie and Moran 2004), tundra was defined according to EBA (2002) and freshwater ecosystems, bedrock and disturbed / barren units were defined according to RIC (1998a). Brief definitions and some key characteristics of these ecosystem classes are presented in Table 2.2-1.

A preliminary ecosystem mapping legend was developed, which further divided the broad ecosystem classes into one or more specific vegetation associations, based largely upon available vegetation association descriptions and respective map codes used within previous mapping projects. Section 3.2 discusses the development of the final map legend, based upon the results of field surveys, and identifies the vegetation associations and accompanying codes that are mapped throughout the LSA.

2.2.2 Field Verification of Terrestrial Ecosystem Mapping

The following text describe the methodology used to collect and analyse terrestrial and wetland ecosystem baseline data, from which a project-specific system of classifying vegetation associations was created. Additionally, the plot data were used to assist in mapping and to conduct quality control checks of the ecosystem mapping.

PROJECT #833-002-05 GIS # BAC-20-008 March 21 2013

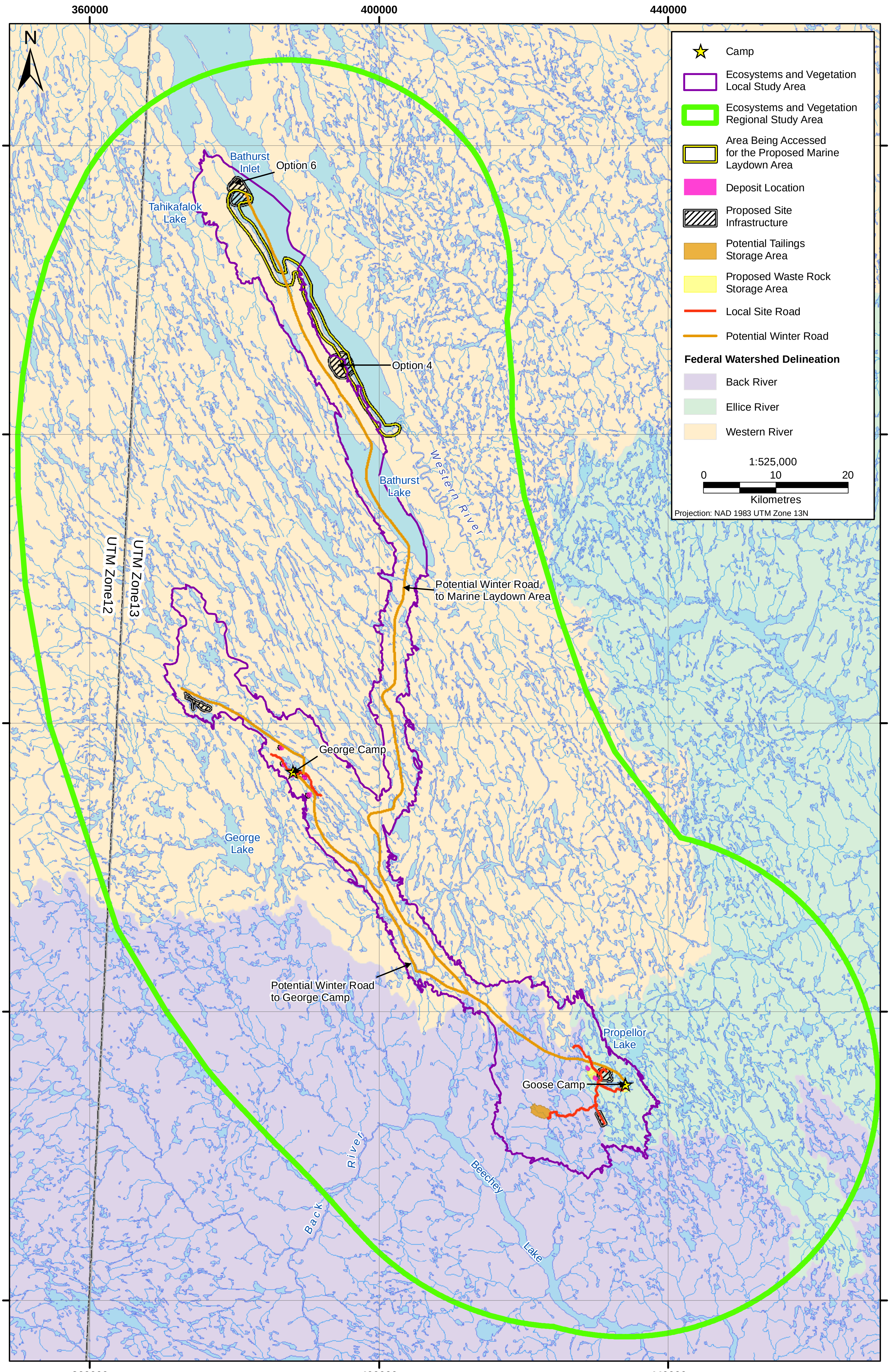

Figure 2.1-1

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Figure 2.1-1

Back River Ecosystems and Vegetation Local and Regional Study Areas

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PROJECT #833-002-05 GIS # BAC-20-009 March 21 2013

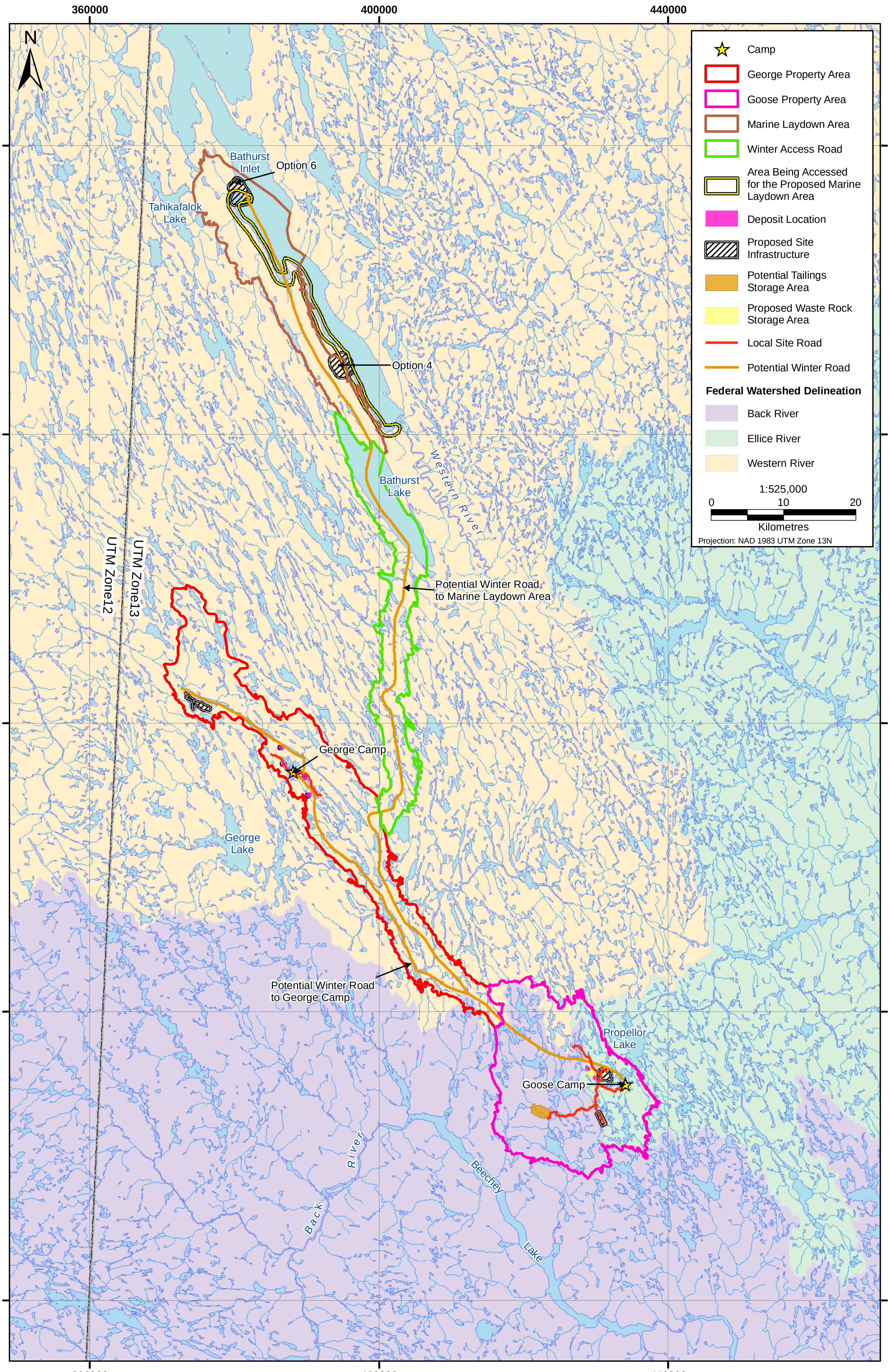

Figure 2.2-2

Figure 2.1-2

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Sub-areas of the Ecosystems and Vegetation LSA

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Table 2.2-1. Ecosystem Classes Applicable to the LSA

Ecosystem Class	Description
Tundra	• permafrost soils • trees excluded due to presence of permafrost in the rooting zone • dwarf ericaceous shrubs often dominate • a variety of sedges, cottongrasses and grasses present • lichen cover can be very high
Freshwater	• freshwater lakes, ponds and rivers • ponds and lakes classified based on size, in accordance with the BC TEM Standards definitions (RIC 1998). Ponds are defined as a small body of water greater than 2 metres deep but not large enough to be classified as a lake (< 50 ha). • lakes are defined as naturally occurring static bodies of water greater than 2 metres deep and larger than 50 ha (RIC 1998). • rivers are defined as watercourses with flowing water between continuous, definable banks; water flow may be intermittent or perennial (RIC 1998).
Marine	• ecosystems occurring in close proximity to the Arctic Ocean • parent materials are marine or glaciomarine derived • high salinity soils common
Wetland	**FEN** • peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone • pH usually above 5 • vegetation includes non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses • develop in basins, lake margins, river floodplains, and seepage slopes, where the water table is usually at or just below the peat surface for most of the growing season. **BOG** • shrubby, nutrient-poor peatlands • pH less than 5.5 • vegetation typically ericaceous shrubs and hummock-forming *Sphagnum* species • highly acid and oxygen-poor soil conditions form basins where peat accumulation has raised the wetland surface above groundwater flow **MARSH** • shallowly flooded mineral wetland dominated by emergent grass-like vegetation • fluctuating water table is typical • exposure of the substrate in late season or during dry years is common • nutrient availability is high
Bedrock	• gentle to steep, bedrock escarpment or outcropping, with little soil development (RIC 1998) and typically non- or sparsely-vegetated (< 10% cover)
Riparian	• flood ecosystems • soils often with high proportion of coarse fragments • shrub species dominate the vegetation
Esker	• typically mounded, linear glaciofluvial features • soils are well to rapidly-drained with abundance of exposed sand and gravel, especially on crest positions • windswept crests often non- or very sparsely-vegetated (< 5% cover), with tall shrubs possible along the sheltered lower and toe slopes
Disturbed / Barren	• areas of exposed soil not included in any of the other definitions and other areas with evidence of recent disturbance (RIC 1998), such as resulting from exploration activity, road construction, or mine camp development • may be non- or very sparsely-vegetated (< 5% cover)

2.2.2.1 *Terrestrial Ecosystems*

Field verification of the preliminary TEM was completed during the summer of 2012 using a combination of detailed sample plots (ground inspections) and visual plots (visual inspections). Each plot was assessed by a vegetation ecologist and soil scientist. At the detailed plots, information included a full list of plant species, by vegetation structural layer (shrub (B layer), herb (C layer), and moss/lichen (D layer)), detailed site information, the vegetation association code, and detailed terrain and soils characterisation. Soils were classified according to the Canadian System of Soil Classification (Warner and Rubec 1997). Field data were collected according to the Rescan Field Data Collection Form (Appendix 2) and per the *Field Manual for Describing Terrestrial Ecosystems (B.C. MELP and B.C. MoF 1998)*, where applicable. At each location, the following attributes were recorded:

- project ID;
- surveyors;
- survey date;
- digital photograph ID;
- GPS coordinates in Universal Transverse Mercator (UTM);
- aspect (slope direction);
- dominant/indicator plant species;
- percent composition and cover of species and by vegetation layer;
- structural stage;
- vegetation association code;
- soil texture;
- soil moisture regime;
- soil nutrient regime; and
- additional soils and terrain information (refer to Terrain and Soils Baseline ReportRescan 2013d)).

Field information collected at visual inspection plots typically included vegetation association and terrain classification, structural stage, as well as any unique site features. A complete list of collected information is available from the sample field forms presented in Appendix 2. Adapted from RIC (1998a), Tables 2.2-2 through 2.2-4 present the codes and descriptions used to describe structural stage, soil moisture regime and soil nutrient regime.

Table 2.2-2. Structural Stage Codes and Descriptions

Code	Structural Stage	Description
1	Sparse/bryoid	Bryophytes and lichens often dominant where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover <20%
1a	Sparse	<10% vegetation cover
1b	Bryoid	Bryophyte- and lichen-dominated communities (>½ of total vegetation cover).
2	Herb	Communities dominated (shrub layer cover <or equal to 20% or <1/3 of total cover, herb-layer cover >20%, or >or equal to 1/3 of total cover;)by herbaceous species.

(continued)

Table 2.2-2. Structural Stage Codes and Descriptions (completed)

Code	Structural Stage	Description
2a	Forb-dominated	Herbaceous communities dominated (>½ of the total herb cover) by non-graminoid herbs, including ferns
2b	Graminoid-dominated	Herbaceous communities dominated (>½ of the total herb cover) by grasses, sedges, reeds, and rushes
2c	Aquatic	Herbaceous communities dominated (>½ of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b)
2d	Dwarf Shrub	Communities dominated (>½ of the total herb cover) by dwarf woody species
3	Shrub/Herb	Communities dominated (>20% or >or equal to 1/3 of total cover) by shrubby vegetation
3a	Low Shrub	Communities dominated by shrub layer vegetation <2 m tall
3b	Tall Shrub	Communities dominated by shrub layer vegetation that are 2–10 m tall

Table 2.2-3. Soil Moisture Regime (SMR)

Code	Class	Description	Primary water source
0	Very xeric	Water removed extremely rapidly in relation to supply; soil is moist for a negligible time after precipitation	precipitation
1	Xeric	Water removed very rapidly in relation to supply; soil is moist for brief periods following precipitation	precipitation
2	Subxeric	Water removed rapidly in relation to supply; soil is moist for short periods following precipitation	precipitation
3	Submesic	Water removed readily in relation to supply; water available for moderately short periods following precipitation	precipitation
4	Mesic	Water removed somewhat slowly in relation to supply; soil may remain moist for a significant, but sometimes short period of the year. Available soil moisture reflects climatic inputs	precipitation in moderate- to fine-textured soils and limited seepage in coarse- textured soils
5	Subhygric	Water removed slowly enough to keep soil wet for a significant part of growing season; some temporary seepage and possibly mottling below 20 cm	precipitation and seepage
6	Hygric	Water removed slowly enough to keep soil wet for most of growing season; permanent seepage and mottling; gleyed colours common	seepage
7	Subhydric	Water removed slowly enough to keep water table at or near surface for most of year; gleyed mineral or organic soils; permanent seepage < 30 cm below surface	seepage or permanent water table
8	Hydric	Water removed so slowly that water table is at or above soil surface all year; gleyed mineral or organic soils	permanent water table

Table 2.2-4. Soil Nutrient Regime (SNR)

Code	Soil Nutrient Regime
A	Very poor
B	Poor
C	Medium
D	Rich
E	Very Rich

2.2.2.2 *Wetland Ecosystems*

Field surveys were completed for wetland ecosystems during July, 2012 by a wetland specialist.Wetland sites were classified to the class and form level according to Canadian Wetland Classification System (Warner and Rubec 1997). Wetland class is based on general site characteristics such as soil type and the extent and quality of predominant vegetation cover. Form is a subdivision of class, and is based upon site specific surface morphology, surface pattern, water type, and soil characteristics (Warner and Rubec 1997).

Surveys were conducted in field plots with an area of 400 m^2. Plot boundaries were circular in large wetlands, while in smaller wetlands plot boundaries were adjusted so the entire plot was within the wetland. A series of soil cores were taken throughout each plot to determine the representative soil type for each wetland. At the centre of the plot a GPS coordinate was recorded and photos were taken in each cardinal direction. Other important features such as associated landforms, unique vegetation, and wildlife use were also noted. A complete list of collected data is provided on the sample field forms in Appendix 2.

The Rescan Wetland Habitat Inspection Form (WHIF), adapted from the *Field Manual for Describing Terrestrial Ecosystems (B.C. MELP and B.C. MoF 1998)* was used to collect the information described above, as well as the following:

- plot number;
- project ID;
- surveyor;
- date;
- photograph numbers;
- GPS coordinates in Universal Transverse Mercator (UTM);
- aspect (slope direction);
- wetland class and association;
- plant species present;
- soil types; and
- pH/conductivity.

In addition to the characterization of wetlands ecosystems, measurements of peat depth were made and representative samples of the peat collected to calculate the total carbon contained with wetlands. Total carbon storage within wetlands was investigated by estimating the volume of peat in a sample of wetlands and collecting peat samples for carbon analysis. Peat depths were measured along two transects in 12 wetlands. The peat depth was measured from 10 locations along each transect at roughly equal intervals. The transect sample depth data were averaged and used to calculate the volume of peat. Peat volume was calculated by multiplying the planar area of a delineated basin to the average transect depth.

Peat density was measured by collecting peat samples, weighing their mass, and measuring their displacement volume. This information was necessary to translate the carbon analysis data, reported in percent (mass/mass), into a mass of carbon stored within a wetland. The total carbon stored in the peat was estimated through the following equation:

$$Total\ Carbon\ (Tonne) = vP(m^3)\ x\ dP\left(\frac{g}{m^3}\right)\ x\ \frac{1\ Tonne}{1x10^6 g}\ x\ pC\ (\%)$$

Where:

vP = volume of peat in a wetland as determined through spatial analysis of wetland areas and peat transects in ArcGIS 10.
dP = density of peat as determined through field measurements of peat density
pC = Percent carbon (mass/mass) in a sample of peat

2.2.3 Final Terrestrial Ecosystem Mapping

Final terrain mapping was completed using the field information to guide the final polygon estimates. Terrain polygon attributes included terrain modifiers such as depth and texture, parent material, surficial expression, geomorphic and periglacial processes. Each polygon described up to three types of unique terrain components (expressed as deciles) in areas where pure units could not be mapped.

The final ecosystem mapping involved splitting the existing terrain polygons into smaller polygons based on dominant vegetation communities or repeating complexes of vegetation types. As with the terrain polygons, each ecosystem polygon was described by up to three unique vegetation associations, reported as deciles. Although most polygons were mapped with more than one vegetation association, homogeneous units were mapped, wherever possible. The final TEM database contains both terrain and ecosystem attributes for every mapped polygon.

2.3 SENSITIVE ECOSYSTEMS

Nunavut has no formal system or agency responsible for the identification, tracking or monitoring of rare and sensitive ecosystems. The methodology for determining the sensitive upland and wetland ecosystems within the LSA is provided in the sections below.

2.3.1 Sensitive Upland Ecosystems

Unique landscape features are often considered rare or sensitive, not just due to their rarity on the landscape, but for their potential to support rare plant species. Features known or suspected of supporting rare plant species include cliff faces, eskers, pingos, and wetland margins. Some of these features, such as cliff faces and pingos, were either not identified in the field or often cannot be mapped at the baseline mapping scale, and thus remain as described features only. However, described within the Wildlife Baseline Report 2012 (Rescan 2013b), the locations of cliffs were identified as point sources during the assessment of raptor nesting habitat.

In some cases, for example cliff faces, the same feature serves as both potential rare plant habitat and important wildlife habitat (i.e. nesting habitat for raptors). Prior to initiation of mapping, Rescan's wildlife staff assisted in determining ecosystems of highest potential wildlife value, primarily on the basis of their limited representation or ability to provide important feeding, nesting, resting or traveling habitat. The following vegetation associations were identified as potentially sensitive on the basis of wildlife habitat:

- *Riparian or wetland shrub ecosystems* (RW, RL, RM, WS and MR): deciduous shrubs are an important food source for ungulates and provide nesting and cover habitat for various wildlife species (e.g. breeding birds);

- *Esker complexes* (EC, EH, and EW): esker-related ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and travel corridors for many wildlife species;
- *Sedge-dominated wetland, shallow open water and marsh ecosystems* (WA, WC, WF, MF, MM, WO and MO): In addition to providing important habitat especially grizzly bears and caribou in the spring;
- *Bedrock cliffs* (BC): steep, exposed bedrock cliffs provide important bird nesting habitat and often provide habitat for rare plant species (Appendix 1); and
- *Bedrock-lichen veneers* (BL): dry, windswept areas often support a continuous mat of lichens, an important food source for caribou.

2.3.2 Sensitive Wetland Ecosystems

Sensitive wetlands are those that are rare or fragile. Rare ecosystems are those whose formation and maintenance is dependent on factors that are uncommon or threatened. They can be dependent on specialized habitats and/or complex ecological processes (Farmer 1993; McPhee et al. 2000). For rare ecosystems, the following must be known in order to determine the level of risk, or rarity, associated with it:

- the ecosystem must be definable by an accepted and tested method of classification; and
- there must be knowledge of the number of occurrences of the particular ecosystem, and the distribution thereof.

Nunavut does not have a defined site-level ecological classification system for wetlands and thus it is not possible to determine rarity. However, there are a number of wetland-related landscape features present within the Arctic that are considered uncommon or unique (NWT Department of Environment and Natural Resources 2012). These include the following:

1. **Saline Sulphur Springs** — landscape features forming when saline water upwells due to artesian flow. The water becomes saline upon contact with the saline parent material. At the surface, salt precipitates out of solution, forming unique features.
2. **Pingos —** mounds or small hills composed of a thin layer of soil overtop of ice. The ice is forced up due to water pressure, causing the soil surface to rise. They are dynamic in that they are constantly in a state of rising or falling due to changes in soil temperature and hydrology.
3. **Karst Wetlands —** wetlands associated with karst landscapes. Karst landscapes form due to the dissolution of soluble bedrock by surface and subsurface water. Usually, the bedrock is carbonate-derived, such as limestone or dolomite. The resulting landscape is dominated by shallow basins and hollows.

Fragile wetlands are those whose functional components are susceptible to even minor amounts of disturbance (McPhee et al. 2000). Natural disturbance is an important and constant feature of Arctic ecosystems. Mechanical disturbances such as freeze-thaw processes, thermokarst landscape formation, wind, slope processes, and flooding occur on a constant basis, significantly influencing wetland development, over various spatial and temporal scales (International Arctic Science Committee 2010).

2.4 WETLAND FUNCTION

Field survey data, vegetation tissue sample data, wetland hydrology data, and peat sampling data were used to characterize wetland function. Wetland function is defined as a process or series of processes that wetlands carry out, such as storage and filtration of water. Four primary functions (hydrological, biochemical, ecological, and habitat) are considered during an environmental assessment (Milko R. 1998). Wetland functions include a series of complex interactions between various wetland components such as water, soil, and vegetation. Table 2.4-1 shows which aspects of wetland functions are described by field data.

Table 2.4-1. Wetland Function and Associated Fieldwork Component

Wetland Function	Fieldwork Component
Hydrological Function	• Wetland classification (wetland class) • Ecosystem survey (hydrodynamics and depth to permafrost) • Ecosystem survey (hydrogeomorphic position)
Biochemical Function	• Wetland Classification (wetland class) • Vegetation tissue samples
Ecological Function	• Ecosystem survey (wetland size and distribution) • Wetland classification (wetland complexes, rare or unique wetlands) • Rare vegetation
Habitat Function	• Ecosystem survey (wildlife observations) • Wetland classification (wetland class)

The principle wetland functions for each wetland class were determined by integrating data collected in support of the functional component of the baseline study, individual wetland class and landscape position, and scientific literature.

General wetland functions were identified for the wetlands within the LSA. Given the northern latitude of the LSA the important wetland functions are:

- hydrological function – permafrost freeze thaw cycling, water storage and release;
- biochemical function – carbon sequestration, role in global carbon cycle, and methane gas production potential; and
- habitat function – structurally diverse vegetation communities containing low shrub communities which provide important niche habitat for small birds and mammals.

2.4.1 Hydrologic Function

Wetland hydrologic function is defined as the wetlands ability to store and discharge water. In Arctic wetlands, movement of surface water and groundwater depends greatly on spring snowmelt and the summer thaw period. Most wetland runoff occurs during snowmelt and may cease entirely in late summer, even if wetland soils remain near saturation (Roulet and Woo 1986). Permafrost limits the storage capacity of soils in the basin and rapid discharge occurs. As spring transitions to summer, thawed peat will retain more water, which reduces discharge (Ryden B. 1977). The depth to permafrost, wetland hydrogeomorphic position, and wetland classification, all support the identification of the primary hydrological function for each wetland class.

2.4.2 Biochemical Function

Wetland biochemical function is defined as a wetland's contribution to the quality of surface and groundwater. Water, sediment, and vegetation components of a wetland influence its biochemical function. Detailed and accurate descriptions of biochemical function at the site level are not possible given site specific interactions between wetland components (water, soil, and vegetation), landscape position, and environmental factors such as salinity, precipitation, and climate (Almas and Singh 2001; Brunham and Bendell 2010).

2.4.3 Ecological Function

Wetland ecological function is defined as the relationship between a wetland and its surrounding ecosystem. For the 2012 Ecosystems and Vegetation baseline program, the aspects of ecological function that were recorded include sensitive wetlands and wetland complexes. Wetland complexes are a combination of multiple wetland classes and associations. Complexes often form synergistic ecological units providing multiple ecological values within localized areas. Wetland complexes were documented when encountered within the LSA. Wetland sensitivity is addressed previously in Section 2.2.1.

2.4.4 Habitat Function

Wetland habitat function includes both terrestrial and aquatic habitat components and is defined as a wetland's contribution to the wildlife habitat within a given region. For example wetlands provide important staging habitat for migratory birds because of the open water and emergent communities they contain when wetland marsh and shallow open waters exist in complex. This habitat type is specific to wetlands and supports not only the migratory bird populations that rely on both ecosystem components but also aquatic and upland species that rely on the individual components. Habitat function was identified by carrying out an inventory of dominant and sub-dominant plant species, classification of vegetation associations and wetland ecosystems, and wildlife observations.

Wetlands provide key habitat for terrestrial wildlife (Milko R. 1998). Functional wetland habitats host a high diversity of avian and small mammal species which in turn provide prey for raptors, wolves, foxes, and other predators. In addition, wetlands provide foraging habitat for ungulates (e.g., caribou and muskox; (Thorpe et al. 2001) and waterfowl). Wildlife observations were recorded to identify habitat use and thus function at wetland sites.

2.5 PLANT SPECIES RICHNESS

Species richness is the number of species present within a defined area and is a way to measure environmental homogeneity. Species richness was determined from the plant list collected during field surveys. Differences in species richness between plots is influenced by variations in the abundance of fine-scale habitat features, the development of which is associated with natural and anthropogenic disturbances that may not be beneficial in terms of promoting site productivity and ecological stability. Species richness was calculated from plot data upon completion of field surveys.

2.6 BASELINE METAL CONCENTRATIONS

Soil and plant tissue samples were collected from sites well distributed throughout the Project area (Figure 2.6-1). The four locations from which these samples were collected were the Goose Property Area, George Property Area, Marine Laydown Area and at additional Reference sites. Samples were collected for lichens, vegetation tissue sampling (berries and sedge), and soils. Collection sites are presented in Figure 2.6-1.

2.6.1 Metal Concentrations in Soil

Mineral exploration programs for the Back River Project were run out of both the Goose and George camps in 2012. It was assumed that access from the Marine Laydown Area to George and Goose properties would be by winter road, as would access between the George and Goose properties. Soil samples were collected as part of the 2012 Terrain and Soils baseline program to inventory and describe the full range of ecosystems and vegetation in the project area.

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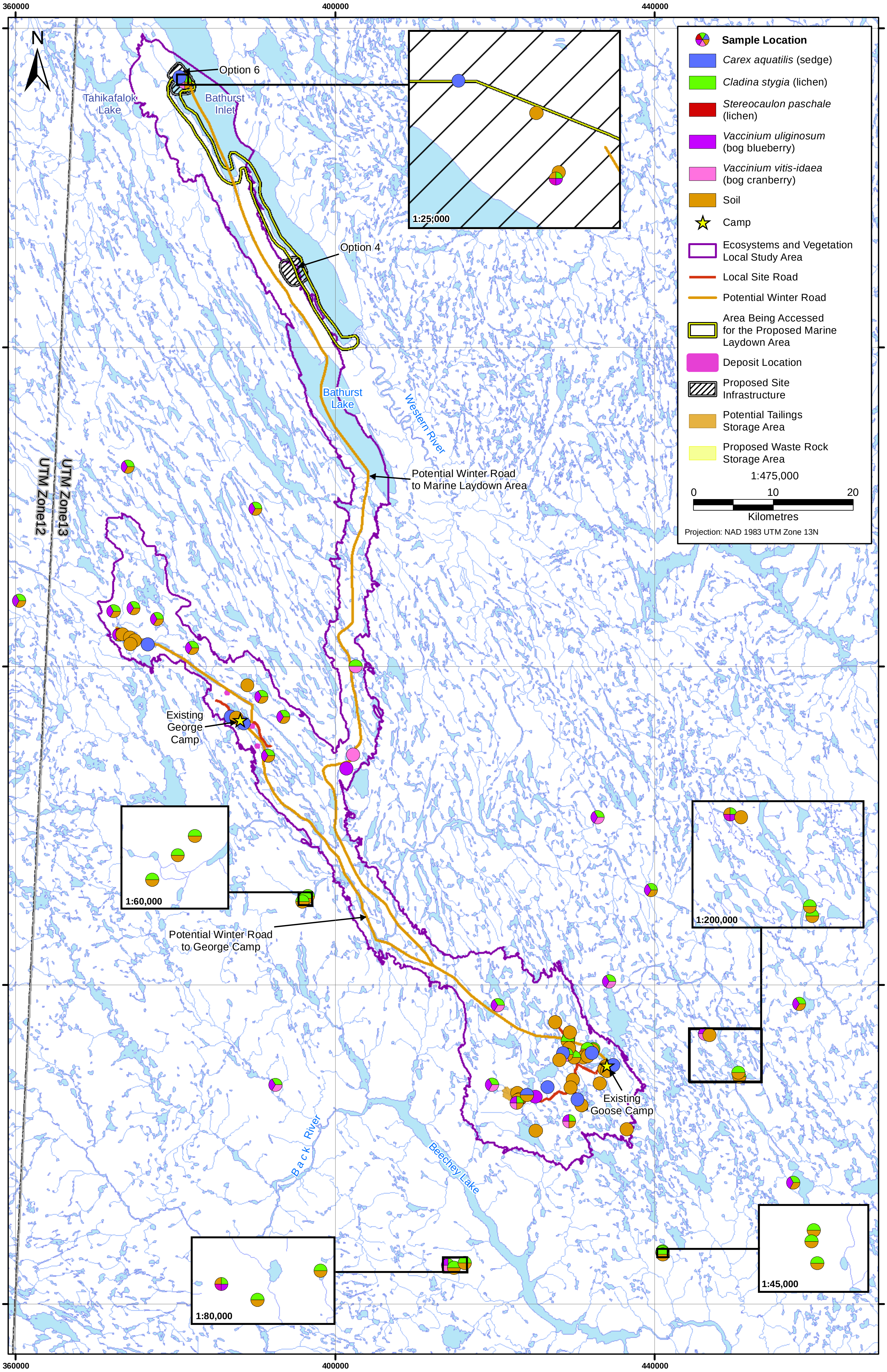

Figure 2.6-1

Sample Locations for Metals Analysis

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

Table 2.6-1 and Figure 2.6-1 summarize the soil sampling sites, their locations and the plant tissues collected. A total of 73 soil samples were collected in 2012 (Table 2.6-2). This included 53 samples from 0-5 cm soil depth and 20 samples from 50-60 cm soil depth. A summary of soil samples by project area is provided in Table 2.6-2 Thirty-three of the soil sampling sites were sampled in conjunction with the plant tissue sampling. Details of the soil sampling and analysis are presented in the 2012 Terrain and Soils Baseline Report (Rescan 2013d).

Table 2.6-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project

Sampling Site	Easting	Northing	Soil Depth 5 cm	60 cm	Tissue Collected * Lichens	Berry	Sedge
Goose Property Area							
023	7266447	422831	1	1			
033	7265984	425094				*V. uliginosum*	
042	7262909	429287	1	1			
049	7264932	430824	1	1			
050	7265703	423118	1	1			
053	7265562	422916	1	1			
054	7265222	422747	1		*C. stygia*		
055	7269834	433891	1	1			
058	7269478	433685	1	1			
061	7271982	432331					
062	7271837	432216	1	1			
064	7271951	431608	1		*C. stygia*		
069	7270920	431080	1	1			
074	7271065	431606	1	1			
080	7270914	429917	1	1	*C. stygia*		
080-5-x	7270914	429917	1				
101	7273311	429202	1		*C. stygia*		
104	7272942	429119	1	1	*C. stygia*		
107	7272098	429293	1	1			
108	7271263	428967	1	1	*C. stygia*	*V.vitis-idaea, V. uliginosum*	
110	7269226	434037	1				
GB52	7267490	419663			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB45	7280456	434299			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB44	7277461	420373			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
422	7262909	429287			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
844	7262909	429287			*C. stygia*		
1083	7271263	428967			*S. paschale*		
2166	7271263	428967				*V. uliginosum*	
GB104	7267490	419663				*V. uliginosum*	
W002	7271477	432127					
W009	7271427	428525					
W019	7267199	426593					
W045	7265649	430329					
W072	7269960	434814					

(continued)

Table 2.6-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project (continued)

Sampling Site	Easting	Northing	Soil Depth 5 cm	Soil Depth 60 cm	Tissue Collected * Lichens	Berry	Sedge
Goose Property Area ***(cont'd)***							
W086	7312809	388575					
W026	7266198	424046					*C.aquatilis*
W052	7274044	429382					*C.aquatilis*
W067	7267668	433128					*C.aquatilis*
W073	7261915	436508					*C.aquatilis*
W075	7261720	425138					*C.aquatilis*
W077	7270580	428052					*C.aquatilis*
W051	7268085	429763					*C.aquatilis*
W080	7267123	429480					*C.aquatilis*
W083	7275338	427543					*C.aquatilis*
Marine Laydown Area							
089	7393677	381049	1	1			
092	7393285	381195	1	1			
093	7393244	381176		1	*C. stygia*	*V.vitis-idaea, V. uliginosum*	
W106	7393890	380535					
George Property Area							
LBS10	7322310	382086	1		*C. stygia*	*V. uliginosum*	
LBS11	7316179	390788	1		*C. stygia*	*V. uliginosum*	
LBS12	7313663	393538	1		*C. stygia*	*V. uliginosum*	
LBS13	7308739	391616	1		*C. stygia*	*V. uliginosum*	
LBS26	7308739	391616			*C. stygia*		
234	7307153	401399				*V. uliginosum*	
W092	7313656	386945					
W134	7313564	387631					*C.aquatilis*
W135	7317620	389028					*C.aquatilis*
225						*V. uliginosum*	
Reference							
094	7323974	372980	1	1		*V. uliginosum*	
097	7324023	373388	1				
099	7323603	374310	1	1			
099-5-x	7323603	374310	1	1			
100	7323246	374885					
NE1	7268503	450632	1		*C. stygia*		
NE2	7269008	450497	1		*C. stygia*		
NE3	7273870	446315	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
NE4	7273709	446891	1				
NW1	7291155	396611	1		*C. stygia*		
NW2	7290851	396337	1		*C. stygia*		
NW3	7290464	395934	1		*C. stygia*		
SE1	7246606	440991			*C. stygia*		

(continued)

Table 2.6-1. Soil and Plant Tissue Sampling Sites in 2012, Back River Project (completed)

Sampling Site	Easting	Northing	Soil Depth 5 cm	Soil Depth 60 cm	Tissue Collected * Lichens	Berry	Sedge
Reference ***(cont'd)***							
SE2	7246474	440965			*C. stygia*		
SE3	7246216	441032			*C. stygia*		
SE-3-X	7246216	441032	1				
SW1	7244864	414130	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
SW2	7244529	414894	1		*C. stygia*		
SW3	7245144	416228	1		*C. stygia*		
SW-3-x	7245144	416228	1				
GB47	7277634	458083					
GB50	7267480	392543			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
GB61	7255209	457340					
LBS1	7291904	439547	1		*C. stygia*	*V. uliginosum*	
LBS2	7277634	458083			*C. stygia*	*V. uliginosum*	
LBS3	7255209	457340			*C. stygia*	*V. uliginosum*	
LBS4	7327884	632234	1		*C. stygia*	*V. uliginosum*	
LBS5	7345042	374029	1		*C. stygia*	*V. uliginosum*	
LBS6	7339762	390032	1		*C. stygia*	*V. uliginosum*	
LBS7	7326911	372292	1		*C. stygia*	*V. uliginosum*	
LBS8	7327299	374755	1		*C. stygia*	*V. uliginosum*	
LBS9	7325922	377694	1		*C. stygia*	*V. uliginosum*	
206	7320003	402571	1		*C. stygia*	*V.vitis-idaea*	
233	7308877	402229	1			*V.vitis-idaea*	
Bearpost	7301041	432856	1		*C. stygia*	*V.vitis-idaea, V. uliginosum*	
SW1-B					*C. stygia*		
NW4	7290851	396337			*C. stygia*		
SSE-3	7246216	441032			*C. stygia*		
NW6	7290464	395934			*C. stygia*		
542	7265222	422747			*C. stygia*	*V.vitis-idaea, V. uliginosum*	
941					*S. paschale*		
W133	7322758	376543	1				
W128	7322794	374371					*C.aquatilis*
GB100	7267480	392543				*V. uliginosum*	

Notes:
Sampling site locations are listed using UTM coordinates. All sampling sites were from UTM Zone 10
C. stygia = Cladina stygia; S. paschale = Stereocaulon paschale; V. uliginosum = Vaccinium uliginosum; V. vitis-idaea = Vaccinium vitis-idaea; C. aquatilis = Carex aquatilis.

Soil samples were placed in clean, plastic, labelled bags and submitted to ALS Environmental (ALS), Vancouver, BC, for laboratory analysis. Samples were analyzed for soil reaction (pH) and concentration of 31 metals. Details of the sampling and analysis are presented in the Back River Terrain and Soils Baseline Report (Rescan 2013d).

Table 2.6-2. Summary of Soil Samples Collected at the Sampling Locations in 2012, Back River Project

Samples:	Soil		
Depth	TOTAL	5 cm	60 cm
Sampling Area			
Goose Property	33	19	14
Marine Laydown Area	5	2	3
George Property	4	4	0
Reference Sites	31	28	3
Total Number of Samples:	73	53	20

2.6.2 Metal Concentrations in Lichen Tissue

Lichens were sampled as they are known bioaccummulator and the main food source for caribou. Lichens were used in the 2012 Country Foods Baseline Assessment (Rescan 2013c).

In 2012, a total of 49 lichen samples were collected from 4 locations (Table 2.6-1, Figure 2.6-1). The two species of lichen samples collected were *Cladina stygia* (Plate 2.6-1) and *Stereocaulon paschale* (Plate 2.6-2). All but two of the collected samples were *Cladina stygia*.

Plate 2.6-1. Cladina stygia (lichen).

Composite samples, consisting of at least two and up to 20 plants were collected at each sampling site. The lichens were collected with nitrile gloves, cleaned from debris *in situ* and stored in paper bags. Three days after collection all bags were oven dried (~40 $^{\circ C}$) for 72 hrs. Lichen tissues were analyzed by ALS for % moisture and total metals. Moisture in the lichen samples was determined gravimetrically by drying the sample at 105 $^{\circ C}$ for a minimum of six hours.

Plate 2.6-2. Stereocaulon paschale (lichen)

2.6.3 Metal Concentrations in Berry Tissue

Berry tissues were sampled for metal content at the locations shown in Figure 2.6-1. Bog Blueberry, or Northern Blueberry (*Vaccinium uliginosum*) and Bog cranberry (*Vaccinium vitis-idaea*) were sampled for metal analysis in 2012. Fourty-six berry samples were collected of which 25 were from the reference sites (Table 2.6-1, Figure 2.6-1). The 46 berry samples collected included 32 samples of *V. uliginosum* (Plate 2.6-3) and 14 of *V. vitis-idaea* (Plate 2.6-4).

Plate 2.6-3. Vaccinium uliginosum (bog blueberry)

Plate 2.6-4. Vaccinium vitis-idaea (bog cranberry)

Berry samples consisted of a minimum of 100 to 150 ripened berries. To collect a sufficient number, berries were typically collected from multiple plants within a sampling site. Samples were collected while wearing nitrile gloves and were sent to ALS for analysis. The % moisture and total metals concentration was determined using the same methodology as was used for the lichen analysis.

The parameters measured from the berry samples and detection limits are presented with the results in Section 3.8.4.

2.6.4 Metal Concentrations in Wetland Sedge Tissue

In 2012, a total of 12 *Carex aquatilis* (sedge) (Plate 2.6-5) tissue samples were collected from locations shown in Figure 2.6-1. Samples consisted of several leaves of the above-ground portion of the sedge plants. Plant tissues were analyzed for total metals by ALS.

2.6.5 Data Analysis of Plant Tissue Metals

Plant tissue metal concentrations vary with plant species, the tissue sampled, soil and environmental characteristics. There are no guidelines for plant tissue metal concentrations. In order to summarize plant tissue metal concentration data, summary statistics (maximum, minimum, median, mean and standard deviation values) were calculated for dry-weight metal concentrations. Dry-weight concentrations are the metal levels present in plant tissue irrespective of moisture status. All dry-weight and wet-weight concentrations can be found within Appendix 7. When metal concentrations fell below the detection limit, half the detection limit was used. All vegetation data were used in the 2012 Country Foods Baseline Report (Rescan 2013c).

Plate 2.6-5. Carex aquatilis (Sedge)

2.7 PLANTS OF CONSERVATION INTEREST

2.7.1 Listed Plant Species

Appendix 1 contains the detailed rare plant survey report, including an expanded methodology description.

In preparation for rare plant surveys a list of potential rare species was created including those having conservation-priority S-ranking (subnational conservation ranking), General Status ranking by the National General Status Working Group (Canadian Endangered Species Conservation Council 2011), or others for which there is evidence of rarity.

Selection of areas of focus for rare plant surveys was guided both by a need to cover a maximal area of proposed footprints and by the distribution of biodiversity in the study area. The most species-rich habitats and the best habitats for finding rare plants and lichens may or may not coincide with footprint areas. Selection of habitats for survey was guided by vegetation, soil and geology mapping. In general, survey sites were selected based on occurrences of small-scale anomalies in soil or surface bedrock types, or hydrologic or topographic features. Vegetation types mapped were usually habitats of a larger spatial scale than those relevant to overall plant and lichen diversity and rare species occurrences. The 2012 rare plant surveys employed a controlled intuitive wander method, with all surveys taking place within the LSA or at reference areas. Intuitive wander methods guide searches through the maximum number of habitats possible during a site survey. The distance covered in each intuitive wander depends on the number of species recorded over spans of time and search effort. Habitats of low species diversity thereby receive less survey time than those having higher species diversity. Habitats with dense concentrations of species may become the focus of an entire day's survey so long as additional species are added to the list with significant frequency up to the end of the field day. In Nunavut, rare species tend to occur in sites having higher overall levels of species diversity, so finding a maximum number of species per site by focusing on species-rich habitats also generates a greater likelihood of finding rare species.

For each site all vascular plant, moss and macrolichen species were recorded. When a species was unknown in the field, or required laboratory techniques to confirm, a specimen was collected for later study. Specimens were deposited at the UBC herbarioum (University of British Columbia Herbarium, Vancouver). Uncertainty in identification may be the result of having only poorly formed specimens that are difficult to interpret, or may arise from having observed too few individuals to be sure of their characteristics.

When a rare species population was encountered, representative GPS coordinates were recorded. The habitat characteristics of the population were recorded, and a general population size was estimated. When possible, at least one example of each rare species encountered was documented with a voucher specimen. Voucher specimens were not taken from exceedingly small populations. Additionally, when weather and lighting conditions allowed, a voucher photograph was taken for at least one population of each rare species. Collections at the UBC Herbarium were used for comparison to confirm identifications.

2.7.2 Invasive Plant Species

Invasive plants or weeds generally refer to species (native or non-native) that have the ability to out-compete native species when introduced into natural settings (Haber 1997). Typically, invasive plants aggressively establish in disturbed areas, thereby decreasing biodiversity (Polster 2005).

There is currently no established invasive plant council or formal means of determining the status of potentially invasive plants in Nunavut. Thus, the following resources were used to generate a list of invasive plants that could potentially occur in the Project area:

1. a list of invasive and alien plants from the Northwest Territories Department of Environment and Natural Resources (Fournier 2012; NWT Department of Environment and Natural Resources 2012)
2. the Evergreen Native Plant Database, which lists considered invasive for specific regions of Canada (Evergreen 2010); and
3. the Global Invasive Species Database (GISD), which tracks invasive alien species at the global scale. It is managed by the Invasive Species Specialist Group (ISSG) of the Species Survival Commission of the IUCN-World Conservation Union (Invasive Species Specialist Group 2008).

A list of 14 potential invasive plant species that could occur in the LSA was compiled based on NWT and Nunavut regions (Table 2.7-1).

Table 2.7-1. Invasive Plants Listed for Northwest Territories and Nunavut

Scientific Plant Name	Life Form	Biostatus	Northwest Territories[1]	Northwest Territories[2]	Nunavut[2]
Agropyron cristatum spp pectinatum	grass	Introduced	X		
Bromus inermis	grass	Introduced	X	X	
Camelina sativa	herb	Introduced		X	
Cirsium arvense	herb	Introduced	X	X	X
Cynoglossum officinale	herb	Introduced		X	
Medicago sativa (including *M. s. falcata*)	herb	Introduced	X		
Melilotus alba	herb	Introduced	X		

(continued)

Table 2.7-1. Invasive Plants Listed for Northwest Territories and Nunavut (completed)

Scientific Plant Name	Life Form	Biostatus	Northwest Territories[1]	Northwest Territories[2]	Nunavut[2]
Melilotus officinalis	herb	Introduced	X		
Phalaris arundinacea	grass	Uncertain	X	X	
Poa compressa	grass	Introduced	X		
Poa pratensis	grass	Uncertain	X		
Setaria verticillata	grass	Introduced		X	
Sonchus oleraceus	herb	Introduced		X	
Tanacetum vulgare	herb	Introduced	X		

[1] *Fournier (2012) - species considered by the government of NWT as having predicted invasiveness as potential to high rating within NWT.*
[2] *ISSG 2008; result of a search on the Global Invasive Species Database in August 2012.*

The species identified during baseline studies were compared to the list generated by these resources, to determine baseline occurrence of invasive species.

The NWT GSRP has been collecting information on plant species present within the NWT since 1999. Its purpose is to create a knowledge base that can be used to determine the status of any particular plant species. The NWT GSRP online database allows users to query information regarding plant likely presence in a defined area; it also identifies plant status (prevalence, rare, alien etc.). The NWT GSRP identifies the following four levels of risk to the environment (NWT Department of Environment and Natural Resources 2012):

- **High** - Typically invades natural and disturbed habitats quickly, and is hard to eradicate. These plants can have severe ecological impacts on physical processes, plant or animal communities, and vegetation structure. Reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. They usually have very broad ecological amplitude (i.e. range of tolerance).
- **Moderate** - Usually invades anthropogenic disturbed habitats and invades some natural habitats. These species are invasive but their ecological impacts are usually moderate. They may be locally persistent and problematic, but distribution is usually limited.
- **Low** - Tends to invades anthropogenic disturbed habitats and some natural habitats with natural disturbances. These species are invasive but their ecological impacts are low or there was not enough information to justify a higher score. Ecological amplitude and distribution are generally very limited, but these species may be locally persistent.
- **Potential** - These plants can invade disturbed habitats if conditions are correct. These species can be invasive but there was not enough information to justify a higher score. Ecological amplitude and distribution are generally very limited, but these species may be locally persistent.

Field surveys for invasive plants were conducted in conjunction with general field surveys and rare plant surveys. The list of plants in each field plot was recorded and evaluated for the presence of invasive plants according to the NWT Environment and Natural Resources databases (Canadian Endangered Species Conservation Council 2011; NWT Department of Environment and Natural Resources 2012).

3. Results

3. Results

3.1 REGIONAL SETTING

The National Ecological Framework is a hierarchal system of ecological classification that provides a framework for describing the distribution of ecological patterns across Canada. At its broadest level, this system recognizes 2 ecozones across Nunavut; the Northern Arctic and the Southern Arctic (Natural Resources Canada 2003). The Project lies within the Southern Arctic Ecozone (Figure 3.1-1). The Southern Arctic Ecozone extends across central Nunavut. It is bordered by the tree line to the south (Taiga Shield Ecozone) and by the Northern Arctic Ecozone to the north. Summers are cool and short with a mean temperature of 5ºC, and winters are long and cold with an average temperature ranging from -28ºC, near the Mackenzie Delta, to -18 ºC, in Northern Quebec. Precipitation is limited to approximately 200 mm per year.

The terrain within the region is comprised largely of flat and rolling bedrock covered by thin veneers of morainal, lacustrine and fluvial deposits. Bedrock exposures are common, as repeated glacial advance and recession has removed much of the surficial material. Much of the exposed bedrock still bears scratch marks from rocks dragged across them by the glaciers' advance (Natural Resources Canada 2003). Permafrost is found throughout the region. Although annual precipitation is low, many low-lying areas (as well as low-gradient hillsides) remain permanently saturated. This is due to very low rates of evaporation and transpiration as well as a continual supply of moisture from within the soil profile due to seasonal melting of permafrost.

The occurrence and development of Arctic wetlands, common throughout the region, is closely connected to the freezing and thawing of soil. The freeze-thaw action results in a number of distinct wetland types depending on the amount of dynamism in the active layer (the mobile layer of soil above the permafrost, which is subject to periodic thawing), the depth of the surficial organic material, landscape position, and the properties of the subsurface mineral parent material. Many Arctic wetlands are located in depressions, caused by glacial scour, that have filled with water from snowmelt. Kettle and kame topography also promotes wetland development (Gracz 2007).

The southern border of the Southern Arctic Ecozone is defined by a lack of full-size trees along its southern edge. Stunted forms of certain tree species, such as dwarf birch (*Betula nana*), green alder (*Alnus viridis* spp. *crispa*), willow species (*Salix* spp.) and less commonly, white and black spruce (*Picea glauca* and *P. mariana*) grow throughout the Ecozone. Much of the area is dominated by sedge meadows, tussock tundra and heath tundra. Sparsely vegetated areas, such as the wind-swept crests of eskers, are also common.

The results of the ecological classification prepared in 2001 during the Vegetation Classification for the West Kitikmeot / Slave Study (WKSS) Region (Matthews et al 2001) provides a regional context for ecosystem distribution. The Back River Ecosystems and Vegetation Regional Study Area (RSA), consistent with the RSA developed for the assessment of wildlife habitat, was delineated based on the expected use of the region by wildlife species assessed as valued components (VCs).

Figure 3.1-2 depicts the Ecosystems and Vegetation LSA and RSA, with the 2001 WKSS regional ecological classification results prepared by Matthews et al. (2001). As described within the final report to the West Kitikmeot / Slave Study Society, image analysis was conducted on Landsat TM imagery at the Northwest Territories (NWT) Centre for Remote Sensing in Yellowknife between 1997 and 2001, with seasonal field data collection conducted between 1997 and 2000 to assist in the development of the classification(Matthews, Epp, and Smith 2001). The mapping boundaries coincided with the extent of the Slave Geological Province, representing a 200,000 km^2 area within the Taiga Shield and Southern Arctic Ecozones.

Figure 3.1-1

Arctic Ecozones and Ecoregions

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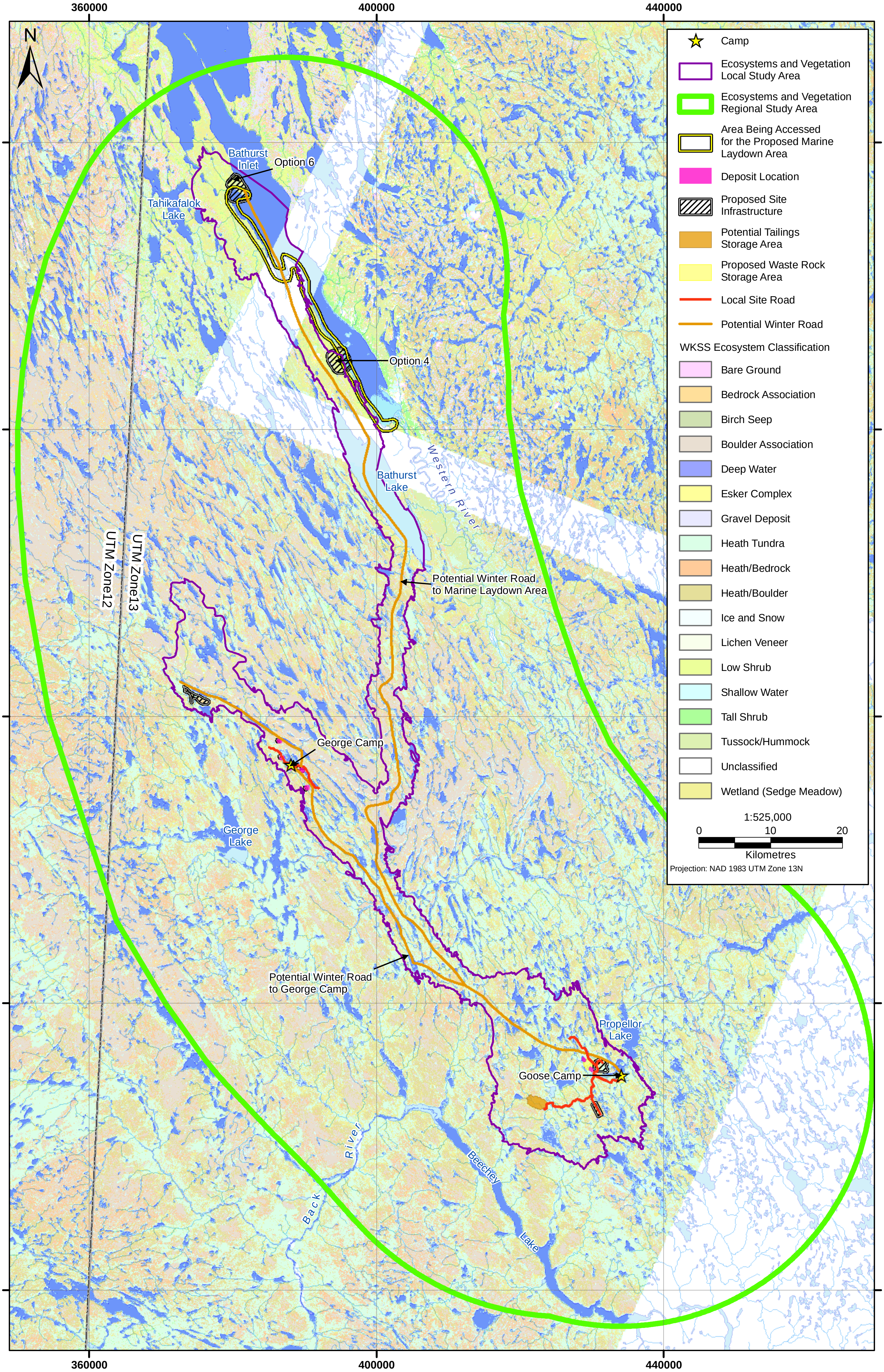

Figure 3.1-2

Regional WKSS Ecological Classification with the Ecosystems and Vegetation Study Areas

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The ecologically equivalent ecosystem classes and specific vegetation associations that are mapped for the Back River Project are provided within Table 3.1-1. The WKSS dataset does not overlap the entire Vegetation RSA and, consequently, nearly 13% of the RSA remains unclassified. No equivalent ecological classification data is currently available to describe the unclassified areas.

Table 3.1-1. Regional WKSS Ecological Classification

WKSS Class ID	WKSS Area within Vegetation RSA (ha)	% Vegetation RSA	Back River Ecosystem Mapping	
			Ecosystem Class(es)	**Vegetation Association(s)**
Heath Tundra	233705.8	18.7	Tundra	TL, MT
Boulder Association	194826.3	15.6	Bedrock	TB
Wetland (Sedge Meadow)	132907.5	10.6	Wetland	WA, WC, WF, WS, MF
Heath/Boulder	127104.6	10.1	Tundra	TH
Deep Water	103289.4	8.2	Freshwater / Saltwater	LA / MW
Shallow Water	98252.6	7.8	Freshwater / Wetland	PD, RI / WO, MO
Heath/Bedrock	63191.5	5.0	Bedrock	BR, BL
Tussock/Hummock	37580.1	3.0	Wetland	WB, TM
Gravel Deposit	22038.2	1.8	Disturbed or Barren / Marine	ES / MB, MH
Low Shrub	16073.8	1.3	Tundra	TS, MS
Birch Seep	52.7	0.0	Tundra	TS
Bedrock Association	12184.1	1.0	Bedrock	BR, BC, BT
Tall Shrub	6662.6	0.5	Riparian	RW, RL, RM, MR
Esker Complex	5745.4	0.5	Esker	EC, EH, EW
Bare Ground	6131.0	0.5	Disturbed or Barren	ES
Lichen Veneer	2727.2	0.2	Bedrock	BL
Ice and Snow	*31657.1*	*2.5*	*N/a*	*N/a*
Unclassified	*158585.0*	*12.7*	*N/a*	*N/a*
Total	**1252714.8**	*100.0*		

3.2 FIELD SURVEYS

Terrestrial ecosystem field surveys were conducted between June 28 and September 3, 2012. A total of 325 full sample plots and 296 visual plots were established, most within the LSA. A separate wetland ecosystem survey was completed between July 5 and July 24, 2012. A total of 136 wetland plots and 60 visual plots were completed (Figure 3.2-1). Field data are presented in Appendix 6.

From the field data and assessment of previous ecological mapping projects an ecosystem classification legend was created that incorporates both vegetated and non-vegetated associations for the purpose of characterizing the LSA and to enable final ecosystem mapping. The resultant legend, designed to enable accurate and repeatable ecosystem mapping, necessitated the generalization of some vegetation associations that could only be identified on the ground. Vegetation associations and non-vegetated units are grouped in either overarching categories based on the dominant terrain feature, environmental condition, or disturbance influencing it. A detailed description of each vegetation association including the range of conditions in which it occurs, the dominant vegetation, and representative photographs, is located in Appendix 3. Table 3.2-1 provides a summary and brief description of the vegetation associations and non-vegetated map units used for mapping, as well as the number of field sample plots established within them. The vegetation associations are listed under their respective ecosystem class headings (bedrock, esker, tundra etc.).

Table 3.2-1. Summary of Vegetation Associations and Non-vegetated Units

Association Name	Map Code	Description
Bedrock		
Bedrock outcrop	BR	A gentle to steep, bedrock escarpment or outcropping, with little soil development and sparse vegetative cover.*
Bedrock-lichen veneer	BL	Sparse lichen and dwarf shrub community that occurs on skeletal soils on bedrock outcrops.
Cliff	BC	A steep, vertical of overhanging rock face.*
Talus	BT	Angular rock fragments of any size accumulated at the foot of steep rock slopes as a result of successive rock falls. It is a type of colluvium.*
Blockfield	TB	Level or gently sloping areas that are covered with moderately sized or large, angular blocks of rock derived from the underlying bedrock or drift by weathering and/or frost heave, and that have not undergone any significant downslope movement.*
Esker		
Sparsely vegetated esker	EC	Sparsely vegetated esker. Characterized by large extents of un-vegetated sand, gravel and cobbles with small patches of vegetation.
Dwarf shrub esker	EH	Mix of dwarf shrub and herbaceous species on the crest and sides of eskers.
Shrubby esker	EW	Low to tall shrub communities that occur in the sheltered areas along toe and lower slopes of eskers.
Tundra		
Dry-sparse tundra	TH	Dry, rocky tundra that occurs in upper slope and crest locations, often complexed with TB, BL or BR. Vegetation is variable, with dwarf shrubs and lichens often dominant.
Mesic dwarf-shrub tundra	TL	Typical tundra that is dominated by dwarf shrubs. Occurs across extensive areas, normally gently sloping tills, and contains a substantial cover of shrub, herb, moss and lichen.
Shrubby tundra	TS	Moist (less commonly mesic) tundra that is dominated by thick dwarf birch. Typically occurs in water receiving slope positions and often has evidence of surface or subsurface water movement.
Undifferentiated tundra	TU	The TU association is a generic classification for TEM polygons that do not strongly fit other classifications, or when accurate airphoto interpretation cannot be done.
Riparian		
Willow riparian	RW	Short to tall, wet shrub community that occurs immediately adjacent to small creeks and streams. Flooding may occur, but scouring is generally absent.
Low bench floodplain	RL	Short to tall, wet shrub community that occurs immediately adjacent to high gradient creeks and large river that scour the community on a regular (annual) basis.
Mid bench floodplain	RM	Tall shrub communities that restricted to the edge of large river systems. Flooding occurs on a regular basis, but scouring is limited.
Wetland		
Raised bog complex	WB	Variable complex that contains severely mounded raised bogs with various other wetlands types in the inter-mound depressions. Low pH and little water movement.
Water sedge marsh	WA	Marsh community that is dominated by a near monoculture of water sedge. Restricted to very wet locations along low gradient watercourses and lake/pond margins.
Cottongrass-sedge fen	WC	Cottongrass and sedge dominated fen. Slightly to strongly hummocked, often with obvious water movement.
Willow-sedge fen	WS	Fen association that is dominated by sedges and willow that typically occurs near moving water. Organic soils distinguish it from riparian associations.
Tussock meadow	WT	Fen association that is severely and regularly tussocked (cottongrass formed) that have distinct wet communities at the base and dry communities on the top.

(continued)

Table 3.2-1. Summary of Vegetation Associations and Non-vegetated Units (completed)

Association Name	Map Code	Description
Wetland *(cont'd)*		
Undifferentiated fen	WF	Fen communities that are not homogeneous or distinct characteristics of other fen types. Often small components of large terrestrial complexes, and/or in abnormal landscape positions.
Shallow open water	WO	Mineral wetlands with permanent flooding and a substantial cover of floating or submerged aquatic species.
Marine		
Marine beach	MB	Active beaches on the edges of the Arctic Ocean that are regularly inundated and are unvegetated.
Old beach heads	MH	Old beaches that are no longer directly influenced by the Arctic ocean. Sparsely vegetated or barren.
Marine riparian shrub	MR	Riparian shrub community that is restricted to the edge of the Arctic Ocean and saline water courses that drain into it.
Marine dwarf shrub tundra	MT	Dwarf shrub community that is restricted to marine derived soils in Bathurst Inlet.
Marine shrubby tundra	MS	Short to tall, wet shrub community that is restricted to marine derived soils in Bathurst Inlet.
Estuary marsh	ME	Generic marsh community within estuarine environment.
Saline Marsh	MM	Generic marsh communities within marine-influenced environments; saline soils
Saline Fen	MF	Generic fen communities within marine-influenced environments; saline soils.
Saline shallow open water	MO	Mineral wetlands with permanent flooding and a substantial cover of floating or submerged aquatic species; marine-influenced environments; saline soils.
Undifferentiated marine wetlands	MU	Saline wetlands that do not fit other classifications.
Saltwater	MW	Any body of water that contains salt or is considered to be salty.*
Freshwater		
Lake	LA	A naturally occurring static body of water, greater than 2 m deep in some portion and exceeding 50 ha. The boundary for the lake is the natural high water mark.*
Pond	PD	A small body of water greater than 2 m deep, but not large enough to be classified as a lake (e.g., less than 50 ha).*
River	RI	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial. An area that has an ephemeral flow and no channel with definable banks is not considered a river.*
Disturbed/Barren		
Disturbed vegetation	DV	Any area with disturbed vegetation - includes drill pads, etc. that does not fall into other disturbed/barren categories.
Exposed soil	ES	Any area of exposed soil that is not included in any of the other definitions. It includes areas of recent disturbance, and human-made disturbances, where vegetation cover is less than 5%.*
Gravel pit	DG	An area exposed through the removal of sand and gravel.*
Road surface	DZ	An area cleared and compacted for the purpose of transporting goods and services by vehicles.*
Mine camp	DR	Any area in which residences and other human developments occur.*
Mine	DM	An unvegetated area used for the extraction of mineral ore and other materials*

**adapted from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).*

3.3 TERRESTRIAL ECOSYSTEM MAPPING

Tables 3.3-1 through 3.3-3 summarize the vegetated, sparsely-vegetated and non-vegetated ecosystems mapped within the LSA. Figures 3.3-1a through 3.3-1d provide an overview of the ecosystem mapping polygons within the four Project sub-areas. The upland ecosystem results are described within Section 3.4 and the wetland ecosystem results within Section 3.5. To reflect geographic differences in the distribution of ecosystems throughout the LSA, the respective areas and percentages of total LSA have been summarized within the following four sub-areas (Figure 1.2-2):

- Goose Property Area
- George Property Area
- Marine Laydown Area
- Proposed Winter Road (to Bathurst Inlet)

Table 3.3-1. Summary of the Vegetated Ecosystems Mapped within the LSA

Ecosystem Name	TEM Code	Ecosystem Class	% Total LSA
Disturbed vegetation	DV	Disturbed/Barren	0.0
Dwarf shrub esker	EH	Esker	0.4
Shrubby esker	EW	Esker	0.2
Mesic dwarf-shrub tundra	TL	Tundra	28.5
Dry-sparse tundra	TH	Tundra	16.0
Shrubby tundra	TS	Tundra	8.4
Marine dwarf shrub tundra	MT	Tundra (Marine)	4.1
Marine shrubby tundra	MS	Tundra (Marine)	1.6
Willow riparian	RW	Riparian	1.1
Low bench floodplain	RL	Riparian	0.04
Mid bench floodplain	RM	Riparian	0.01
Marine riparian shrub	MR	Riparian (Marine)	0.4
Raised bog complex	WB	Wetland	2.2
Cottongrass-sedge fen	WC	Wetland	2.1
Undifferentiated fen	WF	Wetland	1.6
Water sedge marsh	WA	Wetland	1.5
Willow-sedge fen	WS	Wetland	0.3
Tussock meadow	WT	Wetland	0.01
Saline Fen	MF	Wetland (Marine)	0.4
Saline Marsh	MM	Wetland (Marine)	0.3
		Total %	**69.0**

Table 3.3-4 summarizes the respective percentage of the LSA for each of the eight ecosystem classes described in Table 2.1-1. Note some of the classes are split to identify the portion mapped within marine-influenced regions. The percentages pertaining to the respective Project sub-areas describe the distribution within an ecosystem class. For example, the tundra ecosystem class represents nearly 53% of the total LSA, split equally between the George Property Area (40%) and Goose Property Area (40%). The marine tundra units are mapped entirely within the Marine Laydown Area.

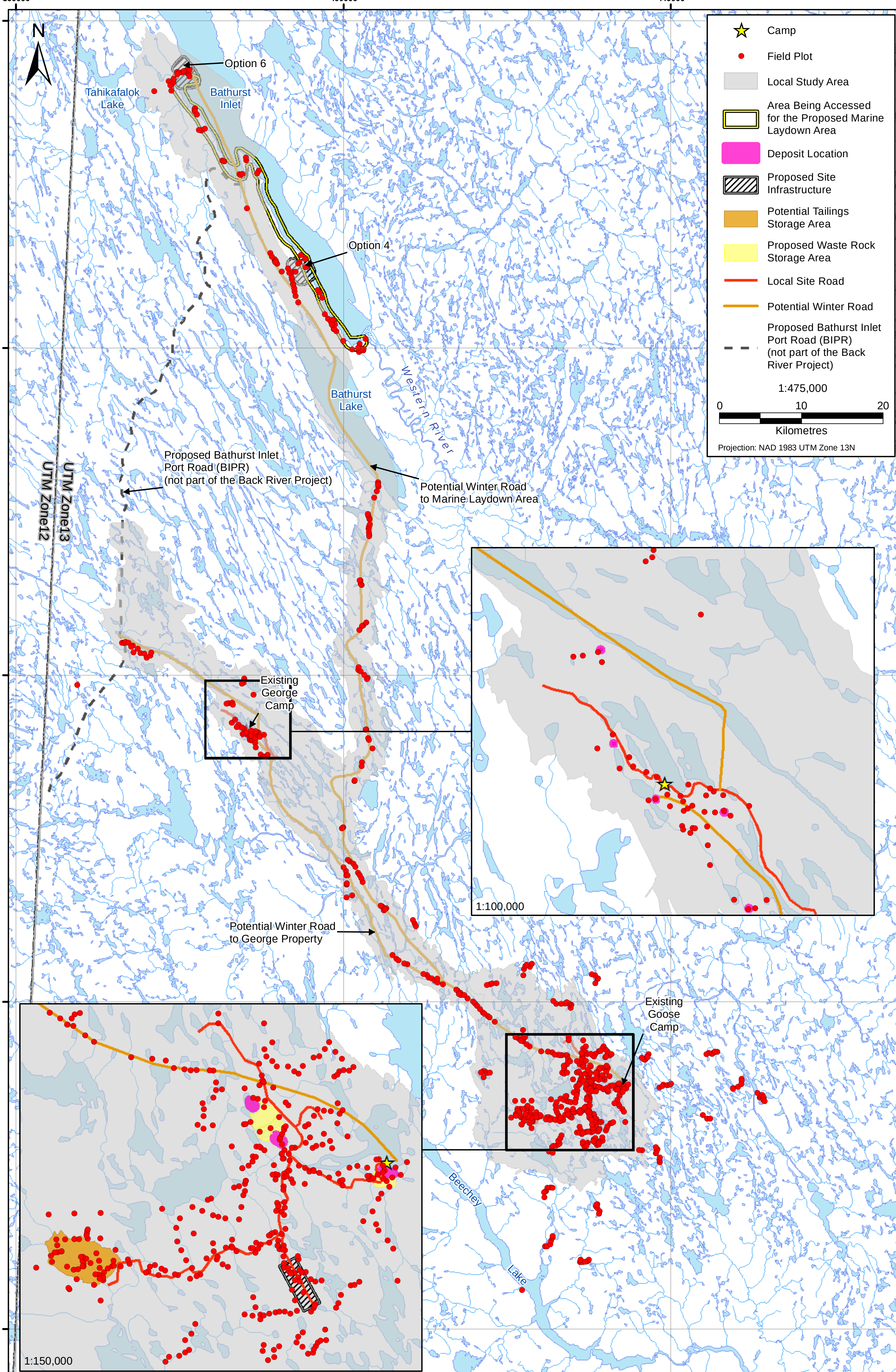

Figure 3.2-1

Distribution of Field Plot Locations

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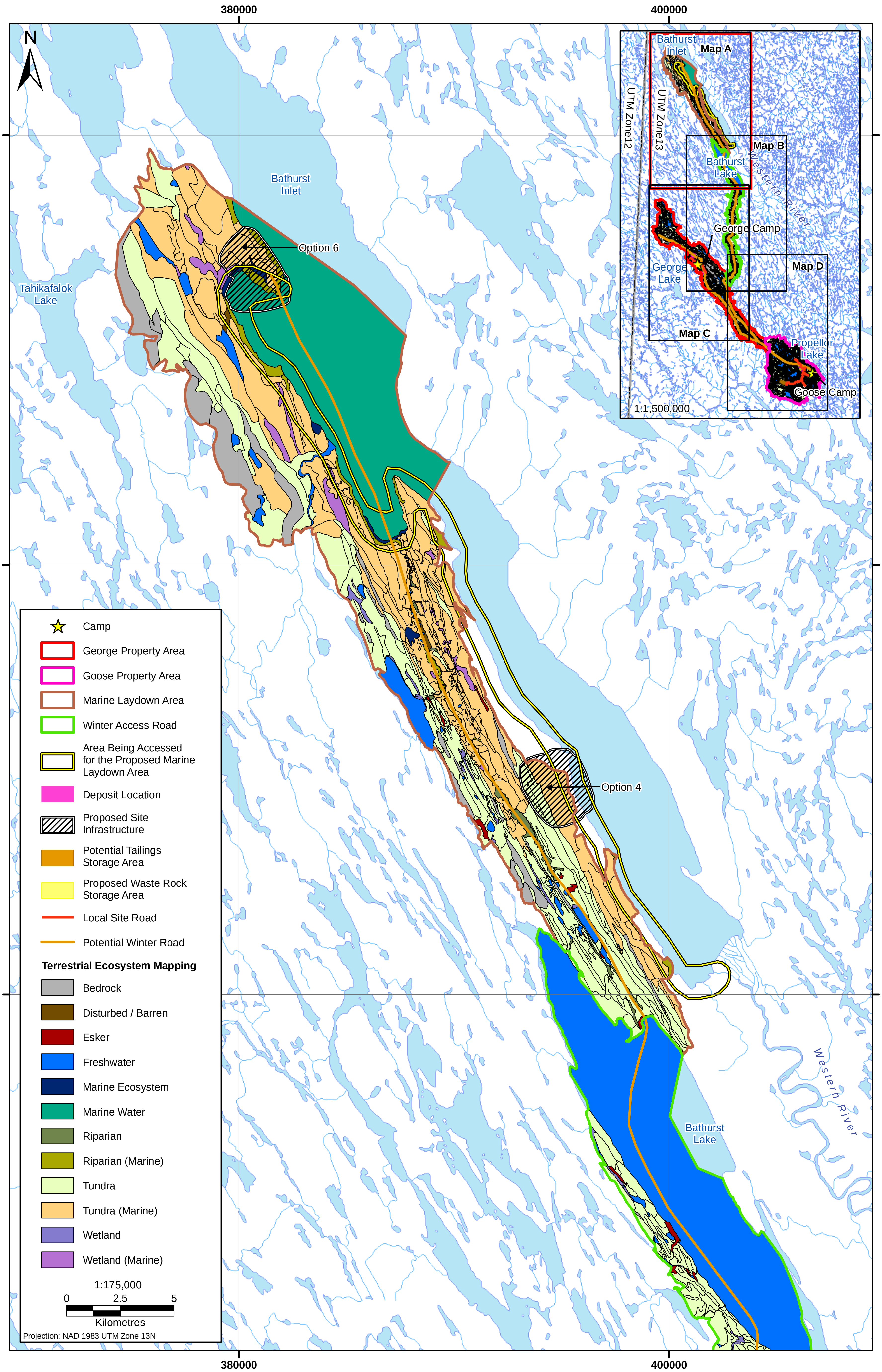

Figure 3.3-1a

Sabina GOLD & SILVER CORP.

Terrestrial Ecosystem Mapping - Overview Map A

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PROJECT #833-002-05 GIS # BAC-20-013b March 19 2013

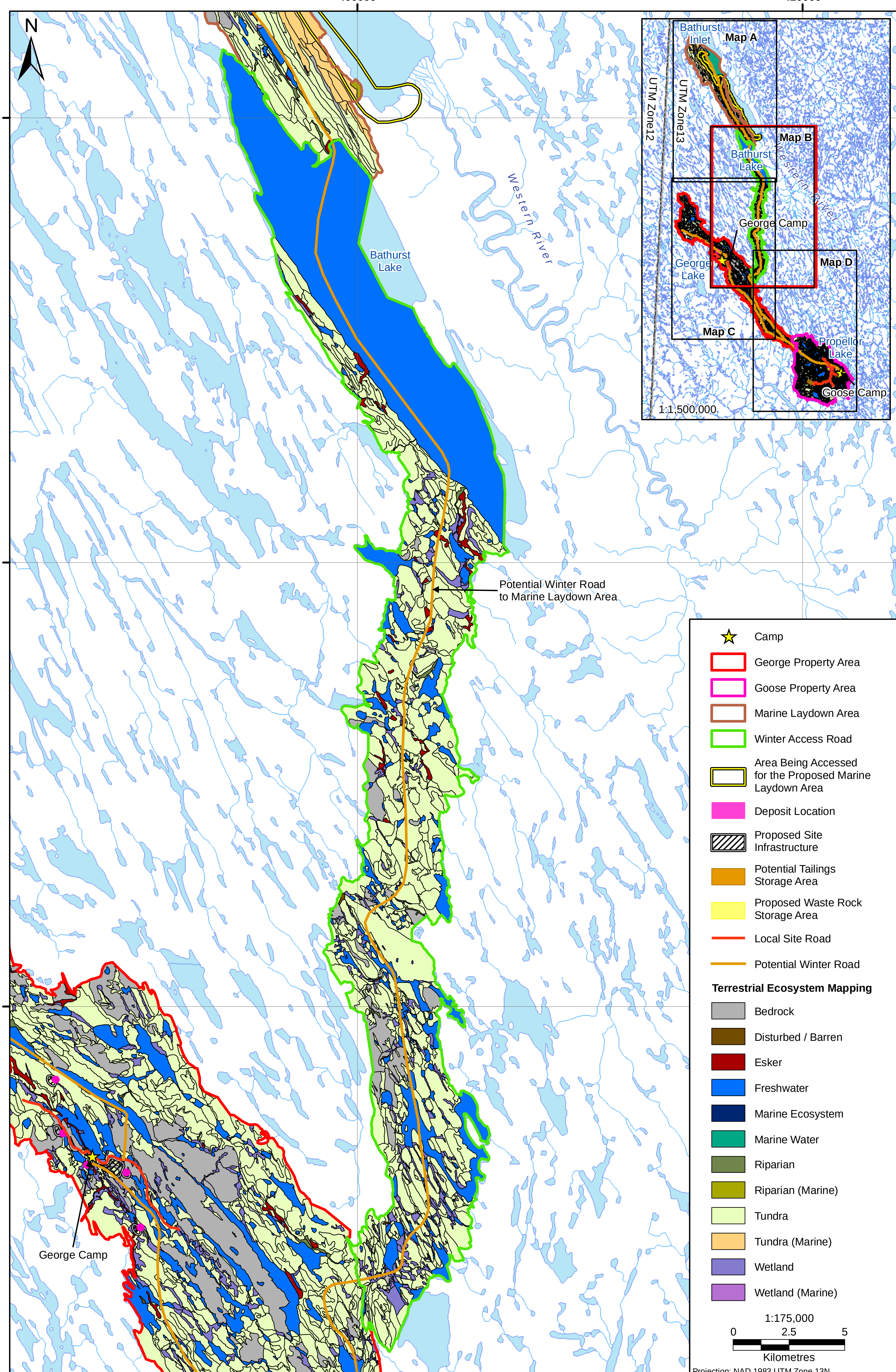

Figure 3.3-1b

Sabina GOLD & SILVER CORP.

Terrestrial Ecosystem Mapping - Overview Map B

Rescan Engineers & Scientists

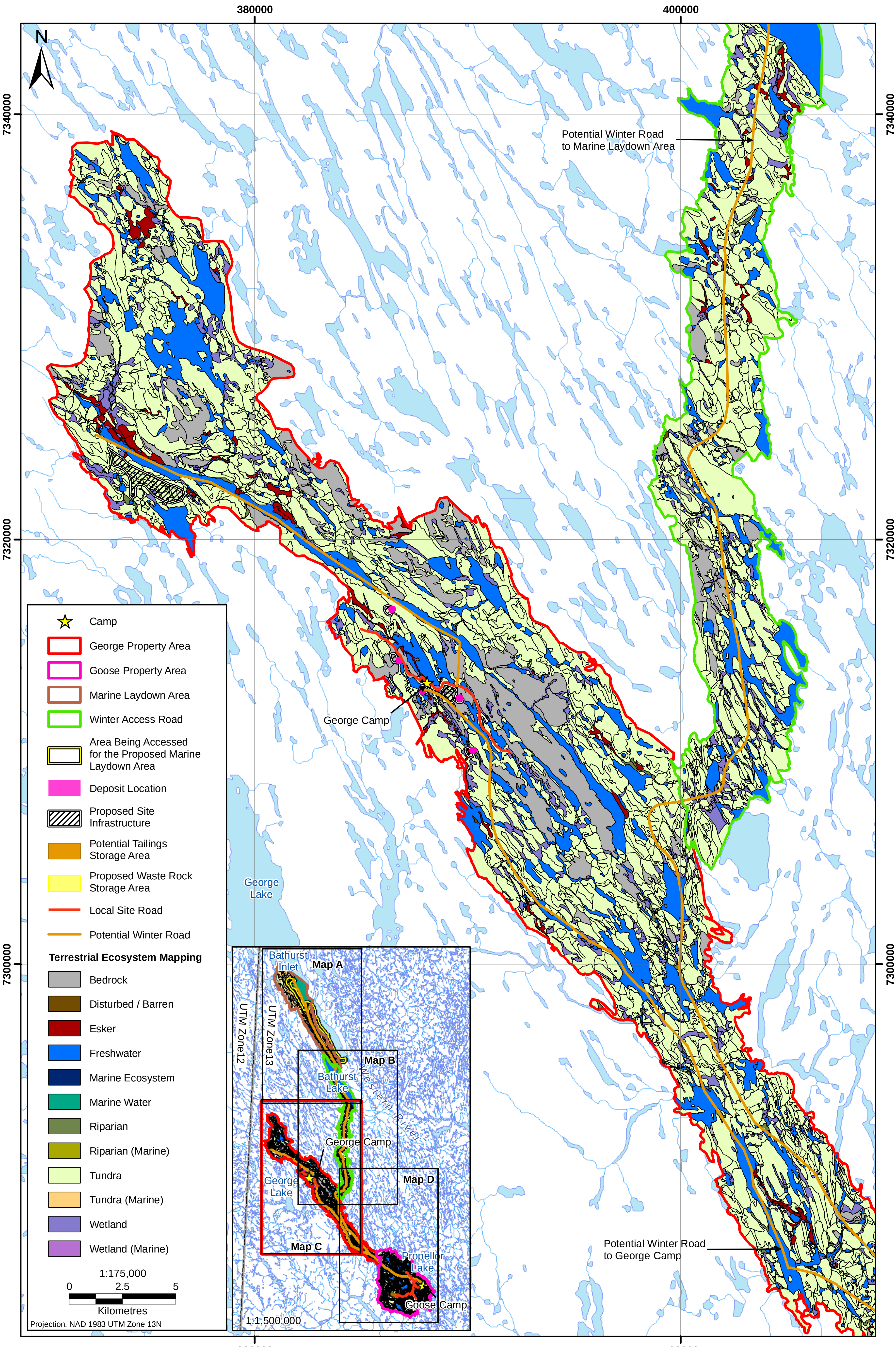

Figure 3.3-1c

Sabina GOLD & SILVER CORP.

Terrestrial Ecosystem Mapping - Overview Map C

Figure 3.3-1c

Rescan Engineers & Scientists

PROJECT #833-002-05 GIS # BAC-20-013d March 19 2013

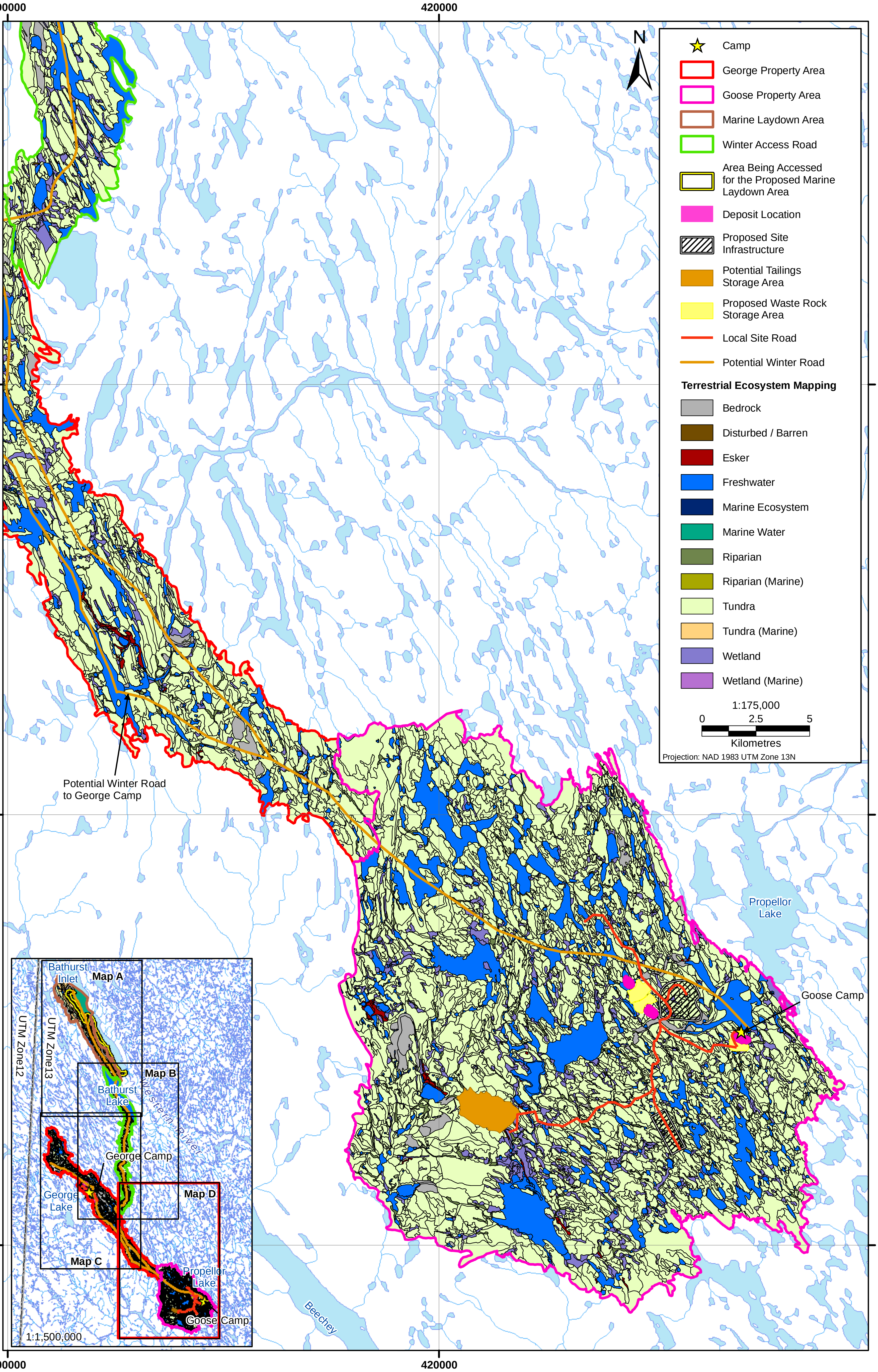

Figure 3.3-1d

Figure 3.3-1d

Terrestrial Ecosystem Mapping - Overview Map D

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

Table 3.3-2. Summary of the Sparsely-Vegetated Ecosystems Mapped within the LSA

Ecosystem Name	TEM Code	Ecosystem Class	% Total LSA
Exposed soil	ES	Disturbed/Barren	0.1
Bedrock-lichen veneer	BL	Bedrock	4.7
Bedrock outcrop	BR	Bedrock	2.7
Blockfield	TB	Bedrock	0.1
Cliff	BC	Bedrock	0.01
Talus	BT	Bedrock	0.00
Sparsely vegetated esker	EC	Esker	0.5
Shallow open water	WO	Wetland	0.1
Saline shallow open water	MO	Wetland (Marine)	0.02
Marine beach	MB	Marine	0.04
Old beach heads	MH	Marine	0.1
		Total %	**8.4**

Table 3.3-3. Summary of the Non-Vegetated Ecosystems Mapped within the LSA

Ecosystem Name	TEM Code	Ecosystem Class	% Total LSA
Lake	LA	Freshwater	13.7
Pond	PD	Freshwater	4.2
River	RI	Freshwater	0.3
Saltwater	MW	Marine	4.5
Mine camp	DR	Disturbed/Barren	0.01
Road surface	DZ	Disturbed/Barren	0.00
		Total %	**22.6**

Table 3.3-4. Ecosystem Distribution Summary within the LSA, by Ecosystem Class

Ecosystem Class	% Total LSA	George Property Area	Goose Property Area	Marine Laydown Area	Winter Road
Tundra	52.9	39.6	39.2	7.6	13.6
(Marine tundra)	5.7	0.0	0.0	100.0	0.0
Freshwater	18.2	30.3	31.5	3.4	36.0
Marine - ocean, beach, old beach head	4.6	0.0	0.0	100.0	0.0
Wetland	7.7	40.6	42.4	1.8	15.3
(Marine wetland)	0.7	0.0	0.0	100.0	0.0
Bedrock	7.5	50.1	9.3	26.0	14.6
Riparian	1.1	34.8	37.4	20.7	7.0
(Marine riparian)	0.4	0.0	0.0	100.0	0.0
Esker	1.1	61.2	9.0	11.5	18.2
Disturbed/Barren	0.1	8.5	6.1	71.2	14.1
Total	100.0				

For all mapped upland and wetland ecosystems (sparsely-vegetated and vegetated, but excluding non-vegetated), Appendix 3 provides detailed summaries of the environmental site, soil and terrain characteristics, the dominant vegetation species identified during field sampling, and provides representative field photographs. Within the environmental characteristics table in Appendix 3, the most common, or typical, situation is provided, with a range (where characteristics are deemed variable) presented within brackets.

Appendix 4 contains a series of detailed maps depicting the distribution and extent of the mapped ecosystems and non-vegetated units.

3.4 UPLAND ECOSYSTEMS

Upland ecosystems mapped within the LSA include sparsely-vegetated and vegetated terrestrial ecosystems. In sparsely-vegetated ecosystems (Plate 3.4-1), the total cover of vegetation is typically less than 10% and may be dominated by lichen or bryophyte communities.

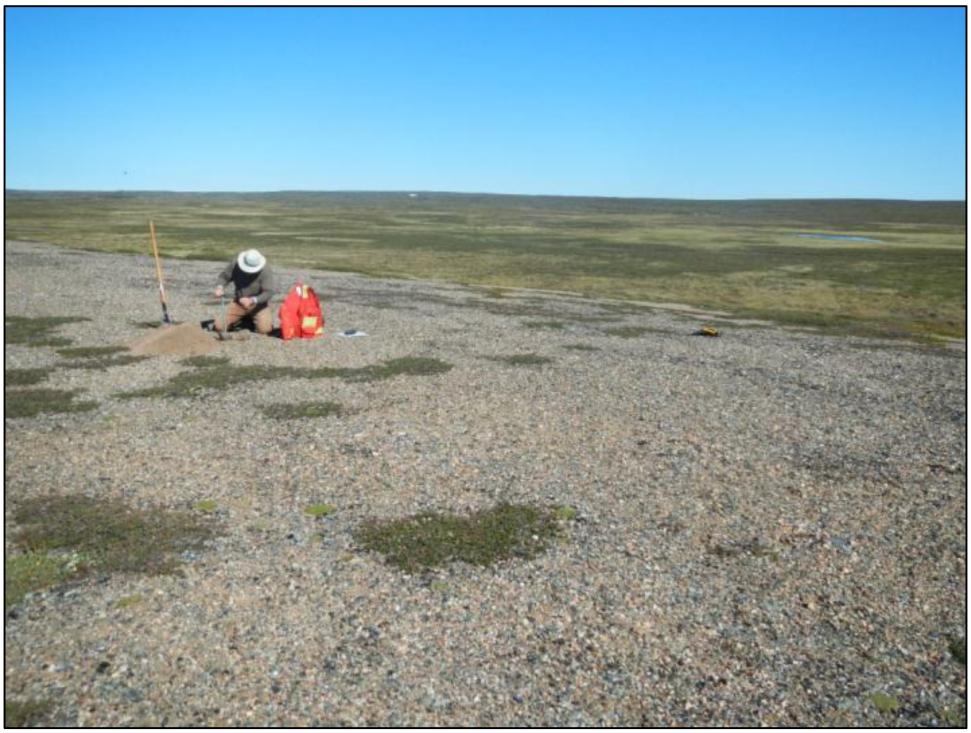

Plate 3.4-1. Sparsely-Vegetated ES Vegetation Association at TEM Plot 2012_020. July 1, 2012

3.4.1 Upland Ecosystem Classification

Summarized in Table 3.3-1, the mapped sparsely-vegetated ecosystems within the LSA are often associated with areas of thin veneers or exposed bedrock (BL, BR, BC, BT and TB associations), windswept esker crests (EC association), blocky tundra (TB association), marine beaches (MB and MH associations) and other disturbed or barren sites (ES association) that limited vegetation establishment. Of the sparsely-vegetated ecosystems, constituting approximately 8 % of the total LSA, the BL (bedrock-lichen veneer) and the BR (bedrock outcrop) associations were the dominant units mapped.

Vegetated ecosystems (Plate 3.4-2), constituting approximately 70 % of the LSA, are largely dominated by the mesic tundra (TL), dry-sparse tundra (TH), and moist (to mesic), dwarf birch-dominated shrubby tundra (TS) associations.

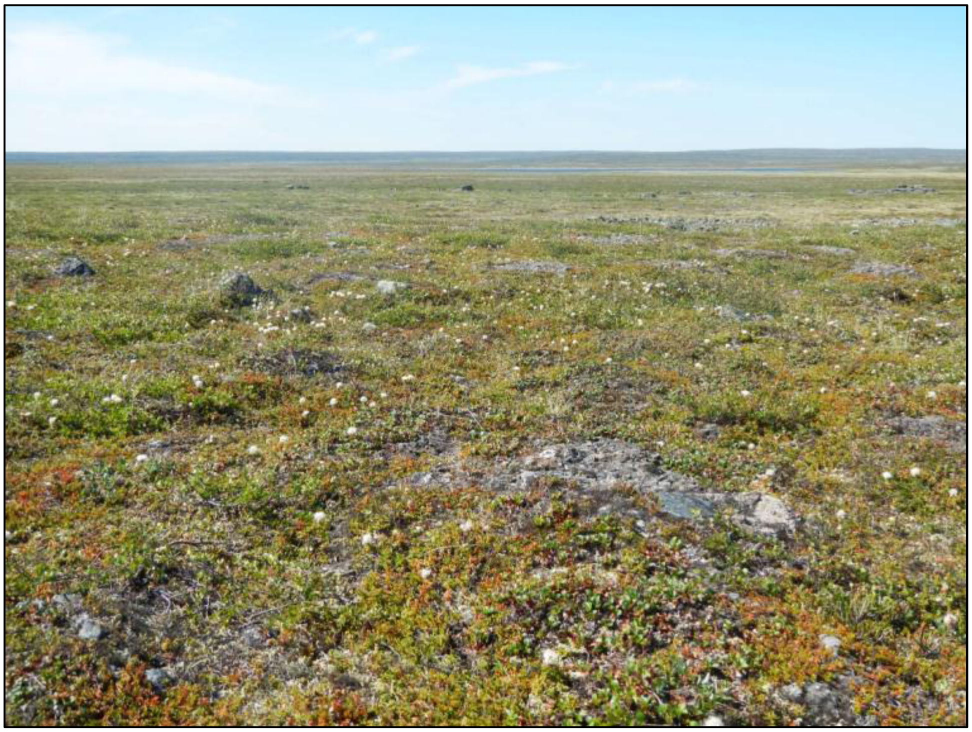

Plate 3.4-2. Vegetated TL Vegetation Association at TEM Plot 2012_036. July 2, 2012.

Non-vegetated ecosystems, constituting approximately 22% of the LSA, are dominated by freshwater lakes (LA) and ponds (PD), and a single large saltwater (MW) polygon.

Described within the 2012 Wildlife Baseline Report (Rescan 2013b), upland ecosystems throughout the LSA provide important habitat for a variety of wildlife species. Described within Section 2.2.1 and reflecting the importance of broad ecosystem classes such as riparian and esker ecosystems, seventeen upland vegetation associations have been considered sensitive ecosystems due to their limited representation on the landscape and their importance to wildlife species as important feeding, nesting, resting or traveling habitat.

The sections below briefly describe the upland ecosystems mapped within each of the ecosystem classes, excluding wetland ecosystems, which are addressed separately within Section 3.5, and the non-vegetated water features (lakes, ponds, rivers and ocean).

3.4.2 Tundra Ecosystem Class

Occupying greater than half (59 %) of the total LSA, the tundra associations are by far the most common ecosystems on the landscape. Mapped ecosystems within the tundra class include the vegetated TL (Mesic dwarf-shrub tundra), TH (Dry-sparse tundra) and the TS (Shrubby tundra) associations. The MT (Marine dwarf shrub tundra) and the MS (Marine shrubby tundra) associations are marine-influenced tundra associations that are mapped solely within the Marine Laydown Area.

The TL association is the most common and extensive unit in the LSA, comprising nearly 30% of the total LSA. This TL association represents the 'typical' tundra situation and is characterized by extensive areas of dwarf, matted shrubs, with a highly variable component of herbs, graminoids, mosses, and lichens. It typically occurs on level to gently sloping, well-drained morainal blankets and veneers, and less commonly on aeolian, colluvial or fluvial parent materials. The majority (83%) of the mapped TL area is nearly equally distributed throughout the George and Goose Property Areas. The TH association is drier than the TL association and typically occurs on thin morainal veneers associated with exposed bedrock and abundant fractured surface rock. It comprises 16% of the total LSA, the majority within the George Property Area. The TS association is characterized by a dense cover of dwarf birch that is much taller (to approximately 50cm) than the prostrate shrub growth within the TL and TH associations. It typically occurs within moisture-receiving areas of the landscape (less commonly mesic areas), often in association with patchy sedge associations.

Appendix 4 provides a detailed description of each vegetation association within the tundra class, including the range of site, soil, terrain and environmental conditions in which it occurs, a list of the dominant vegetation species, and representative field photographs.

3.4.3 Marine Ecosystem Class

Based upon a combination of terrain attributes mapped as WG (glaciomarine), observable differences in vegetation communities in the field and on imagery during terrestrial ecosystem mapping, ecosystems in the marine ecosystem class are mapped in areas immediately adjacent to, or under the climatic influence of, the Arctic Ocean (Bathurst Inlet). As expected, given the uniqueness of ecosystems associated with marine parent materials and high salinity, vegetation communities in marine-influenced areas can differ greatly from the ‘typical’ tundra ecosystems to the south and east, in a continental climate. The riparian shrub-dominated ecosystems along Bathurst Inlet, for example, are typically taller than their inland counterparts and support a greater diversity of shrub species.

Mapped ecosystems within the marine class include the sparsely-vegetated MB (Marine beach) and MH (Old beach head) associations. Sparsely-vegetated and vegetated ecosystems in the marine class constitute 7 % of the LSA, all within the Marine Laydown Area. The vegetated MT (Marine dwarf shrub tundra), MS (Marine shrubby tundra) and MR (Marine riparian shrub) associations are included within the tundra and riparian ecosystem class descriptions, respectively. Marine-influenced wetland ecosystems are addressed separately within Section 3.5.

Appendix 4 provides a detailed description of each vegetation association within the marine class, including the range of site, soil, terrain and environmental conditions in which it occurs, a list of the dominant vegetation species, and representative field photographs.

3.4.4 Riparian Ecosystem Class

Typical of riparian ecosystems, the riparian class is mapped within a small area of the landscape (2,120 ha), 1.5 % of the total LSA. Identified as sensitive features within Section 2.2.1, riparian shrub ecosystems provide an important food source for ungulates, nesting habitat for birds and security and thermal habitat for many other wildlife species.

Mapped ecosystems within the riparian class include the vegetated RW (Willow riparian), RL (Low bench floodplain), and RM (Mid bench floodplain) associations. The MR (Marine riparian shrub) association, a marine-influenced riparian unit, is mapped solely within the Marine Laydown Area. The majority of riparian ecosystems are mapped within the Marine Laydown Area, with nearly equivalent areas mapped within the Goose and George Property Areas.

The RW association, the most commonly mapped unit, is a moist to wet, shrub-dominated community occurring immediately adjacent to small creeks, streams, ponds and lakes. It comprised approximately 1500 ha, 1.1 % of the total LSA, with two-thirds of this area split nearly evenly throughout the George and Goose Property Areas. Flooding may occur within these ecosystems but scouring is generally absent. The RW association, characterized by shrubs much taller (often to 1 metre tall) than those within the tundra ecosystem class, supports shrubs that occur in dense thickets or along narrow channels, often in a bouldery matrix. Shrub cover is often dominated by dwarf birch with various species of willows. The herb cover is typically sparse or absent, while mosses can be locally common.

The deciduous shrub layer within the marine riparian (MR) association, mapped in the Marine Laydown Area, is taller and more diverse than the riparian units within the George and Goose Property Areas. Shrubs in riparian ecosystems along slopes adjacent to Bathurst Inlet often reached 2 metres in height, taller than the typical riparian shrub height of less than 1 metre throughout the George and Goose Property Areas. The MR association is characterized by a continuous cover of low or tall shrubs, with various willow species, dwarf birch and alder forming the main cover.

Appendix 4 provides a detailed description of each vegetation association within the riparian class, including the range of site, soil, terrain and environmental conditions in which it occurs, a list of the dominant vegetation species, and representative field photographs.

3.4.5 Esker Ecosystem Class

Reflective of their uniqueness on the landscape, esker-related ecosystems are mapped within just 1530 ha, 1 % of the total LSA. Mapped ecosystems within the esker class include the EC (Sparsely-vegetated esker), EH (Dwarf shrub-herb esker), and EW (Shrubby esker) associations. Although mapped within each area, the majority of esker ecosystems are mapped within the George Property Area and along the proposed Winter Road to Bathurst Inlet.

Identified as sensitive features within Section 2.2.1, esker ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and provide travel corridors for a variety of other wildlife. During field sampling, caribou were often observed travelling along esker crests.

Summarized in Appendix 4, plant species associated with eskers and their percent cover are highly variable, typically with a very low percentage cover (<1% to 5%) of dwarf shrubs, herbs, mosses and lichens on the bare, windswept mineral soils (typically sands and gravels) of the EC associations. A variety of dwarf shrubs, with smaller amounts of 'tundra' herb, moss and lichen species, dominate the EH association. Within the EW association, shrubs often dominate the sheltered lower slopes of eskers where a prolonged snowpack protects them from wind shear, resulting in some of the tallest shrubs within the LSA.

3.4.6 Bedrock Ecosystem Class

Ecosystems within the bedrock class are sparsely-vegetated and typically occur within a matrix of bedrock outcropping and shallow, rapidly-drained soils. Bedrock ecosystems are mapped within approximately 10,320 ha, nearly 8 % of the total LSA. Mapped ecosystems within the bedrock class include the BL (Bedrock-lichen veneer), BR (Bedrock outcrop), BC (Cliff), BT (Talus) and TB (Blockfield) associations, with the BL and BR associations comprising nearly 98 % of the total bedrock area. The vast majority of bedrock ecosystems are mapped within the George Property Area.

Summarized in Appendix 4, the BL association is among the driest ecosystem type in the LSA. Restricted to crest positions on bedrock outcrops with very thin morainal or organic veneers, it is limited in extent. Open expanses of bedrock and/or mineral soil are common within this ecosystem and soils, where present, are typically restricted to small depressions and cracks. Identified as a sensitive ecosystem within Section 2.2.1, the dry, windswept areas associated with this ecosystem often support a continuous mat of lichen, providing an important food source for caribou.

Some bedrock-dominated ecosystems, such as the BC (cliff) association, have high value as habitat for wildlife (nesting raptors) and rare plant species. Approximately 11 ha of cliff ecosystems are mapped within the total LSA, primarily within the George Property Area.

3.4.7 Disturbed / Barren Ecosystem Class

Occupying a very small fraction of the total LSA, the disturbed or barren units are mapped within approximately 200 ha, 0.1 % of the total LSA. Mapped units within this class include the non-vegetated DR (associated with exploration camp disturbance) and DZ (associated with road surface disturbance), the sparsely-vegetated ES (Exposed soil) ecosystems and the vegetated DV (Disturbed vegetation) ecosystems. Constituting approximately 184 ha of the LSA, the ES (Exposed soil) unit represents the vast majority of the mapped disturbed/barren units. Mapped largely within the Marine Laydown Area, it includes areas of exposed soil that are not included in any of the other definitions, and other areas with evidence of recent disturbance (RIC 1998b) from exploration activity, road construction, or mine camp development.

3.5 WETLAND ECOSYSTEMS

3.5.1 Wetland Classification

Based upon soil composition identified during the wetland surveys within the LSA, wetlands were dominated by two distinct groups: shallow fibric and mesic peat over bedrock wetlands, and shallow mesic peat over silty and sandy lacustrine mineral material. Both of these groups are dominated by fen-type vegetation, with mixed sedge and cotton grass being the most common vegetation associations (Plate 3.5-1). Many of these fens contain a component of bogs. This component ranged from very minor (< 1%) to major (> 50%).

Plate 3.5-1. Shallow open water wetland in complex with sedge fen and open water aquatic ecosystem at survey plot W078.July 15, 2012.

The organic layers, which were typically composed of 20 to 50 cm of fibric to mesic peat, were underlain by permafrost. This permafrost layer occurred in either the mineral or organic materials. The depth to permafrost varied from 40 to 70 cm, depending on whether the substrate was mineral or organic. Areas of thicker peat had permafrost closer to the surface. Marsh wetlands were also observed. Permafrost in these areas was slightly deeper, commonly around 50 to 70 cm.

Vegetation species variety was limited. Within bogs, there was a repeated occurrence of plant associations characterized by *Betula nana*, *Rhododendron tomentosum* subsp. *subArcticum*, *Andromeda polifolia*¸ *Empetrum nigrum*, and *Vaccinium uliginosum*. The drier indicator sphagnums were also occasionally present. Fen vegetation was limited to a few sedge and cottongrass species. No swamp wetland ecosystems were identified in the LSA.

The most important characteristic of the soil types within these wetlands is that the soil material has no strength when saturated, due to very narrow partical size distribution and limited hydrologic storage capacity due to presence of permafrost close to the surface. This was repeatedly demonstrated as the soils would liquefy within minutes upon disturbance with the soil auger.

Wetland classification identified four of the federally described wetland classes (shallow open water, bog, fen, and marsh; Table 3.1.1). These wetland classes were further divided into wetland associations based on generalised interpretations of vegetation structure. Descriptions of wetland classes and associations are presented below.

Appendix 4 provides a detailed description of each vegetation association within the wetland classes, including the range of site, soil, terrain and environmental conditions in which it occurs, a list of the dominant vegetation species, and representative field photographs, where available.

3.5.2 Shallow Open Water Wetland Class

Shallow water wetlands are transitional wetlands between wetlands that are saturated or seasonally wet and permanent, deep water bodies such as lakes (Warner and Rubec 1997)).

These areas contain water shallower than two metres and may contain submerged, floating-leaved, or floating aquatic vegetation. Shallow water wetlands may contain limnic peat, mixed limnic organic-mineral material and marl in stable water regimes. These areas are subject to aquatic processes typical of upper limnetic or infralittoral lake zones such as nutrient and gaseous exchange, oxidation, and decomposition (Warner and Rubec 1997).

Wetland field plots were not conducted within these wetland types, however, visual observations of these communities were made as they often were in complex with other wetland ecosystems.

Shallow open water wetlands (WO) and saline (marine) shallow open water wetlands (MO), mapped within approximately 80 ha and 30 ha, respectively, constitute less than 1 % of the LSA. The majority of the WO ecosystems are mapped within the Goose Property Area, and all of the MO ecosystems are mapped within the Marine Laydown Area.

3.5.3 Bog Wetland Class

Bogs are low nutrient – low pH ecosystems that have low biomass production (MacKenzie and Moran 2004). Precipitation, fog, snowmelt and seasonal melt of permafrost are the primary water sources. Precipitation does not usually contain dissolved minerals and is mildly acidic; subsequently bog waters are low in dissolved minerals and acidic in nature. Bog water acidity is enhanced because of organic acids formed during the decomposition of peat (Warner and Rubec 1997). Due to the acidity, few minerotrophic plant species occur (MacKenzie and Moran 2004).

In the Arctic, bogs are characterized by unique ice-influenced morphologies (Tarnocai and Zoltai 1988; Warner and Rubec 1997). For example, a defining characteristic of a bog is that the surface is raised above the surrounding landscape. In non-permafrost influenced landscapes this is accomplished by peat accumulation. In permafrost environments this is accomplished by permafrost action, where frost and ice heave result in localized and dispersed uplifting of the soil. Five types of bogs were observed (Plate 3.5-2).

Plate 3.5-2. Bog with uplifted soil at survey plot W80. July 16, 2012.

The most common wetland bog association identified during the wetland field surveys was *unclassified*. Within this bog association, the vegetation composition and structure, landscape position, and soil processes did not match other, previously described bog types.

Two cottongrass – peat moss bog associations were observed. As the name suggest, these communities were dominated by cottongrass and peat moss species, had a sluggish hydrodynamic index, and had organic soil over a mineral layer with few coarse fragments. One of the sites was found in complex with two other wetland associations.

Two sedge – cottongrass bog associations were observed, each of which had stagnant hydrology but were observed in basins and slightly sloping areas. Both were found in complex with multiple wetland associations. Overall, this vegetation association was the most commonly observed, having been encountered 38 times; however, the majority of these occurrences were present with fen class wetlands. The two remaining identified bog associations were birch – cottongrass and bog rosemary – cottongrass. Each were slightly different than the others in that they contained a substantial portion of woody vegetation cover.

Within the LSA, a single bog association was mapped. Called a *raised bog complex* (WB association), it includes two ecosystems that had been mapped in previous projects as distinct units: the BR (low shrub bog) and EA (sheathed cottongrass – bog rosemary sedge fen) associations. In the Back River Project area, the latter associations nearly always occur in dynamic complexes with one another and rarely as units that could be independently mapped and/or described. The WB complex, mapped within nearly 3,000 ha (2.2 %) of the total LSA, was the most commonly mapped wetland ecosystem, just slightly higher than the fen (WC association), described below. It was widely mapped throughout the Goose and George Property Areas, and along the proposed Winter Road.

3.5.4 Fen Wetland Class

Fens are nutrient-medium peatland ecosystems dominated by sedges and brown mosses. Mineral-bearing groundwater is within the rooting zone and minerotrophic plant species are common (MacKenzie and Moran 2004). Surface water flow is through channels, pools and other open water features causing characteristic surface patterns. The vegetation distribution in fens is closely related to the depth and chemistry of groundwater. Shrubs occupy drier sites and minerotrophic gramminoids (narrow-leaved vegetation) are typically found in wetter sites (Warner and Rubec 1997).

The fens found in the Arctic differ somewhat in characteristics from those occurring at more southerly latitudes (Tarnocai and Zoltai 1988; Warner and Rubec 1997). One of the defining characteristics of fens is that they have a minimum of 40 cm of peat (MacKenzie and Moran 2004). Many of the fens observed in the LSA did not meet this requirement, yet were demonstrably fens, floristically, chemically, and hydrologically. A review of the literature resulted in the employment of a more relevant class name, Arctic sedge fen.

Arctic sedge fens (sometimes referred to as sedge meadows in the literature; Gregory 1998 and Tarnocai and Zoltai 1988) are amongst the most characteristic Arctic vegetation communities. They occur over a wide latitudinal range being extensive in the south Arctic and becoming less so in the high Arctic. North of the tree line they are restricted to approximately 3-5% of the land base (Gregory 1998). Arctic sedge fen ecosystems tend to be limited to a few species of sedges, mosses and dwarf shrubs that can tolerate the cold and saturated conditions present during the short growing season. Net production is very low and ranges between 100 to 300 g/m^2. This level of production varies little annually or latitudinally (Wilson and Nilsson 2009).

Fens develop on a number of substrates, including sedge peat, *Sphagnum* peat, and medium to fine-textured mineral soils. The most common substrate was organic veneers over mineral materials. However, there seems to be little effect of different soil substrates on species composition and dominance within the vegetation communities. Permafrost was always present, usually between 40 and 70 cm below the vegetative surface. This variation corresponded to thickness of the organic matter layer, as organic matter is an insulator (Black 1976), which reduces the soil diurnal damping depth during the warmer months of the year. This in turn mitigates seasonal permafrost melting (Hinkel 1997).

The two most common fen associations observed during the wetland field surveys were sedge- and sedge - cottongrass dominated communities (Plate 3.5-3). These ecosystems were not substantially different in any of the ecosystem parameters recorded. Their hydrology varied from stagnant to mobile, nutrients ranged from poor to rich, and the majority of sites had an open water component. The only substantial difference was that some of the sites contained relatively high assemblages of *Carex* species and were thus classified as a separate ecological community. The majority of sites were found in complex with other wetland and upland ecosystems.

The remaining fens, Birch - Sedge and Cottongrass - Peat moss were observed as single occurrences. Again these sites were not substantially different from the other fen associations observed, with the only measurable difference being their floristic composition.

Plate 3.5-3. Sedge – Cottongrass fen at wetland survey plot W079. July 15, 2012.

Within the LSA, four distinct fen ecosystems were mapped, including the cottongrass-sedge fen (WC), a willow-sedge fen (WS), a saline fen (MF) and an undifferentiated fen (WF). Mapped within slightly less than 3,000 ha (2.1 %) of the total LSA, the WC association was the most commonly mapped fen ecosystem. As with the WB (bog) complex, the WC association was widely mapped throughout the Goose and George Property Areas, and along the proposed Winter Road. The MF association was by far the most common wetland mapped Within the Marine Laydown Area.

3.5.5 Marsh Wetland Class

Marshes are permanently to seasonally flooded non-tidal mineral wetlands dominated by emergent graminoid (narrow-leaved) vegetation (MacKenzie and Moran 2004). Marshes are strongly influenced by either groundwater or surface water and have relatively high water movement. The influence of surface and groundwater tends to increase the presence of nutrient availability. The water table is above the soil surface throughout the growing season; this limits species richness to those few plants that can tolerate prolonged anoxic conditions. The soil nutrient regime is relatively rich compared to other wetland types. This is a result of nutrient inputs associated with high plant productivity and relatively rapid organic decomposition. Soils are typically mineral but can also have a thin, well decomposed organic surface tier(Warner and Rubec 1997; MacKenzie and Moran 2004).

Typically, a defining characteristic of marshes is that they tend to be nutrient rich (MacKenzie and Moran 2004). It is not clear that this is the situation with these rocky open-water pond and lake fringe ecosystems. The substrates encountered were limited to blocky till. While substrate nutrient levels were not quantitatively determined, gravel, cobble and boulder substrates are not usually associated with nutrient rich growing conditions.

Marsh ecosystems were often limited to lake and pond shores, or slowly moving water. The dominant substrate was rocky, skeletal glacial till. Species diversity was very low, limited to water sedge, narrow-leaved cotton grass, and very few others. Two marsh associations were observed, including sedge- and sedge – cottongrass associations (Plate 3.5-4 and Plate 3.5-5). These communities differed slightly in-terms of their moisture, hydrology, nutrient availability, and landscape position. The sedge communities were generally associated with moving water and thus had higher hydrodynamics, nutrients, and soil moisture content. The sedge – cottongrass communities were associated with lake shores and tended to have slower water movement resulting in lower accumulations of nutrients and decreased soil moisture further away from the water's edge.

Plate 3.5-4. Sedge-dominated marsh at survey plot W075. July 15, 2012

Plate 3.5-5. Sedge – cottongrass marsh at survey plot W076. July 15, 2012.

Within the LSA, two distinct marsh ecosystems were mapped, including a water sedge marsh (WA) and a saline marsh (MA). Mapped within approximately 2,000 ha (1.5 %) of the total LSA, the WA association was the most commonly mapped marsh ecosystem. Often mapped in association with other wetlands, it was widely mapped throughout the Goose and George Property Areas, and along the proposed Winter Road. The MA association, constituting approximately 0.3 % of the LSA, was mapped solely within the Marine Laydown Area.

3.6 SENSITIVE ECOSYSTEMS

Table 3.6-1 summarizes the area and percentage of LSA for each of the seventeen sensitive vegetation associations mapped within the LSA. Sensitive ecosystems were mapped within wetland, riparian, esker and bedrock ecosystem classes.

Table 3.6-1. Summary of the Sensitive Ecosystems Mapped within the LSA.

Ecosystem Name	TEM Code	Ecosystem Class	% Total LSA
Cottongrass-sedge fen	WC	Wetland	2.1
Water sedge marsh	WA	Wetland	1.5
Undifferentiated fen	WF	Wetland	1.6
Willow-sedge fen	WS	Wetland	0.3
Saline Fen	MF	Wetland (Marine)	0.4
Saline Marsh	MM	Wetland (Marine)	0.3
Willow riparian	RW	Riparian	1.1
Marine riparian shrub	MR	Riparian (Marine)	0.4
Low bench floodplain	RL	Riparian	0.04
Mid bench floodplain	RM	Riparian	0.01
Dwarf shrub esker	EH	Esker	0.4
Shrubby esker	EW	Esker	0.2
Shallow open water	WO	Wetland	0.1
Saline shallow open water	MO	Wetland (Marine)	0.02
Sparsely vegetated esker	EC	Esker	0.5
Bedrock-lichen veneer	BL	Bedrock	4.7
Cliff	BC	Bedrock	0.01
		Total %	**13.5**

Approximately 13.5 % of the LSA was mapped with sensitive ecosystems. The highest percentage of sensitive ecosystems occurs within the George Property Area, which contains 45% of all mapped sensitive ecosystems. Within the George Area, most sensitive ecosystems mapped were within the wetland and bedrock ecosystem classes. Although similar areas of sensitive wetland and riparian ecosystem classes were mapped within the George and Goose Property Areas, a much larger area of the bedrock ecosystem class (primarily the BL association) was mapped within the George Property Area. The majority of the sensitive riparian ecosystems are mapped within the Marine Laydown Area.

Similar to ecosystems within the bedrock ecosystem class, the majority of esker-related ecosystems were mapped within the George Property Area.

3.7 WETLAND CARBON STORAGE

An important aspect of biochemical function of high latitude wetland ecosystems is their role in the carbon cycle. The functional and structural responses of carbon storage in high latitude wetland ecosystems have important implications for the amount and rate of CO_2 accumulation in the atmosphere (Smith & Shugart 1993; McGuire and Hobbie 1997; McGuire et al. 2000). While high latitude wetlands cover only 4 to 5% of the earths' surface, they may contain up to 450 gigatonnes of carbon (Gt C). This is approximately 20% of the carbon in the terrestrial biosphere (Gorham 1991; Maltby and Immirzi 1993), and 40% of the worlds' soil carbon inventory (McGuire and Hobbie 1997).

Under current conditions, high latitude wetlands are a small, persistent sink for CO_2 (Gorham 1995) and a large source of CH_4 (Fung et al 1991). Functional and structural changes, caused by Arctic temperature increases, have the potential to influence the current balance between terrestrial and atmospheric carbon (Smith and Shugart, 1993; McGuire and Hobbie 1997; McGuire et al, 2000). In many areas of the Arctic, peat accumulation has been extensive due to production exceeding decomposition. As warming occurs, however, it is predicted that large reservoirs of soil carbon may become available for decomposition. This is particularly the case with frozen peat, as decomposition occurs rapidly once the thaw cycle has been initiated (Bubier et al 1995).

The methane storage capacity of Arctic wetlands is of particular importance, as methane is a potent greenhouse gas (Christensen et al. 2004). Permafrost has stored methane since the end of the last ice age, when organic and mineral Arctic soils became saturated and frozen during glacial advance. Under these conditions decomposition of organic compounds occurs anaerobically. The utilization of CO_2 as a terminal electron acceptor is limited to a group of anaerobic bacteria called methaongens, which only decompose carbon under anaerobic conditions. The final decomposition product is CH_4.

The average peat density was calculated and tabulated from density measurements made in the field. The results of % carbon in a peat sample were also tabulated. Average % carbon (Appendix 5) values were used where more than one sample was collected from a wetland. All calculations and results can be found in Appendix 5.

3.8 BASELINE METALS CONCENTRATIONS

The following section presents the results of the lichen and plant tissue metal analysis.

3.8.1 Metal Concentrations in Lichen Tissue

Lichen species sampled for tissue metal concentrations were *Cladina stygia* and *Stereocaulon paschale*.

3.8.1.1 Cladina Stygia

Concentrations of 31 metals were measured in the 47 *Cladina stygia* tissue samples collected in 2012 from 47 locations. Summary statistics for dry weight metal concentrations in samples from four locations are presented in Table 3.8-1. Metals which were not detected in these samples included antimony, beryllium, bismuth, selenium, silver, sodium, tin and thallium. Metals which were detected in less than 50% of the samples were chromium, lithium, molybdenum and vanadium.

Lichens absorb water and mineral nutrients from the air through the outer surface of the thallus. They are not dependent on soils for nutrients, but substrates may contribute to lichen metal concentrations. Substrate contributions may vary depending on lichen species, substrate type, and the element. There were three Reference sampling locations where *C. stygia* was collected that exhibited naturally high arsenic concentration in both lichen and soils (NW2, NW3 and SE3).

Concentrations of 31 metals were also measured in the two *Stereocaulon paschale* samples collected in 2012. Note that *Stereocaulon pashal* was only collected when *Cladina stygia* was not present at the sample site, and was collected in order that the metals could be compared with those of the soils at the site. This data is presented in Appendix 7.

3.8.2 Metal Concentrations in Berry Tissue

3.8.2.1 Vaccinium Uliginosum (Bog Blueberry)

A total of 32 *Vaccinium uliginosum* berry samples were collected in 2012 from the Goose Property, George Property, Marine Laydown Area and Reference locations. Summary statistics for dry weight metal concentrations from the Goose Property, George Property and Reference locations and dry weight metal concentrations from the Marine Laydown Area are presented in Table 3.8-2. The table lists summary statistics and dry weight metal concentrations for metals which were detected in more than 50% of the samples. Parameters which fell below the detection limit in all samples, or in more than 50% of the samples are not indicated in the tables. Metals with the highest overall concentrations were calcium, magnesium, iron, phosphorus and potassium. Of the terrestrial plant tissues sampled, the berry samples had the lowest concentrations of the elements measured.

In the *Vaccinium uliginosum* berry samples, of the 19 reported metals, the highest concentrations of six metals were measured in the Goose Property (n=8) samples, and the highest concentration of one metal was measured in Reference location (n=17) samples.The highest metal concentrations occurred at different sites from within the locations depending on the metal.

3.8.2.2 Vaccinium Vitis-idaea (Bog Cranberry)

Total of 14 *Vaccinium vitis-idaea* berry samples were collected in 2012 from the Goose Property, George Property, Marine Laydown and Reference Areas. Summary statistics for dry weight metal concentrations from the Goose Property and Reference locations, and dry weight metal concentrations from the Marine Laydown Area are presented in Table 3.8-3. No sample was analyzed from the George Property Area. The table lists summary statistics and dry weight metal concentrations for metals, which were detected in more than 50% of the samples. Parameters that fell below the detection limit in all samples, or in more than 50% of the samples are not indicated in the tables. Metals with highest overall concentrations were calcium, magnesium, iron, phosphorus and potassium.

In the *Vaccinium vitis-idaea* berry samples, of the 14 reported metals, the highest concentrations of nine metals were measured in the samples from the Goose Property (n=5) whereas the highest concentration of four metal were measured in samples collected from Reference location (n=8) (Table 3.8-3). One sample was collected from the Marine Laydown Area and no samples were available from the George Property location.

Averaging the metal concentrations between the locations showed that *V. uliginosum* had a higher average dry weight metal concentration for all metals except aluminium and manganese compared to *Vaccinium vitis-idaea*. Even when the George Property location values were omitted from the *V. uliginosum* mean calculation, as this location was not measured for *V. vitis-idaea,* the trend for metal concentrations remained the same.

Table 3.8-1. Summary of Dry Weight Metal Concentrations in *Cladina Stygia* Tissue Samples Collected in 2012, Back River Project

		Goose property (n = 11)					George property (n =5)					Reference (n = 30)					Marine laydown (n =1)
Total Metals	RDL	Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD	Actual values
Aluminum (Al)-Total	10	1440.00	144.00	249.00	445.91	405.49	796.00	137.00	178.00	364.00	291.35	3450.00	88.00	420.00	611.03	642.91	205.00
Arsenic (As)-Total	0.05	0.92	0.20	0.29	0.43	0.28	0.45	0.18	0.30	0.33	0.11	2.09	0.08	0.28	0.40	0.46	0.1
Barium (Ba)-Total	0.05	31.90	9.84	19.10	19.96	7.03	15.20	6.36	7.19	9.02	3.61	30.70	4.88	15.15	15.54	6.52	18.60
Cadmium (Cd)-Total	0.03	0.08	0.02	0.04	0.05	0.02	0.06	0.04	0.05	0.05	0.01	0.24	0.02	0.06	0.07	0.04	0.015
Calcium (Ca)-Total	10	2590.00	949.00	1250.00	1426.91	539.41	1620.00	577.00	894.00	1011.00	384.09	3970.00	585.00	878.50	1038.60	630.91	1290.000
Cobalt (Co)-Total	0.1	3.78	0.40	1.19	1.38	0.91	0.74	0.15	0.46	0.47	0.26	10.20	0.05	0.90	1.74	2.59	0.16
Copper (Cu)-Total	0.05	6.52	1.51	2.54	3.15	1.52	2.28	1.17	1.79	1.69	0.48	31.50	0.85	1.82	4.47	6.57	1.35
Iron (Fe)-Total	1	1100.00	152.00	343.00	490.91	326.86	738.00	135.00	191.00	381.00	289.93	5150.00	140.00	418.50	673.57	930.73	221.000
Lead (Pb)-Total	0.1	2.97	0.19	0.78	0.92	0.85	2.40	0.26	0.54	0.96	0.87	6.78	0.13	1.19	1.56	1.44	0.410
Magnesium (Mg)-Total	3	655.00	292.00	504.00	482.55	129.05	559.00	360.00	373.00	406.80	85.38	1300.00	162.00	369.50	424.70	213.22	993.00
Manganese (Mn)-Total	0.05	114.00	25.50	54.80	61.65	22.61	89.20	33.20	39.40	47.16	23.68	240.00	13.20	45.75	54.30	44.00	67.700
Mercury (Hg)-Total	0.005	0.11	0.02	0.05	0.06	0.03	0.20	0.03	0.05	0.10	0.08	0.21	0.03	0.06	0.08	0.04	0.04
Nickel (Ni)-Total	0.5	6.34	1.25	2.42	3.48	2.13	1.68	0.25	1.11	1.13	0.59	43.20	0.25	1.87	6.91	11.37	0.250
Phosphorus (P)-Total	20	730.00	261.00	358.00	395.91	122.24	489.00	245.00	445.00	379.40	121.87	620.00	136.00	362.50	367.57	129.36	512.000
Potassium (K)-Total	100	1400.00	760.00	1000.00	1030.00	200.75	1300.00	770.00	1180.00	1042.00	248.64	1450.00	530.00	1010.00	1030.00	241.53	1490.000
Strontium (Sr)-Total	0.05	9.06	3.32	5.07	5.63	1.75	4.59	2.29	2.60	2.98	0.93	10.40	1.65	4.66	4.69	2.09	13.000
Titanium (Ti)-Total	0.5	36.10	3.67	11.80	14.05	10.28	20.50	5.56	6.45	11.53	7.49	156.00	2.80	14.05	21.92	29.47	10.500
Uranium (U)-Total	0.01	0.07	0.01	0.03	0.03	0.02	0.06	0.01	0.02	0.03	0.02	0.44	0.01	0.03	0.06	0.08	0.021
Zinc (Zn)-Total	0.5	39.50	8.73	18.60	19.78	7.81	18.10	11.60	15.90	14.92	2.63	48.50	7.65	19.40	20.17	8.91	14.800

Notes:

Table includes total metal concentrations for parameters detected in more than 50% of the samples.

Metals below realized detection limit in all samples: antimony, beryllium, bismuth, selenium, silver, sodium, tin and thallium.

Metals below realized detection limit in more than 50% of the samples: chromium, lithium, molybdenum and Vanadium..

Table 3.8-2. Summary of Dry Weight Metal Concentrations in *Vaccinium Uliginosum* Berry Tissue Samples Collected in 2012, Back River Project

Total Metals	RDL	Goose property (n = 8)					Marine laydown (n = 1)	George property (n = 6)					Reference (n = 17)				
		Maximum	Minimum	Median	Mean	SD	Actual values	Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD
Aluminum (Al)-Total	10-20	351.00	5.00	13.00	54.38	119.92	15.00	78.00	5.00	14.00	24.33	27.84	261.00	5.00	13.00	28.59	60.54
Arsenic (As)-Total	0.05-0.1	0.4	0.0	0.0	0.1	0.1	0.03	0.2	0.0	0.0	0.1	0.06	0.1	0.0	0.0	0.0	0.01
Barium (Ba)-Total	0.05-0.1	40.30	9.76	17.60	19.56	8.89	10.40	18.80	9.30	15.25	15.05	3.48	26.60	10.20	17.80	17.32	4.59
Cadmium (Cd)-Total	0.03-0.06	0.214	0.067	0.151	0.148	0.054	0.14	0.198	0.057	0.168	0.153	0.057	0.219	0.049	0.137	0.138	0.052
Calcium (Ca)-Total	10-20.	2310.000	919.000	1260.000	1401.000	489.062	1120.00	1500.000	972.000	1400.000	1295.333	214.687	1650.000	828.000	1180.000	1228.118	267.969
Chromium (Cr)-Total	0.5-1	0.97	0.25	0.25	0.37	0.26	0.25	0.25	0.25	0.25	0.25	0.00	0.50	0.25	0.25	0.26	0.06
Cobalt (Co)-Total	0.1-0.2	0.39	0.05	0.14	0.17	0.11	0.05	0.33	0.05	0.09	0.14	0.12	0.34	0.05	0.05	0.10	0.08
Copper (Cu)-Total	0.05-0.1	7.41	3.02	4.22	4.74	1.50	3.57	7.03	4.29	5.48	5.48	0.93	6.94	3.81	4.27	4.76	0.95
Iron (Fe)-Total	10	571.000	5.000	13.500	82.875	197.275	12.00	87.000	13.000	18.000	30.500	28.501	311.000	10.000	16.000	36.647	71.300
Lead (Pb)-Total	0.1-0.2	0.140	0.050	0.050	0.068	0.034	0.05	0.050	0.050	0.050	0.050	0.000	0.400	0.050	0.050	0.081	0.088
Magnesium (Mg)-Total	3-6	920.00	491.00	617.50	648.50	130.54	630.00	838.00	498.00	645.00	663.00	134.27	685.00	459.00	555.00	557.41	55.49
Manganese (Mn)-Total	0.05	162.000	22.400	72.450	84.075	55.968	112.00	101.000	28.800	85.200	78.583	26.806	242.000	17.200	49.300	74.947	64.795
Molybdenum (Mo)-Total	0.05-0.10	0.230	0.025	0.081	0.097	0.078	0.07	0.137	0.025	0.066	0.074	0.048	0.137	0.025	0.054	0.063	0.042
Nickel (Ni)-Total	0.5-1	3.260	0.500	2.005	1.983	0.840	0.93	3.200	1.090	1.805	2.102	0.830	3.560	1.050	1.810	1.959	0.733
Phosphorus (P)-Total	200	1560.000	100.000	1160.000	1068.750	456.929	1150.00	1700.000	950.000	1260.000	1311.667	289.165	1840.000	820.000	1210.000	1234.706	279.846
Potassium (K)-Total	1000	7800.000	500.000	7250.000	6462.500	2444.199	7700.00	8000.000	4900.000	6800.000	6683.333	1066.615	8100.000	4500.000	6700.000	6517.647	1264.039
Strontium (Sr)-Total	0.05-0.1	11.100	1.220	3.135	3.916	3.214	2.67	4.930	1.390	2.450	2.875	1.454	10.800	1.110	3.220	4.197	2.376
Tin (Sn)-Total	0.2-0.4	2.900	0.430	0.810	1.118	0.814	0.41	2.480	0.830	1.175	1.413	0.644	2.040	0.320	1.240	1.229	0.492
Zinc (Zn)-Total	0.5-1	56.900	8.260	17.450	22.495	14.977	33.40	157.000	18.100	32.150	64.517	61.702	78.400	10.800	14.900	19.582	15.981

Notes:

Table includes total metal concentrations for parameters detected in more than 50% of the samples.

Metals below realized detection limit in all samples: antimony, beryllium, bismuth, lithium, mercury, selenium, silver, sodium and thallium.

Metals below realized detection limit in more than 50% of the samples: chromium, cobalt, lead, lithium, tin, uranium and Validium..

Table 3.8-3. Summary of Dry Weight Metal Concentrations in *Vaccinium Vitis-Idaea* Berry Tissue Samples Collected in 2012, Back River Project

Total Metals	RDL	Goose Property Area (n = 5)					Reference (n = 8)					Marine Laydown Area (n =1)
		Maximum	Minimum	Median	Mean	SD	Maximum	Minimum	Median	Mean	SD	Actual values
Aluminum (Al)-Total	10-20	55.00	13.00	22.00	28.40	16.55	299.00	16.00	24.00	57.75	97.58	16.00
Barium (Ba)-Total	0.05-0.1	19.00	8.99	18.50	16.22	4.23	21.80	6.57	13.55	14.35	4.80	8.03
Calcium (Ca)-Total	10-20.	1460.000	941.000	1220.000	1208.200	184.218	1570.000	912.000	1100.000	1115.250	217.792	1040.000
Cobalt (Co)-Total	0.1-0.2	0.20	0.05	0.11	0.11	0.06	-	-	-	-	-	-
Copper (Cu)-Total	0.05-0.1	4.68	3.16	3.62	3.77	0.59	3.71	2.28	3.26	3.06	0.54	3.27
Iron (Fe)-Total	10	63.000	5.000	15.000	24.000	23.108	439.000	5.000	15.500	67.250	150.306	11.000
Magnesium (Mg)-Total	3-6	581.00	480.00	516.00	532.00	42.33	594.00	371.00	464.00	481.00	80.19	410.00
Manganese (Mn)-Total	0.05	330.000	56.600	109.000	147.680	108.338	212.000	55.100	83.700	112.088	60.052	100.000
Nickel (Ni)-Total	0.5-1	1.680	0.670	1.080	1.146	0.377	3.780	0.250	1.215	1.390	1.040	-
Phosphorus (P)-Total	200	1030.000	910.000	950.000	958.000	48.683	970.000	690.000	795.000	811.250	111.026	660.000
Potassium (K)-Total	1000	6900.000	5200.000	6600.000	6400.000	681.909	6700.000	4600.000	5700.000	5637.500	781.825	6200.000
Strontium (Sr)-Total	0.05-0.1	4.250	1.490	2.930	2.834	1.041	6.550	1.420	2.900	3.536	1.792	2.060
Tin (Sn)-Total	0.2-0.4	0.930	0.100	0.430	0.430	0.351	0.680	0.100	0.255	0.336	0.254	-
Zinc (Zn)-Total	0.5-1	27.500	6.210	8.830	14.226	9.210	35.300	4.680	8.345	12.423	10.197	8.160

Notes:

Table includes total metal concentrations for parameters detected in more than 50% of the samples.

Metals below realized detection limit in all samples: antimony,arsenic, beryllium, bismuth, cadmium, lead, mercury, selenium, silver, sodium, thallium, tin, uranium and Validium.

Metals below realized detection limit in more than 50% of the samples: chromium, cobalt, lithium and molybdenum.

3.8.3 Metal Concentrations in Wetland Sedge Tissue

Twelve *Carex aquatilis* tissue samples were collected from the Goose Property, George Property and Reference locations. No sample was collected from the Marine Laydown Area. The sedge samples were analyzed for 30 different metals many of which were below detection limits. Table 3.8-4 lists summary statistics for metals which were above the detection limits in more than 50% of the samples (aluminium, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, Iron, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, strontium, titanium, thallium, uranium, vanadium and zinc). Antimony and tin were not detected in any sedge tissue samples. Beryllium, bismuth, lithium, molybdenum (except reference sample), silver, sodium, thallium were detected in less than 50% of the samples. Metals with highest overall concentrations were calcium and magnesium.

Table 3.8-4. Summary of Dry Weight Metal and Carbon Concentrations in *Carex aquatilis* Tissue Samples Collected in 2012, Back River Project

		Reference (n =1)	Goose property (n=1)
Total Metals	**RDL**	**Actual values**	**Actual values**
Aluminum (Al)-Total	10	333.00	129.0
Arsenic (As)-Total	0.05	0.3	0.2
Barium (Ba)-Total	0.05	12.90	16.3
Cadmium (Cd)-Total	0.03	0.044	0.1
Calcium (Ca)-Total	10	1270.000	1470.0
Cobalt (Co)-Total	0.1	2.36	0.6
Copper (Cu)-Total	0.05	3.58	2.1
Iron (Fe)-Total	1	299.000	144.0
Lead (Pb)-Total	0.1	0.310	0.3
Magnesium (Mg)-Total	3	513.00	456.0
Manganese (Mn)-Total	0.05	33.000	107.0
Mercury (Hg)-Total	0.005	0.02	0.0
Nickel (Ni)-Total	0.5	4.370	2.2
Phosphorus (P)-Total	20	356.000	365.0
Potassium (K)-Total	100	1130.000	1010.0
Strontium (Sr)-Total	0.05	7.090	5.5
Titanium (Ti)-Total	0.5	4.460	5.1
Uranium (U)-Total	0.01	0.036	0.0
Zinc (Zn)-Total	0.5	13.300	16.0

Notes:
Table includes total metal concentrations for parameters detected in more than 50% of the samples.
Metals below realized detection limit in all samples: antimony, beryllium, bismuth, chromium, lithium, molybdenum, selenium, silver, sodium, thallium, tin and vanadium.

Besides metal analysis, organic and inorganic carbon analysis was also done on the sedge tissue samples. Total organic carbon was found to be greater in the samples from the George Property, whereas total inorganic carbon was found to be greater in the samples from the Goose Property. Wetlands where the sedge mainly grows are known for carbon storage and later release into the atmosphere. Carbon movement in these wetlands is also affected by the transpiration of the sedge plants.

3.9 PLANT SPECIES RICHNESS

A total number of 6,351 identifications were made during the field surveys, accounting for 890 species (Table 3.9-1). The largest species group in the Project flora is that of the vascular plants, followed by the macrolichens. Combined, the micro- and macro-lichens are the most species-rich category in the LSA. Third richest in species are the mosses, followed by liverworts and algae.

Table 3.9-1. Total Species Richness Encountered by Species Category

Total Species: 890					
Plants (total: 473)			**Algae (1)**	**Lichens (total: 416)**	
Vascular plants	**Mosses**	**Liverworts**	**Macro-chlorophyta**	**Macrolichens**	**Microlichens**
285	152	36	1	227	189

3.10 PLANTS OF CONSERVATION INTEREST

3.10.1 Listed Plant Species

This section contains a brief summary of the results of the rare species surveys, while Appendix 1 contains the full rare species report. In total, 251 species were included in the potential rare species list, including 66 lichens, 72 mosses, and 113 vascular plants. The list at the outset of the field work included different species than those included at the last day of field surveys. This was due to findings that some species ranked as conservation priorities were found during the field surveys to be more common than previously thought, or in other cases due to the discovery of species not previously identified in NWT, and that are rare, or rare species that are apparently un-described and therefore new to science.

A total of 90 rare species were found in the LSA and reference areas, including 41 vascular plants, 31 lichens, and 18 mosses (Tables 3.10-1, 3.10-2, 3.10-3, and 3.10-4). Brief descriptions of these rare species are given in Annex-A of Appendix 1. None of the rare species found in the 2012 rare plant surveys are currently listed under SARA or by COSEWIC. In total, 236 tracked species occurrences (element occurrences) were recorded (Annex D, Appendix 1).

Table 3.10-1. Rare Vascular Plants Found in the LSA

Argentina egedii	*Epilobium davuricum*	*Potentilla cf. litoralis*
Astragalus australis var. lepagei	*Erysimum coarctatum*	*Primula stricta*
Astragalus eucosmus	*Galium trifidum*	*Puccinellia sp. nov.*
Calamagrostis deschampsioides	*Gentianella propinqua ssp. arctophila*	*Ranunculus pallasii*
Caltha palustris	*Gentianella tenella*	*Salix ovalifolia*
Carex lapponica	*Hippuris tetraphylla*	*Salix sp. 1*
Carex mackenziei	*Juncus Arcticus var. alaskanus*	*Stuckenia filiformis ssp. alpigena*
Carex microglochin	*Kobresia sibirica*	*Suaeda calceoliformis*
Chrysosplenium rosendahlii	*Lomatogonium rotatum*	*Symphyotrichum pygmaeum*
Corallorhiza trifida	*Luzula groenlandica*	*Triglochin palustris*
Dasiphora fruticosa	*Montia fontana*	*Utricularia intermedia*
Draba arabisans	*Oxytropis deflexa var. foliolosa*	*Utricularia macrorhiza*
Draba crassifolia	*Petasites sagittatus*	*Woodsia alpina*
Eleocharis palustris sensu lato	*Plantago canescens*	

Table 3.10-2. Rare Mosses Found in the LSA

Aloina rigida	*Myrinia pulvinata*	*Psilopilum laevigatum*
Arctoa sp. nov.	*Orthotrichum anomalum*	*Pterigynandrum filiforme*
Dicranella cf. subulata "stikinensis"	*Pohlia crudoides*	*Sarmentypnum trichophyllum*
Encalypta brevicollis	*Pohlia proligera*	*Seligeria sp. nov.*
Encalypta vittiana	*Pseudoleskeella tectorum*	*Sphagnum platyphyllum*
Encalypta vulgaris	*Psilopilum cavifolium*	*Splachnum sphaericum*

Table 3.10-3. Rare Lichens Found in the LSA

Brodoa oroArctica	*Leciophysma finmarkicum*	*Placynthium pulvinatum*
Bryoria tenuis	*Leptogium imbricatum*	*Polychidium muscicola*
Collema ceraniscum	*Leptogium intermedium*	*Protopannaria pezizoides*
Collema crispum	*Leptogium tenuissimum*	*Protopannaria sp. nov.*
Endocarpon pulvinatum	*Lichenomphalia hudsoniana*	*Psoroma tenue var. boreale*
Fulgensia bracteata	*Lobaria scrobiculata*	*Pycnothelia papillaria*
Fuscopannaria sp. nov.	*Nephroma parile*	*Ramalina intermedia*
Gyalecta foveolaris	*Parmeliella triptophylla*	*Siphula ceratites*
Gyalecta friesii	*Physconia perisidiosa*	*Solorina octospora*
Hypogymnia dichroma	*Placynthium flabellosum*	*Xanthoparmelia wyomingica*
Hypogymnia imshaugii		

Table 3.10-4. Summary of Rare Species Found in the LSA

Conservation rank*	Vascular Plants	Lichens	Mosses
SARA	0	0	0
GS2	2	N/A	4
GS3	18	N/A	2
Ranked GS4 (but rare)	12	N/A	0
Unranked but rare	9	18	12
S1	N/A	1	N/A
S1S2	N/A	3	N/A
S1S3	N/A	2	N/A
S2S3	N/A	5	N/A
SU	N/A	2	N/A
TOTAL	41	31	18

**No S-rank system exists for Nunavut plants, hence they are entered as N/A. GS ranks for lichens are redundant to and are based on the territorial macrolichen S-ranks, hence N/A is entered for these under GS rank rows.*

Though no species found in the LSA is given Canadian federal listing, some of the rare species found are so seldom documented that they are ranked as rare world-wide. Among these are species given G-ranks of G2G4, that is, globally threatened or possibly sensitive. This is true of *Encalypta vittiana* (G2G4), *Pohlia crudoides* (G2G4), *Psoroma tenue* var. *boreale* (G3G5T2T4), and *Symphyotrichum pygmaeum*. However, the Natureserve system has completed G ranks for only a portion of the total North American flora, so many of the globally rare species on the continent are not yet flagged as conservation priorities. For example, *Gyalecta foveolaris, Gyalecta friesii, Placynthium pulvinatum, Sarmentypnum trichophyllum* are not assigned global conservation ranks, but are so seldom reported as to be most likely of global-scale conservation priority.

Species summarized in Table 3.10-4 under the 'unranked but rare' category are either newly discovered for NWT (no database exists for Nunavut) in the 2012 rare plant surveys, rare species newly discovered for science, or were deemed unrankable when General Status (GS) ranks were assigned. Unrankable species in the GS compilations were those that were either unconfirmed as present in NWT, or those that were thought to be confounded with other species in literature-based records, or that were thought to be greatly under- or over-reported.

3.10.2 Invasive Plants

During the 2012 Ecosystem Mapping field work and rare plant surveys, ecologists and botanists actively searched for non-native species and compared the species list to the list of potential invasive species, identified earlier in Section 2.6.3. No species that are non-native in Nunavut were found in the LSA.

4. Summary

4. Summary

In 2012, baseline studies were initiated to inventory and describe the full range and type of ecosystems and vegetation, rare and invasive plants, in the Project area. This report presents the results of the studies including terrestrial ecosystem classification and mapping, sensitive ecosystems, rare plant surveys, invasive plant surveys, plant tissue collection for baseline metals analysis, and an analysis of the potential carbon storage of wetlands.

Field surveys were completed during the summer of 2012 to characterize the full range of ecosystems that occur in the Project area. The collected data was then used to create a project specific ecosystem classification system to enable ecosystem mapping of the approximately 140,000 hectare Local Study Area (LSA). The classification system includes detailed descriptions of 11 sparsely-vegetated ecosystems, 20 vegetated ecosystems, and 6 non-vegetated ecosystems. Vegetated ecosystems comprise approximately 70 % of the LSA, 8 % of which are wetland ecosystems. The most common ecosystem class mapped within the LSA was tundra, with the mesic dwarf-shrub tundra (TL), the dry-sparse tundra (TH), and the shrubby tundra (TS) vegetation associations comprising greater than 50 % of the LSA. While a formal system for tracking sensitive ecosystems does not presently exist in Nunavut, seventeen ecosystems are considered sensitive, primarily due to their importance as wildlife habitat or heightened sensitivity to disturbance. Of the mapped sensitive ecosystems, representing approximately 14 % of the total LSA, nearly half were mapped within the George Property Area.

Rare plant surveys, conducted in 2012, contributed significantly to the available scientific data of distribution and occurrence of rare plants in western Nunavut. A total of 90 rare species were found in the Project area, including 41 vascular plants, 31 lichens, and 18 mosses. The area around Bathurst Inlet had the highest concentration of rare plant occurrences. None of the rare species are currently listed under the *Species at Risk Act* or by the *Committee on the Status of Endangered Wildlife in Canada*. In total, 236 tracked species observations were recorded. No invasive species were found in the LSA.

References

Rescan™ Engineers and Scientists

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Appendix 1

Listed Plant Species Occurring within the LSA

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Engineers and Scientists

Appendix 1-A. Species accounts of rare plants and lichens observed in the project area

Aloina rigida (Hedw.) Limpr.	MOSS
	Conservation Rank: GS2 Habitat: A pioneer on stabilized disturbed soil; arctic to tropical. In the project area, found on soil over cliff ledge. Among the mosses of Nunavut, this species has few look-alikes. It is distinguished on the basis of its pad of finger-like filaments on the leaf upper surface, and its in-folded leaf margins. Only other *Aloina* species could be confused with this species, but the other arctic species differ either in having thin-walled, colourless cells along the margins of the leaf base, or in having a rounder leaf outline (Delgadillo 2007). Photo from British Columbia.

Arctoa sp. nov.	MOSS
	Conservation Rank: Not ranked, a rare species new to science Habitat: Among other mosses on cliff ledges; arctic. In the project area, observed on seepy cliff ledges. This species differs from other members of its genus in its small size, papillate leaf cells, wide-spreading peristome teeth and more or less straight, exerted capsule. *Cynodontium* differs in having leaves twisted and curled when dry, and shorter, erect peristome teeth (Newmaster 2007). Known only from the southern Arctic of NWT and Nunavut. Photo of specimen from the Northwest Territories.

Argentina egedii (Wormsk.) Rydb.	VASCULAR PLANT
	Conservation Rank: GS3
	Habitat: Near-shore marine habitats; arctic. In the project area, found in estuaries on beaches and on upper edges of tidal mudflats.
	From other *Argentina* species *A. egedii* in the strict sense used here differs in having leaves green on both surfaces, smaller leaflets with a less elongated shape, and its more pliant, almost rubbery texture (Hultén 1968). Photo from the project area.

Astragalus australis var. *lepagei* (Hultén) S.L. Welsh	VASCULAR PLANT
	Conservation Rank: GS3 (ranked at the species level, var. *lepagei* is newly discovered for Nunavut.
	Habitat: Variously sparsely vegetated sites; arctic to temperate. In the project area, found on cobbly or sandy soil in open sites near shorelines.
	This species is easily identified based on its stalked fruits, which open by the upper margin, gaping wide and attaining the shape of a rowboat. *Oxytropis deflexa* has a similar fruit, but the leaves of that species have closer-spaced, broader leaflets and much shorter stems. Variety *lepagei* is distinguished from other varieties of the species by its longer petals and shorter calyx, and by its arctic geographical range (Welsh & Spellenberg 2011). Photo from the project area.

Astragalus eucosmus B.L. Rob.	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than that assessment suggests. Habitat: Various open sites or among dense grassland or shrub vegetation; arctic to temperate, mostly boreal. In the project area, observed on a cobbly beach and on clay soil of badland-like slopes in a ravine. From other *Astragalus* species in the Arctic, *A. eucosmus* is distinguished by its tall, leafy stems, purple-white flowers, and black hairs on the unstalked fruits (Hultén 1968). Photo from the project area.

Brodoa oroarctica **(Krog) Goward**	**LICHEN**
	Conservation Rank: S2S3 Habitat: On rock in arctic or (especially) alpine tundra; in the project area, observed on rock in tundra. This species is similar to certain *Hypogymnia* species, but differs in having solid, not hollow lobes and its smaller size. Other *Brodoa* species are known from arctic Eurasia, but are not yet known from North America. Those species differ in lacking the periodic constrictions along the lobes (Thell & Westberg 2011). Photo from a nearby area of Nunvaut.

Bryoria tenuis **(E. Dahl) Brodo & D. Hawksw.**	**LICHEN**
	Conservation Rank: S1S3
	Habitat: On rocky ground or growing directly from rock; arctic-alpine. Also found on trees in temperate coastal areas.
	Similar to *B. nitidula*, from which it differs in having a two-toned colouration and a relatively spiny appearance. Coastal tree-dwelling forms may be a different species (Myllys et al. 2011). Photo from the project area.

Calamagrostis deschampsioides **Trin.**	**VASCULAR PLANT**
	Conservation Rank: GS3
	Habitat: Along marine shores; arctic. In the project area found in estuaries and in brackish marshes near marine shores.
	This species has no look-alikes in its near-marine shore habitat; diagnostic are the diffuse inflorescence, shortly rhizomatous/clump-forming habit, florets (lemmas) possessing a whisker-like awn and tuft of long, straight hairs at the base (cite Marr et al. 2007). As this plant's Latin name suggests, *Deschampsia caespitosa* may appear similar. It differs in lacking rhizomes and growing in tighter clumps, in its glossy florets and lack of a long hair tuft at the lemma base. Photo from the project area.

***Caltha palustris* L.**	**VASCULAR PLANT**
	Conservation Rank: GS3 Habitat: Various wetlands, mostly boreal and temperate. In the project area, found only in estuaries. *Caltha palustris* is unlike any other plant in Nunavut. The combination of its large, yellow flowers, spiky fruit cluster, large size and rounded leaves with backward-pointing lobes (Porsild & Cody 1980) makes its identification easy. Photo from the project area.

***Carex lapponica* O. Lang**	**VASCULAR PLANT**
	Conservation Rank: GS2 Habitat: Various wetlands; boreo-arctic. Found in the project area in moist, mossy site at a cliff base near a lake shore. From similar *Carex* species, *C. lapponica* is distinguished based on its short, untoothed beak on the ascending, green or pale brown perigynia and somewhat widely spaced spikelets. *Carex brunnescens* is similar, but has wider-spreading perigynia and a slit-like suture over the perigynial back. *Carex mackenziei* has a more conspicuous male portion of the terminal spikelet (Toivonen 2002). Photo from the Northwest Territories.

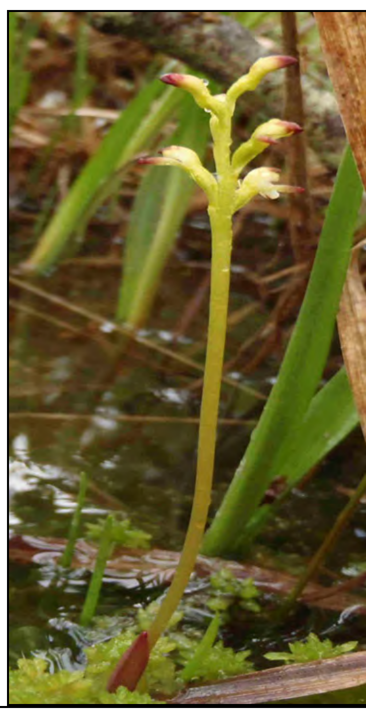
<table>
<tr><td colspan="2">Carex mackenziei V.I. Krecz. — VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: GS2</td></tr>
<tr><td>Habitat: Estuarine marshes and marine foreshores; arctic. Found in the project area only in estuary ecosystems and brackish marshes near marine shores.</td></tr>
<tr><td>This species may be confused with Carex lapponica, which by contrast probably never grows on saline soil, and which differs in having a short, inconspicuous male portion of the terminal floral spikelet (Toivonen 2002). The male portion of the spikelet appears conspicuous in C. lapponica, forming a narrow neck of tightly overlapping scales. Photo from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Carex microglochin ssp. microglochin Wahlenb. — VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: GS4, but appears to be rarer than that assessment suggests.</td></tr>
<tr><td>Habitat: Various calcareous and saline wetlands; arctic to temperate. In the project area, observed in brackish marshes near marine shores, and in estuarine marshes.</td></tr>
<tr><td>When seen in good condition with mature fruits, this species has no lookalikes in the project area. It is highly distinctive in the genus Carex for its backward-pointing, spine-like perigynia (fruit bracts), with a tongue-like rachilla (vestigial inflorescence stem) protruding beyond the perigynial mouth (Cochrane 2002). However, when the fruits drop, the plants may resemble Trichophorum, especially T. pumilum, a rare species not yet known from the project area. Photo from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Chrysosplenium rosendahlii Packer. VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked in Nunavut, but bears a National Rank of N2 (Imperiled).</td></tr>
<tr><td>Habitat: Moist tundra; arctic.</td></tr>
<tr><td>The PanArctic Flora gives three characters to distinguish this species from the similar C. tetrandrum: the occurrence of more than four stamens (mostly eight), the unequal size of sepals, and the larger seeds, 0.8-1.1 mm vs. 0.5-0.8 mm in C. tetrandrum (Elven et. al. 2012). Photo from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Collema ceraniscum Nyl. LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: S2S3</td></tr>
<tr><td>Habitat: On high-pH soil over cliffs or on the ground; arctic-alpine. Observed in the project area on seepy cliff ledges.</td></tr>
<tr><td>From other Collema species, C. ceraniscum differs in having a jet-black colour, coralloid lobes that grow densely, forming a dense cushion, small bowl-shaped apothecia. Species of the Lichinaceae may appear similar, but these have simple spores, while C. ceraniscum is muriform (with multiple cells divided by longitudinal and transverse cross-walls) (Goward et al. 1994). Photo from the project area.</td></tr>
</table>

Collema crispum (Hudson) F. H. Wigg.	**LICHEN**
	Conservation Rank: SU (due to previous uncertainty as to whether the species was correctly reported from Nunavut Habitat: On soil and rock, in high-pH environments; mostly boreo-temperate. *Collema crispum* was reported previously from Nunavut as an unverifiable record. From its closest lookalike *Collema* species, *C. crispum* differs in having chip-like rather than spherical or coral-formed isidia (asexual reproductive structures) (Goward et al. 1994). *Lempholemma polyanthes,* which grows in habitats similar to those of *C. crispum*, may sometimes appear similar. But when dry it has lobes and isidia of variable width, appearing in some parts inflated and in other parts deflated. Photo from British Columbia.

Corallorhiza trifida Châtel.	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank. Habitat: Mostly in forest understory, but also in brushy sites, meadows; mostly boreo-temperate. In the project area, found on mossy ground on slopes over Bathurst Inlet. No other plants within the project area shares this species' traits of pale colouration without strong green tones (lacking chlorophyll or nearly), lack of expanded leaf blades, tiny bisymmetrical flowers and pendent fruits (Porsild & Cody 1980). Photo from British Columbia.

Dasiphora fruticosa (L.) Rydb. — VASCULAR PLANT

Conservation Rank: GS3

Habitat: Riparian banks, tundra flats and along the high-tide mark of marine shores; mostly boreal. Found in the project area only among rocks above a small river near the shore of Bathurst Inlet.

This species has no close lookalikes in Nunavut. Though not widely accepted in North America, there is some precedent for recognizing North American and northern Siberian plants as ssp. *floribunda* a diploid with functionally unisexual flowers. More work remains before applying this taxonomy. Subspecies *fruticosa* is described as a tetraploid with bisexual flowers occurring in Europe and southern Siberia (Elven et. al. 2012). Photo from the project area.

Dicranella cf. subulata (Hedw.) Schimp. ("stikinensis" form?) — MOSS

Conservation Rank: Not ranked, a rare entity with no taxonomic status yet

Habitat: On seepy cliff ledges; arctic.

Like *D. subulata* in leaf shape, long basal leaf cells, presence of an annulus (ring of specialized cells at the mouth of the spore capsule that aid in spore dispersal), and differentiated vegetative and perichaetial leaves (leaves surrounding the sex organs). Differing in a yellowish-brown, not red-brown seta (stalk of the spore capsule), and an erect, more or less symmetrical, smooth capsule (Crum 2007). *Dicranella stikinensis*, long placed in synonymy under *D. subulata*, differs from *D. subulata* in ways similar to local plants. Herbarium research is needed in order to solve this problem, but clearly, the plants in question are not a species previously known from Nunavut. Photo of specimen from the project area.

<table>
<tr><td colspan="2">Draba arabisans Michx.   VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut</td></tr>
<tr><td>Habitat: Various open, mostly rocky habitats; mostly boreo-temperate. In the project area, found on sandy and cobbly beaches along Bathurst Inlet and Bathurst Lake.</td></tr>
<tr><td>Among the numerous Draba species in the project area, D. arabisans is most similar to D. glabella, from which it differs in having unstalked star-shaped hairs on the leaf faces, a lack of simple hairs on the stems, and longer styles (female reproductive structure on the top of the fruit) (Al-Shehbaz et al. 2010). Photo from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Draba crassifolia Graham   VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: GS3</td></tr>
<tr><td>Habitat: Meeadows and various rocky habitats; arctic-alpine. In the project area, found on rocky sites where snow persists late into the season.</td></tr>
<tr><td>This species is easily identified from all other Draba in Nunavut by the combination of short-lived habit, lack of sterile rosettes, nearly hairless leaves, and yellow flowers (Al-Shehbaz et al. 2010). Photo from the project area.</td></tr>
</table>

Eleocharis palustris s. lat. (L.) Roem. & Schult.

VASCULAR PLANT

Conservation Rank: GS2

Habitat: Various wetlands, often growing out of shallow water; the *E. palustris* complex is mostly boreo-temperate. In the project area, found in brackish marshes near marine shores.

We are reporting the observed populations as *E. palustris* sensu lato (s. lat., Latin for 'in the broad sense') though that species in its strict sense is not represented in the project area. Two distinct morphological forms were found during the surveys. One is likely *E. mamillata,* the other *E. ambigens*. The former has its tubercle (cone-shaped structure at the top of the fruit) taller than wide, and lowest two inflorescence scales devoid of fruits; the latter has a tubercle much wider than tall and lowest inflorescence scales containing fruits (Smith et al. 2002). We are confident in calling the former *E. mamillata,* but the latter is of such unlikely occurrence in Bathurst Inlet (nearest populations in Newfoundland), that we are reluctant to definitively report it as *E. ambigens* until herbarium studies can confirm its identity. Photos from the project area.

Encalypta brevicollis (Bruch & Schimp.) Ångstr

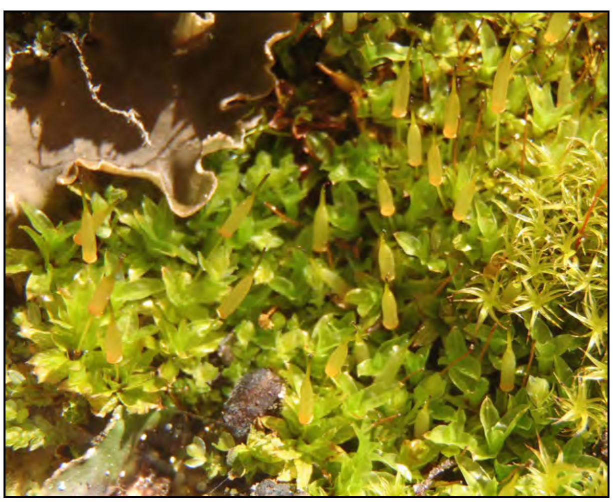
MOSS

Conservation Rank: GS2

Habitat: On soil over cliffs and rock outcrops in high-pH environments; boreo-arctic. Found in the project area on seepy cliff ledges.

This species differs from other arctic *Encalypta* by a suite of characteristics: leaves with a long hair-point, spore capsules with peristome teeth, and smoothly cylindrical (i.e., not ribbed). The common and widespread species *Encalypta rhaptocarpa* is very similar, but has a distinctly ribbed capsule, and the calyptra (sheath over the developing capsule) lacks a fringe of specialized cells (Magill 2007a). Photo from the Northwest Territories.

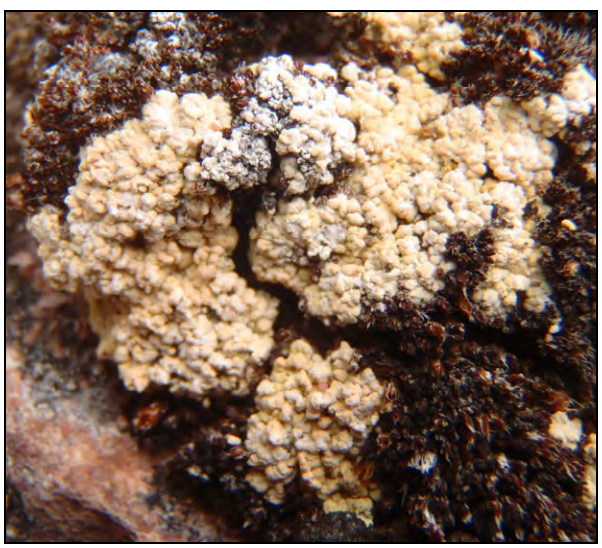
<table>
<tr><td colspan="2">Encalypta vittiana Horton MOSS</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut</td></tr>
<tr><td>Habitat: Thins soil over rock in high-pH habitats; arctic. Found in the project area on ledges of seepy cliffs.</td></tr>
<tr><td>This species is characterized by having leaves variably tipped in a short projection or hair-tip, a well formed ring of peristome teeth at the capsule mouth, a red-grooved, ribbed capsule wall, and calyptra with a fringe of short tassles formed by a ring of cells distinct in colour from the rest of the calyptra. It was not previously reported from Nunavut, and is otherwise known from few reports in Alaska, The Yukon, and the Northwest Territories (Magill 2007a). Photo of specimen from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Encalypta vulgaris Hedw MOSS</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut</td></tr>
<tr><td>Habitat: Thin soil over rock, in high-pH habitats; boreo-temperate. Found in the project area on ledges of seepy cliffs.</td></tr>
<tr><td>This species is characterized by having rather large leaves without a hair-tip, with the costa (leaf midrib) not reach the end of the leaf, no fringe of specialized cells at the base of the calyptra (sheath over the developing spore capsule), and capsules smooth or vaguely wrinkled (Magill 2007a). Photo from British Columbia.</td></tr>
</table>

<table>
<tr><td>Endocarpon pulvinatum Th. Fr.</td><td>LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: S1S3</td></tr>
<tr><td>Habitat: On calcareous rock; mostly boreo-temperate. Found in the project area on seepy basalt cliffs with nitrogen enrichment from guano.</td></tr>
<tr><td>Dermatocarpon species are larger with broadly expanded lobes. Staurothele areolata is fully crustose. Otherwise, no similar species occur in Nunavut. Easily recognized by the ascending, often branching lobes most of which are terminated by a single embedded perithecium (spherical, chamber-like spore-bearing structure) (Goward et al. 1994). Photo from the project area.</td></tr>
</table>

<table>
<tr><td>Epilobium davuricum Fisch. ex Hornem.</td><td>VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: GS4, but appears to be rarer than suggested by that rank</td></tr>
<tr><td>Habitat: Mossy ground, usually in and around wetlands; boreo-arctic. Found in the project area on mossy, brushy tundra on slopes over the shore of Bathurst Inlet.</td></tr>
<tr><td>Epilobium davuricum is similar to Epilobium arcticum, which also grows in the project area. Epilobium davuricum differs in its growth form, with leaves more clustered at the stem base, almost forming rosettes, and its more numerous but shorter leaves (Porsild & Cody 1980). Photo from British Columbia.</td></tr>
</table>

<table>
<tr><td>Erysimum coarctatum Fernald</td><td>VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut</td></tr>
<tr><td>Habitat: Various open, dry habitats; mostly boreo-temperate. In the project area found in sandy and gravelly sites along and near marine shores.</td></tr>
<tr><td>In Nunavut, this species was previously misreported as E. inconspicuum a species with smaller petals, narrower fruits and generally smaller seeds. The only other Erysimum species in Nunavut is E. pallasii, which has larger, purple petals (Al-Shehbaz 2010). Photo from the project area.</td></tr>
</table>

<table>
<tr><td>Fulgensia bracteata (Hoffm.) Räsänen</td><td>LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: SU</td></tr>
<tr><td>Habitat: On soil of slopes, cliff ledges and grassland, in high-pH habitats; mostly temperate. Found in the project area on ledges of a seepy cliff under influence of guano deposits.</td></tr>
<tr><td>Fulgensia fulgens differs in having distinctly elongated lobes and more frequent spore production (Gilbert 2009). Local Xanthoria and Caloplaca species have more intense yellow, orange or red pigmentation. Otherwise not likely to be confused with any other species in Nunavut. Photo from the project area.</td></tr>
</table>

Fuscopannaria sp. nov.	**LICHEN**
	Conservation Rank: Not ranked, a rare species new to science Habitat: Known only from a single collection on birch stem near ground level, near the shore of Bathurst Lake. The numerous species of *Fuscopannaria* in western North America are mostly found in temperate regions. Among species of the genus occurring in the arctic, this species differs in having long, narrow lobes, upturned lobe tips and narrow lobules. The combination of this growth form and the tan-grey pigmentation further distinguishes this species within the rest of the genus. Photo from the project area.

Galium trifidum **L.**	**VASCULAR PLANT**
	Conservation Rank: GS3 Habitat: In and around various wetland types; mostly boreo-temperate. In the project area found only in estuarine marsh habitat. Within the project area, this species is unmistakable its leaves in whorls of 4 to 6, the leaves having their widest point toward the end, and in having paired fruits (Porsild & Cody 1980). Photo from the project area.

Gentianella propinqua ssp. *arctophila* (Griseb.) Tzvelev	**VASCULAR PLANT**
	Conservation Rank: GS3
	Habitat: Various open, high-pH habitats; arctic. Found in the project area only on upper beach margins along marine shores.
	This subspecies, which is rare throughout its range, differs from *Gentianella tenella* in having more deeply coloured flowers with less widely spreading corolla lobe tips, and a rounder, less boxy-looking calyx (Elven et al. 2012). *Gentianella tenella* co-occurs with this species in the project area, and is easily differentiated in its pale bluish flowers with stiffly wide-spreading corolla lobes and in having the calyx lobes only loosely clapsing the corolla. Photo from the project area.

Gentianella tenella (Rottb.) Börner	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank
	Habitat: Various open habitats in high-pH environments; arctic-alpine. Found in the project area on beaches along marine shores, and on open "badland" slopes of old marine sediments along a creek.
	This species is easily differentiated from *G. propinqua*, which also grows in the project area, by its wide-spreading, pale bluish corolla lobes, and its calyx, which only loosely clasps the corolla. Additionally, the growth form of *G. tenella* is more diffuse, with more numerous branches from lower on the stem (Porsild & Cody 1980). Photo from the project area.

Gyalecta foveolaris (Ach.) Schaerer — LICHEN

Conservation Rank: Not ranked, but rare

Habitat: Limited to areas having high pH soils and constantly cool and humid microclimates (as in cliff recesses or near waterfalls); boreo-arctic. Found in the project area on the ledge of a cliff in a narrow canyon.

Gyalecta foveolaris differs from the similar-appearing *Ochrolechia gyalectina* in that it lacks soredia (powder-like asexual reproductive structures) and in having spores with internal cross-walls (Foucard 2001). Additionally, it is one of very few Arctic lichens containing the alga *Trentepohlia* as the photosynthetic partner in the lichen symbiosis (lichens are symbiotic organisms combining fungi and a photosynthetic alga or cyanobacteria). Photo of specimen from Nunavut.

Gyalecta friesii Flotow ex Körber — LICHEN

Conservation Rank: Not ranked, but rare

Habitat: On high-pH soils in humid, cool habitats; boreo-arctic.

This species is one of few arctic lichens containing *Trentepohlia* as the photosynthetic partner in the lichen symbiosis. It is differentiated from other *Gyalecta* species by its large apothecia that are green when wet and orange when dry and that are raised on a short peg (Foucard 2001). Its appearance is highly distinctive and unlikely to be confused with any other species. It has been observed in North America fewer than ten times. Photo from the project area.

Hippuris tetraphylla L. f.	**VASCULAR PLANT**
	Conservation Rank: GS3 Habitat: Occurs only near marine shores, where it occupies brackish pools and oxbows; boreo-arctic. Found in the project area in estuaries and brackish marshes near marine shores. *Hippuris vulgaris* is similar, but has narrower leaves that taper from the base. Additionally, its leaves are usually more numerous in each whorl (6-12 rather than 4-6) and its stems are less red (Porsild & Cody 1980). As observed by others, we found it to be variable, apparently intergrading with *H. vulgaris*, with which it often grows. However, *H. vulgaris* grows mostly in freshwater ecosystems and *H. tetraphylla* in brackish ones. Photo from the project area.

Hypogymnia dichroma Goward	**LICHEN**
	Conservation Rank: Not ranked, a rare species recently described new to science, now newly discovered for Nunavut Habitat: Mostly on trees, also on rock; mostly subalpine. In the project area found on sandstone outcrops near marine shores. This species was recently described new to science, split from *H. austerodes*, from which it differs in having its soredia arise not from isidia-like warts, but from the disintegration of the lobe cortex. Additional characteristics of *H. dichroma* are the two-toned colouration, brown around the thallus margins and pale grey within, and its preference for acidic, nutrient-poor habitats (Goward et al. 2012).

<table>
<tr><td colspan="2">Hypogymnia imshaugii Krog.   LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut.</td></tr>
<tr><td>Habitat: Usually on trees in open forest; temperate. In the project area, found on sandstone outcrop near marine shores.</td></tr>
<tr><td>Not only is Hypogymnia imshaugii not previously known to occur in the arctic, but the entire species complex to which it belongs was previously known only from the western North American Cordillera (Rocky Mountains and westward) (Goward et al. 1994). Non-sorediate forms of H. physodes may appear similar, but lack the gaping pores on the lobe tips of H. imshaugii, and have flatter, more appressed lobes. Non-sorediate forms of H. vittata may also be confused with this species, but have numerous small side-lobes and a lead grey colour.</td></tr>
</table>

<table>
<tr><td colspan="2">Juncus arcticus var. alaskanus
(Hultén) S.L. Welsh   VASCULAR PLANT</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: GS4, but appears to be rarer than suggested by that rank</td></tr>
<tr><td>Habitat: Shores of large rivers and lakes, and in marine shore habitats; boreo-arctic. In the project area found mostly along marine shores, but also in inland wetlands.</td></tr>
<tr><td>Distinguished from other Juncus species in the project area by its lack of leaves and its lateral inflorescence of relatively large flowers. It could not be confused with any other species in the project area, though it is possible J. balticus could be found in the area. That species differs in its smaller flowers with anthers about twice as long as the filaments (anther stalks) (Brooks & Clements 2000).</td></tr>
</table>

Kobresia sibirica **(Turcz. ex Ledeb.) Boeckeler** — VASCULAR PLANT

Conservation Rank: GS3

Habitat: On high-pH soil in tundra; arctic-alpine. Found in the project area on rocky tundra.

This species differs from other *Kobresia* species in North America by the larger perigynia and the larger scales that have a less prominent midvein (Ball 2002). Similar to several *Carex* species, but unlike species of that genus, *Kobresia* has incompletely fused perigynia (fruit bracts); those of *Carex* are bottle-like and those of *Kobresia* are like a wrapping. Photos of specimen from the Yukon (UBC).

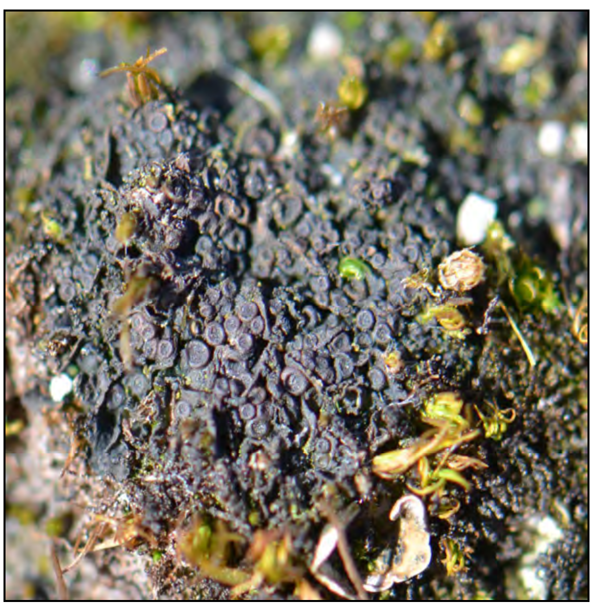
Leciophysma finmarkicum **Th. Fr.** — LICHEN

Conservation Rank: S2S3

Habitat: On mossy ground in tundra in high-pH environments; arctic-alpine. Found in the project area on moss and over sand, in both cases near lake shores.

Distinguished from other gel lichens by the presence of *Nostoc* as the photosynthetic symbiotic partner, its spherical black apothecia, its coralloid thallus, and its broadly elliptic, simple spores (Jørgensen 2007a). Photo from the project area.

***Leptogium imbricatum* P. M. Jørg.**	**LICHEN**
	Conservation Rank: Not ranked, newly discovered for Nunavut. Habitat: Over mosses or on soil in high-pH habitats; boreo-arctic. Found in the project area on ledges of seepy cliffs and on sand near marine shores. From all other *Leptogium* species in North America, *L. imbricatum* differs in having minute lobes that tend to overlap like shingles on a roof (Jørgensen 2007a). *Leptogium gelatinosum* may sometimes produce this shingle-like growth form, but that species is relatively reddish brown, glossier, and with at least a few of its lobes having raised ridges crossing over the lobe upper surface. Photo from the project area.

***Leptogium intermedium* (Arnold) Arnold**	**LICHEN**
	Conservation Rank: Not ranked, previously not known with confidence from Nunavut Habitat: On soil and over mosses in high-pH environments; mostly boreo-temperate. Found in the project area on cliff ledges. Similar in appearance to *L. gelatinosum*, *Leptogium intermedium* can be distinguished by having a flatter more foliose thallus and more frequent presence of apothecia (Jørgensen 2007a). In fact, highly characteristic of ground-dwelling (typical) forms of *L. intermedium* is the habit of covering most of the lobe surface with crowded small apothecia. This species accounts for most of the Nunavut records of what was previously called *Leptogium minutissimum*. Photo from the project area.

Leptogium tenuissimum (Dickson) Körber **LICHEN**

Conservation Rank: S2S3

Habitat: On soil and over mosses on high-pH ground. Found in the project area on ledges of seepy cliffs.

The apothecia (spore bearing plate-like structures) of this species are highly distinctive, being concave, sunken below the level of the thallus, and fringed with numerous lobules that give them the appearance of bird nests (Jørgensen 2007a). Photo from the project area.

Lichenomphalia hudsoniana (L: Fr.) Redhead et al. **LICHEN**

Conservation Rank: S1S2

Habitat: On soil or mosses over rock or soil; arctic-alpine. Found in the project on a ledge of a seepy cliff.

Lichenomphalia is one of few lichen genera having a basidiomycete fungal symbiotic partner. Basidiomycetes are the mushroom-forming fungi. The lichenized thallus of this species occurs as a diffuse patch of flat or bowl-shaped squamules (chips) with a light green upper surface and white outline. No other species of lichen is similar. Photo from the project area.

Lobaria scrobiculata (Scop.) DC . LICHEN

Conservation Rank: S1

Habitat: Usually on trees, less often on rock, in humid areas; boreo-temperate. Found in the project area only on sandstone on an outcrop and in a narrow canyon.

Lobaria scrobiculata is extremely rare in the Canadian Arctic. In Nunavut it was previously known only from a single site on Baffin Island (Thomson 1984). Most occurrences of this species are in mild, oceanic climates or humid sub-boreal forest. It has no close lookalikes in Nunavut, differing from all other lichens in the territory in the combination of its velvety upper and lower surfaces, creamy yellowish to light gray-purple colouration, its patches of soredia (asexual reproductive structures), and in having a cyanobacterium as the photosynthetic lichen partner rather than a green alga (Goward et al. 1994). Photo from the project area.

Lomatogonium rotatum (L.) Fr. ex Fernald VASCULAR PLANT

Conservation Rank: GS3

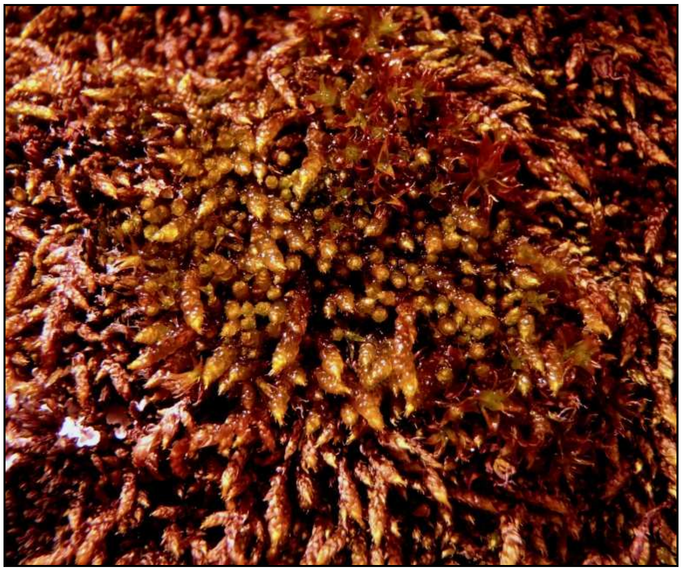
Habitat: Various open habitats on high-pH soil. Found in the project area on sandy beaches and on slopes of old marine sediments.

No similar species occurs in the project area. Unlike the other members of the Gentian family observed in the project area, *Lomatogonium* has its flowers widely open rather than tube-like or funnel-shaped (Porsild & Cody 1980). Photo from the project area.

Luzula groenlandica **Böcher**	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank
	Habitat: Shorelines and tundra; mostly arctic. In the project area, found on sand at upper beach margins along marine shores and along the shore of Bathurst Lake.
	This species is most similar to *Luzula arctica*. From that species it differs most strikingly in having a short, stiff bract that protrudes outward at a broad angle from the base of the inflorescence (Swab 2000). *Luzula multiflora* ssp. *frigida* is also similar, but has a more open, diffuse inflorescence. The common, widespread species *Luzula confusa* differs in having narrower, channeled leaves. Photo from the project area.

Montia fontana **L.**	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank
	Habitat: Various open, moist or seasonally moist habitats;
	This is one of few annual plants in the arctic. It is identifiable as an annual in that it has a weak root system and small, delicate growth form. The only other broad-leaf annual in the project area having a low, spreading growth form is *Koenigia islandica*, which differs in having shorter, deep-red leaves and five distinct sepals rather than 2 indistinct sepals. Photo from the project area.

Myrinia pulvinata (Wahl.) Schimp **MOSS**



Conservation Rank: Not ranked, newly discovered for Nunavut.

Habitat: Over rocks and tree bases near water; mostly boreo-arctic. In the project area, found on sandstone outcrop.

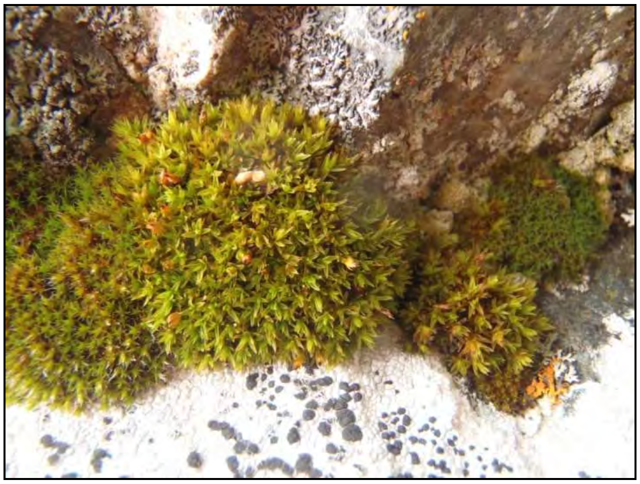
From those similar moss species *M. pulvinata* differs in having a single short costa (leaf midrib), smooth leaf surface, and a large, well formed, paler green leaf bud at the branch and stem tips (Majestyk 2008). Local plants may be atypical in having leaves abruptly tapered to a sharply pointed tip, and its occurrence on a rock outcrop well above shore. Photo of specimen from the project area.

Nephroma parile (Ach) Ach. **LICHEN**

Conservation Rank: S1S2

Habitat: Over and among mosses or on bark or rock; mostly boreo-temperate. In the project area, found on a mossy cliff ledge.

No close look-alikes occur in Nunavut. Sun-burned, brown forms of *Parmelia spp*. may look similar at first glance, but are easily distinguished by their glossy lobes. *Peltigera* species may be similar, but have distinct veins on the lower surface (Goward et al. 1994). Photo from British Columbia.

Orthotrichum anomalum Hedw	**MOSS**
	Conservation Rank: Not ranked, newly discovered for Nunavut. Habitat: On high-pH rock in open habitats; mostly temperate. In the project area, it grows on high-pH rock, or on rocks that are modified by high-pH seepage. In the project area, this species was observed in mixed populations with the somewhat similar species *O. pylaisii*. From that species it differs in having leaves more laxly spreading when dry, its capsules exerted farther past the leaf tips and its stomates (breathing pores) on the capsule wall embedded in pits rather than held at the capsule surface. Most distinctive are the eight long ribs alternating with eight short ribs on the capsules (Vitt 2012). Photo from Nunavut (near the project area).

Oxytropis deflexa (Pall.) DC	**VASCULAR PLANT**
	Conservation Rank: GS3 Habitat: Various open or lightly vegetated habitats, mostly in grassland; mostly boreal. Other *Oxytropis* species do not have leaves on their stems, only at the base of the plant (Porsild & Cody 1980). *Astragalus* species differ in having their flower keel (two fused lower petals) lacking a recurved tooth. In the absence of flowers, similar-appearing *Astragalus* species in the project area can be distinguished from *O. deflexa* by their green leaves with more widely spaced leaflets and taller, leafier stems. Photo from the project area.

Petasites sagittatus (Banks ex Pursh) A. Gray	VASCULAR PLANT
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank Habitat: In and near wetlands; mostly boreal. In the project area found on seepy, mossy slopes and near lake shores. This species is unmistakable in the project area, no other plant in the region having such large, toothed, arrow-shaped leaves (Porsild & Cody 1980). Photo from the project area.

Physconia perisidiosa (Erichsen) Moberg	LICHEN
	Conservation Rank: Not ranked, newly discovered for Nunavut. Habitat: Various nutrient-rich habitats, on bark or rock, over over moss; mostly temperate. In the project area, it was found on seepage-modified cliff ledges. From *P. muscigena*, *P. perisidiosa* differs in its colouration: upper surface reddish brown and lobes white-frosted with a dusting of pruina (minute crystals) at the tips. Also, it differs from that species in producing granular soredia (Goward et al. 1994). Photo from British Columbia.

Placynthium flabellosum (Tuck.) Zahlbr. — LICHEN

Conservation Rank: Not ranked, newly discovered for Nunavut

Habitat: On moderately high-pH rocks along water courses and lake shores; mostly boreal. In the project area, observed on rocks along shores.

This species differs from other Nunavut cyanolichens in having *Scytonema* as the photosynthetic partner, blue pigments in its lower tissue layers, marginal lobes smooth, elongated and wedge-shaped, and in having flattened isidia over the upper surface (Jørgensen 2007b). Other *Placynthium* species in the project area lack the broadly expanded marginal lobes of *P. flabellosum*. Photo from the project area.

Placynthium pulvinatum Øvstedal — LICHEN

Conservation Rank: Not ranked, newly discovered for Nunavut and Canada.

Habitat: On soil in tundra; mostly arctic-alpine. Found in the project area on ledges of seepy cliffs.

This species is a standout morphologically among Nunavut lichens. It differs from all other *Placynthium* species by its growth form: thick heaps of tiny, worm-shaped lobes over a thick, spongy underlayer formed by bluish-pigmented fungal hyphae, and by its habitat: soil dwelling rather than rock-dwelling (Jørgensen 2007b). Photo from the project area.

Plantago canescens Adams — VASCULAR PLANT

Conservation Rank: GS3

Habitat: Brackish and calcareous wetlands; mostly boreal. Found in the project area on sandy and gravelly beaches and sandy benches near marine shores.

Plantago canescens is a highly distinctive plant within the project flora, not likely to be confused with anything else owing to its distinctive whisker-like leaf hairs, its spike of inconspicuous brownish flowers and its habitat (Porsild & Cody 1980). Photo from the project area.

Pohlia crudoides (Sull. & Lesq.) Broth. — MOSS

Conservation Rank: Not ranked, but rare.

Habitat: Over soil on and around cliffs; boreo-arctic. Found in the project area on ledges of seepy cliffs.

This highly distinctive *Pohlia* is one of few species in its genus having leaf margins curled under. It is also distinct in having long, ribbon-like, glossy leaves and a thick, prominent costa (leaf mid-rib) (Shaw 2009). Photos of specimen from the Northwest Territories. The left photo shows a mid-portion of a leaf, with the down-curled leaf margins and thick costa.

Pohlia proligera (Kindb.) S.O. Lindb. ex Arnell	**MOSS**
	Conservation Rank: GS3 Habitat: On soil where naturally and lightly disturbed; boreo-temperate. Found in the project area on semi-stable sand near marine shoreline. This species is identified on the basis of its elongate stems, shiny leaves, narrow leaf cells, lack of a distinct leaf border, and the presence of gemmae (asexual reproductive structures) at the leaf attachment points. The gemmae are very thin and have the appearance of being twisted. The initial leaves growing from the gemmae are peg-like, formed of only a few cells (Shaw 1981). Photo of specimen from the project area.

Polychidium muscicola (Sw.) Gray	**LICHEN**
	Conservation Rank: S1S2 Habitat: Found growing on cliff ledges, nestled among mosses and other lichens; mostly temperate. Found in the project area on ledges of seepy cliff. This small gelatinous lichen has few look-alikes in Nunavut. Forms of *Leptogium tenuissimum* with unusually narrow lobes may appear similar, that the apothecia (plate-like spore bearing structures) have a fringe of lobules around the margins, and are sunken down in “nests” of lobes. Its small size and habit of growing inconspicuously among other species may mean that it is more widespread than previously thought. More field inventory is needed to confirm its rare status. Photo from British Columbia.

Potentilla cf. litoralis **Rydb.**	**VASCULAR PLANT**
	Conservation Rank: Not ranked, possibly a new species Habitat: Typical *P. litoralis* grows in grassland and dry meadows; boreo-temperate. In the project area, found on upper beach margins and sandy/gravelly flats. *Potentilla litoralis* in its strict sense has leaves green on both sides or greyish below, and a more congested inflorescence. Compared with that species, plants from the project area have the leaf lower surface whitish with dense tomentum, and the inflorescence is diffuse and large. *Potentilla bimundorum* has leafier, often sprawling stems and leaves more distinctly pinnate (Ertter et al. 2008). Photo from the project area.

Primula stricta **Hornem.**	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank Habitat: Marine shores and near-marine wetlands. Other small-flowered *Primula* species occur in the vicinity of the Project area. *Primula egaliksensis* differs in having leaves abruptly narrowed into the leaf stalk. *Primula mistassinica* has calyx lobes lacking sack-like bases. Both of those other species grow in inland, not marine habitats (Kelso 2009). Previous floras have confused these species. Their ranges and abundances require reassessment.

Protopannaria pezizoides (Weber) P.M. Jørg. & S. Ekman — LICHEN

Conservation Rank: S2S3

Habitat: Over mosses on the ground, also on wood, rarely on bark; mostly boreo-temperate. In the project area found over moss on ledges of seepy cliffs.

This species is distinguished from *Psoroma* by the more distinctly scalloped apothecial rim, the absence of green algae as a photosynthetic symbiotic partner, and by the structure of the ascus (microscopic spore-bearing structure) (Jørgensen 2007c). *Protopannaria* sp. nov. differs in having longer, paler thallus lobes with whitish markings at the tips, more lobe-like thalline beads along the apothecial margins, and smaller spores. Photo from British Columbia.

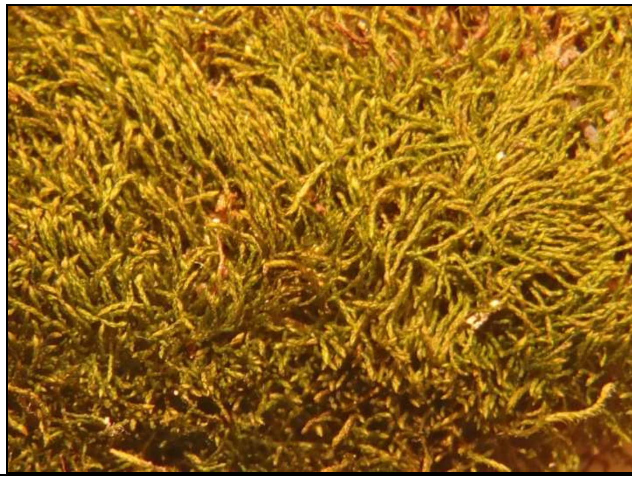
Protopannaria sp. nov. — LICHEN

Conservation Rank: Not ranked, a rare species new to science

Habitat: Grows on soil cut banks and over detritus on seepy cliff ledges.

Protopannaria sp. nov. is currently known only from the vicinity of Bathurst Inlet and George Camp. It differs from *P. pezizoides* in having a paler thallus, white markings at the lobe tips, longer thallus lobes, apothecial rims with a fringe of longer lobes, and smaller spore size. More work is needed to confirm that its characteristics are consistently different from *P. pezizoides* and all other species. Photo from the project area.

Pseudoleskeella tectorum (Funck ex Brid.) Broth **MOSS**



Conservation Rank: GS2

Habitat: Growing over boulders and cliffs in shaded or sheltered, high-pH habitats; mostly boreo-temperate. Found in the project area on basalt cliffs with nitrogen enrichment from guano.

Similar to *Pterigynandrum filiforme*, but darker green, with stems not cascading downward, and with less sharply papillose leaf cells (Lawton 1971). Photo from specimen from the project area.

Psilopilum cavifolium (Wilson) I. Hagen **MOSS**

Conservation Rank: GS3

Habitat: On stabilizing, naturally disturbed soil, as on frost boils or soil creep over cliff tops; arctic-alpine. Found in the project area in habitats described for the species.

A very distinctive species that could only be confused with *Psilopilum laevigatum*. That species differs in having leaves lacking teeth along the margins and more tightly appressed to the stem wether wet or dry, and in their shorter spore capsules (Smith-Merrill 2007). Photo from British Columbia.

***Psilopilum laevigatum* (Wahlenb.) Lindb.**	**MOSS**
	Conservation Rank: Not ranked, but appears to be rare Habitat: On stabilizing, naturally disturbed soil; arctic-alpine. Differs from *Psilopilum cavifolium* by its leaves being clasped tightly to the stem in both wet and dry condition, and by the shorter, swollen looking spore capsules (Smith-Merrill 2007). Photo from the Northwest Territories.

***Psoroma tenue* var. *boreale* Henssen**	**LICHEN**
	Conservation Rank: Not ranked, newly discovered for Nunavut Habitat: Over soil in open tundra; arctic-alpine. Similar to *Psoroma hypnorum*, but with smaller, more elongated thallus lobes with a cinnamon-brown rather than green colour, and smaller spores. Also similar to *Protopannaria pezizoides*, but that species has more distinctly scalloped inner margins of the apothecial rim, a different photosynthetic partner, and various technical differences (Jørgensen 2007c). Photo from British Columbia.

Pterigynandrum filiforme Hedw. — MOSS

Conservation Rank: Not ranked, newly discovered for Nunavut

Habitat: Over boulders and cliffs in semi-shaded habitats; mostly boreo-temperate. In the project area found on sheltered rock faces in a narrow canyon.

This distinctive species is easily recognized in the field by its string-like stems cascading down together in sheets clinging tightly to rock faces. Additionally, the back side of the leaves is rough in texture due to the distinctive prorate leaf cells, with their upper ends poking up off the leaf plane, as if each cell is escaping from its position in the leaf (Lawton 1971). Photo from British Columbia.

Puccinellia sp. nov. — VASCULAR PLANT

Conservation Rank: Not ranked, a rare species new to science

Habitat: On saline clay near marine shores.

Closest at first glance is *P. nuttalliana*, a similarly tall species that grows in inland, not marine habitats in a large swathe of the boreal and temperate zones. That species differs in having stiffer, less nodding inflorescences, longer spikelets, longer lemmas, and a lack of purple pigmentation. Technically similar is *P. distans*, a much smaller species with relatively stiff inflorescence branches, the lowest of which usually are reflexed backward at a broad angle. We are not aware of occurrences of this species from outside the project area. Herbarium research is needed to verify the need to raise it as a new species, and to detect any overlooked specimens of it. Photo from the project area.

<table>
<tr><td colspan="2">Pycnothelia papillaria Dufour   LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut.</td></tr>
<tr><td>Habitat: On soil over rock and on the ground; mostly temperate to tropical. In the project area, found on thin, loamy soil over cliffs and rock outcrops, where slightly seepy during snowmelt and rain.</td></tr>
<tr><td>Pycnothelia papillaria is characterized by its hollow, globose to columnar stems, each topped by a dark brown dot, which is an asexual spore-bearing structure (Pycnidium). It has no close lookalikes in Nunavut. Photo from the project area.</td></tr>
</table>

<table>
<tr><td colspan="2">Ramalina intermedia (Delise ex Nyl.) Nyl.   LICHEN</td></tr>
<tr><td rowspan="3"></td><td>Conservation Rank: Not ranked, newly discovered for Nunavut.</td></tr>
<tr><td>Habitat: More or less vertical rock surfaces, especially where enriched with nitrogen from guano and where sheltered from direct rain-splash; mostly boreal. Found in the project area on a sheltered cliff face.</td></tr>
<tr><td>This species differs from other Ramalina species in Nunavut in having, ribbon like lobes that in terminal branches become thread-like. The lobes are tipped with bundles of soredia (dust-like asexual reproductive structures). Soredia may also occur in bundles at the lobe margins. Ramalina almquistii may appear similar, but that species lacks soredia, has perforated lobes, and does not tend to grow on vertical surfaces of rocks (Thomson 1984). Photo from the project area.</td></tr>
</table>

Ranunculus pallasii Schltdl.	**VASCULAR PLANT**
	Conservation Rank: GS3 Habitat: Usually found on brackish mud near marine shores, rare inland; arctic. Found in the project area on sparsely vegetated muddy shore of a small lake. This highly distinctive species has no look-alikes in Nunavut. Its thick, leathery, paddle-shaped leaves, often with three teeth near the tip, are unlike all other plants in the region. Also distinctive are the creeping habit and flowers with numerous white petals, and the mud-dwelling habitat (Porsild & Cody 1980). Photo from the project area.

Salix ovalifolia Trautv.	**VASCULAR PLANT**
	Conservation Rank: Not ranked, newly discovered for Nunavut. Habitat: Various wetlands and mossy tundra, especially near marine shores; arctic. Found in the project in an estuarine marsh and in tundra wetlands. This species is distinguished based on its low-growing, but not dwarf growth form, with stems mostly 20-30 cm tall. Its leaves are hairless, broadly ovate to broadly elliptical, with a blunt to rounded apex, a reticulated and glossy upper surface and a whitish waxy coating on the lower side, and they are held on short petioles with only inconspicuous stipules at the base. The branches are yellow-brown and hairless. The fruits also are hairless (Argus 2010). Photo from the project area.

***Salix* sp. 1 (eskers)**	**VASCULAR PLANT**
	Conservation Rank: Not ranked, a rare species new to science Habitat: On gravel of esker tops. This apparently undescribed, previously unknown willow is similar to *S. sphenophylla* in having catkins from lateral buds, leaves reddish, especially when young, relatively long catkins, and gradually tapering, hairy ovary. *Salix* sp. 1 differs in its brown to red-brown branches (as opposed to brown to yellow-brown), its consistently evenly hairy ovaries, and its more eastern range. Additionally, its styles are shorter than those of *S. sphenophylla*. Photo from the project area.

***Sarmentypnum trichophyllum* (Warnstorf) Hedenäs**	**MOSS**
	Conservation Rank: Not ranked, but rare in Nunavut Habitat: Submerged in shallow water of lake and pond shores; arctic. Found in the project area in like habitat. This aquatic moss is striking in its extremely long-tapered leaves with a reddish colouration. It is further distinguished by its thin costa (leaf midrib) that extends from the base to past the tip of the leaf blade, forming a thread-like tip (Hedenäs 2008). Photo of specimen from the Northwest Territories.

Seligeria sp. nov.	**MOSS**
	Conservation Rank: Not ranked, a rare species new to science Habitat: Found on ledges of seepy cliffs. This species identifies somewhat with *S. polaris*, having capsules wine-glass shaped, a ring of 16 well formed peristome teeth at the capsule mouth (though these are quickly deciduous), and a seta about 2-3 mm long. However, it differs consistently from that species in having smaller spores (16-19 microns at their widest), leaves more erect and appressed together when dry, and additionally its setae are frequently curved. It shares this latter character with *S. recurvata*, but the spores of that species are only 8-10 microns wide (Vitt 2007). Photo of specimen from the project area.

Siphula ceratites **(Wahlenb.) Fr.**	**LICHEN**
	Conservation Rank: S1S2 Habitat: In shallow pools in tundra or forest clearings; boreo-arctic. Found in the project area growing over liverworts in shallow pools where periodically flooded. This unmistakable species is distinguished by its blunt-tipped, chalky, white stems with a solid centre and often a grooved outer surface. *Thamnolia vermicularis* may appear similar, but that species has tapered stem tips, a hollow stem centre, usually smooth, not grooved outer surface, and grows in drier habitats (Goward 1999). Photo from the project area.

Solorina octospora (Arn.) Arn.	**LICHEN**
	Conservation Rank: S1S2
	Habitat: On high-pH soils; boreo-arctic. Found in the project area on soil near marine shore and on ledges of seepy cliffs.
	This odd looking species is rather easily recognized by its rosette-forming thallus and 'stretched' looking apothecia. Solorina saccata may appear similar, but is thinner lobed, less distinctly rosette-forming, and with less deeply sunken apothecia that are usually round rather than appearing stretched (Goward et al. 1994). Photo from the project area.

Sphagnum platyphyllum (Lindb.) Warnst.	**MOSS**
	Conservation Rank: Not ranked, newly discovered for Nunavut
	Habitat: In fens and along lake shores, especially common in flarks (moats of more or less open water surrounding many fens); Mostly boreo-temperate.
	This species is unusual among *Sphagnum* species in having its stem and branch leaves similar in morphology. It is also distinguished based on its having a small capitulum (terminal "head" of young branches), widely spaced branches, and overall a lax and messy growth form (Laine et al. 2009). Photo of specimen from the project area.

Splachum sphaericum Hedw. — MOSS

Conservation Rank: GS2

Habitat: On concentrations of nitrogen in cool, humid habitats; mostly boreal. Found in the project area on decaying animal waste in mossy tundra.

From other species of the Splachnaceae in Nunavut, this species is distinguished by its broad leaf shape and its nearly globose and dark-coloured apophysis (appendix at the top of the stalk just below the spore capsule) (Marino 2009). Photo from a nearby area of Nunavut.

Stuckenia filiformis ssp. *alpina* (Blytt) Haynes, Les & M. Král — VASCULAR PLANT

Conservation Rank: GS3

Habitat: Growing as a submerged or floating aquatic in shallow water of lakes, ponds and slow-flowing streams; arctic to temperate. Found in the project area in shallow, brackish pools near marine shores.

This species is differentiated from other *Stuckenia* and similarly narrow-leaved *Potamogeton* by the combination of having its stipules (flap-like appendages at the leaf base) fused to the leaf along 2/3 or more of its length, as well as by its blunt leaf tips, and fruits 2-3 mm wide and lacking a beak (Haynes & Hellquist 2000a). From other subspecies of *S. filiformis*, ssp. *alpina* differs in its small size and relatively crowded fruits. Photo from the project area.

***Suaeda calceoliformis* (Hook.) Moq.** **VASCULAR PLANT**

Conservation Rank: GS3

Habitat: Saline mud-flats and playas; mostly temperate. Found in the project area only in sparsely vegetated, brackish mudflats in estuaries.

This species is easily distinguished from all other species in Nunavut based on its saline mud habitat, succulent, purplish red leaves and flower parts having an appearance similar to that of the leaves. In the temperate zone, all populations known to us have erect stems, unlike the consistently prostrate stems of plants in the project area. Further work is needed to determine whether these morphologically odd Arctic populations may represent a different, perhaps undescribed species. Photo from the project area.

***Symphyotrichum pygmaeum* (Lindl.) Brouil. & Sellia** **VASCULAR PLANT**

Conservation Rank: GS4, but this is a rare and regionally endemic species thought to be globally rare

Habitat: Marine habitats; arctic. Found in the project area among sedges and grasses in estuaries and beaches.

This species is unmistakable among the plants of Nunavut. No other aster-like plant in the Southern Arctic has long, broad, lavender ray florets, leafy, often branched stems and a shaggy pubescence (Porsild & Cody 1980). Photo from the project area.

Triglochin palustris L.	**VASCULAR PLANT**
	Conservation Rank: GS4, but appears to be rarer than suggested by that rank
	Habitat: Strongly calcareous or sometimes saline wetlands; mostly boreal. Found in the project area in estuarine foreshores and saline mud-flats.
	No species is similar to *T. palustris*. Its fruits are particularly distinctive in the way that they split open from the base upward, with the resultant segments sharply pointed like spears. *Triglochin maritima* co-occurs in the project area. It differs in having blunt, not sharply pointed fruit segments, thicker leaves and stems, and an overall larger size (Haynes & Hellquist 2000b). Photo from the project area.

Utricularia intermedia Hayne	**VASCULAR PLANT**
	Conservation Rank: GS3
	Habitat: Open water in lakes, ponds and open-water portions of fens; mostly boreal. Found in the project area in small pools in estuaries and other brackish waters near marine shores.
	U. intermedia can be distinguished from similar species of *Utricularia* by the combination of bristle tipped leaf segments and by having its bladders (complex traps on the leaves that capture and digest invertebrates) on thin, pallid, leafless stems (Porsild & Cody 1980). Photos from the project area.

Utricularia macrorhiza LeConte	**VASCULAR PLANT**
	Conservation Rank: GS5 (status uncertain), but appears to be rare in Nunavut
	Habitat: Open water of lakes, ponds and streams; mostly boreo-temperate. Found in the project area in open water of a pond.
	From *Utricularia intermedia,* this species can be distinguished by its overall larger size, its intermixed leaves and bladders (specialized traps that capture and digest invertebrates), and its larger flowers that are compressed laterally (inward from the sides) (Porsild & Cody 1980). Photo from Washington State.

Woodsia alpina (Bolton) S.F. Gray	**VASCULAR PLANT**
	Conservation Rank: GS3
	Habitat: On ledges and in crevices of cliffs, and on talus; boreo-arctic. Observed in the project area on talus.
	This species is of hybrid origin of *Woodsia glabella* x *W. ilvensis*, and combines the traits of those two species in intermediate states. Its leaves are moderately hairy , in contrast to the glabrous *W. glabella* and densely hairy *W. ilvensis*, and the pinnae are moderately divided, more so than *W. glabella,* and less so than *W. ilvensis* (Lellinger 1985). Photo from the project area.

Xanthoparmelia wyomingica (Gyelnik) Hale sensu lato	LICHEN
	Conservation Rank: Not ranked, newly discovered for Nunavut Habitat: Various open, rocky or sandy sites, locally limited to esker tops; mostly temperate. Observed in the project area only on gravelly esker tops. This species is characterized by being semi-vagrant, that is, it starts out growing attached to rocks, but later grows ascending, easily detaching lobes that may tumble in the wind to new habitat, but almost always with at least a small pebble caught up in the tumbling mass. Fully vagrant species are never attached to a substrate, pebbles or otherwise. Other semi-vagrant species in North America differ in having a whitish-mottled upper cortex or different chemical compounds (Hale 1990). Photo from the project area.

Appendix 1-B. Nomenclatural list of all plant and lichen species observed in the project area

Algae

Trentepohlia cf. aurea (L.) Martius

Liverworts

Anastrophyllum minutum (Schreb.) R.M. Schust.
Aneura pinguis (L.) Dumort.
Anthelia juratzkana Limpr.
Asterella cf. gracilis (F. Weber) Underw.
Blepharostoma trichophyllum (L.) Dum.
Cephaloziella arctica Bryhn & Douin
Cephaloziella divaricata var. scabra M. Howe
Diplophyllum taxifolium (Wahlenb.) Dumort.
Gymnocolea acutiloba K. Müller
Gymnomitrion concinnatum (Lightf.) Corda
Gymnomitrion corallioides Nees
Lophozia groenlandica (Gottsche, Lindenb. & Nees) Macoun
Lophozia wenzelii (Nees) Stephani
Marchantia alpina Myrin ex Hartm.
Marchantia polymorpha L.
Marsupella arctica (Berggr.) Bryhn & Kaal.
Marsupella emarginata (Ehrh.) Dumort.
Mesoptychia sahlbergii (Lindb. & Arnell) A. Evans
Moerckia sp.
Nardia scalaris (Schrad.) Gray
Odontoschisma elongatum (Lindb.) A. Evans
Odontoschisma macounii (Austin) Underw.
Pleurocladula albescens (Hook.) Grolle
Preissia quadrata (Scop.) Nees
Ptilidium ciliare (L.) Hampe
Radula complanata (L.) Dumort.
Scapania hyperborea Jörg.
Scapania invisa R.M. Schust.
Scapania paludicola Loeske & K. Müller
Scapania paludosa (K. Müller) K. Müller
Schistochilopsis incisa (Schrad.) Konstant.

(continued)

Liverworts (completed)

Schistochilopsis opacifolia (Kulm) Konstantinova
Tetralophozia setiformis (Ehrh.) Schlj.
Tritomaria polita (Nees) Jörg. ssp. polita
Tritomaria polita ssp. polymorpha R.M. Schust.
Tritomaria quinquedentata (Huds.) H. Buch

Lichens

Acarospora glaucocarpa (Ach.) Körber
Acarospora molybdina (Wahlenb.) Trevisan
Acarospora sinopica (Wahlenb.) Körber
Agonimia tristicula (Nyl.) Zahlbr.
Alectoria ochroleuca (Hoffm.) A. Massal.
Allantoparmelia almquistii (Vainio) Essl.
Allantoparmelia alpicola (Th. Fr.) Essl.
Allantoparmelia cf sibirica (Zahlbr.) Essl.
Amygdalaria panaeola (Ach.) Hertel & Brodo
Anaptychia bryorum Poelt?
Arctomia? Unknown gel genus
Arctoparmelia centrifuga (L.) Hale
Arctoparmelia incurva (Pers.) Hale
Arctoparmelia separata (Th. Fr.) Hale
Arthonia mediella Nyl.
Arthonia unknown (saxicolous, aeruginose upper hymenium, spores 3-septate)
Arthonia varia (Ach.) Nyl.
Arthrorhaphis alpina (Schaerer) R. Sant.
Arthrorhaphis citrinella (Ach.) Poelt
Asahinea chrysantha (Tuck.) W. L. Culb.. & C. F. Culb.
Asahinea scholanderi (Llano) W. L. Culb.. & C. F. Culb.
Aspicilia simoensis? Rasanen
Aspicilia verrucosa (Ach.) Körb.
Atla alpina Savic & Tibell
Bacidia bagliettoana (A. Massal. & De Not.) Jatta
Baeomyces placophyllus Ach.
Bellemerea subsorediza (Lynge) R. Sant.
Biatora cuprea (Sommerf.) Fr.
Biatora efflorescens (Hedl.) Räsänen
Biatora pallens (Kullhem) Printzen
Biatora subduplex (Nyl.) Printzen
Brodoa oroarctica (Krog) Goward

(continued)

Lichens (continued)

Bryocaulon divergens (Ach.) Kärnefelt
Bryonora castanea (Hepp) Poelt
Bryonora pruinosa (Th. Fr.) Holtan-Hartwig
Bryonora rhypariza (Nyl.) Poelt
Bryoria chalybeiformis (L.) Brodo & D. Hawksw.
Bryoria nitidula (Th. Fr.) Brodo & D. Hawksw.
Bryoria simplicior (Vainio) Brodo & D. Hawksw.
Bryoria tenuis (E. Dahl) Brodo & D. Hawksw.
Buellia aethalea (Ach.) Th. Fr.
Buellia alboatra (Hoffm.) Th. Fr.
Buellia badia (Fr.) A. Massal.
Buellia punctata (Hoffm.) A. Massal.
Buellia terricola A. Nordin
Calopalca cf decipiens (Arnold) Blomb. & Forssell
Caloplaca (unknown, similar to Protoblastenia)
Caloplaca ammiospila (Wahlenb.) H. Olivier
Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr.
Caloplaca chrysodeta (Vainio ex Räsänen) Dombr.
Caloplaca citrina (Hoffm.) Th. Fr.
Caloplaca erichansenii S.Y. Kondr., A. Thell, Kärnefelt & Elix
Caloplaca ferruginea (Hudson) Th. Fr.
Caloplaca flavorubescens (Hudson) J. R. Laundon
Caloplaca holocarpa (Hoffm. ex Ach.) A. E. Wade
Caloplaca jungermanniae (Vahl) Th. Fr.
Caloplaca livida (Hepp) Jatta
Caloplaca saxicola (Hoffm.) Nordin
Caloplaca scopularis (Nyl.) Lettau
Caloplaca sinapisperma (Lam. & DC.) Maheu & A. Gillet
Caloplaca tetraspora (Nyl.) H. Olivier
Caloplaca tirolensis? Zahlbr. (too red)
Caloplaca trachyphylla (Tuck.) Zahlbr.
Calvitimela armeniaca (DC.) Hafellner
Calvitimela talayana (Haugan & Timdal) Andreev
Candelariella aurella (Hoffm.) Zahlbr.
Candelariella canadensis H. Magn.
Candelariella kuusamoensis Räsänen
Candelariella reflexa (Nyl.) Lettau
Candelariella rosulans (Müll. Arg.) Zahlbr.
Candelariella vitellina (Hoffm.) Müll. Arg.
Catapyrenium cinereum (Pers.) Körber

(continued)

Lichens (continued)

Catapyrenium daedaleum (Kremp.) Stein
Cetraria andrejevii Oxner
Cetraria delisei Bory ex Schaer.
Cetraria ericetorum Opiz ssp. ericetorum
Cetraria fastigiata Delise ex Nyl.
Cetraria hepatizon (Ach.) Vain.
Cetraria islandica (L.) Ach. ssp. islandica
Cetraria islandica ssp. crispiformis (Räsänen) Kärnefelt
Cetraria laevigata Rass.
Cetraria nigricans Nyl.
Cetraria odontella (Ach.) Ach.
Cetraria sepincola (Ehrh.) Ach.
Chaenothecopsis sp nov
Cladina arbuscula (Wallr.) Hale & W.L. Culb.
Cladina mitis (Sandst.) Hustich
Cladina rangiferina (L.) Nyl.
Cladina stellaris (Opiz) Brodo
Cladina stygia (Fr.) Ahti
Cladina unknown (appearance similar to that of Cladonia wainioi)
Cladonia (ridged stereome, broad-cupped, see specimen)
Cladonia acuminata (Ach.) Norrl.
Cladonia amaurocraea (Flörke) Schaerer
Cladonia bellidiflora (Ach.) Schaerer
Cladonia borealis S. Stenroos
Cladonia cariosa (Ach.) Sprengel
Cladonia carneola (Fr.) Fr.
Cladonia cervicornis (Ach.) Flotow
Cladonia cf. amaurocraea (Flörke) Schaerer
Cladonia cf. macroceras (Delise) Hav.
Cladonia cf. squamosa Hoffm. (minute squamules)
Cladonia cf. uliginosa (Ahti) Ahti
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel
Cladonia coccifera (L.) Willd.
Cladonia cornuta (L.) Hoffm
Cladonia crispata (Ach.) Flotow
Cladonia cyanipes (Sommerf.) Nyl.
Cladonia decorticata (Flörke) Sprengel
Cladonia deformis (L.) Hoffm.
Cladonia digitata (L.) Hoffm.
Cladonia ecmocyna Leighton - sensu lato (but base blackening, an undescribed species?)

(continued)

Lichens (continued)

Cladonia gracilis (L.) Willd. ssp. gracilis
Cladonia gracilis ssp. elongata (Jacq.) Vainio
Cladonia gracilis ssp. vulnerata Ahti
Cladonia macilenta Hoffm.
Cladonia macrophylla (Schaerer) Stenh.
Cladonia macrophyllodes Nyl.
Cladonia maxima? (Asahina) Ahti
Cladonia pocillum (Ach.) Grognot
Cladonia pyxidata (L.) Hoffm.
Cladonia scotteri Ahti & E.S.Hansen
Cladonia squamosa Hoffm.
Cladonia stricta (Nyl.) Nyl. (centrally proliferating form)
Cladonia stricta (Nyl.) Nyl. (typical form)
Cladonia subfurcata (Nyl.) Arnold
Cladonia sulphurina (Michaux) Fr.
Cladonia trassii Ahti
Cladonia uncialis (L.) F. H. Wigg.
Cladonia unknown (K+ yellow and KC+ yellow)
Coelocaulon aculeatum (Schreber) Link
Collema ceraniscum Nyl.
Collema crispum (Hudson) F. H. Wigg.
Collema glebulentum (Nyl. ex Crombie) Degel.
Collema tenax (Sw.) Ach.
Collema undulatum Laurer ex Flotow
Cryptothele granuliformis? (Nyl.) Henssen
Dactylina arctica (Richardson) Nyl.
Dactylina ramulosa (Hooker) Tuck.
Dermatocarpon intestiniforme (Körber) Hasse
Dermatocarpon miniatum var. complicatum (Lightf.) Th. Fr.
Dermatocarpon miniatum var. miniatum (L.) W. Mann
Dibaeis baeomyces (L. f.) Rambold & Hertel
Dimelaena oreina (Ach.) Norman
Diploschistes scruposus (Schreber) Norman
Diploschistes sp nov
Endocarpon pulvinatum Th. Fr.
Ephebe hispida (Ach.) Horw.
Ephebe lanata (L.) Vainio
Ephebe perspinulosa Nyl.
Epilichen scabrosus (Ach.) Clem.
Flavocetraria cucullata (Bellardi) Kärnefelt & Thell

(continued)

Lichens (continued)

Flavocetraria nivalis (L.) Kärnefelt & Thell

Fulgensia bracteata (Hoffm.) Räsänen

Fuscopannaria praetermissa (Nyl.) P. M. Jørg. sensu lato

Fuscopannaria sp. (lobulate, on birch stem)

Gowardia nigricans (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen

Gyalecta foveolaris (Ach.) Schaer.

Gyalecta friesii Flotow ex Körber

Gyalecta kukrinensis (Räsänen) Räsänen

Hypogymnia austerodes (Nyl.) Räsänen

Hypogymnia bitteri (Lynge) Ahti

Hypogymnia dichroma Goward

Hypogymnia imshaugii Krog

Hypogymnia physodes (L.) Nyl.

Hypogymnia subobscura (Vainio) Poelt (in the traditional concept of the species)

Hypogymnia subobscura (Vainio) Poelt (isidiate, flattened form)

Icmadophila ericetorum (L.) Zahlbr.

Illosporium carneum Fr.

Involucropyrenium waltheri (Kremp.) Breuss

Ionaspis lacustris (With.) Lutzoni

Japewia subaurifera Muhr & Tønsberg

Japewia tornoensis (Nyl.) Tønsberg

Lasallia pensylvanica (Hoffm.) Llano

Lecanora argopholis (Ach.) Ach.

Lecanora bicincta Ramond

Lecanora boligera (Norman ex Th. Fr.) Hedl.

Lecanora chlarotera Nyl.

Lecanora epibryon (Ach.) Ach.

Lecanora frustulosa (Dickson) Ach.

Lecanora fuscescens (Sommerf.) Nyl.

Lecanora hagenii (Ach.) Ach.

Lecanora luteovernalis Brodo

Lecanora marginata (Schaerer) Hertel & Rambold

Lecanora muralis (Schreber) Rabenh. grp.

Lecanora orae-frigidae R. Sant.

Lecanora polytropa (Hoffm.) Rabenh.

Lecanora pulicaris (Pers.) Ach.

Lecanora rupicola (L.) Zahlbr.

Lecanora stenotropa Nyl.

Lecanora swartzii (Ach.) Ach.

Lecanora symmicta (Ach.) Ach.

(continued)

Lichens (continued)

Lecanora torrida Vainio

Lecanora unknown (similar to L. argopholis, apothecial rim strongly undulating, disc gaping and black)

Lecanora zosterae (Ach.) Nyl.

Lecidea auriculata Th. Fr.

Lecidea betulicola (Kullh.) H. Magn.

Lecidea confluens (Weber) Ach.

Lecidea diducens Nyl.

Lecidea hypnorum Lib.

Lecidea lapicida (Ach.) Ach.

Lecidea pullata (Norman) Th. Fr.

Lecidea sensu lato (unknown with simple spores, brown hypothecium and Catillaria-type ascus)

Lecidea sublimosa Nyl.

Lecidea theodori? Lynge

Lecidea turficola (Hellb.) Th. Fr.

Lecidella (unknown species, thallus with usnic colour, KC+ yellow)

Lecidella euphorea (Flörke) Hertel

Lecidella stigmatea (Ach.) Hertel & Leuckert

Lecidella xylophila (Th. Fr.) Knoph & Leuckert

Lecidoma demissum (Rutstr.) Gotth. Schneider & Hertel

Leciophysma finmarkicum Th. Fr.

Lempholemma intricatum (Arnold) Zahlbr.

Lempholemma isidioides? (Nyl. ex Arnold) H. Magn.

Lempholemma polyanthes (Bernh.) Malme

Lepraria borealis Lohtander & Tønsberg

Lepraria lobificans Nyl.

Leptogium imbricatum P. M. Jørg.

Leptogium intermedium (Arnold) Arnold

Leptogium saturninum (Dickson) Nyl.

Leptogium tenuissimum (Dickson) Körber

Lichenomphalia hudsoniana (H. S. Jenn.) Redhead, Lutzoni, Moncalvo & Vilgalys

Lichenomphalia umbellifera (L. : Fr.) Redhead, Lutzoni, Moncalvo & Vilgalys

Lichinella nigritella (Lettau) P. P. Moreno & Egea

Lobaria linita (Ach.) Rabenh.

Lobaria scrobiculata (Scop.) DC.

Lobothallia melanaspis (Ach.) Hafellner

Lopadium coralloideum (Nyl.) Lynge

Lopadium pezizoideum (Ach.) Körber

Masonhalea richardsonii (Hook.) Kärnefelt

Massalongia carnosa (Dickson) Körber

Melanelia disjuncta (Erichsen) Essl.

(continued)

Lichens (continued)

Melanelia hepatizon (Ach.) Thell
Melanelia panniformis (Nyl.) Essl.
Melanelia sorediata (Ach.) Goward & Ahti
Melanelia stygia (L.) Essl. ('conturbata' form)
Melanelia stygia (L.) Essl. (typical form)
Melanelia tominii (Oxner) Essl.
Melanelia unknown species, isidiate
Melanohalea exasperatula (Nyl.) O. Blanco et al.
Melanohalea infumata (Nyl.) O. Blanco et al.
Melanohalea septentrionalis (Lynge) O. Blanco et al.
Micarea assimilata (Nyl.) Coppins
Micarea cf. crassipes (Th. Fr.) Coppins
Micarea melaena (Nyl.) Hedl.
Micarea turfosa (A. Massal.) Du Rietz
Mniaecia nivea (P. Crouan & H. Crouan) Boud
Multiclavula sp.
Mycobilimbia carneoalbida (Müll. Arg.) S. Ekman & Printzen
Mycoblastus alpinus (Fr.) Kernst.
Myxobilimbia lobulata (Sommerf.) Hafellner.
Nephroma arcticum (L.) Torss.
Nephroma expallidum (Nyl.) Nyl.
Nephroma parile (Ach.) Ach.
Ochrolechia androgyna (Hoffm.) Arnold
Ochrolechia frigida (Sw.) Lynge
Ochrolechia grimmiae Lynge
Ochrolechia gyalectina (Nyl.) Zahlbr.
Ochrolechia sp nov? (like O. frigida but cortex C+ yellow, strongly coralloid growth form, lacking spinules)
Ochrolechia upsaliensis (L.) A. Massal.
Ophioparma lapponica (Räsänen) Hafellner & R. W. Rogers
Ophioparma ventosa (L.) Norman
Orphniospora moriopsis (A. Massal.) D. Hawksw.
Parmelia frabilis Goward ined.
Parmelia fraudans (Nyl.) Nyl.
Parmelia omphalodes (L.) Ach.
Parmelia saxatilis (L.) Ach.
Parmelia skultii Hale
Parmelia sp. (similar to P. "ernestiae")
Parmelia sulcata Taylor
Parmeliella triptophylla (Ach.) Müll. Arg.
Parmeliopsis ambigua (Wulfen) Nyl.

(continued)

Lichens (continued)

Parmeliopsis hyperopta (Ach.) Arnold

Peltigera aphthosa (L.) Willd.

Peltigera canina (L.) Willd.

Peltigera cf. lyngei Gyeln.

Peltigera cf. praetextata (Flörke ex Sommerf.) Zopf (tiny, appressed lobules)

Peltigera conspersa Goward ined. sensu lato

Peltigera didactyla (With.) J. R. Laundon

Peltigera extenuata (Vainio) Lojka

Peltigera lepidophora (Nyl. ex Vainio) Bitter

Peltigera leucophlebia (Nyl.) Gyelnik

Peltigera malacea (Ach.) Funck

Peltigera neorufescens Goward ined.

Peltigera ponojensis Gyelnik

Peltigera praetextata (Flörke ex Sommerf.) Zopf

Peltigera pseudobritannica Goward ined.

Peltigera rufescens (Weiss) Humb. sensu lato

Peltigera scabrosa Th. Fr.

Peltigera venosa (L.) Hoffm.

Pertusaria bryontha (Ach.) Nyl.

Pertusaria cf. multipunctoides Dibben

Pertusaria coriacea (Th. Fr.) Th. Fr.

Pertusaria dactylina (Ach.) Nyl.

Pertusaria geminipara (Th. Fr.) C. Knight ex Brodo

Pertusaria oculata (Dickson) Th. Fr.

Pertusaria ophthalmiza (Nyl.) Nyl.

Pertusaria panyrga (Ach.) A. Massal.

Pertusaria subdactylina Nyl.

Phaeophyscia constipata (Norrlin & Nyl.) Moberg

Phaeophyscia decolor (Kashiw.) Essl.

Phaeophyscia nigricans (Flörke) Moberg

Phaeophyscia orbicularis (Necker) Moberg

Phaeophyscia sciastra (Ach.) Moberg

Phaeorrhiza nimbosa (Fr.) H. Mayrhofer & Poelt

Physcia alnophila (Vainio) Loht., Moberg, Myllys & Tehler

Physcia caesia (Hoffm.) Fürnr.

Physcia dubia (Hoffm.) Lettau

Physconia muscigena (Ach.) Poelt (normal form)

Physconia muscigena (Ach.) Poelt (odd form, thin, broad and chocolate-brown, lacking pruina, and with sparser simpler rhizines)

Physconia perisidiosa (Erichsen) Moberg

(continued)

Lichens (continued)

Placidium lacinulatum var. atrans Breuss
Placynthiella dasaea (Stirton) Tønsberg
Placynthiella oligotropha (J. R. Laundon) Coppins & P. James
Placynthiella uliginosa (Schrader) Coppins & P. James
Placynthium asperellum (Ach.) Trevisan
Placynthium flabellosum (Tuck.) Zahlbr.
Placynthium nigrum (Hudson) Gray
Placynthium pulvinatum Øvstedal
Platismatia glauca (L.) W. L. Culb. & C. F. Culb.
Pleopsidium chlorophanum (Wahlenb.) Zopf
Polyblastia gelatinosa (Ach.) Th. Fr.
Polyblastia sendtneri Krempelh.
Polyblastia theleodes (Sommerf.) Th. Fr.
Polychidium muscicola (Sw.) Gray
Polysporina simplex (Davies) Vězda.
Porpidia flavicunda (Ach.) Gowan
Porpidia ochrolemma (Vainio) Brodo & R. Sant.
Porpidia speirea (Ach.) Kremp.
Porpidia thomsonii Gowan
Porpidia unknown (like P. speirea, but with small, waxy, dispersed areoles and smaller spores)
Protomicarea limosa (Ach.) Hafellner
Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman
Protopannaria sp nov
Protoparmelia badia (Hoffm.) Hafellner
Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.
Pseudephebe pubescens (L.) M. Choisy
Psilolechia lucida (Ach.) M.Choisy
Psora himalayana (Church. Bab.) Timdal
Psora rubiformis (Ach.) Hook.
Psoroma hypnorum (Vahl) Gray
Psoroma tenue var. boreale Henssen
Pycnora leucococca (R. Sant.) R. Sant.
Pycnothelia papillaria Dufour
Ramalina intermedia (Delise ex Nyl.) Nyl.
Rhizocarpon atroflavescens Lynge
Rhizocarpon chioneum (Norman) Th. Fr.
Rhizocarpon disporum (Nägeli ex Hepp) Müll. Arg.
Rhizocarpon eupetraeum (Nyl.) Arnold
Rhizocarpon geographicum (L.) DC.
Rhizocarpon inarense (Vainio) Vainio

(continued)

Lichens (continued)

Rhizocarpon interstitum Arnold
Rhizocarpon lavatum (Fr.) Hazsl.
Rhizocarpon norvegicum Räsänen
Rhizocarpon oederi (Weber) Körber
Rhizocarpon pusillum Runem.
Rhizocarpon simillimum (Anzi) Lettau
Rhizocarpon unknown species (large, bullate, clustered, brilliant yellow areoles)
Rhizoplaca chrysoleuca (Sm.) Zopf
Rhizoplaca melanophthalma (DC.) Leuckert & Poelt
Rimularia impavida (Th. Fr.) Hertel & Rambold
Rinodina mniaraea var. mniaraea (Ach.) Körber
Rinodina notabilis (Lynge) Sheard.
Rinodina orculata Poelt & M. Steiner
Rinodina terrestris Tomin
Rinodina turfacea (Wahlenb.) Körber
Sarcogyne regularis Körber
Schaereria parasemella (Nyl.) Lumbsch
Siphula ceratites (Wahlenb.) Fr.
Solorina bispora Nyl.
Solorina crocea (L.) Ach.
Solorina octospora (Arnold) Arnold
Sphaerophorus fragilis (L.) Pers.
Sphaerophorus globosus (Hudson) Vainio
Spilonema revertens Nyl.
Sporastatia testudinea (Ach.) A. Massal.
Staurothele areolata (Ach.) Lettau
Stereocaulon arcticum Lynge
Stereocaulon arenarium (Savicz) I. M. Lamb
Stereocaulon cf dactylophyllum Flörke
Stereocaulon condensatum Hoffm.
Stereocaulon cumulatum (Sommerf.) Timdal
Stereocaulon depressum (Frey) I. M. Lamb
Stereocaulon glareosum (Savicz) H. Magn.
Stereocaulon paschale (L.) Hoffm.
Stereocaulon rivulorum H. Magn.
Stereocaulon tomentosum Fr.
Strangospora torvula (Nyl.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen
Tephromela atra (Hudson) Hafellner
Thamnolia vermicularis (Sw.) Ach. ex Schaerer
Toninia tristis ssp. canadensis Timdal

(continued)

Lichens (completed)

Trapeliopsis granulosa (Hoffm.) Lumbsch
Tremolecia atrata (Ach.) Hertel
Umbilicaria arctica (Ach.) Nyl.
Umbilicaria cinereorufescens (Schaerer) Frey
Umbilicaria cylindrica (L.) Delise ex Duby
Umbilicaria deusta (L.) Baumg.
Umbilicaria hyperborea (Ach.) Hoffm.
Umbilicaria lyngei Schol.
Umbilicaria muhlenbergii (Ach.) Tuck.
Umbilicaria phaea Tuck.
Umbilicaria proboscidea (L.) Schrader
Umbilicaria rigida (Du Rietz) Frey
Umbilicaria torrefacta (Lightf.) Schrader
Umbilicaria vellea (L.) Hoffm.
Unknown lichen (sorediate latticework)
Usnea lapponica Vainio
Vulpicida pinastri (Scop.) J.E. Mattsson & M. J. Lai
Vulpicida tilesii (Ach.) J.E. Mattsson & M. J. Lai
Xanthomendoza borealis (R. Sant. & Poelt) Søchting, Kärnefelt & S. Kondr.
Xanthoparmelia taractica (Kremp.) Hale sensu lato
Xanthoparmelia wyomingica (Gyelnik) Hale
Xanthoria candelaria (L.) Th. Fr.
Xanthoria elegans (Link) Th.
Xanthoria sorediata (Vainio) Poelt
Xyloschistes platytropa (Nyl.) Vainio

Mosses

Abietinella abietina (Hedw.) Fleisch.
Aloina rigida (Hedw.) Limpr.
Amblyodon dealbatus (Hedw.) P. Beauv.
Amphidium lapponicum (Hedw.) Schimp.
Andreaea rupestris Hedwig (alkaline depressions form)
Andreaea rupestris Hedwig (saxicole form with straight leaves)
Aplodon wormskjoldii (Hornem.) Kindb.
Arctoa sp nov
Aulacomnium palustre (Hedw.) Schwaegr.
Aulacomnium turgidum (Wahlenb.) Schwaegr.
Bartramia ithyphylla Brid.
Brachythecium frigidum? (C. Müll.) Besch.

(continued)

Mosses (continued)

Brachythecium salebrosum (Hoffm. ex Weber & D. Mohr) W. P. Schimper

Bryum argenteum Hedwig

Bryum lanatum (P. Beauv.) Brid.

Bryum veronense De Not.

Calliergon cordifolium (Hedw.) Kindb.

Campylium protensum (Brid.) Kindb.

Campylium stellatum (Hedw.) C. Jens.

Campylopus schimperi Milde

Catoscopium nigritum (Hedwig) Bridel

Ceratodon purpureus (Hedwig) Bridel

Cinclidium arcticum (Bruch & Schimp.) Schimp.

Cinclidium latifolium Lindb.

Cinclidium subrotundum Lindb.

Climacium dendroides (Hedw.) Web. & Mohr

Conostomum tetragonum (Hedwig) Lindberg

Cyrtomnium hymenophylloides (Hueb.) Koponen

Cyrtomnium hymenophyllum (Bruch & Schimp.) Holmen

Dicranella cf. subulata (Hedw.) Schimp. ("stikinensis" form?)

Dicranoweisia crispula (Hedwig) Milde

Dicranum acutifolium (Lindb. & Arnell) C. Jens. ex Weinm.

Dicranum elongatum Schleich. ex Schwaegr.

Dicranum groenlandicum Brid.

Dicranum muhlenbeckii Br. & Sch.

Dicranum spadiceum J. E. Zetterstedt

Didymodon rigidulus var. gracilis (Schleich. ex Hook. & Grev.) R.H. Zander

Distichium capillaceum (Hedwig) Bruch & W. P. Schimper

Ditrichum flexicaule (Schwaegr.) Hampe

Ditrichum gracile (Mitt.) Kuntze

Drepanocladus polygamus (Schimp.) Hedenäs

Encalypta alpina Smith

Encalypta brevicollis (Bruch & Schimp.) Ångström

Encalypta procera Bruch

Encalypta rhaptocarpa Schwaegr.

Encalypta vittiana Horton

Encalypta vulgaris Hedw.

Fissidens cf. pellucidus Hornsch.

Funaria arctica (Berggr.) Kindb.

Funaria hygrometrica Hedw.

Grimmia longirostris Hooker

Grimmia sessitana De Not.

(continued)

Mosses (continued)

Gymnostomum aeruginosum Sm.
Gyroweisia tenuis? (Schrad. ex Hedw.) Schimp.
Hygrohypnum polare? (Lindb.) Loeske
Hylocomium splendens (Hedw.) Schimp
Hypnum bambergerii Schimp
Hypnum cupressiforme var. cupressiforme Hedw.
Hypnum revolutum (Mitt.) Lindb. var. revolutum
Kiaeria blyttii (Schimp.) Broth.
Leptobryum pyriforme (Hedw.) Wils.
Meesia triquetra (Richt.) Ångstr.
Meesia uliginosa Hedw.
Mnium blyttii Bruch & Schimp.
Myrinia pulvinata (Wahlenb.) Schimp.
Myurella tenerrima (Brid.) Lindb.
Niphotrichum canescens ssp. latifolium (C.E.O. Jens.) Frisvoll
Niphotrichum panschii (Müller Hal.) Bednarek-Ochyra & Ochyra
Oncophorus virens (Hedwig) Bridel
Oncophorus wahlenbergii Bridel
Orthotrichum alpestre Hornsch. ex B.S.G.
Orthotrichum anomalum Hedw.
Orthotrichum pylaisii Brid.
Orthotrichum rupestre Schleich. ex Schwägr.
Orthotrichum speciosum Nees
Paludella squarrosa (Hedw.) Brid.
Philonotis fontana var. fontana (Hedw.) Brid.
Philonotis fontana var. pumila (Turn.) Brid.
Plagiomnium ellipticum (Brid.) T. Kop.
Plagiopus oederianus (Swartz) Crum & Anderson
Plagiothecium laetum Schimp.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum urnigerum (Hedw.) P. Beauv.
Pohlia cruda (Hedw.) Lindb.
Pohlia crudoides (Sull. & Lesq.) Broth.
Pohlia erecta Lindb.
Pohlia filum (Schimp.) Mårtensson
Pohlia nutans (Hedw.) Lindb.
Pohlia proligera (Kindb.) S.O. Lindb.. ex Arnell
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum strictum Brid.

(continued)

Mosses (continued)

Pseudocalliergon angustifolium Hedenäs

Pseudocalliergon brevifolium (Lindb.) Hedenäs

Pseudocalliergon turgescens (T. Jens.) Loeske

Pseudoleskeella tectorum (Funck ex Brid.) Broth.

Pseudotaxiphyllum elegans (Brid.) Z. Iwats.

Psilopilum cavifolium (Wilson) I. Hagen

Psilopilum laevigatum (Wahlenb.) Lindb.

Pterigynandrum filiforme Hedw.

Ptychostomum cryophilum (Mårtensson) J.R. Spence

Ptychostomum inclinatum (Sw. ex Brid.) J.R. Spence

Ptychostomum nitidulum (Lindb.) J.R. Spence

Ptychostomum pallens (Sw.) J.R. Spence

Ptychostomum pallescens (Schleich. ex Schwägr.) J.R. Spence

Ptychostomum pendulum Hornsch.

Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P. Ramsay

Racomitrium lanuginosum (Hedw.) Brid.

Rhizomnium andrewsianum (Steere) T. Kop.

Rhytidium rugosum (Hedw.) Kindb.

Sanionia uncinata (Hedw.) Loeske

Sarmentypnum trichophyllum (Warnst.) Hedenäs

Schistidium frisvollianum H.H. Blom

Schistidium holmenianum Steere & Brassard

Schistidium rivulare (Brid.) Podp.

Sciurohypnum latifolium (Kindb.) Ignatov & Huttunen

Scorpidium cossonii (Schimp.) Hedenäs

Scorpidium revolvens (Sw.) Hedenäs

Scorpidium scorpioides (Hedw.) Limpr.

Seligeria sp nov (similar to S. polaris)

Sphagnum brevifolium (Lindb.) Roll

Sphagnum capillifolium (Ehrh.) Hedw.

Sphagnum centrale C.E.O. Jensen

Sphagnum cf. pylaesii Brid.

Sphagnum compactum Lam. & DC.

Sphagnum contortum Schultz

Sphagnum fuscum (Schimp.) Klinggr.

Sphagnum lenense H. Lindb. ex L.I. Savicz

Sphagnum lindbergii Schimp.

Sphagnum platyphyllum (Lindb.) Warnst.

Sphagnum riparium Ångström

Sphagnum sp nov "up" (same as at Courageous Lake)

(continued)

Mosses (completed)

Sphagnum squarrosum Crome
Sphagnum steerei R.E. Andrus
Sphagnum subfulvum Sjors
Sphagnum subnitens Russow & Warnst.
Sphagnum tenellum (Brid.) Brid.
Sphagnum teres Ångstr.
Sphagnum warnstorfii Russ.
Splachnum sphaericum Hedw.
Straminergon stramineum (Dicks. ex Brid.) Hedenäs
Syntrichia montana Nees
Syntrichia norvegica F. Weber
Tayloria lingulata (Dicks.) S.O. Lindberg
Tetraplodon mnioides (Hedw.) Bruch & Schimp.
Tetraplodon paradoxus (R. Br.) I. Hagen
Tomentypnum nitens (Hedw.) Loeske
Tortella tortuosa var. arctica (Arnell) Broth.
Tortella tortuosa var. tortuosa (Hedw.) Limpr.
Tortula leucostoma (R. Br.) Hook. & Grev.
Warnstorfia pseudostraminea (Müll. Hal.) Tuom. & T.J. Kop.
Unknown moss genus (Kiaeria-like, but lacking a peristome)

Vascular plants

Achillea millefolium L.
Agrostis mertensii Trin.
Alnus viridis ssp. crispa (Aiton) Turrill
Alopecurus magellanicus Lam.
Andromeda polifolia L.
Androsace septentrionalis L.
Anemone parviflora Michx.
Anemone richardsonii Hook.
Antennaria alpina (L.) Gaertn.
Antennaria friesiana (Trautv.) Ekman
Antennaria monocephala ssp. angustata (Greene) Hultén
Antennaria porsildii Ekman
Antennaria rosea ssp. confinis (Greene) Bayer
Antennaria rosea ssp. pulvinata (Greene) Bayer
Anthoxanthum arcticum Veldkamp (syn. Hierochloe pauciflora)
Anthoxanthum monticola (Bigelow) Veldkamp (syn. Hierochloe alpina)
Arabidopsis arenicola (Richardson ex Hook.) Al-Shehbaz, Elven, D.F. Murray & Warwick

(continued)

Vascular plants (continued)

Arctagrostis latifolia (R. Br.) Griseb.

Arctophila fulva (Trin.) Andersson

Arctous alpina (L.) Nied.

Arctous rubra (Rehder & Wilson) Nakai

Arenaria humifusa Wahlenb.

Argentina egedii (Wormsk.) Rydb.

Armeria maritima (Mill.) Willd.

Arnica angustifolia Vahl

Artemisia borealis Pall. ssp. borealis

Artemisia tilesii Ledeb.

Astragalus alpinus L.

Astragalus australis var. lepagei (Hultén) S.L. Welsh

Astragalus eucosmus B.L. Rob.

Betula nana L.

Bistorta vivipara (L.) Delarbre

Bromus pumpellianus Scribn.

Calamagrostis canadensis var. langsdorffii (Link) Inman

Calamagrostis deschampsioides Trin.

Calamagrostis lapponica (Wahlenb.) Hartm.

Calamagrostis purpurascens R. Br.

Calamagrostis stricta (Timm) Koeler

Caltha palustris L.

Campanula uniflora L.

Cardamine bellidifolia L.

Cardamine digitata Richardson

Cardamine nymanii Gand. (pilose form)

Carex aquatilis Wahlenb. var. aquatilis

Carex atrofusca Schkuhr

Carex aurea Nutt.

Carex bicolor Bellardi ex All.

Carex bigelowii Torr. ex Schwein.

Carex bigelowii Torr. ex Schwein. sensu lato (marine form with culms < 10 cm, inflorescences greatly surpassed in length by the basal leaves, perigynia few per spikelet)

Carex capillaris L.

Carex capitata ssp. arctogena (Harry Sm.) Hiitonen

Carex chordorrhiza Ehrh. ex L. f.

Carex fuliginosa Schkuhr

Carex glacialis Mack.

Carex glareosa ssp. glareosa Schkuhr ex Wahlenb.

Carex heleonastes L. f.

(continued)

Vascular plants (continued)

Carex holostoma Drejer

Carex lachenalii Schkuhr

Carex lapponica O. Lang

Carex mackenziei V.I. Krecz.

Carex maritima Gunnerus

Carex media R. Br.

Carex membranacea Hook.

Carex microglochin Wahlenb.

Carex nardina Fr.

Carex rariflora (Wahlenb.) Sm.

Carex rotundata Wahlenb.

Carex rupestris All.

Carex saxatilis L.

Carex scirpoidea Michx. ssp. scirpoidea

Carex sp nov (Section Phacocystis)

Carex supina ssp. spaniocarpa (Steud.) Hultén

Carex tenuiflora Wahlenb.

Carex ursina Dewey

Carex vaginata Tausch

Carex williamsii Britton

Cassiope tetragona var. tetragona (L.) D. Don

Castilleja elegans Malte

Cerastium alpinum ssp. lanatum (Lam.) Ces.

Chrysosplenium rosendahlii Packer

Cochlearia groenlandica L. (short, spreading form)

Cochlearia groenlandica L. (tall, strict form)

Comarum palustre L.

Corallorhiza trifida Châtel.

Cystopteris fragilis (L.) Bernh. sensu lato

Dasiphora fruticosa (L.) Rydb. (syn. Potentilla fruticosa)

Deschampsia caespitosa (L.) P. Beauv. ssp. caespitosa

Deschampsia sukatschewii (Popl.) Roshev.

Diapensia lapponica L.

Draba arabisans Michx.

Draba cinerea Adams

Draba crassifolia Graham

Draba fladnizensis Wulfen

Draba glabella Pursh (normal form)

Draba glabella Pursh (odd form with large, twisted fruits)

Draba juvenilis Delile ex Godr.

(continued)

Vascular plants (continued)

Draba lactea Adams

Draba lonchocarpa Rydb.

Draba nivalis Lilj.

Draba palanderiana Kjellm.

Dryas integrifolia Vahl

Dryopteris fragrans (L.) Schott

Dupontia fisheri ssp. fisheri R. Br.

Dupontia fisheri ssp. psilosantha (Rupr.) Hultén

Eleocharis acicularis (L.) Roem. & Schult.

Eleocharis ambigens Fernald

Eleocharis mamillata H. Lindb.

Elymus alaskanus (Scribn. & Merr.) Á. Löve ssp. alaskanus

Elymus violaceus (Hornem.) Feilberg

Empetrum nigrum L.

Epilobium angustifolium L.

Epilobium arcticum Sam.

Epilobium davuricum Fisch. ex Hornem.

Epilobium latifolium L.

Epilobium palustre L.

Equisetum arvense L.

Equisetum scirpoides Michx.

Equisetum variegatum Schleich. ex F. Weber & D. Mohr

Erigeron humilis Graham

Erigeron uniflorus L.

Eriophorum angustifolium ssp. subarcticum (V.N. Vassil.) Hultén ex Kartesz & Gandhi

Eriophorum angustifolium ssp. triste (Th. Fr.) Hultén

Eriophorum callitrix Cham. ex C.A. Mey.

Eriophorum chamissonis C.A. Mey.

Eriophorum scheuchzeri Hoppe

Eriophorum vaginatum L.

Erysimum coarctatum Fernald

Eutrema edwardsii R. Br.

Festuca brachyphylla Schult. & Schult. f.

Festuca groenlandica (Schol.) Fred.

Festuca rubra ssp. arctica (Hack.) Govor. (form with larger, less reddish lemmas with longer hairs, = ssp. richardsonii?)

Festuca rubra ssp. arctica (Hack.) Govor. (form with smaller, redder, less hairy lemmas)

Galium trifidum L.

Gentianella propinqua ssp. arctophila (Griseb.) Tzvelev

Gentianella tenella (Rottb.) Börner

(continued)

Vascular plants (continued)

Harrimanella hypnoides (L.) Coville
Hedysarum alpinum L.
Hedysarum boreale Nutt.
Hippuris tetraphylla L. f.
Hippuris vulgaris L
Honckenya peploides (Linnaeus) Ehrhart
Hordeum jubatum ssp. jubatum L.
Huperzia arctica Sipliv.
Juncus arcticus var. alaskanus (Hultén) S.L. Welsh
Juncus biglumis L.
Juncus castaneus Sm.
Juncus triglumis var. albescens Lange (syn. Juncus albescens)
Juncus triglumis var. triglumis L.
Jungermannia pumila With.
Kalmia microphylla (Hook.) A. Heller
Kobresia myosuroides (Vill.) Fiori
Kobresia sibirica (Turcz. ex Ledeb.) Boeckeler
Kobresia simpliciuscula (Wahlenb.) Mack.
Koenigia islandica L.
Lathyrus japonicus Willd.
Leymus mollis (Trin.) Pilg.
Loiseleuria procumbens (L.) Desv.
Lomatogonium rotatum (L.) Fr. ex Fernald
Lupinus arcticus ssp. arcticus S. Watson
Luzula confusa Lindeb.
Luzula groenlandica Böcher
Luzula multiflora ssp. frigida (Buchenau) V.I. Krecz.
Luzula nivalis (Laest.) Spreng. (syn. Luzula arctica)
Luzula spicata (L.) DC.
Luzula wahlenbergii Rupr.
Lycopodium annotinum var. pungens Desv.
Mertensia maritima (L.) Gray
Micranthes foliolosa (R. Br.) Gornall
Micranthes nelsoniana var. porsildiana (Calder & Savile) Gornall & H. Ohba
Micranthes nivalis (L.) Small
Micranthes tenuis (Wahlenb.) Small
Minuartia obtusiloba (Rydb.) House
Minuartia rubella (Wahlenb.) Hiern
Montia fontana L.
Myrica gale L.

(continued)

Vascular plants (continued)

Orthilia secunda (L.) House
Oxyria digyna (L.) Hill
Oxytropis arctica R. Br.
Oxytropis arctobia Bunge
Oxytropis deflexa (Pall.) DC.
Oxytropis hudsonica (Greene) Fernald
Oxytropis maydelliana Trautv.
Papaver radicatum ssp. radicatum Rottb.
Parnassia kotzebuei Cham. ex Spreng.
Parnassia palustris L.
Pedicularis capitata M.F. Adams
Pedicularis flammea L.
Pedicularis hirsuta L.
Pedicularis labradorica Wirsing
Pedicularis lanata Cham. & Schltdl.
Pedicularis lapponica L.
Pedicularis sudetica Willd.
Petasites sagittatus (Banks ex Pursh) A. Gray
Phyllodoce caerulea (L.) Bab.
Pinguicula villosa L.
Pinguicula vulgaris L.
Plantago canescens Adams
Platanthera obtusata (Banks ex Pursh) Lindl.
Poa alpina L.
Poa arctica R. Br. ssp. arctica
Poa glauca ssp. glauca Vahl
Poa lanata Scribn. & Merr.
Poa laxa ssp. fernaldiana? (Nannf.) Hyl.
Poa platyantha? Kom.
Poa pratensis L. unknown ssp. (giant)
Poa pratensis ssp. alpigena (Lindm.) Hiitonen
Potentilla arenosa ssp. arenosa (Turcz.) Juz.
Potentilla arenosa x nivea (syn. Potentilla mischkinii Yurtsev)
Potentilla cf. litoralis Rydb.
Potentilla hyparctica (Abrom.) Fernald ssp. hyparctica
Potentilla hyparctica var. elatior (Abrom.) Fernald
Potentilla nivea L.
Primula stricta Hornem.
Puccinellia andersonii Swallen
Puccinellia angustata? (R. Br.) E.L. Rand & Redfield (but anthers far too large)

(continued)

Vascular plants (continued)

Puccinellia arctica (Hook.) Fernald & Weath.

Puccinellia phryganodes (Trin.) Scribn. & Merr.

Puccinellia sp nov.

Puccinellia tenella (Lange) Holmb.

Pyrola grandiflora Radius

Ranunculus aquatilis L.

Ranunculus cymbalaria Pursh

Ranunculus flammula L.

Ranunculus gmelinii DC.

Ranunculus hyperboreus Rottb.

Ranunculus lapponicus L.

Ranunculus nivalis L.

Ranunculus pallasii Schltdl.

Ranunculus pygmaeus Wahlenb.

Ranunculus sabinei R. Br.

Rhododendron lapponicum (L.) Wahlenb.

Rhododendron tomentosum Harmaja (syn. Ledum palustre)

Rubus chamaemorus L.

Sagina nivalis (Lindblom) Fr.

Salix alaxensis ssp. alaxensis (Anderss.) Coville

Salix arctica Pall.

Salix arctophila Cockerell ex A. Heller

Salix glauca var. callicarpaea (Pursh) Dorn (syn. Salix glauca var. cordifolia)

Salix glauca var. stipulata Flod.

Salix herbacea L.

Salix niphoclada Rydb.

Salix ovalifolia var. ovalifolia Trautv.

Salix ovalifolia x glauca

Salix polaris Wahlenb.

Salix pulchra Cham.

Salix reticulata L.

Salix richardsonii Hook.

Salix sp. nov. 1 (subgenus Chamaetia, stems creeping, ovaries hairy, juvenile leaves reddish, stems reddish; always on eskers)

Saussurea angustifolia (Willd.) DC.

Saxifraga aizoides L.

Saxifraga cernua L.

Saxifraga hirculus L.

Saxifraga hyperborea R. Br.

Saxifraga oppositifolia ssp. smalliana (Engl. & Irmsch.) Hultén

(continued)

Vascular plants (completed)

Saxifraga tricuspidata Rottb.
Sibbaldia procumbens L.
Silene acaulis (L.) Jacq.
Silene involucrata (Cham. & Schltdl.) Bocquet
Silene uralensis ssp. uralensis (Rupr.) Bocquet
Sparganium hyperboreum Beurl. ex Laest.
Stellaria crassipes Hultén
Stellaria edwardsii R. Br.
Stellaria humifusa Rottb.
Stellaria longipes Goldie
Stellaria monantha Hultén
Stuckenia filiformis ssp. alpina (Blytt) R.R. Haynes
Suaeda calceoliformis (Hook.) Moq.
Symphyotrichum pygmaeum (Lindl.) Brouillet & S. Selliah
Taraxacum cf. ceratophorum (Ledeb.) DC. (coastal strand form)
Taraxacum cf. ceratophorum (Ledeb.) DC. (phrymatocarpum form?)
Tephroseris frigida (Richardson) Holub
Tofieldia coccinea Richardson
Tofieldia pusilla (Michx.) Pers.
Trichophorum cespitosum (L.) Hartm.
Triglochin maritima L.
Triglochin palustris L.
Tripleurospermum maritimum ssp. phaeocephala (Rupr.) Hämet-Ahti
Trisetum spicatum (L.) K. Richt.
Utricularia intermedia Hayne
Utricularia macrorrhiza Leconte
Vaccinium uliginosum L.
Vaccinium vitis-idaea L.
Viola palustris L.
Woodsia alpina (Bolton) S.F. Gray
Woodsia glabella R. Br. ex Richards.

Appendix 1-C. Plant and Lichen Species Observations

BACK RIVER RARE PLANT SURVEYS

Site 1 July 4, 2012 - North-pointing peninsula on Bathurst Inlet

Argentina egedii
Blepharostoma trichophyllum
Calamagrostis lapponica
Carex maritima
Castilleja elegans
Catascopium nigritum
Drepanocladus polygamus
Epilobium davuricum
Hypnum bambergeri
Lathyrus japonicus
Lecanora zosterae
Leymus mollis
Lupinus arcticus ssp. arcticus
Luzula confusa
Ochrolechia frigida
Pedicularis capitata
Pedicularis labradorica
Ptychostomum pseudotriquetrum
Rinodina terrestris
Salix alaxensis ssp. alaxensis
Saussurea angustifolia
Saxifraga hirculus
Solorina octospora
Syntrichia norvegica
Tephroseris frigida

Site 2   July 20, 2012 - Vicinity of George Camp, around lake across isthmus

Abietinella abietina
Acarospora glaucocarpa
Alectoria ochroleuca
Allantoparmelia almquistii
Allantoparmelia alpicola
Amblyodon dealbatus
Anastrophyllum minutum
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone parviflora
Anemone richardsonii
Aneura pinguis
Antennaria friesiana
Antennaria monocephala
Antennaria porsildii
Anthelia juratzkana
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctoparmelia separata
Arenaria humifusa
Armeria maritima
Arnica angustifolia
Asahinea chrysantha
Asahinea scholanderi
Asterella cf. gracilis
Astragalus alpinus
Aulacomnium turgidum
Bacidia bagliettoana
Baeomyces placophyllus
Betula nana
Bistorta vivipara
Blepharostoma trichophyllum
Brodoa oroarctica
Bryocaulon divergens
Bryonora castanea
Bryoria nitidula
Buellia badia
Calamagrostis lapponica
Calamagrostis purpurascens

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Caloplaca cerina
Caloplaca holocarpa
Caloplaca sinapisperma
Campanula uniflora
Campylium protensum
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Cardamine nymanii
Carex aquatilis
Carex atrofusca
Carex aurea
Carex bigelowii
Carex capillaris
Carex chordorrhiza
Carex holostoma
Carex lachenalii
Carex lapponica
Carex media
Carex rariflora
Carex rotundata
Carex rupestris
Carex saxatilis
Carex scirpoidea
Carex vaginata
Carex williamsii
Cassiope tetragona var. tetragona
Catapyrenium cinereum
Catapyrenium daedaleum
Cephaloziella arctica
Cephaloziella divaricata var. scabra
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria andrejevii
Cetraria delisei
Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria laevigata
Cetraria sepincola
Cladina rangiferina

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia bellidiflora
Cladonia borealis
Cladonia carneola
Cladonia cf. uliginosa
Cladonia cf. macroceras
Cladonia coccifera
Cladonia cyanipes
Cladonia gracilis ssp. elongata
Cladonia gracilis ssp. gracilis
Cladonia macrophylla
Cladonia pocillum
Cladonia pyxidata
Cladonia squamosa
Cladonia stricta (centrally proliferating form)
Cladonia stricta (typical form)
Cladonia trassii
Cladonia uncialis
Collema glebulentum
Conostomum tetragonum
Cryptothele (not collected, see photos)
Cyrtomnium hymenophyllum
Dactylina arctica
Dactylina ramulosa
Diapensia lapponica
Dicranoweisia crispula
Dicranum acutifolium
Dimelaena oreina
Diplophyllum taxifolium
Draba crassifolia
Draba lactea
Draba nivalis
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. fischeri
Dupontia fisheri ssp. psilosantha
Empetrum nigrum
Ephebe hispida
Epilobium angustifolium

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Epilobium latifolium
Equisetum arvense
Erigeron uniflorus
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum callitrix
Eriophorum vaginatum
Festuca brachyphylla
Flavocetraria cucullata
Flavocetraria nivalis
Fuscopannaria praetermissa sensu lato
Gowardia nigricans
Grimmia longirostris
Gymnomitrion corallioides
Harimanella hypnoides
Hedysarum alpinum
Hippuris vulgaris
Huperzia arctica
Hylocomium splendens
Hypogymnia physodes
Hypogymnia subobscura (in the traditional sense)
Icmadophila ericetorum
Ionaspis lacustris
Juncus biglumis
Juncus castaneus
Juncus triglumis var. ablescens
Juncus triglumis var. triglumis
Kobresia myosuroides
Lecanora bicincta
Lecanora hagenii
Lecanora polytropa
Lecanora stenotropa
Lecidea lapicida group
Lecidoma demissum
Lepraria borealis
Lichenomphalia umbellifera
Loiseleuria procumbens
Lophozia groenlandica
Luzula confusa
Luzula nivalis
Luzula wahlenbergii

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Lycopodium annotinum ssp. pungens
Marchantia alpina
Marchantia polymorpha
Masonhalea richardsonii
Massalongia carnosa
Meesia triquetra
Meesia uliginosa
Melanelia hepatizon
Melanelia stygia (normal form)
Melanelia tominii
Micranthes foliolosa
Micranthes nelsoniana ssp. porsildiana
Micranthes nivalis
Minuartia obtusiloba
Minuartia rubella
Moerckia sp.
Ochrolechia frigida
Ochrolechia gyalectina
Ochrolechia sp. nov.
Onchophorus wahlenbergii
Ophioparma ventosa
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Parmelia cf. ernestiae
Parmelia fraudans
Parmelia omphalodes
Parmelia sulcata
Parmeliopsis ambigua
Parnassia kotzebuei
Pedicularis labradorica
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera extenuata
Peltigera lepidophora
Peltigera leucophlebia
Peltigera malacea
Peltigera scabrosa
Peltigera sp. nov. (aff. britannica)
Pertusaria coriacea

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Pertusaria dactylina
Pertusaria geminipara
Pertusaria oculata
Pertusaria panyrga
Pertusaria subdactylina
Phaeophyscia sciastra
Philonotis fontana var. fontana
Phyllodoce caerulea
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula villosa
Placidium lacinulatum var. atrans
Placynthium asperellum
Placynthium nigrum
Plagiothecium laetum
Pleurocladula albescens
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa platyantha?
Pohlia crudoides
Polyblastia sendtneri
Polytrichum piliferum
Polytrichum stricum
Porpidia flavicunda
Porpidia thomsonii
Potentilla arenosa ssp. arenosa
Potentilla hyparctica ssp. elatior
Preissia quadrata
Protoparmelia badia
Pseudephebe minuscula
Pseudephebe pubescens
Pseudocalliergon angustifolium
Psoroma hypnorum
Ptilidium ciliare
Ptychostomum pallens
Pyrola grandiflora
Racomitrium lanuginosum
Ranunculus aquatilis
Ranunculus hyperboreus

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Ranunculus lapponicus
Ranunculus nivalis
Ranunculus pygmaeus
Ranunculus sabinei
Rhizocarpon oederi
Rhizocarpon pusillum
Rhizocarpon simillimum
Rhizocarpon unknown species (large, clustered, bullate areoles, brilliant yellow)
Rhizomnium andrewsianum
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rinodina notabilis
Rubus chamaemorus
Salix arctophila
Salix glauca var. cordifolia
Salix herbacea
Salix niphoclada
Salix planifolia
Salix reticulata
Salix sp. nov. (esker tops)
Sanionia uncinata
Saussurea angustifolia
Saxifraga cernua
Saxifraga hyperborea
Saxifraga oppositifolia ssp. smalliana
Saxifraga rivularis
Saxifraga tricuspidata
Scapania invisa
Scapania paludosa
Schistidium holmenianum
Scorpidium cossonii
Scorpidium revolvens
Silene acaulis
Silene involucrata
Siphula ceratites
Solorina crocea
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum capillifolium
Sphagnum compactum

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Sphagnum contortum
Sphagnum fuscum
Sphagnum lenense
Sphagnum lindbergii
Sphagnum riparium
Sphagnum steerei
Sphagnum tenellum
Sphagnum warnstorfii
Sporastatia testudinea
Stellaria monantha
Stereocaulon arcticum
Stereocaulon arenarium
Stereocaulon depressum
Stereocaulon paschale
Stereocaulon rivulorum
Straminergon stramineum
Tephromela atra
Tephroseris frigida
Tetralophozia setiformis
Thamnolia vermicularis
Tofieldia coccinea
Tofieldia pusilla
Tomentypnum nitens
Trapeliopsis granulosa
Tremolecia atrata
Trentepohlia cf. aurea
Trichophorum cespitosum
Trisetum spicatum
Tritomaria quinquedentata
Umbilicaria cinereorufescens
Umbilicaria cylindrica
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria muhlenbergii
Umbilicaria proboscidea
Umbilicaria torrefacta
Vaccinium uliginosum
Vaccinium vitis-idaea
Vulpicida pinastri
Woodsia glabella
Xanthomendoza borealis

(continued)

Site 2 July 20, 2012 - Vicinity of George Camp, around lake across isthmus (continued)

Xanthoparmelia taractica sensu lato
Xanthoria candelaria
Xanthoria elegans
Xanthoria sorediata

Site 3 July 21, 2012 - Footprint areas nearest camp

Agrostis mertensii
Alectoria ochroleuca
Allantoparmelia alpicola
Allantoparmelia cf. sibirica
Anastrophyllum minutum
Andreaea rupestris (form of alkaline depressions)
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone parviflora
Anemone richardsonii
Aneura pinguis
Antennaria friesiana
Antennaria porsildii
Antennaria rosea ssp. confinis
Anthelia juratzkana
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctophila fulva
Armeria maritima
Arnica angustifolia
Asahinea chrysantha
Asahinea scholanderi
Aspicilia verrucosa
Astragalus alpinus
Aulacomnium turgidum
Baeomyces placophyllus
Betula nana
Bistorta vivipara
Blepharostoma trichophyllum
Bryocaulon divergens
Bryonora castanea
Bryoria nitidula

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Bryoria tenuis
Calamagrostis canadensis
Calamagrostis lapponica
Caloplaca cerina
Caloplaca flavorubescens
Calvitimela talayana
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Carex aquatilis
Carex bigelowii
Carex capillaris
Carex capitata var. arctogena
Carex chordorrhiza
Carex rariflora
Carex rotundata
Carex saxatilis
Carex scirpoidea
Carex ursina
Carex vaginata
Carex williamsii
Cassiope tetragona var. tetragona
Catapyrenium cinereum
Ceratodon purpureus
Cetraria andrejevii
Cetraria ericetorum ssp. ericetorum
Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria laevigata
Cetraria nigricans
Cetraria sepincola
Chaenothecopsis sp. nov.
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladina unknown species
Cladonia amaurocrea
Cladonia bellidiflora

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Cladonia borealis

Cladonia cf. macroceras? (see collection)

Cladonia coccifera

Cladonia cyanipes

Cladonia digitata

Cladonia gracilis ssp. elongata

Cladonia macrophylla

Cladonia macrophyllodes

Cladonia sp. unknown (K+ yellow and KC+ yellow-orange)

Cladonia stricta (centrally proliferating form)

Cladonia sulphurina

Cladonia trassii

Cladonia uncialis

Collema glebulentum

Conostomum tetragonum

Cyrtomnium hymenophyllum

Dactylina arctica

Dactylina ramulosa

Diapensia lapponica

Dibaeis baeomyces

Dicranoweisia crispula

Dicranum acutifolium

Dimelaena oreina

Diploschistes scruposus

Dryas integrifolia

Dryopteris fragrans

Empetrum nigrum

Epilichen scabrosus

Epilobium angustifolium

Equisetum arvense

Erigeron uniflorus

Eriophorum angustifolium ssp. subarcticum

Eriophorum angustifolium ssp. triste

Eriophorum chamissonis

Eriophorum vaginatum

Flavocetraria cucullata

Flavocetraria nivalis

Funaria arctica

Gowardia nigricans

Gymnocolea acutiloba

Gymnomitrion concinnatum

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Gymnomitrion corallioides

Hedysarum alpinum

Huperzia arctica

Hygrohypnum polare?

Hylocomium splendens

Hypogymnia bitteri

Hypogymnia physodes

Hypogymnia subobscura (in the traditional sense)

Icmadophila ericetorum

Ionaspis lacustris

Juncus biglumis

Juncus triglumis var. ablescens

Jungermannia pumila

Lasallia pensylvanica

Lecanora bicincta

Lecanora epibryon

Lecanora polytropa

Lecidea lapicida group

Lecidoma demissum

Leciophysma finmarkicum

Lepraria borealis

Loiseleuria procumbens

Lophozia wenzelii

Luzula confusa

Luzula wahlenbergii

Lycopodium annotinum ssp. pungens

Marchantia polymorpha

Masonhalea richardsonii

Melanelia disjuncta

Melanelia hepatizon

Melanelia panniformis

Melanelia stygia (fruticose form)

Melanelia stygia (normal form)

Melanohalea exasperatula

Melanohalea infumata

Mesopytchia sahlbergii

Micarea assimilata

Micarea melaena

Micranthes nelsoniana ssp. porsildiana

Minuartia obtusiloba

Mycoblastus alpinus

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Nephroma arcticum
Ochrolechia frigida
Ochrolechia gyalectina
Ochrolechia sp. nov.
Odontoschisma macounii
Onchophorus virens
Onchophorus wahlenbergii
Ophioparma ventosa
Orphniospora moriformis
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Parmelia fraudans
Parmelia friabilis ined.
Parmelia omphalodes
Parmelia saxatilis
Parmelia sulcata
Parmeliopsis ambigua
Pedicularis labradorica
Pedicularis lapponica
Pedicularis sudetica
Peltigera extenuata
Peltigera malacea
Peltigera scabrosa
Peltigera venosa
Pertusaria coriacea
Pertusaria dactylina
Phyllodoce caerulea
Physcia caesia
Physcia dubia
Pinguicula vulgaris
Placynthiella dasaea
Placynthium asperellum
Placynthium flabellosum
Placynthium nigrum
Plagiomnium ellipticum
Platismatia glauca
Pleurocladula albescens
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Polytrichum piliferum

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Polytrichum stricum
Porpidia flavicunda
Porpidia ochrolemma
Potentilla hyparctica ssp. elatior
Preissia quadrata
Pseudephebe minuscula
Pseudephebe pubescens
Psilolechia lucida
Psilopilum cavifolium
Ptilidium ciliare
Pycnothelia papillaria
Pyrola grandiflora
Racomitrium lanuginosum
Ramalina intermedia
Ranunculus hyperboreus
Ranunculus lapponicus
Ranunculus pygmaeus
Rhizocarpon pusillum
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rinodina turfacea
Rubus chamaemorus
Salix arctica
Salix arctophila
Salix glauca var. cordifolia
Salix herbacea
Salix ovalifolia
Salix planifolia
Salix reticulata
Sanionia uncinata
Sarmentypnum trichophyllum
Saussurea angustifolia
Saxifraga cernua
Saxifraga tricuspidata
Scapania hyperborea
Schistidium holmenianum
Schistidium rivulare
Scorpidium cossonii
Scorpidium revolvens
Scorpidium scorpioides

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Sibbaldia procumbens

Silene acaulis

Siphula ceratites

Solorina crocea

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum capillifolium

Sphagnum cf. pylaesii

Sphagnum fuscum

Sphagnum platyphyllum

Sphagnum squarrosum

Sphagnum steerei

Stellaria edwardsii

Stellaria monantha

Stereocaulon arcticum

Stereocaulon condensatum

Stereocaulon glareosum

Stereocaulon paschale

Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)

Tephromela atra

Tephroseris frigida

Tetralophozia setiformis

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Tremolecia atrata

Trentepohlia cf. aurea

Trichophorum cespitosum

Trisetum spicatum

Umbilicaria cinereorufescens

Umbilicaria cylindrica

Umbilicaria deusta

Umbilicaria hyperborea

Umbilicaria muhlenbergii

Umbilicaria proboscidea

Umbilicaria rigida

Umbilicaria torrefacta

Umbilicaria vellaea

Utricularia macrorrhiza (Ryan Durand record from estuary of the Western River)

Vaccinium uliginosum

Vaccinium vitis-idaea

(continued)

Site 3 July 21, 2012 - Footprint areas nearest camp (continued)

Viola palustris
Vulpicida pinastri
Vulpicida tilesii
Xanthomendoza borealis
Xanthoria elegans
Xanthoria sorediata

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4

Achillea millefolium var. alpinum
Alectoria ochroleuca
Allantoparmelia cf. sibirica
Alnus viridis ssp. crispa
Alopecurus magellanicus
Anastrophyllum minutum
Andromeda polifolia
Antennaria friesiana
Antennaria porsildii
Anthelia juratzkana
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctophila fulva
Argentina egedii
Armeria maritima
Artemisia borealis
Artemisia tilesii
Asahinea chrysantha
Asterella cf. gracilis
Astragalus alpinus
Aulacomnium turgidum
Betula nana
Bistorta vivipara
Bromus pumpellianus
Bryocaulon divergens
Calamagrostis lapponica
Caltha palustris
Campylium protensum
Campylium stellatum
Candelariella canadensis

(continued)

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4 (continued)

Carex aquatilis

Carex atrofusca

Carex bicolor

Carex bigelowii

Carex bigelowii (marine form with inflorescence much shorter than leaves)

Carex capillaris

Carex chordorrhiza

Carex glareosa var. amphigena

Carex mackenziei

Carex membranacea

Carex microglochin

Carex rariflora

Carex rotundata

Carex scirpoidea

Carex sp. nov. (section Phacocystis)

Carex ursina

Carex vaginata

Carex williamsii

Cassiope tetragona var. tetragona

Castilleja elegans

Ceratodon purpureus

Cetraria andrejevii

Cetraria fastigiata

Cetraria islandica ssp. crispiformis

Cetraria islandica ssp. islandica

Cladina stygia

Cladonia amaurocrea

Cladonia cf. macroceras

Cladonia gracilis ssp. gracilis

Cochlearia groenlandica (short form)

Coelocaulon aculeatum

Comarum palustre

Corallorhiza trifida

Dactylina arctica

Deschampsia caespitosa

Deschampsia sukatschewii

Diapensia lapponica

Dicranum acutifolium

Draba crassifolia

Draba fladnizensis

(continued)

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4 (continued)

Draba nivalis

Dryas integrifolia

Dupontia fisheri ssp. fischeri

Dupontia fisheri ssp. psilosantha

Empetrum nigrum

Epilobium angustifolium

Epilobium arcticum

Epilobium latifolium

Equisetum arvense

Eriophorum angustifolium ssp. triste

Eriophorum scheuchzeri

Eriophorum vaginatum

Erysimum coarctatum

Festuca brachyphylla

Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)

Flavocetraria cucullata

Flavocetraria nivalis

Gentianella propinqua ssp. arctophila

Gentianella tenella

Hedysarum alpinum

Hedysarum boreale

Hippuris tetraphylla

Hippuris vulgaris

Honckenya peploides

Hordeum jubatum var. jubatum

Huperzia arctica

Juncus arcticus var. alaskanus

Juncus biglumis

Juncus castaneus

Juncus triglumis var. ablescens

Juncus triglumis var. triglumis

Jungermannia pumila

Kobresia simpliciuscula

Koenigia islandica

Lathyrus japonicus

Lecanora epibryon

Lecidea sublimosa

Lecidella euphorea

Leptobryum pyriforme

Leymus mollis

(continued)

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4 (continued)

Lobaria linita

Loiseleuria procumbens

Lomatogonium rotatum

Lupinus arcticus ssp. arcticus

Luzula confusa

Luzula groenlandica

Luzula multiflora ssp. frigida

Luzula wahlenbergii

Meesia triquetra

Minuartia rubella

Montia fontana

Myrica gale

Nardia scalaris

Nephroma expallidum

Ochrolechia androgyna

Oxytropis deflexa var. foliolosa

Oxytropis hudsonica

Oxytropis maydelliana

Parmelia omphalodes

Parmelia skultii

Parnassia palustris

Pedicularis labradorica

Pedicularis lanata

Pedicularis lapponica

Pedicularis sudetica

Pertusaria coriacea

Philonotis fontana var. pumila

Phyllodoce caerulea

Physconia muscigena (normal form)

Pinguicula villosa

Pinguicula vulgaris

Plantago canescens

Platanthera obtusata

Pleurocladula albescens

Poa arctica ssp. arctica

Poa glauca ssp. glauca

Polytrichum stricum

Potentilla hyparctica ssp. elatior

Primula egaliksensis

Psilopilum cavifolium

(continued)

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4 (continued)

Ptilidium ciliare
Ptychostomum nitidulum
Ptychostomum pseudotriquetrum
Puccinellia phryganodes
Puccinellia sp. nov.
Puccinellia sp. (purple leaves)
Pyrola grandiflora
Racomitrium lanuginosum
Ranunculus cymbalaria
Ranunculus hyperboreus
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rubus chamaemorus
Salix alaxensis ssp. alaxensis
Salix arctica
Salix glauca var. cordifolia
Salix glauca var. stipulata
Salix niphoclada
Salix planifolia
Sanionia uncinata
Saxifraga cernua
Saxifraga hirculus
Saxifraga hyperborea
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Schistidium holmenianum
Scorpidium cossonii
Scorpidium scorpioides
Silene acaulis
Siphula ceratites (Ryan Durand's veg plot near George Camp, get UTMs from him)
Sparganium hyperboreum
Sphaerophorus globosus
Sphagnum squarrosum
Sphagnum tenellum
Stellaria crassipes
Stellaria humifusa
Stellaria longipes
Stellaria monantha
Stereocaulon paschale

(continued)

Site 4 July 22, 2012 - Bathurst Inlet begins at 13 W 387326 7381315 extends west and then east to 13 W 387793 7381322; estuary next to peninsula of July 4(completed)

Straminergon stramineum

Stuckenia filiformis ssp. alpina

Suaeda calceoliformis

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Trichophorum cespitosum

Triglochin maritima

Triglochin palustris

Tripleurospermum maritimum ssp. phaeocephalum

Trisetum spicatum

Tritomaria polita ssp. polita

Utricularia intermedia

Vaccinium uliginosum

Vaccinium vitis-idaea

Xanthoria elegans

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp

Agrostis mertensii

Alectoria ochroleuca

Amygdalaria panaeola

Anastrophyllum minutum

Andreaea rupestris (form with straight leaves)

Andromeda polifolia

Antennaria alpina

Antennaria friesiana

Antennaria monocephala

Antennaria porsildii

Anthelia juratzkana

Anthoxanthum monticola

Arctagrostis latifolia

Arctoparmelia centrifuga

Arctoparmelia incurva

Arctous alpina

Armeria maritima

Artemisia borealis

Asahinea chrysantha

Asahinea scholanderi

Aspicilia verrucosa

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Astragalus alpinus
Aulacomnium palustre
Aulacomnium turgidum
Baeomyces placophyllus
Betula nana
Bistorta vivipara
Bryocaulon divergens
Bryonora castanea
Bryoria nitidula
Buellia terricola
Calamagrostis canadensis
Calamagrostis lapponica
Calamagrostis purpurascens
Calamagrostis stricta
Caloplaca cerina
Caloplaca chrysodeta
Caloplaca holocarpa
Calvitimela talayana
Candelariella vitellina
Cardamine nymanii
Carex aquatilis
Carex bigelowii
Carex capillaris
Carex capitata var. arctogena
Carex chordorrhiza
Carex fuliginosa
Carex glacialis
Carex lachenalii
Carex membranacea
Carex rariflora
Carex rotundata
Carex saxatilis
Carex scirpoidea
Carex supina ssp. spaniocarpa
Carex vaginata
Carex williamsii
Cassiope tetragona var. tetragona
Catapyrenium cinereum
Cetraria andrejevii
Cetraria delisei
Cetraria ericetorum ssp. ericetorum

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria nigricans
Cetraria sepincola
Cinclidium latifolium
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia borealis
Cladonia cf. macroceras
Cladonia gracilis ssp. elongata
Cladonia gracilis ssp. vulnerata
Cladonia pyxidata
Cladonia scotteri
Cladonia stricta (centrally proliferating form)
Cladonia stricta (typical form)
Cladonia sulphurina
Cladonia trassii
Cladonia uncialis
Comarum palustre
Conostomum tetragonum
Cyrtomnium hymenophyllum
Dactylina arctica
Dactylina ramulosa
Deschampsia sukatschewii
Diapensia lapponica
Dibaeis baeomyces
Dicranum acutifolium
Dicranum groenlandicum
Dicranum muhlenbeckii
Dicranum spadiceum
Dimelaena oreina
Draba glabella (normal form)
Draba lonchocarpa
Draba nivalis
Dryas integrifolia
Dupontia fisheri ssp. psilosantha
Empetrum nigrum
Ephebe hispida

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Ephebe lanata
Epilobium angustifolium
Epilobium davuricum
Epilobium latifolium
Equisetum arvense
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum scheuchzeri
Eriophorum vaginatum
Festuca brachyphylla
Flavocetraria cucullata
Flavocetraria nivalis
Gyalecta kukrinensis
Gymnocolea acutiloba
Gymnomitrion concinnatum
Gymnomitrion corallioides
Hippuris vulgaris
Huperzia arctica
Hylocomium splendens
Hypogymnia bitteri
Hypogymnia physodes
Hypogymnia subobscura (in the traditional sense)
Icmadophila ericetorum
Juncus biglumis
Juncus castaneus
Juncus triglumis var. ablescens
Juncus triglumis var. triglumis
Jungermannia pumila
Kalmia microphylla
Lasallia pensylvanica
Lecanora bicincta
Lecanora boligera
Lecanora frustulosa
Lecanora hagenii
Lecanora polytropa
Lecanora swartzii
Lecidea lapicida group
Lecidea theodori?
Lecidella unknown (usnic thallus)
Lecidoma demissum
Lempholemma polyanthes

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Loiseleuria procumbens
Lopadium pezizoideum
Luzula confusa
Luzula wahlenbergii
Lycopodium annotinum ssp. pungens
Marsupella arctica
Masonhalea richardsonii
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (fruticose form)
Melanelia stygia (normal form)
Melanelia tominii
Minuartia obtusiloba
Mniaecia nivea
Multiclavula sp.
Mycoblastus alpinus
Nephroma expallidum
Niphotrichum canescens ssp. latifolium
Ochrolechia frigida
Ochrolechia grimmiae
Ochrolechia gyalectina
Odontoschisma elongatum
Odontoschisma macounii
Ophioparma lapponica
Ophioparma ventosa
Oxytropis arctica
Parmelia omphalodes
Parmeliopsis ambigua
Pedicularis flammea
Pedicularis labradorica
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera extenuata
Peltigera malacea
Peltigera rufescens
Peltigera scabrosa
Pertusaria coriacea
Pertusaria dactylina
Pertusaria geminipara
Pertusaria oculata

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Pertusaria panyrga
Phaeophyscia constipata
Philonotis fontana var. fontana
Philonotis fontana var. pumila
Physcia dubia
Physconia muscigena (normal form)
Pleurocladula albescens
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa laxa ssp. fernaldiana
Pohlia cruda
Pohlia filum
Polytrichum juniperinum
Polytrichum piliferum
Polytrichum stricum
Porpidia flavicunda
Potentilla arenosa ssp. arenosa
Potentilla arenosa x nivea
Protopannaria sp. nov.
Protoparmelia badia
Pseudephebe minuscula
Pseudephebe pubescens
Psoroma hypnorum
Ptilidium ciliare
Racomitrium lanuginosum
Ranunculus gmelinii
Ranunculus hyperboreus
Rhizocarpon geographicum
Rhizocarpon unknown species (large, clustered, bullate areoles, brilliant yellow)
Rhododendron tomentosum
Rhytidium rugosum
Rubus chamaemorus
Salix arctica
Salix glauca var. cordifolia
Salix herbacea
Salix ovalifolia
Salix planifolia
Salix sp. nov. (esker tops)
Sanionia uncinata
Saxifraga hyperborea

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Saxifraga tricuspidata
Schistidium frisvolleanum
Schistidium holmenianum
Schistochilopsis opacifolia
Scorpidium cossonii
Scorpidium revolvens
Scorpidium scorpioides
Silene acaulis
Silene involucrata
Siphula ceratites
Solorina crocea
Sparganium hyperboreum
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum brevifolium
Sphagnum capillifolium
Sphagnum centrale
Sphagnum compactum
Sphagnum platyphyllum
Sphagnum squarrosum
Sphagnum steerei
Sphagnum subfulvum
Sphagnum subnitens
Sphagnum teres
Sporastatia testudinea
Stellaria monantha
Stereocaulon arcticum
Stereocaulon arenarium
Stereocaulon cf. dactylophyllum
Stereocaulon glareosum
Stereocaulon paschale
Strangospora torvula
Syntrichia norvegica
Tetralophozia setiformis
Thamnolia vermicularis
Tofieldia pusilla
Tremolecia atrata
Trentepohlia cf. aurea
Trichophorum cespitosum
Trisetum spicatum
Tritomaria quinquedentata

(continued)

Site 5 July 23, 2012 - Tailings option about 6 miles WSW of Goose Camp (continued)

Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria proboscidea
Umbilicaria torrefacta
Vaccinium uliginosum
Vaccinium vitis-idaea
Viola palustris
Vulpicida pinastri
Warnstorfia pseudostraminea
Xanthoria elegans
Xanthoria sorediata

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers

Acarospora sinopica
Alectoria ochroleuca
Allantoparmelia alpicola
Amygdalaria panaeola
Anastrophyllum minutum
Andreaea rupestris (form of alkaline depressions)
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone parviflora
Aneura pinguis
Antennaria alpina
Antennaria friesiana
Antennaria monocephala
Antennaria porsildii
Antennaria rosea ssp. confinis
Anthelia juratzkana
Anthoxanthum monticola
Arabidopsis arenicola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctophila fulva
Arctous alpina
Arenaria humifusa
Arnica angustifolia
Arthonia unknown (saxicolous, aeruginose upper hymenium, spores 3-septate)

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Asahinea chrysantha
Asahinea scholanderi
Aspicilia verrucosa
Astragalus alpinus
Aulacomnium palustre
Aulacomnium turgidum
Baeomyces placophyllus
Bellemerea subsorediza
Betula nana
Bistorta vivipara
Blepharostoma trichophyllum
Bryocaulon divergens
Bryoria nitidula
Bryum argenteum
Bryum veronense
Calamagrostis lapponica
Calamagrostis purpurascens
Caloplaca cerina
Caloplaca holocarpa
Calvitimela armeniaca
Campanula uniflora
Campylium stellatum
Candelariella canadensis
Candelariella reflexa
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Cardamine nymanii
Carex aquatilis
Carex atrofusca
Carex bigelowii
Carex capillaris
Carex capitata var. arctogena
Carex chordorrhiza
Carex fuliginosa
Carex glacialis
Carex holostoma
Carex lachenalii
Carex membranacea

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Carex rariflora

Carex rotundata

Carex rupestris

Carex saxatilis

Carex scirpoidea

Carex supina ssp. spaniocarpa

Carex vaginata

Carex williamsii

Cassiope tetragona var. tetragona

Cerastium alpinum ssp. lanatum

Ceratodon purpureus

Cetraria andrejevii

Cetraria delisei

Cetraria ericetorum ssp. ericetorum

Cetraria fastigiata

Cetraria islandica ssp. crispiformis

Cetraria nigricans

Cetraria sepincola

Cladina arbuscula

Cladina mitis

Cladina rangiferina

Cladina stellaris

Cladina stygia

Cladonia (ridged stereome, broad-cupped, see specimen)

Cladonia acuminata

Cladonia amaurocrea

Cladonia borealis

Cladonia cf. macroceras

Cladonia coccifera

Cladonia cyanipes

Cladonia decorticata

Cladonia gracilis ssp. elongata

Cladonia macilenta

Cladonia macrophylla

Cladonia pocillum

Cladonia pyxidata

Cladonia stricta (typical form)

Cladonia trassii

Cladonia uncialis

Coelocaulon aculeatum

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Collema glebulentum

Comarum palustre

Dactylina arctica

Dactylina ramulosa

Diapensia lapponica

Dicranum acutifolium

Dicranum groenlandicum

Dimelaena oreina

Draba fladnizensis

Draba lactea

Draba nivalis

Draba palanderiana

Dryas integrifolia

Dryopteris fragrans

Eleocharis acicularis

Empetrum nigrum

Ephebe hispida

Ephebe lanata

Epilobium angustifolium

Epilobium latifolium

Equisetum arvense

Eriophorum angustifolium ssp. subarcticum

Eriophorum angustifolium ssp. triste

Eriophorum callitrix

Eriophorum scheuchzeri

Eriophorum vaginatum

Festuca brachyphylla

Flavocetraria cucullata

Flavocetraria nivalis

Gowardia nigricans

Grimmia longirostris

Hedysarum alpinum

Hippuris vulgaris

Huperzia arctica

Hylocomium splendens

Hypogymnia physodes

Hypogymnia subobscura (in the traditional sense)

Icmadophila ericetorum

Japewia tornoensis

Juncus biglumis

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Juncus castaneus
Juncus triglumis var. ablescens
Juncus triglumis var. triglumis
Kobresia simpliciuscula
Lecanora bicincta
Lecanora epibryon
Lecanora hagenii
Lecanora polytropa
Lecanora rupicola
Lecanora torrida
Lecidea confluens
Lecidea diducens
Lecidea lapicida group
Lecidoma demissum
Leptogium imbricatum
Lichenomphalia umbellifera
Loiseleuria procumbens
Luzula confusa
Luzula wahlenbergii
Masonhalea richardsonii
Massalongia carnosa
Melanelia disjuncta
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (fruticose form)
Melanelia stygia (normal form)
Melanelia? (isidiate)
Melanohalea infumata
Micranthes foliolosa
Micranthes nelsoniana ssp. porsildiana
Minuartia obtusiloba
Minuartia rubella
Mycobilimbia carneoalbida
Mycoblastus alpinus
Ochrolechia androgyna
Ochrolechia frigida
Ochrolechia gyalectina
Ochrolechia upsaliensis
Odontoschisma elongatum
Ophioparma ventosa

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Oxyria digyna

Oxytropis arctica

Oxytropis maydelliana

Oxytropis nigrescens var. uniflora

Papaver radicatum ssp. radicatum

Parmelia fraudans

Parmelia omphalodes

Parmelia sulcata

Parmeliopsis ambigua

Parnassia palustris

Pedicularis labradorica

Pedicularis lapponica

Pedicularis sudetica

Peltigera aphthosa

Peltigera cf. praetextata (form with minute, appressed lobules)

Peltigera conspersa ined.

Peltigera didactyla

Peltigera extenuata

Peltigera lepidophora

Peltigera malacea

Peltigera neorufescens

Peltigera ponojensis

Peltigera rufescens

Peltigera scabrosa

Pertusaria coriacea

Pertusaria dactylina

Pertusaria geminipara

Pertusaria panyrga

Phaeophyscia constipata

Phaeophyscia sciastra

Philonotis fontana var. fontana

Physcia dubia

Physconia muscigena (normal form)

Pinguicula villosa

Placynthiella uliginosa

Placynthium asperellum

Placynthium flabellosum

Placynthium nigrum

Poa arctica ssp. arctica

Poa glauca ssp. glauca

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Poa laxa ssp. fernaldiana
Pohlia nutans
Polysporina simplex
Polytrichum juniperinum
Polytrichum piliferum
Polytrichum stricum
Porpidia flavicunda
Porpidia ochrolemma
Porpidia speirea
Potentilla arenosa ssp. arenosa
Potentilla arenosa x nivea
Potentilla hyparctica ssp. elatior
Potentilla nivea
Protomicarea limosa
Protopannaria sp. nov.
Pseudephebe minuscula
Pseudephebe pubescens
Ptilidium ciliare
Ptychostomum pseudotriquetrum
Racomitrium lanuginosum
Ranunculus aquatilis
Ranunculus flammula
Ranunculus hyperboreus
Ranunculus pallasii (observed around pond near camp after field day)
Ranunculus pygmaeus
Ranunculus sabinei
Rhizocarpon atroflavescens
Rhizocarpon inarense
Rhizocarpon norvegicum
Rhizocarpon unknown species (large, clustered, bullate areoles, brilliant yellow)
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rimularia impavida
Rinodina mniaraea var. mniaraea
Rinodina notabilis
Rinodina turfacea
Rubus chamaemorus
Salix arctica
Salix arctophila

(continued)

Site 6 July 24, 2012 - Vicinity of George Camp, around infrastructure to south and back north along eskers (continued)

Salix glauca var. cordifolia

Salix herbacea

Salix ovalifolia

Salix planifolia

Salix reticulata

Salix richardsonii

Salix sp. nov. (esker tops)

Saussurea angustifolia

Saxifraga cernua

Saxifraga hyperborea

Saxifraga oppositifolia ssp. smalliana

Saxifraga tricuspidata

Scorpidium cossonii

Scorpidium revolvens

Scorpidium scorpioides

Silene acaulis

Silene involucrata

Siphula ceratites

Solorina crocea

Sparganium hyperboreum

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum capillifolium

Sphagnum fuscum

Sphagnum lindbergii

Sphagnum squarrosum

Sphagnum steerei

Splachnum sphaericum

Stellaria edwardsii

Stellaria monantha

Stereocaulon arcticum

Stereocaulon arenarium

Stereocaulon condensatum

Stereocaulon cumulatum

Stereocaulon glareosum

Stereocaulon paschale

Straminergon stramineum

Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)

Tephromela atra

Tephroseris frigida

Tetralophozia setiformis

Thamnolia vermicularis
Tofieldia coccinea
Tofieldia pusilla
Tremolecia atrata
Trentepohlia cf. aurea
Trichophorum cespitosum
Trisetum spicatum
Umbilicaria cinereorufescens
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria proboscidea
Vaccinium uliginosum
Vaccinium vitis-idaea
Vulpicida pinastri
Woodsia glabella
Xanthomendoza borealis
Xanthoparmelia wyomingica agg.
Xanthoria elegans
Xanthoria sorediata

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula

Achillea millefolium var. alpinum
Alectoria ochroleuca
Alnus viridis ssp. crispa
Alopecurus magellanicus
Andromeda polifolia
Anemone parviflora
Antennaria alpina
Antennaria monocephala
Anthelia juratzkana
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctophila fulva
Arctous alpina
Arenaria humifusa
Argentina egedii
Armeria maritima
Artemisia borealis
Artemisia tilesii

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Arthonia mediella
Asahinea chrysantha
Astragalus alpinus
Aulacomnium palustre
Aulacomnium turgidum
Baeomyces placophyllus
Betula nana
Biatora efflorescens
Biatora pallens
Biatora subduplex
Bistorta vivipara
Bryocaulon divergens
Bryoria nitidula
Bryum argenteum
Buellia punctata
Calamagrostis lapponica
Calamagrostis stricta
Caloplaca tetraspora
Caltha palustris
Candelariella vitellina
Cardamine digitata
Carex aquatilis
Carex atrofusca
Carex bicolor
Carex bigelowii
Carex bigelowii (marine form with inflorescence much shorter than leaves)
Carex capillaris
Carex chordorrhiza
Carex glareosa var. amphigena
Carex holostoma
Carex lachenalii
Carex mackenziei
Carex maritima
Carex microglochin
Carex rariflora
Carex rotundata
Carex saxatilis
Carex scirpoidea
Carex ursina
Carex vaginata

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Cassiope tetragona var. tetragona
Castilleja elegans
Cephaloziella arctica
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria andrejevii
Cetraria ericetorum ssp. ericetorum
Cetraria islandica ssp. crispiformis
Cetraria sepincola
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia acuminata
Cladonia amaurocrea
Cladonia bellidiflora
Cladonia borealis
Cladonia cariosa
Cladonia carneola
Cladonia cervicornis
Cladonia cf. squamosa (minute squamules)
Cladonia cf. macroceras
Cladonia chlorophaea group
Cladonia cornuta
Cladonia cyanipes
Cladonia decorticata
Cladonia deformis
Cladonia ecymocyna sensu lato (base blackening, undescribed species?)
Cladonia gracilis ssp. elongata
Cladonia maxima?
Cladonia pyxidata
Cladonia scotteri
Cladonia subfurcata
Cladonia sulphurina
Cladonia uncialis
Cochlearia groenlandica (short form)
Cochlearia groenlandica (tall form)
Collema ceraniscum
Comarum palustre
Corallorhiza trifida

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Cyrtomnium hymenophyllum
Dactylina arctica
Deschampsia caespitosa
Diapensia lapponica
Dicranum acutifolium
Dimelaena oreina
Draba arabisans
Draba glabella (normal form)
Draba nivalis
Dryas integrifolia
Dupontia fisheri ssp. fischeri
Dupontia fisheri ssp. psilosantha
Eleocharis palustris sensu lato (E. mamillata)
Empetrum nigrum
Epilobium angustifolium
Epilobium arcticum
Epilobium latifolium
Equisetum arvense
Erigeron uniflorus
Eriophorum angustifolium ssp. triste
Eriophorum vaginatum
Erysimum coarctatum
Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)
Flavocetraria cucullata
Flavocetraria nivalis
Gentianella tenella
Gowardia nigricans
Hedysarum alpinum
Hippuris tetraphylla
Honckenya peploides
Huperzia arctica
Hylocomium splendens
Hypnum cupressiforme var. cupressiforme
Hypogymnia physodes
Japewia subaurifera
Japewia tornoensis
Juncus arcticus var. alaskanus
Juncus biglumis
Juncus castaneus
Juncus triglumis var. ablescens

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Koenigia islandica
Lathyrus japonicus
Lecanora epibryon
Lecanora fuscescens
Lecanora hagenii
Lecanora polytropa
Lecanora pulicaris
Lecanora unknown (similar to L. argopholis, apothecial rim strongly undulating, disc gaping and black)
Lecidea lapicida group
Lecidea pullata
Lecidea turficola
Lecidella stigmatea
Leymus mollis
Lobaria linita
Loiseleuria procumbens
Lomatogonium rotatum
Lupinus arcticus ssp. arcticus
Luzula confusa
Luzula groenlandica
Marchantia polymorpha
Masonhalea richardsonii
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (fruticose form)
Mertensia maritima
Minuartia rubella
Montia fontana
Nephroma expallidum
Niphotrichum panschii
Ochrolechia frigida
Ochrolechia gyalectina
Ophioparma ventosa
Orthotrichum alpestre
Orthotrichum pylaisii
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Papaver radicatum ssp. radicatum
Parmelia fraudans
Parmelia friabilis ined.

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Parmelia omphalodes
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia kotzebuei
Parnassia palustris
Pedicularis flammea
Pedicularis labradorica
Pedicularis lanata
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera canina
Peltigera conspersa ined.
Peltigera didactyla
Peltigera extenuata
Peltigera leucophlebia
Peltigera malacea
Peltigera rufescens
Peltigera scabrosa
Peltigera sp. nov. (aff. britannica)
Pertusaria dactylina
Philonotis fontana var. fontana
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula vulgaris
Plantago canescens
Platanthera obtusata
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Polytrichum piliferum
Polytrichum stricum
Potentilla arenosa ssp. arenosa
Potentilla hyparctica ssp. hyparctica
Primula egaliksensis
Pseudephebe minuscula
Pseudephebe pubescens
Psoroma hypnorum

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (continued)

Ptilidium ciliare

Ptychostomum inclinatum

Ptychostomum pallescens

Puccinellia andersonii

Puccinellia angustata? (but anthers far too large)

Puccinellia arctica

Puccinellia phryganodes

Puccinellia sp. nov.

Puccinellia sp. (purple leaves)

Puccinellia tenella

Pycnora leucococca

Pyrola grandiflora

Racomitrium lanuginosum

Ranunculus cymbalaria

Ranunculus hyperboreus

Rhizocarpon eupetraeum

Rhododendron lapponicum

Rhododendron tomentosum

Rhytidium rugosum

Rinodina terrestris

Rinodina turfacea

Rubus chamaemorus

Sagina nivalis

Salix arctica

Salix glauca var. cordifolia

Salix glauca var. stipulata

Salix herbacea

Salix niphoclada

Salix planifolia

Salix reticulata

Salix richardsonii

Sanionia uncinata

Saxifraga hirculus

Saxifraga hyperborea

Saxifraga tricuspidata

Schistidium frisvolleanum

Schistidium holmenianum

Scorpidium scorpioides

Silene acaulis

Silene involucrata

(continued)

Site 7 July 25, 2012 - Bathurst Inlet, peninsula at northern end of study area, walked along shore around peninsula then around the south-opening bay at west side of peninsula (completed)

Solorina crocea

Sparganium hyperboreum

Sphaerophorus globosus

Sphagnum fuscum

Stellaria humifusa

Stellaria longipes

Stellaria monantha

Stereocaulon paschale

Suaeda calceoliformis

Symphyotrichum pygmaeum

Syntrichia montana

Taraxacum ceratophorum aggr. (calyculus bractlets grading into phyllaries, moderately horned, leaves ascending with long, attenuate often retrorse lobes, on saline clay and sand)

Tephroseris frigida

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Tomentypnum nitens

Trichophorum cespitosum

Triglochin maritima

Triglochin palustris

Tripleurospermum maritimum ssp. phaeocephalum

Trisetum spicatum

Tritomaria polita ssp. polymorpha

Tritomaria quinquedentata

Umbilicaria deusta

Umbilicaria hyperborea

Umbilicaria proboscidea

Umbilicaria torrefacta

Vaccinium uliginosum

Vaccinium vitis-idaea

Viola palustris

Vulpicida pinastri

Xanthoria elegans

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas

Agrostis mertensii
Alectoria ochroleuca
Allantoparmelia almquistii
Anastrophyllum minutum
Andreaea rupestris (form of alkaline depressions)
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Aneura pinguis
Antennaria alpina
Antennaria friesiana
Antennaria porsildii
Antennaria rosea ssp. confinis
Anthoxanthum monticola
Aplodon wormskjoldii
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctous alpina
Arenaria humifusa
Armeria maritima
Arnica angustifolia
Arthonia varia
Asahinea chrysantha
Asahinea scholanderi
Astragalus alpinus
Aulacomnium palustre
Aulacomnium turgidum
Bellemerea subsorediza
Betula nana
Bistorta vivipara
Brachythecium frigidum?
Bryocaulon divergens
Bryonora rhypariza
Bryoria simplicior
Bryum argenteum
Bryum lanatum
Calamagrostis lapponica
Calamagrostis purpurascens
Caloplaca cerina
Caloplaca citrina
Caloplaca holocarpa

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Candelariella kuusamoensis
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Cardamine nymanii
Carex aquatilis
Carex atrofusca
Carex bigelowii
Carex capillaris
Carex fuliginosa
Carex holostoma
Carex lachenalii
Carex membranacea
Carex rariflora
Carex rotundata
Carex rupestris
Carex saxatilis
Carex scirpoidea
Carex supina ssp. spaniocarpa
Carex vaginata
Cassiope tetragona var. tetragona
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria ericetorum ssp. ericetorum
Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria islandica ssp. islandica
Cetraria sepincola
Chrysosplenium rosendahlii
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia borealis
Cladonia coccifera
Cladonia crispata
Cladonia gracilis ssp. elongata
Cladonia macrophylla
Cladonia pocillum

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Cladonia trassii
Cladonia uncialis
Collema ceraniscum
Collema glebulentum
Collema undulatum
Comarum palustre
Conostomum tetragonum
Dactylina arctica
Diapensia lapponica
Dibaeis baeomyces
Dicranum acutifolium
Dicranum spadiceum
Dimelaena oreina
Diploschistes sp. nov.
Ditrichum gracile
Draba juvenilis?
Draba lactea
Draba nivalis
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. psilosantha
Empetrum nigrum
Encalypta brevicollis
Encalypta rhabtocarpa
Encalypta vulgaris
Ephebe lanata
Epilobium angustifolium
Epilobium latifolium
Equisetum arvense
Erigeron humilis
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum scheuchzeri
Eriophorum vaginatum
Festuca brachyphylla
Flavocetraria cucullata
Flavocetraria nivalis
Grimmia longirostris
Gymnomitrion corallioides
Hedysarum alpinum
Huperzia arctica

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Hylocomium splendens
Hypnum cupressiforme var. cupressiforme
Hypogymnia bitteri
Hypogymnia physodes
Icmadophila ericetorum
Juncus biglumis
Juncus castaneus
Juncus triglumis var. ablescens
Juncus triglumis var. triglumis
Lasallia pensylvanica
Lecanora bicincta
Lecanora epibryon
Lecanora polytropa
Lecanora swartzii
Lecidea auriculata
Lecidea lapicida group
Lecidella euphorea
Lecidella stigmatea
Lecidoma demissum
Lempholemma intricatum
Lempholemma polyanthes
Lichenomphalia hudsoniana
Loiseleuria procumbens
Lopadium pezizoideum
Luzula confusa
Luzula wahlenbergii
Marchantia polymorpha
Marsupella emarginata
Masonhalea richardsonii
Massalongia carnosa
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (fruticose form)
Melanelia tominii
Melanohalea infumata
Micranthes foliolosa
Micranthes nelsoniana ssp. porsildiana
Minuartia obtusiloba
Minuartia rubella
Myxobilimbia lobulata
Ochrolechia frigida

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Ochrolechia grimmiae
Ochrolechia gyalectina
Ochrolechia sp. nov.
Ophioparma ventosa
Orphniospora moriformis
Orthotrichum alpestre
Orthotrichum pylaisii
Orthotrichum speciosum
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Parmelia fraudans
Parmelia omphalodes
Parmelia sulcata
Parnassia kotzebuei
Pedicularis flammea
Pedicularis labradorica
Pedicularis lapponica
Pedicularis sudetica
Peltigera didactyla
Peltigera malacea
Peltigera rufescens
Pertusaria bryontha
Pertusaria oculata
Pertusaria ophthalmiza group
Petasites sagittatus
Phaeophyscia constipata
Phaeophyscia orbicularis
Phaeophyscia sciastra
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula villosa
Placynthiella oligotropha
Placynthium asperellum
Plagiomnium ellipticum
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Pogonatum urnigerum
Polytrichum piliferum
Polytrichum stricum

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Potentilla arenosa ssp. arenosa

Potentilla hyparctica ssp. elatior

Potentilla nivea

Protopannaria pezizoides

Protoparmelia badia

Pseudephebe minuscula

Pseudephebe pubescens

Pseudocalliergon brevifolium

Pseudocalliergon turgescens

Pseudotaxiphyllum elegans

Ptychostomum pseudotriquetrum

Pyrola grandiflora

Racomitrium lanuginosum

Radula complanata

Ranunculus flammula

Ranunculus hyperboreus

Ranunculus lapponicus

Ranunculus pygmaeus

Ranunculus sabinei

Rhizocarpon atroflavescens

Rhizocarpon chioneum

Rhizocarpon lavatum

Rhizoplaca melanophthalma

Rhododendron lapponicum

Rhododendron tomentosum

Rhytidium rugosum

Rinodina notabilis

Rubus chamaemorus

Salix arctica

Salix arctophila

Salix glauca var. cordifolia

Salix herbacea

Salix planifolia

Salix reticulata

Salix richardsonii

Salix sp nov (esker tops)

Saussurea angustifolia

Saxifraga cernua

Saxifraga hyperborea

Saxifraga oppositifolia ssp. smalliana

Saxifraga tricuspidata

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (continued)

Scapania paludicola

Schistidium rivulare

Schistochilopsis incisa

Scorpidium revolvens

Scorpidium scorpioides

Sibbaldia procumbens

Silene acaulis

Silene involucrata

Siphula ceratites

Solorina crocea

Sparganium hyperboreum

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum capillifolium

Sphagnum centrale

Sphagnum compactum

Sphagnum contortum

Sphagnum fuscum

Sphagnum lenense

Sphagnum squarrosum

Sporastatia testudinea

Stellaria monantha

Stereocaulon condensatum

Stereocaulon glareosum

Stereocaulon paschale

Stereocaulon tomentosum

Straminergon stramineum

Syntrichia norvegica

Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)

Tephromela atra

Tephroseris frigida

Tetralophozia setiformis

Tetraplodon mnioides

Tetraplodon paradoxus

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Toninia tristis ssp. canadensis

Tortella tortuosa var. arctica

Tortella tortuosa var. tortuosa

Tortula leucostoma

(continued)

Site 8 July 27, 2012 - North of George Camp, proposed footprint areas (completed)

Trapeliopsis granulosa
Trentepohlia cf. aurea
Trichophorum cespitosum
Trisetum spicatum
Tritomaria quinquedentata
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria muhlenbergii
Umbilicaria proboscidea
Umbilicaria torrefacta
Umbilicaria vellaea
Vaccinium uliginosum
Vaccinium vitis-idaea
Vulpicida tilesii
Woodsia glabella
Xanthomendoza borealis
Xanthoparmelia wyomingica agg.
Xanthoria elegans

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus

Acarospora molybdina
Achillea millefolium var. alpinum
Alectoria ochroleuca
Allantoparmelia alpicola
Allantoparmelia cf. sibirica
Alnus viridis ssp. crispa
Aloina rigida
Alopecurus magellanicus
Anastrophyllum minutum
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone richardsonii
Aneura pinguis
Antennaria friesiana
Anthelia juratzkana
Anthoxanthum monticola
Aplodon wormskjoldii
Arabidopsis arenicola
Arctagrostis latifolia

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Arctomia?

Arctoparmelia centrifuga

Arctoparmelia incurva

Arctophila fulva

Arctous alpina

Argentina egedii

Armeria maritima

Artemisia borealis

Artemisia tilesii

Asahinea chrysantha

Asahinea scholanderi

Aspicilia verrucosa

Astragalus alpinus

Astragalus australis var. lepagei

Astragalus eucosmus

Aulacomnium palustre

Aulacomnium turgidum

Betula nana

Bistorta vivipara

Bromus pumpellianus

Bryocaulon divergens

Bryoria nitidula

Bryoria simplicior

Bryum argenteum

Calamagrostis canadensis

Calamagrostis lapponica

Caloplaca cerina

Caloplaca saxicola

Caltha palustris

Calvitimela talayana

Campylium protensum

Candelariella aurella

Candelariella reflexa

Candelariella rosulans

Candelariella vitellina

Cardamine digitata

Cardamine nymanii

Carex aquatilis

Carex bigelowii

Carex capillaris

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Carex chordorrhiza

Carex fuliginosa

Carex glareosa var. amphigena

Carex holostoma

Carex lachenalii

Carex mackenziei

Carex maritima

Carex membranacea

Carex rariflora

Carex rotundata

Carex saxatilis

Carex scirpoidea

Carex sp. nov. (section Phacocystis)

Carex supina ssp. spaniocarpa

Carex vaginata

Cassiope tetragona var. tetragona

Castilleja elegans

Cerastium alpinum ssp. lanatum

Ceratodon purpureus

Cetraria ericetorum ssp. ericetorum

Cetraria fastigiata

Cetraria hepatizon

Cetraria islandica ssp. crispiformis

Cetraria islandica ssp. islandica

Cetraria nigricans

Cetraria odontella

Cetraria sepincola

Cladina mitis

Cladina rangiferina

Cladina stellaris

Cladina stygia

Cladonia amaurocrea

Cladonia borealis

Cladonia cariosa

Cladonia cervicornis

Cladonia cf. macroceras

Cladonia coccifera

Cladonia gracilis ssp. elongata

Cladonia macrophylla

Cladonia pocillum

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Cladonia pyxidata
Cladonia sulphurina
Cladonia uncialis
Coelocaulon aculeatum
Comarum palustre
Corallorhiza trifida
Dactylina arctica
Deschampsia caespitosa
Diapensia lapponica
Dicranum acutifolium
Didymodon rigidulus var. gracilis
Dimelaena oreina
Draba arabisans
Draba glabella (normal form)
Draba nivalis
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. fischeri
Dupontia fisheri ssp. psilosantha
Empetrum nigrum
Epilobium angustifolium
Epilobium arcticum
Epilobium latifolium
Epilobium palustre
Equisetum arvense
Eriophorum angustifolium ssp. triste
Eriophorum vaginatum
Erysimum coarctatum
Festuca brachyphylla
Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)
Flavocetraria cucullata
Flavocetraria nivalis
Galium trifidum
Gentianella tenella
Gymnomitrion corallioides
Hedysarum alpinum
Hedysarum boreale
Hippuris tetraphylla
Hippuris vulgaris
Honckenya peploides

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Hordeum jubatum var. jubatum
Huperzia arctica
Hylocomium splendens
Hypogymnia bitteri
Hypogymnia physodes
Icmadophila ericetorum
Juncus arcticus var. alaskanus
Juncus castaneus
Juncus triglumis var. ablescens
Lathyrus japonicus
Lecanora epibryon
Lecanora hagenii
Lecanora polytropa
Lecanora stenotropa
Lecanora zosterae
Leptogium imbricatum
Leymus mollis
Lobaria linita
Loiseleuria procumbens
Lomatogonium rotatum
Lopadium pezizoideum
Lupinus arcticus ssp. arcticus
Luzula confusa
Luzula groenlandica
Luzula multiflora ssp. frigida
Luzula wahlenbergii
Masonhalea richardsonii
Melanelia disjuncta
Melanelia hepatizon
Melanelia panniformis
Melanelia sorediata
Melanelia stygia (normal form)
Melanelia tominii
Melanohalea septentrionalis
Mertensia maritima
Mesopytchia sahlbergii
Minuartia rubella
Montia fontana
Mycoblastus alpinus
Myrica gale

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Nephroma expallidum
Ochrolechia frigida
Ochrolechia gyalectina
Ochrolechia upsaliensis
Onchophorus wahlenbergii
Ophioparma ventosa
Orphniospora moriformis
Orthilia secunda
Oxyria digyna
Oxytropis arctica
Oxytropis hudsonica
Oxytropis maydelliana
Papaver radicatum ssp. radicatum
Parmelia fraudans
Parmelia omphalodes
Parmelia sulcata
Parmeliopsis ambigua
Parnassia kotzebuei
Parnassia palustris
Pedicularis labradorica
Pedicularis lanata
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera malacea
Peltigera praetextata
Peltigera scabrosa
Peltigera sp. nov. (aff. britannica)
Pertusaria coriacea
Pertusaria oculata
Petasites sagittatus
Phaeophyscia sciastra
Physcia alnophila
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula villosa
Pinguicula vulgaris
Placynthium asperellum
Plantago canescens

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Platanthera obtusata
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa pratensis ssp. alpigena
Polytrichum piliferum
Polytrichum stricum
Porpidia flavicunda
Potentilla arenosa ssp. arenosa
Potentilla cf. litoralis
Potentilla nivea
Primula egaliksensis
Pseudephebe minuscula
Pseudephebe pubescens
Psilolechia lucida
Psoroma hypnorum
Ptilidium ciliare
Puccinellia phryganodes
Puccinellia sp. nov.
Pyrola grandiflora
Racomitrium lanuginosum
Ranunculus cymbalaria
Ranunculus hyperboreus
Rhizocarpon oederi
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rinodina notabilis
Rubus chamaemorus
Salix alaxensis ssp. alaxensis
Salix arctica
Salix arctophila
Salix glauca var. cordifolia
Salix glauca var. stipulata
Salix herbacea
Salix niphoclada
Salix planifolia
Salix reticulata
Salix richardsonii
Saussurea angustifolia
Saxifraga hirculus

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (continued)

Saxifraga tricuspidata

Scorpidium cossonii

Silene acaulis

Solorina octospora

Sparganium hyperboreum

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum capillifolium

Sporastatia testudinea

Stellaria crassipes

Stellaria humifusa

Stellaria monantha

Stereocaulon paschale

Suaeda calceoliformis

Taraxacum ceratophorum aggr. (calyculus bractlets grading into phyllaries, moderately horned, leaves ascending with long, attenuate often retrorse lobes, on saline clay and sand)

Tayloria lingulata

Tephromela atra

Tephroseris frigida

Tetralophozia setiformis

Tetraplodon mnioides

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Tomentypnum nitens

Trapeliopsis granulosa

Tremolecia atrata

Trichophorum cespitosum

Triglochin maritima

Triglochin palustris

Tripleurospermum maritimum ssp. phaeocephalum

Trisetum spicatum

Umbilicaria deusta

Umbilicaria hyperborea

Umbilicaria proboscidea

Umbilicaria torrefacta

Usnea lapponica

Utricularia intermedia

Vaccinium uliginosum

Vaccinium vitis-idaea

(continued)

Site 9 July 28, 2012 - South end of Bathurst Inlet, around west side of estuary of Western River, then north along west shore, detour up slope to sandstone talus (completed)

Vulpicida pinastri
Xanthoria elegans

Site 10 July 29, 2012 - Proposed tailings facility south to camp

Acarospora glaucocarpa
Acarospora molybdina
Agrostis mertensii
Alectoria ochroleuca
Allantoparmelia alpicola
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone parviflora
Anemone richardsonii
Aneura pinguis
Antennaria alpina
Antennaria friesiana
Antennaria monocephala
Antennaria porsildii
Antennaria rosea ssp. confinis
Antennaria rosea ssp. pulvinata
Anthelia juratzkana
Anthoxanthum arcticum
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctoparmelia separata
Arctophila fulva
Arctous alpina
Armeria maritima
Arnica angustifolia
Artemisia tilesii
Asahinea chrysantha
Asahinea scholanderi
Aspicilia simoensis?
Astragalus alpinus
Aulacomnium palustre
Aulacomnium turgidum
Baeomyces placophyllus

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Bartramia ithyphylla
Betula nana
Biatora pallens
Bistorta vivipara
Brachythecium salebrosum
Bryonora castanea
Bryonora pruinosa
Bryoria nitidula
Bryum argenteum
Calamagrostis canadensis
Calamagrostis lapponica
Calamagrostis purpurascens
Calamagrostis stricta
Calliergon cordifolium
Caloplaca cerina
Caloplaca ferruginea
Caloplaca jungermanniae
Caloplaca tirolensis?
Campanula uniflora
Campylium protensum
Campylopus schimperi
Candelariella reflexa
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Cardamine nymanii
Carex aquatilis
Carex atrofusca
Carex bigelowii
Carex capillaris
Carex capitata var. arctogena
Carex chordorrhiza
Carex holostoma
Carex lachenalii
Carex marina
Carex nardina
Carex rariflora
Carex rotundata
Carex rupestris
Carex saxatilis

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Carex scirpoidea
Carex supina ssp. spaniocarpa
Carex vaginata
Cassiope tetragona var. tetragona
Catapyrenium daedaleum
Cephaloziella arctica
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria andrejevii
Cetraria ericetorum ssp. ericetorum
Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria nigricans
Cetraria sepincola
Chrysosplenium rosendahlii
Cinclidium arcticum
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia borealis
Cladonia cariosa
Cladonia cervicornis
Cladonia cf. macroceras
Cladonia gracilis ssp. elongata
Cladonia macrophylla
Cladonia pocillum
Cladonia pyxidata
Cladonia scotteri
Cladonia sulphurina
Cladonia uncialis
Climacium dendroides
Coelocaulon aculeatum
Collema undulatum
Comarum palustre
Cystopteris cf. fragilis
Dactylina arctica
Dactylina ramulosa
Deschampsia caespitosa
Deschampsia sukatschewii

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Diapensia lapponica
Dibaeis baeomyces
Dicranum acutifolium
Dicranum elongatum
Dicranum spadiceum
Didymodon rigidulus var. gracilis
Dimelaena oreina
Distichum capillaceum
Ditrichum flexicaule
Draba arabisans
Draba crassifolia
Draba fladnizensis
Draba lactea
Draba nivalis
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. fischeri
Dupontia fisheri ssp. psilosantha
Eleocharis acicularis
Empetrum nigrum
Epilobium angustifolium
Epilobium latifolium
Equisetum arvense
Equisetum scirpoides
Equisetum variegatum
Erigeron uniflorus
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum scheuchzeri
Eriophorum vaginatum
Eutrema edwardsii
Festuca brachyphylla
Flavocetraria cucullata
Flavocetraria nivalis
Grimmia longirostris
Gyalecta friesii
Gymnomitrion corallioides
Hedysarum alpinum
Hippuris vulgaris
Huperzia arctica
Hylocomium splendens

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Hypnum revolutum var. revolutum
Hypogymnia bitteri
Hypogymnia dichroma
Hypogymnia physodes
Hypogymnia subobscura (in the traditional sense)
Icmadophila ericetorum
Japewia tornoensis
Juncus arcticus var. alaskanus
Juncus biglumis
Juncus castaneus
Juncus triglumis var. ablescens
Kobresia myosuroides
Lecanora bicincta
Lecanora chlarotera
Lecanora epibryon
Lecanora fuscescens
Lecanora hagenii
Lecanora luteovernalis
Lecanora muralis group
Lecanora polytropa
Lecanora pulicaris
Lecanora rupicola
Lecanora symmicta
Lecidea sensu lato (unknown - simple spores, brown hypothecium and Catillaria-type ascus)
Lecidea theodori?
Lecidella euphorea
Leptogium imbricatum
Leptogium intermedium
Loiseleuria procumbens
Lopadium pezizoideum
Luzula confusa
Luzula nivalis
Luzula spicata
Luzula wahlenbergii
Masonhalea richardsonii
Meesia triquetra
Melanelia disjuncta
Melanelia hepatizon
Melanelia stygia (fruticose form)
Melanohalea infumata
Melanohalea septentrionalis

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Mesopytchia sahlbergii
Micarea cf. crassipes
Micranthes foliolosa
Micranthes nelsoniana ssp. porsildiana
Micranthes nivalis
Minuartia obtusiloba
Minuartia rubella
Mnium blyttii
Mycoblastus alpinus
Nephroma expallidum
Ochrolechia frigida
Ochrolechia grimmiae
Ochrolechia sp. nov.
Ochrolechia upsaliensis
Odontoschisma macounii
Onchophorus wahlenbergii
Ophioparma ventosa
Orphniospora moriformis
Orthotrichum speciosum
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Oxytropis nigrescens var. uniflora
Parmelia fraudans
Parmelia omphalodes
Parmelia skultii
Parmelia sulcata
Parmeliopsis ambigua
Parnassia kotzebuei
Pedicularis hirsuta
Pedicularis labradorica
Pedicularis lanata
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera leucophlebia
Peltigera malacea
Peltigera rufescens
Peltigera scabrosa
Peltigera sp. nov. (aff britannica)
Pertusaria coriacea

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Pertusaria dactylina
Pertusaria oculata
Pertusaria panyrga
Phaeophyscia constipata
Phaeophyscia orbicularis
Phaeophyscia sciastra
Philonotis fontana var. fontana
Phyllodoce caerulea
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula vulgaris
Placynthium asperellum
Placynthium nigrum
Placynthium pulvinatum
Plagiomnium ellipticum
Pleopsidium chlorophanum
Pleurozium schreberi
Poa alpina
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa pratensis ssp. alpigena
Pohlia nutans
Polychidium muscicola
Polytrichum stricum
Porpidia flavicunda
Porpidia ochrolemma
Porpidia unknown (like P. speirea, but with small, waxy, dispersed areoles and smaller spores)
Potentilla arenosa ssp. arenosa
Potentilla hyparctica ssp. elatior
Potentilla nivea
Preissia quadrata
Protopannaria sp. nov.
Pseudephebe minuscula
Pseudephebe pubescens
Pseudocalliergon turgescens
Psilolechia lucida
Psilopilum cavifolium
Psilopilum laevigatum
Psoroma hypnorum

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Ptilidium ciliare
Ptychostomum pendulum
Ptychostomum pseudotriquetrum
Pyrola grandiflora
Racomitrium lanuginosum
Ranunculus gmelinii
Ranunculus lapponicus
Ranunculus sabinei
Rhizocarpon atroflavescens
Rhizocarpon unknown species (large, clustered, bullate areoles, brilliant yellow)
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rinodina orculata
Rinodina terrestris
Rubus chamaemorus
Salix arctica
Salix glauca var. cordifolia
Salix herbacea
Salix planifolia
Salix reticulata
Sanionia uncinata
Saussurea angustifolia
Saxifraga cernua
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Schistidium frisvolleanum
Schistidium holmenianum
Schistidium rivulare
Scorpidium cossonii
Scorpidium scorpioides
Sibbaldia procumbens
Silene acaulis
Silene involucrata
Silene uralensis ssp. uralensis
Solorina bispora
Solorina crocea
Solorina octospora
Sparganium hyperboreum
Sphaerophorus fragilis
Sphaerophorus globosus

(continued)

Site 10 July 29, 2012 - Proposed tailings facility south to camp (continued)

Sphagnum capillifolium
Sphagnum fuscum
Sphagnum sp. nov. "up" (same as at Courageous Lake)
Sphagnum squarrosum
Spilonema revertens
Sporastatia testudinea
Stellaria edwardsii
Stellaria monantha
Stereocaulon condensatum
Stereocaulon glareosum
Stereocaulon paschale
Syntrichia norvegica
Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)
Tayloria lingulata
Tephromela atra
Tephroseris frigida
Tetralophozia setiformis
Tetraplodon mnioides
Thamnolia vermicularis
Tofieldia coccinea
Tofieldia pusilla
Tomentypnum nitens
Tortella tortuosa var. tortuosa
Tremolecia atrata
Trentepohlia cf. aurea
Trichophorum cespitosum
Trisetum spicatum
Umbilicaria cinereorufescens
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria proboscidea
Umbilicaria torrefacta
Usnea lapponica
Vaccinium uliginosum
Vaccinium vitis-idaea
Warnstorfia pseudostraminea
Woodsia glabella
Xanthomendoza borealis
Xanthoria elegans
Xanthoria sorediata

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts

Abietinella abietina

Acarospora molybdina

Achillea millefolium var. alpinum

Alectoria ochroleuca

Allantoparmelia alpicola

Alnus viridis ssp. crispa

Alopecurus magellanicus

Anaptychium bryorum

Andreaea rupestris (form with straight leaves)

Andromeda polifolia

Androsace septentrionalis

Anemone parviflora

Anemone richardsonii

Aneura pinguis

Antennaria alpina

Antennaria friesiana

Antennaria monocephala

Antennaria porsildii

Anthelia juratzkana

Anthoxanthum monticola

Arctagrostis latifolia

Arctoparmelia centrifuga

Arctoparmelia incurva

Arctoparmelia separata

Arctophila fulva

Arctous alpina

Arenaria humifusa

Armeria maritima

Arnica angustifolia

Artemisia tilesii

Arthrorhaphis alpina

Asahinea chrysantha

Asahinea scholanderi

Aspicilia verrucosa

Astragalus alpinus

Astragalus australis var. lepagei

Aulacomnium palustre

Aulacomnium turgidum

Bacidia bagliettoana

Betula nana

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (completed)

Bistorta vivipara
Bromus pumpellianus
Bryocaulon divergens
Bryoria nitidula
Bryoria tenuis
Bryum argenteum
Bryum lanatum
Calamagrostis canadensis
Calamagrostis lapponica
Calamagrostis purpurascens
Caloplaca ammiospila
Caloplaca cerina
Caloplaca cf. decipiens
Caloplaca erichansenii
Caloplaca jungermanniae
Caloplaca livida
Caloplaca saxicola
Caloplaca scopularis
Caloplaca trachyphylla
Caltha palustris
Candelariella canadensis
Candelariella rosulans
Candelariella vitellina
Cardamine bellidifolia
Cardamine digitata
Cardamine nymanii
Carex aquatilis
Carex atrofusca
Carex bigelowii
Carex capillaris
Carex chordorrhiza
Carex fuliginosa
Carex lachenalii
Carex maritima
Carex membranacea
Carex nardina
Carex rariflora
Carex rotundata
Carex saxatilis
Carex scirpoidea

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Carex sp. nov. (section Phacocystis)
Carex supina ssp. spaniocarpa
Carex tenuiflora
Carex vaginata
Cassiope tetragona var. tetragona
Castilleja elegans
Catapyrenium cinereum
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria andrejevii
Cetraria ericetorum ssp. ericetorum
Cetraria fastigiata
Cetraria islandica ssp. crispiformis
Cetraria sepincola
Chrysosplenium rosendahlii
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia borealis
Cladonia coccifera
Cladonia cyanipes
Cladonia gracilis ssp. elongata
Cladonia macrophylla
Cladonia pyxidata
Cladonia trassii
Cladonia uncialis
Climacium dendroides
Collema crispum
Collema glebulentum
Collema tenax
Collema undulatum
Comarum palustre
Cystopteris cf. fragilis
Dactylina arctica
Dermatocarpon intestiniforme
Dermatocarpon miniatum var. complicatum
Dermatocarpon miniatum var. miniatum
Diapensia lapponica

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Dicranum acutifolium
Dicranum spadiceum
Dimelaena oreina
Draba arabisans
Draba cinerea
Draba fladnizensis
Draba lactea
Draba nivalis
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. fischeri
Elymus alaskanus
Elymus violaceus
Empetrum nigrum
Encalypta rhabtocarpa
Endocarpon pulvinatum
Ephebe lanata
Epilobium angustifolium
Epilobium latifolium
Equisetum arvense
Equisetum variegatum
Erigeron humilis
Erigeron uniflorus
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum scheuchzeri
Eriophorum vaginatum
Eutrema edwardsii
Festuca brachyphylla
Fissidens cf. pellucidus
Flavocetraria cucullata
Flavocetraria nivalis
Fulgensia bracteata
Fuscopannaria praetermissa sensu lato
Fuscopannaria sp. nov.
Grimmia longirostris
Gyroweisia tenuis?
Hedysarum alpinum
Hippuris vulgaris
Huperzia arctica

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Hylocomium splendens

Hypogymnia bitteri

Hypogymnia physodes

Hypogymnia subobscura (in the traditional sense)

Hypogymnia subobscura (non-isidiate form)

Icmadophila ericetorum

Juncus arcticus var. alaskanus

Juncus biglumis

Juncus castaneus

Juncus triglumis var. triglumis

Kobresia myosuroides

Kobresia sibirica

Lecanora argopholis

Lecanora bicincta

Lecanora epibryon

Lecanora hagenii

Lecanora luteovernalis

Lecanora polytropa

Lecanora rupicola

Lecanora stenotropa

Lecidella stigmatea

Leciophysma finmarkicum

Lempholemma isidioides?

Lempholemma polyanthes

Lepraria lobificans

Leptogium imbricatum

Leptogium saturninum

Leymus mollis

Lichinella nigritella

Lobothallia melanspis

Loiseleuria procumbens

Lupinus arcticus ssp. arcticus

Luzula confusa

Luzula groenlandica

Luzula multiflora ssp. frigida

Luzula nivalis

Luzula wahlenbergii

Lycopodium annotinum ssp. pungens

Marchantia polymorpha

Masonhalea richardsonii

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Melanelia disjuncta
Melanelia hepatizon
Melanelia stygia (fruticose form)
Melanelia stygia (normal form)
Melanelia tominii
Micranthes foliolosa
Micranthes nelsoniana ssp. porsildiana
Micranthes nivalis
Micranthes tenuis
Minuartia obtusiloba
Minuartia rubella
Nephroma arcticum
Nephroma expallidum
Ochrolechia frigida
Ochrolechia upsaliensis
Ophioparma ventosa
Orthilia secunda
Orthotrichum rupestre
Orthotrichum speciosum
Oxyria digyna
Oxytropis arctica
Oxytropis hudsonica
Oxytropis maydelliana
Oxytropis nigrescens var. uniflora
Papaver radicatum ssp. radicatum
Parmelia fraudans
Parmelia omphalodes
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Parnassia kotzebuei
Pedicularis hirsuta
Pedicularis labradorica
Pedicularis lanata
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera cf. lyngei
Peltigera cf. praetextata (form with minute, appressed lobules)
Peltigera didactyla

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Peltigera malacea
Peltigera ponojensis
Peltigera praetextata
Peltigera rufescens
Peltigera scabrosa
Pertusaria coriacea
Pertusaria dactylina
Pertusaria ophthalmiza group
Pertusaria panyrga
Phaeophyscia constipata
Phaeophyscia decolor
Phaeophyscia sciastra
Phaeorrhiza nimbosa
Philonotis fontana var. pumila
Physcia caesia
Physcia dubia
Physconia muscigena (normal form)
Pinguicula villosa
Pinguicula vulgaris
Placynthium asperellum
Placynthium nigrum
Platanthera obtusata
Platismatia glauca
Poa alpina
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa laxa ssp. fernaldiana
Polytrichum juniperinum
Polytrichum piliferum
Polytrichum stricum
Porpidia flavicunda
Potentilla arenosa ssp. arenosa
Potentilla arenosa x nivea
Potentilla hyparctica ssp. elatior
Potentilla nivea
Preissia quadrata
Pseudephebe pubescens
Pseudoleskeella tectorum
Psora himalayana

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Psora rubiformis
Ptilidium ciliare
Ptychostomum cryophilum
Pycnora leucococca
Pyrola grandiflora
Racomitrium lanuginosum
Ranunculus aquatilis
Ranunculus hyperboreus
Ranunculus lapponicus
Ranunculus pygmaeus
Rhizoplaca chrysoleuca
Rhizoplaca melanophthalma
Rhododendron lapponicum
Rhododendron tomentosum
Rhytidium rugosum
Rubus chamaemorus
Sagina nivalis
Salix alaxensis ssp. alaxensis
Salix arctica
Salix arctophila
Salix glauca var. cordifolia
Salix glauca var. stipulata
Salix herbacea
Salix planifolia
Salix reticulata
Salix richardsonii
Sanionia uncinata
Sarcogyne regularis
Saussurea angustifolia
Saxifraga cernua
Saxifraga hirculus
Saxifraga hyperborea
Saxifraga oppositifolia ssp. smalliana
Saxifraga tricuspidata
Schistidium frisvolleanum
Schistidium rivulare
Scorpidium cossonii
Scorpidium scorpioides
Silene acaulis
Silene involucrata

(continued)

Site 11 July 30, 2012 - Bathurst Lake east shore at entry of winter road, around peninsula to west, thence northward to cliffs of pillow basalts (continued)

Solorina bispora

Solorina crocea

Sparganium hyperboreum

Sphaerophorus globosus

Sphagnum capillifolium

Sphagnum fuscum

Sphagnum squarrosum

Sporastatia testudinea

Staurothele areolata

Stellaria edwardsii

Stellaria monantha

Stereocaulon cumulatum

Stereocaulon paschale

Syntrichia montana

Syntrichia norvegica

Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)

Tayloria lingulata

Tephroseris frigida

Tetralophozia setiformis

Thamnolia vermicularis

Tofieldia pusilla

Tremolecia atrata

Trichophorum cespitosum

Trisetum spicatum

Umbilicaria deusta

Umbilicaria hyperborea

Umbilicaria phaea

Umbilicaria proboscidea

Umbilicaria torrefacta

Unknown lichen (sorediate latticework)

Usnea lapponica

Vaccinium uliginosum

Vaccinium vitis-idaea

Vulpicida pinastri

Xanthomendoza borealis

Xanthoparmelia taractica sensu lato

Xanthoria elegans

Xanthoria sorediata

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355

Abietinella abietina

Achillea millefolium var. alpinum

Agonimia tristicula

Alectoria ochroleuca

Allantoparmelia almquistii

Alnus viridis ssp. crispa

Alopecurus magellanicus

Amygdalaria panaeola

Andreaea rupestris (form with straight leaves)

Andromeda polifolia

Anemone richardsonii

Aneura pinguis

Antennaria alpina

Antennaria friesiana

Antennaria porsildii

Anthelia juratzkana

Anthoxanthum monticola

Arctagrostis latifolia

Arctoparmelia centrifuga

Arctoparmelia incurva

Arctoparmelia separata

Arctous alpina

Arenaria humifusa

Armeria maritima

Arnica angustifolia

Artemisia borealis

Artemisia tilesii

Asahinea chrysantha

Asahinea scholanderi

Aspicilia verrucosa

Astragalus alpinus

Aulacomnium palustre

Aulacomnium turgidum

Bacidia bagliettoana

Betula nana

Biatora cuprea

Bistorta vivipara

Bromus pumpellianus

Bryocaulon divergens

Bryonora castanea

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Bryoria nitidula

Calamagrostis lapponica

Calamagrostis purpurascens

Caloplaca (unknown, similar to Protoblastenia)

Caloplaca ammiospila

Caloplaca cerina

Caloplaca holocarpa

Candelariella canadensis

Candelariella rosulans

Cardamine digitata

Carex aquatilis

Carex atrofusca

Carex bigelowii

Carex capillaris

Carex chordorrhiza

Carex fuliginosa

Carex lachenalii

Carex rariflora

Carex rotundata

Carex scirpoidea

Carex sp. nov. (section Phacocystis)

Carex vaginata

Carex williamsii

Cassiope tetragona var. tetragona

Castilleja elegans

Cephaloziella arctica

Cerastium alpinum ssp. lanatum

Cetraria andrejevii

Cetraria fastigiata

Cetraria islandica ssp. crispiformis

Cetraria nigricans

Cetraria sepincola

Cladina arbuscula

Cladina mitis

Cladina rangiferina

Cladina stellaris

Cladina stygia

Cladonia gracilis ssp. elongata

Cladonia macrophylla

Cladonia pocillum

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Cladonia trassii
Cladonia uncialis
Comarum palustre
Cryptothele granuliformis?
Cyrtomnium hymenophylloides
Dactylina arctica
Diapensia lapponica
Dicranum acutifolium
Distichum capillaceum
Draba nivalis
Dryas integrifolia
Dupontia fisheri ssp. fischeri
Empetrum nigrum
Ephebe lanata
Epilobium angustifolium
Epilobium latifolium
Equisetum arvense
Erigeron humilis
Erigeron uniflorus
Eriophorum angustifolium ssp. triste
Eriophorum vaginatum
Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)
Festuca rubra ssp. arctica (form with tan, larger lemmas with longer hairs)
Fissidens cf. pellucidus
Flavocetraria cucullata
Flavocetraria nivalis
Fuscopannaria praetermissa sensu lato
Grimmia longirostris
Gymnomitrion corallioides
Hedysarum alpinum
Honckenya peploides
Huperzia arctica
Hylocomium splendens
Hypogymnia bitteri
Hypogymnia dichroma
Hypogymnia imshaugii
Hypogymnia physodes
Icmadophila ericetorum
Illosporium carneum
Juncus arcticus var. alaskanus

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Juncus biglumis
Lathyrus japonicus
Lecanora epibryon
Lecanora luteovernalis
Lecanora polytropa
Lecidea lapicida group
Leptobryum pyriforme
Leptogium imbricatum
Leptogium tenuissimum
Leymus mollis
Lobaria scrobiculata
Loiseleuria procumbens
Lopadium coralloideum
Lopadium pezizoideum
Lupinus arcticus ssp. arcticus
Luzula confusa
Luzula groenlandica
Luzula multiflora ssp. frigida
Marchantia polymorpha
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (fruticose form)
Melanelia tominii
Melanohalea infumata
Mycoblastus alpinus
Myrinia pulvinata
Nephroma arcticum
Ochrolechia frigida
Ochrolechia gyalectina
Odontoschisma macounii
Ophioparma ventosa
Orthilia secunda
Orthotrichum anomalum
Orthotrichum pylaisii
Oxyria digyna
Oxytropis arctica
Oxytropis maydelliana
Papaver radicatum ssp. radicatum
Parmelia fraudans
Parmelia omphalodes

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Parmelia skultii

Parmelia sulcata

Parmeliopsis ambigua

Parnassia kotzebuei

Pedicularis capitata

Pedicularis labradorica

Pedicularis lapponica

Pedicularis sudetica

Peltigera canina

Peltigera extenuata

Peltigera malacea

Peltigera sp. nov. (aff. britannica)

Pertusaria coriacea

Pertusaria dactylina

Pertusaria oculata

Phaeophyscia constipata

Physcia caesia

Physcia dubia

Physconia muscigena (normal form)

Physconia perisidiosa

Platanthera obtusata

Platismatia glauca

Poa arctica ssp. arctica

Poa glauca ssp. glauca

Polyblastia gelatinosa

Polytrichum juniperinum

Polytrichum piliferum

Polytrichum stricum

Porpidia flavicunda

Potentilla arenosa ssp. arenosa

Potentilla nivea

Preissia quadrata

Protopannaria pezizoides

Protopannaria sp. nov.

Pseudephebe pubescens

Psoroma hypnorum

Ptilidium ciliare

Ptychostomum pendulum

Puccinellia sp. nov.

Pyrola grandiflora

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Racomitrium lanuginosum

Ranunculus lapponicus

Rhizoplaca melanophthalma

Rhododendron tomentosum

Rinodina turfacea

Rubus chamaemorus

Salix arctica

Salix arctophila

Salix glauca var. cordifolia

Salix glauca var. stipulata

Salix herbacea

Salix planifolia

Salix reticulata

Salix richardsonii

Saxifraga cernua

Saxifraga hyperborea

Saxifraga oppositifolia ssp. smalliana

Saxifraga tricuspidata

Schistidium frisvolleanum

Scorpidium cossonii

Silene acaulis

Silene involucrata

Solorina bispora

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum fuscum

Stellaria edwardsii

Stellaria monantha

Stereocaulon arenarium

Stereocaulon condensatum

Stereocaulon paschale

Stereocaulon tomentosum

Stuckenia filiformis ssp. alpina

Tephroseris frigida

Thamnolia vermicularis

Tofieldia coccinea

Tofieldia pusilla

Tomentypnum nitens

Trichophorum cespitosum

Trisetum spicatum

(continued)

Site 12 July 31, 2012 - Bathurst Inlet survey begins at 13 W 390314 7380452 and extends NW to 13 W 387759 7383355 (continued)

Umbilicaria deusta

Umbilicaria hyperborea

Umbilicaria torrefacta

Vaccinium uliginosum

Vaccinium vitis-idaea

Vulpicida pinastri

Woodsia glabella

Xanthoria elegans

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000

Achillea millefolium var. alpinum

Alectoria ochroleuca

Alnus viridis ssp. crispa

Alopecurus magellanicus

Amphidium lapponicum

Andreaea rupestris (form with straight leaves)

Andromeda polifolia

Androsace septentrionalis

Anemone parviflora

Anemone richardsonii

Aneura pinguis

Antennaria alpina

Antennaria friesiana

Anthoxanthum arcticum

Anthoxanthum monticola

Arctagrostis latifolia

Arctoa sp. nov.?

Arctoparmelia centrifuga

Arctophila fulva

Arctous alpina

Argentina egedii

Armeria maritima

Arnica angustifolia

Artemisia borealis

Artemisia tilesii

Asahinea chrysantha

Asahinea scholanderi

Astragalus alpinus

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Atla alpina
Aulacomnium palustre
Aulacomnium turgidum
Bartramia ithyphylla
Betula nana
Biatora cuprea
Bistorta vivipara
Bromus pumpellianus
Bryocaulon divergens
Bryoria nitidula
Bryum veronense
Calamagrostis canadensis
Calamagrostis deschampsioides
Calamagrostis lapponica
Calamagrostis purpurascens
Calamagrostis stricta
Caloplaca holocarpa
Caloplaca saxicola
Caltha palustris
Candelariella vitellina
Cardamine digitata
Carex aquatilis
Carex atrofusca
Carex bicolor
Carex bigelowii
Carex capillaris
Carex chordorrhiza
Carex glareosa var. amphigena
Carex heleonastes
Carex lachenalii
Carex mackenziei
Carex maritima
Carex membranacea
Carex microglochin
Carex rariflora
Carex rotundata
Carex saxatilis
Carex scirpoidea
Carex sp. nov. (section Phacocystis)
Carex vaginata

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Carex williamsii

Cassiope tetragona var. tetragona

Castilleja elegans

Catapyrenium cinereum

Cerastium alpinum ssp. lanatum

Cetraria andrejevii

Cetraria fastigiata

Cetraria islandica ssp. crispiformis

Cetraria sepincola

Cinclidium arcticum

Cinclidium latifolium

Cinclidium subrotundum

Cladina arbuscula

Cladina mitis

Cladina stellaris

Cladina stygia

Cladonia acuminata

Cladonia amaurocrea

Cladonia borealis

Cladonia cf. macroceras

Cladonia chlorophaea group

Cladonia gracilis ssp. elongata

Cladonia gracilis ssp. vulnerata

Cladonia macrophylla

Cladonia pocillum

Cladonia pyxidata

Cladonia stricta (centrally proliferating form)

Cladonia sulphurina

Cladonia uncialis

Cochlearia groenlandica (short form)

Collema crispum

Collema glebulentum

Comarum palustre

Corallorhiza trifida

Cyrtomnium hymenophylloides

Cystopteris cf. fragilis

Dactylina arctica

Dasiphora fruticosa

Deschampsia caespitosa

Dicranum acutifolium

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Dicranum elongatum

Distichum capillaceum

Draba arabisans

Draba glabella (normal form)

Draba glabella (odd form with large, twisted fruits)

Draba nivalis

Drepanocladus polygamus

Dryas integrifolia

Dryopteris fragrans

Dupontia fisheri ssp. fischeri

Dupontia fisheri ssp. psilosantha

Eleocharis palustris sensu lato (E. ambigens)

Eleocharis palustris sensu lato (E. mamillata)

Elymus violaceus

Empetrum nigrum

Encalypta alpina

Encalypta procera

Encalypta vittiana

Ephebe lanata

Epilobium angustifolium

Epilobium arcticum

Epilobium latifolium

Equisetum arvense

Erigeron humilis

Eriophorum angustifolium ssp. triste

Eriophorum scheuchzeri

Eriophorum vaginatum

Erysimum coarctatum

Eutrema edwardsii

Festuca brachyphylla

Festuca groenlandica

Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)

Flavocetraria cucullata

Flavocetraria nivalis

Funaria hygrometrica

Fuscopannaria praetermissa sensu lato

Gentianella propinqua ssp. arctophila

Gentianella tenella

Gowardia nigricans

Gyalecta foveolaris

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Gymnostomum aeruginosum
Hedysarum alpinum
Hippuris tetraphylla
Hippuris vulgaris
Honckenya peploides
Huperzia arctica
Hygrohypnum polare?
Hylocomium splendens
Hypnum cupressiforme var. cupressiforme
Hypogymnia dichroma
Hypogymnia physodes
Hypogymnia subobscura (in the traditional sense)
Involucropyrenium waltheri
Juncus castaneus
Juncus triglumis var. triglumis
Kiaeria blyttii
Kobresia myosuroides
Kobresia simpliciuscula
Lathyrus japonicus
Lecanora epibryon
Lecanora marginata
Lecanora polytropa
Lecanora stenotropa
Lecidea hypnorum
Lecidea theodori?
Leptogium imbricatum
Leptogium intermedium
Leymus mollis
Lobaria scrobiculata
Loiseleuria procumbens
Lomatogonium rotatum
Lopadium pezizoideum
Lupinus arcticus ssp. arcticus
Luzula confusa
Luzula groenlandica
Luzula wahlenbergii
Meesia triquetra
Meesia uliginosa
Melanelia hepatizon
Melanelia stygia (normal form)

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Melanelia tominii

Melanohalea infumata

Mertensia maritima

Micranthes foliolosa

Micranthes nivalis

Minuartia obtusiloba

Minuartia rubella

Mnium blyttii

Montia fontana

Moss unknown (Kiaeria-like, but without a peristome)

Mycoblastus alpinus

Myurella tenerrima

Nephroma expallidum

Nephroma parile

Niphotrichum canescens ssp. latifolium

Ochrolechia frigida

Ophioparma ventosa

Orthilia secunda

Orthotrichum pylaisii

Oxyria digyna

Oxytropis arctica

Oxytropis deflexa var. foliolosa

Oxytropis hudsonica

Oxytropis maydelliana

Papaver radicatum ssp. radicatum

Parmelia fraudans

Parmelia omphalodes

Parmelia skultii

Parmelia sulcata

Parmeliopsis ambigua

Parmeliopsis hyperopta

Parnassia palustris

Pedicularis capitata

Pedicularis labradorica

Pedicularis lanata

Pedicularis lapponica

Pedicularis sudetica

Peltigera aphthosa

Peltigera canina

Peltigera didactyla

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Peltigera lepidophora
Peltigera malacea
Peltigera venosa
Pertusaria coriacea
Pertusaria oculata
Pertusaria panyrga
Phaeophyscia decolor
Phaeophyscia nigricans
Phaeophyscia orbicularis
Phaeophyscia sciastra
Physcia alnophila
Physconia muscigena (normal form)
Physconia perisidiosa
Pinguicula vulgaris
Placynthium nigrum
Plagiopus oederianus
Plantago canescens
Platanthera obtusata
Poa alpina
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa platyantha?
Poa pratensis ssp. alpigena
Pohlia erecta
Polyblastia theleodes
Polytrichum juniperinum
Polytrichum stricum
Potentilla arenosa ssp. arenosa
Potentilla hyparctica ssp. elatior
Potentilla nivea
Primula egaliksensis
Protopannaria pezizoides
Psoroma hypnorum
Pterigynandrum filiforme
Puccinellia phryganodes
Puccinellia sp. nov.
Puccinellia sp. (purple leaves)
Puccinellia tenella
Pyrola grandiflora

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Racomitrium lanuginosum

Ranunculus cymbalaria

Ranunculus hyperboreus

Rhizocarpon chioneum

Rhizocarpon disporum

Rhizocarpon oederi

Rhizomnium andrewsianum

Rhododendron lapponicum

Rhododendron tomentosum

Rimularia impavida

Rinodina terrestris

Rinodina turfacea

Rubus chamaemorus

Sagina nivalis

Salix alaxensis ssp. alaxensis

Salix arctica

Salix arctophila

Salix glauca var. cordifolia

Salix herbacea

Salix niphoclada

Salix ovalifolia

Salix ovalifolia x glauca

Salix planifolia

Salix reticulata

Salix richardsonii

Saussurea angustifolia

Saxifraga aizoides

Saxifraga cernua

Saxifraga hirculus

Saxifraga hyperborea

Saxifraga tricuspidata

Seligeria sp. nov.

Silene acaulis

Silene involucrata

Solorina bispora

Solorina crocea

Sparganium hyperboreum

Sphaerophorus fragilis

Sphaerophorus globosus

Sphagnum fuscum

(continued)

Site 13 August 1, 2012 - Bathurst Inlet starting from 13 W 387079 7381169 and heading NW to 13 W 383721 7385000 (continued)

Sphagnum teres
Stellaria edwardsii
Stellaria humifusa
Stellaria monantha
Stereocaulon condensatum
Stereocaulon paschale
Stereocaulon rivulorum
Straminergon stramineum
Stuckenia filiformis ssp. alpina
Tephroseris frigida
Thamnolia vermicularis
Tofieldia coccinea
Tofieldia pusilla
Tomentypnum nitens
Trichophorum cespitosum
Triglochin maritima
Triglochin palustris
Tripleurospermum maritimum ssp. phaeocephalum
Trisetum spicatum
Umbilicaria arctica
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria proboscidea
Utricularia intermedia
Vaccinium uliginosum
Vaccinium vitis-idaea
Vulpicida pinastri
Woodsia glabella
Xanthomendoza borealis
Xanthoria elegans
Xanthoria sorediata

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467

Acarospora molybdina
Achillea millefolium var. alpinum
Agrostis mertensii
Alectoria ochroleuca
Allantoparmelia almquistii
Alnus viridis ssp. crispa
Alopecurus magellanicus
Andreaea rupestris (form with straight leaves)
Andromeda polifolia
Anemone richardsonii
Aneura pinguis
Antennaria alpina
Antennaria friesiana
Antennaria porsildii
Anthoxanthum monticola
Arctagrostis latifolia
Arctoparmelia centrifuga
Arctoparmelia incurva
Arctoparmelia separata
Arctophila fulva
Arctous alpina
Arctous rubra
Argentina egedii
Armeria maritima
Arnica angustifolia
Artemisia borealis
Artemisia tilesii
Arthrorhaphis citrinella
Asahinea chrysantha
Asahinea scholanderi
Astragalus alpinus
Astragalus eucosmus
Aulacomnium palustre
Aulacomnium turgidum
Betula nana
Bistorta vivipara
Brachythecium salebrosum
Bromus pumpellianus
Bryocaulon divergens
Bryoria chalybeiformis
Bryoria nitidula

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Bryoria simplicior
Calamagrostis canadensis
Calamagrostis deschampsioides
Calamagrostis lapponica
Calamagrostis purpurascens
Calamagrostis stricta
Caloplaca ammiospila
Caloplaca cerina
Caloplaca flavorubescens
Caloplaca holocarpa
Candelariella vitellina
Cardamine digitata
Carex aquatilis
Carex atrofusca
Carex bicolor
Carex bigelowii
Carex capillaris
Carex chordorrhiza
Carex glacialis
Carex glareosa var. amphigena
Carex mackenziei
Carex maritima
Carex membranacea
Carex rariflora
Carex rotundata
Carex rupestris
Carex saxatilis
Carex scirpoidea
Carex sp. nov. (section Phacocystis)
Carex supina ssp. spaniocarpa
Carex vaginata
Carex williamsii
Cassiope tetragona var. tetragona
Castilleja elegans
Catapyrenium cinereum
Catascopium nigritum
Cerastium alpinum ssp. lanatum
Ceratodon purpureus
Cetraria andrejevii
Cetraria ericetorum ssp. ericetorum
Cetraria fastigiata

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Cetraria islandica ssp. crispiformis
Cetraria odontella
Cetraria sepincola
Cladina mitis
Cladina rangiferina
Cladina stellaris
Cladina stygia
Cladonia amaurocrea
Cladonia borealis
Cladonia cervicornis
Cladonia cf. macroceras
Cladonia chlorophaea group
Cladonia cyanipes
Cladonia gracilis ssp. gracilis
Cladonia macrophylla
Cladonia uncialis
Coelocaulon aculeatum
Comarum palustre
Conostomum tetragonum
Dactylina arctica
Deschampsia caespitosa
Dicranella cf. subulata (stickinensis form)
Dimelaena oreina
Draba glabella (normal form)
Dryas integrifolia
Dryopteris fragrans
Dupontia fisheri ssp. fischeri
Empetrum nigrum
Epilobium angustifolium
Epilobium arcticum
Epilobium latifolium
Equisetum arvense
Erigeron uniflorus
Eriophorum angustifolium ssp. subarcticum
Eriophorum angustifolium ssp. triste
Eriophorum scheuchzeri
Eriophorum vaginatum
Eutrema edwardsii
Festuca brachyphylla
Festuca rubra ssp. arctica (form with reddish, smaller lemmas and shorter hairs)
Flavocetraria cucullata

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Flavocetraria nivalis

Funaria arctica

Fuscopannaria praetermissa sensu lato

Gentianella tenella

Gowardia nigricans

Grimmia longirostris

Grimmia sessitana

Gymnomitrion corallioides

Hedysarum alpinum

Hippuris tetraphylla

Honckenya peploides

Huperzia arctica

Hylocomium splendens

Hypnum cupressiforme var. cupressiforme

Hypogymnia austerodes

Hypogymnia bitteri

Hypogymnia dichroma

Hypogymnia physodes

Hypogymnia subobscura (in the traditional sense)

Japewia tornoensis

Juncus arcticus var. alaskanus

Juncus castaneus

Kobresia myosuroides

Lathyrus japonicus

Lecanora bicincta

Lecanora chlarotera

Lecanora hagenii

Lecanora orae-frigidae

Lecanora polytropa

Lecidea betulicola

Lecidella xylophila

Leptobryum pyriforme

Leptogium imbricatum

Leymus mollis

Lobaria scrobiculata

Loiseleuria procumbens

Lomatogonium rotatum

Lopadium coralloideum

Lopadium pezizoideum

Lupinus arcticus ssp. arcticus

Luzula confusa

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Luzula groenlandica
Luzula wahlenbergii
Lycopodium annotinum ssp. pungens
Marchantia polymorpha
Melanelia disjuncta
Melanelia hepatizon
Melanelia sorediata
Melanelia stygia (normal form)
Melanelia tominii
Melanohalea infumata
Melanohalea septentrionalis
Micarea turfosa
Micranthes nelsoniana ssp. porsildiana
Micranthes nivalis
Minuartia obtusiloba
Mycobilimbia carneoalbida
Mycoblastus alpinus
Nephroma arcticum
Nephroma expallidum
Ochrolechia frigida
Ochrolechia gyalectina
Ochrolechia upsaliensis
Onchophorus wahlenbergii
Ophioparma ventosa
Orthilia secunda
Oxyria digyna
Oxytropis arctica
Oxytropis deflexa var. foliolosa
Oxytropis maydelliana
Oxytropis nigrescens var. uniflora
Paludella squarrosa
Papaver radicatum ssp. radicatum
Parmelia fraudans
Parmelia omphalodes
Parmelia saxatilis
Parmelia sulcata
Parmeliella triptophylla
Parmeliopsis ambigua
Parnassia kotzebuei
Parnassia palustris
Pedicularis labradorica

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Pedicularis lanata
Pedicularis lapponica
Pedicularis sudetica
Peltigera aphthosa
Peltigera didactyla
Peltigera extenuata
Peltigera malacea
Peltigera scabrosa
Pertusaria cf. multipunctoides
Pertusaria coriacea
Pertusaria dactylina
Pertusaria oculata
Pertusaria panyrga
Physcia alnophila
Physcia caesia
Physconia cf. muscigena (large form with thin, chocolate-brown lobes)
Physconia muscigena (normal form)
Physconia perisidiosa
Pinguicula vulgaris
Plantago canescens
Platanthera obtusata
Poa arctica ssp. arctica
Poa glauca ssp. glauca
Poa lanata
Poa pratensis ssp. alpigena
Poa pratensis ssp. unknown
Pohlia proligera
Polytrichum piliferum
Polytrichum stricum
Potentilla arenosa ssp. arenosa
Potentilla cf. litoralis
Potentilla nivea
Primula egaliksensis
Protopannaria sp. nov.
Pseudephebe minuscula
Pseudephebe pubescens
Psoroma tenue var. boreale
Puccinellia phryganodes
Puccinellia sp. nov.
Pyrola grandiflora
Racomitrium lanuginosum

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (continued)

Ranunculus cymbalaria
Rhizocarpon oederi
Rhizoplaca chrysoleuca
Rhizoplaca melanophthalma
Rhytidium rugosum
Rinodina terrestris
Rubus chamaemorus
Salix arctica
Salix arctophila
Salix glauca var. cordifolia
Salix glauca var. stipulata
Salix herbacea
Salix niphoclada
Salix planifolia
Salix reticulata
Salix richardsonii
Sanionia uncinata
Saussurea angustifolia
Saxifraga hirculus
Saxifraga tricuspidata
Schaereria parasemella
Schistidium frisvolleanum
Sciurohypnum latifolium
Silene acaulis
Silene involucrata
Sparganium hyperboreum
Sphaerophorus fragilis
Sphaerophorus globosus
Sphagnum capillifolium
Sphagnum fuscum
Stellaria edwardsii
Stellaria humifusa
Stellaria monantha
Stereocaulon condensatum
Straminergon stramineum
Symphyotrichum pygmaeum
Taraxacum ceratophorum aggr. (calyculus bractlets of varying lengths, rays few, leaves of narrow outline)
Tephroseris frigida
Tetraplodon mnioides
Thamnolia vermicularis
Tofieldia coccinea

(continued)

Site 14 August 2, 2012 - Bathurst Inlet starting from 13 W 397469, 7366467 (completed)

Tofieldia pusilla
Tomentypnum nitens
Trichophorum cespitosum
Triglochin maritima
Triglochin palustris
Tripleurospermum maritimum ssp. phaeocephalum
Trisetum spicatum
Tritomaria quinquedentata
Umbilicaria arctica
Umbilicaria deusta
Umbilicaria hyperborea
Umbilicaria lyngei
Vaccinium uliginosum
Vaccinium vitis-idaea
Woodsia alpina
Woodsia glabella
Xanthomendoza borealis
Xanthoria elegans
Xyloschistes platytropa

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP50		*Argentina egedii*	2012/7/4	N	N			map as point with 10 m buffer	13	387421	7383139	100-200 ramets	Upper beach margins, on gravel at upper tide line
BRVP1	VP1	*Epilobium davuricum*	2012/7/4	Y	Y	UBC	*Björk 26528*	map as point with 10 m buffer	13	387411	7383216	1-5 genets	On peaty soil in brushy tundra near shore, 10 degree west slope
BRL1	L1	*Solorina octospora*	2012/7/4	Y	Y	UBC	*Björk 27611*	map as point with 10 m buffer	13	387411	7383216	1 thallus	On peaty soil of erosional cutbank shortly above marine shoreline
BRL17		*Brodoa oroarctica*	2012/7/20	Y	N			map as point with 10 m buffer	13	389386	7313364	1 patch seen	On cliff ledges above lake
BRVP51		*Carex lapponica*	2012/7/20	N	Y	UBC	*Björk 26728*	map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence VP9	13	388300	7314088	5-10 genets	Mossy seep along lakeshore
BRVP52		*Draba crassifolia*	2012/7/20	Y	Y	UBC	*Björk 26756*	map as point with 10 m buffer	13	389386	7313364	5-10 genets	On cliff ledges above lake
BRM8		*Pohlia crudoides*	2012/7/20	N	Y	UBC	*Björk 29122*	map as point with 10 m buffer	13	389386	7313364	1 patch seen	On cliff ledges above lake
BRVP53		*Salix sp. nov. (esker tops)*	2012/7/20	N	N			map as point with 30 m buffer	13	389318	7313465	20-30 genets	Exposed, sparesly vegetated ridge-top with western exposure
BRL18		*Siphula ceratites*	2012/7/20	Y	Y	UBC	*Björk 28142, 28157*	map as point with 10 m buffer	13	388452	7313092	2,000-3,000 ramets (stems)	Low tundra depression, periodically flooded
BRL19		*Bryoria tenuis*	2012/7/21	N	Y	UBC	*Björk 28249*	map as point with 10 m buffer	13	431276	7269894	5-10 thalli	At lip of cliff of siliceous rock
BRL20		*Leciophysma finmarkicum*	2012/7/21	Y	N			map as point with 10 m buffer	13	429080	7272210	1 thallus seen	On moss mats by lake shore on tussock, with Cladonia cyanipes
BRL21		*Placynthium flabellosum*	2012/7/21	Y	N			map as point with 10 m buffer	13	431960	7269756	10-20 thalli	Vertical rock face of short canyon, nitrogen enriched
BRM9		*Psilopilum cavifolium*	2012/7/21	N	N			map as point with 10 m buffer	13	429917	7271729	500-1000 genets	Eroding cut-bank of fine textured materials
BRL22		*Pycnothelia papillaria*	2012/7/21	Y	Y	UBC	*Björk 28226*	map as point with 10 m buffer	13	429917	7271729	1 discontinuous patch over a half meter square	Eroding cut-bank of fine textured materials
BRL23		*Ramalina intermedia*	2012/7/21	Y	N			map as point with 10 m buffer	13	431276	7269894	10-20 thalli	Sheltered rock underhang, nitrogen enriched
BRL24		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	432257	7269473	1,000-2,000 ramets	Low tundra depression, periodically flooded
BRL25		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	429155	7271245	2,000-5,000 ramets	Low tundra depression, periodically flooded
BRL26		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	429923	7271450	1,000-2,000 ramets	Damp, Unvegetated runnels between hummocks
BRL27		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	431781	7269707	2,000-5,000 ramets	On tilted depression at edge of plateau
BRL28		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	433730	7269807	500-1,000 ramets	Low tundra depression, periodically flooded
BRL29		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	433399	7269105	1,000-2,000 ramets	Low tundra depression, periodically flooded
BRM10		*Sphagnum platyphyllum*	2012/7/21	N	Y	UBC	*Björk 28234*	map as point with 10 m buffer	13	429080	7272210	1 patch observed	Among other Sphagnum at lake shore
BRVP54		*Utricularia macrorhiza*	2012/7/21	Y (Ryan Durand photo)	N			Unknown	13	402012	7360502	Unknown	Ryan Durand Utricularia macrorrhiza record from estuary of the Western River, 1% cover, pH 7.4, conductivity 1030, 95% open water, depth 0, with Carex saxatilis 3, Sparganium hyperboreum 5, Carex aquatilis 3, Hippuris vulgaris 3
BRVP3	VP3	*Argentina egedii*	2012/7/22	Y	N			map as point with 50 m buffer	13	387669	7381502	100,000-200,000 ramets	Sandy, gravelly and silty marine shoreline and marshes, mostly where sparsely vegetated
BRVP4	VP4	*Caltha palustris*	2012/7/22	Y	Y	UBC	*Björk 26810*	map as point with 100 m buffer	13	387762	7381384	about 500 genets	In and around open-water pools and along sluggish water channels in estuarine marsh
BRVP5	VP5	*Carex mackenziei*	2012/7/22	Y	N			map as point with 50 m buffer	13	387545	7381474	5,000-10,000 genets	Estuarine marsh and in low, wet depressions in beaches and benches
BRVP6	VP6	*Carex microglochin*	2012/7/22	Y	Y	UBC	*Björk 26788*	map as point with 30 m buffer	13	387687	7381471	5,000-10,000 ramets	Estuarine marsh and in low, wet depressions on benches, mostly where brackish

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP7	VP7	*Corallorhiza trifida*	2012/7/22	N	N			map as point with 100 m buffer, a large diffuse population	13	387762	7381384	about 10 genets	Mossy ground in brushy tundra near marine shore
BRVP55		*Draba crassifolia*	2012/7/22	Y	N				13			5-10 genets	Near George camp, brief visit to Ryan Durand's wetland site to north of camp, get waypoint from him, Siphula ceratites, Draba (nearly glabrous)
BRVP8	VP8	*Erysimum coarctatum*	2012/7/22	Y	N			map as point with 50 m buffer	13	387457	7381422	50-100 genets	Open sites, sandy beaches along marine shore
BRVP10	VP10	*ianella propinqua ssp. arcto*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence BRVP9	13	387314	7381302	About 5,000 genets (including VP10)	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP9	VP9	*ianella propinqua ssp. arcto*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence BRVP10	13	387337	7381314	About 5,000 genets (including VP10)	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP11	VP11	*Gentianella tenella*	2012/7/22	Y	Y	UBC	*Björk 26787*	map as point with 20 m buffer, combine along shoreline to form polygon with BRVP12	13	387335	7381306	5,000-10,000 genets, total between both sites	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP12	VP12	*Gentianella tenella*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form polygon with BRVP11	13	387547	7381466	5,000-10,000 genets, total between both sites	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP13	VP13	*Hippuris tetraphylla*	2012/7/22	Y	N			map as point with 30 m buffer	13	387660	7381482	About 10,000 ramets	In and around open-water pools and along sluggish water channels in estuarine marsh
BRVP14	VP14	*uncus arcticus var. alaskanu*	2012/7/22	Y	Y	UBC	*iörk 26772, Björk 2678*	map as point with 50 m buffer	13	387339	7381300	5,000-10,000 ramets	Sandy beaches and estuarine marshes
BRVP15	VP15	*Lomatogonium rotatum*	2012/7/22	Y	Y	UBC	*Björk 26786*	map as point with 20 m buffer	13	387295	7381307	10,000-20,000 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP16	VP16	*Luzula groenlandica*	2012/7/22	Y	Y	UBC	*Björk 26778*	map as point with 30 m buffer	13	387536	7381474	50-100 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP17	VP17	*Montia fontana*	2012/7/22	N	N			map as point with 10 m buffer	13	387467	7381420	1000-5000 genets	Open or sparsely vegetated brackish mud in estuary
BRVP56		*Oxytropis deflexa* var. *foliolo*	2012/7/22	N	Y	UBC	*Björk 26770*	map as point with 20 m buffer	13	387431	7381367	5-10 genets	Ericaceous tundra on level plateau 10 m above sea level
BRVP18	VP18	*Plantago canescens*	2012/7/22	Y	N			map as point with 30 m buffer	13	387317	7381311	About 5,000 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP20	VP20	*Primula stricta*	2012/7/22	N	Y	UBC	*Björk 26792*	map as point with a largest enough buffer to connect to August 1 waypoint for same species, but only along shoreline	13	387352	7381309	500-1000 genets	Sparsely vegetated, brackish mud or silty sand along marine shoreline at margins of estuary
BRM11		*Psilopilum cavifolium*	2012/7/22	N	Y	UBC	*Björk 28396*	map as point with 10 m buffer	13	387847	7381732	100-200 genets	On erosional cutslope in brushy tundra shortly above estuary and beach
BRVP19	VP19	*Puccinellia* sp. nov.	2012/7/22	Y	N			map as point with 30 m buffer	13	387283	7381304	1,000-5,000 genets	Erosional cutbanks at beach/estuary interface, and around low, wet depressions in beach along marine shore
BRL30		*Siphula ceratites*	2012/7/22	N	N				13			1,000-2,000 ramets (stems)	Near George camp, brief visit to Ryan Durand's wetland site to north of camp, get waypoint from him, Siphula ceratites, Draba crassifolia
BRVP57		*Stuckenia filiformis* ssp. *alpin*	2012/7/22	Y	Y	UBC	*Björk 26811*	map as point with 30 m buffer	13	387671	7381509	50-100 genets	Saline mud flat behind beach
BRVP22	VP22	*Suaeda calceoliformis*	2012/7/22	Y	N			map as point with 40 m buffer to capture large population	13	387660	7381482	5,000-10,000 genets	On open brackish mud, broad flats and depressions in estuarine marsh
BRVP23	VP23	*Triglochin palustris*	2012/7/22	N	Y	UBC	*Björk 26801*	map as point with 30 m buffer	13	387743	7381599	About 1,000 genets	Estuarine marsh along marine shore, mostly among dense vegetation
BRVP24	VP24	*Utricularia intermedia*	2012/7/22	Y	Y	UBC	*Björk 26809*	map as point with 10 m buffer	13	387660	7381482	500-1000 genets	Floating in open-water pools in estuarine marsh

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP58		*Epilobium davuricum*	2012/7/23	Y	N			map as point with 10 m buffer	13	423657	7265838	2 genets	Bottom of small mossy depression in tundra
BRL31		*Protopannaria sp. nov.*	2012/7/23	N	Y	UBC	*örk 28300, 28762, 283*	map as point with 10 m buffer	13	421680	7266441	1 patch	On thin soil over rock, lip of short cliff
BRVP59		*Salix ovalifolia*	2012/7/23	Y	Y	UBC	*Björk 26815*	map as point with 20 m buffer	13	423114	7265808	50-100 genets	Among sedges along small stream in shallow ravine
BRVP60		*Salix sp. 1*	2012/7/23	Y	N			map as point with 20 m buffer	13	421978	7266140	10-15 genets	On gravelly ground on esker top
BRL32		*Siphula ceratites*	2012/7/23	Y	N			map as point with 10 m buffer	13	421518	7266841	5,000-10,000 ramets	Flat, moist depression in tundra
BRL33		*Siphula ceratites*	2012/7/23	N	N			map as point with 10 m buffer	13	423182	7265818	2,000-5,000 ramets	Flat, moist depression in tundra
BRM12		*Sphagnum platyphyllum*	2012/7/23	N	Y	UBC	*Björk 28388*	map as point with 10 m buffer	13	423696	7265852	1 patch seen	Mossy ground in slight depression, more moist than surrounding tundra
BRL34		*Leptogium imbricatum*	2012/7/24	N	Y	UBC	*Björk 28378*	map as point with 10 m buffer	13	389633	7312131	2 thalli	In fine soil of tilted calcareous strata with Oxytropis nigrescens
BRL35		*Placynthium flabellosum*	2012/7/24	N	N			map as point with 10 m buffer	13	389915	7311397	5-10 thalli	With Ephebe lanata on rock at lake shore
BRL36		*Placynthium flabellosum*	2012/7/24	N	N			map as point with 10 m buffer	13	379452	7312391	About 20 thalli	On rock at edge of broad depression, periodically flooded
BRL37		*Protopannaria sp. nov.*	2012/7/24	Y	N			map as point with 10 m buffer	13	389966	7310953	1 thallus	Over soil next low flat boulder at the base of a small cliff
BRVP61		*Ranunculus pallasii*	2012/7/24	Y	N			map as point with 20 m buffer	13	388051	7313281	5-10 genets	On open or sparsely vegetated mud along margin of small lake shortly west of George Camp airstrip and shortly south of the heli pads
BRVP62		*Salix ovalifolia*	2012/7/24	N	Y	UBC	'brid form of *S. ovalifo*	map as point with 20 m buffer	13	390094	7310037	1 genet	Moist, low, mossy ground in brushy tundra at base of esker
BRL38		*Siphula ceratites*	2012/7/24	N	Y	UBC	*Björk 28364*	map as point with 10 m buffer	13	389452	7312391	500-1000 ramets	Moist depression, periodically flooded
BRM13		*Splachnum sphaericum*	2012/7/24	N	Y	UBC	*Björk 28417*	map as point with 10 m buffer	13	389841	7309515	1 patch	On decaying animal matter in mossy lakeshore vegetation
BRL39		*Xanthoparmelia wyomingica*	2012/7/24	Y	Y	UBC	*örk 28353, 28387, 284*	map as point with 20 m buffer	13	390042	7309814	About 20 fragmented thalli	With Xanthomendoza borealis, associated collections, nitrogen hotspot around animal burrow on peak on esker
BRVP63		*Argentina egedii*	2012/7/25	N	N			map as point with 50 m buffer	13	380547	7393332	20-30 genets	Level sandy flat just above the high tide line
BRVP64		*Caltha palustris*	2012/7/25	N	N			map as point with 20 m buffer	13	379593	7393435	5-10 genets	On brackish mud, bottom of low cut in tudra near edge of inlet
BRVP65		*Carex mackenziei*	2012/7/25	Y	Y	UBC	*Björk 26835*	map as point with 30 m buffer	13	379974	7393625	500-1000 genets	Brackish pool in tundra on low bench above marine shore
BRVP66		*Carex microglochin* ssp. *microglc*	2012/7/25	N	Y	UBC	*Björk 26868*	map as point with 20 m buffer	13	379910	7393556	200-500 ramets	Brackish pool in tundra on low bench above marine shore
BRL40		*Collema ceraniscum*	2012/7/25	Y	Y	UBC	*Björk 28431*	map as point with 10 m buffer	13	381379	7393621	5-10 thalli	On soil among mosses and other lichens in shallow depression on slope, in brushy tundra
BRVP67		*Corallorhiza trifida*	2012/7/25	N	Y	UBC	*Björk 29136*	map as point with 20 m buffer	13	382096	7393482	5-10 genets	On mossy ground in brushy tundra
BRVP68		*Draba arabisans*	2012/7/25	N	Y	UBC	*Björk 29137*	map as point with 10 m buffer	13	382073	7393623	5-10 genets	On sand of high beach above tide-line where vegetation begins
BRVP69		*Eleocharis palustris* sensu lat	2012/7/25	Y	Y	UBC	*Björk 26856*	map as point with 20 m buffer	13	379799	7393447	20-50 ramets	Along edges of narrow, dried out estuarine channel
BRVP70		*Erysimum coarctatum*	2012/7/25	Y	N			map as point with 20 m buffer	13	382069	7393674	5-10 genets	In sand of high beach above tide-line where vegetation begins
BRVP71		*Gentianella tenella*	2012/7/25	Y	N			map as point with 20 m buffer	13	380130	7393675	100-500 genets	Sandy and gravelly ground along beach upper margins
BRVP72		*Hippuris tetraphylla*	2012/7/25	Y	N			map as point with 30 m buffer	13	380084	7393621	200-500 ramets	Brackish pool in tundra on low bench above marine shore
BRVP73		*Juncus arcticus* var. *alaskanu*	2012/7/25	N	N			map as point with 20 m buffer	13	379924	7393593	20-50 ramets	Along edge of narrow pool above beach
BRVP74		*Lomatogonium rotatum*	2012/7/25	Y	N			map as point with 20 m buffer	13	380130	7393675	100-500 genets	On high beach at edge of estuary
BRVP75		*Luzula groenlandica*	2012/7/25	Y	Y	UBC	*Björk 26837*	map as point with 20 m buffer	13	379892	7393579	20-50 genets	Along edge of tundra above inlet
BRVP76		*Montia fontana*	2012/7/25	Y	Y	UBC	*Björk 26839*	map as point with 10 m buffer	13	382132	7393549	20-50 genets	Sandy and gravelly ground along beach upper margins
BRVP77		*Plantago canescens*	2012/7/25	Y	N			map as point with 20 m buffer	13	382079	7393616	50-100 genets	Dry, clayey soil and open flats
BRVP78	*ccinellia sp. nov.*		2012/7/25	Y	Y	UBC	*Björk 26842, 26862*	map as point with 20 m buffer	13	380013	7393649	500-1000 genets	Dense stands on 'islands' and on edges of cut-slopes at mouth of estuary with other species of Puccinellia
BRVP79		*Suaeda calceoliformis*	2012/7/25	Y	Y	UBC	*Björk 26854*	map as point with 20 m buffer	13	380506	7393402	100-500 genets	Sparsely vegetated saline mud flats along edge of estuary
BRVP80		*Symphyotrichum pygmaeum*	2012/7/25	Y	Y	UBC	*Björk 26853*	map as point with 30 m buffer	13	379847	7393544	50-100 genets	Slightly elevated grass dominated sites in estuarine mud flat
BRVP81		*Triglochin palustris*	2012/7/25	N	N			map as point with 20 m buffer	13	380573	7393317	100-500 genets	Along edges of saline mud flats
BRVP82		*Chrysosplenium rosendahlii*	2012/7/27	Y	Y	UBC	*Björk 29133*	map as point with 20 m buffer	13	387696	7314307	20-30 genets	Partially sheltered under low, eroding bank of small lake
BRL41		*Collema ceraniscum*	2012/7/27	N	Y	UBC	*Björk 28549*	map as point with 10 m buffer	13	386913	7314275	1 patch	On seepy, calc-modified cliff ledges

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRM14		*Encalypta brevicollis*	2012/7/27	N	Y	UBC	*Björk 28530*	map as point with 10 m buffer	13	386913	7314275	5-10 tufts	On seepy, calc-modified cliff ledges
BRM15		*Encalypta vulgaris*	2012/7/27	Y	Y	UBC	*Björk 28525*	map as point with 10 m buffer	13	386913	7314275	5-10 tufts	On seepy, calc-modified cliff ledges
BRL42		*Lichenomphalia hudsoniana*	2012/7/27	Y	N			map as point with 10 m buffer	13	387501	7314433	1 patch of numerous squamules	Over moss on ledges of seepy cliff
BRVP83		*Petasites sagittatus*	2012/7/27	Y	N			map as point with 10 m buffer	13	386718	7314229	5-10 genets	Along saturated margin of small lake
BRL43		*Protopannaria pezizoides*	2012/7/27	N	N			map as point with 10 m buffer	13	387501	7314433	5-10 thalli	Over moss on ledges of seepy cliff
BRL44		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	387104	7314603	1,000-2,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL45		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	386557	7314200	1,000-2,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL46		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	386302	7314410	500-1,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL47		*Xanthoparmelia wyomingica*	2012/7/27	Y	N			map as point with 10 m buffer	13	387595	7314034	20-50 thalli	Exposed ridge of esker, mostly around animal burrows and near bases of bird-perch rocks
BRM16		*Aloina rigida*	2012/7/28	N	Y	UBC	*Björk 28572* (sub *Candelariella rosulans*), *28574* (sub Candelariella aurella)	map as point with 10 m buffer	13	401078	7360223	About 30 ramets (rosettes)	On loamy soil perched at top of short cliff
BRVP84		*Argentina egedii*	2012/7/28	N	N			map as point with 30 m buffer	13	401095	7360215	50-100 ramets	Sandy flat of high beach
BRVP85		*Astragalus australis* var. *lepag*	2012/7/28	Y	N			map as point with 20 m buffer	13	399181	7362891	5-10 genets	Along edge of tundra above high tide line
BRVP86		*Astragalus eucosmus*	2012/7/28	Y	N			map as point with 20 m buffer	13	400216	7360509	5-10 genets	Along edge of tundra above high tide line
BRVP87		*Caltha palustris*	2012/7/28	N	N			map as point with 10 m buffer	13	399394	7362557	5-10 genets	Small, wet depression near inlet
BRVP88		*Carex mackenziei*	2012/7/28	N	N			map as point with 20 m buffer	13	401028	7360214	500-1000 genets	Sandy saline flat above marine shore, periodically inundated
BRVP89		*Corallorhiza trifida*	2012/7/28	N	N			map as point with 10 m buffer	13	398800	7363569	5-10 genets	On mossy slopes in brushy tundra near marine shore
BRVP90		*Corallorhiza trifida*	2012/7/28	N	N			map as point with 10 m buffer	13	401095	7360215	5-10 genets	On mossy slopes in brushy tundra near marine shore
BRVP91		*Draba arabisans*	2012/7/28	N	Y	UBC	*Björk 29132*	map as point with 10 m buffer	13	401361	7360503	4 genets	Along edge of tundra above high tide line
BRVP92		*Erysimum coarctatum*	2012/7/28	N	N			map as point with 10 m buffer	13	399041	7363121	5-10 genets	Sandy, gravelly beach upper margins
BRVP93		*Erysimum coarctatum*	2012/7/28	N	N			map as point with 10 m buffer	13	398935	7363400	5-10 genets	Sandy, gravelly beach upper margins
BRV107		*Galium trifidum*	2012/7/28	N	N			map as point with 20 m buffer	13	401588	7360564	50-100 ramets	Among sedges, saline mud flat of estuary
BRVP94		*Galium trifidum*	2012/7/28	Y	Y	UBC	*Björk 26873*	map as point with 20 m buffer	13	401028	7360214	20-50 genets	Just within the edge of the tundra at marine shore, in small, brackish depression
BRVP95		*Gentianella tenella*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	100-500 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP96		*Hippuris tetraphylla*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	500-1000 ramets	Brackish pool in tundra above marine shore
BRVP97		*Juncus arcticus* var. *alaskanu*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	50-100 ramets	At edges of brackish pools and channels
BRL48		*Leptogium imbricatum*	2012/7/28	Y	N			map as point with 10 m buffer	13	399612	7362181	5-10 thalli	On sparsely vegetated sand of blow-out, sandy bench above marine shore
BRL49		*Leptogium intermedium*	2012/7/28	N	N			map as point with 10 m buffer	13	401078	7360223	1 thallus	Over moss, with other calciphilic species of lichens and bryophytes
BRVP98		*Lomatogonium rotatum*	2012/7/28	Y	N			map as point with 20 m buffer	13	401406	7360549	100-500 genets	Sandy, gravelly beach upper margins
BRVP99		*Luzula groenlandica*	2012/7/28	N	N			map as point with 20 m buffer	13	398800	7363569	50-100 genets	Along edge of tundra above high tide line
BRV100		*Montia fontana*	2012/7/28	Y	N			map as point with 20 m buffer	13	401028	7360214	10-20 genets	High beach zone at edge of tundra, in damp sand
BRV101		*Montia fontana*	2012/7/28	N	N			map as point with 20 m buffer	13	401334	7360373	10-20 genets	Sandy beach with Honkenya peploides

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV102		*Petasites sagittatus*	2012/7/28	y	N			map as point with 20 m buffer	13	399551	7360656	500-1000 ramets (single leaves or clusters of leaves, many connected by long rhizomes)	Slightly lower ground in tussocky tundra on slopes near base of cliffs
BRV103		*Plantago canescens*	2012/7/28	Y	N			map as point with 20 m buffer	13	399549	7362274	20-50 genets	Silty-sand flat near estuary
BRV104		*Potentilla* cf. *litoralis*	2012/7/28	Y	Y	UBC	*Björk 26874*	map as point with 20 m buffer	13	398933	7363404	5-10 genets	On sand/gravel of low bench at upper beach margin, where sparsely vegetated
BRV105		*ccinellia sp. nov.*	2012/7/28	Y	Y	UBC	*0* (to be designated as	map as point with 20 m buffer	13	401406	7360549	500-1000 genets	Low, inundated shoreline of estuary with other Puccinellia species
BRL50		*Solorina octospora*	2012/7/28	N	N			map as point with 10 m buffer	13	400976	7360273	5-10 thalli	Over moss, with other calciphilic species of lichens and bryophytes
BRV106		*Suaeda calceoliformis*	2012/7/28	Y	N			map as point with 20 m buffer	13	401588	7360564	100-500 genets	Saline mud flat of estuary
BRV108		*Triglochin palustris*	2012/7/28	N	N			map as point with 20 m buffer	13	401028	7360214	100-500 genets	Saline mud flat of estuary
BRV109		*Utricularia intermedia*	2012/7/28	Y	N			map as point with 20 m buffer	13	401028	7360214	ca. 200 plants	Shallow brackish pond near marine shore
BRV110		*Utricularia intermedia*	2012/7/28	N	N			map as point with 20 m buffer	13	400493	7360624	about 500 plants?	Shallow brackish pond near marine shore
BRV111		*Chrysosplenium rosendahlii*	2012/7/29	Y	Y	UBC	*Björk 26893*	map as point with 20 m buffer	13	382212	7319712	20-50 genets	Among rocks along edge of large lake, within the splash zone of the lake water
BRV112		*Draba arabisans*	2012/7/29	N	Y	UBC	*Björk 26882*	map as point with 20 m buffer	13	378506	7321958	10-20 genets	On small, gravelly ledges of isolated cliff complex
BRV113		*Draba crassifolia*	2012/7/29	Y	N			map as point with 10 m buffer	13	372955	7325451	3 genets	At top of small cliff above lakes
BRL51		*Gyalecta friesii*	2012/7/29	Y	Y	UBC	*Björk 26832*	map as point with 10 m buffer	13	378542	7321974	2 thalli	Over soil at sheltered base of nitrogen enriched, seepy cliff
BRL52		*Hypogymnia dichroma*	2012/7/29	N	Y	UBC	*Björk 28584*	map as point with 10 m buffer	13	372777	7325359	1 thallus	On surface of boulder embedded level in tudra
BRV114		*Juncus arcticus* var. *alaskanu*	2012/7/29	N	N			map as point with 20 m buffer	13	372718	7325232	50-100 ramets	Along sedge-dominated lake margin
BRL53		*Leptogium imbricatum*	2012/7/29	N	Y	UBC	*Björk 28586*	map as point with 10 m buffer	13	378553	7321983	5-10 thalli	Over fine exposed silt
BRL54		*Leptogium intermedium*	2012/7/29	N	Y	UBC	*Björk 28610*	map as point with 10 m buffer	13	378553	7321983	2 thalli	On moss and exposed soil of calcareous seams
BRL55		*Polychidium muscicola*	2012/7/29	N	N			map as point with 10 m buffer	13	372955	7325451	2 thalli	Nitrogen enriched cliff ledge
BRL56		*Protopannaria sp. nov.*	2012/7/29	Y	N			map as point with 10 m buffer	13	378805	7322041	1 thallus	At base of cliff over soil and rock
BRM17		*Psilopilum cavifolium*	2012/7/29	N	N			map as point with 10 m buffer	13	378805	7322041	1 patch of about 50 stems	On soil of cliff ledge
BRM18		*Psilopilum laevigatum*	2012/7/29	Y	N			map as point with 20 m buffer	13	384519	7316776	50-100 discontinuous patches	Broad, sparsely vegetated, sandy, periodically flooded flat with Eleocharis acicularis
BRL57		*Solorina octospora*	2012/7/29	N	N			map as point with 10 m buffer	13	377323	7322329	10-20 thalli	At the bottom of low, seepy rock walls, with other calcophilic species
BRV115		*Astragalus australis* var. *lepag*	2012/7/30	N	Y	UBC	*Björk 26900*	map as point with 20 m buffer	13	399101	7358973	5-10 genets	On gravel bench at upper beach margin, where sparsely vegetated
BRL58		*Bryoria tenuis*	2012/7/30	Y	N			map as point with 20 m buffer	13	399101	7358973	5-10 genets	On gravel bench at upper beach margin, where sparsely vegetated
BRV116		*Caltha palustris*	2012/7/30	N	N			map as point with 20 m buffer	13	398818	7358861	5-10 genets	Along channels in marsh at lake shore
BRV117		*Chrysosplenium rosendahlii*	2012/7/30	N	N			map as point with 20 m buffer	13	398818	7358861	5-10 genets	Eroding bank at water's edge
BRL59		*Collema crispum*	2012/7/30	N	Y	UBC	*Björk 28794*	map as point with 10 m buffer	13	396848	7361759	5-10 thalli	Nitrogen enriched, seepy cliff face
BRV118		*Draba arabisans*	2012/7/30	Y	Y	UBC	*Björk 29150*	map as point with 20 m buffer	13	396848	7361762	10-20 genets	Base of nitrogen enriched cliff, with Elymus alaskanus
BRL60		*Endocarpon pulvinatum*	2012/7/30	Y	Y	UBC	*Björk 28649, 28792*	map as point with 10 m buffer	13	396848	7361759	500-1000 thalli	Nitrogen enriched cliff face
BRL61		*Fulgensia bracteata*	2012/7/30	Y	Y	UBC	*Björk 28657*	map as point with 10 m buffer	13	396848	7361759	10-20 thalli	Nitrogen enriched cliff ledges
BRL62		*Fuscopannaria sp. nov.*	2012/7/30	Y	Y	UBC	*Björk 28797*	map as point with 10 m buffer	13	398847	7358917	1 thallus	On base of stem of Betula nana, dense brushy vegetation near upper beach margin by lake shore
BRV119		*Juncus arcticus* var. *alaskanu*	2012/7/30	N	N			map as point with 20 m buffer	13	398109	7357872	20-50 ramets	Small fresh water pond near edge of Bathurst lake

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV120		*Kobresia sibirica*	2012/7/30	N	Y	UBC	*Björk 29147*	map as point with 20 m buffer	13	398109	7357872	1 plant observed, more probably present	On gravelly ground at edge of small fresh water pond near edge of Bathurst lake
BRL63		*Leciophyscma finmarkicum*	2012/7/30	Y	Y	UBC	*Björk 29147*	map as point with 10 m buffer	13	398273	7358114	2 thalli	Mossy cutbank at shore of lake
BRL64		*Leptogium imbricatum*	2012/7/30	Y	N			map as point with 10 m buffer	13	398743	7358717	5-10 thalli	On semistable sand of low, sandy bench near marine shore
BRV121		*Luzula groenlandica*	2012/7/30	N	N			map as point with 20 m buffer	13	399022	7358944	20-50 genets	On sandy and gravelly ground at upper beach margin near marine shore
BRM19		*Pseudoleskeella tectorum*	2012/7/30	N	Y	UBC	*Björk 28648, 28805*	map as point with 10 m buffer	13	396848	7361759	1 patch	Nitrogen-enriched ledges of seepy cliff, below bird perch
BRL2	L2	*Bryoria tenuis*	2012/7/31	N	N			map as point with 10 m buffer	13	388266	7383089	About 20 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL3	L3	*Hypogymnia dichroma*	2012/7/31	Y	Y	UBC	*Björk 28111*	map as point with 10 m buffer	13	388364	7383055	About 100 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL4	L4	*Hypogymnia imshaugii*	2012/7/31	Y	Y	UBC	*Björk 28690*	map with 25 m buffer	13	388266	7383089	2 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRVP25	VP25	*'uncus arcticus var. alaskanu:*	2012/7/31	N	N			map with 40 m buffer	13	389484	7381944	1000-5000 ramets	Sandy, gravelly and silty sites on upper beach margins
BRL5	L5	*Leptogium imbricatum*	2012/7/31	Y	N			map as point with 20 m buffer	13	390070	7380585	Unknown, but inconspicuous at the site, so probably less than 100 thalli	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL6	L6	*Leptogium tenuissimum*	2012/7/31	Y	Y	UBC	*Björk 28682*	map as point with 20 m buffer	13	389892	7380689	Unknown, but inconspicuous at the site, so probably less than 100 thalli	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL7	L7	*Lobaria scrobiculata*	2012/7/31	Y	N			map as point with 10 m buffer	13	388364	7383055	20-30 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRVP26	VP26	*Luzula groenlandica*	2012/7/31	N	Y	UBC	*Björk 26778*	map with 30 m buffer	13	389531	7381196	30-50 genets	Sandy and gravelly beach flats
BRM1	M1	*Myrinia pulvinata*	2012/7/31	N	Y	UBC	*Björk 28686*	map as point with 20 m buffer	13	390070	7380585	Unknown, but inconspicuous at the site, so probably less than 100 patches	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRM2	M2	*Orthotrichum anomalum*	2012/7/31	N	Y	UBC	*Björk 28678*	map as point with 20 m buffer	13	388387	7383260	100-200 tufts	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL8	L8	*Physconia perisidiosa*	2012/7/31	N	Y	UBC	*Björk 28674*	map as point with 10 m buffer	13	388364	7383055	About 10 patches (number of thalli unknown, may be multiple thalli per patch)	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL65		*Protopannaria pezizoides*	2012/7/31	N	N			map as point with 10 m buffer	13	388355	7383277	1 patch	Over moss on ledge of short basalt cliff at marine shore
BRL10	L10	*Protopannaria* sp. nov.	2012/7/31	N	Y	UBC	*Björk 28676*	map as point with 20 m buffer	13	388266	7383089	5-10 thalli	Over moss and suspended, exposed roots on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRV122		*ccinellia sp. nov.*	2012/7/31	Y	Y	UBC	*Björk 26902*	map as point with 20 m buffer	13	389534	7381896	500-1000 genets	On saline clay along marine shore
BRV123		*Stuckenia filiformis* ssp. *alpin*	2012/7/31	N	Y	UBC	*Björk 26904*	map as point with 20 m buffer	13	389556	7381087	50-100 genets	Sparsely vegetated saline mud flat

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRM3	*M3*	*Arctoa sp. nov.*	2012/8/1	N	Y	UBC	*3817 (sub Encalypta vi*	map as point with 20 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Among other mosses in crevices and on ledges of sandstone cliffs in narrow canyon
BRVP27	VP27	*Argentina egedii*	2012/8/1	Y	N			map with 50 m buffer	13	384628	7384945	500-1000 ramets	Open or sparsely vegetated ground on upper beach margins and transition into brushy tundra
BRVP28	VP28	*alamagrostis deschampsioide*	2012/8/1	Y	Y	UBC	*Björk 26914*	map as point with 20 m buffer	13	384616	7384735	100-500 genets	Around small, marshy pool in brushy tundra near marine shore, saline soil
BRVP29	VP29	*alamagrostis deschampsioide*	2012/8/1	Y	N			map as point with 20 m buffer	13	386665	7381115	100-500 genets	Around small, marshy pool in brushy tundra near marine shore, saline soil
BRVP30	VP30	*Caltha palustris*	2012/8/1	N	N			map with 100 m buffer	13	386843	7380994	200-300 genets	Around small ponds and along sluggish-water channels in estuarine marsh near marine shore
BRVP31	VP31	*Carex mackenziei*	2012/8/1	Y	N			map with 30 m buffer	13	385530	7382834	500-1000 genets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore
BRVP32	VP32	*Carex microglochin*	2012/8/1	Y	N			map as point with 20 m buffer	13	385408	7383071	5,000-10,000 ramets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore
BRL11	L11	*Collema crispum*	2012/8/1	Y	Y	UBC	*Björk 28702*	map as point with 10 m buffer	13	383774	7385054	About 10 thalli seen	Over mosses on ledge of sandstone cliff in narrow canyon
BRVP33	VP33	*Corallorhiza trifida*	2012/8/1	N	N			map with 100 m buffer along shoreline	13	386973	7381098	About 10 genets	Mossy ground in brushy tundra near marine shore
BRVP34	VP34	*Corallorhiza trifida*	2012/8/1	N	N			map with 100 m buffer along shoreline	13	385590	7382701	About 10 genets	Mossy ground in brushy tundra near marine shore
BRVP35	VP35	*Dasiphora fruticosa*	2012/8/1	N	N			map as two points surrounded by 20 m ellipse	13	4987 and 385	7384987	Three genets	Rocky shore of creek near marine shoreline
BRV124		*Draba arabisans*	2012/8/1	N	Y	UBC	*Björk 26915, 29112*	map as point with 10 m buffer	13	383772	7385038	5-10 genets	Along nitrogen enriched cliff ledges of canyon
BRVP36	VP36	*Eleocharis palustris*	2012/8/1	N	Y	UBC	*Björk 26915, Björk 29113, Björk 29114*	map with 30 m buffer	13	386085	7381727	1,000-5,000 ramets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore
BRM4	*M4*	*Encalypta vittiana*	2012/8/1	N	Y	UBC	*Björk 28817*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	On ledges of sandstone cliff in narrow canyon
BRVP37	VP37	*Erysimum coarctatum*	2012/8/1	Y	Y	UBC	*Björk 26913*	representative waypoint for diffuse population strung along the immediate shoreline	13	384516	7385114	200-300 genets	Sandy, gravelly beach upper margins
BRVP38	VP38	*ianella propinqua ssp. arcto*	2012/8/1	N	N			map as point with 20 m buffer	13	387093	7381276	About 5,000 genets	Sandy and gravelly ground along beach upper margins
BRVP39	VP39	*Gentianella tenella*	2012/8/1	N	Y	UBC	*Björk 26916*	map as point with 20 m buffer	13	386746	7381016	100-500 genets	Sandy and gravelly ground along beach upper margins
BRL12	L12	*Gyalecta foveolaris*	2012/8/1	Y	Y	UBC	*iörk 28839, Björk 287*	map as point with 10 m buffer	13	383774	7385054	One patch seen	Over mosses on ledge of sandstone cliff in narrow canyon
BRVP40	VP40	*Hippuris tetraphylla*	2012/8/1	Y	N			map with 40 m buffer	13	387146	7381260	100-500 ramets	Shallow pools on low benches above marine shore, brackish water
BRL66		*Hypogymnia dichroma*	2012/8/1	Y	N			map as point with 10 m buffer	13	383546	7385036	1 thallus	At margin of tundra embedded rock

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRL13	L13	*Leptogium imbricatum*	2012/8/1	Y	Y	UBC	*Björk 28838*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRL14	L14	*Leptogium intermedium*	2012/8/1	Y	Y	UBC	*Björk 28807*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRL67		*Leptogium tenuissimum*	2012/8/1	N	N			map as point with 10 m buffer	13	383772	7385038	1 thallus	In fine nutrient enriched sand
BRL15	L15	*Lobaria scrobiculata*	2012/8/1	Y	Y	UBC	*Björk 28723*	map as point with 20 m buffer	13	383519	7385070	200-300 thalli	On sandstone talus and cliff bases in narrow canyon
BRVP41	VP41	*Lomatogonium rotatum*	2012/8/1	Y	N			map as point with 20 m buffer	13	386746	7381016	5,000-10,000 genets	Sandy and gravelly ground along beach upper margins
BRVP42	VP42	*Luzula groenlandica*	2012/8/1	Y	N			map as point with 20 m buffer	13	386683	7381140	5-10 genets	Sandy and gravelly ground along beach upper margins
BRL68		*Nephroma parile*	2012/8/1	N	Y	UBC	*rk 28712* (sub *Gowarc*	Map as point with 10 m buffer	13	383519	7385070	1 thallus	On sandstone talus and cliff bases in narrow canyon
BRVP43	VP43	*Oxytropis deflexa*	2012/8/1	Y	N			map with 50 buffer about 200 m above the shore to capture diffuse population	13	386233	7381421	About 50 genets	Open, brushy vegetation on low bench above marine shore, sandy soil
BRL16	L16	*Physconia perisidiosa*	2012/8/1	N	N			map as point with 20 m buffer	13	383519	7385070	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRV125		*Plantago canescens*	2012/8/1	N	N			map as point with 20 m buffer	13	387095	7381274	50-100 genets	Gently sloping clay and gravel flat
BRVP44	VP44	*Primula stricta*	2012/8/1	N	N			map with sufficent buffer to connect to the waypoint on July 22	13	387170	7381237	About 100 genets	Sparsely vegetated upper beach margins along marine shore, sandy and silty soil
BRL69		*Protopannaria pezizoides*	2012/8/1	N	N			map as point with 10 m buffer	13	385688	7382430	1 thallus	Along nitrogen enriched cliff ledge
BRM5	*M5*	*Pterigynandrum filiforme*	2012/8/1	N	Y	UBC	*Björk 28827*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	On ledges of sandstone cliff in narrow canyon
BRVP45	VP45	*Puccinellia sp. nov.*	2012/8/1	Y	N			map with 50 m buffer	13	387095	7381274	2,000-5,000 genets	Open or sparsely vegetated ground, erosional cutbanks along beach upper margins
BRVP46	VP46	*ialix ovalifolia var. ovalifolic*	2012/8/1	Y	Y	UBC	*Björk 26917*	map with 50 m buffer	13	386855	7380904	About 10 genets	Along sluggish-water channels in estuarine marsh
BRM6	*M6*	*Seligeria sp. nov.*	2012/8/1	Y	Y	UBC	*Björk 28825*	map as point with 20 m buffer	13	383519	7385070	50-100 tufts	In crevices of sandstone cliff in narrow canyon
BRV126		*Stuckenia filiformis* ssp. *alpin*	2012/8/1	Y	N			map as point with 20 m buffer	13	385666	7282453	200-300 genets	Saline mud flat covered in red algae?
BRVP48	VP48	*Triglochin palustris*	2012/8/1	Y	N			map with 30 m buffer	13	384610	7384846	About 1,000 genets	Shallow pools on low benches above marine shore, brackish water
BRVP49	VP49	*Utricularia intermedia*	2012/8/1	N	N			map as point with 10 m buffer	13	385666	7382453	About 500 genets	Floating in shallow pools on low benches above marine shore, brackish water
BRV127		*Argentina egedii*	2012/8/2	N	N			map with 50 m buffer	13	395486	7370225	50-100 ramets	Wet sand beach at edge of estuary

Appendix 1-D. Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV128		*Astragalus eucosmus*	2012/8/2	Y	Y	UBC	*Björk 26930*	map as point with 20 m buffer	13	393637	7367721	50-100 genets	On sloping bank of small stream
BRV129		*Calamagrostis deschampsioide*	2012/8/2	Y	N			map as point with 20 m buffer	13	397222	7366730	10-20 genets	In sand of high beach above tide-line where vegetation begins
BRV130		*Carex mackenziei*	2012/8/2	N	N			map with 30 m buffer	13	397465	7366199	100-500 genets	Brackish pool in tundra on low bench above marine shore
BRM20		*Dicranella* cf. *subulata* (*stickinensi*	2012/8/2	N	Y	UBC	*Björk 28759*	map as point with 10 m buffer	13	393677	7369999	2 patches	On ledge of short cliff
BRV145		*Draba arabisans*	2012/8/2	N	N			map as point with 10 m buffer	13	397437	7366142	About 10 genets	On sparsely vegetated sand at upper beach margin by marine shore
BRV131		*Gentianella tenella*	2012/8/2	N	N			map as point with 20 m buffer	13	393356	7368232	20-50 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRV132		*Hippuris tetraphylla*	2012/8/2	N	N			map as point with 20 m buffer	13	395218	7371165	200-500 ramets	Brackish ponds above high beach
BRL70		*Hypogymnia dichroma*	2012/8/2	N	Y	UBC	*Björk 28740*	map as point with 10 m buffer	13	393733	7370055	1 large thallus	Part of moss crust covering cobbles
BRV133		*Juncus arcticus* var. *alaskanu*	2012/8/2	N	N			map as point with 20 m buffer	13	395401	7370680	50-100 ramets	Along sedge-dominated estuary shoreline
BRL71		*Leptogium imbricatum*	2012/8/2	N	N			map as point with 10 m buffer	13	397064	7366911	5 thalli	Immersed in calcareous modifed silt
BRL72		*Lobaria scrobiculata*	2012/8/2	N	Y	UBC	*Björk 28756*	map as point with 10 m buffer	13	396885	7367217	5-10 thalli	Over rock at base of small cliff
BRV134		*Lomatogonium rotatum*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	20-50 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRV135		*Luzula groenlandica*	2012/8/2	N	N			map as point with 20 m buffer	13	395376	7371132	20-50 genets	In the bottom of small cuts and runnels leading to inlet
BRV136		*Oxytropis deflexa* var. *foliolo:*	2012/8/2	N	N			map as point with 10 m buffer	13	397437	7366142	About 10 genets	On sparsely vegetated sand at upper beach margin by marine shore
BRL73		*Physconia perisidiosa*	2012/8/2	N	Y	UBC	*Björk 28755*	map as point with 10 m buffer	13	393677	7369999	5-10 thalli	Over rock on low cliff
BRV137		*Plantago canescens*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	20-50 genets	Gravel and clay flats at tundra's edge
BRV138		*Pohlia proligera*	2012/8/2	N	Y	UBC	*Björk 28730*	map as point with 10 m buffer	13	393677	7369999	About 100 genets	Over moss and soil on ledge of short cliff
BRV139		*Potentilla* cf. *litoralis*	2012/8/2	N	N			map as point with 10 m buffer	13	397400	7366495	About 50 genets	On sparsely vegetated gravelly sand on low bench at marine shore
BRV140		*Primula stricta*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	5-10 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRL74		*Protopannaria sp. nov.*	2012/8/2	N	Y	UBC	*Björk 28752*	map as point with 10 m buffer	13	393677	7369999	1 patch	Over moss and soil on ledge of short cliff
BRL75		*Psoroma tenue* var. *boreale*	2012/8/2	N	Y	UBC	*Björk 28854*	map as point with 10 m buffer	13	393677	7369999	1 patch (multiple thalli?)	Over moss and soil on ledge of short cliff
BRV141		*ccinellia sp. nov.*	2012/8/2	Y	N			map with 30 m buffer	13	397253	7366630	20-50 genets	Isolated tufts on eroding clay cutbank of inlet
BRV142		*Symphyotrichum pygmaeum*	2012/8/2	N	Y	UBC	*Björk 26926*	map as point with 20 m buffer	13	395432	7370602	2 genets	On grassy bench above inlet
BRV143		*Triglochin palustris*	2012/8/2	N	N			map with 30 m buffer	13	394669	7370509	50-100 genets	Saline mud flat
BRV144		*Woodsia alpina*	2012/8/2	Y	N			map as point with 20 m buffer	13	393731	7370049	3 genets	Pockets of soil tucked into cobbly talus

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP50		*Argentina egedii*	2012/7/4	N	N			map as point with 10 m buffer	13	387421	7383139	100-200 ramets	Upper beach margins, on gravel at upper tide line
BRVP1	VP1	*Epilobium davuricum*	2012/7/4	Y	Y	UBC	*Björk 26528*	map as point with 10 m buffer	13	387411	7383216	1-5 genets	On peaty soil in brushy tundra near shore, 10 degree west slope
BRL1	L1	*Solorina octospora*	2012/7/4	Y	Y	UBC	*Björk 27611*	map as point with 10 m buffer	13	387411	7383216	1 thallus	On peaty soil of erosional cutbank shortly above marine shoreline
BRL17		*Brodoa oroarctica*	2012/7/20	Y	N			map as point with 10 m buffer	13	389386	7313364	1 patch seen	On cliff ledges above lake
BRVP51		*Carex lapponica*	2012/7/20	N	Y	UBC	*Björk 26728*	map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence VP9	13	388300	7314088	5-10 genets	Mossy seep along lakeshore
BRVP52		*Draba crassifolia*	2012/7/20	Y	Y	UBC	*Björk 26756*	map as point with 10 m buffer	13	389386	7313364	5-10 genets	On cliff ledges above lake
BRM8		*Pohlia crudoides*	2012/7/20	N	Y	UBC	*Björk 29122*	map as point with 10 m buffer	13	389386	7313364	1 patch seen	On cliff ledges above lake
BRVP53		*Salix sp. nov. (esker tops)*	2012/7/20	N	N			map as point with 30 m buffer	13	389318	7313465	20-30 genets	Exposed, sparesly vegetated ridge-top with western exposure
BRL18		*Siphula ceratites*	2012/7/20	Y	Y	UBC	*Björk 28142, 28157*	map as point with 10 m buffer	13	388452	7313092	2,000-3,000 ramets (stems)	Low tundra depression, periodically flooded
BRL19		*Bryoria tenuis*	2012/7/21	N	Y	UBC	*Björk 28249*	map as point with 10 m buffer	13	431276	7269894	5-10 thalli	At lip of cliff of siliceous rock
BRL20		*Leciophysma finmarkicum*	2012/7/21	Y	N			map as point with 10 m buffer	13	429080	7272210	1 thallus seen	On moss mats by lake shore on tussock, with Cladonia cyanipes
BRL21		*Placynthium flabellosum*	2012/7/21	Y	N			map as point with 10 m buffer	13	431960	7269756	10-20 thalli	Vertical rock face of short canyon, nitrogen enriched
BRM9		*Psilopilum cavifolium*	2012/7/21	N	N			map as point with 10 m buffer	13	429917	7271729	500-1000 genets	Eroding cut-bank of fine textured materials
BRL22		*Pycnothelia papillaria*	2012/7/21	Y	Y	UBC	*Björk 28226*	map as point with 10 m buffer	13	429917	7271729	1 discontinuous patch over a half meter square	Eroding cut-bank of fine textured materials on short cliff
BRL23		*Ramalina intermedia*	2012/7/21	Y	N			map as point with 10 m buffer	13	431276	7269894	10-20 thalli	Sheltered rock underhang, nitrogen enriched
BRL24		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	432257	7269473	1,000-2,000 ramets	Low tundra depression, periodically flooded
BRL25		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	429155	7271245	2,000-5,000 ramets	Low tundra depression, periodically flooded
BRL26		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	429923	7271450	1,000-2,000 ramets	Damp, Unvegetated runnels between hummocks
BRL27		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	431781	7269707	2,000-5,000 ramets	On tilted depression at edge of plateau
BRL28		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	433730	7269807	500-1,000 ramets	Low tundra depression, periodically flooded
BRL29		*Siphula ceratites*	2012/7/21	N	N			map as point with 10 m buffer	13	433399	7269105	1,000-2,000 ramets	Low tundra depression, periodically flooded
BRM10		*Sphagnum platyphyllum*	2012/7/21	N	Y	UBC	*Björk 28234*	map as point with 10 m buffer	13	429080	7272210	1 patch observed	Among other Sphagnum at lake shore
BRVP54		*Utricularia macrorhiza*	2012/7/21	Y (Ryan Durand photo)	N			Unknown	13	402012	7360502	Unknown	Ryan Durand Utricularia macrorrhiza record from estuary of the Western River, 1% cover, pH 7.4, conductivity 1030, 95% open water, depth 0, with Carex saxatilis 3, Sparganium hyperboreum 5, Carex aquatilis 3, Hippuris vulgaris 3
BRVP3	VP3	*Argentina egedii*	2012/7/22	Y	N			map as point with 50 m buffer	13	387669	7381502	100,000-200,000 ramets	Sandy, gravelly and silty marine shoreline and marshes, mostly where sparsely vegetated
BRVP4	VP4	*Caltha palustris*	2012/7/22	Y	Y	UBC	*Björk 26810*	map as point with 100 m buffer	13	387762	7381384	about 500 genets	In and around open-water pools and along sluggish water channels in estuarine marsh

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP5	VP5	*Carex mackenziei*	2012/7/22	Y	N			map as point with 50 m buffer	13	387545	7381474	5,000-10,000 genets	Estuarine marsh and in low, wet depressions in beaches and benches
BRVP6	VP6	*Carex microglochin* ssp. *microglochin*	2012/7/22	Y	Y	UBC	*Björk 26788*	map as point with 30 m buffer	13	387687	7381471	5,000-10,000 ramets	Estuarine marsh and in low, wet depressions on benches, mostly where brackish
BRVP7	VP7	*Corallorhiza trifida*	2012/7/22	N	N			map as point with 100 m buffer, a large diffuse population	13	387762	7381384	about 10 genets	Mossy ground in brushy tundra near marine shore
BRVP55		*Draba crassifolia*	2012/7/22	Y	N				13			5-10 genets	Near George camp, brief visit to Ryan Durand's wetland site to north of camp, get waypoint from him, Siphula ceratites, Draba (nearly glabrous)
BRVP8	VP8	*Erysimum coarctatum*	2012/7/22	Y	N			map as point with 50 m buffer	13	387457	7381422	50-100 genets	Open sites, sandy beaches along marine shore
BRVP10	VP10	*Gentianella propinqua ssp. arctophila*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence BRVP9	13	387314	7381302	About 5,000 genets (including VP10)	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP9	VP9	*Gentianella propinqua ssp. arctophila*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form a polygon with Element Occurrence BRVP10	13	387337	7381314	About 5,000 genets (including VP10)	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP11	VP11	*Gentianella tenella*	2012/7/22	Y	Y	UBC	*Björk 26787*	map as point with 20 m buffer, combine along shoreline to form polygon with BRVP12	13	387335	7381306	5,000-10,000 genets, total between both sites	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP12	VP12	*Gentianella tenella*	2012/7/22	Y	N			map as point with 20 m buffer, combine along shoreline to form polygon with BRVP11	13	387547	7381466	5,000-10,000 genets, total between both sites	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP13	VP13	*Hippuris tetraphylla*	2012/7/22	Y	N			map as point with 30 m buffer	13	387660	7381482	About 10,000 ramets	In and around open-water pools and along sluggish water channels in estuarine marsh
BRVP14	VP14	*Juncus arcticus var. alaskanus*	2012/7/22	Y	Y	UBC	*Björk 26772, Björk 26782*	map as point with 50 m buffer	13	387339	7381300	5,000-10,000 ramets	Sandy beaches and estuarine marshes
BRVP15	VP15	*Lomatogonium rotatum*	2012/7/22	Y	Y	UBC	*Björk 26786*	map as point with 20 m buffer	13	387295	7381307	10,000-20,000 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP16	VP16	*Luzula groenlandica*	2012/7/22	Y	Y	UBC	*Björk 26778*	map as point with 30 m buffer	13	387536	7381474	50-100 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP17	VP17	*Montia fontana*	2012/7/22	N	N			map as point with 10 m buffer	13	387467	7381420	1000-5000 genets	Open or sparsely vegetated brackish mud in estuary
BRVP56		*Oxytropis deflexa* var. *foliolosa*	2012/7/22	N	Y	UBC	*Björk 26770*	map as point with 20 m buffer	13	387431	7381367	5-10 genets	Ericaceous tundra on level plateau 10 m above sea level
BRVP18	VP18	*Plantago canescens*	2012/7/22	Y	N			map as point with 30 m buffer	13	387317	7381311	About 5,000 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP20	VP20	*Primula stricta*	2012/7/22	N	Y	UBC	*Björk 26792*	map as point with a largest enough buffer to connect to August 1 waypoint for same species, but only along shoreline	13	387352	7381309	500-1000 genets	Sparsely vegetated, brackish mud or silty sand along marine shoreline at margins of estuary
BRM11		*Psilopilum cavifolium*	2012/7/22	N	Y	UBC	*Björk 28396*	map as point with 10 m buffer	13	387847	7381732	100-200 genets	On erosional cutslope in brushy tundra shortly above estuary and beach
BRVP19	VP19	*Puccinellia sp. nov.*	2012/7/22	Y	N			map as point with 30 m buffer	13	387283	7381304	1,000-5,000 genets	Erosional cutbanks at beach/estuary interface, and around low, wet depressions in beach along marine shore

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRL30		*Siphula ceratites*	2012/7/22	N	N				13			1,000-2,000 ramets (stems)	Near George camp, brief visit to Ryan Durand's wetland site to north of camp, get waypoint from him, Siphula ceratites, Draba crassifolia
BRVP57		*Stuckenia filiformis* ssp. *alpina*	2012/7/22	Y	Y	UBC	*Björk 26811*	map as point with 30 m buffer	13	387671	7381509	50-100 genets	Saline mud flat behind beach
BRVP22	VP22	*Suaeda calceoliformis*	2012/7/22	Y	N			map as point with 40 m buffer to capture large population	13	387660	7381482	5,000-10,000 genets	On open brackish mud, broad flats and depressions in estuarine marsh
BRVP23	VP23	*Triglochin palustris*	2012/7/22	N	Y	UBC	*Björk 26801*	map as point with 30 m buffer	13	387743	7381599	About 1,000 genets	Estuarine marsh along marine shore, mostly among dense vegetation
BRVP24	VP24	*Utricularia intermedia*	2012/7/22	Y	Y	UBC	*Björk 26809*	map as point with 10 m buffer	13	387660	7381482	500-1000 genets	Floating in open-water pools in estuarine marsh
BRVP58		*Epilobium davuricum*	2012/7/23	Y	N			map as point with 10 m buffer	13	423657	7265838	2 genets	Bottom of small mossy depression in tundra
BRL31		*Protopannaria sp. nov.*	2012/7/23	N	Y	UBC	*Björk 28300, 28762, 28318*	map as point with 10 m buffer	13	421680	7266441	1 patch	On thin soil over rock, lip of short cliff
BRVP59		*Salix ovalifolia*	2012/7/23	Y	Y	UBC	*Björk 26815*	map as point with 20 m buffer	13	423114	7265808	50-100 genets	Among sedges along small stream in shallow ravine
BRVP60		*Salix sp. 1*	2012/7/23	Y	N			map as point with 20 m buffer	13	421978	7266140	10-15 genets	On gravelly ground on esker top
BRL32		*Siphula ceratites*	2012/7/23	Y	N			map as point with 10 m buffer	13	421518	7266841	5,000-10,000 ramets	Flat, moist depression in tundra
BRL33		*Siphula ceratites*	2012/7/23	N	N			map as point with 10 m buffer	13	423182	7265818	2,000-5,000 ramets	Flat, moist depression in tundra
BRM12		*Sphagnum platyphyllum*	2012/7/23	N	Y	UBC	*Björk 28388*	map as point with 10 m buffer	13	423696	7265852	1 patch seen	Mossy ground in slight depression, more moist than surrounding tundra
BRL34		*Leptogium imbricatum*	2012/7/24	N	Y	UBC	*Björk 28378*	map as point with 10 m buffer	13	389633	7312131	2 thalli	In fine soil of tilted calcareous strata with Oxytropis nigrescens
BRL35		*Placynthium flabellosum*	2012/7/24	N	N			map as point with 10 m buffer	13	389915	7311397	5-10 thalli	With Ephebe lanata on rock at lake shore
BRL36		*Placynthium flabellosum*	2012/7/24	N	N			map as point with 10 m buffer	13	379452	7312391	About 20 thalli	On rock at edge of broad depression, periodically flooded
BRL37		*Protopannaria sp. nov.*	2012/7/24	Y	N			map as point with 10 m buffer	13	389966	7310953	1 thallus	Over soil next low flat boulder at the base of a small cliff
BRVP61		*Ranunculus pallasii*	2012/7/24	Y	N			map as point with 20 m buffer	13	388051	7313281	5-10 genets	On open or sparsely vegetated mud along margin of small lake shortly west of George Camp airstrip and shortly south of the heli pads
BRVP62		*Salix ovalifolia*	2012/7/24	N	Y	UBC	*Björk 29142* (hybrid form of *S. ovalifolia x S. glauca*)	map as point with 20 m buffer	13	390094	7310037	1 genet	Moist, low, mossy ground in brushy tundra at base of esker
BRL38		*Siphula ceratites*	2012/7/24	N	Y	UBC	*Björk 28364*	map as point with 10 m buffer	13	389452	7312391	500-1000 ramets	Moist depression, periodically flooded
BRM13		*Splachnum sphaericum*	2012/7/24	N	Y	UBC	*Björk 28417*	map as point with 10 m buffer	13	389841	7309515	1 patch	On decaying animal matter in mossy lakeshore vegetation
BRL39		*Xanthoparmelia wyomingica*	2012/7/24	Y	Y	UBC	*Björk 28353, 28387, 28416*	map as point with 20 m buffer	13	390042	7309814	About 20 fragmented thalli	With Xanthomendoza borealis, associated collections, nitrogen hotspot around animal burrow on peak on esker
BRVP63		*Argentina egedii*	2012/7/25	N	N			map as point with 50 m buffer	13	380547	7393332	20-30 genets	Level sandy flat just above the high tide line
BRVP64		*Caltha palustris*	2012/7/25	N	N			map as point with 20 m buffer	13	379593	7393435	5-10 genets	On brackish mud, bottom of low cut in tudra near edge of inlet
BRVP65		*Carex mackenziei*	2012/7/25	Y	Y	UBC	*Björk 26835*	map as point with 30 m buffer	13	379974	7393625	500-1000 genets	Brackish pool in tundra on low bench above marine shore

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP66		*Carex microglochin* ssp. *microglochin*	2012/7/25	N	Y	UBC	*Björk 26868*	map as point with 20 m buffer	13	379910	7393556	200-500 ramets	Brackish pool in tundra on low bench above marine shore
BRL40		*Collema ceraniscum*	2012/7/25	Y	Y	UBC	*Björk 28431*	map as point with 10 m buffer	13	381379	7393621	5-10 thalli	On soil among mosses and other lichens in shallow depression on slope, in brushy tundra
BRVP67		*Corallorhiza trifida*	2012/7/25	N	Y	UBC	*Björk 29136*	map as point with 20 m buffer	13	382096	7393482	5-10 genets	On mossy ground in brushy tundra
BRVP68		*Draba arabisans*	2012/7/25	N	Y	UBC	*Björk 29137*	map as point with 10 m buffer	13	382073	7393623	5-10 genets	On sand of high beach above tide-line where vegetation begins
BRVP69		*Eleocharis palustris* sensu lato	2012/7/25	Y	Y	UBC	*Björk 26856*	map as point with 20 m buffer	13	379799	7393447	20-50 ramets	Along edges of narrow, dried out estuarine channel
BRVP70		*Erysimum coarctatum*	2012/7/25	Y	N			map as point with 20 m buffer	13	382069	7393674	5-10 genets	In sand of high beach above tide-line where vegetation begins
BRVP71		*Gentianella tenella*	2012/7/25	Y	N			map as point with 20 m buffer	13	380130	7393675	100-500 genets	Sandy and gravelly ground along beach upper margins
BRVP72		*Hippuris tetraphylla*	2012/7/25	Y	N			map as point with 30 m buffer	13	380084	7393621	200-500 ramets	Brackish pool in tundra on low bench above marine shore
BRVP73		*Juncus arcticus* var. *alaskanus*	2012/7/25	N	N			map as point with 20 m buffer	13	379924	7393593	20-50 ramets	Along edge of narrow pool above beach
BRVP74		*Lomatogonium rotatum*	2012/7/25	Y	N			map as point with 20 m buffer	13	380130	7393675	100-500 genets	On high beach at edge of estuary
BRVP75		*Luzula groenlandica*	2012/7/25	Y	Y	UBC	*Björk 26837*	map as point with 20 m buffer	13	379892	7393579	20-50 genets	Along edge of tundra above inlet
BRVP76		*Montia fontana*	2012/7/25	Y	Y	UBC	*Björk 26839*	map as point with 10 m buffer	13	382132	7393549	20-50 genets	Sandy and gravelly ground along beach upper margins
BRVP77		*Plantago canescens*	2012/7/25	Y	N			map as point with 20 m buffer	13	382079	7393616	50-100 genets	Dry, clayey soil and open flats
BRVP78		*Puccinellia sp. nov.*	2012/7/25	Y	Y	UBC	*Björk 26842, 26862*	map as point with 20 m buffer	13	380013	7393649	500-1000 genets	Dense stands on 'islands' and on edges of cut-slopes at mouth of estuary with other species of Puccinellia
BRVP79		*Suaeda calceoliformis*	2012/7/25	Y	Y	UBC	*Björk 26854*	map as point with 20 m buffer	13	380506	7393402	100-500 genets	Sparsely vegetated saline mud flats along edge of estuary
BRVP80		*Symphyotrichum pygmaeum*	2012/7/25	Y	Y	UBC	*Björk 26853*	map as point with 30 m buffer	13	379847	7393544	50-100 genets	Slightly elevated grass dominated sites in estuarine mud flat
BRVP81		*Triglochin palustris*	2012/7/25	N	N			map as point with 20 m buffer	13	380573	7393317	100-500 genets	Along edges of saline mud flats
BRVP82		*Chrysosplenium rosendahlii*	2012/7/27	Y	Y	UBC	*Björk 29133*	map as point with 20 m buffer	13	387696	7314307	20-30 genets	Partially sheltered under low, eroding bank of small lake
BRL41		*Collema ceraniscum*	2012/7/27	N	Y	UBC	*Björk 28549*	map as point with 10 m buffer	13	386913	7314275	1 patch	On seepy, calc-modified cliff ledges
BRM14		*Encalypta brevicollis*	2012/7/27	N	Y	UBC	*Björk 28530*	map as point with 10 m buffer	13	386913	7314275	5-10 tufts	On seepy, calc-modified cliff ledges
BRM15		*Encalypta vulgaris*	2012/7/27	Y	Y	UBC	*Björk 28525*	map as point with 10 m buffer	13	386913	7314275	5-10 tufts	On seepy, calc-modified cliff ledges
BRL42		*Lichenomphalia hudsoniana*	2012/7/27	Y	N			map as point with 10 m buffer	13	387501	7314433	1 patch of numerous squamules	Over moss on ledges of seepy cliff
BRVP83		*Petasites sagittatus*	2012/7/27	Y	N			map as point with 10 m buffer	13	386718	7314229	5-10 genets	Along saturated margin of small lake
BRL43		*Protopannaria pezizoides*	2012/7/27	N	N			map as point with 10 m buffer	13	387501	7314433	5-10 thalli	Over moss on ledges of seepy cliff

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRL44		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	387104	7314603	1,000-2,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL45		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	386557	7314200	1,000-2,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL46		*Siphula ceratites*	2012/7/27	N	N			map as point with 10 m buffer	13	386302	7314410	500-1,000 ramets	Over liverworts in broad depression in tundra, periodically flooded
BRL47		*Xanthoparmelia wyomingica*	2012/7/27	Y	N			map as point with 10 m buffer	13	387595	7314034	20-50 thalli	Exposed ridge of esker, mostly around animal burrows and near bases of bird-perch rocks
BRM16		*Aloina rigida*	2012/7/28	N	Y	UBC	*Björk 28572* (sub *Candelariella rosulans*), *28574* (sub Candelariella aurella)	map as point with 10 m buffer	13	401078	7360223	About 30 ramets (rosettes)	On loamy soil perched at top of short cliff
BRVP84		*Argentina egedii*	2012/7/28	N	N			map as point with 30 m buffer	13	401095	7360215	50-100 ramets	Sandy flat of high beach
BRVP85		*Astragalus australis* var. *lepagei*	2012/7/28	Y	N			map as point with 20 m buffer	13	399181	7362891	5-10 genets	Along edge of tundra above high tide line
BRVP86		*Astragalus eucosmus*	2012/7/28	Y	N			map as point with 20 m buffer	13	400216	7360509	5-10 genets	Along edge of tundra above high tide line
BRVP87		*Caltha palustris*	2012/7/28	N	N			map as point with 10 m buffer	13	399394	7362557	5-10 genets	Small, wet depression near inlet
BRVP88		*Carex mackenziei*	2012/7/28	N	N			map as point with 20 m buffer	13	401028	7360214	500-1000 genets	Sandy saline flat above marine shore, periodically inundated
BRVP89		*Corallorhiza trifida*	2012/7/28	N	N			map as point with 10 m buffer	13	398800	7363569	5-10 genets	On mossy slopes in brushy tundra near marine shore
BRVP90		*Corallorhiza trifida*	2012/7/28	N	N			map as point with 10 m buffer	13	401095	7360215	5-10 genets	On mossy slopes in brushy tundra near marine shore
BRVP91		*Draba arabisans*	2012/7/28	N	Y	UBC	*Björk 29132*	map as point with 10 m buffer	13	401361	7360503	4 genets	Along edge of tundra above high tide line
BRVP92		*Erysimum coarctatum*	2012/7/28	N	N			map as point with 10 m buffer	13	399041	7363121	5-10 genets	Sandy, gravelly beach upper margins
BRVP93		*Erysimum coarctatum*	2012/7/28	N	N			map as point with 10 m buffer	13	398935	7363400	5-10 genets	Sandy, gravelly beach upper margins
BRV107		*Galium trifidum*	2012/7/28	N	N			map as point with 20 m buffer	13	401588	7360564	50-100 ramets	Among sedges, saline mud flat of estuary
BRVP94		*Galium trifidum*	2012/7/28	Y	Y	UBC	*Björk 26873*	map as point with 20 m buffer	13	401028	7360214	20-50 genets	Just within the edge of the tundra at marine shore, in small, brackish depression
BRVP95		*Gentianella tenella*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	100-500 genets	Open or sparsely vegetated sites, sandy beaches along marine shore
BRVP96		*Hippuris tetraphylla*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	500-1000 ramets	Brackish pool in tundra above marine shore
BRVP97		*Juncus arcticus* var. *alaskanus*	2012/7/28	N	N			map as point with 20 m buffer	13	401406	7360549	50-100 ramets	At edges of brackish pools and channels
BRL48		*Leptogium imbricatum*	2012/7/28	Y	N			map as point with 10 m buffer	13	399612	7362181	5-10 thalli	On sparsely vegetated sand of blow-out, sandy bench above marine shore
BRL49		*Leptogium intermedium*	2012/7/28	N	N			map as point with 10 m buffer	13	401078	7360223	1 thallus	Over moss, with other calciphilic species of lichens and bryophytes
BRVP98		*Lomatogonium rotatum*	2012/7/28	Y	N			map as point with 20 m buffer	13	401406	7360549	100-500 genets	Sandy, gravelly beach upper margins
BRVP99		*Luzula groenlandica*	2012/7/28	N	N			map as point with 20 m buffer	13	398800	7363569	50-100 genets	Along edge of tundra above high tide line
BRV100		*Montia fontana*	2012/7/28	Y	N			map as point with 20 m buffer	13	401028	7360214	10-20 genets	High beach zone at edge of tundra, in damp sand
BRV101		*Montia fontana*	2012/7/28	N	N			map as point with 20 m buffer	13	401334	7360373	10-20 genets	Sandy beach with Honkenya peploides

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV102		*Petasites sagittatus*	2012/7/28	y	N			map as point with 20 m buffer	13	399551	7360656	500-1000 ramets (single leaves or clusters of leaves, many connected by long rhizomes)	Slightly lower ground in tussocky tundra on slopes near base of cliffs
BRV103		*Plantago canescens*	2012/7/28	Y	N			map as point with 20 m buffer	13	399549	7362274	20-50 genets	Silty-sand flat near estuary
BRV104		*Potentilla* cf. *litoralis*	2012/7/28	Y	Y	UBC	*Björk 26874*	map as point with 20 m buffer	13	398933	7363404	5-10 genets	On sand/gravel of low bench at upper beach margin, where sparsely vegetated
BRV105		*Puccinellia sp. nov.*	2012/7/28	Y	Y	UBC	*Björk 29130* (to be designated as the type?)	map as point with 20 m buffer	13	401406	7360549	500-1000 genets	Low, inundated shoreline of estuary with other Puccinellia species
BRL50		*Solorina octospora*	2012/7/28	N	N			map as point with 10 m buffer	13	400976	7360273	5-10 thalli	Over moss, with other calciphilic species of lichens and bryophytes
BRV106		*Suaeda calceoliformis*	2012/7/28	Y	N			map as point with 20 m buffer	13	401588	7360564	100-500 genets	Saline mud flat of estuary
BRV108		*Triglochin palustris*	2012/7/28	N	N			map as point with 20 m buffer	13	401028	7360214	100-500 genets	Saline mud flat of estuary
BRV109		*Utricularia intermedia*	2012/7/28	Y	N			map as point with 20 m buffer	13	401028	7360214	ca. 200 plants	Shallow brackish pond near marine shore
BRV110		*Utricularia intermedia*	2012/7/28	N	N			map as point with 20 m buffer	13	400493	7360624	about 500 plants?	Shallow brackish pond near marine shore
BRV111		*Chrysosplenium rosendahlii*	2012/7/29	Y	Y	UBC	*Björk 26893*	map as point with 20 m buffer	13	382212	7319712	20-50 genets	Among rocks along edge of large lake, within the splash zone of the lake water
BRV112		*Draba arabisans*	2012/7/29	N	Y	UBC	*Björk 26882*	map as point with 20 m buffer	13	378506	7321958	10-20 genets	On small, gravelly ledges of isolated cliff complex
BRV113		*Draba crassifolia*	2012/7/29	Y	N			map as point with 10 m buffer	13	372955	7325451	3 genets	At top of small cliff above lakes
BRL51		*Gyalecta friesii*	2012/7/29	Y	Y	UBC	*Björk 26832*	map as point with 10 m buffer	13	378542	7321974	2 thalli	Over soil at sheltered base of nitrogen enriched, seepy cliff
BRL52		*Hypogymnia dichroma*	2012/7/29	N	Y	UBC	*Björk 28584*	map as point with 10 m buffer	13	372777	7325359	1 thallus	On surface of boulder embedded level in tudra
BRV114		*Juncus arcticus* var. *alaskanus*	2012/7/29	N	N			map as point with 20 m buffer	13	372718	7325232	50-100 ramets	Along sedge-dominated lake margin
BRL53		*Leptogium imbricatum*	2012/7/29	N	Y	UBC	*Björk 28586*	map as point with 10 m buffer	13	378553	7321983	5-10 thalli	Over fine exposed silt
BRL54		*Leptogium intermedium*	2012/7/29	N	Y	UBC	*Björk 28610*	map as point with 10 m buffer	13	378553	7321983	2 thalli	On moss and exposed soil of calcareous seams
BRL55		*Polychidium muscicola*	2012/7/29	N	N			map as point with 10 m buffer	13	372955	7325451	2 thalli	Nitrogen enriched cliff ledge
BRL56		*Protopannaria sp. nov.*	2012/7/29	Y	N			map as point with 10 m buffer	13	378805	7322041	1 thallus	At base of cliff over soil and rock
BRM17		*Psilopilum cavifolium*	2012/7/29	N	N			map as point with 10 m buffer	13	378805	7322041	1 patch of about 50 stems	On soil of cliff ledge
BRM18		*Psilopilum laevigatum*	2012/7/29	Y	N			map as point with 20 m buffer	13	384519	7316776	50-100 discontinuous patches	Broad, sparsely vegetated, sandy, periodically flooded flat with Eleocharis acicularis
BRL57		*Solorina octospora*	2012/7/29	N	N			map as point with 10 m buffer	13	377323	7322329	10-20 thalli	At the bottom of low, seepy rock walls, with other calcophilic species
BRV115		*Astragalus australis* var. *lepagei*	2012/7/30	N	Y	UBC	*Björk 26900*	map as point with 20 m buffer	13	399101	7358973	5-10 genets	On gravel bench at upper beach margin, where sparsely vegetated
BRL58		*Bryoria tenuis*	2012/7/30	Y	N			map as point with 20 m buffer	13	399101	7358973	5-10 genets	On gravel bench at upper beach margin, where sparsely vegetated

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV116		*Caltha palustris*	2012/7/30	N	N			map as point with 20 m buffer	13	398818	7358861	5-10 genets	Along channels in marsh at lake shore
BRV117		*Chrysosplenium rosendahlii*	2012/7/30	N	N			map as point with 20 m buffer	13	398818	7358861	5-10 genets	Eroding bank at water's edge
BRL59		*Collema crispum*	2012/7/30	N	Y	UBC	*Björk 28794*	map as point with 10 m buffer	13	396848	7361759	5-10 thalli	Nitrogen enriched, seepy cliff face
BRV118		*Draba arabisans*	2012/7/30	Y	Y	UBC	*Björk 29150*	map as point with 20 m buffer	13	396848	7361762	10-20 genets	Base of nitrogen enriched cliff, with Elymus alaskanus
BRL60		*Endocarpon pulvinatum*	2012/7/30	Y	Y	UBC	*Björk 28649, 28792*	map as point with 10 m buffer	13	396848	7361759	500-1000 thalli	Nitrogen enriched cliff face
BRL61		*Fulgensia bracteata*	2012/7/30	Y	Y	UBC	*Björk 28657*	map as point with 10 m buffer	13	396848	7361759	10-20 thalli	Nitrogen enriched cliff ledges
BRL62		*Fuscopannaria sp. nov.*	2012/7/30	Y	Y	UBC	*Björk 28797*	map as point with 10 m buffer	13	398847	7358917	1 thallus	On base of stem of Betula nana, dense brushy vegetation near upper beach margin by lake shore
BRV119		*Juncus arcticus* var. *alaskanus*	2012/7/30	N	N			map as point with 20 m buffer	13	398109	7357872	20-50 ramets	Small fresh water pond near edge of Bathurst lake
BRV120		*Kobresia sibirica*	2012/7/30	N	Y	UBC	*Björk 29147*	map as point with 20 m buffer	13	398109	7357872	1 plant observed, more probably present	On gravelly ground at edge of small fresh water pond near edge of Bathurst lake
BRL63		*Leciophysma finmarkicum*	2012/7/30	Y	Y	UBC	*Björk 29147*	map as point with 10 m buffer	13	398273	7358114	2 thalli	Mossy cutbank at shore of lake
BRL64		*Leptogium imbricatum*	2012/7/30	Y	N			map as point with 10 m buffer	13	398743	7358717	5-10 thalli	On semistable sand of low, sandy bench near marine shore
BRV121		*Luzula groenlandica*	2012/7/30	N	N			map as point with 20 m buffer	13	399022	7358944	20-50 genets	On sandy and gravelly ground at upper beach margin near marine shore
BRM19		*Pseudoleskeella tectorum*	2012/7/30	N	Y	UBC	*Björk 28648, 28805*	map as point with 10 m buffer	13	396848	7361759	1 patch	Nitrogen-enriched ledges of seepy cliff, below bird perch
BRL2	L2	*Bryoria tenuis*	2012/7/31	N	N			map as point with 10 m buffer	13	388266	7383089	About 20 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL3	L3	*Hypogymnia dichroma*	2012/7/31	Y	Y	UBC	*Björk 28111*	map as point with 10 m buffer	13	388364	7383055	About 100 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL4	L4	*Hypogymnia imshaugii*	2012/7/31	Y	Y	UBC	*Björk 28690*	map with 25 m buffer	13	388266	7383089	2 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRVP25	VP25	*Juncus arcticus* var. *alaskanus*	2012/7/31	N	N			map with 40 m buffer	13	389484	7381944	1000-5000 ramets	Sandy, gravelly and silty sites on upper beach margins
BRL5	L5	*Leptogium imbricatum*	2012/7/31	Y	N			map as point with 20 m buffer	13	390070	7380585	Unknown, but inconspicuous at the site, so probably less than 100 thalli	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL6	L6	*Leptogium tenuissimum*	2012/7/31	Y	Y	UBC	*Björk 28682*	map as point with 20 m buffer	13	389892	7380689	Unknown, but inconspicuous at the site, so probably less than 100 thalli	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL7	L7	*Lobaria scrobiculata*	2012/7/31	Y	N			map as point with 10 m buffer	13	388364	7383055	20-30 thalli	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRVP26	VP26	*Luzula groenlandica*	2012/7/31	N	Y	UBC	*Björk 26778*	map with 30 m buffer	13	389531	7381196	30-50 genets	Sandy and gravelly beach flats
BRM1	M1	*Myrinia pulvinata*	2012/7/31	N	Y	UBC	*Björk 28686*	map as point with 20 m buffer	13	390070	7380585	Unknown, but inconspicuous at the site, so probably less than 100 patches	On sandstone outcrops in brushy tundra, on slopes above marine shore

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Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRM2	M2	*Orthotrichum anomalum*	2012/7/31	N	Y	UBC	*Björk 28678*	map as point with 20 m buffer	13	388387	7383260	100-200 tufts	On sandstone outcrops in brushy tundra, on slopes above marine shore
BRL8	L8	*Physconia perisidiosa*	2012/7/31	N	Y	UBC	*Björk 28674*	map as point with 10 m buffer	13	388364	7383055	About 10 patches (number of thalli unknown, may be multiple thalli per patch)	Over moss on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRL65		*Protopannaria pezizoides*	2012/7/31	N	N			map as point with 10 m buffer	13	388355	7383277	1 patch	Over moss on ledge of short basalt cliff at marine shore
BRL10	L10	*Protopannaria sp. nov.*	2012/7/31	N	Y	UBC	*Björk 28676*	map as point with 20 m buffer	13	388266	7383089	5-10 thalli	Over moss and suspended, exposed roots on sandstone outcrops in brushy tundra on slopes above marine shoreline
BRV122		*Puccinellia sp. nov.*	2012/7/31	Y	Y	UBC	*Björk 26902*	map as point with 20 m buffer	13	389534	7381896	500-1000 genets	On saline clay along marine shore
BRV123		*Stuckenia filiformis* ssp. *alpina*	2012/7/31	N	Y	UBC	*Björk 26904*	map as point with 20 m buffer	13	389556	7381087	50-100 genets	Sparsely vegetated saline mud flat
BRM3	M3	*Arctoa sp. nov.*	2012/8/1	N	Y	UBC	*Björk 28817 (sub Encalypta vittiana)*	map as point with 20 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Among other mosses in crevices and on ledges of sandstone cliffs in narrow canyon
BRVP27	VP27	*Argentina egedii*	2012/8/1	Y	N			map with 50 m buffer	13	384628	7384945	500-1000 ramets	Open or sparsely vegetated ground on upper beach margins and transition into brushy tundra
BRVP28	VP28	*Calamagrostis deschampsioides*	2012/8/1	Y	Y	UBC	*Björk 26914*	map as point with 20 m buffer	13	384616	7384735	100-500 genets	Around small, marshy pool in brushy tundra near marine shore, saline soil
BRVP29	VP29	*Calamagrostis deschampsioides*	2012/8/1	Y	N			map as point with 20 m buffer	13	386665	7381115	100-500 genets	Around small, marshy pool in brushy tundra near marine shore, saline soil
BRVP30	VP30	*Caltha palustris*	2012/8/1	N	N			map with 100 m buffer	13	386843	7380994	200-300 genets	Around small ponds and along sluggish-water channels in estuarine marsh near marine shore
BRVP31	VP31	*Carex mackenziei*	2012/8/1	Y	N			map with 30 m buffer	13	385530	7382834	500-1000 genets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore
BRVP32	VP32	*Carex microglochin* ssp. *microglochin*	2012/8/1	Y	N			map as point with 20 m buffer	13	385408	7383071	5,000-10,000 ramets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore
BRL11	L11	*Collema crispum*	2012/8/1	Y	Y	UBC	*Björk 28702*	map as point with 10 m buffer	13	383774	7385054	About 10 thalli seen	Over mosses on ledge of sandstone cliff in narrow canyon
BRVP33	VP33	*Corallorhiza trifida*	2012/8/1	N	N			map with 100 m buffer along shoreline	13	386973	7381098	About 10 genets	Mossy ground in brushy tundra near marine shore
BRVP34	VP34	*Corallorhiza trifida*	2012/8/1	N	N			map with 100 m buffer along shoreline	13	385590	7382701	About 10 genets	Mossy ground in brushy tundra near marine shore
BRVP35	VP35	*Dasiphora fruticosa*	2012/8/1	N	N			map as two points surrounded by 20 m ellipse	13	383857 7384987 and 385590 7382071	7384987	Three genets	Rocky shore of creek near marine shoreline
BRV124		*Draba arabisans*	2012/8/1	N	Y	UBC	*Björk 26915, 29112*	map as point with 10 m buffer	13	383772	7385038	5-10 genets	Along nitrogen enriched cliff ledges of canyon
BRVP36	VP36	*Eleocharis palustris*	2012/8/1	N	Y	UBC	*Björk 26915, Björk 29113, Björk 29114*	map with 30 m buffer	13	386085	7381727	1,000-5,000 ramets	Small, shallow, marshy pool in brushy tundra on low bench above marine shore

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRM4	M4	*Encalypta vittiana*	2012/8/1	N	Y	UBC	*Björk 28817*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	On ledges of sandstone cliff in narrow canyon
BRVP37	VP37	*Erysimum coarctatum*	2012/8/1	Y	Y	UBC	*Björk 26913*	representative waypoint for diffuse population strung along the immediate shoreline	13	384516	7385114	200-300 genets	Sandy, gravelly beach upper margins
BRVP38	VP38	*Gentianella propinqua ssp. arctophila*	2012/8/1	N	N			map as point with 20 m buffer	13	387093	7381276	About 5,000 genets	Sandy and gravelly ground along beach upper margins
BRVP39	VP39	*Gentianella tenella*	2012/8/1	N	Y	UBC	*Björk 26916*	map as point with 20 m buffer	13	386746	7381016	100-500 genets	Sandy and gravelly ground along beach upper margins
BRL12	L12	*Gyalecta foveolaris*	2012/8/1	Y	Y	UBC	*Björk 28839, Björk 28707*	map as point with 10 m buffer	13	383774	7385054	One patch seen	Over mosses on ledge of sandstone cliff in narrow canyon
BRVP40	VP40	*Hippuris tetraphylla*	2012/8/1	Y	N			map with 40 m buffer	13	387146	7381260	100-500 ramets	Shallow pools on low benches above marine shore, brackish water
BRL66		*Hypogymnia dichroma*	2012/8/1	Y	N			map as point with 10 m buffer	13	383546	7385036	1 thallus	At margin of tundra embedded rock
BRL13	L13	*Leptogium imbricatum*	2012/8/1	Y	Y	UBC	*Björk 28838*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRL14	L14	*Leptogium intermedium*	2012/8/1	Y	Y	UBC	*Björk 28807*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRL67		*Leptogium tenuissimum*	2012/8/1	N	N			map as point with 10 m buffer	13	383772	7385038	1 thallus	In fine nutrient enriched sand
BRL15	L15	*Lobaria scrobiculata*	2012/8/1	Y	Y	UBC	*Björk 28723*	map as point with 20 m buffer	13	383519	7385070	200-300 thalli	On sandstone talus and cliff bases in narrow canyon
BRVP41	VP41	*Lomatogonium rotatum*	2012/8/1	Y	N			map as point with 20 m buffer	13	386746	7381016	5,000-10,000 genets	Sandy and gravelly ground along beach upper margins
BRVP42	VP42	*Luzula groenlandica*	2012/8/1	Y	N			map as point with 20 m buffer	13	386683	7381140	5-10 genets	Sandy and gravelly ground along beach upper margins
BRL68		*Nephroma parile*	2012/8/1	N	Y	UBC	*Björk 28712* (sub *Gowardia*)	Map as point with 10 m buffer	13	383519	7385070	1 thallus	On sandstone talus and cliff bases in narrow canyon
BRVP43	VP43	*Oxytropis deflexa* var. *foliolosa*	2012/8/1	Y	N			map with 50 buffer about 200 m above the shore to capture diffuse population	13	386233	7381421	About 50 genets	Open, brushy vegetation on low bench above marine shore, sandy soil
BRL16	L16	*Physconia perisidiosa*	2012/8/1	N	N			map as point with 20 m buffer	13	383519	7385070	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	Over mosses on ledge of sandstone cliff in narrow canyon
BRV125		*Plantago canescens*	2012/8/1	N	N			map as point with 20 m buffer	13	387095	7381274	50-100 genets	Gently sloping clay and gravel flat

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	Species	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRVP44	VP44	*Primula stricta*	2012/8/1	N	N			map with sufficent buffer to connect to the waypoint on July 22	13	387170	7381237	About 100 genets	Sparsely vegetated upper beach margins along marine shore, sandy and silty soil
BRL69		*Protopannaria pezizoides*	2012/8/1	N	N			map as point with 10 m buffer	13	385688	7382430	1 thallus	Along nitrogen enriched cliff ledge
BRM5	M5	*Pterigynandrum filiforme*	2012/8/1	N	Y	UBC	*Björk 28827*	map as point with 10 m buffer	13	383774	7385054	Unknown, too inconspicuous for an meaningful estimate, but obviously not abundant	On ledges of sandstone cliff in narrow canyon
BRVP45	VP45	*Puccinellia sp. nov.*	2012/8/1	Y	N			map with 50 m buffer	13	387095	7381274	2,000-5,000 genets	Open or sparsely vegetated ground, erosional cutbanks along beach upper margins
BRVP46	VP46	*Salix ovalifolia*	2012/8/1	Y	Y	UBC	*Björk 26917*	map with 50 m buffer	13	386855	7380904	About 10 genets	Along sluggish-water channels in estuarine marsh
BRM6	M6	*Seligeria sp. nov.*	2012/8/1	Y	Y	UBC	*Björk 28825*	map as point with 20 m buffer	13	383519	7385070	50-100 tufts	In crevices of sandstone cliff in narrow canyon
BRV126		*Stuckenia filiformis* ssp. *alpina*	2012/8/1	Y	N			map as point with 20 m buffer	13	385666	7282453	200-300 genets	Saline mud flat covered in red algae?
BRVP48	VP48	*Triglochin palustris*	2012/8/1	Y	N			map with 30 m buffer	13	384610	7384846	About 1,000 genets	Shallow pools on low benches above marine shore, brackish water
BRVP49	VP49	*Utricularia intermedia*	2012/8/1	N	N			map as point with 10 m buffer	13	385666	7382453	About 500 genets	Floating in shallow pools on low benches above marine shore, brackish water
BRV127		*Argentina egedii*	2012/8/2	N	N			map with 50 m buffer	13	395486	7370225	50-100 ramets	Wet sand beach at edge of estuary
BRV128		*Astragalus eucosmus*	2012/8/2	Y	Y	UBC	*Björk 26930*	map as point with 20 m buffer	13	393637	7367721	50-100 genets	On sloping bank of small stream
BRV129		*Calamagrostis deschampsioides*	2012/8/2	Y	N			map as point with 20 m buffer	13	397222	7366730	10-20 genets	In sand of high beach above tide-line where vegetation begins
BRV130		*Carex mackenziei*	2012/8/2	N	N			map with 30 m buffer	13	397465	7366199	100-500 genets	Brackish pool in tundra on low bench above marine shore
BRM20		*Dicranella* cf. *subulata* (*stickinensis* form)	2012/8/2	N	Y	UBC	*Björk 28759*	map as point with 10 m buffer	13	393677	7369999	2 patches	On ledge of short cliff
BRV145		*Draba arabisans*	2012/8/2	N	N			map as point with 10 m buffer	13	397437	7366142	About 10 genets	On sparsely vegetated sand at upper beach margin by marine shore
BRV131		*Gentianella tenella*	2012/8/2	N	N			map as point with 20 m buffer	13	393356	7368232	20-50 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRV132		*Hippuris tetraphylla*	2012/8/2	N	N			map as point with 20 m buffer	13	395218	7371165	200-500 ramets	Brackish ponds above high beach
BRL70		*Hypogymnia dichroma*	2012/8/2	N	Y	UBC	*Björk 28740*	map as point with 10 m buffer	13	393733	7370055	1 large thallus	Part of moss crust covering cobbles
BRV133		*Juncus arcticus* var. *alaskanus*	2012/8/2	N	N			map as point with 20 m buffer	13	395401	7370680	50-100 ramets	Along sedge-dominated estuary shoreline
BRL71		*Leptogium imbricatum*	2012/8/2	N	N			map as point with 10 m buffer	13	397064	7366911	5 thalli	Immersed in calcareous modifed silt
BRL72		*Lobaria scrobiculata*	2012/8/2	N	Y	UBC	*Björk 28756*	map as point with 10 m buffer	13	396885	7367217	5-10 thalli	Over rock at base of small cliff
BRV134		*Lomatogonium rotatum*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	20-50 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRV135		*Luzula groenlandica*	2012/8/2	N	N			map as point with 20 m buffer	13	395376	7371132	20-50 genets	In the bottom of small cuts and runnels leading to inlet

Appendix 1-D. Rare Plant Survey Field Data

Element Occurrence	BIPR reference	*Species*	Survey date (yyyy/m/d)	Field photo (Y/N)	Specimen collected	Herbarium	Collection#	Polygon Description	Zone	Easting	Northing	Population sz.	Habitat
BRV136		*Oxytropis deflexa* var. *foliolosa*	2012/8/2	N	N			map as point with 10 m buffer	13	397437	7366142	About 10 genets	On sparsely vegetated sand at upper beach margin by marine shore
BRL76		*Parmeliella triptophylla*	2012/8/2	N	Y	UBC	*Björk 28737*	map as point with 10 m buffer	13	393677	7369999	1 patch	On bark of stem base (Betula nana) on ledge of seepy cliff near marine shore
BRL73		*Physconia perisidiosa*	2012/8/2	N	Y	UBC	*Björk 28755*	map as point with 10 m buffer	13	393677	7369999	5-10 thalli	Over rock on low cliff
BRV137		*Plantago canescens*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	20-50 genets	Gravel and clay flats at tundra's edge
BRV138		*Pohlia proligera*	2012/8/2	N	Y	UBC	*Björk 28730*	map as point with 10 m buffer	13	393677	7369999	About 100 genets	Over moss and soil on ledge of short cliff
BRV139		*Potentilla* cf. *litoralis*	2012/8/2	N	N			map as point with 10 m buffer	13	397400	7366495	About 50 genets	On sparsely vegetated gravelly sand on low bench at marine shore
BRV140		*Primula stricta*	2012/8/2	N	N			map as point with 20 m buffer	13	393376	7368340	5-10 genets	On mineral-rich clay (stranded marine sediments, fast-eroding), sparsely vegetated erosional slopes
BRL74		*Protopannaria sp. nov.*	2012/8/2	N	Y	UBC	*Björk 28752*	map as point with 10 m buffer	13	393677	7369999	1 patch	Over moss and soil on ledge of short cliff
BRL75		*Psoroma tenue* var. *boreale*	2012/8/2	N	Y	UBC	*Björk 28854*	map as point with 10 m buffer	13	393677	7369999	1 patch (multiple thalli?)	Over moss and soil on ledge of short cliff
BRV141		*Puccinellia sp. nov.*	2012/8/2	Y	N			map with 30 m buffer	13	397253	7366630	20-50 genets	Isolated tufts on eroding clay cutbank of inlet
BRV142		*Symphyotrichum pygmaeum*	2012/8/2	N	Y	UBC	*Björk 26926*	map as point with 20 m buffer	13	395432	7370602	2 genets	On grassy bench above inlet
BRV143		*Triglochin palustris*	2012/8/2	N	N			map with 30 m buffer	13	394669	7370509	50-100 genets	Saline mud flat
BRV144		*Woodsia alpina*	2012/8/2	Y	N			map as point with 20 m buffer	13	393731	7370049	3 genets	Pockets of soil tucked into cobbly talus

Appendix 2
Field Forms

SITE INFORMATION			NOTES / DIAGRAM
PROJECT	UTM ZONE		
DATE	NORTHING		
PLOT #	EASTING		
SURVEYORS	ELEVATION		
SLOPE % length	TOPO SLOPE POS.	**MACRO** AP FA UP MD LO VFL PL	
ASPECT		**MESO** CR UP MD LO TO LV DP	
GENERAL LOCATION			PHOTO #

SOIL INFORMATION							
DRAINAGE VR R W MW Imp P VP					HUMUS FORM (FORESTED)	R D L	**IN-SITU GEO-PROC** DEPTH / NOTES
WATER SOURCE					SALVAGE	cm	SEEPAGE cm
FLOODING REGIME					SURF. STONINESS	< 3% 3-15% 16-50% > 50%	CRYOTURB
TERRAIN	**TEX.**	**MAT.**	**EXPR.**	**PROC.**	DISTURBANCE	Comp Chem Excv Fill Road Mine	GULLY EROS
Surface					SOIL CLASS.	TC SC OC G F M H FO R	MASS MOV
Sub-surf					LANDUSE	For Tun Wet Urb Ind Other	
ROOT RESTR / DEPTH cm					NOTES		
C P K L W X Z							WATER TBL cm
Samples							PERMAFR cm

ORGANIC

HOR.	DEPTH		STRUCTURE			ROOTS		pH	COMMENTS	NOTES / DIAGRAM
	FROM	TO	AGGR.	KIND	vPOST	AB.	SIZE			

MINERAL

HOR.	DEPTH		STRUCTURE		CONSIS TENCE	% COARSE FRAGMENTS					COLOUR	MOTTLES			TEX.	ROOTS		pH	FIZZ
	FROM	TO	CLASS	KIND		G	C	S	TOTAL	SHAPE		AB.	SIZE	COL		AB.	SIZE		

SITE INFORMATION				NOTES / DIAGRAM
PROJECT		UTM ZONE		
DATE		NORTHING		
PLOT #		EASTING		
SURVEYORS		ELEVATION		
SLOPE	% length	TOPO SLOPE POS.	**MACRO** AP FA UP MD LO VFL PL	
ASPECT			**MESO** CR UP MD LO TO LV DP	
GENERAL LOCATION				PHOTO #

VEGETATION INFORMATION						
REALM		**STAND**	SUCCESS STATUS		**SUBSTRATE (%)**	
CLASS			STRUCT. STAGE		BARE MIN SOIL	
VEG. ASSOCIATION			STAND AGE		ORGANIC MATTER	
ECOSITE		**SOIL**	SMR		ROCK	
TRANS / DISTRIB			SNR		COARSE WOODY	
DISTURBANCE		**TOPO GRAPHY**	SURFACE SHAPE		WATER	
EXPOSURE			MICROTOP.		BEDROCK	
NOTES						

VEG SPECIES INFORMATION	% COVER BY LAYER SHRUB (B) _____ HERB (C) _____ MOSS / LICHEN (D) _____								COMPLETE INDICATOR
SPECIES	**B1**	**B2**	**C**	**D**	**SPECIES**	**B1**	**B2**	**C**	**D**

PLOT # ________	SURVEYORS _________________________	DATE _____________

PROFILE / DIAGRAM

WILDLIFE OBSERVATIONS

NOTES / DRAWINGS

WETLAND HABITAT INFORMATION FORM

Rescan Engineers & Scientists

W ☐ T ☐	PHOTO	X:	Y:	DATE

PROJECT ID	SURV.
MAPSHEET	PLOT #

UTM ZONE	NORTH	EAST

ASPECT	ELEVATION

SLOPE %	SMR	HDI	SNR

MESO SLOPE POSITION	☐ Crest ☐ Upper slope	☐ Mid slope ☐ Lower slope ☐ Toe	☐ Depression ☐ Level
HYDROGEO-MORPHIC POSITION	☐ Estuarine ☐ Fluvial	☐ Lacustrine ☐ Ponds & Potholes	☐ Basins & Hollows ☐ Seepage Slopes
DRAINAGE - MINERAL SOILS	☐ Very rapidly ☐ Rapidly	☐ Well ☐ Mod. well ☐ Imperfectly	☐ Poorly ☐ Very poorly

MINERAL SOIL TEXTURE	☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL)	☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

MOISTURE SUBCLASSES ORGANIC SOIL	☐ Aqueous ☐ Peraquic	☐ Aquic ☐ Subaquic	☐ Perhumid ☐ Humid

ORGANIC SOIL TEXTURE			SURF. ORGANIC HORIZON THICKNESS
☐ Fibric	☐ Mesic	☐ Humic	___________ cm
HUMUS FORM			ROOTING DEPTH
☐ Mor	☐ Moder	☐ Mull	Depth ______ cm Type ___________

VON POST

1 2 3 4 5 6 7 8 9 10

COARSE FRAGMENT CONTENT

☐ < 20% ☐ 20-35% ☐ 35-70% ☐ > 70%

ECOSYSTEM COMPONENT: ☐ WL1 ☐ WL2 ☐ WL3

BGC UNIT	WETLAND CLASS
SITE SERIES	ASSOCIATION
STRUCTURAL STAGE	MODIFIER

WETLAND POLYGON SUMMARY

	%	CLASS	ASSOCIATION
WL1			
WL2			
WL3			

WB-RES10-01 100510

WETLAND MAP

Features to include: North arrow, wildlife features, open water, slope, vegetation communities, wetland boundary, direction of water flow, soil core locations.

NOTES

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	TALL TREE	TREE / SHRUB	FORB	BRYOP.

TREE / SHRUB	%	FORB	%	FORB cont'd	%
				BRYOP.	%

☐ COMPLETE ☐ PARTIAL

WATER COLOUR

- ☐ Tea Coloured
- ☐ Yellow-Deep Brown Turbid
- ☐ Green-Brown Clear
- ☐ Green-Brown Turbid
- ☐ Blue-Green Clear

pH	CONDUCTIVITY	% OPEN WATER	DEPTH TO WATER

SOIL PROFILE	WILDLIFE OBSERVATIONS	
	SPECIES	FEATURE

Adapted from Ground Inspection Form: FS FS212-2(1) HRE 98/5-7610000694

Appendix 3
Vegetation Associations Summaries

Rescan
Engineers and Scientists

Appendix 3. Vegetation Associations Summaries

The following chapter provides summaries of the environmental characteristics, dominant species, and representative photographs of all vegetation associations. Non-vegetated ecosystem types are not described. In the environmental characteristics table, the most common condition is given, with typical ranges (if conditions are variable) presented in brackets.

Bedrock Lichen-Heath (BL)	
Environmental Characteristics	
Dominant Vegetation	Variable. Heather (*Cassiope tetragona* var. *tetragona*), crowberry (*Empetrum nigrum*), alpine bilberry (*Vaccinium uliginosum* var. *alpinum*), dwarf birch (*Betula nana*), *Loiseleuria procumbens*, *Carex nardina*, *Flavocetraria cucullata*, *F. nivalis*, *Racomitrium* spp., *Polytrichum* spp., *Cladina mitis* , C. stygia, tumble lichen (*Masonhalea richardsonii*), *Umbilicaria* spp.
SMR:	1 (0 - 2)
SNR:	Very poor (poor)
Percent Slope:	0-10%
Slope Position:	Crest (upper, level)
Microtopography:	Variable
Structural Stage:	Sparse (bryoid, graminoid, dwarf shrub)
Soil Classification:	Static cryosol (none or organic cryosol)
Soil Texture:	Boulders, gravel, sand, angular fragments (mesic, fibric)
Parent Material:	Thin morainal veneers, thin organic veneer, bedrock
Periglacial Processes:	Absent (rarely permafrost)
Water Table:	Absent
Soil Drainage:	Rapid (very rapid)
Typical Complexes	Bedrock outcrops and TH

The BL vegetation association is the driest ecosystem type in the LSA. It is restricted to crest positions on bedrock outcrops with very thin morainal or organic veneers, and is typically limited in extent. Open expanses of bedrock and/or mineral soil are common. Soils are thin or absent, and typically restricted to small depressions and cracks. Ground cover of vascular species is highly variable, but generally sparse, while lichens can cover significant areas. Total shrub cover ranges from 0 to 45%, while herb cover ranges from 0 to 20% and moss and lichens range from 1 to 60%.

Plate A3-1. Patchy BL on bedrock outcrop.

Plate A3-2. Close up of BL with organic soils on a bedrock outcrop.

Sparsely Vegetated Esker (ES)	
Environmental Characteristics	
Dominant Vegetation:	Highly variable. Pussytoes (*Antennaria* spp.), avens (*Dryas integrifolia)*, locoweed (*Oxytropis* spp.), crowberry (*Empetrum nigrum*), alpine bilberry (*Vaccinium uliginosum* var. *alpinum*), dwarf birch (*Betula nana*), campion (*Silene* sp.), saxifrage (*Saxifraga* spp.), *Flavocetraria cucullata*, and *F. nivalis*.
SMR:	1-2
SNR:	Very poor to poor
Percent Slope:	0
Slope Position:	Crest
Microtopography:	None or slightly mounded
Structural Stage:	Sparse
Soil Classification:	Regosol
Soil Texture:	Sand and gravel
Parent Material:	Glacialfluvial
Periglacial Processes:	Absent
Water Table:	Absent
Soil Drainage:	Rapid (very rapid)
Typical Complexes:	EH, EW

The ES community type is restricted to the crests of eskers. It is a sparsely vegetated community, typically with less than 10% total cover. Species and percent cover are highly variable, with <1% to 5% of dwarf shrubs, herbs or moss and lichens typical. Bare, windswept mineral soil (typically sand and gravel; occasionally gravel and cobble) dominates the association.

Plate A3-3. Sparse ES on the crest of a gravel esker with EH on upper and mid slopes.

Plate A3-4. Sparse ES on the crest of a gravel esker, with EW on lower slopes.

Dwarf Shrub-Herb Esker (EH)	
Environmental Characteristics	
Dominant Vegetation:	Variable. Heather (*Cassiope tetragona* var. *tetragona*), avens (*Dryas integrifolia*), crowberry (*Empetrum nigrum*), alpine bilberry (*Vaccinium uliginosum* var. *alpinum*), dwarf birch (*Betula nana*), rhododendron (*Rhododendron lapponicum*), northern Labrador tea (*Ledum decumbens*), campion (*Silene* sp.), sweetvetch (*Hedysarum* spp.), locoweed (*Oxytropis* spp.), sedges (*Carex bigelowii*, *C. nardina*), *Thamnolia vermicularis*, *Flavocetraria cucullata*, and *F. nivalis*.
SMR:	1-2 (3)
SNR:	Poor (very poor)
Percent Slope:	0 to 11%
Slope Position:	Crest, upper (mid, level)
Microtopography:	Slightly mounded
Structural Stage:	Dwarf shrub
Soil Classification:	Regasol
Soil Texture:	Sand and gravel
Parent Material:	Glacialfluvial (moraine)
Periglacial Processes:	No (permafrost 16 to 100cm)
Water Table:	Absent
Soil Drainage:	Moderate to very well (rapid)
Typical Complexes:	ES, EW

The EH association is restricted to the partially sheltered sides and crests of eskers. It was sampled 4 times. Vegetation cover is variable, but often contains a significant cover of dwarf shrubs (25 to 75%), with a lesser component of herbs (1 to 30%) and moss and lichens (6 to 15%). Bare, windswept mineral soil (typically sand and gravel; occasionally gravel and cobble) comprises the majority of the non-vegetated area.

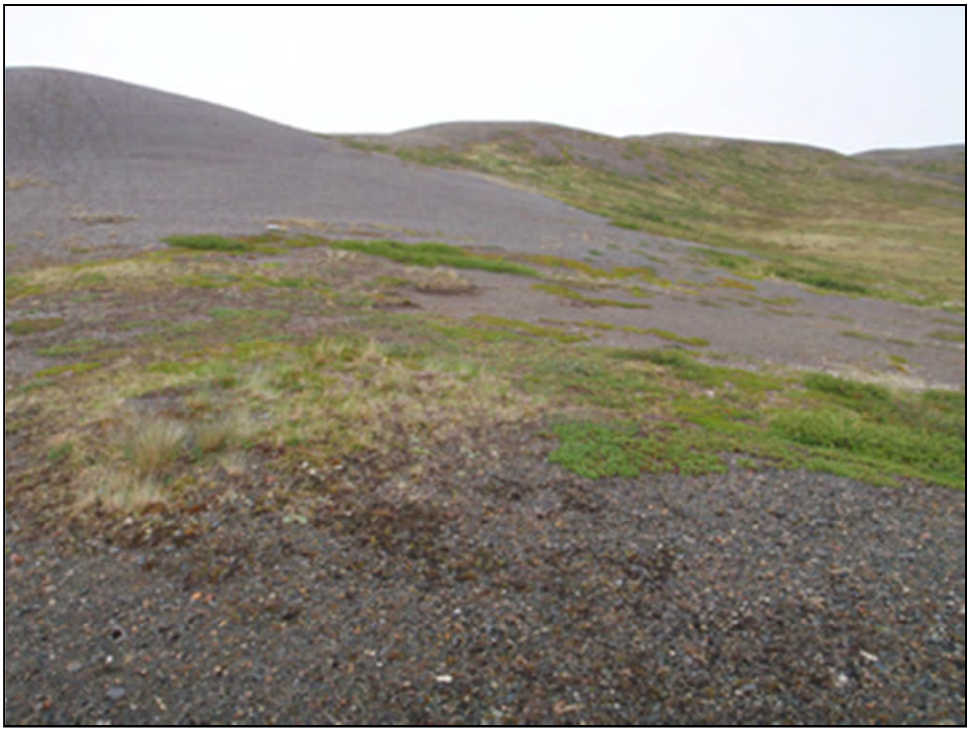

Plate A3-5. EH community with patches dwarf shrubs and herbs.

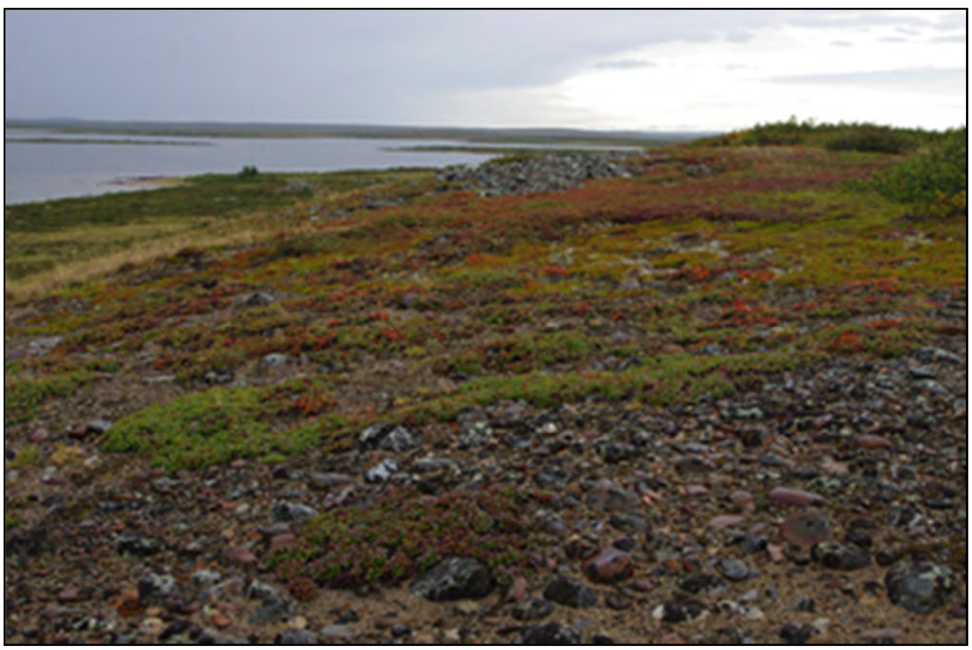

Plate A3-6. Dwarf shrub EH on cobble esker.

Shrubby Esker (EW)	
Environmental Characteristics	
Dominant Vegetation:	Willow species (*Salix planifolia, S. glauca*), dwarf birch.
SMR:	4-5
SNR:	Poor to medium
Percent Slope:	<10%
Slope Position:	Lower, Toe
Microtopography:	Slightly mounded
Structural Stage:	Low shrub (tall shrub)
Soil Classification:	Regosol
Soil Texture:	Sand and gravel
Parent Material:	Glacialfluvial (Moraine)
Periglacial Processes:	No (permafrost <100cm)
Water Table:	Absent
Soil Drainage:	Moderate
Typical Complexes:	EH, EW

The EW association was not sampled in the field. This summary is based on data from other projects as well as assumed conditions. The EW association occurs on sheltered slopes of eskers where a prolonged snowpack protects shrubs from wind shear, resulting in some of the tallest shrubs found in the LSA. The EW occurs on sand and gravel glacialfluvial deposits, but typical slope position and the above average snow pack results in higher soil nutrients and moisture relative to the other esker associations.

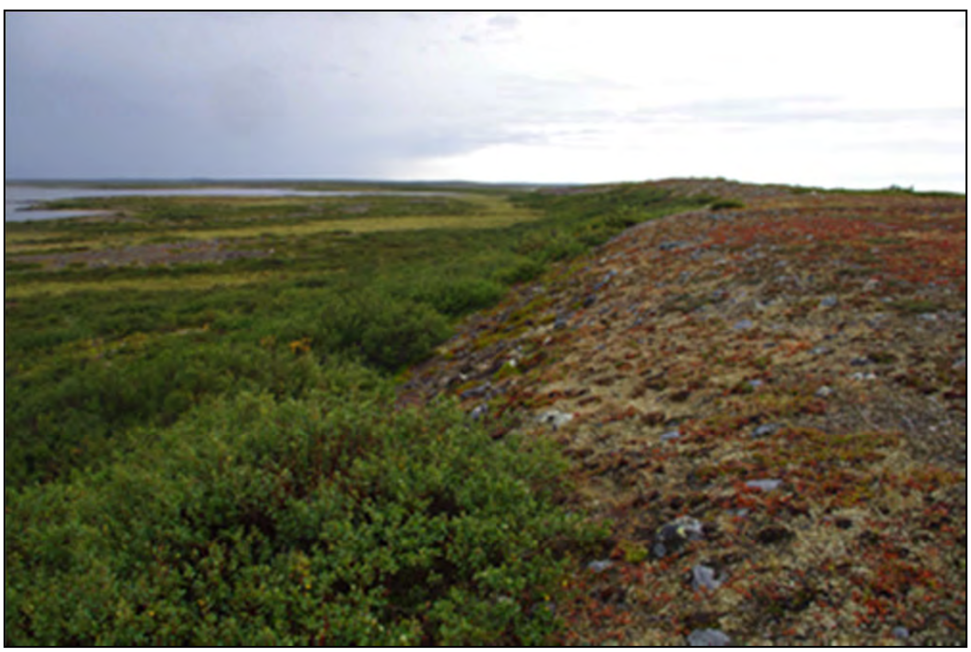

Plate A3-7. Low shrub EW along the sheltered toe of an esker.

Plate A3-8. Ew ecosystem on side of esker.

Dry Sparse Tundra (TH)	
Environmental Characteristics	
Dominant Vegetation:	Heather (*Cassiope tetragona* var. *tetragona*), avens (*Dryas integrifolia)*, crowberry (*Empetrum nigrum*), alpine bilberry (*Vaccinium uliginosum* var. *alpinum*), dwarf birch (*Betula nana*), rhododendron (*Rhododendron lapponicum),* sweetvetch, sedges (*Carex bigelowii, C. nardina*), *Thamnolia vermicularis, Flavocetraria cucullata*, and *F. nivalis*.
SMR:	2-3 (1-4)
SNR:	Poor (very poor to medium)
Percent Slope:	0 – 7%
Slope Position:	Variable. Typically level, upper or crest.
Microtopography	Variable
Structural Stage:	2d (3a)
Soil Classification:	Static and turbic cryosols (regosol)
Soil Texture:	Silt, sand, gravel (cobble, angular fragments)
Parent Material:	Morainal veneers (glacialfluvial, eaolian, bedrock)
Periglacial Processes:	Frost boils common; permafrost 14 to 100cm deep or absent.
Water Table:	Absent (rarely 40 to 65cm)
Soil Drainage:	Well to rapid (irregular, moderate)
Typical Complexes	Variable (TL, TS, TR, BL)

The TH association is one of the most common terrestrial communities in the LSA. It often occurs in extensive areas in conjunction with BL, BR and TL. It is the driest tundra community, and often contains small block fields or exposed bedrock. Vegetation is characterized by a high cover of dwarf shrubs (34% average cover; ranges from 3 to 95%), with a variable herb (9% average; ranges from 2 to 50%) and moss/lichen cover (15% average; ranges from <1 to 60%). Non vegetated portions are typically covered with dead and decaying organic material, with less than 20%.

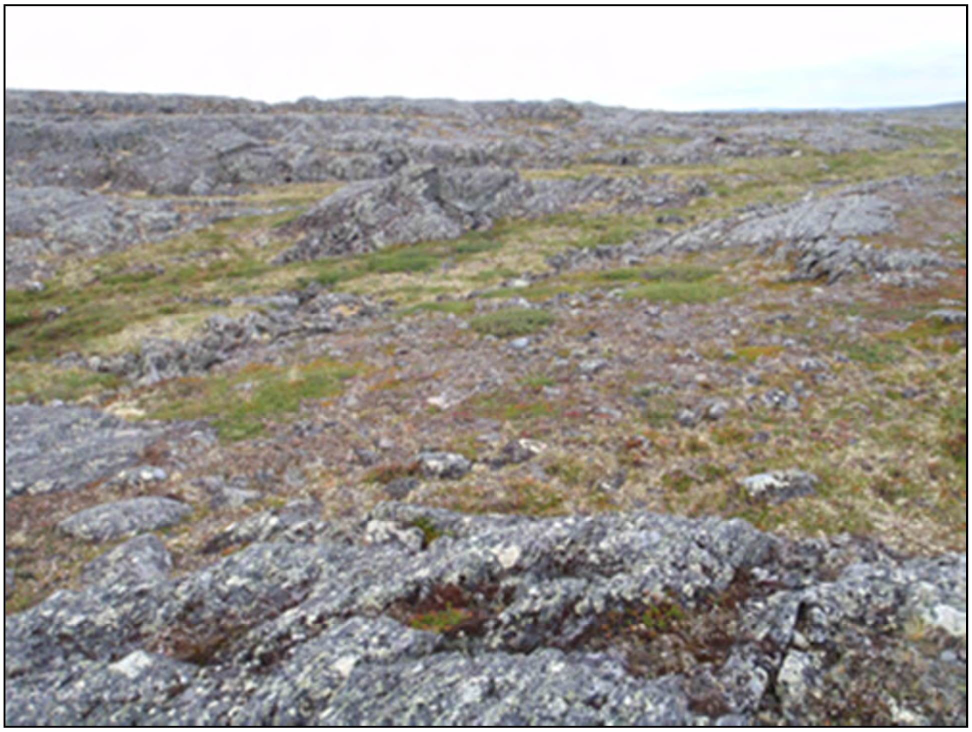

Plate A3-9. TH community in small patches on bedrock outcrop.

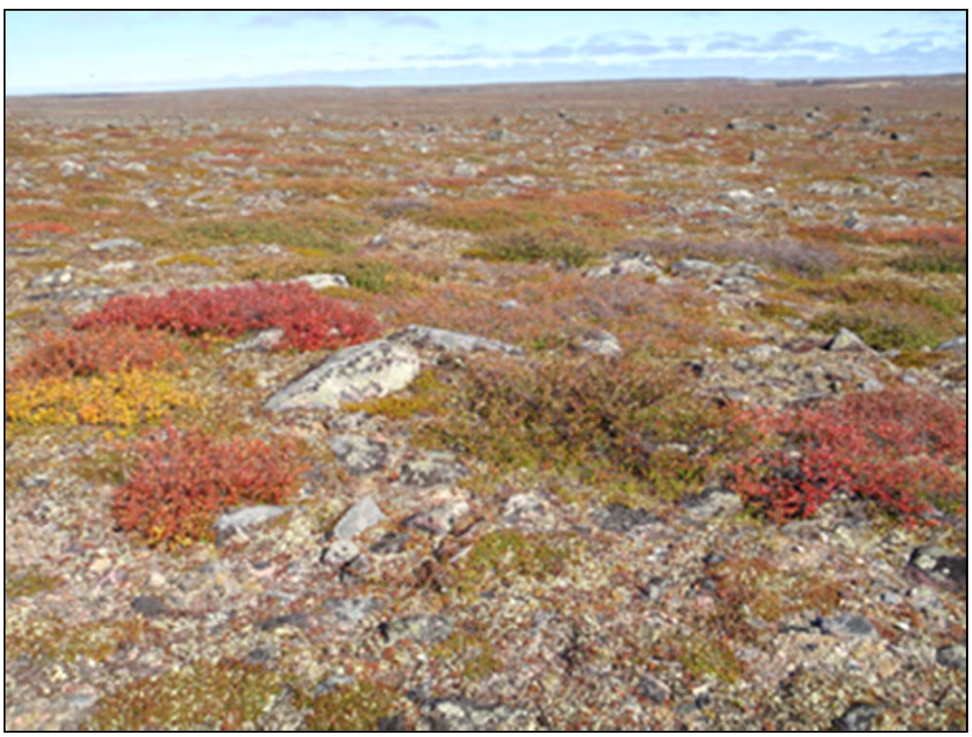

Plate A3-10. Typical expanse of dry, rocky TH.

Mesic Dwarf Shrub Tundra (TL)	
Environmental Characteristics	
Dominant Vegetation:	Dwarf birch (*Betula nana*), northern Labrador tea (*Ledum decumbens*), Alpine bilberry (*Vaccinium uliginosum* var. *alpinum*), lingonberry (*Vaccinium vitis-idaea* var. *minus*), crowberry (*Empetrum nigrum*), and sedge and cottongrass species.
SMR:	3-4
SNR:	Poor (very poor to medium)
Percent Slope:	3% (0 to 15%)
Slope Position:	Variable (Mid, level, lower; rarely upper or crest)
Microtopography	Micro-mounded to moderately mounded (rarely slightly or severely mounded)
Structural Stage:	2d (3a)
Soil Classification:	Static and turbic cryosols (regosol)
Soil Texture:	Silt, sand, gravel (mud, cobbles)
Parent Material:	Morainal blankets and veneers (rarely aeolian, colluvium, fluvial)
Periglacial Processes:	Cryoturbation. Frost boils common. Permafrost (16 to 100cm or absent)
Water Table:	Generally absent (20 to 100cm)
Soil Drainage:	Well (moderate to rapid)
Typical Complexes	TH, TS, all wetland associations

The TL association is the most common and extensive ecosystem in the LSA. It is the 'typical' tundra, characterized by extensive areas of dwarf shrubs, with a highly variable component of herbs, mosses, and lichens. It typically occurs on gently sloping well drained morainal blankets or veneers, and less commonly on aeolian, colluvial or fluvial parent materials. Soils are generally static and turbic cryosols, where cryoturbation and frost boils are common and permafrost is found at depths of 16 to 100cm. Vegetation is variable, but typically characterized by a high cover of dwarf shrubs. As with most arctic ecosystems, the composition and cover of individual species is highly dependent on micro sites that create favorable conditions (water retention and protection from wind). Dwarf birch and northern Labrador tea are typically the dominant shrubs, and several willow species occur. Alpine bilberry and lingonberry are typically present and often abundant. Alpine bearberry and crowberry are usually present at low cover, while several sedge and cottongrass species may occurs. Numerous other herbaceous species occur, but are highly variable. Moss and lichen species are also highly variable and occasionally very diverse.

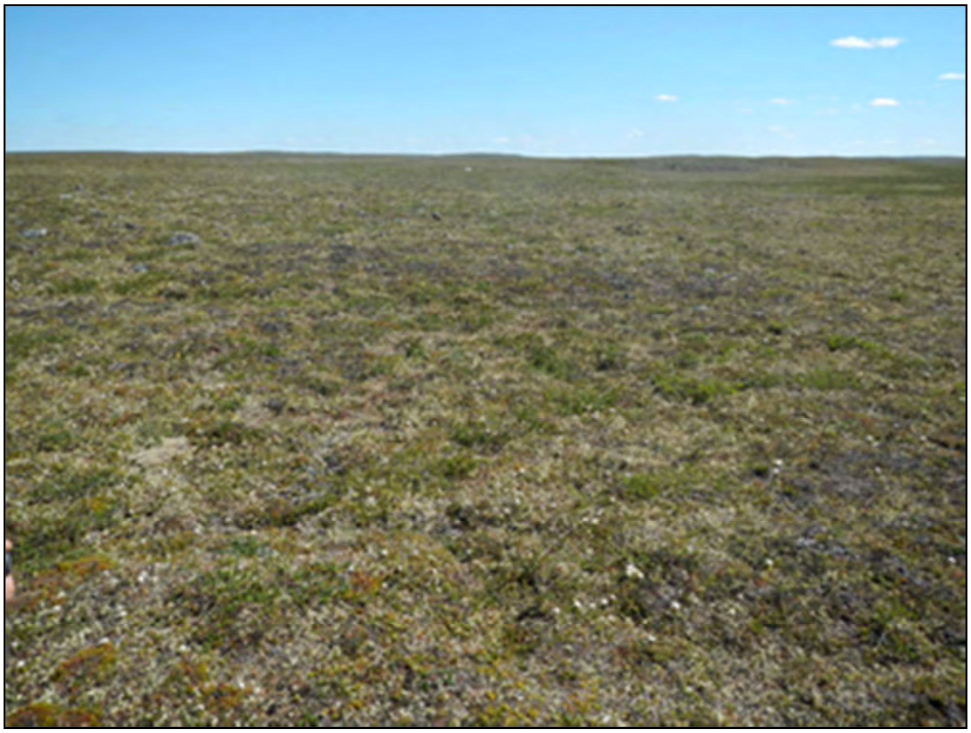

Plate A3-11. Typical TL association.

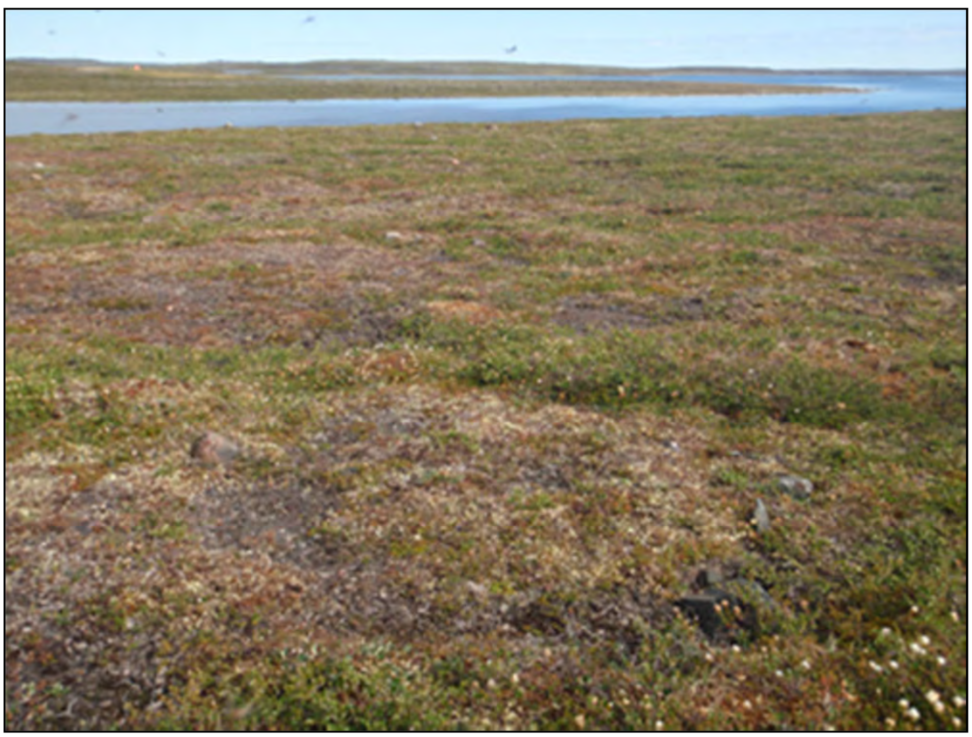

Plate A3-12. TL community with slightly raised frost boils.

Tundra Seepage (TS)	
Environmental Characteristics	
Dominant Vegetation	Dwarf birch, willow (*Salix planifolia, S. glauca, S.* spp.), sedges, cottongrass species.
SMR:	5-6 (3)
SNR:	Poor to medium
Percent Slope:	3% (0 to 14%)
Slope Position:	Mid, lower (toe, level)
Microtopography:	Hummocks, strongly to severely mounded
Structural Stage:	Low shrub, dwarf shrub
Soil Classification:	Turbic cryosols
Soil Texture:	Silt, sand, gravel (mud)
Parent Material:	Morainal blanket (morainal veneers; rarely organic veneers or fluvialglacial plain)
Periglacial Processes:	Permafrost (30 to 100cm), frost boils.
Water Table:	Common at 10 to 60cm
Soil Drainage:	Irregular (moderate, poor)
Typical Complexes	TL, RW, all wetlands

The TS association is a seepage community that typically occurs on mid and lower slopes with surface or subsurface seepages. The TS typically occurs on irregularly drained morainal blankets, and to a lesser degree on morainal veneers and rarely on thin organic veneers or glacialfluvial plains. Soils are always turbic cyrosols with permafrost present at a depth of 30 to 100cm, and frost boils are common. The water table is present on most sites at depths 10 to 60cm, and seasonal surface seepage is common. Soil nutrients are low or medium, and moisture regimes are subhygric to hygric. The TS is characterized by a high cover of low or dwarf shrubs, typically dense covers of dwarf birch and various willow species. It is the only non-riparian or esker association that commonly has a low shrub layer (as opposed to dwarf shrubs that is the more common structural stage in the LSA). Dwarf birch and dimondleaf willow along with minor components of other willow species comprise the low shrub layer. Dwarf birch, northern Labrador tea Alpine bilberry, lingonberry are common and often abundant in the dwarf shrub layer. Herbaceous cover is variable, with several sedge and cottongrass species common and occasionally abundant. Typical species in the moss and lichen layer include *Aulacomnium* spp., *Dicranium* spp., *Flavocetraria cucullata*, and *F. nivalis*, and to a lesser extent *Sphagnum* spp., *Racomitrium* sp., and *Pleurozium schreberi*.

Plate A3-13. Dense, low shrub TS on a lower slope.

Plate A3-14. Wet, willow and sedge dominated TS.

Undifferentiated Tundra (TU)	
Environmental Characteristics	
Dominant Vegetation:	Dwarf birch, northern Labrador tea, cottongrass, sedges. Lichens and moss variable.
SMR:	3-5
SNR:	Poor to medium
Percent Slope:	Variable
Slope Position:	Variable
Microtopography:	Variable (mounded, hummocked)
Structural Stage:	Dwarf shrub, graminoid
Soil Classification:	Cryosols
Soil Texture:	Sand, gravel, silt
Parent Material:	Variable (morainal veneers and lichens, thin organic veneers, bedrock)
Periglacial Processes	Variable (permafrost at depth, frost boils common)
Water Table:	Variable; generally absent.
Soil Drainage:	Irregular, moderate (well)
Typical Complexes	TH, TL, TS, BR, WF

The TU association is common but never extensive in the LSA. It is characterized by a random assortment of vegetation that does not fit into any of the other tundra associations. Parent materials are variable, but it typically occurs in small patchy areas in larger complexes of TH, TL and TS. Vegetation is variable in response to parent material and slope position with no common domain species.

Plate A3-15. Dry TU with a mix of graminoid and dwarf shrubs.

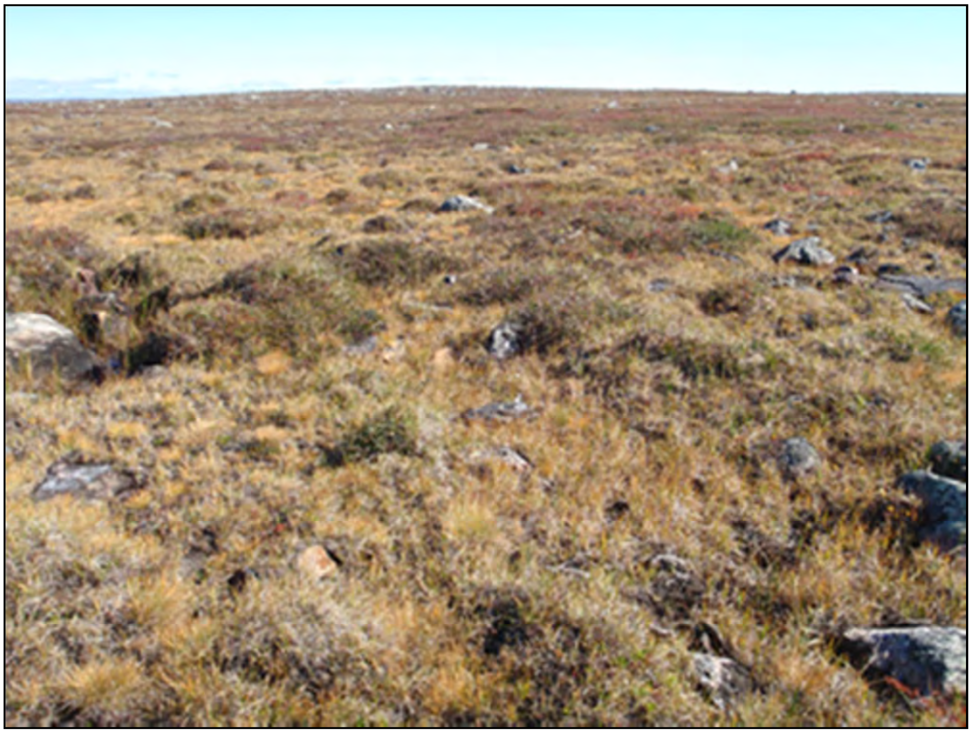

Plate A3-16. Wet TU with sedges, dwarf birch complexed with TS.

Riparian Willow (RW)	
Environmental Characteristics	
Dominant Vegetation	Willow (*Salix planifolia, S. glacua, Salix* spp.), dwarf birch, sedges, and glow moss.
SMR:	4-5
SNR:	Medium
Percent Slope:	0 to 4%
Slope Position:	Level, mid, toe
Microtopography:	Slightly to moderately mounded, slightly hummocked
Structural Stage:	Short and tall shrubs
Soil Classification:	Static and turbic cryosols
Soil Texture:	Sand, gravel, silt, mud
Parent Material:	Morainal blankets
Periglacial Processes:	Permafrost (0 to 60 cm)
Water Table:	Absent
Soil Drainage:	Moderate to well
Typical Complexes	

The RW association is a short to tall, wet shrub community that occurs immediately adjacent to small creeks, streams, ponds and lakes. Flooding may occur, but scouring is generally absent. The RW association is characterized by taller than average shrubs that occur in dense thickets. Shrub cover is generally various species of willow and dwarf birch. Herb cover is limited or absent, while mosses can be abundant.

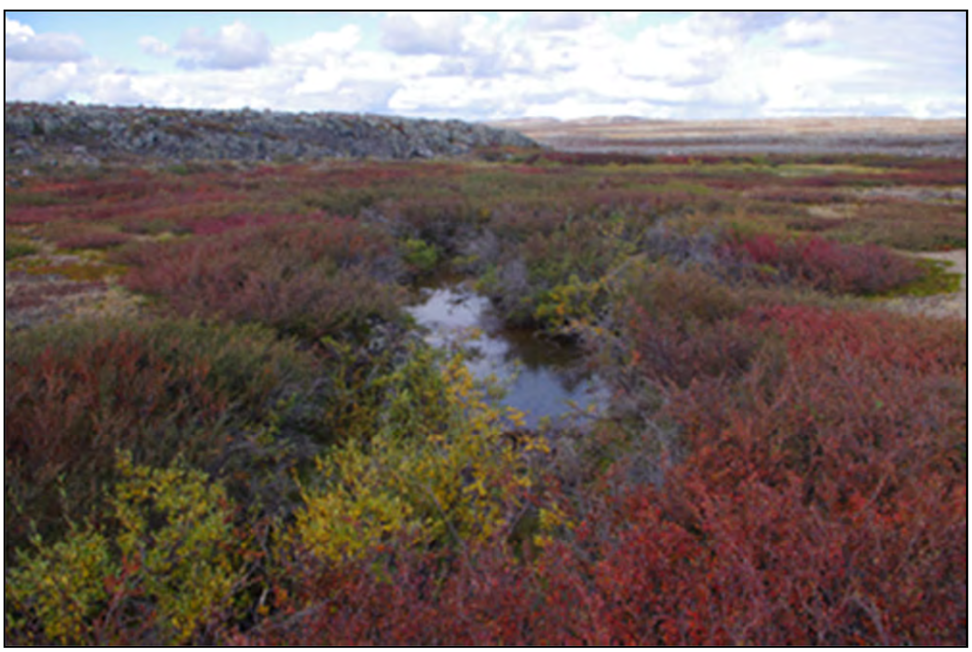

Plate A3-17. Dwarf birch and willow low shrub RW along a low gradient creek.

Plate A3-18. Tall shrub willow RW on rocky edges of a pond.

Low Bench Floodplain (RL)	
Environmental Characteristics	
Dominant Vegetation:	Willow
SMR:	4 - 6
SNR:	Poor
Percent Slope:	0%
Slope Position:	Level
Microtopography:	NA
Structural Stage:	Short or tall shrub
Soil Classification:	Regosol
Soil Texture:	Sand, gravel
Parent Material:	Fluvial plain
Periglacial Processes:	Absent
Water Table:	Seasonal flooding
Soil Drainage:	Well (very well)
Typical Complexes	FM, RI

The RL association is uncommon in the LSA. It is a short to tall, wet shrub community that occurs immediately adjacent to high gradient creeks and large rivers that scour the community on a regular (annual) basis. Due to the constant disturbance, vegetation is often sparse or patchy, and limited to species that can tolerate flooding. Willow species are typically present and a low cover of herbs may occur. Mosses and lichens are generally absent.

Plate A3-19. RL community on the active floodplain of a small creek.

Plate A3-20. Extensive, scoured RL along the Western River.

Mid-Bench Floodplain (RM)	
Environmental Characteristics	
Dominant Vegetation:	Multiple willow species, sedges and horsetails.
SMR:	4-6
SNR:	Poor to medium
Percent Slope:	0%
Slope Position:	Level
Microtopography:	NA
Structural Stage:	Tall shrub
Soil Classification:	Regosol
Soil Texture:	Sand, gravel
Parent Material:	Active fluvial plains
Periglacial Processes:	Absent
Water Table:	Variable; always present
Soil Drainage:	Well
Typical Complexes	RL, RI

The RM association is restricted to the active floodplains of large river systems. The RM is characterized by tall shrub communities along large rivers where flooding occurs on a regular basis, but scouring is limited. Vegetation is dominated by a near continuous, thick cover of various willow species. As soil development is limited and flooding occurs regularly, herbaceous species are expected to be sparse and limited to species of sedge, rush and horsetail that are adapted to fluctuating water tables. Moss and lichens are generally absent.

Plate A3-21. RM along the Western River shown in complex with RL, RI and WM.

Plate A3-22. Tall shrub RM along the Western River.

Raised Bog Complex (WB)	
Dominant Vegetation:	Dwarf birch, crowberry, northern Labrador tea, lingonberry, sedges, cottongrass, peat mosses, lichens.
SMR, Moisture Subclass:	Wet, Peraquic (Aquic)
SNR:	B-C
HDI:	Stagnant, sluggish
pH & Conductivity:	5.5 (3.8 to 7.3), 100us
Percent Slope:	0%
Slope Position:	Depression, level
Microtopography:	Strongly to severely mounded
Structural Stage:	Dwarf shrub, graminoid
Soil Classification:	Static and organic cryosols
Soil Texture:	Fibric and mesic organics (silt, sand)
Parent Material:	Fibric and mesic organic veneers and blankets (lacutstrine plains, morainal plains)
Periglacial Processes:	Cryoturbation, permafrost, ice core mounds
Water Table:	0 to 26cm
Soil Drainage:	Poorly (very poorly, imperfectly)
Typical Complexes	WA, WC, HS, RW, LA

The WB is common, but rarely extensive, in the LSA. It was sampled 58 times, typically complexed with WC and WA wetlands. It occurs in a variety of landscape positions, but is generally found in slight depressions that have minimal water movement (peat version), or along the edges of large ponds and small lakes (mineral version). In depression situations, the WB is characterized by moderate to severe mounds with ericaceous species on the top of the mounds, and fen-like sedge dominated communities between the mounds. Mounds often have ice cores, are developed from poorly decomposed peat (thermokarst is common), and are acidic. Dwarf birch and crowberry are often present on the mounds, but lichens and sphagnum mosses are typically the dominant cover. The mineral version often occurs along the edge of waterbodies, or less frequently complexed with terrestrial communities that do not contain other wetland associations. The mounds often have ice cores, but are composed of mineral soils with severe cryoturbation. Various shrub species occur on and between the mineral soil mounds including dwarf birch, northern Labrador tea, crowberry, and lingonberry. Moss and lichen layers may be well developed, with sphagnum typically present. Herbaceous cover is highly variable, but often includes sedges and cottongrass.

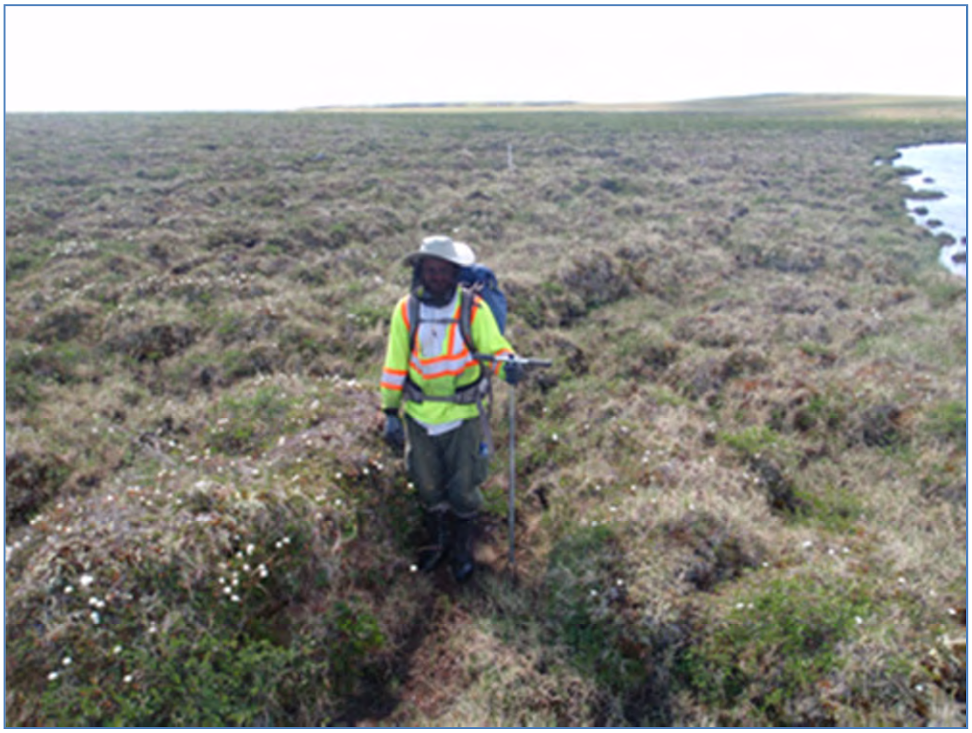

Plate A3-23. BR association on the edge of a pond.

Plate A3-24. Cross section of a WB mound.

Cottongrass Sedge Fen (WC)	
Environmental Characteristics	
Dominant Vegetation:	Sedges (*Carex aquatilis, C. rotundata, C. membranacea, C. rariflora, C. chordorriza*), cottongrass (*Eriophorum vaginatum, E. angustifolium*), *Sphagnum* spp., *Scorpidium* spp., *Aulacomnium* spp.
SMR, Moisture Subclass:	Very wet, peraquic
SNR:	Poor - medium
HDI:	Sluggish to stagnant
pH & Conductivity:	6.2, 90us
Percent Slope:	0-5%
Slope Position:	Level (depression, mid slope)
Microtopography:	Slightly hummocked, strongly mounded
Structural Stage:	Graminoid
Soil Classification:	Organic or static cryosols
Soil Texture:	Mesic and fibric organics
Parent Material:	Organic veneers and blankets
Periglacial Processes:	Permafrost (20 - 30 cm)
Water Table:	20 to 30 cm depth
Soil Drainage:	Very poor to poor
Typical Complexes	WA, WB, RW, TS, TL

The WC association is the most common and extensive wetland found in the LSA. It was sampled 24 times. It often occurs as the main portion of large wetland complexes, and as a pure wetland mixed with tundra. It is found on saturated mesic and fibric organic veneers and blankets in water receiving positions, typically in the valley bottom. Several species of sedge are always the dominant vegetative cover along with one or more species of cottongrass (average cover of 35%). Shrubs are generally absent (less than 5% total cover), or restricted with sporadic individuals on raised areas. The moss layer is well developed (average cover of 40%). Lichens are absent or very sparse.

Plate A3-25. Typical WC few with dense sedge cover in large wetland complex.

Plate A3-26. WC fen with small cottongrass hummocks in tundra complex.

Water Sedge Marsh (WA)	
Environmental Characteristics	
Dominant Vegetation:	Water sedge, various edge species, *Scorpidium* spp., *Aulacomnium* spp.
SMR, Moisture Subclass:	Very wet, peraquic to aqeous
SNR:	Medium (poor to rich)
HDI:	Sluggish, stagnant
pH & Conductivity:	6.1, 124us
Percent Slope:	0-3%
Slope Position:	Level, depression
Microtopography:	Slightly mounded, tussocked or hummocked
Structural Stage:	Graminoid
Soil Classification:	Organic or static cryosols
Soil Texture:	Mesic and fibric organics (2 to 30cm) over silt and loam.
Parent Material:	Organic veneers and thin organic veneers over morainal and fluvial plains.
Periglacial Processes	Permafrost (35 to 90cm)
Water Table:	Standing water most of growing season.
Soil Drainage:	Poor to very poor.
Typical Complexes	WC, WB, RW, LA, RI, PD,

The WA is the only marsh community that occurs in the LSA. It was sampled 48 times. The WA is restricted to very wet locations along low gradient watercourses and lake/pond margins. It occurs on thin organic veneers (12 cm average depth) over saturated morainal and fluvial mineral soil. The WA is characterized by a near monoculture of water sedge (*Carex aquatilis*), with a low cover of other sedges (*C. rotundata, C. membranacea,*), for a average total cover of 34%. Mosses are common (mainly *Scorpidium* spp., *Aulacomnium* spp.) accounting for an average cover of 35%. Shrubs are absent to sparse (3% average cover) while lichens are absent.

Plate A3-27. Close up of WA showing dominance of water sedge.

Plate A3-28. Extensive WA marsh adjacent to small lake.

Riparian Shrub Fen (WS)	
Environmental Characteristics	
Dominant Vegetation:	Willow, dwarf birch, sedges, peatmoss
SMR:	Poor
SNR, Moisture Subclass:	Wet to very wet, peraquic
HDI:	Sluggish
pH & Conductivity:	5.4, 30us
Percent Slope:	1%
Slope Position:	Level
Microtopography:	NA
Structural Stage:	Graminoid, low shrub
Soil Classification:	Organic cryosol, regosol
Soil Texture:	Fibric and mesic organics
Parent Material:	Organic veneers over fluvial plains and glacial till
Periglacial Processes:	Permafrost at depth
Water Table:	Flooded most of the growing season
Soil Drainage:	Poor to very poor
Typical Complexes	WA, WC, RW, RI, PD

The WS is uncommon in the LSA and never extensive. It was sampled one time. It is a fen association that is dominated by sedges and willow that typically occurs in a narrow linear band along moving water. Organic soils and a low shrub cover distinguish it from riparian associations. The WS is ether shrub or graminoid dominated, with a total shrub cover of 15% (willows and dwarf birch), herb cover of 20% (*C. aquatilis, C. chordorrhiza, C. capillaris, Comarum palustre*) and moss cover of 20% (*Sphagnum* sp., *Polytrichum* sp.). Lichens are generally absent.

Plate A3-29. Sedge dominated WS fen along low gradient stream.

Plate A3-30. Shrub dominated WS fen beside stream and pond system.

Tussock Meadow (WT)	
Environmental Characteristics	
Dominant Vegetation:	Sheathed cotton-grass (*Eriophorum vaginatum*), sedges.
SMR:	Wet to very wet (Peraquic to aquic)
SNR, Moisture Subclass:	Poor to medium
HDI:	Stagnant
pH & Conductivity:	5.5, 170us
Percent Slope:	0% (4%)
Slope Position:	Level, depression
Microtopography:	Severely hummocked
Structural Stage:	Graminoid (dwarf shrub)
Soil Classification:	Turbic, organic or static cryosol
Soil Texture:	Mesic and fibric organics (silt, sand)
Parent Material:	Thin organic veneer, lacustrine plain, morainal veneer
Periglacial Processes	Permafrost (60 to 90cm)
Water Table:	Absent or 10cm
Soil Drainage:	Poor (irregular)
Typical Complexes	WB, WA, WC

The WT is uncommon in the LSA and sampled eight times. The WT is characterized by an abundance of distinct sheathed cotton-grass (*Eriophorum vaginatum*) tussocks. While other vegetation associations may have sporadic tussocks, the WT is the only one that contains a continuous occurrence of well formed, distinct tussocks. The WT has several distinct communities within it due to microsites created by the tussocks. Elevated microsites on the top of tussocks contain dry species such as arctic avens, alpine bilberry, arctic heather and lichens. Vegetation communities become progressively wetter at the bottom of tussocks and in inter-tussock troughs which are dominated by tall cotton-grass (*Eriophorum angustifolium*) and various species of *Carex* and mosses. Dwarf birch and several species of willows occur sporadically or in extensively on small to large mounds within the tussocks.

Plate A3-31. Dry WT tussocks in complex with WC.

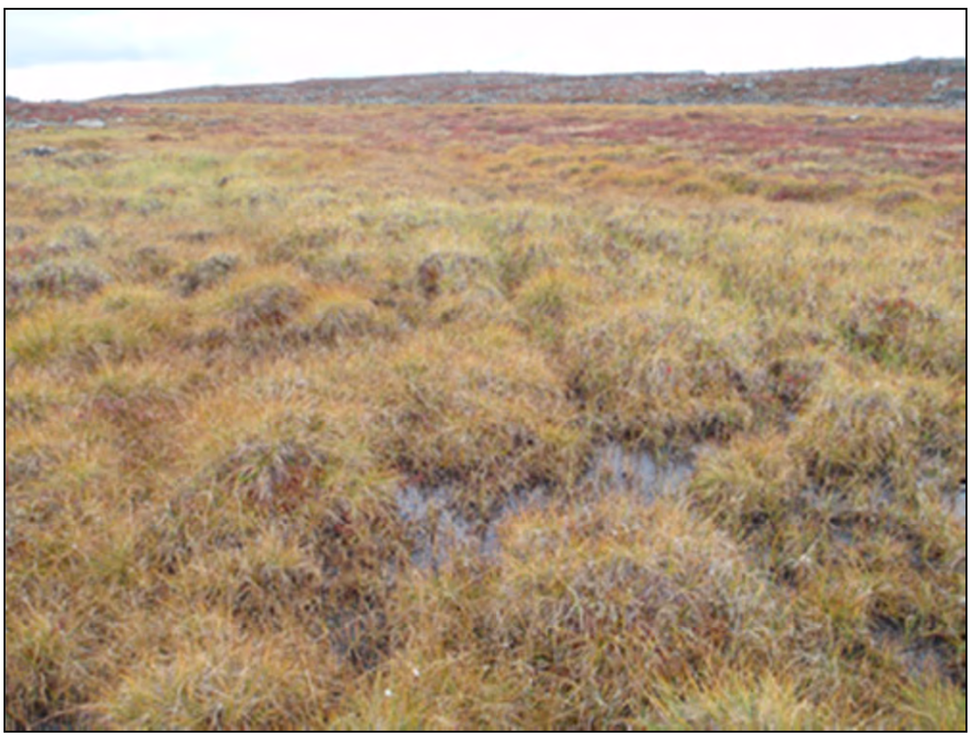

Plate A3-32. Wet WT tussocks in complex with TS.

Undifferentiated Fen (WF)	
Environmental Characteristics	
Dominant Vegetation:	Variable. Sedges and cottongrass dominant. Dwarf birch, northern Labrador tea and willow species may occur.
SMR:	Medium (poor to rich)
SNR, Moisture Subclass:	Wet to very wet, peraquic
HDI:	Sluggish to stagnant
pH & Conductivity:	6.4, 58us
Percent Slope:	0-5%
Slope Position:	Variable (level, depression, toe)
Microtopography:	Variable (hummocks, mounded)
Structural Stage:	Graminoid (dwarf shrub)
Soil Classification:	Turbic, organic or static cryosol (regosol)
Soil Texture:	Mesic and fibric organics, sand, silt
Parent Material:	Organic and morainal veneers and blankets (fluvial veneer, lacustrine plain)
Periglacial Processes:	Permafrost (23 to 110 cm)
Water Table:	0 to 87 cm
Soil Drainage:	Variable (well to poor)
Typical Complexes:	TH, TL, TS

The WF association is used for fen-like communities that do not fit into other classifications. It was sampled 46 times. It typically occur in small depressions within level and upper slope positions with a thin organic layer over wet morainal material. Boulders, rock outcrops and mounds with typical terrestrial species (including shrubs) often occur. Microtopography is variable, but small mounds and hummocks are common. The WF association typically occurs in complexes with tundra associations and rarely with other wetlands.

Plate A3-33. Bouldery WF in a tundra complex.

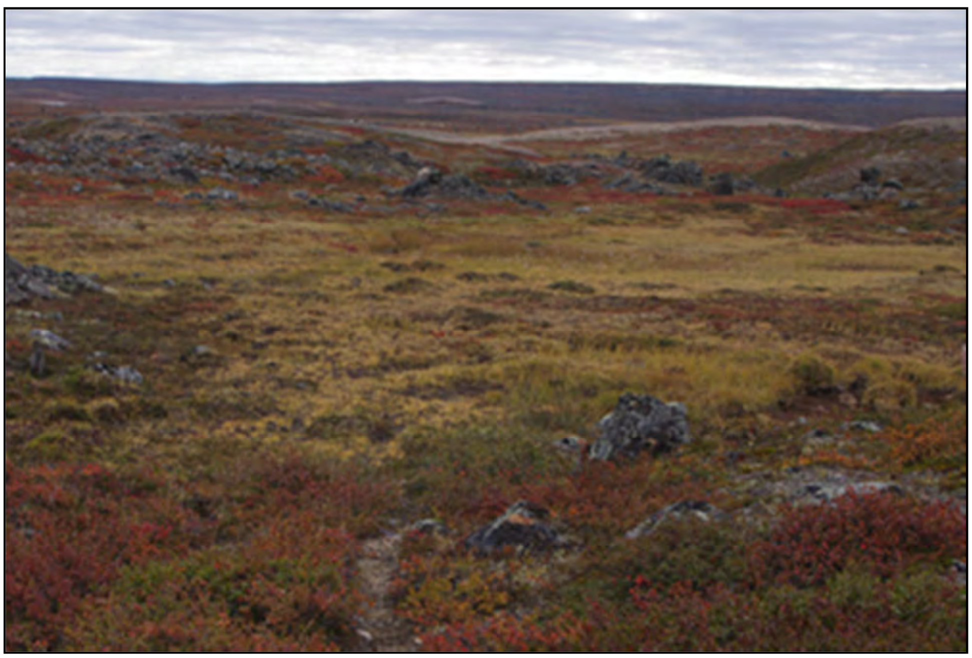

Plate A3-34. Small WF depression in complex of TL and BL.

Old Marine Beach Heads (MH)	
Environmental Characteristics	
Dominant Vegetation:	n/a
SMR:	2
SNR:	A
Percent Slope:	0
Slope Position:	Level
Microtopography:	None
Structural Stage:	Graminoid, sparse
Soil Classification:	Regosol
Soil Texture:	Sand, gravel
Parent Material:	Glacialmarine, marine
Periglacial Processes:	Absent
Water Table:	Absent
Soil Drainage:	Well to rapid
Typical Complexes	n/a

The MH association is restricted to the Bathurst Inlet area. It occurs in a limited extent in slightly raised locations near the existing ocean edge.

Plate A3-35. MH ecosystem at Bathurst Inlet.

Plate A3-36. Marine Beach Head ecosystem.

Marine Riparian (MR)	
Environmental Characteristics	
Dominant Vegetation	Willows, dwarf birch, and alder
SMR:	3
SNR:	B
Percent Slope:	0-10%
Slope Position:	Level, toe
Microtopography:	Flat
Structural Stage:	Low and tall shrubs
Soil Classification:	Regosol
Soil Texture:	Gravel, sand
Parent Material:	WG
Water Table:	0-60 cm
Soil Drainage:	rapid
Typical Complexes	n/a

The WR association is restricted to Bathurst Inlet. It is located along the edges of the Arctic Ocean and watercourses that drain into the ocean. The WR is characterized by a continuous cover of low or tall shrubs, with various willow species, dwarf birch and alder forming the main cover.

Plate A3-37. MR ecosystem.

Plate A3-38. MR ecosystem.

Marine Tundra (MT)	
Environmental Characteristics	
Dominant Vegetation:	Dwarf birch
SMR:	3
SNR:	C
Percent Slope:	0-40
Slope Position:	midslope
Microtopography:	hummocks
Structural Stage:	Dwarf shrub
Soil Classification:	Turbic cryosol
Soil Texture:	Sand, gravel
Parent Material:	Glacial marine/glacialfluvial
Periglacial Processes:	none
Water Table:	0-50 cm
Soil Drainage:	well
Typical Complexes	none

The MT is restricted to Bathurst Inlet. It occurs on glacialmarine derived soils, or locations that are directly influenced by the ocean (mainly salt spray).

Plate A3-39. MT ecosystem.

Plate A3-40. MT ecosystem.

Appendix 4
Terrestrial Ecosystems Maps

Included on DVD

Appendix 5

Carbon Analysis Data

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Appendix 5. Carbon Analysis

Sample ID			W026	W052	W067	W073	W075	W077
Date Sampled			09-JUL-12	12-JUL-12	13-JUL-12	14-JUL-12	15-JUL-12	15-JUL-12
Time Sampled			00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	Detection		L1184194-1	L1184194-2	L1184194-3	L1184194-4	L1184194-5	L1184194-6
Matrix	Limits	Units	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests								
Moisture	0.25	%	80.6	73.5	82.0	80.0	86.2	92.0
Organic / Inorganic Carbon								
$CaCO_3$ Equivalent	0.80	%	9.97	4.02	1.60	1.59	1.69	1.57
Inorganic Carbon	0.10	%	1.20	0.48	0.19	0.19	0.20	0.19
Total Carbon by Combustion	0.1	%	19.9	27.8	39.7	43.1	38.1	38.5
Total Organic Carbon	0.10	%	18.7	27.3	39.5	42.9	37.9	38.3
Metals								
Aluminum (Al)	50	mg/kg	10600	5070	2140	2410	859	3970
Antimony (Sb)	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	0.050	mg/kg	23.1	2.05	1.73	1.50	1.65	37.7
Barium (Ba)	0.50	mg/kg	83.6	106	130	60.1	68.5	46.9
Beryllium (Be)	0.20	mg/kg	0.41	<0.20	<0.20	<0.20	<0.20	0.53
Bismuth (Bi)	0.20	mg/kg	0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	0.050	mg/kg	0.400	0.420	0.244	0.252	0.180	0.368
Calcium (Ca)	50	mg/kg	1790	3200	4560	2740	2060	5340
Chromium (Cr)	0.50	mg/kg	30.6	17.6	4.68	11.6	0.88	2.64
Cobalt (Co)	0.10	mg/kg	9.04	4.13	6.54	4.93	5.11	64.0
Copper (Cu)	0.50	mg/kg	63.0	41.9	26.7	37.0	12.6	72.5
Iron (Fe)	50	mg/kg	14000	8130	4460	5320	4670	10900
Lead (Pb)	0.50	mg/kg	8.10	1.44	0.94	0.98	0.78	4.42
Lithium (Li)	5.0	mg/kg	10.9	<5.0	<5.0	<5.0	<5.0	<5.0
Magnesium (Mg)	20	mg/kg	3420	1070	892	471	653	1670
Manganese (Mn)	1.0	mg/kg	57.8	25.9	12.1	8.1	15.3	281
Mercury (Hg)	0.0050	mg/kg	0.113	0.0545	0.125	0.0557	0.0748	0.0977
Molybdenum (Mo)	0.50	mg/kg	1.73	0.66	<0.50	<0.50	0.53	0.64
Nickel (Ni)	0.50	mg/kg	38.9	27.9	17.1	21.3	10.4	145
Phosphorus (P)	50	mg/kg	913	398	1340	805	931	636
Potassium (K)	100	mg/kg	930	220	490	320	420	380
Selenium (Se)	0.20	mg/kg	0.52	0.67	0.28	0.57	<0.20	0.47
Silver (Ag)	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.27
Sodium (Na)	100	mg/kg	120	<100	<100	<100	<100	<100
Strontium (Sr)	0.50	mg/kg	26.3	15.2	27.7	11.0	17.9	32.9
Thallium (Tl)	0.050	mg/kg	0.168	<0.050	0.070	<0.050	<0.050	0.054
Tin (Sn)	2.0	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	1.0	mg/kg	246	149	43.7	48.2	17.4	27.7
Uranium (U)	0.050	mg/kg	1.71	0.704	0.411	0.825	0.269	1.57
Vanadium (V)	0.20	mg/kg	54.6	27.5	6.14	17.4	1.63	3.30
Zinc (Zn)	1.0	mg/kg	30.5	39.8	8.7	5.3	21.6	30.6

Appendix 5. Carbon Analysis

Sample ID			W051	W080	W083	W128	W134	W135
Date Sampled			15-JUL-12	16-JUL-12	16-JUL-12	22-JUL-12	23-JUL-12	24-JUL-12
Time Sampled			00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID	Detection		L1184194-7	L1184194-8	L1184194-9	L1184194-10	L1184194-11	L1184194-12
Matrix	Limits	Units	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests								
Moisture	0.25	%	89.4	75.9	71.8	82.3	82.8	75.4
Organic / Inorganic Carbon								
$CaCO_3$ Equivalent	0.80	%	2.62	<0.80	1.98	1.13	1.39	2.13
Inorganic Carbon	0.10	%	0.31	<0.10	0.24	0.14	0.17	0.26
Total Carbon by Combustion	0.1	%	27.7	19.3	38.9	29.5	36.6	30.5
Total Organic Carbon	0.10	%	27.4	19.3	38.6	29.3	36.4	30.2
Metals								
Aluminum (Al)	50	mg/kg	797	2350	6060	2790	2170	7870
Antimony (Sb)	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.27
Arsenic (As)	0.050	mg/kg	18.7	5.39	8.65	7.44	4.19	15.3
Barium (Ba)	0.50	mg/kg	32.5	80.0	87.7	36.7	11.8	20.6
Beryllium (Be)	0.20	mg/kg	<0.20	0.23	0.34	<0.20	<0.20	0.57
Bismuth (Bi)	0.20	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	0.050	mg/kg	0.122	0.408	0.255	0.066	0.266	0.357
Calcium (Ca)	50	mg/kg	6460	4490	2420	6280	4450	551
Chromium (Cr)	0.50	mg/kg	1.67	2.54	18.6	8.97	6.24	13.2
Cobalt (Co)	0.10	mg/kg	14.0	7.66	7.32	5.64	6.47	3.63
Copper (Cu)	0.50	mg/kg	9.77	28.5	71.9	7.51	5.78	32.0
Iron (Fe)	50	mg/kg	3980	3190	11300	14900	4070	12100
Lead (Pb)	0.50	mg/kg	2.19	0.91	3.39	1.79	1.35	1.70
Lithium (Li)	5.0	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	5.9
Magnesium (Mg)	20	mg/kg	1730	1010	1350	1680	1300	2320
Manganese (Mn)	1.0	mg/kg	25.9	7.8	25.2	33.5	17.9	26.4
Mercury (Hg)	0.0050	mg/kg	0.114	0.119	0.0642	0.0513	0.133	0.0573
Molybdenum (Mo)	0.50	mg/kg	<0.50	<0.50	<0.50	<0.50	0.96	0.75
Nickel (Ni)	0.50	mg/kg	28.7	75.8	28.4	12.2	6.35	16.0
Phosphorus (P)	50	mg/kg	517	362	1080	582	407	696
Potassium (K)	100	mg/kg	490	290	300	260	410	420
Selenium (Se)	0.20	mg/kg	<0.20	0.21	0.65	<0.20	<0.20	0.45
Silver (Ag)	0.10	mg/kg	<0.10	<0.10	0.15	<0.10	<0.10	<0.10
Sodium (Na)	100	mg/kg	<100	<100	<100	<100	<100	<100
Strontium (Sr)	0.50	mg/kg	32.0	32.9	11.5	28.8	18.1	3.00
Thallium (Tl)	0.050	mg/kg	<0.050	<0.050	<0.050	0.108	<0.050	<0.050
Tin (Sn)	2.0	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	1.0	mg/kg	22.8	35.2	215	72.9	102	52.3
Uranium (U)	0.050	mg/kg	0.099	0.359	3.78	0.333	0.121	1.22
Vanadium (V)	0.20	mg/kg	1.82	2.89	31.4	7.70	5.79	19.7
Zinc (Zn)	1.0	mg/kg	27.4	15.3	8.8	12.4	43.0	9.0

RESCAN ENVIRONMENTAL SERVICES
ATTN: Wade Brunham
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 25-JUL-12
Report Date: 22-AUG-12 11:48 (MT)
Version: FINAL

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1184194
Project P.O. #: NOT SUBMITTED
Job Reference: 0833-002-19
C of C Numbers:
Legal Site Desc:

Amber Springer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1184194-1	L1184194-2	L1184194-3	L1184194-4	L1184194-5
	Description	Peat Samples x 1	Peat Samples x 1	Peat Samples x 1	Peat Samples x 1	Peat Samples x 1
	Sampled Date	09-JUL-12	12-JUL-12	13-JUL-12	14-JUL-12	15-JUL-12
	Sampled Time					
	Client ID	W026	W052	W067	W073	W075
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	80.6	73.5	82.0	80.0	86.2
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	9.97	4.02	1.60	1.59	1.69
	Inorganic Carbon (%)	1.20	0.48	0.19	0.19	0.20
	Total Carbon by Combustion (%)	19.9	27.8	39.7	43.1	38.1
	Total Organic Carbon (%)	18.7	27.3	39.5	42.9	37.9
Metals	Aluminum (Al) (mg/kg)	10600	5070	2140	2410	859
	Antimony (Sb) (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Arsenic (As) (mg/kg)	23.1	2.05	1.73	1.50	1.65
	Barium (Ba) (mg/kg)	83.6	106	130	60.1	68.5
	Beryllium (Be) (mg/kg)	0.41	<0.20	<0.20	<0.20	<0.20
	Bismuth (Bi) (mg/kg)	0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.400	0.420	0.244	0.252	0.180
	Calcium (Ca) (mg/kg)	1790	3200	4560	2740	2060
	Chromium (Cr) (mg/kg)	30.6	17.6	4.68	11.6	0.88
	Cobalt (Co) (mg/kg)	9.04	4.13	6.54	4.93	5.11
	Copper (Cu) (mg/kg)	63.0	41.9	26.7	37.0	12.6
	Iron (Fe) (mg/kg)	14000	8130	4460	5320	4670
	Lead (Pb) (mg/kg)	8.10	1.44	0.94	0.98	0.78
	Lithium (Li) (mg/kg)	10.9	<5.0	<5.0	<5.0	<5.0
	Magnesium (Mg) (mg/kg)	3420	1070	892	471	653
	Manganese (Mn) (mg/kg)	57.8	25.9	12.1	8.1	15.3
	Mercury (Hg) (mg/kg)	0.113	0.0545	0.125	0.0557	0.0748
	Molybdenum (Mo) (mg/kg)	1.73	0.66	<0.50	<0.50	0.53
	Nickel (Ni) (mg/kg)	38.9	27.9	17.1	21.3	10.4
	Phosphorus (P) (mg/kg)	913	398	1340	805	931
	Potassium (K) (mg/kg)	930	220	490	320	420
	Selenium (Se) (mg/kg)	0.52	0.67	0.28	0.57	<0.20
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Sodium (Na) (mg/kg)	120	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	26.3	15.2	27.7	11.0	17.9
	Thallium (Tl) (mg/kg)	0.168	<0.050	0.070	<0.050	<0.050
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	246	149	43.7	48.2	17.4
	Uranium (U) (mg/kg)	1.71	0.704	0.411	0.825	0.269
	Vanadium (V) (mg/kg)	54.6	27.5	6.14	17.4	1.63
	Zinc (Zn) (mg/kg)	30.5	39.8	8.7	5.3	21.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1184194-6 Peat Samples x 1 15-JUL-12 W077	L1184194-7 Peat Samples x 1 15-JUL-12 W051	L1184194-8 Peat Samples x 1 16-JUL-12 W080	L1184194-9 Peat Samples x 1 16-JUL-12 W083	L1184194-10 Peat Samples x 1 22-JUL-12 W128
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	92.0	89.4	75.9	71.8	82.3
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	1.57	2.62	<0.80	1.98	1.13
	Inorganic Carbon (%)	0.19	0.31	<0.10	0.24	0.14
	Total Carbon by Combustion (%)	38.5	27.7	19.3	38.9	29.5
	Total Organic Carbon (%)	38.3	27.4	19.3	38.6	29.3
Metals	Aluminum (Al) (mg/kg)	3970	797	2350	6060	2790
	Antimony (Sb) (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10
	Arsenic (As) (mg/kg)	37.7	18.7	5.39	8.65	7.44
	Barium (Ba) (mg/kg)	46.9	32.5	80.0	87.7	36.7
	Beryllium (Be) (mg/kg)	0.53	<0.20	0.23	0.34	<0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.368	0.122	0.408	0.255	0.066
	Calcium (Ca) (mg/kg)	5340	6460	4490	2420	6280
	Chromium (Cr) (mg/kg)	2.64	1.67	2.54	18.6	8.97
	Cobalt (Co) (mg/kg)	64.0	14.0	7.66	7.32	5.64
	Copper (Cu) (mg/kg)	72.5	9.77	28.5	71.9	7.51
	Iron (Fe) (mg/kg)	10900	3980	3190	11300	14900
	Lead (Pb) (mg/kg)	4.42	2.19	0.91	3.39	1.79
	Lithium (Li) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Magnesium (Mg) (mg/kg)	1670	1730	1010	1350	1680
	Manganese (Mn) (mg/kg)	281	25.9	7.8	25.2	33.5
	Mercury (Hg) (mg/kg)	0.0977	0.114	0.119	0.0642	0.0513
	Molybdenum (Mo) (mg/kg)	0.64	<0.50	<0.50	<0.50	<0.50
	Nickel (Ni) (mg/kg)	145	28.7	75.8	28.4	12.2
	Phosphorus (P) (mg/kg)	636	517	362	1080	582
	Potassium (K) (mg/kg)	380	490	290	300	260
	Selenium (Se) (mg/kg)	0.47	<0.20	0.21	0.65	<0.20
	Silver (Ag) (mg/kg)	0.27	<0.10	<0.10	0.15	<0.10
	Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
	Strontium (Sr) (mg/kg)	32.9	32.0	32.9	11.5	28.8
	Thallium (Tl) (mg/kg)	0.054	<0.050	<0.050	<0.050	0.108
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	27.7	22.8	35.2	215	72.9
	Uranium (U) (mg/kg)	1.57	0.099	0.359	3.78	0.333
	Vanadium (V) (mg/kg)	3.30	1.82	2.89	31.4	7.70
	Zinc (Zn) (mg/kg)	30.6	27.4	15.3	8.8	12.4

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1184194-11	L1184194-12			
	Description	Peat Samples x 1	Peat Samples x 1			
	Sampled Date	23-JUL-12	24-JUL-12			
	Sampled Time					
	Client ID	W134	W135			
Grouping	**Analyte**					
SOIL						
Physical Tests	Moisture (%)	82.8	75.4			
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	1.39	2.13			
	Inorganic Carbon (%)	0.17	0.26			
	Total Carbon by Combustion (%)	36.6	30.5			
	Total Organic Carbon (%)	36.4	30.2			
Metals	Aluminum (Al) (mg/kg)	2170	7870			
	Antimony (Sb) (mg/kg)	<0.10	0.27			
	Arsenic (As) (mg/kg)	4.19	15.3			
	Barium (Ba) (mg/kg)	11.8	20.6			
	Beryllium (Be) (mg/kg)	<0.20	0.57			
	Bismuth (Bi) (mg/kg)	<0.20	<0.20			
	Cadmium (Cd) (mg/kg)	0.266	0.357			
	Calcium (Ca) (mg/kg)	4450	551			
	Chromium (Cr) (mg/kg)	6.24	13.2			
	Cobalt (Co) (mg/kg)	6.47	3.63			
	Copper (Cu) (mg/kg)	5.78	32.0			
	Iron (Fe) (mg/kg)	4070	12100			
	Lead (Pb) (mg/kg)	1.35	1.70			
	Lithium (Li) (mg/kg)	<5.0	5.9			
	Magnesium (Mg) (mg/kg)	1300	2320			
	Manganese (Mn) (mg/kg)	17.9	26.4			
	Mercury (Hg) (mg/kg)	0.133	0.0573			
	Molybdenum (Mo) (mg/kg)	0.96	0.75			
	Nickel (Ni) (mg/kg)	6.35	16.0			
	Phosphorus (P) (mg/kg)	407	696			
	Potassium (K) (mg/kg)	410	420			
	Selenium (Se) (mg/kg)	<0.20	0.45			
	Silver (Ag) (mg/kg)	<0.10	<0.10			
	Sodium (Na) (mg/kg)	<100	<100			
	Strontium (Sr) (mg/kg)	18.1	3.00			
	Thallium (Tl) (mg/kg)	<0.050	<0.050			
	Tin (Sn) (mg/kg)	<2.0	<2.0			
	Titanium (Ti) (mg/kg)	102	52.3			
	Uranium (U) (mg/kg)	0.121	1.22			
	Vanadium (V) (mg/kg)	5.79	19.7			
	Zinc (Zn) (mg/kg)	43.0	9.0			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
NR:NR	No Result: Sample Not Received At Laboratory - samples # W081 and W094 - Not received

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456

When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.

Reference:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-VA	Soil	Moisture content	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

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CHAIN OF CUSTODY RECORD

PROJECT NAME: Back River

PROJECT #: 0833-002-19

Laboratory Contact:

FIELD SCIENTISTS AND/OR ENGINEERS: *(Print Name and Sign)* Ryan Durand [signature]

L1184194

Laboratory Address: See attached list for carbon analysis

Rescan Contact: wbrunham@rescan.com Wade Brunham

STATION NUMBER	DATE	TIME	COMP. SAMPLE	GRAB SAMPLE	SAMPLE IDENTIFICATION (DEPTH, REPLICATE)	NUMBER OF CONTAINERS:					
1 W026	7/9/2012				Peat Samples x 1						
2 W052	7/12/2012				↓						
3 W067	7/13/2012										
4 W073	7/14/2012										
5 W075	7/15/2012										
6 W077	7/15/2012										
7 W051	7/15/2012										
8 W080	7/16/2012										
9 W081	7/16/2012										
10 W083	7/16/2012										
11 W094	7/18/2012										
12 W128	7/22/2012										
13 W134	7/23/2012										
14 W135	7/24/2012										
15											
16											
17											
18											
19											
20											
21											

L1184194-COFC

Received by:	Date/Time	Relinquished by:	Date/Time
Company: ALS	D/M/Y	Company:	D/M/Y
Name: [signature] (Print and Sign)	25/7/12 15:00	Name: (Print and Sign)	/ /

Received by:	Date/Time	Received for Laboratory by:	Date/Time
Company:	D/M/Y	Company:	D/M/Y
Name: (Print and Sign)	/ /	Name: (Print and Sign)	/ /

Routine Analysis: ☑ Rush Analysis: ☐

Remarks:

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Page ___ of ___

Plant Tissue Metals Analyzed and Associated Detection Limits

Metal	Abbreviation	Dry Weight Detection Limit (mg/kg)	Wet Weight Detection Limit (mg/kg)
Aluminium	Al	20	2.0
Antimony	Sb	0.1	0.01
Arsenic	As	0.1	0.01
Barium	Ba	0.1	0.01
Beryllium	Be	0.6	0.01
Bismuth	Bi	0.6	0.1
Cadmium	Cd	0.06	0.1
Calcium	Ca	20	0.005
Chromium	Cr	1.0	2.0
Cobalt	Co	0.2	0.1
Copper	Cu	0.1	0.02
Lead	Pb	0.2	0.01
Lithium	Li	1.0	0.02
Magnesium	Mg	6.0	0.1
Manganese	Mn	0.1	1.0
Mercury	Hg	0.005	0.01
Molybdenum	Mo	0.1	0.001
Nickel	Ni	1.0	0.01
Selenium	Se	2.0	0.1
Strontium	Sr	0.10	0.
Thallium	Tl	0.06	0.01
Tin	Sn	0.4	0.01
Uranium	U	0.02	0.05
Vanadium	V	1.0	0.002
Zinc	Zn	1.0	0.1

PLUS $CaCO_3$ EQ
INORGANIC CARBON
TOTAL CARBON (BY COMBUSTION)
TOTAL ORGANIC CARBON
} FOR PEAT SAMPLES

Appendix 6
Field Data

Rescan™
Engineers and Scientists

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
001	28-Jun-12	3	B	HT	2d	hmk	1	r	20	80	0	0	0	5	75	5	ST		999	R		13	7381742	389634	10	150	LWR	PL
002	28-Jun-12	5	D	BiS	3a		5	m	5	95	0	0	0	65	35	5	ST	35	39	SC		13	7381403	389466	13	250	LO	PL
003	28-Jun-12	2	B	EC	2d			w	90	10	0	0	0	3	12	6	ST		100	R		13	7371017	395388	5	plateau	LVL	PL
004	29-Jun-12	8	B	CA	2b			v	0	95	0	5	0	0	80	20			20	OC	40	13	7382978	388115	0	200	LVL	PL
005	29-Jun-12	4	C	HT	2d		1	w	0	99	1	0	0	6	60	30	ST	45	50	SC		13	7383368	388071	4	100	MD	PL
006	29-Jun-12	6	C	SE	2b		1	i	1	98	0	0	0	6	53	25	ST			SC	7	13	7319591	387901	7	500	MD	PL
007	29-Jun-12	7	C	SE	2b		2	p	0	99	1	0	0	5	83	10	CC		22	OC		13	7319279	387822	0		TOE	PL
008	29-Jun-12	6	C	SE	2b		3	i	1	96	3	0	0	6	70	15	ST		10	SC	8	13	7319088	387789	4	300	MD	PL
009	29-Jun-12	2	B	LR	2d		1		2	13	0	0	85	2	20	10						13	7318991	387618	7		UP	
010	12-Jun-12	8	B	SE	2b		1	v	0	75	15	10	0	0.4	75	15	ST		8	OC		13	7318798	367492	0		LVL	PL
011	30-Jun-12	5	C	BiS	3a		1	m	0	100	0	0	0	65	17	10	ST			SC	20	13	7369976	395496	14	150	MD	LO
012	30-Jun-12	3	B	HT	2d	mnd	1	w	10	90	0	0	0	27	35	10	CV			TC	23	13	7369910	395359	9	500	MD	LO
013	30-Jun-12	3	B	HT	2d		1	r	0	100	0	0	0	14	43	10	ST		71	SC		13	7362983	398864	6	150	MD	LO
013A	30-Jun-12							i	0	0	0	0	0	0	0	0				SC	30							
014	30-Jun-12	4	C	HT	2d/(3a)	hmk	6	m	5	83	12	0	0	15	20	14	ST		60	SC		13	7275723	422195	2	na	LVL	PL
015	30-Jun-12	8	B	SE	2b	hmk	6	v	0	98	0	2	0	10	70	15	ST		0	OC	30	13	7275676	421991	0		LVL	PL
016	30-Jun-12	4	B	HT	2d		1	i	1	97	2	0	0	23	18	13	ST		20	SC	20	13	7275522	421877	2			
017	30-Jun-12	5	B	HT	2b		5		0	0	0	0	0	0	0	0						13	7275285	421707	2		MD,LV	PL
018	1-Jul-12	6	B	EA	2b	st. hmk	1	p	1	99	0	0	0	20	48	24			26	SC		13	7265810	421948	0	100	DP	PL
019	1-Jul-12	8	B	EA	2b	mc. Hmk	1	v	0	80	10	10	0	4	75	10	ST		0	SC	12	13	7265824	422122	0		LVL	PL
020	1-Jul-12	1	A	EC	3a		1	r	0	5	95	0	0	3	1.4	3	CV		1	R		13	7265928	422338	0	200	CR	
021	1-Jul-12	4	B	HT	3a		2	i	1	99	0	0	0	45	18	19		6		SC		13	7226019	422368	2		LVL	PL
022	1-Jul-12	8	B	CA	2b		1		0	90	0	10	0	1	90	0						13	7266223	422431	0	200	LVL	PL
023	1-Jul-12	3	B	HT	2d		5		0	94	6	0	0	7	18	13	ST					13	7266447	422831	1		MD	PL
024	1-Jul-12	3	B	HT	2d		1		2	95	3	0	0	0	0	0	ST					13	7266149	422928	0		LVL	PL
026	1-Jul-12	3	B	HT	2d		1		10	89	1	0	0	15	19	15	ST					13	7265857	423276	0		LVL	PL
027	1-Jul-12	8	B	SE	2b		1		0	0	0	0	0	0.2	98	50						13	7265947	423442	0	>500	LVL	PL
028	1-Jul-12	6	B	BiS	3a		1		2	98	0	0	0	56	8	25	CC					13	7266569	423569	2		LVL	PL
029	1-Jul-12	6	B	HT	3a		1		0	100	0	0	0	16	8	19	ST					13	7265940	423774	4	100	MD	PL
030	1-Jul-12	6	B	SE	3a	hmk	3		2	96	2	0	0	19	60	30	CV					13	7266031	424116	4		TOE	PL
031	1-Jul-12	5	B	HT	3a	mnd	1	m	4	95	1	0	0	58	8	15	ST		55	SC		13	7265739	424838	0		LVL	PL
032	2-Jul-12	7	B	SE	2b	mnd	5	v	1	99	0	0	0	8	85	25	ST		8	SC	15	13	7265924	424900	0		LVL	PL
033	2-Jul-12	4	B	HT	3a		1	m	4	94	2	0	0	17	10	30	ST		55	SC		13	7265984	425094	0		LVL	PL
034	2-Jul-12	8	B	CA	2b	hmk	1	v	0	85	0	15	0	5	85	20			0	SC		13	7265843	425342	2		LVL	PL
035	2-Jul-12	6	C	BiS	3a		5	i	1	94	2	3	0	90	8	15	ST			SC		13	7265775	425479	3		MD	PL
036	2-Jul-12	3	B	HT	2d		5	w	8	89	3	0	0	20	31	15	ST		60	SC		13	7265595	425976	3	300	MD	PL
037	2-Jul-12	6	B	RHT	3a		5	p	0	85	15	0	0	17	19	38	ST	30	30	SC		13	7244777	421813	0		LVL	PL
038	2-Jul-12	6	B	HT	3a		5	i	2	91	7	0	0	27	17	43	ST	30	30	SC		13	7275285	421704	3	300	MD	PL
039	2-Jul-12	6	C	BiS	3a		5	p	1	99	0	0	0	75	5	70	ST	25	27	SC		13	7276619	421932	3	300	MD	PL
040	3-Jul-12	4	B	HT	3a		1	w	8	90	2	0	0	18	7	20	ST		65	SC		13	7262843	429879	0		LVL	PL
041	3-Jul-12			RHT	3a(2d)			w	5	60	35	0	0	12	9	35			55	SC		13	7262710	429678	3	300	MD	PL
042	3-Sep-12			BiS	3a		5	i	10	89	1	0	0	25	27	23			60	TC		13	7262900	429287	2	300	LVL	PL
043	3-Jul-12	6	B	BR	2b	mnd	1	i	2	97	1	0	0	14	67	40	ST	20	20	SC		13	7262664	429249	2	200	LVL	PL
044	3-Jul-12	4	B	HT	3a		1	w	8	92	0	0	0	28	5	50	ST		75	SC		13	7262310	429451	2	200	LVL	PL
045	3-Jul-12	4	B	RHT	3a		1	m	5	60	25	0	10	22	12	30	CV			SC		13	7262426	429694	7	150	UP	PL
046	3-Jul-12	8	B	CA	2b	tus	1	v	0	90	0	10	0	3.8	75	45	ST		0	OC	30	13	7264484	431275	0	250	LVL	PL
047	3-Jul-12	6	B	BiS	3a	mnd	1	p	1	98	1	0	0	70	9	20	ST	27	27	SC		13	7264319	431216	2	200	LVL	PL
048	3-Jul-12	4	B	RHT	2d		1	w	1	39	60	0	0	8	15	25			60	SC		13	7264179	431109	0	>500	LVL	PL
049	3-Jul-12			RHT	3a(2d)		6	w	8	67	15	0	10	23	19	15				SC		13	7264932	430824	0	>500	LVL	PL
050	4-Jul-12	4	B	HT	2d		1	w	20	80	0	0	0	9	25	18	ST			SC		13	7265703	423118	1	>200	UP	PL
051	4-Jul-12	8	B	SE	2b	hmk	1	v	0	100	0	0	0	6	83	30	ST		10	OC		13	7265544	423079	0		LVL	PL
052	4-Jul-12			CA	2b		1	p	15	65	0	20	0	1.7	70	10	CC		50	SC	24	13	7265400	423099	0		LVL	PL
053	4-Jul-12	4	B	HT	3a		6	w	2	98	0	0	0	47	9	17	ST			SC		13	7265620	422916	0		LVL	PL
054	4-Jul-12	3	B	RHT	3a		5		2	76	7	0	15	25	7	23			30	SC		13	7265222	422747	7	150	UP	PL
055	5-Jul-12							i	0	0	0	0	0	0	0	0				TC	2	13	7269834	433891	2	200	LO	PL
056	5-Jul-12							v	0	0	0	0	0	0	0	0				SC	10	13	7269632	433950	0		LVL	PL
057	5-Jul-12							w	0	0	0	0	0	0	0	0		40	64	SC		13	7269550	433882	4	300	LO	PL
058	5-Jul-12							m	0	0	0	0	0	0	0	0		25		TC		13	7269478	433684	2	300	UP	PL
059	5-Jul-12	4	B	HT	2d	hmk		m	5	0	0	0	0	40	0.01	40		0		SC		13	7269741	433286	6	200	MD	PL
060	6-Jul-12	8	C	EA	2b			v	0	0	0	0	0	0	0	0			0	OC		13	7269429	433389	0		LVL	PL

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
061	6-Jul-12	4	B	HT	2d	hmk		w	0	100	0	0	0	18	3	55	ST		100	TC			7271982	432332	0		LVL	PL
062	6-Jul-12	4	B	BiS	3a			w	0	100	0	0	0	62	3	45			90	SC		13	7271837	432216	0		LVL	PL
063	6-Jul-12	4	B	HT	2d	smo		w	0	100	0	0	0	65	1	50	ST		82	TC		13	7271947	431879	8	250	MD	PL
064	6-Jul-12	3	B	RHT(HT)	2d	rocky		r	0	0	30	0	0	68	0	5	CV		40	SC	20	13	7271951	431608	2	300	CR	PL
065	6-Jul-12	4	B	HT	2d			w	0	0	0	0	0	65	0.01	30	ST			TC		13	7272015	431370	0		UP	PL
066	6-Jul-12	3	B	RHT	2d	smo		m	0	0	0	0	0	78	0.01	19	ST			SC		13	7271767	431222	2		UP	PL
067	6-Jul-12			RHT	2d				0	0	0	0	0	0	0	0						13	7271427	431005	0			
068	6-Jul-12			EA	2b			v	0	100	0	0	0	0	8	60			16	OC		13	7271362	430885	0		LVL	PL
069	6-Jul-12	4	B	RHT	2d	smo		w	0	85	15	0	0	0	0	0	ST		65	TC		13	7270920	431079	3	250	UP	PL
070	6-Jul-12	3	B	HT	2d			w	0	0	0	0	0	55	7	40				SC		13	7270513	431180	4	200	UP	PL
071	7-Jul-12	2	B	RHT	2d			r	1	0	55	2	0	0	0	0				OC	10	13	7270511	431928	12	300	MD	PL
072	7-Jul-12	3	B	HT	2d			w	0	6	94	0	0	80	0	25			80	TC		13	7270780	431849	2	150	UP	PL
073	7-Jul-12	5	C	BiS	2d	hummocky		i	4	93	3	0	0	70	4	45				SC		13	7270651	431555	11	70	MD	PL
074	7-Jul-12	4	C	BiS	3a	sl smk		m	15	85	0	0	0	80	3	20	ST			SC		13	7271065	431606	0		LVL	PL
075	7-Jul-12	4	B	RHT	2d	smo		w	45	0	15	0	0	50	4	13	ST			SC		13	7265496	430617	0		LVL	PL
076	7-Jul-12	5	B	RHT	2d	sl hmk		i	5	85	10	0	0	0	0	0	ST	5		SC	20	13	7265397	430489	0		LVL	PL
077	7-Jul-12	5	B	HT	2d			i	8	0	0	0	0	75	0.01	20	sm mnds	5		SC		13	7265678	430390	0		LVL	PL
078	7-Jul-12	1	A	LR	1			r	0	0	92	0	0	0	0	0				OC	20	13	7265739	430256	0		LVL	PL
079	8-Jul-12	1	A	LR	1	undulating rock		vr	0	0	80	0	0	0	0	10	ongular			SC		13	7270658	429998	9	50	UP	PL
080	8-Jul-12	5	B	HT	2d			m	0	10	0	0	0	85	5	10			65	TC		13	7270914	429917	0		LVL	PL
081	8-Jul-12			HT	2d	flat		w	4	0	0	0	0	70	5	50				TC	10 -20	13	7271046	429997	4	120	MD	PL
082	5-Jul-12	3	B	RHT	2d	rockt		r	3	0	30	0	0	70	0	36	ST			SC	10-20	13	7271214	430070	0		LVL	PL
083	8-Jul-12	6	B	TM	2d	hmk		i	0	3	6	0	0	30	12	30			10	TC	10	13	7271312	430066	0		LVL	PL
084	8-Jul-12	3	B	RHT	2d	rocky		w	3	63	30	0	4	55	2	20	ST			TC		13	7271362	430132	0		LVL	PL
085	8-Jul-12	6	B	TM	2a	hmk		p	0	3	10	2	0	55	10	40	ST			OC		13	7266054	430064	0		DP	PL
086	8-Jul-12	3	B	RHT	2d	rocky		i	0	65	35	4	0	0	0	0	ST					13	7265883	430065	0		LVL	PL
087	8-Jul-12	4	B	RHT	2d	Rocky		w	5	50	35	10	0	60	0	15	ST		55	SC		13	7266588	429897	0		LVL	PL
088	8-Jul-12			EA	2b	sl hmk		v	0	85	0	10	5	12	8	20	CC		17	SC		13	7266707	729914	0		LVL	PL
089	9-Jul-12	1	A	ES	1a	smo		vr	82	15	5	0	0	65	1	50	ST		100	R		13	7393677	381049	0		CR	PL
090	9-Jul-12	4	C	BiR	3a	und		w	0	100	0	0	0	85	10	10	ST			SC	31	13	7393641	380972	20	250	MD	MD
091	9-Jul-12	2	A	LH	2d	smo		r	25	72	3	0	0	72		4	ST		50			13	7393570	381115	14	250	MD	MD
092	9-Jul-12	3	B	LH	2d	smo		r	5	95	0	0	0	95	3	4	ST		65	SC		13	7393285	381195	9	200	TOE	LO
093	9-Jul-12	8	B	EA	2b	hmk		v	0	98	0	10	0	3	40	70	ST		25	SC		13	7893244	381176	5	250	TOE	LO
094	10-Jul-12	4	B	HT	2d	smo		w	5	94	5	0	0	85	3	55	ST		78	TC		13	7323974	372980	5	200	UP	PL
095	10-Jul-12	7	B	EA	2a	hmk		p	0	100	0	0	0	20	18	10			13	SC		13	7324007	373212	0		TOE	PL
096	10-Jul-12	8	B	CA	2b	smo		v	0	90	0	10	0	4	14	40	ST			OC		13	7323917	373236	0		DP	PL
097	10-Jul-12	1	A	LR	1c			vr	0	40	60	0	0	35	3	20				SC		13	7324023	373388	0		CR	PL
098	10-Jul-12	5	B	HT	2d	smo		i	15	75	20	5	0	65	5	25	CV	25				13	7323976	373752	2	250	LO	PL
099	10-Jul-12	5	B	HT	2d	smo		m	2	95	3	0	0	85	3	20	ST		90	SC		13	7323603	374310	2	100	UP	PL
100	10-Jul-12			HT	2d	hmk		m	5	97	1	0	0	80	14	35	ST		55	TC		13	7323246	374885	6	300	MD	PL
101	11-Jul-12	4	B	HT	2d	smo		w	3	97	1	0	0	70	4	60	ST		75	TC		13	7273311	429202	4	250	MD	PL
102	11-Jul-12	6	C	BiS	3a	hmk		i	0	100	0	0	0	95	2	90	ST			TC		13	7273128	429226	5	150	LO	PL
103	11-Jul-12	7	B	EA	2b	hmk		p	0	100	0	0	0	50	20	95	ST			SC	20	13	7273045	429284	0		LVL	PL
104	10-Jul-12	5	B	HT	2d	smo		m	1	99	0	0	0	65	3	45	ST		55	TC		13	7272942	429112	6	250	MD	PL
105	11-Jul-12	5	B	HT	2d	smo		m	5	95	0	0	0	85	5	85	ST			TC		13	7272453	428880	5	90	MD	PL
106	11-Jul-12	1	A	LR	2c			x	0	50	50	0	0	45	1	55	ST					13	7272338	429339	0	na	LVL	PL
107	11-Jul-12	5	B	BiS	2d	hmk		i	0	0	0	0	0	85	6	85	ST	10		TC		13	7272098	429293	4	300	LO	PL
108	11-Jul-12	5	B	BiS	3a	hmk		i	2	98	0	0	0	85	10	90	ST	30	30	TC			7271263	426967	0		LVL	PL
109	12-Jul-12	7	B	BiS	3a	hmk		v	9	90	0	0	0	0	0	0	ST		32	SC		13	7265375	434451	0		LVL	PL
110	12-Jul-12	4	B	HT	2d	mnd		w	10	89	0	0	0	0	0	0	ST		85	TC		13	7269226	434037	7	250	MD	PL
111	12-Jul-12	6	C	BiS	3a	hmk		i	10	27	0	0	0	0	0	0	ST	25		SC		13	7269324	433904	4	300	MD	PL
112	14-Jul-12	4	B	HT	2d			w	10	85	5	0	0	0	0	0			60	TC		13	7270528	430485	11	100	MD	PL
113	14-Jul-12	1	A	LR	2a			x	0	25	15	0	60	0	0	0				SC	0-8	13	7270537	430369	6			
114	14-Jul-12	6	C	BiS	2d			m	0	60	20	0	20	0	0	0	ST	17		SC		13	7270441	430081	0		LVL	PL
115	14-Jul-12	1	A	LR	2d			r	0	20	80	0	0	0	0	0				SC	0-12	13	7270268	429982	2		LVL	PL
116	14-Jul-12			HT	2d				2	97	1	0	0	0	0	0	ST			TC		13	7270094	430058	8	20	LO	PL
117	14-Jul-12	4	B	HT	2d	LV		m	6	94	0	0	0	90	5	7	ST			TC		13	7269303	433365	3		LWR	PL
121	15-Jul-12	4	B	RHT	2d			w	0	60	40	0	0	50	2	40	ST		40	SC		13	7266336	421073	2	>250	LVL	PL
122	15-Jul-12	1	A	EC	1a	smo		x	95	5	0	0	0	5	0.001	0	CV			R		13	7265934	422301			CR	PL
123	15-Aug-12	7	B	CE	2b	smo		v	0	90	0	10	0	11	15	90	ST		21	OC	27	13	7266308	422309			LVL	PL

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
124	15-Jul-12	2	A	HT	2d (3a)	smo		r	10	75	15	0	0	60	0.001	20	ST			R	36	13	7267350	422500	1	200	CR	PL
126	24-Jul-12	2	B	HT	2d	mnd	1	m	0	78	22	0	0	70	8	55	CC	8		SC	51	13	7277631	418493	6	100	MD	PL
127	24-Jul-12	2	B	RHT	2d(3a)	smo		w	3	65	10	0	22	60	1	5	CV			SC	42	13	7282888	411496	8	75	MD	UP
128	24-Jul-12	4	B	HT	2d	smo		m	0	97	3	0	0	70	1	27	ST					13	7282209	412158	5	150	LWR	PL
129	24-Jul-12	4	B	HT	3a(2d)	smo		m	3	97	1	0	0	90	1	10	ST			SC	14	13	7291394	405085	9	150	MD	MD
130	24-Jul-12			HT	2d	smo		w	5	85	5	0	5	60	0	25	ST			SC	57	13	7291815	404568	0	>250	LVL	PL
131	24-Jul-12			HT	2d	sl mnd		m	0	100	0	0	0	50	7	23	ST			SC	55	13	7294438	400385	2	>250	TOE	PL
132	17-Jul-12	3	B	BiS	2d	st		r	2	97	1	0	0	21	14	6	ST				40	13	7269058	432325	3	200	MD	PL
133	17-Jul-12	2	B	RHT	2d	mnd		r	5	75	15	0	5	19	3	0.1	CV				30	13	7269221	432224	14	30	CR	PL
134	17-Jul-12	3	B	HT	2d	mc		r	2	94	4	0	0	23	17	26	ST					13	7269358	431812	8	200	MD	PL
135	17-Jul-12	3	B	HT	2d	mc		r	2	92	6	0	0	36	6	15	CV	100			35	13	7269546	431433	5	300	MD	PL
136	17-Jul-12	6	C	SE	2b	st		i	0	100	0	0	0	8	36	10	ST	10			10	13	7269655	431205	3	200	MD	PL
137	17-Jul-12	2	B	RHT	2a	mc		r	8	59	30	0	3	3	1	0	CV				45	13	7269591	431048	4	50	UP	PL
138	17-Jul-12	3	C	HT	2d	mc		w	5	80	15	0	0	30	3	15	CV					13	7269727	430878	3	100	UP	PL
139	18-Jul-12	6	D	SE	2b	st		i	1	98	0	0	0	11	21	13	ST	30	40		110	13	7269820	430640	2	100	dp	PL
140	18-Jul-12	3	B	HT	2d	mc		w	5	85	10	0	0	32	3	12	ST					13	7270023	430287	5	200	MD	PL
141	18-Jul-12	3	B	HT	2d	mc		w	1	98	1	0	0	20	9	10	ST				85	13	7270085	430017	5	400	MD	PL
142	18-Jul-12	2	C	RHT	3a	st/mnd		r	0	50	50	0	0	32	1	18	CC				10	13	7270286	429978	4	150	LWR	PL
143	18-Jul-12	3	B	HT	2d	mc/smt		w	2	97	1	0	0	17	5	6	CV					13	7269628	430268	9	50	LWR	PL
144	18-Jul-12	5	C	BiR	3a	mc/smo		m	0	100	0	0	0	76	1	31	ST				60	13	7269301	430353	0		LVL	PL
145	18-Jul-12	5	C	BiS	2b	sl/hmk		l	3	96	0	0	0	13	24	14	ST	20			70	13	7269579	430178	2	100	LVL	PL
146	18-Jul-12	7	D	SE	2b	mc/hmk		p	0	60	10	30	0	3	25	4	CC	10			10	13	7269514	430075	2	100	TOE	PL
147	19-Jul-12	2	B	EC	1a	no mounds		r	15	7	78	0	0	4	3	0.01	CV					13	7269850	429677	2	100	CR	PL
148	19-Jul-12	2	B	RHT	2d	mc/und		x	10	40	25	0	25	19	18	2	CV				0-50	13	7269459	429827	1	30	CR	PL
149	19-Jul-12	2	B	HT	2d	mc/mnd		r	5	80	15	0	0	34	10	11	CV			TC	45	13	7269494	429735	10	50	UP	PL
150	19-Jul-12	4	C	BiR	2d	sl/hmk		w	2	96	2	0	0	24	2	18	CC			SC	33	13	7269481	429626	3	100	TOE	PL
151	19-Jul-12	5	C	BiR	3a	mc/hmk		w	0	100	0	0	0	75	0.2	28	ST			TC		13	7269372	430082	4	200	MD	PL
152	19-Jul-12	3	B	RHT	2a	mc		w	0	40	60	0	0	13	11	23	ST			TC		13	7269291	429741	4	150	TOE	PL
153	19-Jul-12	3	B	HT	2d	mc/mnd		w	10	55	35	0	0	28	8	15	ST			TC	50	13	7269024	430060	2	200	LVL	PL
154	19-Jul-12	7	C	SE	2b			v	0	90	0	10	0	0.1	80	1.5	ST	5	10	OC	30	13	7268899	430048	0		dp	PL
155	19-Jul-12	7	C	SE	2b	mc		p	0	100	0	0	0	0.3	66	7	ST	20	40	TC	70	13	7268410	430083	2	300	dp	PL
156	19-Jul-12	3	B	HT	2d	mc/mnd		w	5	80	15	0	0	15	9	24	CV			TC		13	7268202	430101	6	200	LWR	PL
157	20-Jul-12	2	B	RHT	2d	mc		r	10	65	15	0	10	30	10	5	ST				20	13	7268386	429804	2	60	LVL	PL
158	20-Jul-12	6	B	SE	2b	md/hmk		p	0	100	0	0	0	1	48	20	CC	0	0	TC	0	13	7268256	429836	1	200	LVL	PL
159	20-Jul-12	4	C	HT	2d	mc/mnd		w	15	65	20	0	0	27	11	15	CV					13	7268045	429981	2	40	MD	PL
160	20-Jul-12	2	B	RHT	2d	mc/mnd		r	10	65	15	0	10	24	11	5	CV				20	13	7267911	430074	1	50	UP	PL
161	20-Jul-12	5	D	SE	2b	md/hmk		l	0	99	1	0	0	3	42	0	ST	25	25	TC	30	13	7267178	429962	3	200	LWR	PL
162	20-Jul-12	3	B	HT	2d	mc/mnd		r	10	70	15	0	5	13	7	8	C			TC	35	13	7267249	429722	3	70	MD	PL
163	20-Jul-12	6	C	SE	2b	md/hmk		p	0	96	2	2	0	1	41	4	ST	0	0	SC	0	13	7267150	429541	0	200	LVL	PL
164	20-Jul-12	4	B	RHT	2d	mc/mnd		w	0	0	50	0	0	16	11	11	ST	40				13	7266843	429498	0		LVL	PL
165	20-Jul-12	4	C	BiS	3a	mc/mnd		m	5	90	5	0	0	73	2	14	ST			TC		13	7266777	429170	0		LVL	PL
166	21-Jul-12	6	B	SE	2b	st/hmk		p	0	98	2	0	0	15	29	29	ST	60	10	TC	10	13	7266844	428994	0		dp	PL
167	21-Jul-12	3	B	HT	2d	mc/mnd		r	15	65	20	0	0	33	9	10	ST					13	7266616	429060	0		LVL	PL
168	21-Jul-12	3	B	HT	3a	mc/mnd		r	15	60	25	0	0	41	6	11	CV					13	7266449	428961	3	100	MD	PL
169	21-Jul-12	5	B	BiS	3a	st/hmk		p	2	95	3	0	0	80	9	9	ST			SC	70	13	7266633	428786	1	200	TOE	PL
170	21-Jul-12	6	B	SE	2b	st/hmk		p	0	93	2	5	0	13	32	33	ST	20	50	TC	50	13	7266524	428234	5	150	LWR	PL
171	21-Jul-12	7	C	SE	2b			v	0	45	0	55	0	0.4	49	0	ST	0	0	SC	0	13	7266714	428033	2	100	LVL	PL
172	21-Jul-12	3	B	HT	2d	mc/mnd		w	2	96	2	0	0	44	4	13	ST					13	7266659	427840	5	100	MD	PL
173	21-Jul-12	3	B	HT	2d	mc/mnd		r	10	88	2	0	0	31	8	25	ST					13	7265905	427912	3	300	MD	PL
174	21-Jul-12	3	B	HT	2d	mc/mnd		w	5	93	2	0	0	46	11	18	CC					13	7266006	427708	4	200	LWR	PL
175	21-Jul-12	7	B	SE	2b	mc/hmk		p	5	65	30	0	0	7	23	22	ST	0	10	OC	10	13	7266206	427476	2	200	TOE	PL
176	22-Jul-12	3	B	HT	2d	mc/mnd		r	5	87	8	0	0	28	15	0	CV					13	7266523	427364	1	50	LVL	PL
177	22-Jul-12	2	B	RHT	2d	T		r	10	20	70	0	0	3	5	10	ST				15	13	7266245	427085	0		LVL	PL
178	22-Jul-12	2	B	HT	2d			r	15	60	25	0	0	28	14	12	ST				50	13	7265617	426843	1	50	LVL	PL
179	22-Jul-12	5	C	SE	2b	st/hmk		l	0	98	2	0	0	14	36	29	ST	50		TC	70	13	7265548	426703	2	50	LVL	PL
180	22-Jul-12	3	B	HT	2d	mc/mnd		r	5	70	25	0	0	30	11	9	CV					13	7265449	426452	4	75	CR	PL
181	22-Jul-12	3	B	HT	2d	mc/mnd		w	10	55	35	0	0	30	16	10	ST					13	7266175	426301	1	50	LVL	PL
182	22-Jul-12	2	B	HT	2d	mc/mnd		r	10	75	15	0	0	39	6	6	CV				35	13	7266919	429836	3	60	UP	PL
183	22-Jul-12	7	B	SE	2b	sl/hmk		p	0	100	0	0	0	1	54	12	ST	0	10	SC	10	13	7266729	429830	1	100	dp	PL
184	22-Jul-12	3	B	HT	2d	mc/mnd		w	10	70	20	0	0	53	13	7	CV					13	7266728	430051	6	50	CR	PL

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
185	22-Jul-12	5	C	BiS	2d	mc/mnd		I	5	75	20	0	0	19	8	9	ST	60		TC		13	7266562	430103	4	100	UP	PL
186	23-Jul-12	2	B	RHT	2d	st/und		r	10	40	10	0	40	17	0	0	CV				30	13	7266309	430043	1	200	LVL	PL
187	23-Jul-12	3	B	HT	2d	mc/mnd		w	10	55	35	0	0	26	7	7	ST			TC		13	7265925	430083	1	30	LVL	PL
188	23-Jul-12	3	B	HT	2b	mc/mnd		w	30	60	10	0	0	28	9	4	CV					13	7265867	430224	2	30	LVL	PL
189	23-Jul-12	3	B	HT	2b	mc/mnd		w	15	77	8	0	0	23	10	13	ST			TC		13	7265689	430465	2	100	LVL	PL
190	23-Jul-12	1	B	RHT	2b	st/und		x	10	35	15	0	40	14	8	8	CV				20	13	7265708	430746	5	50	CR	PL
191	23-Jul-12	5	B	SE	2b	st/hmk		I	0	95	5	0	0	14	18	6	ST	10		SC	60	13	7265355	430680	1	100	dp	PL
192	23-Jul-12	3	B	HT	2d	mc/mnd		w	10	75	15	0	0	16	9	8	ST			TC		13	7266561	426101	3	70	LWR	PL
193	23-Jul-12	5	C	BiS	3a	mc/hmk		I	0	98	2	0	0	65	12	13	ST	20		G		13	7266901	425954	2	400	MD	PL
194	23-Jul-12	6	C	SE	2b	st/hmk		p	0	100	0	0	0	2	25	3	ST	0	0	SC	0	13	7267418	425913	1	500	LVL	PL
195	23-Jul-12	1	B	EC	1a			r	29	6	65	0	0	3	2	1	CV					13	7268151	425365	10	25	CR	PL
196	24-Jul-12	3	B	HT	2d	mc/mnd		w	10	60	30	0	0	12	15	8	CV					13	7280889	414755	6	50	MD	PL
197	24-Jul-12	3	B	HT	2d	mc/mnd		w	20	55	25	0	0	21	5	6	CV					13	7281536	413770	4	40	CR	PL
198	24-Jul-12	2	B	LR	1a	mc/mnd	2	r	15	5	60	0	20	0.5	3	1	CV				60	13	7290041	408517	10	100	UP	PL
199	24-Jul-12	3	B	HT	2d	mc/mnd		w	10	55	35	0	0	40	6	5	CV					13	7289299	408885	15	75	MD	PL
200	13-Jul-12	2	A	HT	2d	smo		r	20	80	0	0	0	70	5	60	ST			SC	98	13	7312683	388237	2	150	LVL	PL
201	13-Jul-12	3	B	HT	2d	smo		w	0	90	10	0	0	90	6	85	ST			SC	41	13	7312696	388808	3	100	LVL	PL
202	14-Jul-12	4	C	BiS	3a(2d)	hmk		m	55	45	0	0	0	40	8	45	ST	9		SC	61	13	7326460	402785	1	200		LO
203	14-Jul-12	4	A	HT	3a (2d)	sl hmk		m	45	54	2	0	0	45	5	50	ST	6		SC	0	13	7326009	402298	3	>250	LVL	PL
204	14-Jul-12	7	C	EA	2b/2d	sl hmk		p	0	98	0	2	0	12	12	90	ST		33	OC	38	13	7325514	401949	1	100	TOE	LO
205	14-Jul-12	3	C	HT	2d	smo		w	45	45	10	0	0	40	35	3	ST			SC	16	13	7320971	401898	1	>250	LVL	PL
206	14-Jul-12	3	C	HT	2d (3a)			w	45	55	5	0	0	45	6	40		7		SC		13	7320003	402571	0	250	LVL	PL
212	16-Jul-12	3	D	RHT	2d	smo		w	40	50	10	0	0	50	12	12	ST		54	SC		13	7331158	402114	3	>250	LVL	PL
213	16-Aug-12	3	B	EC	2d	smo		w	3	15	6	0	16	75	7	6	CV			R		13	7331599	402063	3	35	CR	PL
214	16-Jul-12	5	C	BiS	2b	hmk		i	0	70	28	2	0	30	65	8	ST	45	63	R	63	13	7331581	401992	4	200	TOE	LO
215	16-Jul-12	1	A	EC	2d	smo		r	40	30	30	0	0	30	6	0	ST			R	16	13	7336980	403159	0	100	LVL, CR	PL
216	16-Jul-12	3	D	SE	3a (2b)	smo		w	30	70	0	0	0	30	45	35	ST			R		13	7338457	403253			LVL	PL
217	16-Jul-12	3	D	SE	2d	terraced		w	0	95	5	0	0	0	0	0	ST			R		13	7339694	402987	10	100	MD	UP
218	17-Jul-12	4	B	HT	3a (2d)	smo		m	50	40	10	0	0	40	10	15	ST			TC		13	7313374	402793		>250	LVL	PL
219	17-Jul-12			LRR	1c	rocky		r	0	10	90	0	0	10	4	60	ST		87	non soil	0	13	7313324	402723			LVL	PL
220	17-Jul-12	4	C	HT	3a	smo		w	20	77	3	0	0	70	7	60	ST	29		R		13	7312093	403144	4	>250	LO	LO
221	17-Jul-12	1	A	EC	1a	smo			90	10	0	0	0	0	0	0	ST					13	7311068	403566	3	>250	CR	PL
222	17-Jul-12	5	C	CA	2b	smo		i	2	98	0	0	0	25	40	50	ST	18		R		13	7343290	404272	3	>250	MD	MD
223	17-Jul-12	4	C	HT	2a	smo		m	0	100	0	0	0	50	50	40	ST			R		13	7342512	404090	10	>250	LO	UP
224	17-Jul-12	3	C	HT	2d	sl hmk		w	0	98	2	0	0	45	30	50	ST			R		13	7341702	403750	4	>250	LO	LO
225	17-Jul-12			RHT	2d	smo		w	30	35	20	0	15	35	6	25	ST			R		13	7314172	386369	2	>250	CR	PL
226	18-Jul-12	3	B	RHT	2d/1a	smo		w	55	35	10	0	0	32	3	10	ST			R	14	13	7312832	387696	3	50	LVL	PL
227	18-Jul-12	7	C	TM	2b	hmk		p	0	100	0	0	0	25	60	0	ST			SC		13	7312866	387874	0	100	LVL	LO
228	18-Jul-12	4	C	HT	3a(2d)	smo		w	20	65	15	0	0	30	3	25				SC	49	13	7312534	389125	0	>250	CR	UP
229	18-Jul-12	7	C	SE	2b	hmk		v	0	100	15	2	0	2	90	0	ST	15	19	OC	19	13	7312559	389625	3	>250	LVL	PL
230	18-Jul-12	2	B	LH	2d	hmk		w	0	60	10	0	30	55	6	45				SC	32	13	7312973	389607	5	50	MD	MD
231	18-Jul-12	7	C	HT	2b (2d)	smo		p	0	100	0	0	0	0	0	0	ST	8		SC	34	13	7313064	389360	6	200	MD	MD
232	18-Jul-12	3	B	RHT	2d	smo		w	5	60	35	0	0	50	50	35	ST			SC	53	13	7309350	402300	5	100	LVL	PL
233	18-Jul-12	6	B	CE	2b	sl hmk		i	0	95	0	5	0	0	90		ST	11	33	SC	36	13	7308877	402229	1	150	LVL	PL
234	19-Jul-12	1	B	EC	2d	smo		x	80	20	0	0	0	20	1	13	ST			R		13	7307153	401399	4	100	CR	PL
235	19-Jul-12	1	A	HT	2d	smo		r	15	80	5	0	0	75	0.01	10	ST			SC	23	13	7297397	400533	0	>250	LVL	PL
236	19-Jul-12	3	C	RHT	2d	smo		w	5	55	3	0	37	50	0.01	30	ST			SC		13	7296930	401245	1	150	CR	PL
237	19-Jul-12	8	C	CA	2b	smo		v	0	99	0	1	0	5	12	0	ST		14	OC	14	13	7296580	401464	2	100	LVL	PL
238	19-Jul-12	4	B	HT	2d			w	5	90	5	0	0	80	5	40	ST			SC		13	7295568	402004	7	>250	MD	MD
239	19-Jul-12	7	A	SE	2d	hmk		p	0	5	0	95	0	55	60	50	ST		29	SC	47	13	7295164	402206	4	>250	LVL	PL
240	19-Jul-12			SE	2b	hmk		v	0	100	0	0	0	5	30	85	ST		3	OC		13	7301268	399843	3	>250	TOE	LO
241	20-Jul-12	2	A	HT	2d	mnd	1	m	0	95	5	0	0	25	4	5	ST		53	R	53	13	7394062	380983	1	>100	MD	PL
242	20-Jul-12	4	B	BiS	3a	smo		m	0	100	0	0	0	95	3	10	ST			SC	33	13	7393901	380520	6	>250	MD	MD
243	20-Jul-12	4	B	BiR	3a	smo		i	0	100	0	0	0	80	7	0	ST	50	50	OC		13	7393830	379730	1	100	LVL	PL
244	21-Jul-12	5	B	BiR	3a	smo		I	0	100	0	0	0	50	10	3	ST	42		OC		13	7389061	381838	1	>250	LVL	PL
245	21-Jul-12	3	B	BiR	3a	mnd		m	0	100	0	0	0	80	8	2	ST			SC	41	13	7388956	381876	2	>250	LVL	PL
246	20-Jul-12			SE	2b	smo		p	0	100	0	0	0	18	20	10	ST		14	G	14	13	7393700	379901	0	>250	LVL	PL
247	20-Jul-12	6	D	SE	2b	mnd		I	0	100	0	0	0	3	18	13	ST		33	SC	33	13	7392672	378679	0		LVL	PL
248	20-Jul-12	3	B	HT	2d	mnd		w	2	95	3	0	0	75	7	15	CV			SC		13	7392172	378895	4	150	UP	PL
249	20-Jul-12	3	C	HT	2d	mnd		w	0	100	0	0	0	75	11	20	ST			R	21	13	7386710	382773	6	200	MD	MD

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
250	21-Jul-12	3	B	HT	2d	smo		w	2	98	0	0	0	95	0	0	ST				41	13	7388604	382116	6	50	UP	UP
251	21-Jul-12	4	B	HT	3a	mnd		mw	10	90	0	0	0	85	6	11	ST			SC	z	13	7382963	385245	5	50	MD	LO
252	21-Jul-12	7	C	MCE	2b	smo		v	0	100	0	0	0	0	12	0	ST		2		98	13	7382930	385382	0	>250	LVL	PL
253	21-Jul-12			HT	2d	smo		r	5	95	0	0	0	85	3	15	ST				77	13	7377134	388191		>250	LVL	PL
254	22-Jul-12	3	A	RHT	2d	sl mnd		m	2	38	30		30	25	8	40		7		SC		13	7316563	385997	3	>250	LVL	MD
255	21-Jul-12	2	A	RHT	2d	sl mnd		w	0	60	40	0	0	20	3	0				SC		13	0	0	9	100	MD	LO
256	22-Jul-12			RHT	2d	smo but rocky		r	15	40	15	0	30	0	0	0	CV			SC		13	7316532	385756	12	>250	MD	MD
257	22-Jul-12			SE		smo		r	45	55	0	0	0	4	25	15	ST			R		13	7381303	387300	0	>250m	LVL	PL
258	22-Jul-12	3	B	BiR	3a	smo		r	0	100	0	0	0	96	4	5	ST				56	13	7381247	387451	250	>250	LVL	PL
259	22-Jul-12			SE	2b			p	0	0	0	0	0	0	20	0			87	G		13	7381330	387626	250	>250	LVL	PL
260	22-Jul-12	2	A	HT	2d	smo		r	0	0	0	0	0	20	5	3	ST					13	7370890	395331	250	>250	LVL	PL
261	23-Jul-12	5	C	BiS	3a	hmk		l	0	100	0	0	0	65	12	20	ST			SC	91	13	7363221	398837	4	250	MD	LO
262	23-Jul-12			HT	2d	sl smk		m	0	100	0	0	0	0	0	0	ST			SC		13	7362909	398999	10	250		
263	23-Jul-12	5	B	BiS	3a			i	0	100	0	0	0	55	30	3	ST			SC		13	7359770	401974	0	250	LVL	PL
264	23-Jul-12	4	B	HT	3a	smo		m	15	20	0	0	0	5	58	1	MC		60	SC	60	13	7359715	402456	0	>250	LVL	PL
265	23-Jul-12	5	C	HT	3a	hmk		l	10	10	0	0	0	25	42.1	3.1	MC		38	TC	38	13	7359875	402475	0	>250	LVL	PL
267	23-Jul-12			BE	3a(2d)			m	45	0	0	0	0	20	37	0.1			59	SC	59	13	7359885	402248	0	>250	LVL	PL
268	23-Jul-12			HT	3a			w	15	25	0	0	0	8	45	16				SC	63	13	7371661	391069	1	200	UP	MD
269	23-Jul-12			HT	2d			l	0	0	0	0	0	30	35	1.8		9		SC	32	13	7370751	391747	8	>250	MD	MD
272	23-Jul-12	3	B	BiS	3a			w	5	95	0	0	0	80	5	10				SC		13	7370512	391714	12	75	MD	MD
273	27-Jul-12	3	B	HT	2d	mnd		w	5	80	15	0	0	18	16	18	ST	30		TC		13	7264743	428876	4	150	MD	PL
274	23-Jul-12	3	B	BE	2b	sl mnd		w	5	85	10	0	0	50	10	10	CC			SC		13	7363239	398460	9	100	MD	MD
275	23-Jul-12	3	B	BE	2d	sl mnd	1	w	0	95	5	0	0	40	2	10	CV			SC		13	7362922	398589	8	100	MD	MD
278	23-Jul-12	7	C	SE	2b			p	0	100	0	0	0	4	30	20	ST		14	SC	82	13	7363494	398683	3	>250	DP	LO
279	23-Jul-12	3	B	BiS	3a	sl smk		m	3	97	0	0	0	80	9	15	ST			SC		13	7371211	391266	8	200	LO	LO
287	27-Jul-12	6	B	CA	2c	hmk		i	0	96	0	4	0	1	60	18	ST	12	10	SC	10	13	7264358	428969	0		LVL	PL
288	27-Jul-12	5	C	BiS	3a	mnd		i	1	98	1	0	0	70	5	38	CV			SC	25	13	7264077	428543	2	300	LO	PL
289	27-Jul-12	3	B	HT	2d			w	5	85	10	0	0	25	17	18	CV			TC		13	7264030	428849			LO	PL
290	27-Jul-12	5	C	BiS	3a	mnd	2	i	2	98	0	0	0	80	8	26	ST			SC		13	7264039	429283	3	250	LO	PL
291	27-Jul-12	6	C	BiS	3a	hmk		i	5	89	6	0	0	25	18	30	ST	0		TC		13	7264175	429898	2	500	MD	PL
292	28-Jul-12	3	B	HT	3a(2d)		1	w	8	90	2	0	0	30	30	22	ST			TC	90	13	7263382	430796	0		LVL	PL
293	28-Jul-12	6	C	BiS	3a		5		3	96	1	0	0	69	17	30				TC	90	13	7263000	430558	2		LO	PL
294	28-Jul-12	7	B	SE	2b	hmk	1	p	6	87	7	0	0	8	55	33	ST	0		OC	0	13	7262732	431230			LVL	PL
295	28-Jul-12	4	B	HT	3a(2d)		1	w	3	97	0	0	0	37	23	28	ST			TC		13	7263492	431658	3	200	MD	PL
296	29-Jul-12			EA				p	0	0	0	0	0	60	17	35		0	55	OC		13	7273347	432124			LVL	PL
297	29-Jul-12	3	B	RHT	2d(3a)		5	w	5	70	10	0	15	33	16	11	CV			TC	40	13	7273644	432752	9	100	UP	PL
298	29-Jul-12	3	B	HT	3a(2d)		1	w	6	90	4	0	0	40	9	16	ST			TC		13	7274061	431431			LVL	PL
299	29-Jul-12	4	C	HT	3a	mnd	1	w	10	89	1	0	0	50	16	50	ST			TC		13	7273674	430226	3	>200	MD	PL
300	29-Jul-12	4	B	HT	3a		1	w	10	89	1	0	0	28	16	45	ST			SC		13	7274325	429304	6	200	MD	PL
301	24-Jul-12	2	B	HT	2d	mnd		r	5	60	25	0	10	21	5	12	CC					13	7294554	400439	2	40	UP	PL
302	25-Jul-12	7	C	SE	2b	hmk		p	0	80	0	20	0	0.01	63	1	ST	0	0	SC	10	13	7296472	400043	0	40	LVL	PL
303	25-Jul-12	3	B	HT	2d	mnd		w	15	55	30	0	0	33	19	15	ST					13	7295507	400520	5	250	TOE	PL
304	25-Jul-12	2	B	HT	2d			r	5	85	10	0	0	19	22	13	ST					13	7293092	401091	0		LVL	PL
305	25-Jul-12	0	A	LR	1a			x	0	10	80	0	10	0	0	0	CV				10	13	7285792	406018	0		LVL	PL
306	25-Jul-12	4	C	HT	2d	mnd		w	5	60	35	0	0	24	8	21	CC					13	7284731	407461	3	100	MD	PL
307	25-Jul-12	3	B	HT	2d	mnd		w	10	75	15	0	0	25	10	10	ST		7			13	7283458	409812	2	50	MD	PL
308	26-Jul-12	3	B	HT	2d	mnd		w	10	75	15	0	0	30	9	6	ST					13	7267016	422981	2	50	LVL	PL
309	26-Jul-12	3	B	HT	2d	mnd		w	5	55	35	0	5	17	3	27	ST				50	13	7266991	421985	2	200	LVL	PL
310	26-Jul-12	5	C	HT	2d	mnd		m	2	93	5	0	0	32	7	23	ST			SC	80	13	7266742	421318	0		LVL	PL
311	26-Jul-12	3	B	HT	2d	mnd		r	10	75	15	0	0	48	2	30	CC					13	7265435	422067	5	10	LWR	PL
312	26-Jul-12	4	C	HT	2d	mnd		m	10	65	25	0	0	18	12	18	ST			TC	60	13	7267996	422996	5	125	MD	PL
313	26-Jul-12	3	B	HT	2d	mnd		w	15	60	25	0	0	32	14	11	CV			TC		13	7267983	421976	0		LVL	PL
314	26-Jul-12	6	C	SE	2b	hmk		i	0	97	3	0	0	0.4	60	2	ST	10	40	TC	90	13	7267936	420993	1	100	LVL	PL
315	27-Jul-12	2	B	HT	2d	mnd		r	5	65	30	0	0	43	22	11	ST			TC	50	13	7267745	428334	0		LVL	PL
316	27-Jul-12	3	B	HT	2d	mnd			5	60	35	0	0	29	19	12	ST					13	7268681	428501	5	200	LWR	PL
317	27-Jul-12	4	C	HT	2d	mnd		w	20	70	10	0	0	43	5	27	ST			TC		13	7269819	428692	1	50	LVL	PL
318	28-Jul-12	4	C	HT	2d	mnd		m	10	60	30	0	0	15	11	25	ST			TC		13	7265097	421745	0		LVL	PL
319	28-Jul-12	4	C	HT	2d	mnd		m	3	95	2	0	0	20	9	29	ST			TC		13	7273602	425832	3	150	MD	PL
320	28-Jul-12	4	C	HT	2d	mnd		w	25	65	10	0	0	37	12	28	ST			TC		13	7274860	422401	2	100	LVL	PL
321	29-Jul-12	5	C	HT	2d	mnd		m	5	85	10	0	0	18	15	26	ST	50	60	TC	60	13	7281001	414110	2	100	LVL	PL

Appendix 6. Field Data

Plot	Date	SMR	SNR	Veg_Assoc	Str_Stg	Microtop	Trans_Dist	Drainage	Min_Soil	Org_Soil	Rock	Water	Bedrock	B_Layer	C_Layer	D_Layer	Sfc_Shape	Seep_Dpth	H20_Table	Soil_Clss	Root_Restr	UTM	Northing	Easting	Slope	Slp_Lgth	Slp_Pos	Slp_Macro
322	29-Jul-12	2	B	HT	2d	mnd		r	15	60	25	0	0	50	26	34	ST				38	13	7279162	416673	4	100	MD	PL
323	29-Jul-12	6	C	SE		hmk		l	0	100	0	0	0	15	53	18	ST	10	20	SC	20	13	7278140	417830	3	250	LWR	PL
501	30-Jul-12	3	B	HT	3a		5	r / w	6	78	15	0	1	40	19	20				SC		13	7269761	438981			LVL	PL
502	30-Jul-12	3	B	RHT	2d		1	r / w	2	83	15	0	0	15	11	40	ST			TC		13	7273959	445412			LVL	PL
503	30-Jul-12	6	B	BR	3a	mnd	1	p	1	98	1	0	0	40	11	43	ST			TC	30	13	7273277	437185			LVL	PL
504	30-Jul-12	3	B	HT	3a		1	w	11	80	8	0	1	24	23	14				TC		13	7273204	436458			LVL	PL
506	31-Jul-12	5	B	HT	2c		1	m	0	100	0	0	0	23	35	65	ST			TC	76	13	7255183	430896			LVL	PL
507	31-Jul-12	3	B	HT	3a		1	w	12	81	7	0	0	19	19	50	ST			SC	12	13	7254088	431255			LVL	PL
508	31-Jul-12	5	C	BiS	3a		1	w / m	2	98	0	0	0	80	8	60	ST			TC, SC		13	7257297	425568	5	300	LO	PL
509	1-Aug-12	3	B	HT	3a		1	w	7	93	0	0	0	24	20	47	ST			TC	0	13	7272782	427686				
510	1-Aug-12	3	B	HT	3a		1	w	15	83	2	0	0	40	17	28	CV			SC		13	7272248	426928	5	200	UP	PL
511	1-Aug-12	7	B	BR	2	st.hmk	6	p	3	96	1	0	0	16	60	30	ST	27		TC		13	7269989	428847			LVL	PL
512	3-Aug-12	4	B	HT	3a		1		1	99	0	0	0	33	14	68	ST	75		TC		13	7266620	434285	3	200	LVL	PL
513	4-Aug-12	3	B	HT	3a		5	w	8	85	7	0	0	45	9	34	ST			TC	36	13	7282349	430812	2		LVL	PL
514	4-Aug-12	4	B	RHT	2d		1	i	10	70	20	0	0	30	22	33	ST	20		TC		13	7282094	417529	3		LVL	PL
515	5-Aug-12	6	B	BiS	3a		1	i	0	100	0	0	0	65	30	30	ST	26		SC		13	7248460	429002			TOE	PL
516	5-Aug-12	2	B	RHT	3a		1	w	2	85	10	0	3	27	28	30	ST			SC	41	13	7248228	429548	5	100	UP	PL
517	5-Aug-12	2	B	HT	3a		1	w	15	82	3	0	0	34	32	17	ST			TC		13	7260985	438666			LVL	PL
518	6-Aug-12	2	B	EC	2d		1	x / r	40	60	0	0	0	25	30	15	ST			R		13	7268889	450589	11	50	UP	PL
519	6-Aug-12	2	B	HT	3a		5	x / r	10	78	12	0	0	25	29	20	ST			SC		13	7270005	448628	7		MD	PL
520	6-Aug-12	5	B	BR	2c	st.hmk	1	i	0	100	0	0	0	22	47	50	ST	55		TC	50	13	7265760	444788	0		LVL	PL
521	7-Aug-12	3	B	HT	2d		1	w	8	90	2	0	0	19	11	59	ST			SC		13	7271447	416805	8	20	UP	PL

Appendix 7
Baseline Metals Analysis

Engineers and Scientists

Appendix 7-1. Metal Levels in Soil Samples Collected in 2012, Back River Project

Location			Goose property														
Sample ID		CCME	023-5	042-5	049-5	050-5	053-5	054-5	055-5	058-5	062-5	064-5	069-5	074-5	080-5	080-5-X	101-5
Depth		Industrial	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm
Matrix	Units	Guideline	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests																	
pH (1:2 soil:water)	pH	6 to 8	5.86	5.93	5.86	6.16	5.93	5.18	6.31	6.21	6.01	5.42	5.83	6.83	4.73	4.73	5.76
Metals																	
Aluminum (Al)	mg/kg	-	3020	6360	5400	3960	7070	4480	3880	4080	3870	3980	4260	4430	4650	4600	5240
Antimony (Sb)	mg/kg	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	mg/kg	12	5.53	8.76	7.03	7.00	6.29	5.65	2.41	2.44	2.37	1.89	3.29	3.07	4.84	4.30	4.72
Barium (Ba)	mg/kg	2,000	15.5	23.3	25.1	24.2	62.4	31.1	23.6	28.7	23.3	20.2	20.2	28.5	21.3	23.6	28.7
Beryllium (Be)	mg/kg	8	<0.2	<0.2	<0.2	<0.2	0.22	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bismuth (Bi)	mg/kg	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	22	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium (Ca)	mg/kg	-	1310	1620	1690	1470	2290	911	1870	1830	1820	1300	1440	1820	1390	1100	1930
Chromium (Cr)	mg/kg	87	10.4	22.0	18.5	13.5	24.8	15.0	13.7	14.9	13.4	13.1	13.1	15.3	13.0	12.8	19.1
Cobalt (Co)	mg/kg	300	2.71	5.15	5.84	4.46	6.42	2.97	3.35	3.52	3.34	3.02	4.24	4.61	3.25	2.99	5.32
Copper (Cu)	mg/kg	91	6.46	15.2	14.2	7.72	11.1	9.37	9.75	10.3	7.27	7.42	9.74	10.2	5.29	6.66	16.7
Iron (Fe)	mg/kg	-	6870	11500	11000	7830	13600	9060	7760	9040	8110	8180	8510	9980	9280	8340	11200
Lead (Pb)	mg/kg	600	1.54	2.48	2.78	1.94	3.28	4.06	2.09	2.08	1.96	2.07	1.96	2.08	2.27	2.33	2.62
Lithium (Li)	mg/kg	-	6.0	11.8	9.4	6.9	10.7	6.3	6.4	6.8	6.1	6.9	7.3	7.6	8.4	7.3	9.1
Magnesium (Mg)	mg/kg	-	1720	4320	3150	2110	4100	2100	2330	2460	2170	2080	2630	2800	3120	3100	3260
Manganese (Mn)	mg/kg	-	51.6	97.7	96.2	70.6	125	58.4	63.9	75.4	65.5	63.5	71.3	81.0	71.3	63.3	102
Mercury (Hg)	mg/kg	50	<0.005	<0.005	<0.005	<0.005	<0.005	0.0097	<0.005	<0.005	<0.005	0.0078	<0.005	<0.005	0.0052	0.0064	<0.005
Molybdenum (Mo)	mg/kg	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (Ni)	mg/kg	50	7.38	15.7	14.8	9.58	14.4	10.7	8.74	8.80	8.09	6.66	9.66	10.4	8.02	7.19	14.1
Phosphorus (P)	mg/kg	-	344	445	479	378	571	184	439	428	435	305	388	442	325	209	428
Potassium (K)	mg/kg	-	280	550	400	450	730	190	370	470	380	370	430	540	340	410	520
Selenium (Se)	mg/kg	2.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver (Ag)	mg/kg	40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (Na)	mg/kg	-	<100	100	100	<100	130	120	110	180	110	<100	<100	120	<100	<100	130
Strontium (Sr)	mg/kg	-	5.59	5.62	6.03	7.44	20.2	5.76	8.99	8.42	8.67	6.99	5.29	8.21	7.55	6.65	8.72
Thallium (Tl)	mg/kg	1	<0.05	<0.05	<0.05	<0.05	0.054	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin (Sn)	mg/kg	300	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	-	228	285	341	282	507	238	315	386	356	306	271	351	398	415	401
Uranium (U)	mg/kg	300	0.274	0.421	0.433	0.487	0.826	0.482	0.372	0.427	0.380	0.334	0.403	0.355	0.244	0.330	0.368
Vanadium (V)	mg/kg	130	14.2	19.7	21.4	16.6	29.0	19.6	21.4	22.6	20.9	20.3	18.7	22.7	21.7	19.9	25.0
Zinc (Zn)	mg/kg	360	9.0	20.8	16.4	10.0	18.5	12.3	11.8	12.0	11.1	11.5	12.5	14.2	13.9	13.6	17.4

Notes

Shaded cells indicate concentrations greater than CCME guideline levels.

b) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

Appendix 7-1. Metal Levels in Soil Samples Collected in 2012, Back River Project

Location			Goose property														
Sample ID Depth Matrix	Units	CCME Industrial Guideline	104-5 5cm Soil	107-5 5cm Soil	108-5 5cm Soil	110-5 5cm Soil	023-60 60 Soil	042-60 60 Soil	049-60 60 Soil	050-60 60 Soil	053-60 60 Soil	055-60 60 Soil	058-60 60 Soil	062-60 60 Soil	069-60 60 Soil	074-60 60 Soil	080-60 60 Soil
Physical Tests																	
pH (1:2 soil:water)	pH	6 to 8	5.60	5.48	5.69	6.04	5.72	6.00	5.72	6.64	6.79	5.85	6.56	6.84	6.07	6.54	5.58
Metals																	
Aluminum (Al)	mg/kg	-	4720	4830	6950	3680	3880	5900	5840	3610	8160	3730	4190	4260	4730	3850	5110
Antimony (Sb)	mg/kg	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	mg/kg	12	4.78	1.69	7.80	1.42	4.62	10.3	6.72	7.90	7.08	2.83	2.56	2.13	4.97	2.72	3.63
Barium (Ba)	mg/kg	2,000	23.5	24.8	29.8	27.0	19.7	23.2	22.7	24.1	74.7	23.8	31.4	23.6	23.2	23.9	30.8
Beryllium (Be)	mg/kg	8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.26	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bismuth (Bi)	mg/kg	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	22	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium (Ca)	mg/kg	-	1460	1970	1960	1620	1100	1630	1750	1370	2220	1730	1930	2010	1620	1930	1490
Chromium (Cr)	mg/kg	87	13.9	14.6	23.2	15.3	12.5	20.4	19.4	13.0	26.4	12.7	15.7	15.3	17.5	14.8	15.8
Cobalt (Co)	mg/kg	300	3.05	3.02	4.84	3.59	2.70	6.26	4.82	3.90	6.12	3.26	3.92	3.64	5.20	3.45	4.30
Copper (Cu)	mg/kg	91	11.9	8.54	17.2	6.92	13.3	16.7	17.3	7.69	11.5	10.4	11.1	7.15	12.3	8.68	10.7
Iron (Fe)	mg/kg	-	8850	7180	11500	8420	7070	11400	11000	7600	14900	8570	9510	9260	9970	8630	9520
Lead (Pb)	mg/kg	600	2.16	2.40	2.98	2.14	1.92	2.63	2.79	1.60	3.77	2.05	2.31	1.77	2.11	1.88	2.14
Lithium (Li)	mg/kg	-	8.5	8.4	12.2	6.1	5.3	11.1	8.6	7.0	12.6	6.1	7.0	7.4	7.7	6.7	9.6
Magnesium (Mg)	mg/kg	-	2670	2710	4620	2520	1570	3970	3160	2240	4310	2150	2710	2740	2950	2300	3160
Manganese (Mn)	mg/kg	-	67.3	74.4	97.2	69.7	45.1	99.1	88.2	70.1	131	66.0	75.5	82.3	83.6	71.2	72.9
Mercury (Hg)	mg/kg	50	<0.005	<0.005	<0.005	<0.005	0.0067	<0.005	0.0125	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)	mg/kg	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (Ni)	mg/kg	50	9.11	9.05	15.2	11.8	10.9	16.5	12.2	9.50	15.0	8.51	9.79	8.53	13.6	8.45	10.8
Phosphorus (P)	mg/kg	-	282	492	480	365	354	445	592	318	519	413	418	453	418	485	358
Potassium (K)	mg/kg	-	390	440	550	410	260	520	440	430	870	420	470	510	470	430	420
Selenium (Se)	mg/kg	2.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver (Ag)	mg/kg	40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (Na)	mg/kg	-	<100	110	<100	<100	<100	<100	<100	<100	130	<100	120	110	<100	110	<100
Strontium (Sr)	mg/kg	-	7.12	8.77	8.37	8.99	5.55	5.76	6.95	5.60	21.5	7.47	8.08	8.55	7.07	8.07	7.38
Thallium (Tl)	mg/kg	1	<0.05	<0.05	0.058	<0.05	<0.05	<0.05	<0.05	<0.05	0.069	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin (Sn)	mg/kg	300	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	-	325	369	395	288	219	305	324	258	446	317	419	347	323	350	374
Uranium (U)	mg/kg	300	0.354	0.370	0.553	0.384	0.471	0.487	0.541	0.366	0.924	0.381	0.592	0.364	0.326	0.397	0.314
Vanadium (V)	mg/kg	130	21.2	18.3	26.3	20.5	15.6	20.7	21.5	15.8	30.1	20.5	23.3	21.4	21.1	21.3	21.6
Zinc (Zn)	mg/kg	360	12.6	14.6	22.5	10.2	9.3	19.5	15.7	10.6	20.3	12.0	13.1	13.4	14.8	11.7	15.4

Notes

Shaded cells indicate concentrations greater than CCME guideline levels.

b) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

Appendix 7-1. Metal Levels in Soil Samples Collected in 2012, Back River Project

Location			Goose property			Marine laydown					Reference						
Sample ID		CCME	104-60	107-60	108-60	089-5	092-5	089-60	092-60	093-60	094-5	097-5	099-5	099-5-X	NW1	NW2	NW3
Depth		Industrial	60	60	60	5cm	5cm	60	60	60	5cm	5cm	5cm	5cm	5cm	5cm	5cm
Matrix	Units	Guideline	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests																	
pH (1:2 soil:water)	pH	6 to 8	6.04	5.67	5.73	5.76	5.12	5.82	6.05	6.97	5.58	5.46	6.11	6.02	4.49	4.90	5.46
Metals																	
Aluminum (Al)	mg/kg	-	4730	4720	6480	1570	674	1420	766	12700	7880	9520	7720	8300	7920	10300	14600
Antimony (Sb)	mg/kg	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	mg/kg	12	4.15	3.27	9.56	0.870	0.352	0.990	0.395	3.86	6.85	11.4	14.2	15.8	10.8	19.4	15.9
Barium (Ba)	mg/kg	2,000	25.0	27.6	27.5	25.2	5.39	199	5.67	80.0	20.5	15.2	16.5	18.2	11.3	14.6	18.5
Beryllium (Be)	mg/kg	8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.52	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.30
Bismuth (Bi)	mg/kg	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.21	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	22	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.224	0.060	<0.05
Calcium (Ca)	mg/kg	-	1710	1610	1760	144	100	196	140	2480	1030	603	1270	1360	463	1110	1620
Chromium (Cr)	mg/kg	87	14.6	16.6	22.4	2.61	1.27	2.69	1.55	28.5	30.2	35.8	29.1	33.2	25.6	41.1	50.2
Cobalt (Co)	mg/kg	300	3.36	3.88	5.62	0.75	0.25	0.66	0.40	7.65	5.44	5.29	9.56	10.6	5.25	5.98	10.6
Copper (Cu)	mg/kg	91	7.79	7.39	17.2	0.55	<0.5	<0.5	<0.5	16.4	13.7	11.2	22.1	23.2	18.8	17.5	39.9
Iron (Fe)	mg/kg	-	8710	9650	12200	3650	1320	4280	1500	17700	13700	17400	15700	17300	11400	19100	23800
Lead (Pb)	mg/kg	600	2.55	2.40	2.61	0.91	<0.5	0.94	<0.5	5.19	3.12	3.52	3.47	3.52	6.53	6.03	6.73
Lithium (Li)	mg/kg	-	8.4	8.5	12.0	<5	<5	<5	<5	19.3	15.5	16.4	17.1	17.7	6.5	18.3	30.7
Magnesium (Mg)	mg/kg	-	2750	2930	4500	535	254	445	423	7040	5200	5190	5060	5690	2430	6850	9420
Manganese (Mn)	mg/kg	-	74.2	79.7	107	28.5	5.6	36.8	8.7	184	117	130	156	178	61.5	167	236
Mercury (Hg)	mg/kg	50	<0.005	<0.005	<0.005	0.0057	<0.005	<0.005	<0.005	0.0051	<0.005	0.0305	0.0068	0.0062	0.0720	0.0168	0.0088
Molybdenum (Mo)	mg/kg	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.70	0.58	0.58	0.72	0.83	0.57
Nickel (Ni)	mg/kg	50	9.89	9.52	15.7	1.30	0.52	1.24	0.89	18.8	20.6	17.9	25.1	27.3	20.3	20.7	37.6
Phosphorus (P)	mg/kg	-	354	434	484	109	<50	104	53	424	311	156	387	417	606	424	497
Potassium (K)	mg/kg	-	420	490	530	520	220	570	190	2740	670	470	390	440	470	460	440
Selenium (Se)	mg/kg	2.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.35	<0.2	<0.2
Silver (Ag)	mg/kg	40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1
Sodium (Na)	mg/kg	-	110	<100	100	<100	<100	<100	<100	280	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)	mg/kg	-	8.13	7.26	7.34	73.4	11.7	84.5	12.3	20.9	4.13	5.20	5.75	6.12	6.11	7.34	7.18
Thallium (Tl)	mg/kg	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.099	0.050	0.062	0.069	0.070	<0.05	<0.05	0.054
Tin (Sn)	mg/kg	300	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	-	338	329	367	28.0	27.6	22.0	31.5	508	348	481	230	294	200	432	437
Uranium (U)	mg/kg	300	0.377	0.349	0.424	0.276	0.134	0.316	0.144	1.14	0.524	0.468	0.605	0.608	0.693	0.666	0.706
Vanadium (V)	mg/kg	130	20.8	22.8	24.5	3.36	1.79	3.61	2.04	30.3	23.8	33.5	21.2	23.3	14.3	30.6	34.1
Zinc (Zn)	mg/kg	360	14.4	16.1	23.8	3.2	1.3	2.7	1.6	31.8	22.8	27.2	32.0	36.1	19.7	33.3	54.3

Notes

Shaded cells indicate concentrations greater than CCME guideline levels.

b) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

Appendix 7-1. Metal Levels in Soil Samples Collected in 2012, Back River Project

Location			Reference														
Sample ID		CCME	SW1	SW2	SW3	SW-3-X	NE1	NE2	NE3	NE4	SE1	SE2	SE3	SE-3-X	LBS-1	LBS-2	LBS-3
Depth		Industrial	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm	5cm
Matrix	Units	Guideline	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests																	
pH (1:2 soil:water)	pH	6 to 8	5.32	5.54	5.51	5.64	4.85	6.20	5.35	5.71	4.73	5.19	5.77	5.83	4.64	5.68	4.92
Metals																	
Aluminum (Al)	mg/kg	-	11100	9500	7970	7500	1750	5100	2730	5050	7470	12300	9790	9440	13400	3790	5080
Antimony (Sb)	mg/kg	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	mg/kg	12	14.3	12.0	6.13	5.67	0.588	0.721	1.35	1.07	9.30	20.4	22.9	22.8	0.939	0.753	0.462
Barium (Ba)	mg/kg	2,000	57.0	20.0	28.2	26.3	15.0	28.0	13.0	16.3	34.9	13.2	20.9	19.2	143	26.9	25.4
Beryllium (Be)	mg/kg	8	0.32	0.28	0.26	0.26	<0.2	<0.2	<0.2	<0.2	<0.2	0.25	0.26	0.25	<0.2	<0.2	<0.2
Bismuth (Bi)	mg/kg	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	22	0.080	0.051	<0.05	<0.05	<0.05	<0.05	<0.05	0.054	0.079	0.056	0.053	0.053	0.065	<0.05	<0.05
Calcium (Ca)	mg/kg	-	2130	1840	1830	1700	388	1160	585	1450	504	1410	1580	1480	2780	1630	933
Chromium (Cr)	mg/kg	87	42.2	31.7	26.7	24.3	8.03	13.5	7.94	14.6	24.4	31.5	31.4	30.0	17.5	13.8	10.6
Cobalt (Co)	mg/kg	300	11.4	6.98	5.68	5.16	0.76	3.92	1.58	4.07	3.28	7.43	9.28	8.99	7.65	2.71	2.78
Copper (Cu)	mg/kg	91	36.4	21.9	19.6	17.9	1.58	5.70	2.17	16.0	5.31	23.7	25.3	24.7	1.58	6.52	5.08
Iron (Fe)	mg/kg	-	17300	16200	14000	12900	5580	9910	7060	12300	14100	18400	18400	18100	19400	8410	7630
Lead (Pb)	mg/kg	600	6.55	8.00	4.23	4.07	1.72	2.54	1.58	2.17	2.93	4.77	3.96	3.96	2.29	2.30	2.15
Lithium (Li)	mg/kg	-	23.0	23.4	20.1	19.0	<5	10.4	<5	8.2	10.0	20.2	20.9	20.3	23.0	7.4	11.2
Magnesium (Mg)	mg/kg	-	7530	5820	4950	4480	557	3820	1060	3430	3380	4620	5870	5730	10500	2030	3460
Manganese (Mn)	mg/kg	-	146	141	125	116	27.0	105	36.9	72.9	74.9	111	133	130	192	61.2	69.2
Mercury (Hg)	mg/kg	50	0.0088	0.0126	<0.005	<0.005	0.0168	0.0099	0.0278	0.0173	0.0689	0.0276	0.0103	0.0101	0.0136	<0.005	<0.005
Molybdenum (Mo)	mg/kg	40	0.90	0.57	0.57	0.56	<0.5	<0.5	<0.5	<0.5	<0.5	0.68	0.54	0.54	<0.5	<0.5	<0.5
Nickel (Ni)	mg/kg	50	38.1	24.7	16.6	14.7	1.60	8.72	3.23	6.98	11.7	26.6	27.6	27.2	17.5	5.58	7.10
Phosphorus (P)	mg/kg	-	714	579	525	456	170	268	222	418	414	442	424	384	973	464	266
Potassium (K)	mg/kg	-	1640	570	950	920	390	640	350	390	410	260	450	390	4050	670	370
Selenium (Se)	mg/kg	2.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.28	<0.2	<0.2	<0.2	<0.2	<0.2
Silver (Ag)	mg/kg	40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (Na)	mg/kg	-	150	<100	120	100	<100	<100	<100	<100	<100	<100	<100	<100	130	<100	<100
Strontium (Sr)	mg/kg	-	8.39	7.29	6.89	6.99	8.79	7.54	36.0	12.0	7.11	8.93	8.71	8.97	15.1	7.11	6.38
Thallium (Tl)	mg/kg	1	0.142	0.058	0.074	0.068	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.052	<0.05	0.110	<0.05	<0.05
Tin (Sn)	mg/kg	300	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	-	614	382	446	405	203	349	145	357	284	410	420	432	1480	374	435
Uranium (U)	mg/kg	300	1.10	0.838	0.773	0.797	0.355	0.221	0.254	0.341	0.444	0.601	0.568	0.574	0.288	0.343	0.264
Vanadium (V)	mg/kg	130	37.5	27.5	26.4	24.3	17.1	22.3	16.9	39.0	27.0	31.4	33.1	32.4	51.8	20.8	17.5
Zinc (Zn)	mg/kg	360	42.6	30.1	24.3	22.3	5.0	19.5	6.2	12.2	19.1	23.6	26.9	25.9	49.5	11.9	17.1

Notes

Shaded cells indicate concentrations greater than CCME guideline levels.

b) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

Appendix 7-1. Metal Levels in Soil Samples Collected in 2012, Back River Project

Location			Reference									George Property			
Sample ID		CCME	LBS-4	LBS-5	LBS-6	LBS-7	LBS-8	LBS-9	094-60	099-60	100-60	LBS-10	LBS-11	LBS-12	LBS-13
Depth		Industrial	5cm	5cm	5cm	5cm	5cm	5cm	60	60	60	5cm	5cm	5cm	5cm
Matrix	Units	Guideline	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests															
pH (1:2 soil:water)	pH	6 to 8	5.12	5.44	4.94	5.68	5.42	5.15	6.14	6.83	6.38	6.50	6.40	4.48	5.28
Metals															
Aluminum (Al)	mg/kg	-	5720	4860	3580	9070	4970	6290	7620	8420	10900	10100	31800	7590	8980
Antimony (Sb)	mg/kg	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.52	<0.1	0.14
Arsenic (As)	mg/kg	12	2.88	6.31	2.04	6.55	6.42	9.51	5.51	16.2	16.3	14.4	55.4	10.7	33.0
Barium (Ba)	mg/kg	2,000	26.7	13.9	15.0	22.4	11.7	14.1	24.5	18.2	24.8	18.8	149	15.5	13.1
Beryllium (Be)	mg/kg	8	<0.2	<0.2	0.22	<0.2	<0.2	<0.2	<0.2	<0.2	0.20	0.24	2.32	0.21	<0.2
Bismuth (Bi)	mg/kg	-	0.22	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.21	<0.2	0.75	<0.2	<0.2
Cadmium (Cd)	mg/kg	22	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.059	<0.05	0.112	<0.05	0.053
Calcium (Ca)	mg/kg	-	878	776	568	1760	806	1070	1230	1670	1560	1990	4070	630	1130
Chromium (Cr)	mg/kg	87	22.7	13.8	8.51	32.6	16.0	18.7	28.8	32.5	44.7	33.7	44.2	18.6	34.2
Cobalt (Co)	mg/kg	300	2.77	3.05	2.71	4.66	3.47	4.28	7.56	9.85	18.9	8.91	22.4	5.83	9.43
Copper (Cu)	mg/kg	91	15.7	7.49	3.54	12.3	9.45	12.1	17.2	26.9	41.0	12.0	86.7	13.3	16.1
Iron (Fe)	mg/kg	-	7950	8250	7920	12800	8800	10000	13000	17200	22800	18900	36300	14100	15900
Lead (Pb)	mg/kg	600	2.35	1.70	1.13	3.02	2.05	2.40	2.85	3.74	4.94	3.36	7.18	3.99	4.45
Lithium (Li)	mg/kg	-	9.4	8.0	5.7	18.0	9.9	11.0	14.6	18.0	23.4	20.7	39.4	13.9	21.2
Magnesium (Mg)	mg/kg	-	3140	2550	1840	5300	2730	3240	4960	5630	7540	6730	14300	4990	6100
Manganese (Mn)	mg/kg	-	67.9	80.4	56.7	121	69.7	88.5	133	170	312	280	696	130	156
Mercury (Hg)	mg/kg	50	<0.005	<0.005	0.0211	0.0109	<0.005	0.0214	<0.005	0.0080	0.0054	0.0182	0.0553	0.0200	0.0059
Molybdenum (Mo)	mg/kg	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.58	0.89	<0.5	0.70	<0.5	<0.5
Nickel (Ni)	mg/kg	50	10.3	8.57	6.35	17.3	10.5	12.2	22.2	26.0	45.3	20.2	47.5	14.7	23.8
Phosphorus (P)	mg/kg	-	351	314	205	448	305	372	322	435	460	259	724	254	340
Potassium (K)	mg/kg	-	930	250	320	520	260	280	880	470	770	380	5290	420	370
Selenium (Se)	mg/kg	2.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.29	<0.2	<0.2
Silver (Ag)	mg/kg	40	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (Na)	mg/kg	-	<100	<100	<100	<100	<100	<100	<100	<100	100	<100	<100	<100	<100
Strontium (Sr)	mg/kg	-	2.91	3.64	2.51	7.39	4.70	5.49	4.78	6.72	7.70	7.76	17.2	3.59	4.27
Thallium (Tl)	mg/kg	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.055	0.067	0.076	<0.05	0.231	<0.05	<0.05
Tin (Sn)	mg/kg	300	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	-	260	215	202	398	217	236	329	289	307	221	72.5	182	337
Uranium (U)	mg/kg	300	0.502	0.558	0.489	0.652	0.401	0.452	0.515	0.782	0.796	0.652	3.06	0.512	0.446
Vanadium (V)	mg/kg	130	16.8	11.4	12.3	21.7	12.3	14.6	22.3	24.1	30.5	22.2	38.2	18.7	23.2
Zinc (Zn)	mg/kg	360	13.5	12.1	7.3	24.3	13.3	16.9	23.4	32.4	46.1	33.8	72.7	21.9	29.1

Notes

Shaded cells indicate concentrations greater than CCME guideline levels.

b) CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.

Appendix 7-2. Lichen Tissue Metal Analysis Results for *Cladina stygia* and *Stereocaulon paschale* Samples Collected in 2012 Back River Project

Species			*Cladina stygia*									
Location			Goose property									
Sample ID			GB45 CLADINA STYGIA	104 CLADINA STYGIA	GB52 CLADINA STYGIA	101 CLADINA STYGIA	054 CLADINA STYGIA	064 CLADINA STYGIA	108 CLADINA STYGIA	422 CLADINA STYGIA	PLOT 080 CLADINA STYGIA	844 CLADINA STYGIA
Date Sampled			27-JUL-12	11-JUL-12	27-JUL-12	10-JUL-12	04-JUL-12	06-JUL-12	11-JUL-12	27-JUL-12	08-JUL-12	27-JUL-12
ALS Sample ID		Detection	L1204737-3	L1204737-7	L1204737-8	L1204737-17	L1204737-18	L1204737-21	L1204737-22	L1204737-1	L1204737-5	L1204737-26
Matrix	units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests												
% Moisture	%	0.10	-	7.55	9.44	9.76	-	9.17	6.50	7.15	8.91	7.24
Metals												
Aluminum (Al)-Total	mg/kg	10	276	190	591	144	249	695	178	1440	159	800
Antimony (Sb)-Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.025	0.025	0.025
Arsenic (As)-Total	mg/kg	0.050	0.236	0.228	0.916	0.198	0.216	0.914	0.289	0.658	0.222	0.446
Barium (Ba)-Total	mg/kg	0.050	13.5	15.0	30.3	23.5	19.1	22.5	14.2	23.2	31.9	16.5
Beryllium (Be)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.15	0.15	0.15
Bismuth (Bi)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.15	0.15	0.15
Cadmium (Cd)-Total	mg/kg	0.030	0.062	<0.03	0.081	0.036	0.041	0.075	0.040	0.063	0.043	0.057
Calcium (Ca)-Total	mg/kg	10	2590	1250	1440	1540	1100	1740	961	996	2130	1000
Chromium (Cr)-Total	mg/kg	0.50	0.54	<0.5	1.27	<0.5	<0.5	0.87	<0.5	0.89	0.25	1.09
Cobalt (Co)-Total	mg/kg	0.10	1.30	1.19	0.56	0.40	1.24	3.78	1.05	2.07	1.16	1.45
Copper (Cu)-Total	mg/kg	0.050	3.83	1.90	3.17	2.06	2.54	6.52	1.51	4.81	2.39	3.96
Iron (Fe)-Total	mg/kg	1.0	343	286	800	152	250	756	257	1100	223	878
Lead (Pb)-Total	mg/kg	0.10	0.78	0.19	0.84	0.38	0.80	1.02	0.49	2.97	0.47	2.00
Lithium (Li)-Total	mg/kg	0.50	<0.5	<0.5	0.53	<0.5	<0.5	<0.5	<0.5	0.25	0.25	0.52
Magnesium (Mg)-Total	mg/kg	3.0	655	550	642	590	292	579	377	363	504	409
Manganese (Mn)-Total	mg/kg	0.050	25.5	64.9	72.6	63.6	54.6	54.8	114	48.6	49.9	48.9
Mercury (Hg)-Total	mg/kg	0.0050	0.0348	0.0243	0.0431	0.0320	0.106	0.0610	0.0648	0.0817	0.0469	0.0954
Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.056	0.096	0.025
Nickel (Ni)-Total	mg/kg	0.50	4.40	1.25	2.42	1.57	5.93	6.34	1.25	5.54	2.06	5.91
Phosphorus (P)-Total	mg/kg	20	324	261	730	456	337	353	396	354	427	358
Potassium (K)-Total	mg/kg	100	1010	760	1400	1210	970	1080	1280	770	1000	950
Selenium (Se)-Total	mg/kg	1.0	<1	<1	<1	<1	<1	<1	<1	0.5	0.5	0.5
Silver (Ag)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.015	0.058	0.015
Sodium (Na)-Total	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	50	50	50
Strontium (Sr)-Total	mg/kg	0.050	6.93	5.07	7.26	4.18	4.73	6.66	3.68	6.20	9.06	4.80
Thallium (Tl)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.015	0.015	0.015
Tin (Sn)-Total	mg/kg	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.1	0.1	0.1
Titanium (Ti)-Total	mg/kg	0.50	14.6	4.14	36.1	5.80	8.94	15.3	11.8	21.7	6.37	26.1
Uranium (U)-Total	mg/kg	0.010	0.029	0.017	0.032	0.018	0.032	0.069	0.015	0.073	0.005	0.067
Vanadium (V)-Total	mg/kg	0.50	<0.5	<0.5	1.82	<0.5	<0.5	0.88	0.56	1.05	0.25	1.12
Zinc (Zn)-Total	mg/kg	0.50	13.2	8.73	39.5	18.6	20.7	18.6	20.0	21.0	24.3	18.5

Appendix 7-2. Lichen Tissue Metal Analysis Results for *Cladina stygia* and *Stereocaulon paschale* Samples Collected in 2012 Back River Project

Species			*Cladina stygia*								
Location			Goose property	George property					Marine laydown	Reference	
Sample ID			GB44 CLADINA STYGIA	LBS 26 CLADINA STYGIA	LBS 10 CLADINA STYGIA	LBS 11 CLADINA STYGIA	LBS 12 CLADINA STYGIA	LBS 13 CLADINA STYGIA	2012-093 CLADINA STYGIA	REF NW2 CLADINA STYGIA	REF NE3 CLADINA STYGIA
Date Sampled			27-JUL-12	03-AUG-12	03-AUG-12	03-AUG-12	03-AUG-12	03-AUG-12	09-JUL-12	04-JUL-12	15-JUL-12
ALS Sample ID		Detection	L1204737-32	L1204737-49	L1204737-45	L1204737-46	L1204737-47	L1204737-48	L1204737-27	L1204737-2	L1204737-4
Matrix	units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests											
% Moisture	%	0.10	7.34	7.36	6.67	6.89	-	6.69	7.27	8.82	9.72
Metals											
Aluminum (Al)-Total	mg/kg	10	183	178	537	796	137	172	205	874	231
Antimony (Sb)-Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.050	0.405	0.285	0.445	0.423	0.183	0.296	0.085	0.434	0.138
Barium (Ba)-Total	mg/kg	0.050	9.84	6.36	7.12	9.21	15.2	7.19	18.6	14.9	15.3
Beryllium (Be)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.030	0.035	0.039	0.056	0.053	0.037	0.055	<0.03	0.080	0.031
Calcium (Ca)-Total	mg/kg	10	949	894	1620	577	1070	894	1290	585	893
Chromium (Cr)-Total	mg/kg	0.50	<0.5	<0.5	0.84	0.96	<0.5	<0.5	<0.5	0.54	<0.5
Cobalt (Co)-Total	mg/kg	0.10	0.99	0.46	0.73	0.29	0.15	0.74	0.16	2.16	<0.1
Copper (Cu)-Total	mg/kg	0.050	1.95	1.79	1.96	1.17	1.24	2.28	1.35	3.83	0.960
Iron (Fe)-Total	mg/kg	1.0	355	187	654	738	135	191	221	356	195
Lead (Pb)-Total	mg/kg	0.10	0.20	0.54	1.13	2.40	0.26	0.46	0.41	1.39	0.47
Lithium (Li)-Total	mg/kg	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3.0	347	378	559	364	360	373	993	412	277
Manganese (Mn)-Total	mg/kg	0.050	80.7	39.4	33.2	34.4	89.2	39.6	67.7	15.7	73.1
Mercury (Hg)-Total	mg/kg	0.0050	0.0285	0.0369	0.167	0.0463	0.201	0.0273	0.0392	0.0385	0.0639
Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.077	<0.05	<0.05
Nickel (Ni)-Total	mg/kg	0.50	1.60	1.11	1.66	0.96	<0.5	1.68	<0.5	6.28	<0.5
Phosphorus (P)-Total	mg/kg	20	359	489	245	249	445	469	512	393	522
Potassium (K)-Total	mg/kg	100	900	1300	780	770	1180	1180	1490	1340	1100
Selenium (Se)-Total	mg/kg	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	100	<100	<100	<100	<100	<100	<100	160	<100	<100
Strontium (Sr)-Total	mg/kg	0.050	3.32	2.93	4.59	2.29	2.60	2.48	13.0	5.78	3.53
Thallium (Tl)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Titanium (Ti)-Total	mg/kg	0.50	3.67	6.45	18.9	20.5	5.56	6.22	10.5	10.1	9.99
Uranium (U)-Total	mg/kg	0.010	0.025	0.020	0.043	0.059	<0.01	0.011	0.021	0.022	0.030
Vanadium (V)-Total	mg/kg	0.50	<0.5	<0.5	0.87	1.25	<0.5	<0.5	<0.5	0.60	<0.5
Zinc (Zn)-Total	mg/kg	0.50	14.5	15.9	12.9	11.6	16.1	18.1	14.8	24.8	15.0

Appendix 7-2. Lichen Tissue Metal Analysis Results for *Cladina stygia* and *Stereocaulon paschale* Samples Collected in 2012 Back River Project

Species			*Cladina stygia*								
Location			Reference								
Sample ID			GB-50 CLADINA STYGIA	PLOT 206 CLADINA STYGIA	REF SW1-B CLADINA STYGIA	REF NE1 CLADINA STYGIA	REF-NE-3B CLADINA STYGIA	REF NW 4 CLADINA STYGIA	REF-SE-1 CLADINA STYGIA	BEARPOST (13 W 7301041/432856) CLADINA STYGIA	REF-SE-3 CLADINA STYGIA
Date Sampled			27-JUL-12	14-JUL-12	12-JUL-12	14-JUL-12	15-JUL-12	04-JUL-12	14-JUL-12	27-JUL-12	14-JUL-12
ALS Sample ID		Detection	L1204737-25	L1204737-20	L1204737-6	L1204737-10	L1204737-11	L1204737-12	L1204737-13	L1204737-14	L1204737-15
Matrix	units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests											
% Moisture	%	0.10	6.53	6.56	5.91	9.51	8.58	-	6.41	9.99	6.66
Metals											
Aluminum (Al)-Total	mg/kg	10	165	129	456	277	618	829	241	201	1310
Antimony (Sb)-Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.050	0.290	0.404	0.335	0.107	0.335	0.395	0.224	0.113	0.817
Barium (Ba)-Total	mg/kg	0.050	18.2	8.82	24.0	22.7	13.5	14.3	4.88	9.62	20.2
Beryllium (Be)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.030	0.032	<0.03	0.071	0.044	0.054	0.073	0.050	<0.03	0.085
Calcium (Ca)-Total	mg/kg	10	843	1060	1320	975	711	606	627	914	893
Chromium (Cr)-Total	mg/kg	0.50	<0.5	<0.5	0.80	<0.5	0.73	0.54	<0.5	<0.5	2.62
Cobalt (Co)-Total	mg/kg	0.10	0.14	0.99	1.60	0.18	0.24	2.15	0.66	0.15	1.41
Copper (Cu)-Total	mg/kg	0.050	1.29	1.84	3.52	1.55	1.43	3.65	1.50	1.14	5.02
Iron (Fe)-Total	mg/kg	1.0	172	148	562	339	546	436	222	257	1760
Lead (Pb)-Total	mg/kg	0.10	0.17	0.29	1.78	0.62	1.47	1.48	0.96	0.13	3.54
Lithium (Li)-Total	mg/kg	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.27
Magnesium (Mg)-Total	mg/kg	3.0	519	423	619	471	230	356	255	506	656
Manganese (Mn)-Total	mg/kg	0.050	50.4	74.1	101	73.5	48.6	13.4	23.7	98.4	41.2
Mercury (Hg)-Total	mg/kg	0.0050	0.0262	0.0252	0.0831	0.0568	0.150	0.0389	0.0611	0.0292	0.210
Total	mg/kg	0.050	<0.05	<0.05	0.074	<0.05	<0.05	<0.05	<0.05	<0.05	0.078
Nickel (Ni)-Total	mg/kg	0.50	0.77	1.16	6.05	0.68	0.57	6.36	2.86	<0.5	6.41
Phosphorus (P)-Total	mg/kg	20	620	393	447	549	354	362	254	588	295
Potassium (K)-Total	mg/kg	100	1360	1030	850	1450	890	1240	870	1380	820
Selenium (Se)-Total	mg/kg	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	mg/kg	0.050	4.96	4.97	4.85	3.38	5.23	6.15	2.90	2.65	5.02
Thallium (Tl)-Total	mg/kg	0.030	<0.03	<0.03	0.049	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Titanium (Ti)-Total	mg/kg	0.50	8.27	2.80	15.0	21.1	27.1	13.1	9.43	12.5	38.6
Uranium (U)-Total	mg/kg	0.010	0.011	0.014	0.041	0.019	0.059	0.023	0.014	0.011	0.084
Vanadium (V)-Total	mg/kg	0.50	<0.5	0.69	0.76	0.78	1.15	0.59	<0.5	0.53	2.24
Zinc (Zn)-Total	mg/kg	0.50	21.0	15.5	30.9	20.8	13.0	20.2	13.8	19.2	14.1

Appendix 7-2. Lichen Tissue Metal Analysis Results for *Cladina stygia* and *Stereocaulon paschale* Samples Collected in 2012 Back River Project

Species			*Cladina stygia*									
Location			Reference									
Sample ID			REF-SE-2 CLADINA STYGIA	REF-NW3 CLADINA STYGIA	REF-NW6 CLADINA STYGIA	REFSW3 CLADINA STYGIA	REF-SW2 CLADINA STYGIA	REF-NW1 CLADINA STYGIA	542 CLADINA STYGIA	LBS 1 CLADINA STYGIA	LBS 2 CLADINA STYGIA	LBS 3 CLADINA STYGIA
Date Sampled			14-JUL-12	04-JUL-12	04-JUL-12	12-JUL-12	12-JUL-12	04-JUL-12	27-JUL-12	02-AUG-12	02-AUG-12	02-AUG-12
ALS Sample ID		Detection	L1204737-28	L1204737-29	L1204737-30	L1204737-31	L1204737-33	L1204737-34	L1204737-9	L1204737-36	L1204737-37	L1204737-38
Matrix	units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests												
% Moisture	%	0.10	6.91	7.45	6.91	6.50	8.03	-	9.86	6.58	6.68	7.26
Metals												
Aluminum (Al)-Total	mg/kg	10	1220	3450	258	384	461	1410	792	376	224	88
Antimony (Sb)-Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.050	1.83	2.09	0.230	0.251	0.423	0.502	0.137	0.090	0.086	0.076
Barium (Ba)-Total	mg/kg	0.050	28.5	30.7	5.70	15.2	16.0	9.22	17.3	19.2	15.1	23.8
Beryllium (Be)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.030	0.087	0.128	0.054	0.045	0.143	0.236	0.067	0.062	<0.03	0.047
Calcium (Ca)-Total	mg/kg	10	1350	1690	850	851	750	3970	1230	1310	1130	1290
Chromium (Cr)-Total	mg/kg	0.50	2.20	7.33	<0.5	0.78	0.66	1.42	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.10	4.02	6.09	1.07	0.28	1.80	9.80	10.2	0.89	0.34	0.90
Copper (Cu)-Total	mg/kg	0.050	11.2	21.3	1.80	1.58	4.04	31.5	8.65	2.91	1.20	1.31
Iron (Fe)-Total	mg/kg	1.0	1440	5150	259	456	514	1000	330	401	276	213
Lead (Pb)-Total	mg/kg	0.10	2.21	6.78	1.27	1.21	1.86	4.76	0.83	1.16	0.42	0.24
Lithium (Li)-Total	mg/kg	0.50	0.93	3.27	<0.5	<0.5	<0.5	0.68	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3.0	658	1300	254	321	274	587	249	550	351	542
Manganese (Mn)-Total	mg/kg	0.050	46.3	47.7	27.5	52.8	30.5	28.8	44.6	42.3	47.2	240
Mercury (Hg)-Total	mg/kg	0.0050	0.119	0.119	0.0620	0.0411	0.117	0.0777	0.0300	0.0565	0.0402	0.0350
Total	mg/kg	0.050	0.076	0.196	<0.05	<0.05	<0.05	0.063	<0.05	<0.05	<0.05	<0.05
Nickel (Ni)-Total	mg/kg	0.50	17.3	31.6	4.51	1.39	7.34	43.2	39.6	2.28	0.70	0.59
Phosphorus (P)-Total	mg/kg	20	551	363	222	342	173	384	398	522	483	260
Potassium (K)-Total	mg/kg	100	1350	840	710	990	530	1240	930	1290	1220	940
Selenium (Se)-Total	mg/kg	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	mg/kg	0.050	5.78	8.47	3.77	4.46	3.60	9.28	10.4	5.84	6.01	6.18
Thallium (Tl)-Total	mg/kg	0.030	0.041	0.073	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Titanium (Ti)-Total	mg/kg	0.50	29.2	156	10.9	21.5	15.6	19.7	6.80	17.0	5.33	3.97
Uranium (U)-Total	mg/kg	0.010	0.146	0.443	0.020	0.031	0.027	0.159	0.108	0.146	0.012	<0.01
Vanadium (V)-Total	mg/kg	0.50	1.75	6.10	0.52	0.84	0.89	1.20	<0.5	0.85	0.61	<0.5
Zinc (Zn)-Total	mg/kg	0.50	23.6	19.6	18.2	17.1	21.2	48.5	23.3	40.2	21.3	35.5

Appendix 7-2. Lichen Tissue Metal Analysis Results for *Cladina stygia* and *Stereocaulon paschale* Samples Collected in 2012 Back River Project

Species			*Cladina stygia*						*Stereocaulon paschale*	
Location			Reference						Reference	Goose property
Sample ID			LBS 4 CLADINA STYGIA	LBS 5 CLADINA STYGIA	LBS 6 CLADINA STYGIA	LBS 7 CLADINA STYGIA	LBS 8 CLADINA STYGIA	LBS 9 CLADINA STYGIA	941 S. PASCHALE	1083 S.Paschale
Date Sampled			02-AUG-12	02-AUG-12	02-AUG-12	02-AUG-12	03-AUG-12	03-AUG-12	10-JUL-12	11-JUL-12
ALS Sample ID		Detection	L1204737-39	L1204737-40	L1204737-41	L1204737-42	L1204737-43	L1204737-44	L1204737-19	L1204737-35
Matrix	units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	%	0.10	6.48	6.72	7.21	6.12	6.28	6.91	6.54	7.92
Metals										
Aluminum (Al)-Total	mg/kg	10	669	207	373	604	308	188	333	129
Antimony (Sb)-Total	mg/kg	0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.050	0.310	0.129	0.130	0.555	0.277	0.146	0.307	0.200
Barium (Ba)-Total	mg/kg	0.050	12.9	5.10	9.23	19.3	13.0	9.50	12.9	16.3
Beryllium (Be)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.30	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.030	0.066	0.054	0.057	0.048	0.039	0.039	0.044	0.078
Calcium (Ca)-Total	mg/kg	10	864	601	649	782	933	593	1270	1470
Chromium (Cr)-Total	mg/kg	0.50	1.03	<0.5	<0.5	1.17	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.10	2.43	<0.1	0.28	0.41	0.66	<0.1	2.36	0.58
Copper (Cu)-Total	mg/kg	0.050	7.16	0.904	1.04	1.63	1.57	0.849	3.58	2.13
Iron (Fe)-Total	mg/kg	1.0	975	168	487	708	297	140	299	144
Lead (Pb)-Total	mg/kg	0.10	0.92	1.02	0.94	1.53	0.88	0.83	0.31	0.33
Lithium (Li)-Total	mg/kg	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3.0	371	259	325	368	317	162	513	456
Manganese (Mn)-Total	mg/kg	0.050	45.2	24.0	13.2	59.6	125	44.9	33.0	107
Mercury (Hg)-Total	mg/kg	0.0050	0.0628	0.0557	0.0738	0.107	0.0792	0.103	0.0238	0.0315
Total	mg/kg	0.050	0.056	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel (Ni)-Total	mg/kg	0.50	11.9	<0.5	0.77	1.30	1.34	<0.5	4.37	2.15
Phosphorus (P)-Total	mg/kg	20	349	369	198	343	136	264	356	365
Potassium (K)-Total	mg/kg	100	1150	1000	870	1080	1210	840	1130	1010
Selenium (Se)-Total	mg/kg	1.0	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)-Total	mg/kg	0.050	4.01	1.74	1.65	2.62	3.29	1.69	7.09	5.49
Thallium (Tl)-Total	mg/kg	0.030	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Titanium (Ti)-Total	mg/kg	0.50	18.9	7.27	8.05	25.9	10.6	6.35	4.46	5.05
Uranium (U)-Total	mg/kg	0.010	0.078	0.013	0.048	0.059	0.027	0.011	0.036	0.013
Vanadium (V)-Total	mg/kg	0.50	1.03	<0.5	<0.5	1.13	0.54	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.50	21.8	7.65	10.7	13.0	14.3	10.9	13.3	16.0

Appendix 7-3. Plant Tissue Metal Analysis Results for *Vaccinium Uliginosum* Berry Samples Collected in 2012, Back River Project

Location			Reference							
			LBS 1	**LBS 2**	**LBS 3**	**LBS 4**	**LBS 5**	**LBS 6**	**LBS 7**	**LBS 8**
Sample ID			**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**	**VACCINIUM ULIGINOSUM**
Date Sampled			**02-SEP-12**	**02-SEP-12**	**02-SEP-12**	**02-SEP-12**	**02-SEP-12**	**02-SEP-12**	**02-SEP-12**	**03-SEP-12**
Time Sampled			**00:00**	**00:00**	**00:00**	**00:00**	**00:00**	**00:00**	**00:00**	**00:00**
ALS Sample ID		**Detection**	**L1204735-1**	**L1204735-2**	**L1204735-3**	**L1204735-4**	**L1204735-5**	**L1204735-6**	**L1204735-7**	**L1204735-8**
Matrix	**Units**	**Limit**	**Tissue**	**Tissue**	**Tissue**	**Tissue**	**Tissue**	**Tissue**	**Tissue**	**Tissue**
Physical Tests										
% Moisture	%		82.0	83.1	82.9	81.5	78.6	79.6	81.8	82.4
Metals										
Aluminum (Al)-Total	mg/kg	10-20.	<10	13	12	11	28	<10	<10	14
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	0.025	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	19.7	18.2	25.7	14.5	17.9	12.5	14.8	26.6
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	0.099	0.102	0.068	0.098	0.113	0.079	0.153	0.148
Calcium (Ca)-Total	mg/kg	20-Oct	1610	1270	1630	1650	1280	903	1460	1550
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	<0.1	0.11	0.14	0.11	<0.1	<0.1	<0.1	<0.1
Copper (Cu)-Total	mg/kg	0.05-0.1	5.81	5.33	6.64	5.15	6.94	4.22	4.02	5.05
Iron (Fe)-Total	mg/kg	10	17	15	23	17	37	15	13	16
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.1	0.40	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	576	550	512	599	685	488	579	536
Manganese (Mn)-Total	mg/kg	0.05-0.1	17.2	44.2	190	36.7	37.1	61.8	79.0	137
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	0.062	0.130	<0.05	0.080	0.054	<0.05	0.132	0.115
Nickel (Ni)-Total	mg/kg	0.5-1	1.41	1.58	1.76	2.74	1.82	1.20	1.19	2.23
Phosphorus (P)-Total	mg/kg	200	1480	1420	1000	1400	1840	820	1150	1620
Potassium (K)-Total	mg/kg	1000	4600	5900	4500	6700	5500	6100	6300	5300
Selenium (Se)-Total	mg/kg	1-2.	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	5.73	3.22	3.14	5.40	3.13	1.11	3.79	5.25
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	1.47	1.44	1.91	1.55	1.48	2.04	1.13	0.84
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	24.6	28.3	78.4	18.6	20.4	12.3	17.2	16.5

Appendix 7-3. Plant Tissue Metal Analysis Results for *Vaccinium Uliginosum* Berry Samples Collected in 2012, Back River Project

Location			Reference						
Sample ID			LBS 9 VACCINIUM ULIGINOSUM	SW1 VACCINIUM ULIGINOSUM	542 VACCINIUM ULI	NE3 VACCINIUM ULIGINOSUM	GB100 VACCINIUM ULIGINOSUM (Duplicate for GB50)	PLOT 94 VACCINIUM ULIGINOSUM	BEARPOST VACCINIUM ULIGINOSUM (Duplicate for Bearpost)
Date Sampled			03-SEP-12	12-JUL-12	27-JUL-12	14-JUL-12	27-JUL-12	10-JUL-12	27-JUL-12
Time Sampled			00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID		Detection	L1204735-9	L1204735-15	L1204735-20	L1204735-22	L1204735-27	L1204735-31	L1204735-37
Matrix	Units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	%		80.9	85.4	85.1	85.1	83.3	84.9	85.5
Metals									
Aluminum (Al)-Total	mg/kg	10-20.	18	34	10	<10	20	<10	27
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	19.0	13.6	17.8	11.8	22.8	10.2	14.7
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.6	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.6	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	0.137	0.219	0.049	0.157	0.206	0.135	0.179
Calcium (Ca)-Total	mg/kg	20-Oct	1240	828	1150	962	1070	1180	935
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	<0.1	<0.2	0.34	<0.1	<0.1	0.20	<0.1
Copper (Cu)-Total	mg/kg	0.05-0.1	4.81	4.27	4.14	4.17	4.30	4.25	4.12
Iron (Fe)-Total	mg/kg	10	16	44	10	13	22	12	29
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	635	513	551	459	589	567	498
Manganese (Mn)-Total	mg/kg	0.05-0.1	25.3	33.2	242	67.4	54.5	145	25.2
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.0075	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	<0.05	<0.1	<0.05	<0.05	0.070	0.137	<0.05
Nickel (Ni)-Total	mg/kg	0.5-1	2.68	2.9	3.56	1.34	2.53	1.81	1.05
Phosphorus (P)-Total	mg/kg	200	1190	1150	1360	1350	1280	1210	890
Potassium (K)-Total	mg/kg	1000	4700	8000	6900	7600	8100	7900	7600
Selenium (Se)-Total	mg/kg	1-2.	<1	<2	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	10.8	3.02	2.63	1.92	6.81	1.93	3.05
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	1.24	0.87	1.77	0.57	0.66	1.62	0.84
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	19.0	11.5	10.8	14.7	11.1	14.9	10.9

Appendix 7-3. Plant Tissue Metal Analysis Results for *Vaccinium Uliginosum* Berry Samples Collected in 2012, Back River Project

Location			Reference		George property				
Sample ID			GB 50 VACCINIUM ULIGINOSUM	BEARPOST VACCINIUM ULIGINOSUM (DUPLICATE)	LBS 10 VACCINIUM ULIGINOSUM	LBS 11 VACCINIUM ULIGINOSUM	LBS 12 VACCINIUM ULIGINOSUM	LBS 13 VACCINIUM ULIGINOSUM	PLOT 225 VACCINIUM ULIGINOSUM
Date Sampled			27-JUL-12	27-JUL-12	03-SEP-12	03-SEP-12	03-SEP-12	03-SEP-12	27-JUL-12
Time Sampled			00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID		Detection	L1204735-36	L1204735-47	L1204735-10	L1204735-11	L1204735-12	L1204735-13	L1204735-48
Matrix	Units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	%		83.2	85.1	79.9	82.3	81.7	82.0	84.3
Metals									
Aluminum (Al)-Total	mg/kg	10-20.	13	261	<10	13	<10	15	78
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	0.053	<0.05	<0.05	<0.05	<0.05	0.184
Barium (Ba)-Total	mg/kg	0.05-0.10	18.1	16.5	14.5	9.30	18.2	13.5	16.0
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	0.198	0.204	0.127	0.198	0.057	0.198	0.197
Calcium (Ca)-Total	mg/kg	20-Oct	1050	1110	972	1500	1080	1390	1410
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	<0.1	0.15	<0.1	<0.1	<0.1	0.33	0.24
Copper (Cu)-Total	mg/kg	0.05-0.1	3.84	3.81	7.03	5.73	5.72	4.88	5.23
Iron (Fe)-Total	mg/kg	10	13	311	15	20	16	13	87
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	0.17	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	555	584	640	801	498	650	838
Manganese (Mn)-Total	mg/kg	0.05-0.1	49.3	29.2	99.6	101	81.0	71.7	89.4
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0086
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	0.073	<0.05	0.137	0.074	<0.05	0.057	0.124
Nickel (Ni)-Total	mg/kg	0.5-1	2.31	1.19	1.84	1.68	1.09	3.20	3.03
Phosphorus (P)-Total	mg/kg	200	1010	820	1100	1220	1700	1300	1600
Potassium (K)-Total	mg/kg	1000	7800	7300	6200	6800	8000	4900	6800
Selenium (Se)-Total	mg/kg	1-2.	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	6.72	3.70	1.66	2.27	1.39	4.93	4.37
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	1.15	0.32	0.98	0.96	0.83	1.86	1.37
Titanium (Ti)-Total	mg/kg	5	<5	7.6	<5	<5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	0.026	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	0.71	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	11.5	12.2	22.3	18.1	128	19.7	42.0

Appendix 7-3. Plant Tissue Metal Analysis Results for *Vaccinium Uliginosum* Berry Samples Collected in 2012, Back River Project

Location			George property						
Sample ID			234 VACCINIUM ULIGINOSUM	2166 VACCINIUM ULIGINOSUM (Duplicate for 108)	108 VACCINIUM ULIGINOSUM	GB44 VACCINIUM ULIGINOSUM	422 VACCINIUM ULIGINOSUM	GB 52 VACCINIUM ULIGINOSUM	ULIGINOSUM (Duplicate for GB 52)
Date Sampled			19-JUL-12	11-JUL-12	11-JUL-12	27-JUL-12	27-JUL-12	27-JUL-12	27-JUL-12
Time Sampled			00:00	00:00	00:00	00:00	00:00	00:00	00:00
ALS Sample ID		Detection	L1204735-29	L1204735-18	L1204735-26	L1204735-41	L1204735-32	L1204735-34	L1204735-38
Matrix	Units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests									
% Moisture	%		87.0	85.0	86.1	84.7	86.8	85.6	86.1
Metals									
Aluminum (Al)-Total	mg/kg	10-20.	30	10	11	<10	351	18	15
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	<0.05	0.060	<0.05	0.369	<0.05	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	18.8	16.0	17.1	9.76	40.3	17.6	17.6
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	0.139	0.178	0.202	0.067	0.214	0.150	0.151
Calcium (Ca)-Total	mg/kg	20-Oct	1420	1440	1270	989	1950	919	1080
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<0.5	<0.5	<0.5	0.97	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	0.13	0.23	0.22	0.15	0.39	0.12	0.12
Copper (Cu)-Total	mg/kg	0.05-0.1	4.29	6.07	5.64	4.01	4.29	3.32	3.02
Iron (Fe)-Total	mg/kg	10	32	14	12	12	571	19	17
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.1	<0.1	<0.1	0.14	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	0.77	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	551	654	703	491	920	581	568
Manganese (Mn)-Total	mg/kg	0.05-0.1	28.8	156	162	118	59.5	23.8	22.4
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	<0.05	0.132	0.092	0.180	0.069	<0.05	<0.05
Nickel (Ni)-Total	mg/kg	0.5-1	1.77	2.42	2.66	1.51	3.26	2.01	2.00
Phosphorus (P)-Total	mg/kg	200	950	1560	1280	1130	1470	970	850
Potassium (K)-Total	mg/kg	1000	7400	7600	7800	7200	6500	7100	7700
Selenium (Se)-Total	mg/kg	1-2.	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	2.63	2.38	2.18	1.33	11.1	3.89	4.17
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	2.48	0.75	0.45	0.84	0.78	1.22	1.57
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5	<5	14.9	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.01	<0.01	<0.01	0.075	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	1.24	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	157	56.9	17.1	17.8	15.3	8.26	27.8

Appendix 7-3. Plant Tissue Metal Analysis Results for *Vaccinium Uliginosum* Berry Samples Collected in 2012, Back River Project

Location			George property		Marine laydown
Sample ID			GB45 VACCINIUM ULIGINOSUM	033 VACCINIUM ULIGINOSUM	2012-093 VACCINIUM ULIGINOSUM
Date Sampled			25-JUL-12	17-JUL-12	25-JUL-12
Time Sampled			00:00	00:00	00:00
ALS Sample ID		Detection	L1204735-43	L1204735-45	L1204735-25
Matrix	Units	Limit	Tissue	Tissue	Tissue
Physical Tests					
% Moisture	%		83.3	85.6	86.0
Metals					
Aluminum (Al)-Total	mg/kg	10-20.	15	<10	15
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.1	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	<0.1	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	18.9	19.2	10.4
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.6	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.6	0.15
Cadmium (Cd)-Total	mg/kg	0.03-0.06	0.150	0.075	0.138
Calcium (Ca)-Total	mg/kg	20-Oct	1250	2310	1120
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<1	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	<0.1	<0.2	<0.1
Copper (Cu)-Total	mg/kg	0.05-0.1	4.14	7.41	3.57
Iron (Fe)-Total	mg/kg	10	13	<10	12
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.2	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<1	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	579	692	630
Manganese (Mn)-Total	mg/kg	0.05-0.1	45.5	85.4	112
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.0075	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	<0.05	0.23	0.066
Nickel (Ni)-Total	mg/kg	0.5-1	1.50	<1	0.93
Phosphorus (P)-Total	mg/kg	200	1190	<200	1150
Potassium (K)-Total	mg/kg	1000	7300	<1000	7700
Selenium (Se)-Total	mg/kg	1-2.	<1	<2	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.06	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	5.06	1.22	2.67
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.06	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	0.43	2.90	0.41
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.02	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<1	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	15.3	21.5	33.4

Appendix 7-4. Plant Tissue Metal Analysis Results for *Vaccinium vitis-idaea* Berry Samples Collected in 2012, Back River Project

Location			Reference							
Sample ID			SW1 VACCINIUM VITIS-IDAEA	BEARPOST VACCINIUM VITIS-IDAEA	542 VACCINIUM VITIS-IDAEA	NE3 VACCINIUM VITIS-IDAEA	BEARPOST VACCINIUM VITIS-IDAEA	GB 50 VACCINIUM VITIS-IDAEA	233 VACCINIUM VITIS-IDAEA	206 VACCINIUM VITIS-IDAEA
Date Sampled			12-JUL-12	27-JUL-12	27-JUL-12	14-JUL-12	27-JUL-12	27-JUL-12	18-JUL-12	14-JUL-12
ALS Sample ID		Detection	L1204735-14	L1204735-17	L1204735-19	L1204735-21	L1204735-30	L1204735-39	L1204735-44	L1204735-46
Matrix	Units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests										
% Moisture	%		59.1	48.3	70.6	50.1	48.0	68.2	72.2	68.7
Metals										
Aluminum (Al)-Total	mg/kg	10-20.	23	299	20	24	24	32	16	24
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	19.1	14.6	21.8	11.3	12.5	16.7	6.57	12.2
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Calcium (Ca)-Total	mg/kg	20-Oct	1130	925	1570	1160	912	1220	935	1070
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	0.81	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	<0.1	0.18	0.34	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Cu)-Total	mg/kg	0.05-0.1	3.30	2.35	3.71	3.51	2.28	3.21	3.37	2.75
Iron (Fe)-Total	mg/kg	10	15	439	<10	18	16	23	10	12
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	0.60	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	478	578	594	450	415	533	429	371
Manganese (Mn)-Total	mg/kg	0.05-0.1	80.7	78.8	212	130	86.7	55.1	192	61.4
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.178	0.105
Nickel (Ni)-Total	mg/kg	0.5-1	1.12	1.44	3.78	<0.5	1.11	1.35	0.76	1.31
Phosphorus (P)-Total	mg/kg	200	970	690	900	820	710	930	700	770
Potassium (K)-Total	mg/kg	1000	6700	5000	5700	4800	6100	5700	6500	4600
Selenium (Se)-Total	mg/kg	1-2.	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	4.90	2.72	5.17	2.04	2.41	6.55	1.42	3.08
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	0.52	<0.2	0.68	<0.2	<0.2	0.68	0.24	0.27
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	18.0	5.47	7.75	8.94	4.68	35.3	6.84	12.4

Appendix 7-4. Plant Tissue Metal Analysis Results for *Vaccinium vitis-idaea* Berry Samples Collected in 2012, Back River Project

Location			Goose property					Marine laydown
Sample ID			108 VACCINIUM VITIS-IDAEA	422 VACCINIUM VITIS-IDAEA	GB 52 VACCINIUM VITIS-IDAEA	GB 44 VACCINIUM VITIS-IDAEA	GB45 VACCINIUM VITIS-IDAEA	2012-093 VACCINIUM VITIS-IDAEA
Date Sampled			11-JUL-12	27-JUL-12	27-JUL-12	27-JUL-12	25-JUL-12	25-JUL-12
ALS Sample ID		Detection	L1204735-28	L1204735-33	L1204735-35	L1204735-40	L1204735-42	L1204735-24
Matrix	Units	Limit	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
Physical Tests								
% Moisture	%		69.1	58.4	50.2	62.5	75.1	71.4
Metals								
Aluminum (Al)-Total	mg/kg	10-20.	13	33	55	19	22	16
Antimony (Sb)-Total	mg/kg	0.05-0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic (As)-Total	mg/kg	0.05-0.10	<0.05	<0.05	0.076	<0.05	<0.05	<0.05
Barium (Ba)-Total	mg/kg	0.05-0.10	15.9	18.7	18.5	8.99	19.0	8.03
Beryllium (Be)-Total	mg/kg	0.3-0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bismuth (Bi)-Total	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Cadmium (Cd)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Calcium (Ca)-Total	mg/kg	20-Oct	1460	1190	1220	941	1230	1040
Chromium (Cr)-Total	mg/kg	0.5-1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (Co)-Total	mg/kg	0.1-0.2	0.14	0.11	<0.1	0.20	<0.1	<0.1
Copper (Cu)-Total	mg/kg	0.05-0.1	4.68	3.16	3.42	3.98	3.62	3.27
Iron (Fe)-Total	mg/kg	10	<10	26	63	11	15	11
Lead (Pb)-Total	mg/kg	0.1-0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium (Li)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium (Mg)-Total	mg/kg	3-6.	570	480	516	513	581	410
Manganese (Mn)-Total	mg/kg	0.05-0.1	157	85.8	109	330	56.6	100
Mercury (Hg)-Total	mg/kg	0.005-0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum (Mo)-Total	mg/kg	0.05-0.1	<0.05	<0.05	<0.05	0.064	<0.05	<0.05
Nickel (Ni)-Total	mg/kg	0.5-1	1.08	1.31	1.68	0.99	0.67	<0.5
Phosphorus (P)-Total	mg/kg	200	910	950	1030	920	980	660
Potassium (K)-Total	mg/kg	1000	6900	5200	6600	6700	6600	6200
Selenium (Se)-Total	mg/kg	1-2.	<1	<1	<1	<1	<1	<1
Silver (Ag)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Sodium (Na)-Total	mg/kg	1000	<1000	<1000	<1000	<1000	<1000	<1000
Strontium (Sr)-Total	mg/kg	0.05-0.10	2.25	4.25	3.25	1.49	2.93	2.06
Thallium (Tl)-Total	mg/kg	0.03-0.06	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Tin (Sn)-Total	mg/kg	0.2-0.4	0.43	<0.2	<0.2	0.93	0.59	<0.2
Titanium (Ti)-Total	mg/kg	5	<5	<5	<5	<5	<5	<5
Uranium (U)-Total	mg/kg	0.01-0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium (V)-Total	mg/kg	0.5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)-Total	mg/kg	0.5-1	27.5	6.21	8.39	20.2	8.83	8.16

Appendix 7-5. Plant Tissue Metal Analysis Results for *Carex aquatilis*. Samples Collected from Wetlands in 2012, Back River Project

Location			Goose property							
Sample ID			W026	W052	W067	W073	W075	W077	W051	W080
Date Sampled			09-JUL-12	12-JUL-12	13-JUL-12	14-JUL-12	15-JUL-12	15-JUL-12	15-JUL-12	16-JUL-12
ALS Sample ID		Detection	L1184194-1	L1184194-2	L1184194-3	L1184194-4	L1184194-5	L1184194-6	L1184194-7	L1184194-8
Matrix	Units	Limit	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Physical Tests										
Moisture	%		80.6	73.5	82.0	80.0	86.2	92.0	89.4	75.9
Organic / Inorganic Carbon										
CaCO3 Equivalent	%	0.8	9.97	4.02	1.60	1.59	1.69	1.57	2.62	<0.8
Inorganic Carbon	%	0.1	1.20	0.48	0.19	0.19	0.20	0.19	0.31	<0.1
Total Carbon by Combustion	%	0.1	19.9	27.8	39.7	43.1	38.1	38.5	27.7	19.3
Total Organic Carbon	%	0.1	18.7	27.3	39.5	42.9	37.9	38.3	27.4	19.3
Metals										
Aluminum (Al)	mg/kg	50	10600	5070	2140	2410	859	3970	797	2350
Antimony (Sb)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	mg/kg	0.05	23.1	2.05	1.73	1.50	1.65	37.7	18.7	5.39
Barium (Ba)	mg/kg	0.5	83.6	106	130	60.1	68.5	46.9	32.5	80.0
Beryllium (Be)	mg/kg	0.2	0.41	<0.2	<0.2	<0.2	<0.2	0.53	<0.2	0.23
Bismuth (Bi)	mg/kg	0.2	0.20	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	0.05	0.400	0.420	0.244	0.252	0.180	0.368	0.122	0.408
Calcium (Ca)	mg/kg	50	1790	3200	4560	2740	2060	5340	6460	4490
Chromium (Cr)	mg/kg	0.5	30.6	17.6	4.68	11.6	0.88	2.64	1.67	2.54
Cobalt (Co)	mg/kg	0.1	9.04	4.13	6.54	4.93	5.11	64.0	14.0	7.66
Copper (Cu)	mg/kg	0.5	63.0	41.9	26.7	37.0	12.6	72.5	9.77	28.5
Iron (Fe)	mg/kg	50	14000	8130	4460	5320	4670	10900	3980	3190
Lead (Pb)	mg/kg	0.5	8.10	1.44	0.94	0.98	0.78	4.42	2.19	0.91
Lithium (Li)	mg/kg	5	10.9	<5	<5	<5	<5	<5	<5	<5
Magnesium (Mg)	mg/kg	20	3420	1070	892	471	653	1670	1730	1010
Manganese (Mn)	mg/kg	1	57.8	25.9	12.1	8.1	15.3	281	25.9	7.8
Mercury (Hg)	mg/kg	0.005	0.113	0.0545	0.125	0.0557	0.0748	0.0977	0.114	0.119
Molybdenum (Mo)	mg/kg	0.5	1.73	0.66	<5	<5	0.53	0.64	<5	<5
Nickel (Ni)	mg/kg	0.5	38.9	27.9	17.1	21.3	10.4	145	28.7	75.8
Phosphorus (P)	mg/kg	50	913	398	1340	805	931	636	517	362
Potassium (K)	mg/kg	100	930	220	490	320	420	380	490	290
Selenium (Se)	mg/kg	0.2	0.52	0.67	0.28	0.57	<0.2	0.47	<0.2	0.21
Silver (Ag)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.27	<0.1	<0.1
Sodium (Na)	mg/kg	100	120	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)	mg/kg	0.5	26.3	15.2	27.7	11.0	17.9	32.9	32.0	32.9
Thallium (Tl)	mg/kg	0.05	0.168	<0.05	0.070	<0.05	<0.05	0.054	<0.05	<0.05
Tin (Sn)	mg/kg	2	<2	<2	<2	<2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	1	246	149	43.7	48.2	17.4	27.7	22.8	35.2
Uranium (U)	mg/kg	0.05	1.71	0.704	0.411	0.825	0.269	1.57	0.099	0.359
Vanadium (V)	mg/kg	0.2	54.6	27.5	6.14	17.4	1.63	3.30	1.82	2.89
Zinc (Zn)	mg/kg	1	30.5	39.8	8.7	5.3	21.6	30.6	27.4	15.3

Appendix 7-5. Plant Tissue Metal Analysis Results for *Carex aquatilis*. Samples Collected from Wetlands in 2012, Back River Project

Location			Goose property	George property		Reference
Sample ID			W083	W134	W135	W128
Date Sampled			16-JUL-12	23-JUL-12	24-JUL-12	22-JUL-12
ALS Sample ID		Detection	L1184194-9	L1184194-11	L1184194-12	L1184194-10
Matrix	Units	Limit	Soil	Soil	Soil	Soil
Physical Tests						
Moisture	%		71.8	82.8	75.4	82.3
Organic / Inorganic Carbon						
CaCO3 Equivalent	%	0.8	1.98	1.39	2.13	1.13
Inorganic Carbon	%	0.1	0.24	0.17	0.26	0.14
Total Carbon by Combustion	%	0.1	38.9	36.6	30.5	29.5
Total Organic Carbon	%	0.1	38.6	36.4	30.2	29.3
Metals						
Aluminum (Al)	mg/kg	50	6060	2170	7870	2790
Antimony (Sb)	mg/kg	0.1	<0.1	<0.1	0.27	<0.1
Arsenic (As)	mg/kg	0.05	8.65	4.19	15.3	7.44
Barium (Ba)	mg/kg	0.5	87.7	11.8	20.6	36.7
Beryllium (Be)	mg/kg	0.2	0.34	<0.2	0.57	<0.2
Bismuth (Bi)	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (Cd)	mg/kg	0.05	0.255	0.266	0.357	0.066
Calcium (Ca)	mg/kg	50	2420	4450	551	6280
Chromium (Cr)	mg/kg	0.5	18.6	6.24	13.2	8.97
Cobalt (Co)	mg/kg	0.1	7.32	6.47	3.63	5.64
Copper (Cu)	mg/kg	0.5	71.9	5.78	32.0	7.51
Iron (Fe)	mg/kg	50	11300	4070	12100	14900
Lead (Pb)	mg/kg	0.5	3.39	1.35	1.70	1.79
Lithium (Li)	mg/kg	5	<5	<5	5.9	<5
Magnesium (Mg)	mg/kg	20	1350	1300	2320	1680
Manganese (Mn)	mg/kg	1	25.2	17.9	26.4	33.5
Mercury (Hg)	mg/kg	0.005	0.0642	0.133	0.0573	0.0513
Molybdenum (Mo)	mg/kg	0.5	<5	0.96	0.75	<5
Nickel (Ni)	mg/kg	0.5	28.4	6.35	16.0	12.2
Phosphorus (P)	mg/kg	50	1080	407	696	582
Potassium (K)	mg/kg	100	300	410	420	260
Selenium (Se)	mg/kg	0.2	0.65	<0.2	0.45	<0.2
Silver (Ag)	mg/kg	0.1	0.15	<0.1	<0.1	<0.1
Sodium (Na)	mg/kg	100	<100	<100	<100	<100
Strontium (Sr)	mg/kg	0.5	11.5	18.1	3.00	28.8
Thallium (Tl)	mg/kg	0.05	<0.05	<0.05	<0.05	0.108
Tin (Sn)	mg/kg	2	<2	<2	<2	<2
Titanium (Ti)	mg/kg	1	215	102	52.3	72.9
Uranium (U)	mg/kg	0.05	3.78	0.121	1.22	0.333
Vanadium (V)	mg/kg	0.2	31.4	5.79	19.7	7.70
Zinc (Zn)	mg/kg	1	8.8	43.0	9.0	12.4

Appendix V5-5A

2013 Wildlife Habitat Suitability Report

Rescan™
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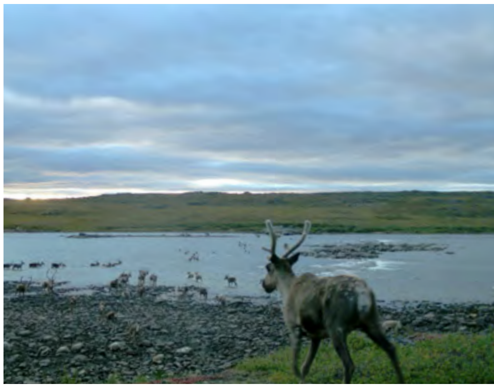
Sabina Gold & Silver Corp.

BACK RIVER PROJECT
2013 Wildlife Habitat Suitability Baseline

Sabina
GOLD & SILVER CORP.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November 2013

BACK RIVER PROJECT

2013 WILDLIFE HABITAT SUITABILITY BASELINE

November 2013
Project #0194096-0040

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan Environmental Services Ltd., an ERM company
Vancouver, British Columbia

Executive Summary

Executive Summary

This report presents the wildlife habitat suitability mapping study conducted for Sabina Gold & Silver Corporation (Sabina) for the Back River Project (the Project). Suitability mapping was completed at two levels, using a Local Study Area (LSA) and a Regional Study Area (RSA).

The goal of the wildlife habitat suitability modelling was to evaluate wildlife habitat in the LSA and RSA. The objectives were to inventory and rate the habitat types for select wildlife species (focal species), quantify suitable habitat available for these focal species, and identify key and important wildlife habitat and habitat features.

Mapping was completed for caribou (*Rangifer tarandus groenlandicus*) calving, post-calving and summer, and fall habitat; muskox (*Ovibos moschatus*) summer to fall and winter to spring habitat; grizzly bear (*Ursus arctos*) spring, summer, fall, and denning habitat; grey wolf (*Canis lupus*) denning habitat; wolverine (*Gulo gulo*) denning habitat; short-eared owl (*Asio flammeus*) nesting habitat, and peregrine falcon (*Falco peregrinus tundrius*) nesting habitat.

The area of mapped habitat within the LSA is approximately 134,369 ha; the RSA measured approximately 1,262,005 ha. Caribou, muskox, grizzly bear, and wolf habitat were rated using a 4-class rating system; wolverine, short-eared owl and peregrine falcon habitat were rated using a 2-class rating system.

Overall, over 75% of the LSA was rated as Highly to Moderately (HSR 1 and 2) suitable habitat for caribou during the calving, post-calving and summer, and fall seasons (75%, 85%, and 83% of the LSA, respectively). The amount of combined HSR 1 and HSR 2 habitat within the RSA varied from roughly half of the RSA during calving (52%) and the fall (49%) to over three-quarters (86%) during the post-calving and summer periods. It is important to note that despite the presence of suitable calving habitat in the LSA and RSA, caribou calving currently occurs northwest of the RSA and does not overlap with the LSA or RSA.

The results of the habitat suitability modelling for muskox reveal that approximately one-third of the LSA (35%) and RSA (38%) were rated as HSR 1 and HSR 2 habitat for muskox in the summer and fall. Similarly, roughly a one-third of the LSA (30%) and RSA (33%) were rated as Highly to Moderately suitable muskox winter and early spring habitat. During the snow-free months (summer and fall), higher rated habitats generally occurred in lower slope positions, such as riparian corridors and in wetland area where preferred forage is plentiful. Higher rated habitats in the winter and early spring were primarily located in higher elevation habitats, such as windswept tundra and ridges.

The LSA and RSA contained similar amounts of Highly to Moderately suitable spring, summer, and fall habitat for grizzly bears. HSR 1 and HSR 2 for grizzly bear in the any season totalled over half the LSA and ranged from 58% in the fall to 76% in the summer. Within the RSA, Highly to Moderately suitable habitats amounted to roughly half of the RSA, and ranged from 43% in the fall to 54% in the summer. Conversely, denning habitat was very limited in both the LSA and RSA, with less than 2% of both study areas rated as High and Moderately suitable denning habitat. These results suggest that the LSA and RSA contain a variety of suitable foraging habitats for grizzly bears during the snow free season. The very low quantity of higher rated denning habitat for grizzly bears was a result of the rarity of eskers and lacustrine deposits, habitats where bears may easily excavate den sites.

The results of the habitat suitability modelling for grey wolf denning habitat suggest that potential denning sites in eskers in both the LSA and RSA are scarce. High and Moderately suitable denning habitats covered less than 3% of the area within the LSA and RSA. However, this may underestimate the total denning potential of the study areas, as wolves may den in other areas, such as in sandy areas along lake banks (lacustrine materials). These areas could not be reliably differentiated from the open water portion of the lake within mapped areas and thus were not included in habitat suitability modelling.

Wolverine denning habitat was rated using a two class system (suitable and not suitable). Suitable wolverine denning habitat was widely distributed across the study areas, covering approximately half of the LSA (48%) and RSA (45%). These suitable habitats were primarily located in rocky habitats where may be a deep and persistent snowpack throughout the winter, thus providing wolverines with opportunities to create snow tunnels down to the ground that would remain stable for long periods of time.

Suitable short-eared owl nesting habitat was mapped across half of the LSA (52%); suitable nesting habitat in the RSA was more limited at around a one-third (32%) of the RSA. Suitable nesting habitat for short-eared owls consisted of lowland tundra with low to tall shrub cover, as short-eared owls are a ground-nesting raptor and select areas with shrub cover to conceal nest sites.

Overall, less than 10% of both the LSA and RSA was modelled as suitable peregrine falcon nesting habitat. The vast majority of this suitable habitat was identified through modelling previously identified nests locations surrounded by a 1 km nesting territory buffer; very little (< 3%) of either the LSA or RSA contained suitable cliff habitats for nesting that were modelled with a Digital Elevation Model (DEM).

Acknowledgements

Rescan™ an ERM company

Acknowledgements

This report was prepared for Sabina Gold & Silver Corporation (Sabina) by Rescan Environmental Services Ltd., an ERM company (Rescan). Fieldwork was conducted by Ryan Durand (B.Sc., Dipl. T., M.Sc. candidate, R.P.Bio.). The report was written by Ryan Durand, Julia Shewan (B.Sc.), Kate Fremlin (B.Sc., R.P.Bio.), Josh Traylor (M.Sc., Ph.D.), and Cole Kirkham (B.Sc.). Technical review was provided by Greg Sharam (M.Sc., Ph.D.), Andrea Buckman (Ph.D.), and Deborah Muggli (Ph.D., M.Sc., R.P.Bio.). GIS support was coordinated by Pieter van Luezen (M.Sc.) and report production was coordinated Robert Tarbuck (BTech).

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BACK RIVER PROJECT

2013 WILDLIFE HABITAT SUITABILITY BASELINE

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Glossary and Abbreviations

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DEM	Digital Elevation Model
Focal Species	Organism(s) of ecological and/or human value that is of priority interest for management.
GIS	Geographical Information System
HSR	Habitat Suitability Rating: final rating assigned to an ecosystem unit with all assumptions and adjustments taken into account.
Keystone Species	A keystone species is a species that plays a critical role in maintaining the structure of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or total biomass.
Life Requisite	Specific activities of an animal that are critical for sustaining and perpetuating the species and that depend on particular habitat attributes or conditions. Life requisites include feeding, cover, breeding, migration, hibernation, etc.
LSA	Local Study Area
MBCA	*Migratory Birds Convention Act*
Model	A graphical representation of a species' habitat use over a defined landscape. It is based on the species account and is used to develop the assumptions, rating tables, and adjustments.
NU	Nunavut
NWT	Northwest Territories
Rating	A relative estimate or evaluation; a value assigned to a map unit to express the suitability of that unit to support a wildlife species for a particular life requisite and season. The rating is based on assumptions about the species' habitat requirements as defined in the model.
RISC	Resources Information Standards Committee of British Columbia. RISC establishes standards for collection, storage, analysis, interpretation and reporting of inventory data.
RSA	Regional Study Area

SARA	*Species at Risk Act*
Species Account	A summary of geographic distribution, life requisites, seasonal use of habitats, limiting factors, and habitat attributes for an animal species within a geographic range.
Suitability	Ability of the habitat in its current condition to provide life requisites of an animal.
Umbrella Species	Species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.
WAPPRIITA	*Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act*
WHR	Wildlife Habitat Rating: preliminary rating assigned to an ecosystem unit.
WKSS	West Kitikmeot/Slave Study

1. Introduction

1. Introduction

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut (Figure 1-1). This report presents the results of wildlife habitat suitability modelling developed to support the wildlife effects assessment for the draft Environmental Impact Statement (DEIS; Volume 5, Chapters 5 to 10).

This report details the methodology used in the development of habitat suitability models for caribou, muskox, grizzly bear, grey wolf, wolverine, short-eared owl, and peregrine falcon, all of which are wildlife Valued Ecosystem Components (VECs) in the DEIS. Model development included thorough literature searches on species ecology and seasonal habitat use. This background information was then utilized in conjunction with the ecosystem and vegetation maps (Rescan 2013a, Appendix V5-4A) in order to identify and rate each habitat type within the terrestrial wildlife Local Study Area (LSA) and terrestrial wildlife Regional Study Area (RSA) for a specified season. The habitat ratings were also evaluated in the field and adjusted as necessary.

The overall objective of the wildlife habitat suitability modelling was to support the assessment of potential Project effects on wildlife VECs, including the assessment of habitat loss and disturbance due to noise (Volume 5, Chapters 5 to 10). Specifically, the modelling results were used to evaluate how much habitat would be lost due to Project development within the Potential Development Areas (PDAs) and how much habitat beyond that lost due to the Project would be disturbed by noise from Project activities, such as blasting noise and aircraft noise (Volume 5, Chapters 5 to 10).

PROJECT # 0194096-0040-0022 GRAPHICS # BAC-0040-064 November 7, 2013

Figure 1-1

Back River Project Location

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2. Background Information

2. Background Information

Wildlife and wildlife habitat are protected by both federal and territorial legislation, including the Nunavut *Wildlife Act* (2003), Nunavut *Land Claims Agreement Act* (1993a), Canadian *Wildlife Act* (1994a), the Canada *Migratory Birds Convention Act* (1994b), the Canada *Species at Risk Act* (SARA; 2002), and the Canada *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (1992b); Table 2-1).

Table 2-1. Relevant Acts or Regulations for Wildlife and Wildlife Habitat

Act or Regulation	Implications for Management
Nunavut *Wildlife Act* (2003)	• Identifies and defines wildlife management strategies for Nunavut, including strategies for conservation, protection and recovery of species at risk, managing nuisance wildlife, and possession of wildlife. The Act provides interpretation of approved and restricted hunting and related activities, including the possession of wildlife and enforcement that will follow should any of the Act's issued sections and corresponding regulations be contravened.
Nunavut Land Claims Agreement Act (1993a)	• Legislation that enforces the Nunavut Land Claims Agreement (NLCA; 1993b). The Nunavut Wildlife Management Board (NWMB) is established under the NLCA with the responsibility to manage wildlife and wildlife habitat in conjunction with the Government of Nunavut Department of Environment (GN DOE). • Within Section 5.2.34 of the NLCA, additional responsibilities for the NWMB are outlined, including the approval of conservation areas, wildlife management zones, wildlife management strategies, species at risk recovery plans, and designation of species of conservation concern and disseminate wildlife management information to appropriate government bodies.
Canada *Wildlife Act* (1994a)	• Identifies and defines wildlife management strategies for Canada, including strategies for managing nuisance wildlife and possession of wildlife. It provides interpretation of approved and restricted hunting and related activities including the possession of wildlife and enforcement that will follow should any of the Acts issued sections and corresponding regulations be contravened.
Canada *Migratory Birds Convention Act* (1994b)	• Prohibits the taking or killing of migratory birds, their nests, and eggs, and the deposition of harmful substances in areas frequented by migratory birds.
Canada *Species at Risk Act* (2002)	• Protects wildlife on federal lands as well as the critical habitat of those species listed on the "List of Wildlife Species at Risk," and protects all SARA-listed migratory birds. • Section 137 amends the *Canadian Environmental Assessment Act* (1992a) to clarify, for greater certainty, that environmental assessments must always consider effects to listed wildlife species, their critical habitat, or the residences of individuals of that species. • Section 79(2) states "the person must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans."
Canada Wild Animal and Plant Protection and Regulation (1992b)	• Prohibits the import, export, and interprovincial transportation of species on the "Convention on International Trade in Endangered Species of Wild Fauna and Flora" control list; foreign species whose capture, possession, and export are prohibited or regulated by laws in their country of origin, Canadian species whose capture, possession, and transportation are regulated by provincial or territorial laws; and species whose introduction into Canadian ecosystems could endanger Canadian species.

3. Study Area

3. Study Area

3.1 BOUNDARIES

Wildlife habitat suitability studies were conducted within two terrestrial wildlife study areas, a Local Study Area (LSA) and a Regional Study Area (RSA; Figure 3.1-1).

The boundaries of the terrestrial wildlife LSA (hereafter in this report referred to as the LSA) were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5; Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property Area, George Property Area, and MLA. The LSA covers an area of approximately 134,369 ha.

The terrestrial wildlife RSA (hereafter in this report referred to as the RSA) encompasses the PDAs, the LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three Project areas (Goose Property Area, George Property Area, and MLA). The RSA covers an area of approximately 1,262,005 ha. The RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

3.2 ECOLOGICAL OVERVIEW

The National Ecological Framework is a hierarchal system of ecological classification that provides a framework for describing the distribution of ecological patterns across Canada. At its broadest level, this system recognizes two ecozones across Nunavut; the Northern Arctic and the Southern Arctic (Natural Resources Canada 2003). The Project lies within the Southern Arctic Ecozone. The Southern Arctic Ecozone extends across central Nunavut. It is bordered by the tree line to the south and by the Northern Arctic Ecozone to the north. Summers are cool and short with a mean temperature of 5ºC. Winters are long and cold with an average temperature ranging from -28ºC near the MacKenzie Delta to -18ºC in Northern Quebec. Precipitation is limited to about 200 mm per year.

The terrain is comprised of flat and rolling bedrock covered by thin veneers of till, lacustrine and fluvial deposits. Bedrock exposures are common, as repeated glacial advance and recession has removed much of the surficial material. Permafrost is found throughout the region. Although annual precipitation is low, many low-lying areas (as well as low-gradient hillsides) remain permanently saturated. This is due to very low rates of evaporation and transpiration as well as the continual supply of moisture from within the soil profile due to seasonal permafrost melting.

Wetlands are common throughout the region. The occurrence and development of Arctic wetlands is closely connected to the freezing and thawing of soil. The freeze-thaw action results in a number of wetland types depending on the amount of dynamism in the active layer (the mobile layer of soil above the permafrost, which is subject to periodic thawing), the depth of the surficial organic material, landscape position, and the properties of the subsurface mineral parent material. Many Arctic wetlands are located in depressions, caused by glacial scour, that have filled with water from snowmelt. Kettle and kame topography also promotes wetland development (Gracz 2007).

The southern border of the Southern Arctic Ecozone is defined by a lack of full-size trees along its southern edge. Stunted forms of certain tree species, such as dwarf birch (*Betula nana*), green alder (*Alnus viridis* spp. *crispa*), willow species (*Salix* ssp.) and less commonly, white and black spruce (*Picea glauca* and *P. mariana*) grow throughout the ecozone. Much of the area is dominated by sedge meadows, tussock tundra and heath tundra. Sparsely vegetated areas, such as the wind-swept crests of eskers, are also common.

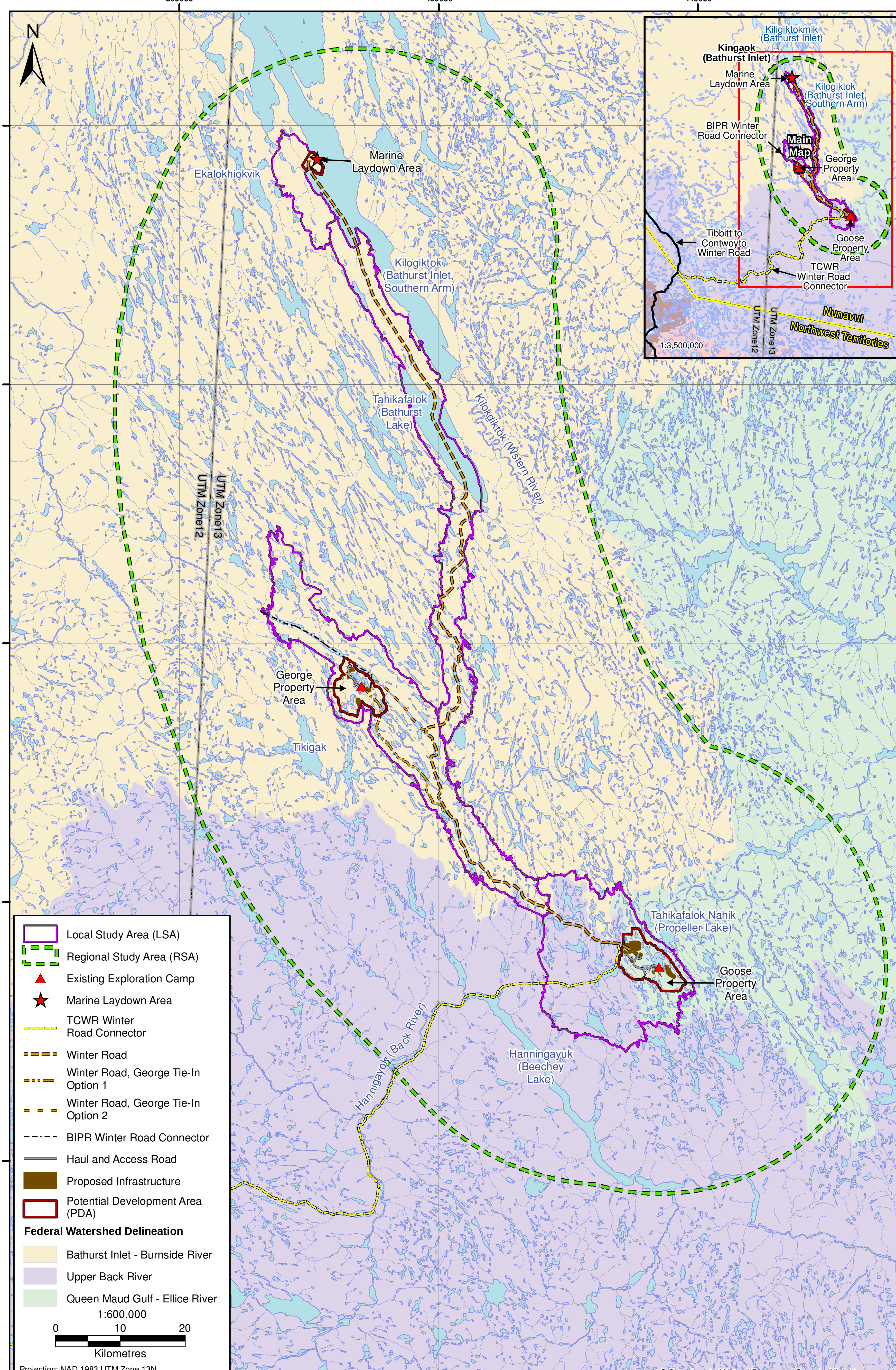

Figure 3.1-1

Figure 3.1-1

Terrestrial Wildlife Local and Regional Study Areas

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4. Methodology

4. Methodology

4.1 MODELLING APPROACH - OVERVIEW

Modelling wildlife habitat enables the identification of areas that contain suitable habitat for chosen wildlife species. Maps are developed which can be used to assess the effects of development on wildlife habitat. The process of selecting species for habitat suitability modelling relied on identifying species of concern that occur in the RSA based on several factors, including conservation status, biological importance (e.g., keystone species, umbrella species), and economic or social importance to regional governing agencies, Nunavut residents, and the Inuit. Using this rationale, seven species were selected:

- caribou;
- muskox;
- grizzly bear;
- grey wolf;
- wolverine;
- short-eared owl; and
- peregrine falcon.

Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). BC standards were used because habitat suitability standards are not set for Nunavut and the BC standards are well developed and sufficiently flexible to make them appropriate for tundra ecosystems. As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question. In summary, these standards guide the interpretation of data derived from ecosystem maps and other biophysical information to spatially inventory wildlife habitat and to facilitate land management planning. While these standards were developed for interpreting wildlife habitat within British Columbia, they have been applied with success to other areas in Canada by Rescan.

The development of the wildlife habitat suitability models requires the following steps:

1. Development of species accounts with description of wildlife species' ecology, including habitat characteristics (variables) appropriate to the LSA and RSA.
2. Development of habitat suitability models for each species of interest using local data such as topography, slope, and vegetation (from the ecosystem maps) and the identified habitat variables.
3. Testing of habitat suitability models against field observations of habitat quality and wildlife use of the area.

4.2 MODEL DEVELOPMENT

4.2.1 Species Accounts

Species accounts are summaries of the geographic distribution, life requisites (i.e., the special requirements of an animal for survival and reproduction), seasonal use of habitat, limiting factors, and habitat attributes for an animal species within a geographic range (RIC 1999). The species accounts were primarily developed from literature reviews with particular emphasis on the ecology of the LSA and RSA. This information helped guide the formulation of Wildlife Habitat Ratings (WHRs) and habitat models. Species accounts are provided in Appendices 1 to 7.

Data from the following reports have been implemented in this wildlife habitat suitability report where applicable:

- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012, Appendix V5-5D);
- *Back River Project: 2012 Wildlife Baseline Report* (Rescan 2013b, Appendix V5-5C); and
- *Back River Project: 2012 Ecosystems and Vegetation Baseline Report* (Rescan 2013a, Appendix V5-4A).

4.2.2 Habitat Suitability Models

The second step of model development is to identify suitable habitat used by each species. This step has two stages. In the first stage, ecosystem mapping is used to identify a variety of ecosystems throughout the LSA and RSA, termed ecosystem units. A wildlife habitat rating (WHR) is then assigned to each ecosystem unit, based on the characteristics of each species and season and its requirements for food, security, and thermal protection. The second stage takes the ecosystem units and their assigned WHRs, and may add other important variables specific to the species of interest. These variables include, but are not limited to, elevation, slope, aspect, and distance to a terrain feature or waterbody.

4.2.2.1 Local and Regional Ecosystem Mapping

Mapping of the LSA was conducted using British Columbia Terrestrial Ecosystem Mapping (TEM) procedures (Rescan 2013a, Appendix V5-4A). The classification system used for the TEM is a regional system developed by Rescan for the Back River Project. Ecosystem mapping was conducted in conjunction with ecosystem and vegetation baseline field studies conducted for the Project from 2012 to 2013. Ecosystems were mapped based on the field results and air photo interpretation. A final TEM map was developed for the LSA to identify the spatial distribution and types of ecosystems across the landscape (more details can be found in Rescan 2013a, Appendix V5-4A).

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the RSA. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km^2 of the West Kitikmeot / Slave Study Area, which stretches from the arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001). Small portions of the RSA were not covered by the WKSS mapping, so the national Land Cover dataset from GeoBase was used to supplement the WKSS. The Land Cover data was derived from multiple sources including Landsat 5 and 7 imagery from a partnership of provincial, territorial, and federal governments and agencies (GeoBase 2009).

4.2.2.2 Wildlife Habitat Ratings

Wildlife habitat ratings are based on assumptions regarding the habitat requirements of the species throughout the year and are defined in the species-habitat model. WHRs also take into account specific life requisites, or activities, as applicable. For this study, life requisites were divided into three categories: living, reproducing, and travelling. Living refers to habitat used for food, cover, and security. Reproducing refers to habitat used specifically for giving birth to live young, rutting, building nests, laying eggs, incubation, hatching, and feeding non-mobile young. Travel refers to landscape features that target species utilize for migration and predator avoidance. Habitats for each focal species were rated for seasons and life requisites as outlined in Table 4.2-1.

Table 4.2-1. Focal Species, Habitats Rated, and Rating Schemes Used for Habitat Suitability Models

Common Name	Rating Scheme	Season(s) Rated	Life Requisite	Time Period
Caribou	4 class	Calving	Living[1] and Reproducing[2]	June 1 to June 20
		Post-calving	Living[1]	June 15 to July 15
		Summer	Living[1]	July 16 to August 31
		Fall	Living[1], Reproducing[2], and Migrating[3]	September 1 to October 31
Muskox	4 class	Summer	Living[1] - food only	June to September
		Winter	Living[1] - food only	October to May
Grizzly bear	4 class	Denning	Reproducing[2]	October to May
		Spring	Living[1] - food only	May and June
		Summer	Living[1] - food only	June - September
		Fall	Living[1] - food only	September - October
Grey wolf	4 class	Denning	Reproducing[2]	late April to September
Wolverine	4 class	Denning	Reproducing[2]	February to early May
Short-eared Owl	2 class	Nesting	Living[1] and Reproducing[2]	May to July
Peregrine falcon	2 class	Nesting	Living[1] and Reproducing[2]	Late May to August

[1] *Living: food and cover provided by vegetation composition and physical structure of habitat.*
[2] *Reproducing: includes nest locations, changes in home range and forage consumption by pregnant/lactating females.*
[3] *Migration: habitat used for regular, annual travel.*

Ratings were assigned according to either a four class system or a two class system, depending on the level of knowledge of the species ecology and habitat requirements (Table 4.2-1). The four class rating scheme was applied to species where there was an intermediate to good understanding of habitat use within study areas and where the ecosystem mapping was robust (detailed) enough to identify the range of habitats used by the focal species throughout the year. For habitat rated using the four class scheme, ratings are as follows:

- High: ecosystem units representing essential habitat encompassing preferred habitat characteristics, the best habitat available for the species to meet its life requisites (and reproduce where applicable);
- Moderate: ecosystem units that provide some benefit to the species, but may not meet all of their food, security, or thermal requirements;
- Low: ecosystem units that provide little benefit to the species for living (e.g., cover, food); and
- Nil: ecosystem units that are avoided or not used by the species and that have no positive value.

The two class rating system was used for species where there was poor understanding of habitat use in the study areas, or where habitat use by the focal species is very fine scale and the ecosystem mapping was not robust enough to allow for a more detailed interpretation of habitat use. For habitat rated using the two class scheme, ratings are as follows:

- Usable/Suitable (U): ecosystem units that are preferred or represent usable habitat; and
- Likely No Value/Not suitable (X): ecosystem units that have very little or no positive value for the species.

The preliminary WHRs were developed specifically for ecosystem units occurring within the LSA and were later adapted for use for ecosystem units in the RSA. The ecosystem mapping in the RSA was completed at a coarser scale than the TEM mapping in the LSA. Typically, the RSA ecosystem units encompassed one or more LSA vegetation associations. For example, the Wetland (Sedge Meadow) ecosystem unit in the RSA may be equivalent to five different ecosystem units in the LSA, including Raised Bog Complex, Cottongrass Sedge Fen, Water Sedge Marsh, Undifferentiated Fen, and Shallow Open Water Wetland ecosystem units. In these situations the WHR values from the LSA ecosystem units are averaged based on the similarity to RSA characteristics. Where comparisons are not possible, new WHR values were created for the RSA ecosystems.

It is important to note that the WHR is a preliminary rating which may be quite different from the final rating used in the model, based on the number of adjustments made to include important geographic features or results of field evaluations. The final rating is called the Habitat Suitability Rating (HSR).

4.2.2.3 Additional Modelling

Additional modelling inputs were used for the peregrine falcon nesting model. The nesting model was developed by including occupied raptor nesting habitat identified during 2007, 2011, and 2012 baseline studies, as well as modelling cliff habitat using digital elevation models (DEM; see Section 5.8.2.1 for more details).

4.2.3 Field Evaluations

The third step of model development is to test the model in the field. This step is used to evaluate the model's ability to predict actual field conditions (i.e., for the model to predict the suitability of the habitat on the ground for a particular species). Field testing requires the collection of data at a sample of the mapped locations in representative habitat types. The model evaluation can be supplemented with wildlife surveys (e.g., aerial or ground surveys) to evaluate use and local habitat selection. Field evaluations were completed in August and September, 2012. Evaluations involved a biologist performing habitat assessments for each of the target species and life seasons in the LSA and to a lesser extent in the RSA. The field suitability values for each species, season and vegetation association (LSA) or ecosystem type (RSA) were compared to the preliminary WHR at the same location, and the WHRs were then adjusted as necessary to create final HSR values.

4.2.4 Model Adjustments

Model adjustments were required to determine the overall suitability of habitat in the LSA. The output of TEM mapping is ecosystem polygons, which may contain up to three different ecosystem units. In these cases, the percent of a polygon classified as a given ecosystem unit is determined; this percentage is also referred to as the decile. Therefore, ecosystem polygons may contain habitat which is of different value to focal species. To account for these differences in habitat values, the HSRs assigned to ecosystem units were given a numerical value, as outlined in Tables 4.2-2 and 4.2-3.

A weighted average HSR value that accounted for the relative proportion of each ecosystem unit and its value to the focal species was then calculated using the following equation:

$$\text{Weighted Average HSR} = \frac{HSR_{(decile\ 1)}}{Decile\ 1} + \frac{HSR_{(decile\ 2)}}{Decile\ 2} + \frac{HSR_{(decile\ 3)}}{Decile\ 3}$$

Table 4.2-2. Habitat Suitability Ratings and Weighted Averages for Four-class Schemes

HSR	HSR Value	Equivalent Weighted Average HSR Value
High	1	1.0 - 1.7
Moderate	2	1.8 - 2.5
Low	3	2.6 - 3.3
Nil	4	3.4 - 4.0

Table 4.2-3. Habitat Suitability Ratings and Weighted Averages for Two-class Schemes

HSR	HSR Value	Equivalent Weighted Average HSR Value
Suitable	1	1.0 - 1.5
Not-Suitable	2	1.6 - 2.0

The weighted average HSR for the ecosystem polygon was then translated back to final HSR. This conversion was achieved by defining the range of weighted average values that would be equivalent to high, moderate, low, and nil rated habitat (Tables 4.2-2 and 4.2-3). It was important to ensure that polygons that supported high value habitat (HSR 1) were identified and that the process of averaging did not mask the high valued component. As such, the range of weighted average values that defined HSR 1 habitat exceeded the midway mark between HSR 1 and 2 (i.e., 1.5), accounting for the ecological value these habitats represent. This was only performed for species where habitats were rated under the four class scheme.

No model adjustments were required for the regional ecosystem mapping. The WKSS mapping is a raster dataset where each pixel was given a single ecosystem classification (i.e., no deciles as is used in the TEM mapping). Therefore, a single and final HSR value can be assigned to each individual pixel, as defined in Tables 4.2-2 and 4.2-3.

4.3 SOURCES OF ERROR AND LIMITATIONS

Limitations in the resolution of the maps present difficulties in assessing habitat, particularly for species that exploit home ranges and habitat features at smaller spatial scales. Considering the limitations, the habitat suitability maps presented should provide sufficient accuracy to evaluate potential impacts from the Project on the wildlife species at a landscape level of resolution. The maps are not intended to be used for fine scale level management (i.e., for attributes within an ecosystem unit polygon).

One limitation of the methods used is that there is no formal evaluation of the final model fit. Typically, there are two options for evaluating model fit. In the, first option, the modeller can use all of the field data to update and refine the model. This leads to a model that better fits the available data, and the wildlife habitat, but does not allow for a formal evaluation of how well the model fits the data. In the second option, half of the data is used to refine the model, while the other half of the data is used to test the model fit. This second option invariably leads to a less well-fit model, but has the benefit of providing a formal evaluation of model fit. In this case, the first option was chosen such that the fit of individual models was maximized.

An additional limitation is the WKSS did not cover the entire RSA and that GeoBase Land Cover data were used to fill gaps. The Land Cover data lacks the extensive ground work used to verify the WKSS accuracy. As well, the classification system used for the two remote sensing products differed both in the classification systems used and the interpretation of pixel classification. Therefore, the GeoBase Land Cover may not be as accurate as the WKSS imagery.

5. Results

5. Results

5.1 SUMMARY OF HABITAT SUITABILITY MAPPING RESULTS

In summary, the LSA and RSA contained moderate to large amounts (20-80% of study area) of highly rated (HSR 1) seasonal habitat for caribou. Approximately half of the habitat within the LSA and the RSA was rated as useable/suitable denning habitat for wolverine and useable/suitable nesting habitat for short-eared owl. Conversely, very little habitat within the LSA and the RSA was rated as highly suitable for muskox, grizzly bear, grey wolf, and peregrine falcon. For these species, between 1% and 11% of each study area was rated as highly suitable for any one season and life requisite. The results of habitat suitability mapping are summarized according to TEM mapping within the LSA and WKSS and GeoBase mapping in the RSA; results are also presented in Appendix 8, which also includes habitat suitability mapping according to WKSS and GeoBase mapping within the LSA.

The final HSRs represent the quality of each ecosystem type in providing the seasonal life requisites for the species in question (e.g., forage opportunities for grizzly bears). While additional modelling was completed for peregrine falcon, most HSRs are the same as the WHRs given to the identified ecosystem units within the LSA and RSA for most ecosystem types.

5.2 CARIBOU

5.2.1 Background

Barren-ground caribou (*Rangifer tarandus groenlandicus*) are a biologically and culturally important species in the Arctic. Caribou not only sustain wild predator populations such as wolves, grizzly bear, and wolverine, but also provide an important resource for human populations living in the North, particularly Aboriginal communities. Caribou are most sensitive during calving and post-calving when calves are most susceptible to predation and disturbance (Russell, Kofinas, and Griffith 2002). Calving and post-calving areas are designated as important habitat for caribou in Nunavut (NPC 2012). Three caribou herds have been recorded in the vicinity of the Project: the Bathurst, Beverly, and Dolphin and Union herds. The Dolphin and Union herd are recognized as a distinct subspecies of barren-ground caribou (*R.t. groenlandicus x pearyi*). For the purposes of this study, individual herds are not assessed separately as it is assumed that habitat requirements are similar, if not identical, for all individuals (Gustine et al. 2012).

5.2.2 Habitat Suitability Model Development

Caribou habitat suitability was assessed for calving (June 1 to ca. June 20), post-calving and summer (ca. June 20 to August 31) and the fall (September 1 to October 31).

The calving period refers to the time when cows are giving birth, which is defined both by the initiation of calving and the one week period of “peak calving,” when 50% of cows have calved (Russell, Kofinas, and Griffith 2002; A. Gunn and Poole 2009). The dates for the peak calving period can be identified by the relatively slow movement rate of satellite-collared cows during calving (< 4 km/day during calving versus 14-20 km/day before calving, and about 12 km/day after calving), as calves have very limited movement ability in the first days of life (A. Gunn and D'Hont 2002; A. Gunn, Dragon, and Boulanger 2002; A. Gunn and Poole 2009; Nishi et al. 2010). There is annual variability in the dates of initiation of calving and peak calving (A. Gunn, Poole, and Wierzchowski 2008); therefore, an approximate date for end of calving (ca. June 20) is used in this report based on available literature.

Habitat selection for each season was developed from literature searches, local knowledge, previous and concurrent wildlife surveys, and project specific habitat assessments. Table 5.2-1 provides a summary of the seasons and life requisites that were assessed, with the following sections expanding on the habitat preferences for each season and HSR ratings for each vegetation association that occurs in the LSA and RSA.

Table 5.2-1. Seasonal Life Requisites of Caribou

Season	Date	Life Requisite	Habitat Preference
Calving	June 1 to ca. June 20	Reproduction and Living	Variable. Predator avoidance, lichen availability, and early vegetation growth is preferred.
Post-calving and Summer	ca. June 20 to July 15 (post-calving) July 16 to August 31 (summer)	Living	Caribou use eskers for insect and heat relief, lakes for predator avoidance, insect, and heat relief, eat green plants from riparian and sedge communities. Cows require high quality forage to replenish fat reserves.
Fall (including Rut)	September 1 to October 31	Living, Reproduction, and Travel	Caribou travel to southern rutting areas, selecting habitat for ease of travel, predator avoidance, and late season forage.

5.2.2.1 Model Assumptions

<u>Calving</u>

Key characteristics of caribou calving grounds on the tundra are believed to be areas that facilitate predator avoidance, and where forage availability after snowmelt offers females the nutritional requirements they need for lactation (Griffith et al. 2001; Wilson et al. 2012). There appears to exist a trade-off between safety and forage availability; calving females may choose calving grounds that are relatively safe from predators but are not necessarily places where snow melts earlier nor where vegetation biomass is greatest (Wilson et al. 2012). Though forage availability may be lower, it is thought that calving grounds generally are located in areas where forage quality is high (reviewed in Wilson et al. 2012; Griffith et al. 2001). Lichen provides caribou with additional nutrients before green-up (Ferguson, L. Gauthier, and F. Messier 2001). Lichen heath is one of the main vegetation cover types for the Bathurst herd calving grounds (Griffith et al. 2001; Johnson et al. 2005). Willow and cottongrass species can be important forage species during and following calving, where available (Russell, Kofinas, and Griffith 2002).

The following general assumptions were made to define calving WHRs:

- High value calving habitat (primarily assessed for forage) includes ecosystem units that are snow free early, and those that contain a significant cover of lichen and shrubs.
- Moderate value habitat includes a variety of ecosystem units that contain suitable early forage such as cottongrass flower buds, sedges, and various shrub species.
- Low value habitat includes ecosystem units that are more likely to retain snow packs or have limited suitable forage.
- Nil ratings were given to vegetation associations that have a lack of forage, or are disturbed.

Given that lichens may be the typical food source for females on calving grounds but that green spring vegetation may also important whenever available, suitability was based on ecosystem types and vegetation associations that occur in landscape positions that have limited snow packs, lichen cover, and have the potential to green up early in the spring season. Suitability modelling could not account for the trade-off between predator avoidance and forage availability and quality.

Post-calving and Summer Habitat

Access to high quality forage is likely the key driver of habitat selection in the post-calving period (Witter et al. 2012), as females need to acquire adequate nutrient reserves for lactation, which last for about three weeks. Sedge meadows may be an important habitat during this time, due to the highly nutritious cotton grass (*Eriophorum* spp.) and sedges (e.g., *Carex aquatilis*) that grow in these areas. After the post-calving period, females expand their selection of vegetation from sedge meadows to include other vegetation types, but tend to remain in moist habitat where grasses, sedges, and willow and birch shrubs are abundant (Griffith et al. 2001; Thorpe et al. 2001; Wilson et al. 2012; Zamin and Grogan 2012).

In addition to forage, caribou require habitat that provides relief from insects, heat, and predators. Relief is found by moving to windier, cooler places during the daytime, such as on top of eskers, at the edges of large rivers and lakes, and to higher elevation tundra where insects are less dense (Russell, Martell, and Nixon 1993; Skarin et al. 2008; Wilson et al. 2012; Witter et al. 2012). Caribou often gather along lake shorelines, especially late in the day, because they can enter the water to escape predators such as wolves when necessary (Thorpe et al. 2001). In addition, caribou are also often seen swimming in lakes to escape the heat and insects (Thorpe et al. 2001).

Considering the importance of high quality forage during post-calving and the summer, suitability was based on ecosystem types and vegetation associations that could produce abundant and high quality forage. In addition, habitats that provide insect or predator relief were also identified. The following general assumptions were made to define post-calving and summer WHRS:

- High value post-calving/summer habitat includes areas that produce abundant and high quality forage (e.g., sedges and graminoids), in addition to those that provide insect or predator relief (e.g., lakes and esker).
- Moderate value habitat included ecosystem units that provide forage opportunities, but generally have limited insect and heat relief relative to the high value habitat.
- Low value habitat includes barren areas and rock outcrops that have limited vegetation and limited opportunities for relief (e.g., shallow water areas that are not deep enough to provide insect relief).
- Nil rated habitat were those that lacked forage, or are disturbed.

Fall Habitat (including Rut)

Habitat use during the fall and the rut is focused on ease of travel and opportunistic foraging. As herds move south towards wintering grounds, they feed on remaining high quality forage as it is available, such as shrubs, grasses, and lichens. Bathurst caribou, for example, choose lichen veneer for foraging in the fall (Johnson et al. 2005). Eskers, ridges, and other high points are selected for easy travel (Thorpe et al. 2001). The following general assumptions were made to define fall WHRs:

- High ratings were given to vegetation associations that contain a diversity and abundance of forage species, as well as those that contain esker for ease of travel.
- Moderate ratings were assigned to vegetation associations that contain some preferred forage species, but typically have a lower cover of lichens, sedges, and shrub species.
- Low ratings were given to vegetation associations that contained limited forage opportunities.
- Nil ratings were given to vegetation associations that contained sparse vegetation, or where travel was difficult.

5.2.3 Results and Discussion

5.2.3.1 Calving

Roughly half (53%) of the LSA is Highly (HSR 1) rated calving habitat for caribou (Table 5.2-2). Spatially, high rated habitat was distributed across the LSA (Figure 5.2-1). Moderately suitable (HSR 2) habitats accounted for 22% (30,436 ha) of the LSA. HSR 2 habitats represented areas where lichens are present, but green vegetation may be present in lower quantities or would likely be covered by snow well into June. Moderately suitable habitat habitats, like Highly rated habitat, were also well distributed across the LSA. Of the remaining habitat that was rated, 5% was Low and 19% was Nil (Table 5.2-2). These habitats encompass areas of sparse vegetation, lakes, and rivers – areas that provide little to no forage value for caribou.

Table 5.2-2. Caribou Calving Habitat within the Local Study Area and Regional Study Area

	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
Suitability Rating	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	71,492.97	53	355,417.77	28
Moderate	30,436.22	22	300,905.11	24
Low	7,140.63	5	301,581.58	24
Nil	25,299.49	19	299,248.12	24

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

Within the RSA, over a quarter (28%) of the area was rated as Highly suitable calving habitat (Table 5.2-2). Highly rated habitats were distributed for the most part in the southern RSA below the Western River drainage (Figure 5.2-2). The remainder of the RSA was equally distributed between Moderate, Low, and Nil rated habitats (24% each; Table 5.2-2). Most of the Moderate rated habitat was located in the northern RSA surrounding Bathurst Inlet; Moderate rated habitat was also frequently located adjacent to Highly (HSR 1) rated habitat (Figure 5.2-2). Much of the Low suitability habitat was vast boulder fields with little vegetation cover; this habitat type is common to the north of the George Property (Figure 5.2-2). Nil rated habitats encompassed all water and unvegetated ecosystems.

Despite the presence of suitable calving habitat in the LSA, caribou do not currently calve in the LSA or the RSA. Calving grounds for Bathurst and Beverly herds are known to occur northwest and northeast of the RSA, respectively; the Dolphin and Union herd calves on Victoria Island to the north of the Project.

5.2.3.2 Post-calving and Summer

Within the LSA, roughly 19% was rated as Highly (HSR 1) suitable habitat for caribou during post-calving and the summer (Table 5.2-3). Highly rated habitats were present across larger, continuous areas in the central LSA surrounding the George Property and were sparsely distributed across the rest of the LSA in small quantities (Figure 5.2-3). This spatial trend was primarily influenced by the distribution of areas producing high quality forage (e.g., sedge wetlands) or areas that could be used for insect or heat relief (e.g., eskers, ponds); these habitats were generally small and isolated. Two-thirds (66%) of the LSA was rated as Moderate (Table 5.2-3), representing areas where modest amounts of lower quality forage (e.g., shrubby browse) are accessible or where high quality forage may be present in lower quantities because habitat is mixed. The rest of the LSA was rated as Low (15%) and Nil (1%).

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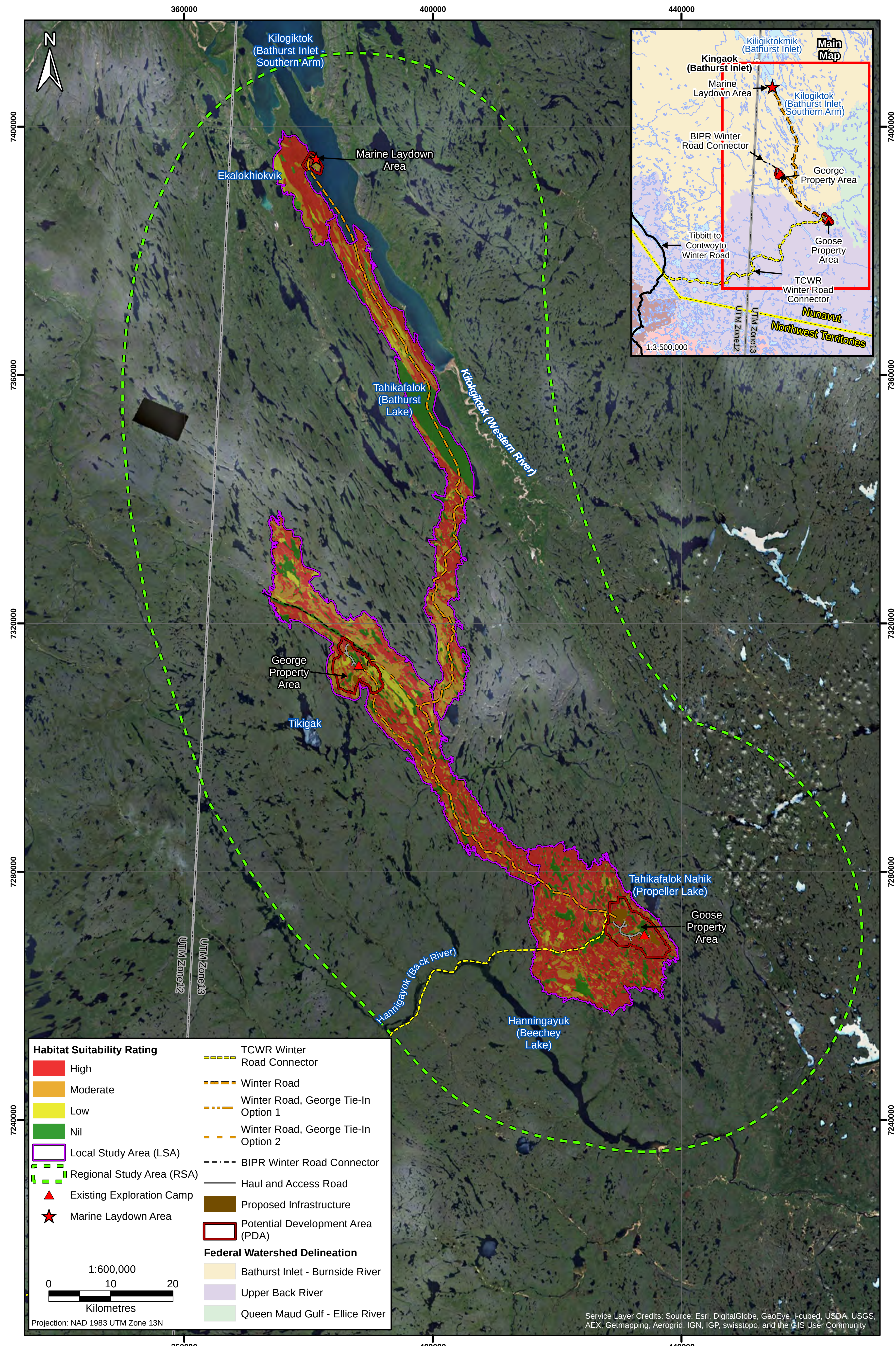

Figure 5.2-1

Caribou: Calving Habitat in the Local Study Area

Figure 5.2-1

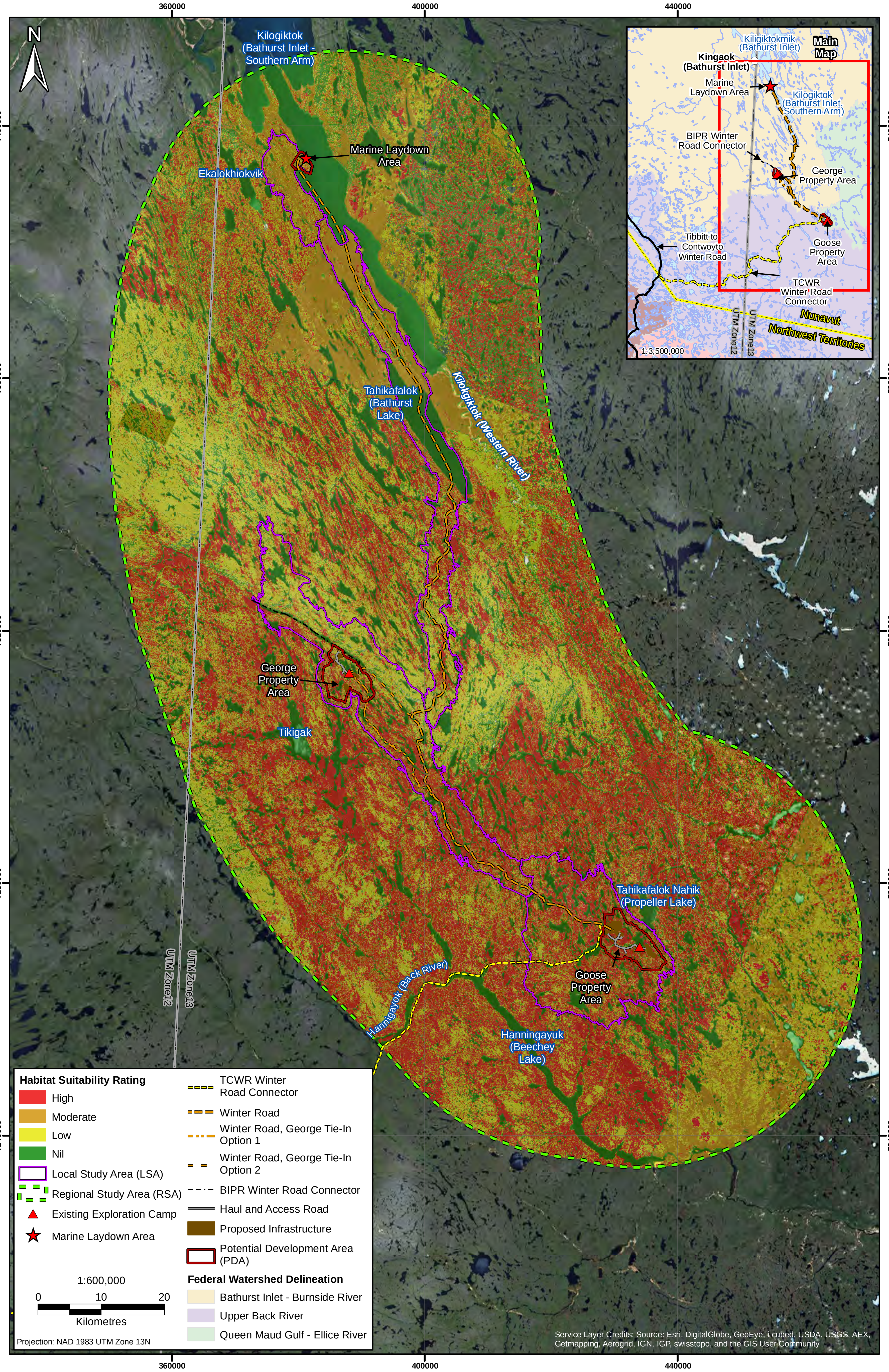

Figure 5.2-2

Caribou: Calving Habitat in the Regional Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Figure 5.2-2

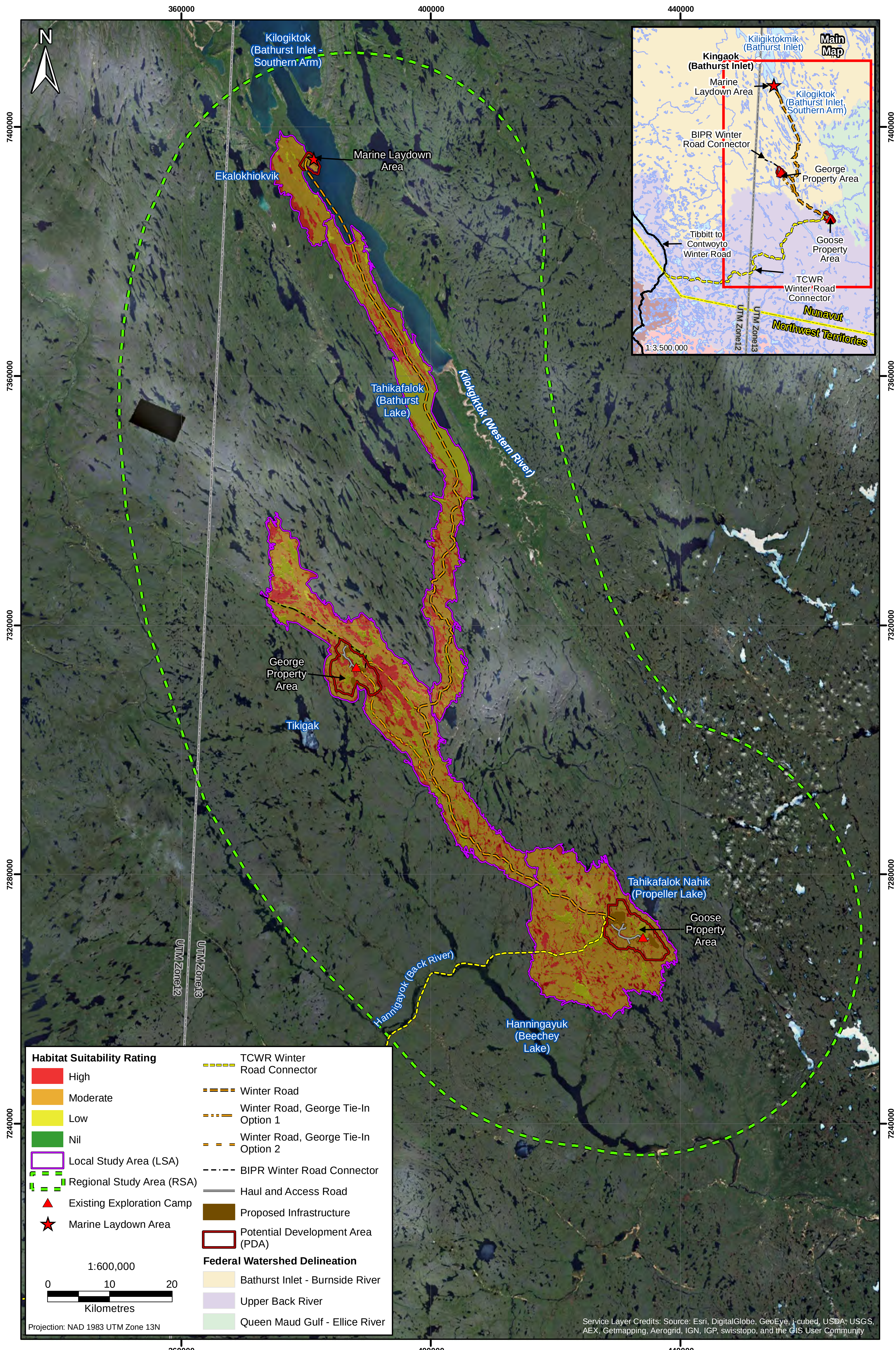

Figure 5.2-3

Caribou: Post-calving and Summer Habitat in the Local Study Area

Sabina GOLD & SILVER CORP.

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Table 5.2-3. Caribou Post-calving and Summer Habitat within the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	25,850.80	19	343,578.60	27
Moderate	88,824.94	66	738,800.73	59
Low	19,556.98	15	107,137.87	8
Nil	136.58	1	67,635.37	5

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

The amounts of High, Moderate, Low, and Nil rated habitats were similar between the RSA and LSA. The majority of habitat rated was of Moderate suitability, followed by Highly rated habitat (59 and 27% of the RSA, respectively). No spatial trends were evident in the distribution of Highly and Moderately rated habitats across the RSA (Figure 5.2-4). The remainder of the RSA was rated as Low (8%) and Nil (5%; Table 5.2-3).

5.2.3.1 Fall

Highly rated habitat was widely distributed across the LSA in the fall (Figure 5.2-5); three-quarters (75%) of the LSA was rated as HSR 1 habitat (Table 5.2-4). Fall habitat represents the areas used while caribou migrate southward to fall rutting grounds and onwards to wintering grounds. The large amount of highly suitable fall habitat in the LSA was primarily influenced by the large number of ecosystem polygons that can produce a wide variety of green and shrubby forage in the fall. As caribou are more opportunistic in their feeding habitats later in the year, these habitats represent areas where caribou are likely to browse as they travel south. HSR 1 habitat within the LSA was dominated by ecosystems that can produce forage for caribou as opposed to habitat that may be used for travelling; very little (approximately 1%) of the LSA was mapped as esker habitat (Rescan 2013a, Appendix V5-4A). Low rated habitats covered 18% of the LSA, followed by Moderate (7%) and Nil (less than 1%) rated habitats. Generally, Low to Nil rated habitats were mixed ecosystem polygons that contained higher proportions of low quality foraging areas (e.g., barren and sparsely vegetated tundra, bedrock and boulder fields) relative to habitat that could produce preferred forage, or were represented by lakes, ponds, and rivers. Moderate rated habitats did not have ideal composition and abundance of preferred fall forage, but are still able to produce browse in modest quantity.

Table 5.2-4. Caribou Fall Habitat within the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)[1]	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	100,265.28	75	562,764.43	45
Moderate	9,795.05	7	178,261.57	14
Low	24,177.80	18	448,491.21	36
Nil	131.17	< 1	67,635.37	5

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.28 ha.

Highly rated fall habitat for caribou covered nearly half (45%) of the RSA (Table 5.2-4). Spatially, Highly rated habitats were widely distributed across the RSA (Figure 5.2-6). Highly rated habitats encompassed lower elevation wetland habitats (which are common in the southern RSA around the Goose Property) where green vegetation may still be available in the fall, as well as the surrounding drier tundra where lichen, some grasses, and shrubby vegetation are common. Similar to the results of the suitability mapping in the LSA, HSR 1 habitat was based primarily on forage quality and quantity as opposed to habitats that may facilitate quick travel, as less than 1% of the RSA was mapped as esker (Rescan 2013a, Appendix V5-4A). Moderately suitable (HSR 2) habitat, totalling 14% of the RSA, was distributed in areas on the west and east side of Bathurst Inlet in the northern RSA and in the southern area; Moderate habitats were generally defined as those with a larger amount of shrub cover in both dry and wet areas. Of the remaining habitat that was rated, a large amount was rated as Low (36%) while a small proportion was rated as Nil (5%). Much of these lower rated habitats were either characterized by large expanses of dry, rocky habitats, or by water. Barren, rocky habitats offer little forage value as the vegetation is sparse, In addition, travel through these area may be challenging.

It should be noted that the Beverly herd uses the RSA during fall, but the Bathurst herd uses an area approximately 150-200 km to the south of the RSA during this period.

5.3 MUSKOX

5.3.1 Background

Muskox are the only other large ungulate species (aside from caribou) that occupy tundra habitats year round (Larter and Nagy 2004); muskox are distributed across most of the Kitikmeot Region of Nunavut (A. Gunn and Adamczewski 2003). Unlike caribou, muskox do not migrate long distances and tend to concentrate habitat use in areas of sedge and willow growth in riparian corridors. Muskox are presently designated as secure in Nunavut (CESCC 2010). Muskox are important prey for carnivores and are highly valued by the Inuit as a source of food, leather, and meat for commercial export. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing. Muskox were close to extinction in the late nineteenth and early twentieth centuries due to overhunting (Fournier and Gunn 1998; Campbell and Setterington 2001), but numbers have generally increased over the last three decades and the historic range has been recolonized (Fournier and Gunn 1998; Campbell and Setterington 2001). The Inuit have also remarked on the expansion in distribution and numbers of the muskox since the 1960s. Muskox are particularly sensitive to disturbance during the calving season (late March through May), because animals are in their poorest condition at the end of winter and have high energetic demands during calving. Disturbance to herds may culminate in stampeding behaviour that can cause calves to be trampled or abandoned (A Gunn and Case 1984).

5.3.2 Habitat Suitability Model Development

Habitat selection for each season was developed from literature searches, local knowledge, previous and concurrent wildlife surveys, and project specific habitat assessments. Table 5.3-1 provides a summary of the seasons and life requisites that were assessed for muskox, with the following sections expanding on the habitat preferences for each season and habitat ratings for each vegetation association that occurs in the LSA and RSA.

Table 5.3-1. Seasonal Life Requisites of Muskox

Season	Date	Life Requisite	Habitat Preference
Summer/Fall	June to September	Living	Wetlands, shrubby areas, eskers with graminoid cover.
Winter/Early Spring	October to May	Living, Reproducing	Windswept ridges and other areas that have low snow cover allowing for accessibility of forage.

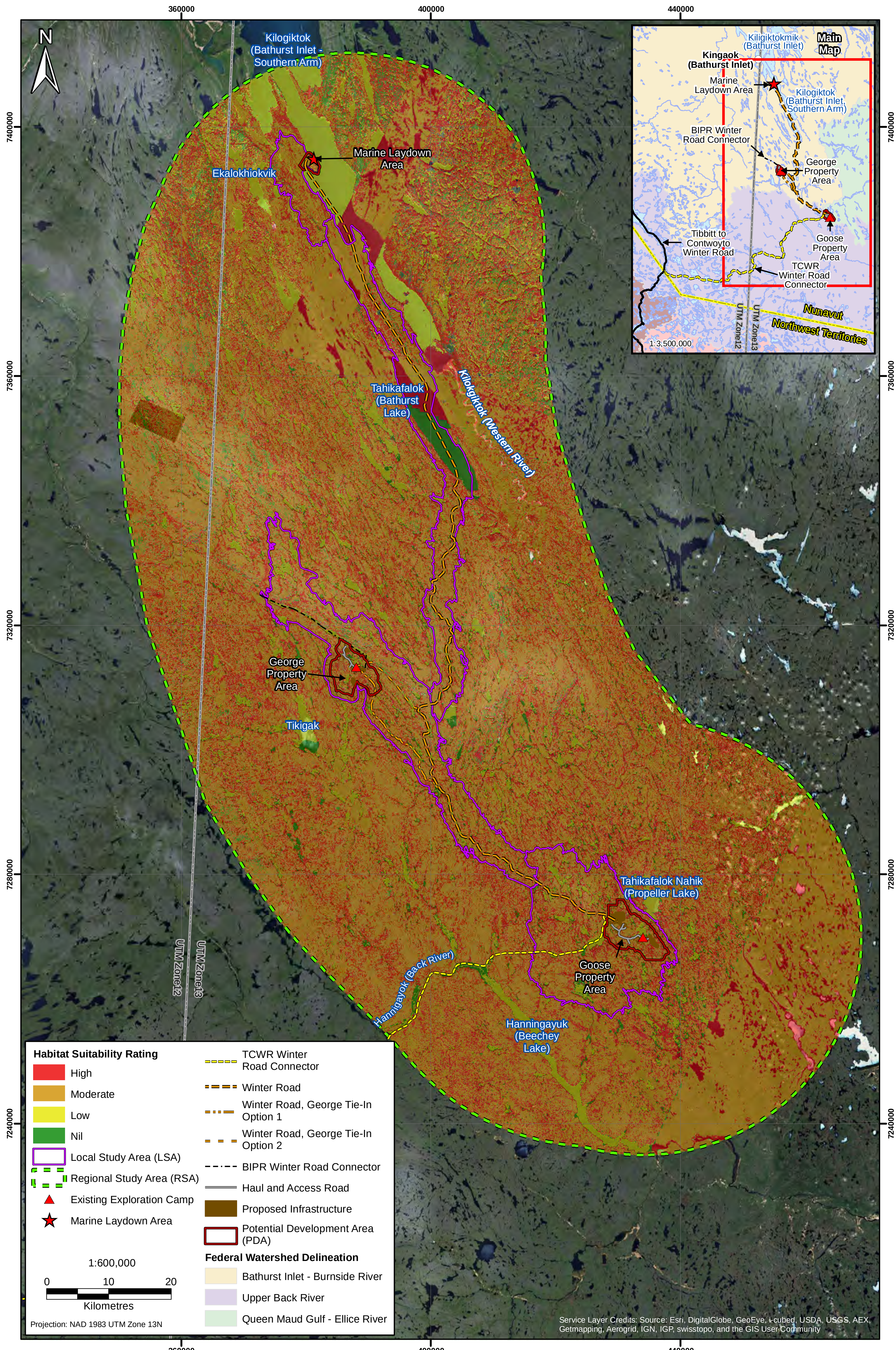

Figure 5.2-4

Sabina GOLD & SILVER CORP.

Caribou: Post-calving and Summer Habitat in the Regional Study Area

Rescan an ERM company

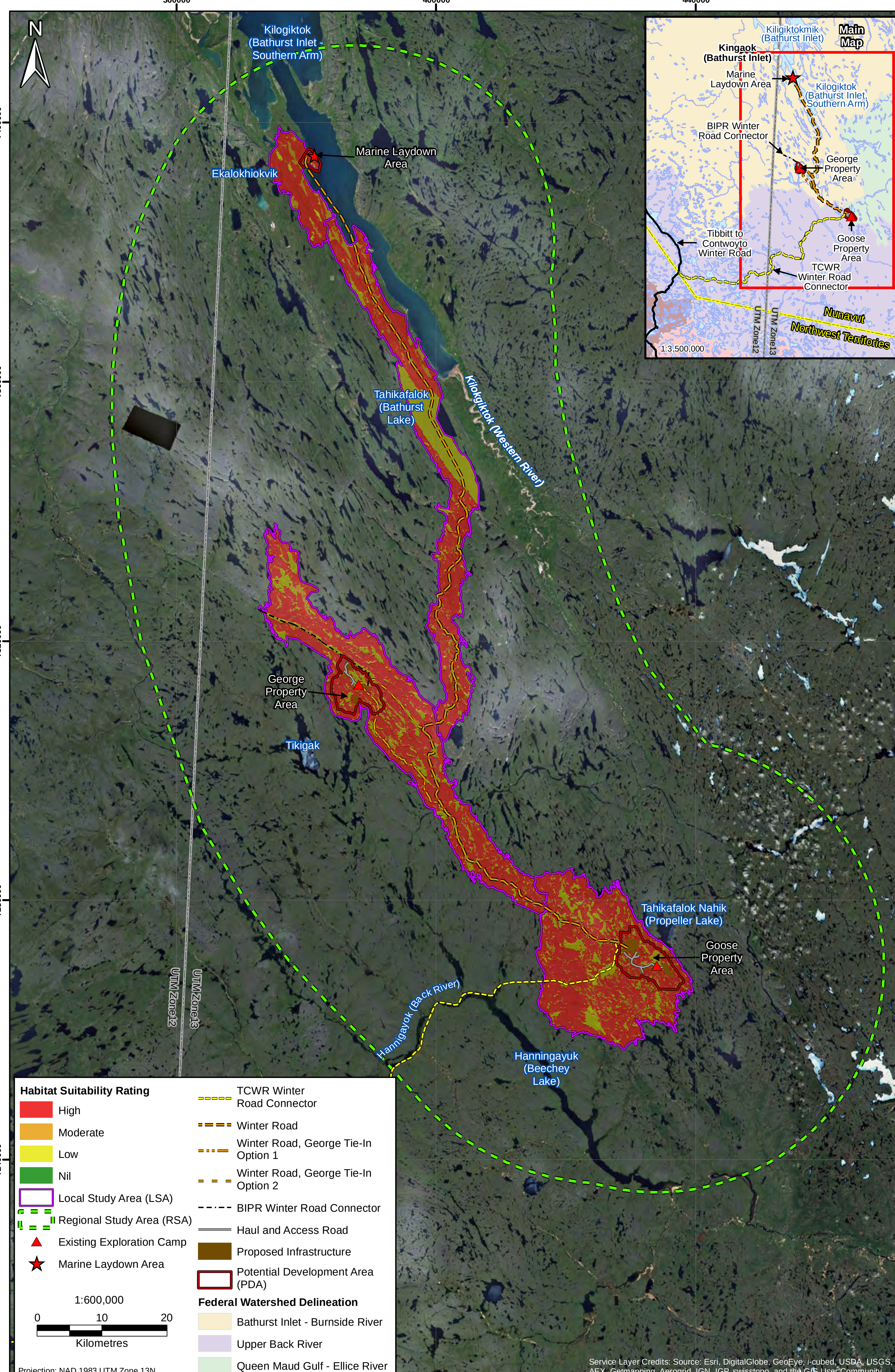

Figure 5.2-5

Caribou: Fall Habitat in the Local Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

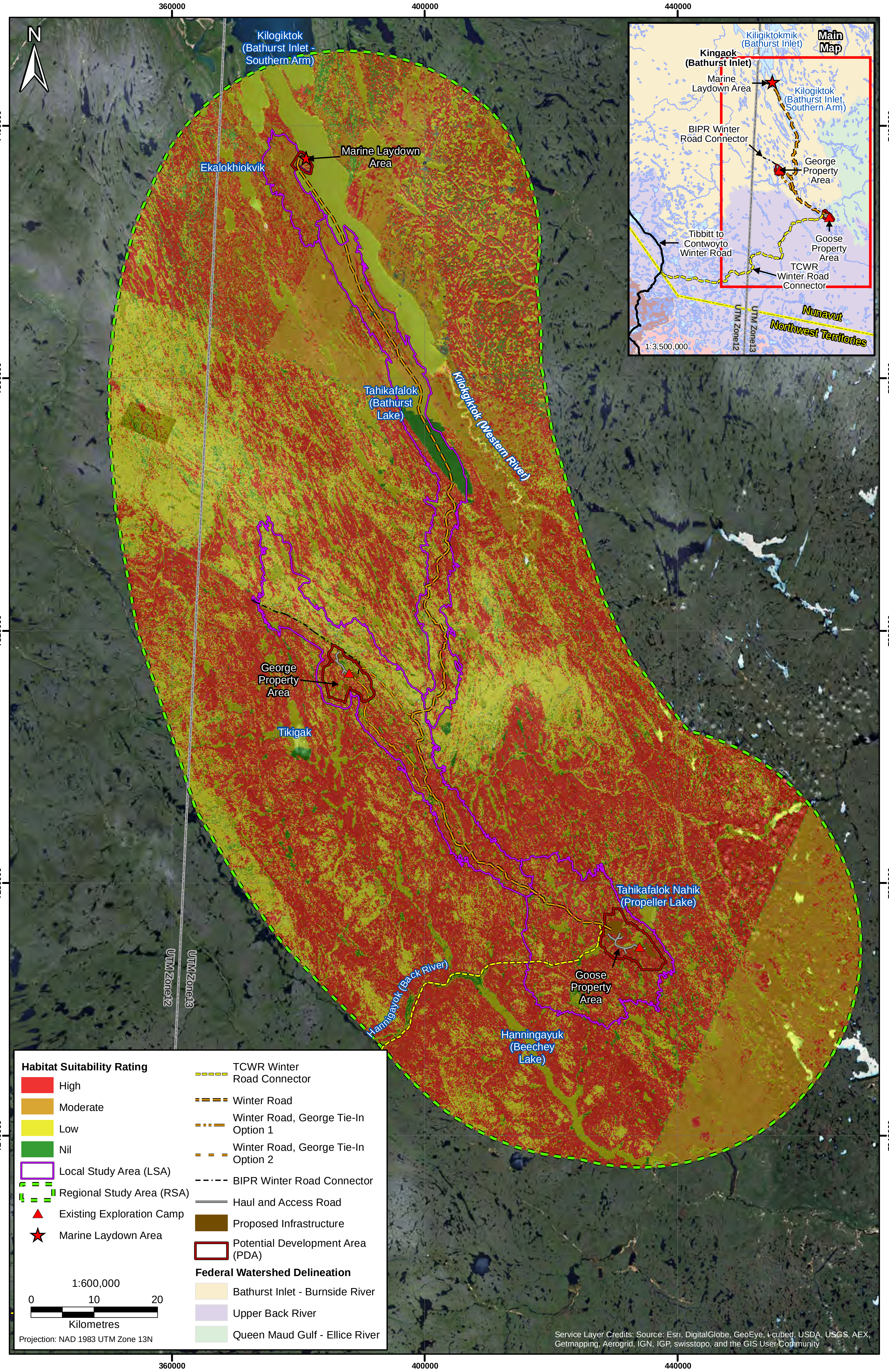

Figure 5.2-6

Caribou: Fall Habitat in the Regional Study Area

5.3.2.1 Model Assumptions

<u>Summer/Fall</u>

Early in the summer, muskox are known to feed on sedges as they are greening up (Gunn, 1984). As the summer progresses, the main forage of muskox includes graminoids such as sedges and grasses, willows and forbs which grow quickly, producing rich forage (A. Gunn and Sutherland 1997b; Nellemann and Reynolds 1997; A. Gunn and Adamczewski 2003). Muskox are commonly found near wetland and in wetter, shrubby tundra habitats in the summer (A. Gunn and Sutherland 1997b). Gunn and Sutherland (1997b) also found that single bulls and immature males used the immediate vicinity of water bodies more often than any other age or sex class. The fringes of these water bodies may support muskox forage such as sedges. The following general assumptions were made to define summer habitat ratings:

- High ratings were given to vegetation associations that contain preferred forage species, mainly willow and sedges.
- Moderate ratings were assigned to vegetation associations that contain some preferred forage species, but typically have a lower cover of sedges and willow species.
- Low ratings were given to vegetation associations that contained limited forage opportunities.
- Nil ratings were given to vegetation associations that contained sparse vegetation, or where travel was difficult.

<u>Winter/Early Spring</u>

Habitat use during the winter and early spring is focused on areas that provide accessible forage (e.g., low snowpack or windswept areas) and/or early vegetation growth. Willows are especially selected in spring when willow leaves are emerging (A. Gunn and Sutherland 1997a; Larter and Nagy 2004; Kristensen et al. 2011). Habitat studies have shown that late winter/early spring habitat use is varied, ranging from rugged exposed terrain in the high Arctic, to lowland areas in Alaska, indicating that habitat use may vary from region to region (Schaefer, Stevens, and Messier 1996; Nellemann and Reynolds 1997). Habitat preference is based on the need for low winter fat reserves to be replenished, and for pregnant or lactating cows to access high quality forage (Reynolds, Reynolds, and Shideler 2002). The following general assumptions were made to define winter and early spring habitat ratings:

- High ratings were given to vegetation associations where limited snowpack is likely (e.g., windswept ridges) and areas with a significant amount of early vegetation.
- Moderate ratings assumed that forage opportunities were available, but were not as accessible or available as early in the season as high value vegetation associations.
- Low ratings were given to vegetation associations with limited seasonal forage, or areas where the snowpack likely persists thereby reducing foraging opportunities.
- Nil ratings were given to vegetation associations with sparse vegetation, high disturbance, and those that typically occur in landscape positions where snow packs are deep and persistent.

5.3.3 Results and Discussion

5.3.3.1 Summer/Fall

Very little (7%) of the LSA was rated as Highly suitable summer and fall habitat for muskox (Table 5.3-2). Highly rated habitat was mapped over relatively small areas in the LSA (Figure 5.3-1), as few ecosystem polygons contained high proportions of habitat that could produce large amounts of preferred forage (e.g., sedge wetlands and riparian areas). Moderately suitable habitats, encompassing

28% of the LSA, covered larger geographic areas than Highly rated habitats and were spread across the LSA (Figure 5.3-1; Table 5.3-2). The largest proportion of the LSA was rated as Low (65%). For the most part, Low suitability habitats were those that were almost purely composed of habitats that would produce low quantities of forage (i.e., ecosystem polygons dominated by WHR 3 rated habitats). Less than 1% of the LSA was rated as Nil.

Table 5.3-2. Muskox Summer and Fall Habitat within the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)[1]	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	9,416.09	7	168,221.76	13
Moderate	37,545.98	28	314,380.74	25
Low	87,203.99	65	702,002.89	56
Nil	203.24	< 1	72,547.20	6

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*

High and Moderate rated habitats accounted for 13% and 25% of the RSA, respectively. These habitats represented areas capable of producing large to moderate amounts of high quality summer forage; these higher quality habitat areas appeared to be most abundant in the north RSA surrounding Bathurst Inlet and in the southeastern RSA (Figure 5.3-2). Low rated habitats occupied over two-thirds (56%) of the RSA, covering the vast tracts of drier tundra and boulder fields where little to no forage may be available. A small amount (6%) of the RSA was rated as Nil.

5.3.3.2 Winter/Early Spring

Highly rated winter and early spring muskox habitat, covering 8% of the LSA, is primarily near the George Property Area and northern portion of the LSA (Figure 5.3-3; Table 5.3-3). High rated habitat was sparse within the southern portion of the LSA. Moderate rated habitats accounted for approximately a fifth (22%) of the LSA; these habitats generally had high to modest amounts of shrubby forage over the winter and into the spring but not all forage may be accessible due to deeper snowpack. Moderate rated habitat was mainly located near the George Property Area and northern portion of the LSA. The remainder of the LSA was rated as Low (44%) and Nil (26%; Table 5.3-3). These lower rated habitats encompassed much of the lower elevation habitats in the LSA, such as wetlands and larger water bodies (Figure 5.3-3). Vegetation in wetlands (e.g., sedges and grasses) can be an important food source for muskox in the winter where they can crater through soft snow down to the ground or where the wind exposes these types of habitats. However, it was assumed that the vast majority of wetlands would be covered in a deep and persistent snowpack into the spring because they generally occurred on the lowest slope positions in the study area.

A total of 6% (69,629 ha) of the RSA was rated as Highly suitable habitat for muskox in the winter and early spring (Table 5.3-3). Highly rated habitats were sparsely distributed across the RSA (Figure 5.3-4). Generally these highly rated habitats were windswept tundra and ridges where herbaceous or shrubby forage would be accessible. Moderate rated habitats accounted for 27% of the RSA and represented higher elevation, windswept habitats that have a lower quantity of suitable forage for muskox over winter and into the spring (e.g., rocky heath habitats where lichens are common but grasses and shrubs grow more sparsely). The remaining habitat was rated as Low (26%) and Nil (41%). Low and Nil rated habitats generally encompassed river valleys, water bodies, and surrounding lowland habitats were snowpack would limit foraging opportunities (Figure 5.3-4; Table 5.3-3).

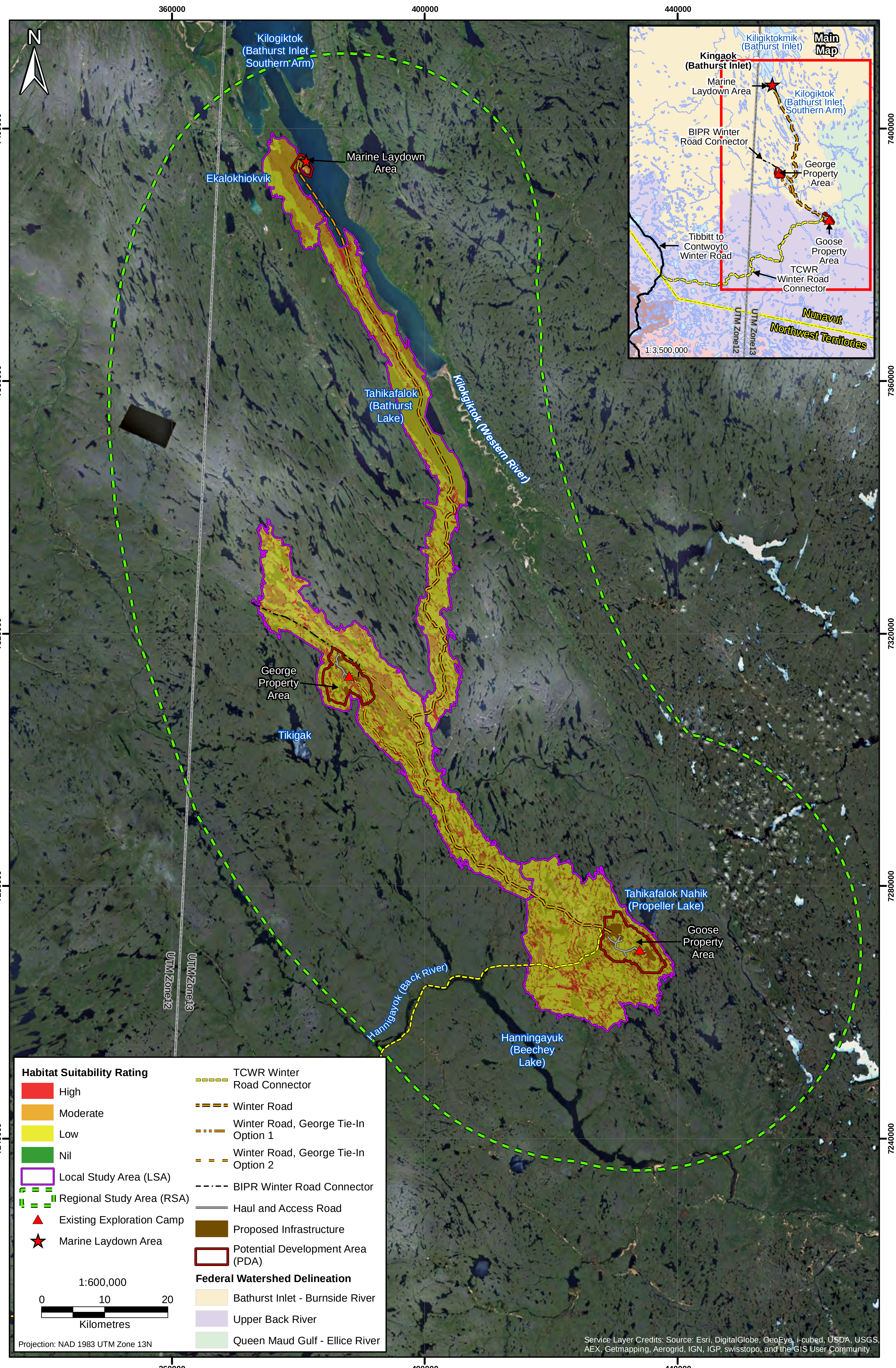

Figure 5.3-1

Sabina GOLD & SILVER CORP.

Muskox: Summer and Fall Habitat in the Local Study Area

Figure 5.3-1

Rescan an ERM company

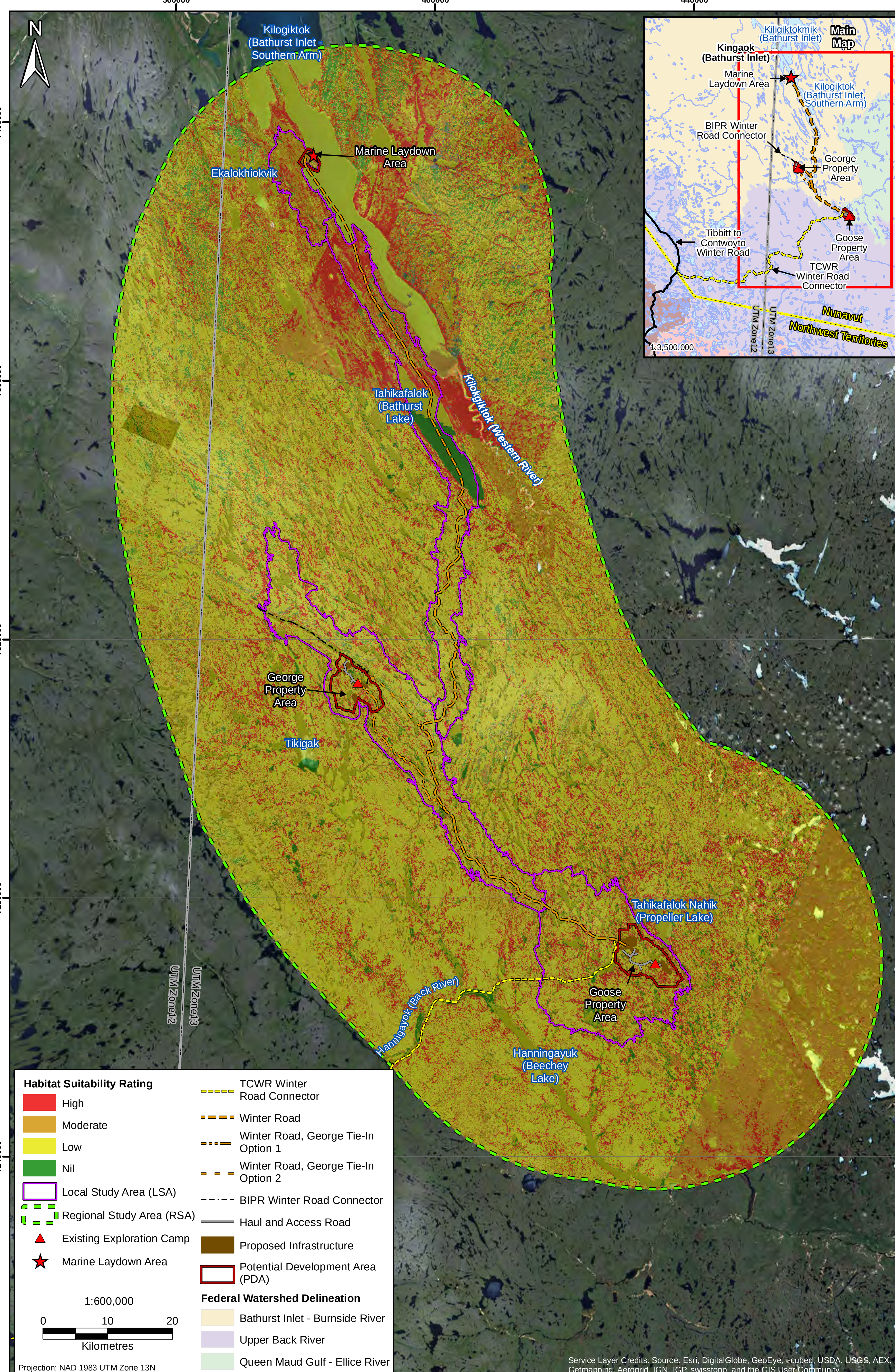

Figure 5.3-2

Muskox: Summer and Fall Habitat in the Regional Study Area

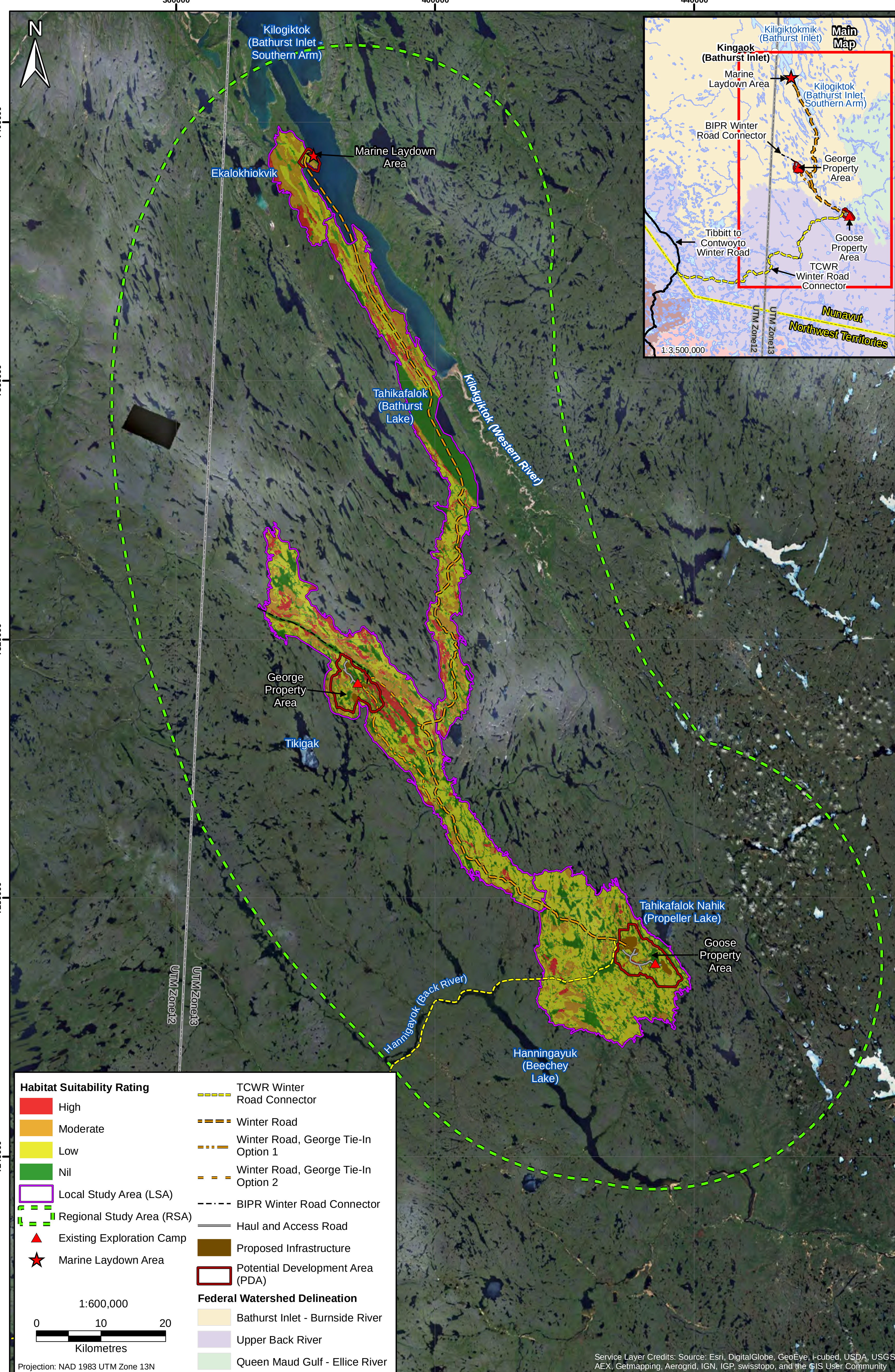

Figure 5.3-3

Sabina GOLD & SILVER CORP.

Muskox: Winter and Early Spring Habitat in the Local Study Area

Rescan an ERM company

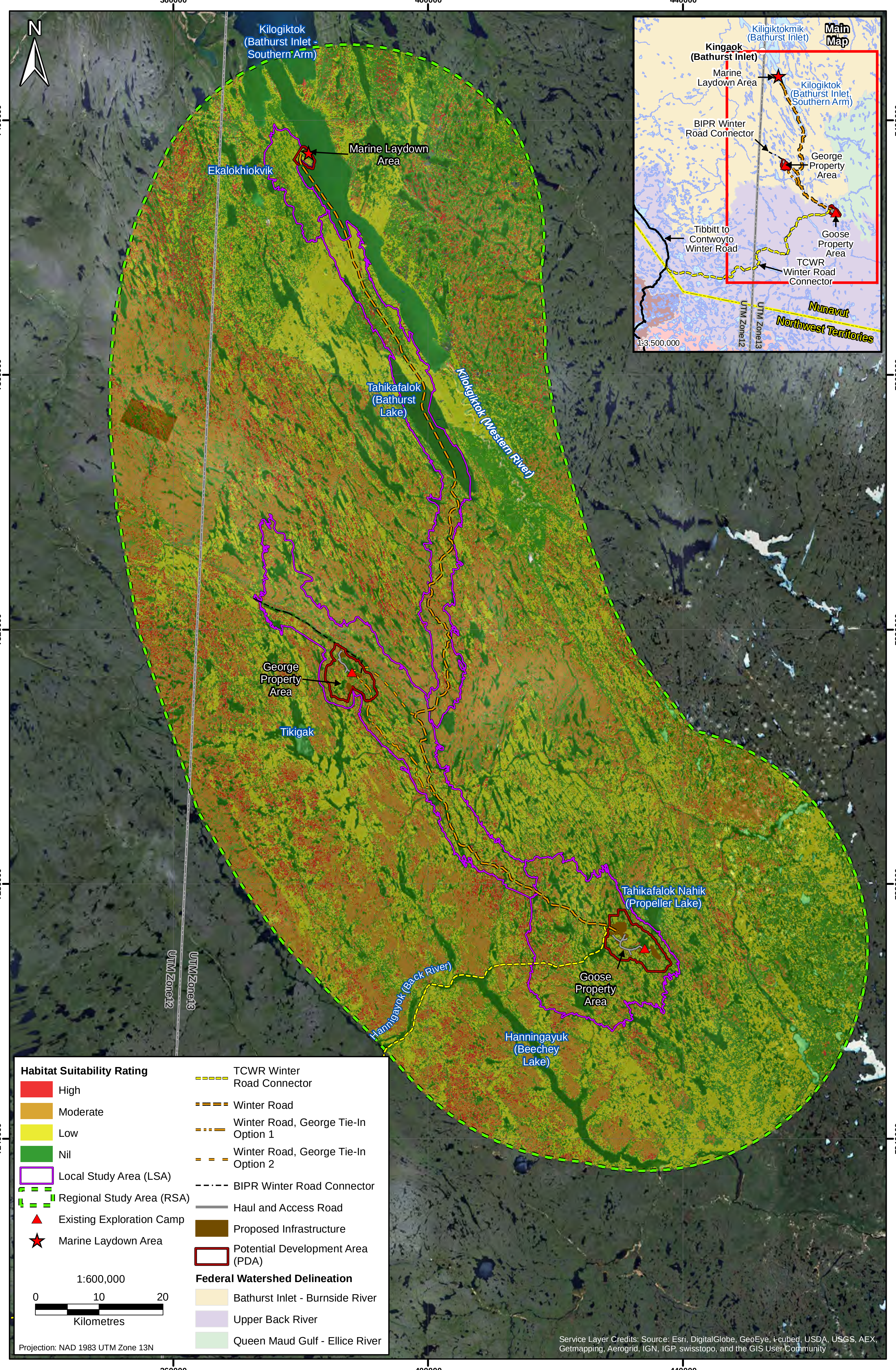

Figure 5.3-4

Muskox: Winter and Early Spring Habitat in the Regional Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Table 5.3-3. Muskox Winter and Early Spring Habitat within the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)[1]	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	10,371.54	8	69,629.33	6
Moderate	29,754.76	22	340,442.43	27
Low	58,950.99	44	330,149.21	26
Nil	35,292.03	26	516,931.61	41

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*

5.4 GRIZZLY BEAR

5.4.1 Background

Grizzly bears (*Ursus arctos*) in the Arctic, often referred to as barren-ground grizzly bears, are an important, top-level predator in the Arctic ecosystem. Grizzly bears in the Canadian Arctic belong to the larger, western Canadian population of grizzly bear, which are currently listed as Special Concern under COSEWIC (COSEWIC 2002), and in Nunavut, grizzly bear are considered Sensitive (CESCC 2010).

There is no official estimate on grizzly bear population sizes for Nunavut. However, a crude estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which includes the Project area (Ross 2002). This estimate assumed a density of four bears per 1,000 km^2 based on grizzly bear densities in nearby areas (Ross 2002). The barren-ground grizzly bear population is stable or slightly increasing, but is considered vulnerable to decline from increased adult mortality (McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003; McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Population modelling studies using demographic data of bears in the region show that even slight increases in mortality can precipitate a negative population trend (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003).

Barren-ground grizzly bear occur at the northern and eastern edge of the continental grizzly bear range. These bears have the largest home ranges of any grizzly bear in North America, ranging around 2,100 km^2 for females and 7,245 km^2 for males (McLoughlin, Ferguson, and Messier 2000). These extensive home ranges are necessitated by the lower quality and quantity of suitable foraging habitats in the Arctic. Given the lower productivity and high seasonality of the Arctic environment, the home range of individual grizzly bear overlap more on the tundra than they do in southern, more productive areas (McLoughlin, Ferguson, and Messier 2000).

5.4.2 Habitat Suitability Model Development

Grizzly bear are omnivorous and opportunistic feeders that select habitat largely based on seasonal availability of forage (MacHutchon and Wellwood 2003; Wellwood 2003). Table 5.4-1 presents the seasonal life requisites for grizzly bear used to develop suitability ratings. Ratings focused on living requisites for the spring, summer, and fall seasons, and were based on an assessment of the ecosystem units' abilities to produce forage species. Vegetation phenology was used to rate ecosystem units for target forage species for a given season (e.g., blueberries are absent in the spring, ripen during the summer, and die off during the fall). Prey sources that are strongly associated with specific ecosystem units were included in the ecosystem unit ratings where possible, e.g., Arctic ground squirrel

(*Spermophilus parryii*) colonies located within esker habitats. For the denning season, ratings were geared towards satisfying the reproducing life requisite and focussed on identifying habitats with high potential for denning opportunities (e.g., easily excavated soils).

Table 5.4-1. Seasonal Life Requisites of Grizzly Bear

Season	Date	Life Requisite	Habitat Preference
Spring	May - June	Living	Esker, crowberry, blueberry, sedge, riparian shrub, caribou, ground squirrel
Summer	June - September	Living	Esker, blueberry, sedge, riparian shrub, ground squirrel
Fall	September - October	Living	Esker, blueberry, sedge, riparian shrub, caribou, ground squirrel
Denning	October to May	Reproducing	Eskers, lacustrine deposits

5.4.2.1 Model Assumptions

The assumptions developed for grizzly bear were based on literature reviews, suitability mapping completed for similar projects in Nunavut and the NWT, and field assessments. The main assumptions are that grizzly bears target a variety of vegetation as it becomes available through the short, Arctic growing season, but are strongly influenced by the availability of caribou and other protein sources (e.g., ground squirrels) in the early spring and again in the late summer and fall (Gau et al. 2002). Caribou availability was not included in the rating assumptions as it is not a factor that can be accurately applied (due to the variability in the location and timing of caribou presence). The following sections describe the wildlife habitat rating assumptions and rating for each season for the LSA and RSA.

<u>Spring</u>

Spring habitat provides grizzly bears their first opportunity to feed after emerging from winter hibernation. Important habitat includes areas that become snow-free early, and ecosystem units that contain last season’s over-wintered berries, Arctic ground squirrel burrows, winter-weakened ungulates, and early vegetation (Gau et al. 2002; MacHutchon and Wellwood 2003). The following general assumptions were made to define spring WHRs:

- High ratings were assigned to vegetation associations that provide early season food sources. These are upland areas that are generally windswept resulting in low snowpack. Over-wintered berries from the previous season are typically available, as are Arctic ground squirrels.
- Moderate ratings were given to vegetation associations that provide some food sources, but are generally not windswept and have limited over-wintered berries. These vegetation associations also have the potential for some early season forage of sedges and grasses.
- Low ratings were given to vegetation associations that were considered to have low forage potential and are not preferred habitat for prey species.
- Nil ratings were given to vegetation associations that have a lack of forage and prey, or are disturbed.

<u>Summer</u>

Summer habitat use by grizzly bears is highly variable. Grizzlies primarily feed on horsetails, sedges, and cottongrass in the early summer when caribou are scarce, as well as berries if they are available. Caribou calves and Arctic ground squirrels are considered to be their primary prey sources in mid-summer (Gau et al. 2002). Late summer use focuses on areas with high berry production. The following general assumptions were made to define summer WHRs:

- High ratings were given to vegetation associations that provide berries, cottongrass, and sedges which are critical vegetative food sources when caribou are absent from the region. Eskers were included for Arctic ground squirrel availability and ease of travel.
- Moderate ratings were assigned to vegetation associations that provide late summer berry production and those which contain sedges and cottongrass in limited quantities.
- Low ratings were given to vegetation associations that were considered to have low forage potential and are not preferred habitat for prey species.
- Nil ratings were given to vegetation associations that lacked forage and prey, and those that were disturbed.

Fall

The fall season is critical for grizzly bears as they must gain weight rapidly in order to survive the winter. Fall habitat selection is focused on areas of high caribou occurrence (Johnson et al. 2004) and berry availability. The following general assumptions were made to define fall WHRs:

- High ratings were given to vegetation associations that are most likely to contain large quantities of berries and Arctic ground squirrels.
- Moderate ratings were assigned to vegetation associations that may contain limited quantities of berries, and to a lesser extent browning sedge and cottongrass forage.
- Low ratings were given to vegetation associations that were considered to have low forage potential and are not preferred habitat for prey species.
- Nil ratings were given to vegetation associations that lacked forage and prey, and those that were disturbed.

Denning

In general, denning lasts from late October to early May for most bears; some bears, males in particular, may den for shorter periods of time (McLoughlin, Cluff, and Messier 2002). Dens have been found in a wide variety of habitat types. Of 56 dens located by McLoughlin, Cluff, and Messier (2002), most (60%) were found in heath tundra and heath-boulder habitats, and many of the remaining dens were located in riparian tall shrub and birch seep habitats. Although eskers accounted for only seven of 56 den sites studied, this habitat type was selected more than expected given its low availability in the central Arctic. Hence, many habitats appear to have suitable soil texture and structure for denning, but eskers may be selected where available given the ease in which bears may excavate dens. The following general assumptions were made to define denning WHRs:

- High ratings were assigned to vegetation associations that provide terrain features that allow for denning opportunities, specifically parent materials that are easily excavated, have deep permafrost layers, and contain sufficient vegetative root masses to provide soil stability.
- Moderate ratings were given to vegetation associations that are similar to high value habitat, but are more likely to contain limitations in the form of shallow permafrost layer, or consolidated materials.
- Low ratings were given to vegetation associations that were considered to have limited potential for successful den excavations, but recognize that the arctic landscape generally provides few high value denning sites, so sub-optimal sites may be utilized.

- Nil ratings were given to vegetation associations that were not suitable for excavation due to shallow soils, high permafrost layers, organic soils, or other conditions that would make a successful den excavation difficult.

5.4.3 Results and Discussion

5.4.3.1 Spring

Very little (2%) of the LSA was rated as Highly suitable spring habitat for grizzly bear (Table 5.4-2), indicating that few ecosystem polygons contained high proportions of habitat with preferred spring forage and prey species (e.g., windswept areas with low snowpack and over-wintered berries or abundant Arctic ground squirrel colonies). The largest concentrations of Highly rated habitat were mapped northwest of the George Property Area along the LSA boundary (Figure 5.4-1). The majority (65%) of the LSA was rated as Moderately suitable spring habitat for grizzly bear and covered large expanses of most of the LSA (Figure 5.4-1). These areas have higher snowpack and are generally not windswept, so vegetation and over-wintered berries are limited. Approximately a third of the LSA was rated as Low (14%) and Nil (18%) suitability habitats and would provide very limited forage and prey species.

Table 5.4-2. Grizzly Bear Spring Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	3,182.31	2	5,457.20	< 1
Moderate	87,405.09	65	637,044.63	51
Low	19,074.53	14	412,168.14	33
Nil	24,707.36	18	202,482.60	16

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

Half of the RSA (51%) contained Moderately suitable spring habitat for grizzly bear and was distributed fairly evenly throughout the area (Table 5.4-2; Figure 5.4-2). Approximately one-third of the RSA was rated as Low suitability habitat (33%). Moderate and Low habitats would represent areas producing average to limited amounts of preferred early season forage and prey species. Nil suitability habitat (16% of RSA) covered much of the water and barren ecosystems, and thus provides limited to no value for foraging or hunting. Very limited portions (less than 1%) in the northern segment of the RSA were rated as Highly suitable spring habitat.

5.4.3.2 Summer

A small amount (9%) of the LSA was rated as Highly suitable summer habitat for grizzly bear. These areas are sparse throughout the LSA with a concentration along the western side of Bathurst Inlet (Figure 5.4-3). Highly suitable summer habitat was generally associated with wetlands, such as marshes or fens, which provide abundant sedges and cottongrass. Two-thirds (67%) of the LSA was comprised of Moderate suitability summer habitat and approximately one-quarter (24%) of the LSA was rated as Low suitability habitat for grizzly bear (Table 5.4-3). Moderate habitats were fairly evenly distributed within the LSA, particularly within and surrounding the Goose Property Area (Figure 5.4-3). These habitats were generally associated with shrubby areas that provide late summer berries. A larger amount of Low suitability habitat was identified near the George Property Area. Low rated habitats were typically associated with dry, sparse tundra with low forage potential and limited prey species.

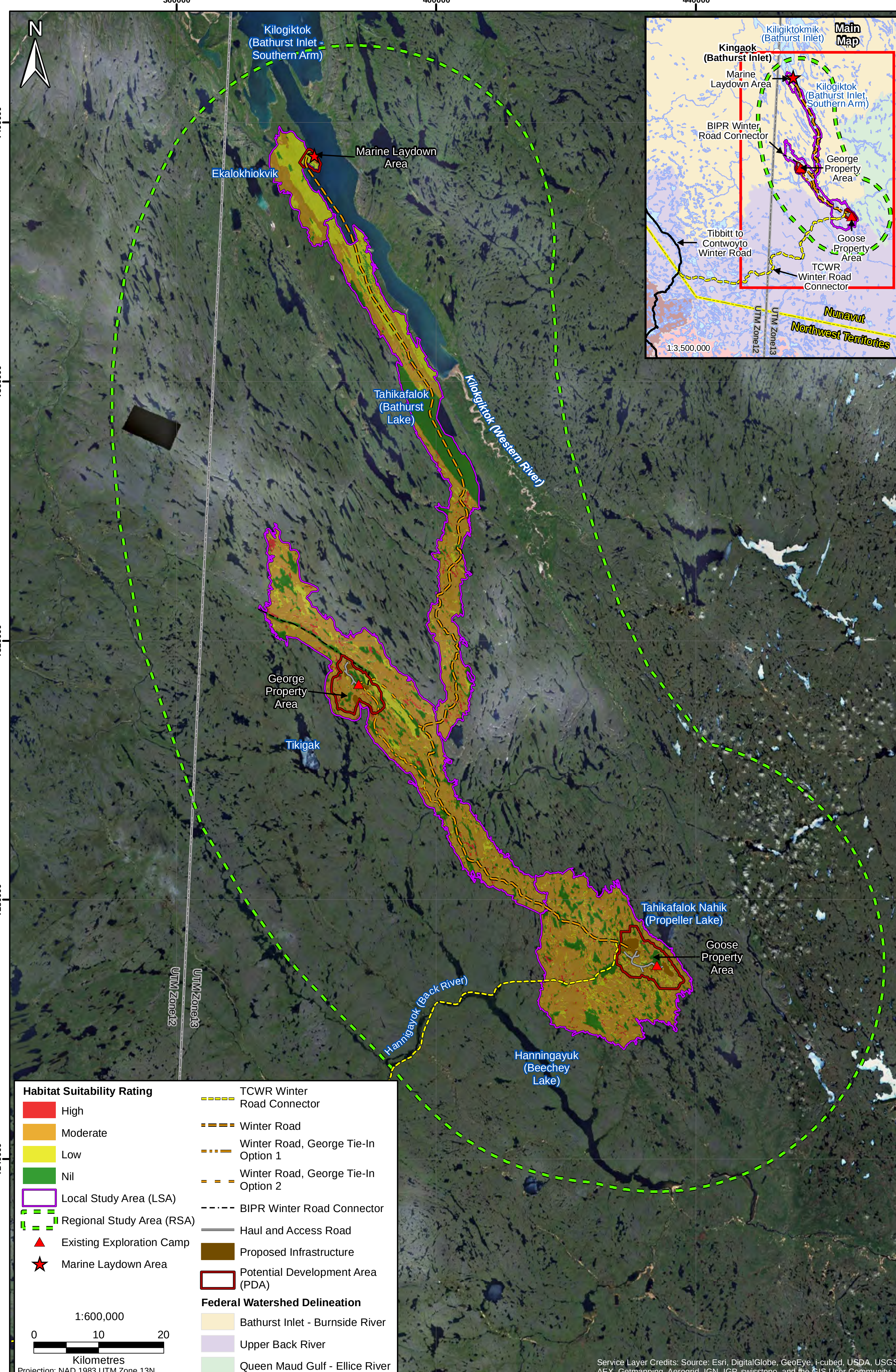

Figure 5.4-1

Grizzly Bear: Spring Habitat in the Local Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

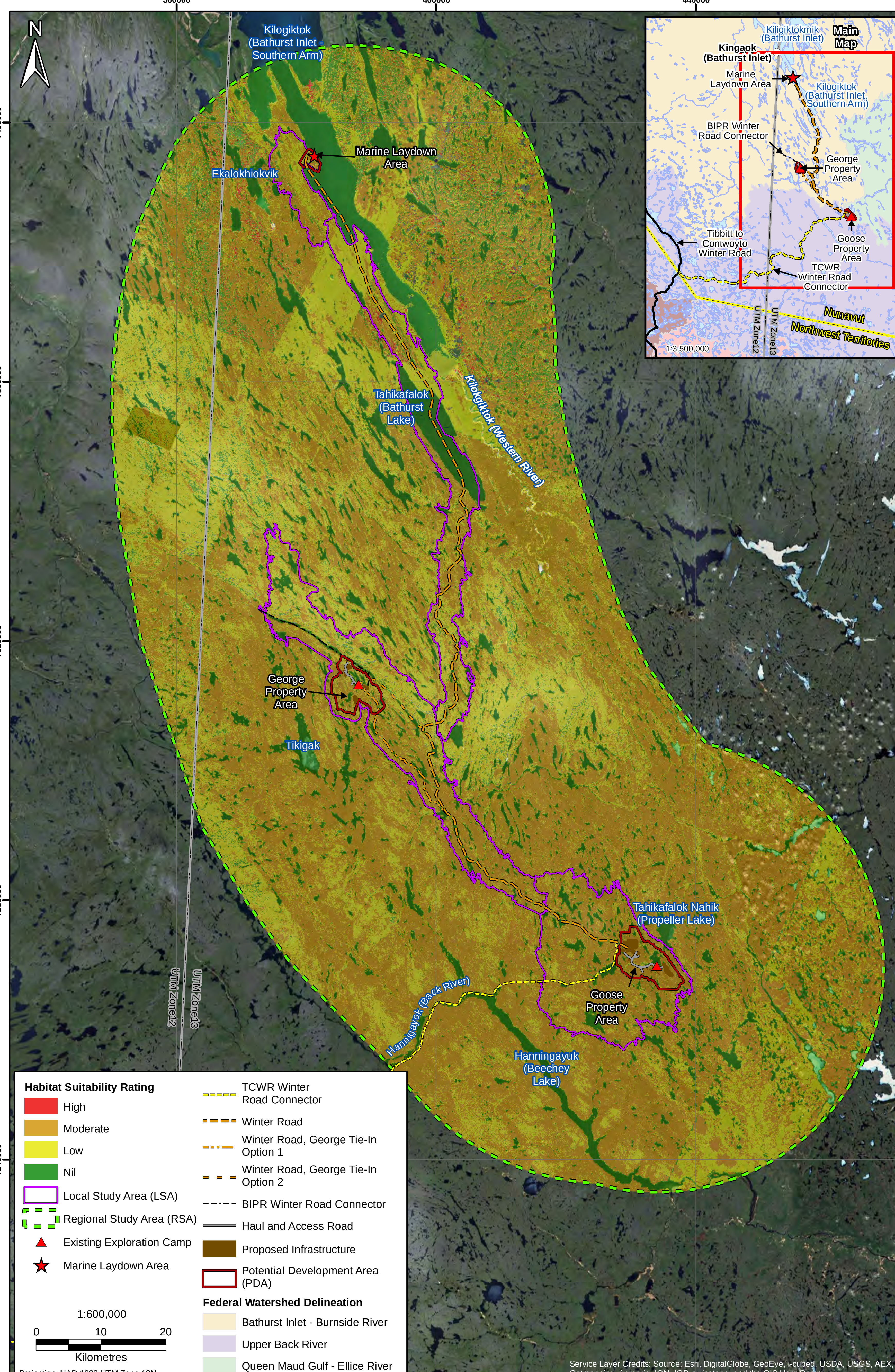

Figure 5.4-2

Sabina GOLD & SILVER CORP.

Grizzly Bear: Spring Habitat in the Regional Study Area

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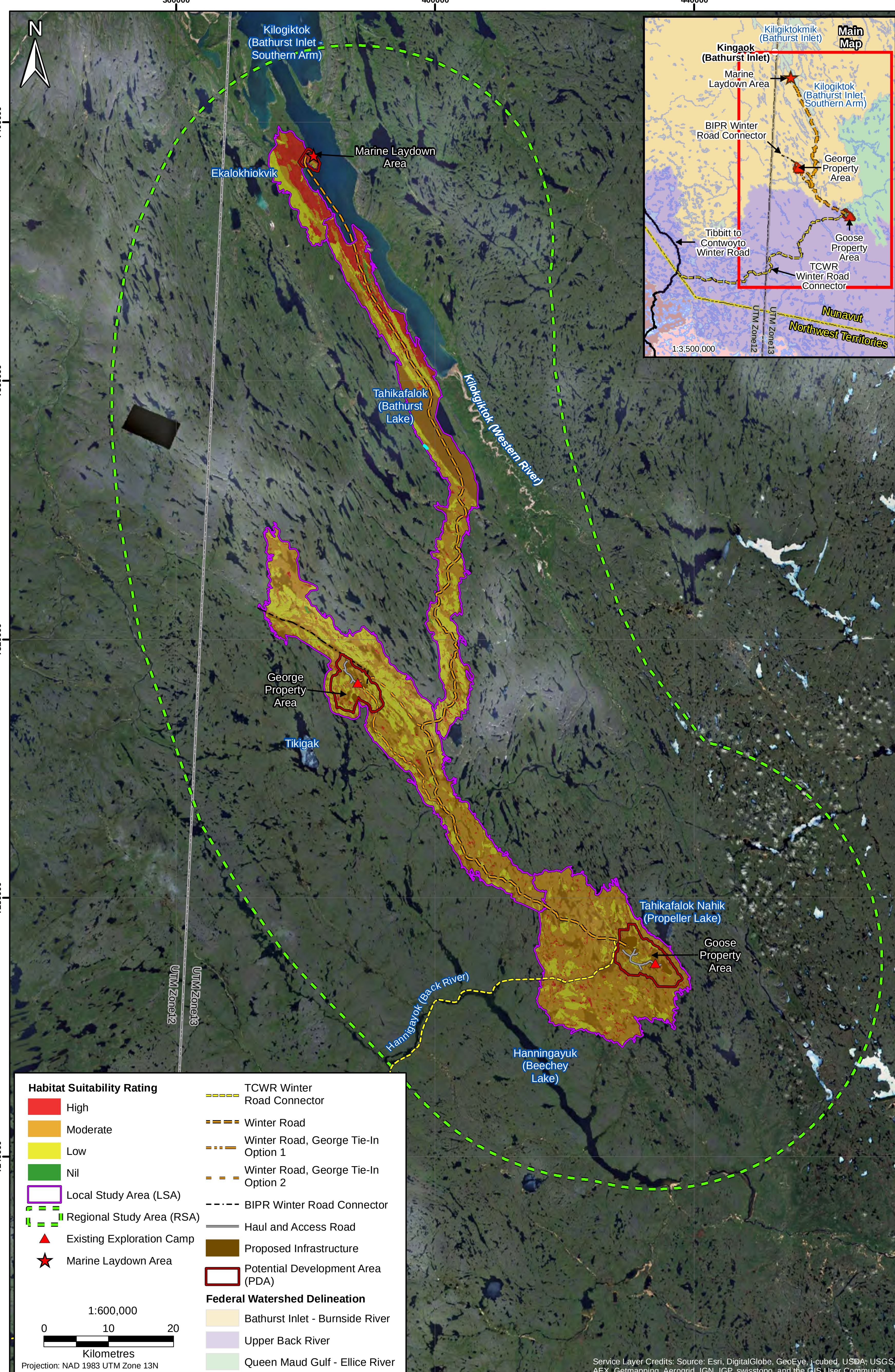

Figure 5.4-3

Sabina GOLD & SILVER CORP.

Grizzly Bear: Summer Habitat in the Local Study Area

Rescan an ERM company

Table 5.4-3. Grizzly Bear Summer Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	11,887.54	9	137,717.33	11
Moderate	90,219.29	67	540,367.41	43
Low	31,740.05	24	506,521.65	40
Nil	518.18	< 1	72,547.20	6

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

The majority (83%) of the RSA was composed of relatively equal portions of Moderate (43%) and Low (40%) suitability summer habitats for grizzly bear (Figure 5.4-4; Table 5.4-3). Moderate and Low rated habitats consist of shrubby to drier tundra areas with adequate to low forage and prey species. The remaining habitat was comprised of High rated (11%) and Nil rated habitat (6%; Table 5.4-3). Highly suitability habitats were sparsely distributed throughout the RSA and were associated with sedge-meadow wetlands, which would provide both early and late summer forage (Figure 5.4-4).

5.4.3.3 Fall

Limited areas (6%) of the LSA were rated as Highly suitable fall habitat for grizzly bear (Table 5.4-4); Highly rated habitat predominately encompassed shrubby esker areas, particularly along the coasts of Bathurst Inlet (Figure 5.4-5), where there be high berry availability and potentially prey species (e.g., ground squirrels, caribou). The majority of the LSA consisted of Moderately suitable fall habitat for grizzly bear (52%; Table 5.4-4). Moderate habitat was fairly evenly distributed within the LSA, representing areas with lower potential for berry production and late season sedge and graminoid forage. Under half (42%) of the LSA was rated as Low suitability fall habitat and predominately consisted of rocky or dry, sparse tundra with low berry availability. A large portion of Low habitat was mapped around the George Property Area. The remaining area (less than 1%) was rated as Nil suitability habitat.

Table 5.4-4. Grizzly Bear Fall Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	7,347.94	6	5,457.20	< 1
Moderate	70,011.78	52	542,692.12	43
Low	56,448.67	42	636,456.05	51
Nil	556.67	< 1	72,547.20	6

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

Approximately half (51%) of the RSA was rated as Low suitability fall habitat for grizzly bear (Table 5.4-4). Low rated habitat covered large tracts of the RSA and were characterized by rocky heath tundra or boulder fields that produce little to no berry forage (Figure 5.4-6). There was 43% of Moderately suitable fall grizzly bear habitat in the RSA; this habitat is dominated by mesic, shrubby tundra and sedge wetlands. Very little (less than 1%) of the RSA was rated as Highly suitable fall habitat for grizzly bear; this limited High rated habitat was constrained to esker complexes in the northern portion of the RSA (Figure 5.4-6). The remaining habitat was rated as Nil (6%; Table 5.4-4).

5.4.3.4 Denning

Suitable denning habitat was very limited in the LSA and RSA. Both the LSA and RSA were predominately rated as Nil suitability for grizzly bear denning habitat, respectively 97% and 96% (Table 5.4-5; Figure 5.4-7 and Figure 5.4-8). This was expected due to the limited extent of eskers and lacustrine deposits within the LSA and RSA and the dominance of rocky heath tundra and boulder fields. High suitability grizzly bear denning habitat was limited (less than 1%) within both the RSA and LSA and was constrained to shrubby, esker complexes (Figure 5.4-7 and Figure 5.4-8). Spatially, High suitability habitat was very sparse throughout the LSA and was constrained to the northern portion of the RSA.

Table 5.4-5. Grizzly Bear Denning Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	942.09	< 1	5,457.20	< 1
Moderate	532.56	< 1	0.00	0
Low	2,242.55	~2	49,677.98	~4
Nil	130,652.11	97	1,202,017.39	96

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes area of LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*

5.5 GREY WOLF

5.5.1 Background

The largest member of the *Canis* genus, the grey wolf (*Canis lupus*) was once abundant over much of North America and Eurasia; however, its range has reduced due to habitat destruction and hunting. Wolves are still widespread throughout much of northern Canada, including the West Kitikmeot Region of Nunavut. Populations are stable or increasing within their Canadian range, except in northern Alberta and some parts of the NWT (Hayes and Gunson 1995). In Nunavut, grey wolf is listed as secure (CESCC 2010).

Wolves are the main predators of barren-ground caribou and rely on adequate ungulate densities to maintain wolf population size (Walton et al. 2001; Paquette and Ludwig 2003). As predators of migratory caribou, wolves in the Arctic are also migratory and trail caribou populations through much of the year. Grey wolves overwinter alongside boreal and barren-ground caribou below the treeline and in the spring follow the migration of barren-ground caribou northwards towards their calving grounds. Grey wolves select denning sites on the tundra in late April, which are located to the south of the primary caribou calving grounds. Dens are focal points of wolf activity during the summer, and there is evidence that individual wolves exhibit fidelity to den sites (Cluff, Walton, and Paquet 2002), returning and using the same areas in successive years (Walton et al. 2001). Adults make long distance forays from den sites in search of caribou during the summer, and alternative prey, such as young birds and small mammals, can sustain wolves during periods of low ungulate availability. Wolves begin to follow caribou herds southward towards caribou winter grounds as soon as the young are able to travel with the pack, generally in September. On account of their migratory behaviour, wolves in the Arctic have exceptionally large home ranges (approximately 63,000 km^2 for males and 45,000 km^2 for females) and exhibit fewer territorial behaviours than wolves in other parts of North America (Walton et al. 2001).

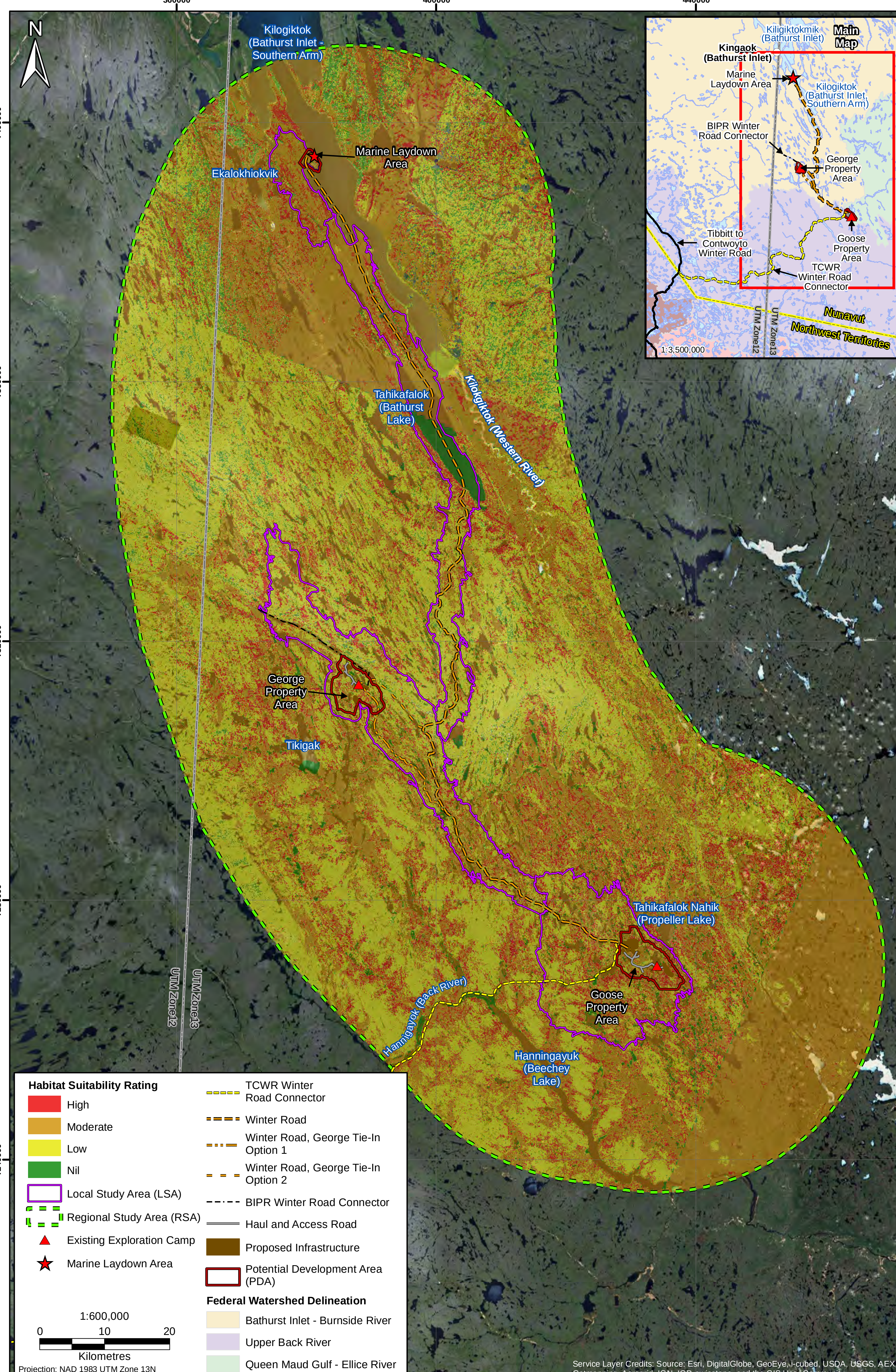

Figure 5.4-4

Grizzly Bear: Summer Habitat in the Regional Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

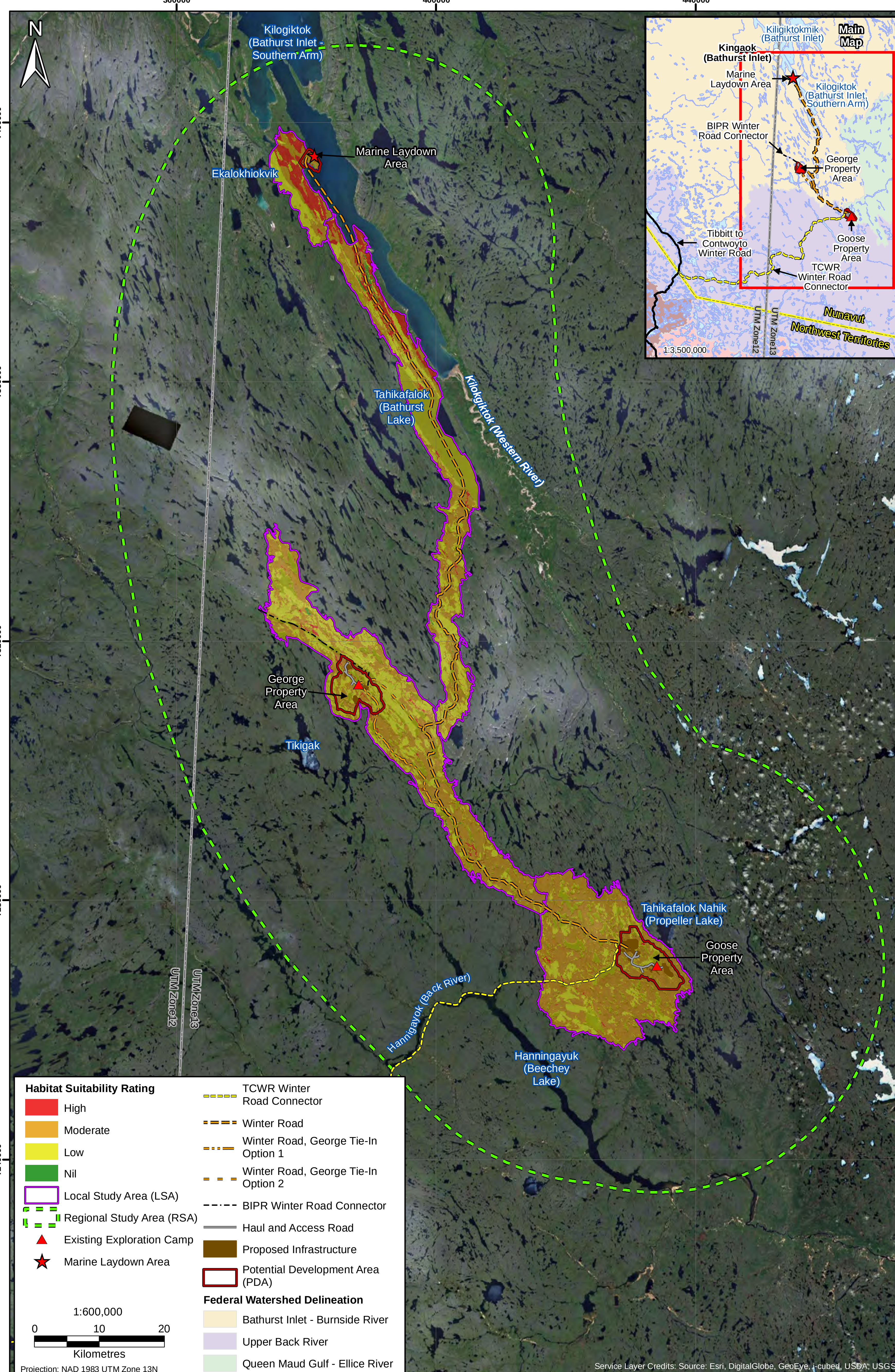

Figure 5.4-5

Grizzly Bear: Fall Habitat in the Local Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

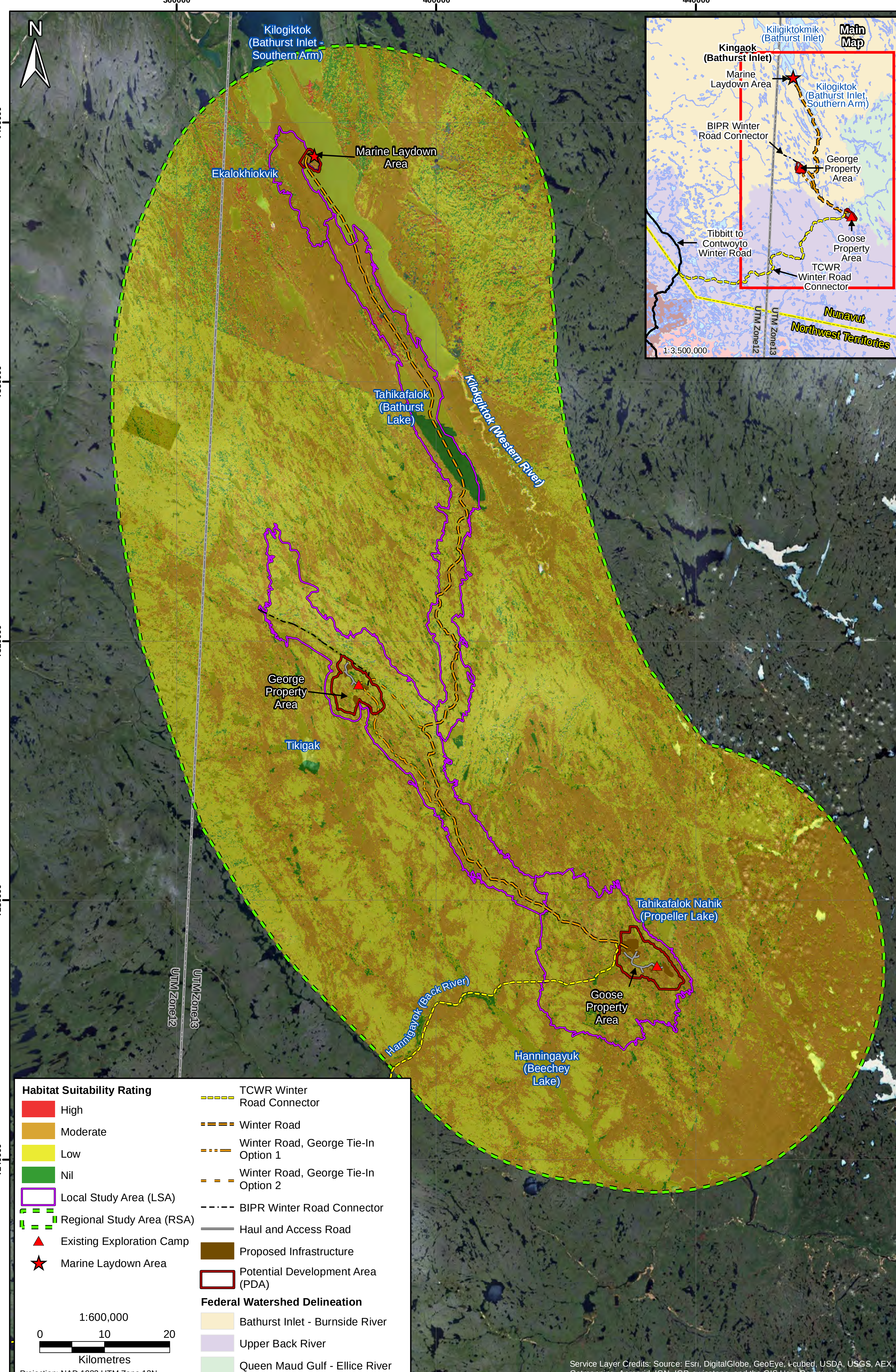

Figure 5.4-6

Sabina GOLD & SILVER CORP.

Grizzly Bear: Fall Habitat in the Regional Study Area

Rescan an ERM company

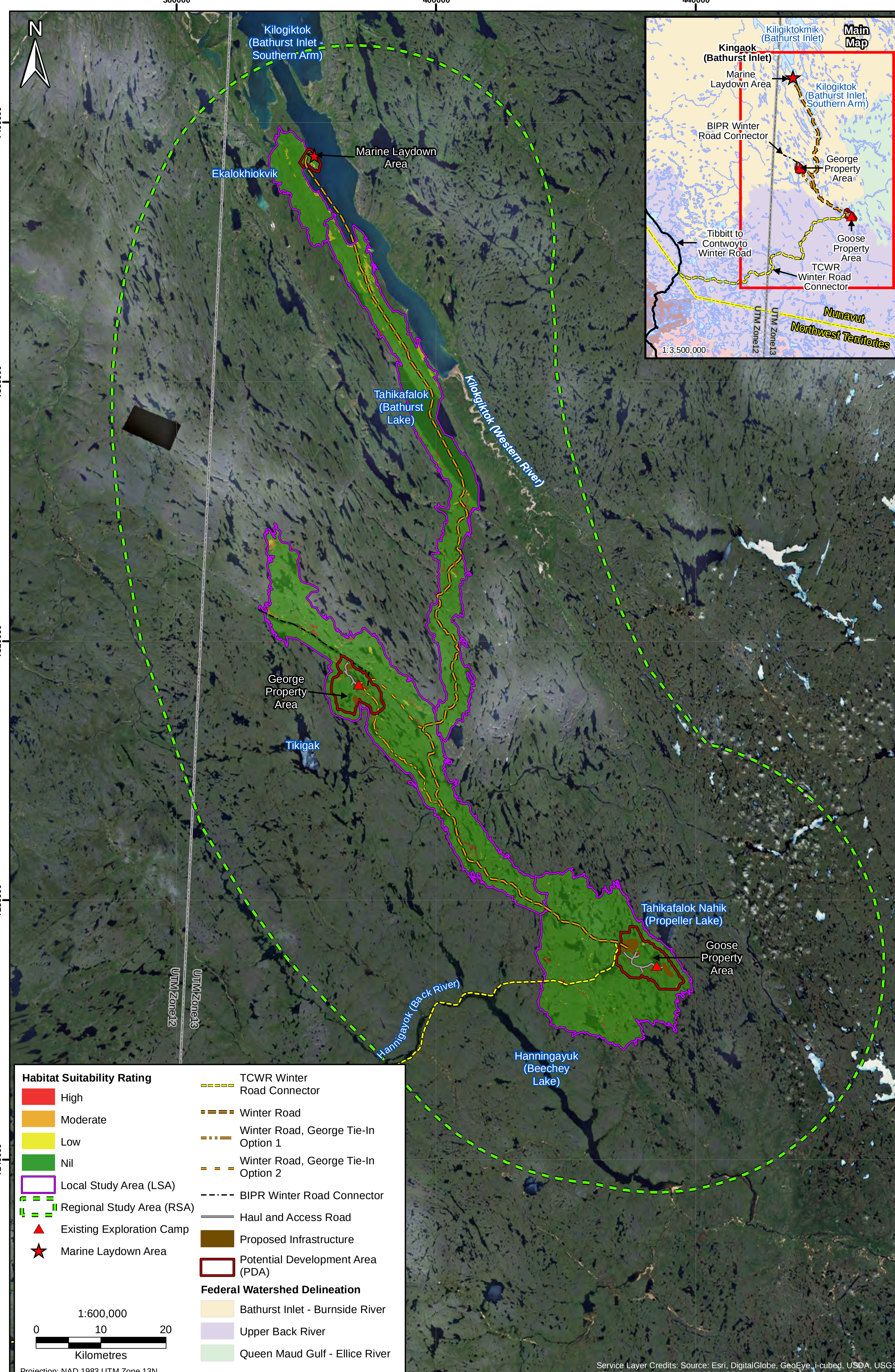

Figure 5.4-7

Sabina GOLD & SILVER CORP.

Grizzly Bear: Denning Habitat in the Local Study Area

Figure 5.4-7

Rescan an ERM company

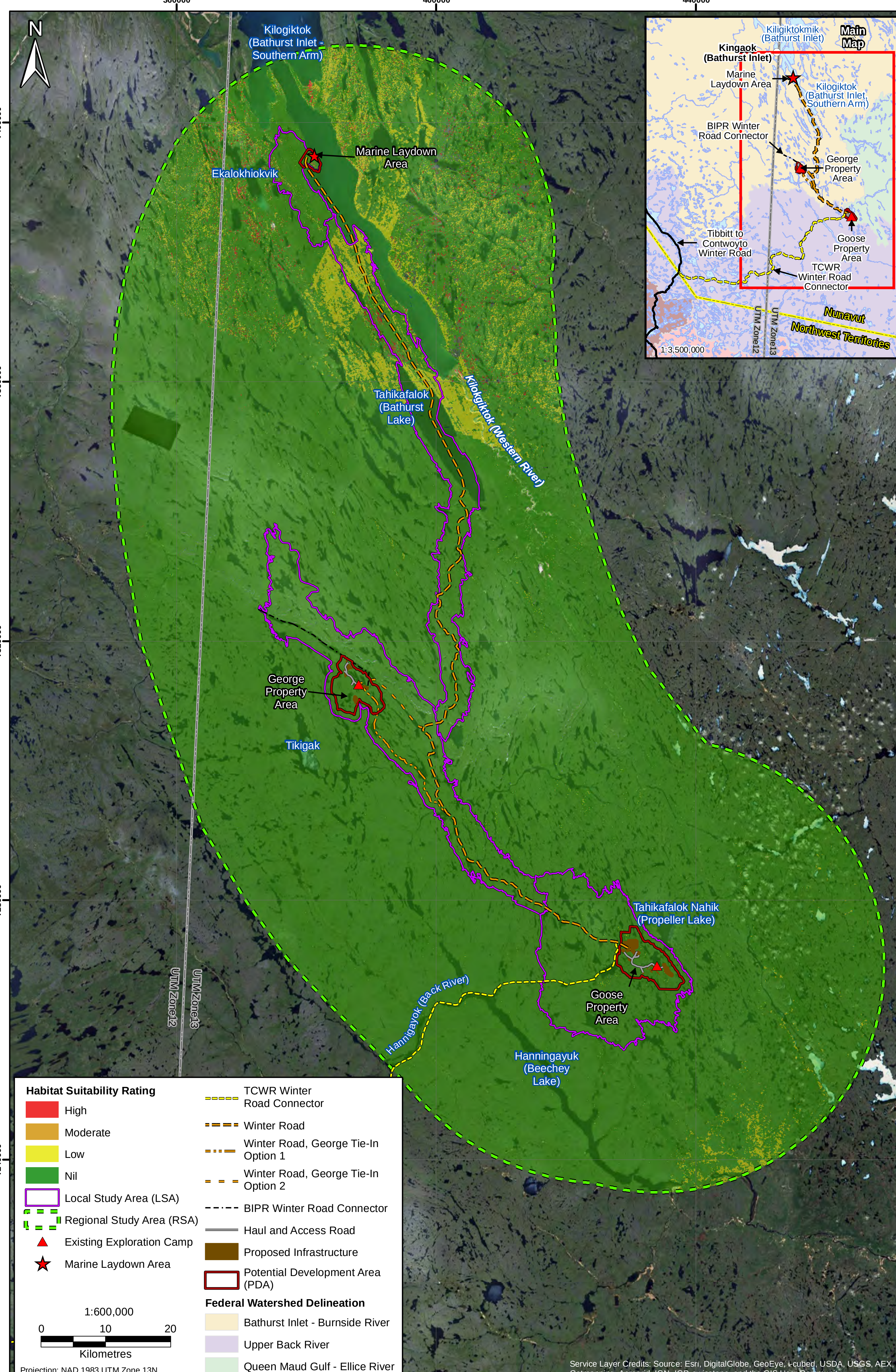

Figure 5.4-8

Sabina GOLD & SILVER CORP.

Figure 5.4-8

Grizzly Bear: Denning Habitat in the Regional Study Area

Rescan an ERM company

5.5.2 Habitat Suitability Model Development

Habitat suitability modelling for grey wolves focussed on identifying suitable denning habitat, satisfying the living and reproducing life requisites in the late spring through fall (Table 5.5-1). Wolves require specific habitat features that allow them to dig denning structures. In the tundra environment, eskers and other glacial deposits provide the best habitat for den sites (Mueller 1995; Rescan 1995; Golder 1998; Walton et al. 2001; Cluff, Walton, and Paquet 2002; McLoughlin et al. 2004). Dens may also occur in other areas that are easy to excavate such as mounds of glacial-fluvial sediment or along lake banks.

Table 5.5-1. Seasonal Life Requisites of Grey Wolf

Season	Date	Life Requisite	Habitat Preference
Denning	Late April to September	Living and Reproducing	Eskers, near prey

5.5.2.1 Model Assumptions

The grey wolf denning model assumed that eskers are the preferred habitats for den construction. Esker habitats are granular and sandy, likely facilitating soil excavation for complex dens sites in a landscape dominated by bedrock, boulders, standing water, and permafrost (McLoughlin et al. 2004). However, habitats that may have denning potential (e.g., gravelly areas where the permafrost layer is deep and soils are relatively loose) were also incorporated into the model where possible. The following general assumptions were made to define denning WHRs:

- High ratings were assigned to vegetation associations that provide terrain features that allow for denning opportunities, specifically parent materials that are easily excavated, have deep permafrost layers, and contain sufficient vegetative root masses to provide soil stability.
- Moderate ratings were given to vegetation associations that are similar to high value habitat, but are more likely to contain limitations in the form of shallow permafrost layer, or consolidated materials.
- Low ratings were given to vegetation associations that were considered to have limited potential for successful den excavations, but recognize that the arctic landscape generally provides few high value denning sites, so sub-optimal sites may be utilized.
- Nil ratings were given to vegetation associations that were not suitable for excavation due to shallow soils, high permafrost layers, organic soils, or other conditions that would make a successful den excavation difficult.

5.5.3 Results and Discussion

Highly suitable denning sites for grey wolves in both the LSA and RSA were scarce (less than 1%), as well as Moderate and Low rated habitats (< 4%; Table 5.5-2). Most of the habitat within the LSA (97%) and RSA (93%) was rated with Nil suitability for grey wolf denning (Table 5.5-2; Figures 5.5-1 and 5.5-2). High rated denning habitat was restricted to esker complexes. In the LSA, high and moderate rated habitat was sparsely distributed (Figure 5.5-1). However, in the RSA, high and moderate rated denning habitat was limited to the northern portion of the RSA; there was also additional moderate rated habitat in the southeastern portion (Figure 5.5-2).

However, even though eskers are generally limited within both the LSA and RSA, the calculated proportion of suitable denning habitat for grey wolves is likely underestimated since additional denning opportunities may occur in areas such as lake banks with lacustrine materials, which were not included in the modelling due to the inability to differentiate between suitable lake banks and open water.

Table 5.5-2. Grey Wolf Denning Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
High	945.67	< 1	5,457.20	< 1
Moderate	825.07	< 1	33,355.98	3
Low	2,923.58	2	49,677.98	4
Nil	129,674.99	97	1,168,661.41	93

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*

5.6 WOLVERINE

5.6.1 Background

Wolverine are the largest member of the mustelid family, which also includes weasels, badgers, and marten. The total population size of wolverines in Nunavut is estimated as 2,000-2,500 individuals (COSEWIC 2003; Slough 2007). The wolverine is ranked as Secure in Nunavut (CESCC 2010), but the western Canadian population (which includes wolverine in Nunavut) was listed as a species of Special Concern by COSEWIC (2003).

The wolverine is an important cultural and economic resource for the Inuit. Wolverine pelts are highly valued for their frost-resistant properties. The Inuit use wolverine pelts as trim and lining for their clothing, including parkas and mittens.

Wolverines in the Arctic are both scavengers and predators, and as such, are largely nomadic throughout the year (excepting the denning period) as they search for food. This lifestyle results in large home ranges; wolverines in the Slave Geologic Province have an estimated home range size of 126 km^2 for adult females and 404 km^2 for adult males (Mulders 2000). The primary food source for wolverines is caribou supplemented with a variety of other species, such as large mammals (muskox or moose), carnivores (wolverine, red fox, Arctic fox, and ermine), small mammals (lemmings, voles, Arctic ground squirrels, and hares), seals, and fish (Mulders 2000).

5.6.2 Habitat Suitability Model Development

Habitat suitability modelling for wolverine focussed on the identification of suitable denning habitat during the late winter (Table 5.6-1), as the availability of adequate security cover (i.e., dens) for kits in winter can affect wolverine reproduction (Banci 1994; Persson 2005).

Table 5.6-1. Seasonal Life Requisites of Wolverine Denning

Season	Date	Life Requisite	Habitat Preference
Denning	February to early May	Living and Reproducing	Landscape features that provide deep, persistent snow packs.

Wolverines use two types of dens for reproduction: 1) natal dens, where the young are born; and 2) maternal dens, where the mother may move the kits if the conditions at the natal den are no longer suitable (Magoun and Copeland 1998). The birth of wolverine kits occurs earlier than other northern non-hibernating carnivores (i.e., wolves and foxes). The peak period for birthing is February through mid-March (Magoun and Copeland 1998; Inman et al. 2012).

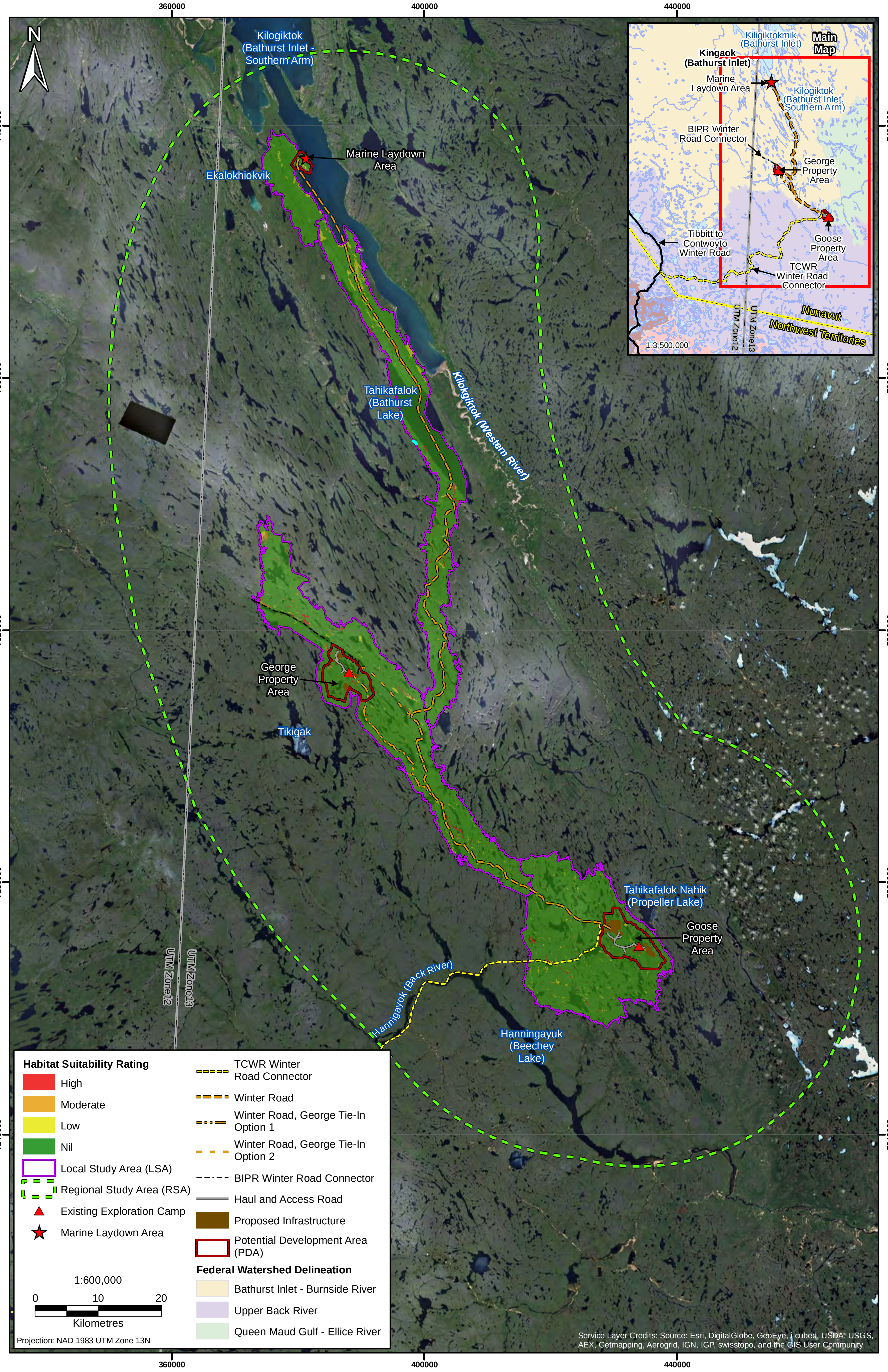

Figure 5.5-1

Sabina GOLD & SILVER CORP.

Grey Wolf: Denning Habitat in the Local Study Area

Rescan an ERM company

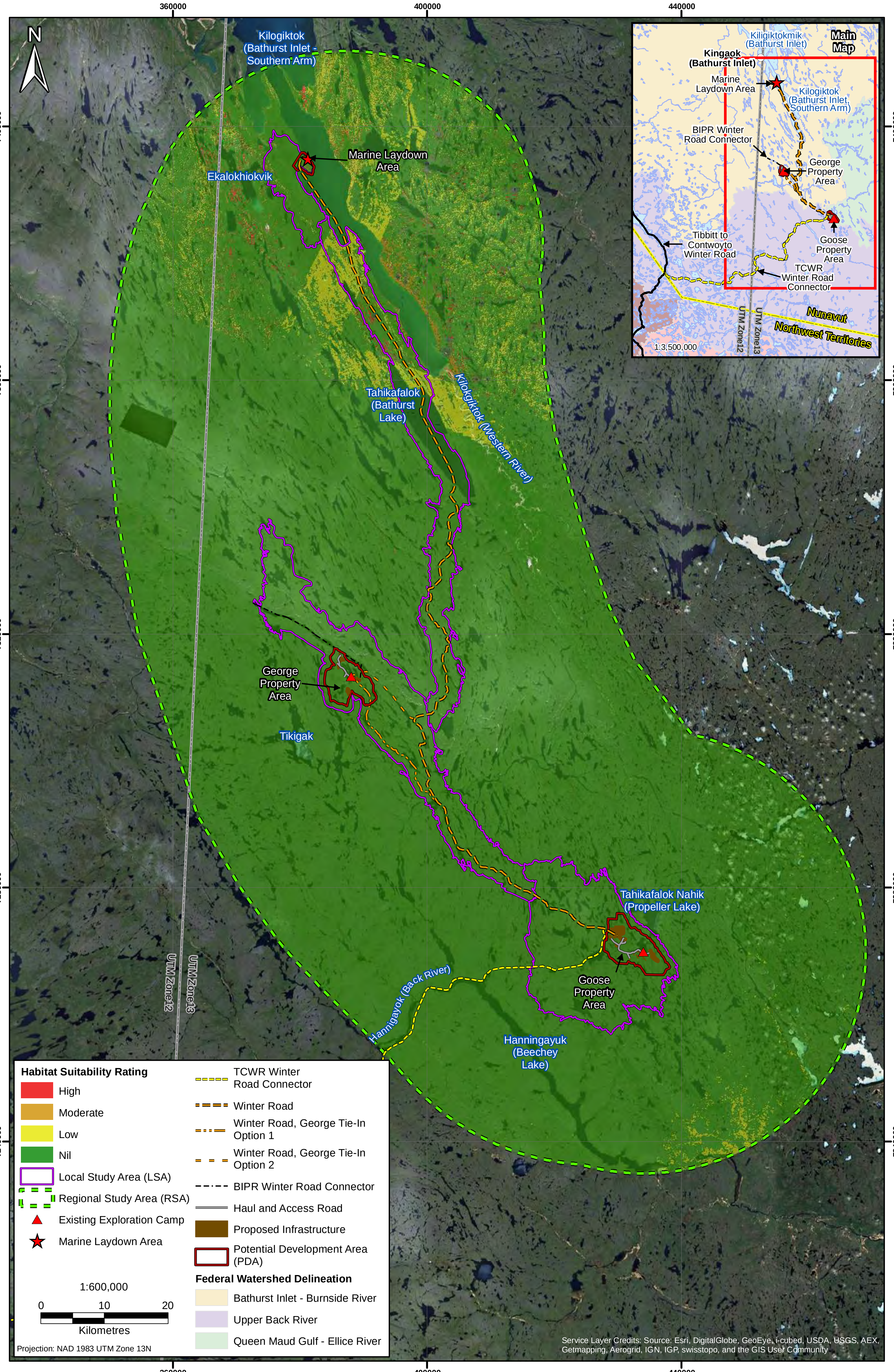

Figure 5.5-2

Grey Wolf: Denning Habitat in the Regional Study Area

Sabina Gold & Silver Corp.

Rescan an ERM company

Rocky outcrops and wind hardened snowdrifts are commonly used sites for wolverine reproductive dens in tundra areas (Magoun and Copeland 1998). Typically, wolverine dens are built under at least 1 – 5 m of snow and consist of long, complex snow tunnels that lead down to boulder fields, rock overhangs, or large cracks in rocks, which are large enough to allow kits to move around and provide additional protection from predators (Magoun and Copeland 1998; Inman et al. 2012; May et al. 2012). Wolverines will often use the same den site or general location (within 1–2 km of the original den site) in multiple years (Lee and Niptanatiak 1996; Magoun and Copeland 1998).

5.6.2.1 Model Assumptions

The following general assumptions were made to define WHRs in the LSA and RSA:

- Suitable denning ratings were limited to vegetation associations that provide potential deep, long-lasting snow packs dues to topography and/or physical structure (tall vegetation, boulders, etc.).
- Not suitable ratings were given to all other vegetation associations due to a lack of features that provide deep snow packs.

5.6.3 Results and Discussion

Roughly half of the LSA and RSA (48% and 45%, respectively) had suitable habitat for wolverine denning (Table 5.6-2). Suitable wolverine denning habitat was more or less evenly distributed throughout the LSA and RSA (Figures 5.6-1 and 5.6-2). In the LSA, suitable denning habitat was more abundant in the central and south portions as compared to the north portion around Bathurst Inlet and the Marine Laydown Area. Denning habitat was generally well distributed within the RSA, with the exception of a small extent on the east side of Bathurst Inlet in the northeastern RSA. The remainder of the LSA and RSA were rated as Not Suitable for denning.

Table 5.6-2. Wolverine Denning Habitat in the Local Study Area and Regional Study Area

	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
Suitability Rating	**Area (ha)**	**% of LSA[1]**	**Area (ha)[2]**	**% of RSA[1]**
Suitable (Useable)	64,127.65	48	562,221.39	45
Not Suitable	70,241.65	52	694,931.19	55

[1] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[2] Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.

Due to the variable nature of wolverine denning preferences, these results should be assumed to be a coarse assessment of denning potential where the actual total area of the suitable denning habitat in the LSA and RSA is likely much lower.

5.7 SHORT-EARED OWL

5.7.1 Background

The short-eared owl is a ground-nesting raptor that breeds in the Arctic during the summer and overwinters in southern regions. The short-eared owl listed on Schedule 1 of *SARA* as a species of Special Concern and is considered sensitive in Nunavut by the Canadian Endangered Species Conservation Council (CESCC 2010). Nationally, populations of short-eared owl are decreasing, largely due to sensitivity to anthropogenic disturbance (COSEWIC 2008).

Short-eared owls are found throughout the eastern and western hemispheres (Wiggins, Holt, and Leasure 2006). Populations fluctuate significantly on an approximately three year cycle in response to lemming populations (Ims and Fuglei. 2005). Short-eared owls utilize a variety of habitat that contains enough ground cover to hide nests, as well as areas that support small mammals (their primary food source; Alderfer 2006). Small birds, especially shorebirds, and insects and crustaceans have also been taken as prey (Holt 1993, 1994).

5.7.2 Habitat Suitability Model Development

Habitat suitability modelling for short-eared owl was conducted for the nesting season and for the living and reproducing life requisites during this time (Table 5.7-1). Nests are the focal point of activity until young have fledged (i.e., left the nest site). Though 'nesting' specifically happens earlier in the year when the pair chooses a nest site, the suitability model covers the initial nest construction period and all time following until the young are mobile and can leave the nest site. Thus, the habitat model identifies the areas that may contain suitable habitat for nesting and spans the length of time in which birds may use the nest over the course of the breeding season.

Table 5.7-1. Seasonal Life Requisites of Short-eared Owl

Season	Date	Life Requisite	Habitat Preference
Nesting	May - July	Living and Reproducing	Dense vegetation close to water

Short-eared owls arrive on their breeding grounds in early spring, with female owls beginning to nest in late May to early June (Wiggins, Holt, and Leasure 2006). Short-eared owls make a rudimentary nest on the ground by gathering leaves, feathers, or grass; nests are hidden in dense vegetation, often close to water and under low shrubs. Short-eared owls will often choose a breeding site that is adjacent to more open habitats used for hunting; typical prey species include voles and small mammals (Wiggins, Holt, and Leasure 2006). Females are attentive and stay with the nest until all the young have left the nest (Clark 1975), which generally occurs 24-27 days after hatching (Schmelzer 2005).

5.7.2.1 Model Assumptions

The following general assumptions were made to define ratings for short-eared owl nesting habitats in the LSA and RSA:

- Suitable nesting ratings were limited to vegetation associations that were characterized by substantial low to tall shrub cover and no surface water (including seasonal seepages and inundation). These areas were assumed to provide the necessary cover for nesting sites.
- Not suitable ratings were given to all other vegetation associations due to a lack of nesting cover, presence of water, or disturbance.

5.7.3 Results and Discussion

Over half of the LSA (52%) was rated as suitable nesting habitat for short-eared owls, and was distributed fairly consistently throughout the LSA (Table 5.7-2; Figure 5.7-1). Within the RSA, Approximately one third (32%) was rated as suitable nesting habitat for short-eared owls (Table 5.7-2). Suitable nesting habitat within the RSA was distributed throughout, but had concentrations in the north and southeast portions of the RSA (Figure 5.7-2). The remainder of the study areas were rated as Not Suitable, representing habitats with poor cover for nesting sites.

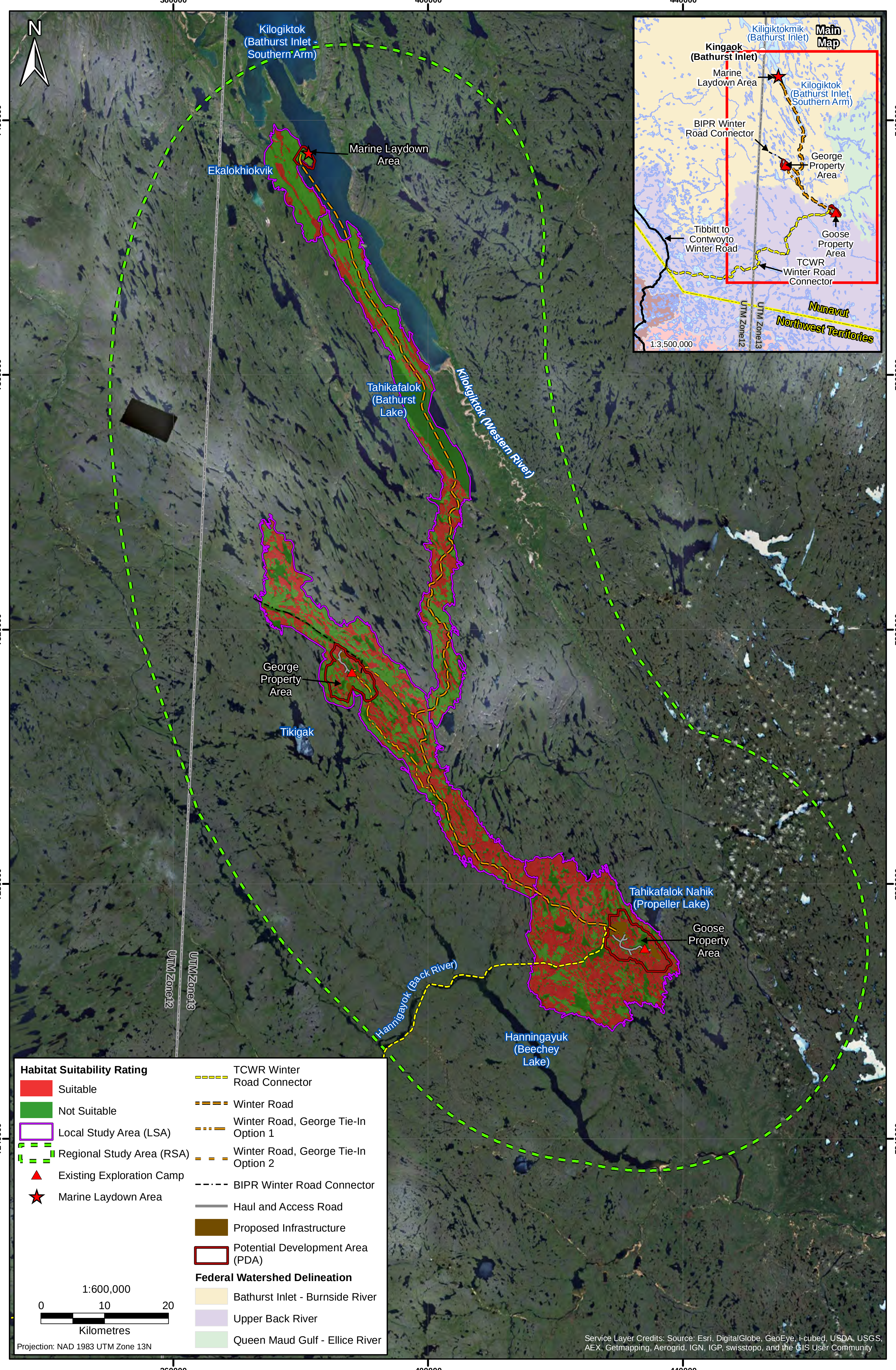

Figure 5.6-1

Wolverine: Denning Habitat in the Local Study Area

Sabina GOLD & SILVER CORP. Rescan an ERM company

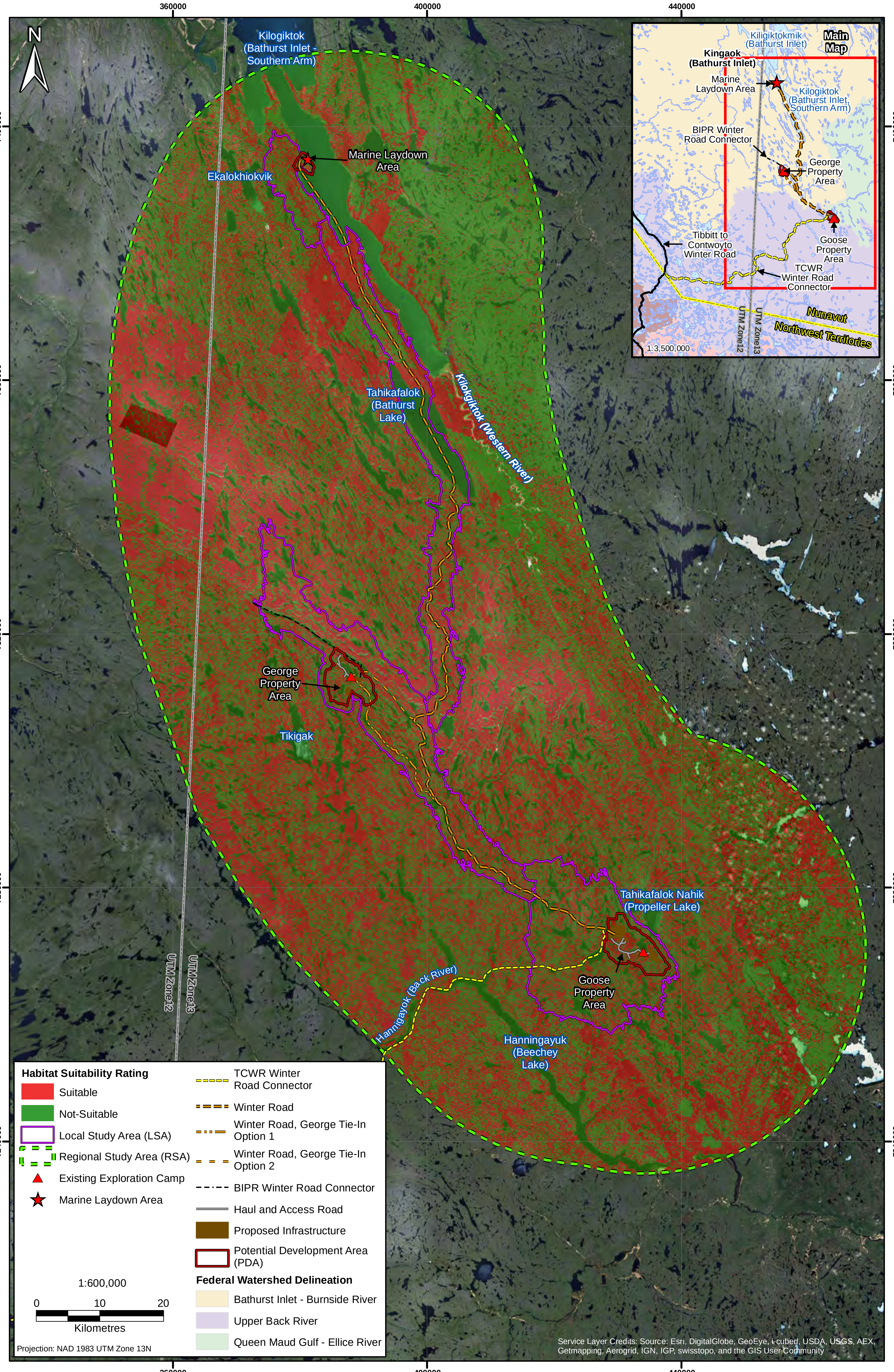

Figure 5.6-2

Sabina GOLD & SILVER CORP.

Wolverine: Denning Habitat in the Regional Study Area

Figure 5.6-2

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-244w October 11 2013

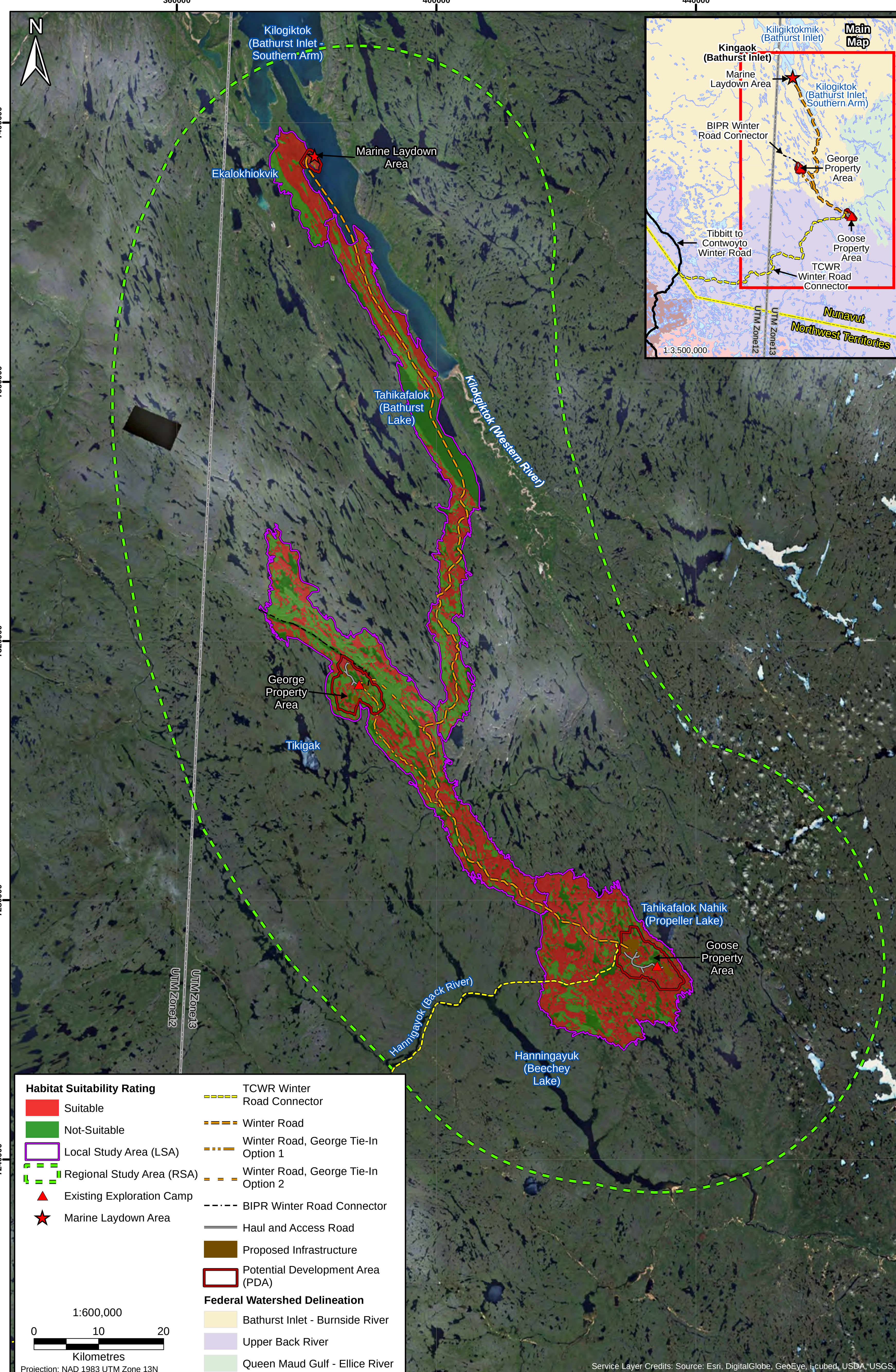

Figure 5.7-1

Sabina GOLD & SILVER CORP

Short-eared Owl: Nesting Habitat in the Local Study Area

Rescan an ERM company

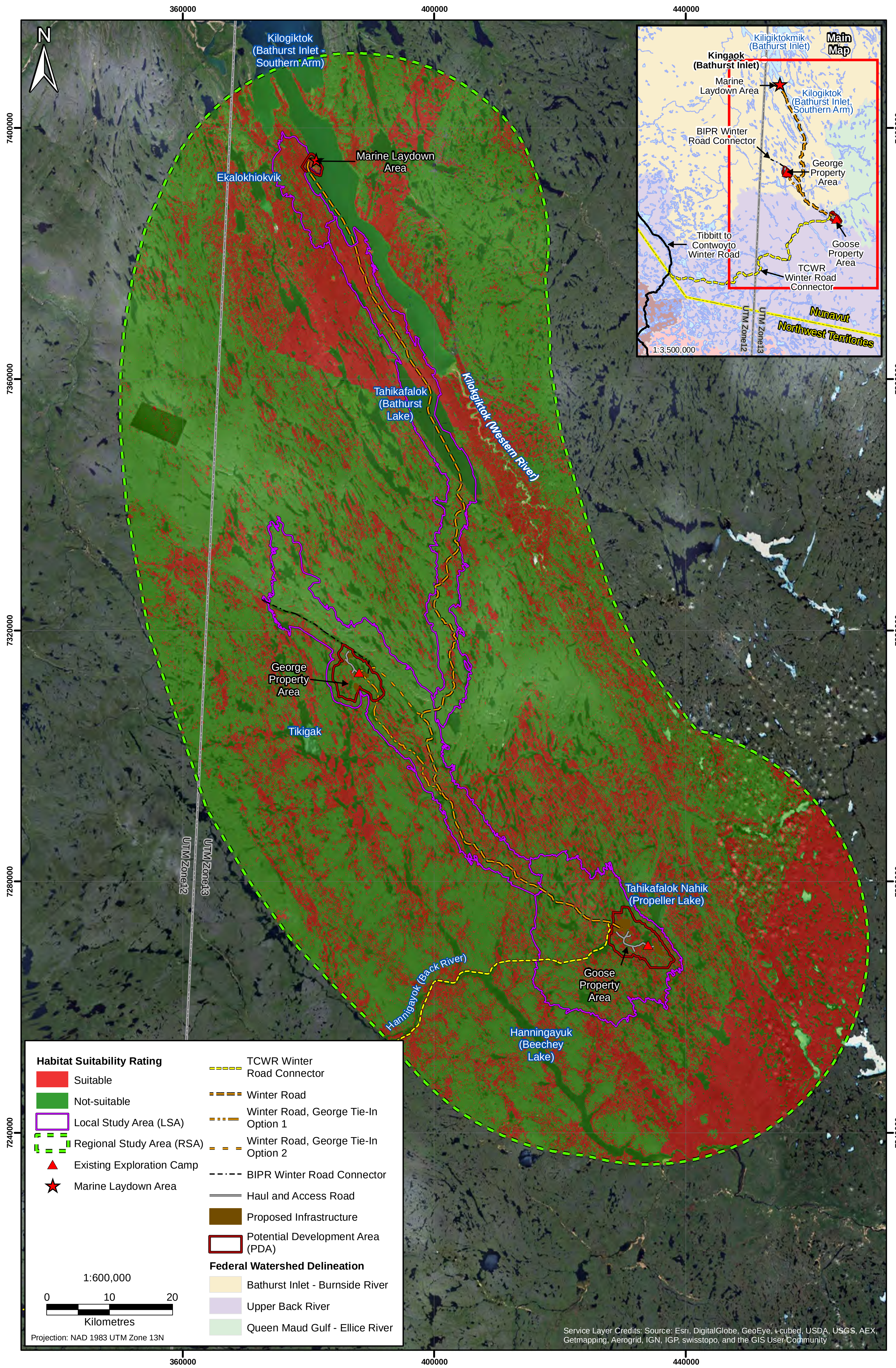

Figure 5.7-2

Short-eared Owl: Nesting Habitat in the Regional Study Area

Sabina GOLD & SILVER CORP.

Rescan an ERM company

Figure 5.7-2

Table 5.7-2. Short-eared Owl Nesting Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
	Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
Suitable (Useable)	69,804.67	52	404,974.79	32
Not Suitable	64,564.63	48	852,177.78	68

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes LSA. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*

As the population density of short-eared owls in the arctic is relatively unknown and significantly affected by fluctuations in small mammal populations, the total area of suitable nesting habitat in the LSA is likely much lower.

5.8 PEREGRINE FALCON

5.8.1 Background

Peregrine falcons are a cliff-nesting raptor found throughout the northern hemisphere. There are three subspecies of the peregrine falcon in Canada, each with distinct distributions. The tundra peregrine falcon (*Falco peregrinus tundrius*) is the subspecies that likely breeds in the region; its breeding grounds in Canada spread across the central Arctic and extend west into Alaska and east into Greenland. The species is highly migratory and travels as far south as Argentina and Chile for the winter.

The tundra peregrine falcon is listed nationally as a species of Special Concern under Schedule 3 of *SARA* but is considered Secure in Nunavut (CESCC 2010). The peregrine falcon is also protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), restricting the import and export of birds and eggs (COSEWIC 2007).

5.8.2 Habitat Suitability Model Development

The availability of suitable cliffs for nesting is likely the most critical feature of peregrine falcon breeding habitat and the same cliffs can be occupied and used for decades by this species (Sinclair et al. 2003). Habitat modelling focused on identifying areas that contain suitable nesting habitat that would support both the living and reproducing life requisites for peregrine falcons (Table 5.8-1). Nests are the focal point of activity until young have fledged (i.e., left the nest site). Though 'nesting' specifically happens earlier in the year when the pair chooses a nest site, the suitability model covers the initial nest construction period and all time following until the young are mobile and can leave the nest site. The habitat model identifies the areas that may contain suitable habitat for nesting and spans the length of time in which birds may use the nest over the course of the breeding season.

Table 5.8-1. Seasonal Life Requisites of Peregrine Falcon

Season	Date	Life Requisite	Habitat Preference
Nesting	Late May - August	Living and Reproducing	Southern facing cliffs over 10m, near water.

Peregrine falcons are the latest to nest among other cliff-nesting raptors in the Arctic (e.g., gyrfalcon, golden eagle). Peregrines arrive on their breeding grounds in May and most nests are established and eggs are laid by early June, though some pairs may nest in late May. Peregrine falcons typically nest on cliff edges or in crevices situated near good foraging areas. Nest cliffs range from 7 to 400 m in height;

however, cliffs 50 to 200 m are preferred (Cade 1960; White and Cade 1971; White et al. 2002). Many nest sites have been found on south facing cliffs (Court et al. 1988; White et al. 2002), possibly because these areas become snow free earlier in the year and become accessible nesting sites in comparison to areas with more northern aspects. Southern aspects are generally warmer as well, as they receive greater amounts of sunlight relative to northern aspects, which may be advantageous in keeping adults, eggs, and young birds warm. Young hatch in July and are cared for by both parents; young birds generally fledge by mid to late August (Court et al. 1988). Peregrines occupy nests sites from May onwards to August.

5.8.2.1 Model Assumptions

South facing cliffs and outcrops adjacent to or near bodies of water were assumed to be the most suitable nesting habitat for peregrine falcons in the study area. As cliff habitats were not specifically identified in the local or regional ecosystem mapping, additional modelling techniques were required to select areas with potential nesting ledges.

Digital elevation models (DEM) were obtained from Natural Resources Canada that covered the RSA. These data were used to identify all potential cliff habitats, and was used in conjunction with regional ecosystem mapping to identify suitable habitat. It was assumed that suitable nesting habitats for peregrine were cliffs that were a minimum of 10 m high and were within one kilometre of a waterbody. The one kilometre distance to a water feature was used as research suggests that the area within one kilometre of the nest site is the approximate size of the peregrine's nesting territory, or the area within which the adults actively defend from other peregrine falcons (SARA 2010). Therefore, the most important habitat features in addition to the nest site are likely contained within the nesting territory.

Raptor nests that were found during baseline studies for the Project were also incorporated into the peregrine nesting model (data from 2007, 2008, 2012, and 2013). These areas not only identify where there are cliffs, but also highlight areas that were selected and used by raptors and likely contain all the nesting habitat requirements (e.g., nearby hunting areas). All known raptor nesting sites (regardless of the species observed utilizing it) and the nesting territory (i.e., one kilometre radius from the nest site) were considered to be suitable nesting habitat in the model.

5.8.3 Results and Discussion

Very little (8%) of the LSA was identified as suitable cliff-nesting habitat for peregrine falcon. When modelling the previously identified nest sites and the one kilometre buffer, 6% of the LSA was rated as suitable (Table 5.8-2). A very small portion (2%) of the LSA had cliffs that were rated as suitable (i.e., cliffs modelled with DEM; Table 5.8-2). Suitable habitat was more abundant in the central and northern portions of the LSA; it was also found within both George and Goose Property Areas (Figure 5.8-1). The vast majority of the LSA (~92%) was rated as not suitable for nesting.

Within the RSA, 7% was considered to be suitable nesting habitat (Table 5.8-2). Of this suitable habitat, 4% was identified through modelling the location of known nest sites and surrounding nest territories, and 3% was identified with DEM (Table 5.8-2). Suitable habitat identified from known nesting areas were often clustered together, identifying long ridges of cliff habitat such as those located to the east of the Goose Property Area (Figure 5.8-2). Suitable habitats identified with the DEM were concentrated along the Western River drainage and within the northern RSA near Bathurst Inlet (Figure 5.8-2). Similar to the result in the LSA, the majority of the RSA (94%) was rated as not suitable for peregrine falcon nesting.

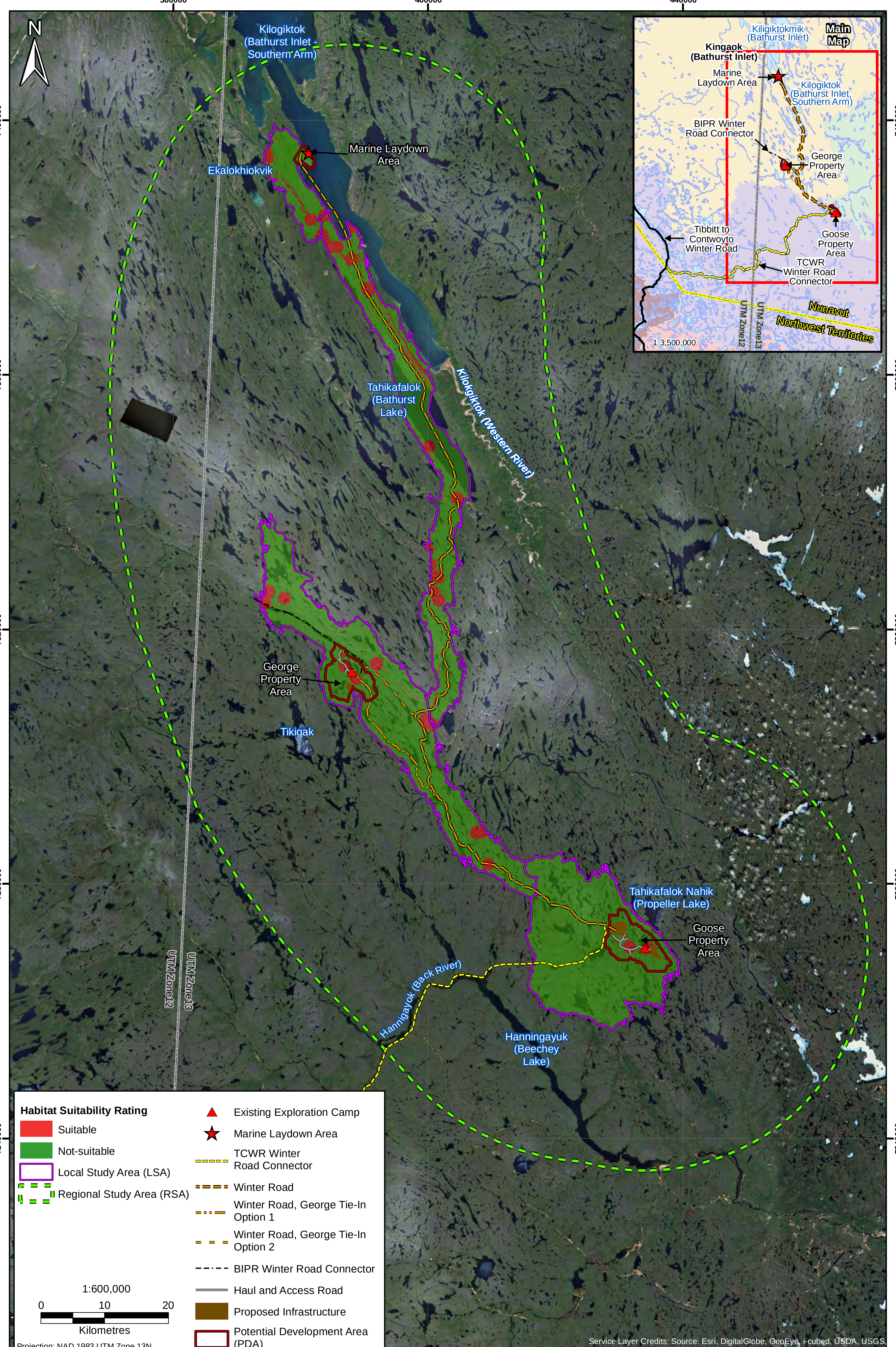

Figure 5.8-1

Sabina GOLD & SILVER CORP.

Peregrine Falcon: Nesting Habitat in the Local Study Area

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-244z October 15 2013

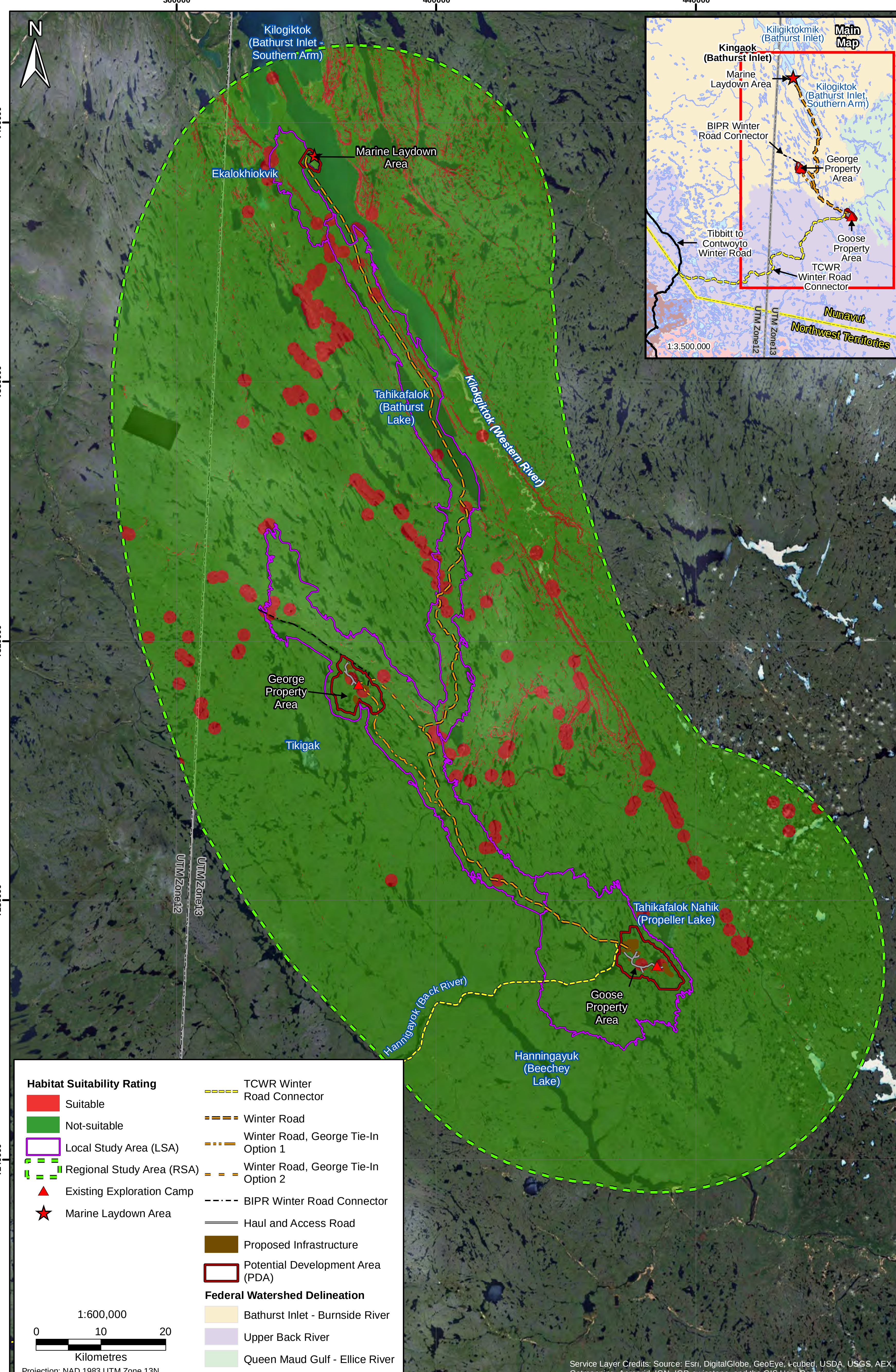

Figure 5.8-2

Sabina GOLD & SILVER CORP.

Peregrine Falcon: Nesting Habitat in the Regional Study Area

Rescan an ERM company

Table 5.8-2. Peregrine Falcon Nesting Habitat in the Local Study Area and Regional Study Area

Suitability Rating	Model Type	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
		Area (ha)	% of LSA[1]	Area (ha)[2]	% of RSA[1]
Suitable (Useable)	Nest Locations w/ buffer	8,520.45	6	45,673.56	4
	Modelled Cliffs	1,974.98	2	33,413.94	3
Not Suitable		123,873.88	92	1,182,917.13	94

[1] *For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
[2] *Includes LSA.*

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Appendix 1

Species Account for Caribou

Appendix 1. Species Account for Caribou

BACKGROUND INFORMATION

Common Name: Caribou, specifically barren-ground caribou

Scientific Name: *Rangifer tarandus groenlandicus*

Species Code: M-RATA

Status:

- **Global:** G5TNR – Globally secure, but subspecies or varieties at the national or subnational level not ranked.
- **National:** *R. t. groenlandicus* are not listed at federal level, but Dolphin and Union herd (*R. t. groenlandicus* x *pearyi*) are a population of special concern under Schedule 1 of the *Species At Risk Act* (2002).
- **Territorial:** Secure (CESCC 2010).

DISTRIBUTION

Range within Nunavut

Barren-ground caribou are distributed across much of mainland Nunavut, as well as on some islands within the Arctic archipelago. The ranges of several caribou herds are partially or completely contained across mainland Nunavut, including the Ahiak, Bathurst, Beverly, Bluenose-East, Bluenose-West, Dolphin and Union, Qamanarijuaq, Lorillard, Wager Bay (Gunn, Russell, and Eamer 2011). Many of these herds, such as the Bathurst herd, are migratory caribou and travel from wintering areas below the treeline in the Northwest Territories north to calving areas near the coasts in Nunavut. Other herds, such as the Lorillard and Wager Bay herds, are defined as non-migratory caribou, spending the summer and winter above the treeline on the tundra.

Territorial Context

Representing an important component of the regional biodiversity of the Arctic, barren-ground caribou are a keystone species of its ecosystem. They support grizzly bear, wolf and wolverine populations, as well as influence the survival, both economically and culturally, of the Inuit people.

Project Area

Baseline survey data documenting the distribution of caribou during the spring migration, calving, post-calving, summer, and fall periods suggest that the study area lies within the seasonal ranges of the Bathurst and Ahiak caribou herds.

The Bathurst caribou herd winters below the treeline in Northwest Territories and travels north to calving grounds to the west of Bathurst Inlet. Following calving, the herd disperses to the southeast and travel through the study area. The herd then spends the rest of the summer in areas surrounding and south of Contwoyto Lake, located to the southwest of the Project. The Bathurst herd's traditional rutting area, used in the fall, is located near Lac de Gras in the Northwest Territories. Following rutting, the herd then returns to wintering areas at or below the treeline.

The Ahiak caribou herd is thought to be primarily composed of tundra-wintering caribou, though in some years animals may travel south below the treeline during the winter (Gunn, Fournier, and Nishi 2000; Gunn and D'Hont 2002). Wintering areas for Ahiak caribou occur discretely across Nunavut; wintering

Ahiak caribou have been documented around Bathurst Inlet (Gunn, Fournier, and Nishi 2000) and within south of the Thelon Wildlife Sanctuary along border of the Northwest Territories and Nunavut. The calving grounds for the Ahiak herd are located along the coast within the Queen Maud Gulf Migratory Bird Sanctuary. Following calving, the herd slowly travels to the south and in the summer, Ahiak caribou may be found in the study area. The herd then converges in fall grounds located within the Thelon Game Sanctuary, following which they disperse to wintering grounds across the tundra.

The Dolphin and Union herd spends most of the year to the north of the study area. Dolphin and Union caribou winter on the Nunavut mainland along the Coronation Gulf, on the Kent Peninsula, and along the western extent of the Queen Maud Gulf (COSEWIC 2004). This herd migrates across the sea ice to its calving grounds on Victoria Island. These caribou may occasionally travel as far south as the Project area in the winter, though this use is expected to be very infrequent.

POPULATION TRENDS

Bathurst Herd

The size of the Bathurst caribou herd, as estimated from annual counts of the number of calving females, has declined from about 200,000 females in 1986, to 55,000 in 2006, and then to 16,000 in 2009 (Nishi et al. 2010; Boulanger et al. 2011). The results of the 2009 calving ground survey suggested that the total herd size was approximately 31,900 ± 11,000 individuals (GNWT ENR 2009). The population estimates suggest an average annual decline of about 6% per year from 1986 to 2006, and then a very rapid decline of 35% per year between 2006 and 2009 (Adamczewski et al. 2009; Boulanger et al. 2011). These population trends have been attributed to declining calf survival and concomitant declines in adult female fecundity that may have been a result of several factors including environmental conditions and predation; declines in adult survival in winter due to hunting is also postulated to be a source of these population declines (Boulanger et al. 2011). Annual monitoring of calf survival indicates that mean winter calf survival and calf-cow ratios for the Bathurst herd have declined by almost 50% from 2001 to 2004 compared with the 1985 to 1996 period (Gunn, Boulanger, and Williams 2005). More recently (2007-2009), indicators of breeding productivity such as cow-calf ratios, pregnancy rates, and body condition indicate that the environmental conditions have improved for the Bathurst herd (Adamczewski et al. 2009). A survey conducted in 2012 reports that the population has remained stable, or may have increased to 35,000 individuals since 2009 (GNWT 2012).

Ahiak Herd

A systematic calving area survey along the Queen Maud Gulf in 1986 estimated the Ahiak herd size at 40,000 to 60,000 animals (Gunn, Fournier, and Nishi 2000). A decade later the herd increased in size to roughly 200,000 animals (based on a calving female count of 83,134 ± 5,298 caribou; Gunn, Russell, and Eamer 2011). In 2006, 123,000 female caribou were counted on the calving grounds, suggesting that the population increased again from 1996 to 2006 (Gunn, Russell, and Eamer 2011). However, data from satellite-collared cows has revealed that the Beverly herd, which formally calved south of the Ahiak herd, has gradually shifted their calving to the area used by the Ahiak herd (Nagy et al. 2011). Thus, apparent population increases in the Ahiak herd may be due to the gradual shift of the Beverly herd to the Ahiak calving grounds (Gunn, Russell, and Eamer 2011; Nagy et al. 2011).

The Ahiak herd has declined in recent years. Between 2006 and 2009, the number of calving cows counted on the calving grounds declined by 60% (Adamczewski et al. 2009; Gunn, Russell, and Eamer 2011). Similar to that observed for the Bathurst herd, these data likely reveal a fast rate of population decline, possibly due to low recruitment rates in 2008 and poor body condition in 2009 (D. Johnson, Nagy, and Williams 2008; Adamczewski et al. 2009). An aerial survey in 2010 reported a modest increase in the number of caribou counted on the calving grounds (Gunn, Russell, and Eamer 2011).

Dolphin and Union Herd

The Dolphin and Union caribou herd is a genetically distinct population from the mainland barren-ground herds and from the Peary caribou of the Arctic archipelago (COSEWIC 2004). In the early 1900s, the Dolphin and Union caribou herd was estimated at 100,000 animals (COSEWIC 2004). Overhunting and possibly ice storms caused a population crash between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland after about 1930 (Gunn 2005). Beginning in the 1970s, the herd size increased, and in the late 1980s caribou resumed migration between Victoria Island and the mainland (Gunn et al. 1997). In 1993, approximately 7,200 Dolphin and Union caribou were counted on the mainland prior to migrating over the ice in the spring (Gunn et al. 1997). In 1997, the Dolphin and Union herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn 2004), about one-third of its historic size. A population estimate of 28,000 ± 2,500 in 2007 suggests the population is stable or declining slightly, though still only a third of its historic size (M. Dumond, GN, unpubl. data, cited from Poole et al. 2010).

As a result of population declines, Dolphin and Union caribou are currently listed as a population of special concern on Schedule 1 of the *Species at Risk Act* (*SARA*). Potential threats to this herd's long term viability are climate warming and shipping activity across the herd's migration route (COSEWIC 2004). Climate warming may shorten the amount of time caribou have to overwinter on the mainland. This herd migrates between the mainland and Victoria Island during the spring and fall migrations and this movement is dependent on ice formation. Shipping and icebreaking may weaken or create gaps in the ice in Coronation Gulf and Dolphin and Union Strait that the Dolphin and Union caribou migrate across twice each year, which may increase the chances that caribou fall through the ice or drown during their annual migrations.

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

The nutritional requirements and the distribution and availability of forage drive the seasonal distribution of caribou. The most critical seasons for barren-ground caribou are calving and post-calving/summer. The late summer and fall seasons are also important times for caribou to acquire necessary nutrient resources before the winter; caribou also breed in the fall, referred to as the rut.

For caribou, habitat suitability was assessed for three periods: calving (June 1 to ca. June 20), post-calving and summer (ca. June 20 to August 31) and the fall (September 1 to October 31). The life requisites assigned to these three periods are provided in Table 1.

Table 1. Seasonal Life Requisites of Caribou

Season	Date	Life Requisite	Habitat Preference
Calving	June 1 to ca. June 20	Reproduction and Living	Variable. Predator avoidance, lichen availability, and early vegetation growth is preferred.
Post-calving and Summer	ca. June 20 to July 15 (post-calving) July 16 to August 31 (summer)	Living	Caribou use eskers for insect and heat relief, lakes for predator avoidance, insect, and heat relief, eat green plants from riparian and sedge communities. Cows require high quality forage to replenish fat reserves.
Fall (including Rut)	September 1 to October 31	Living, Reproduction, and Travel	Caribou travel to southern rutting areas, selecting habitat for ease of travel, predator avoidance, and late season forage.

Calving

Key characteristics of caribou calving grounds on the tundra are believed to be areas that facilitate predator avoidance, and where forage availability after snowmelt offers females the nutritional requirements they need for lactation (Griffith et al. 2001; Wilson et al. 2012). Terrain that may facilitate predator avoidance includes more rugged areas, higher elevations, and proximity to large lakes (Griffith et al. 2001; Wilson et al. 2012). The calves are born during the beginning of June and are dependent on milk until they are about three weeks old (CWS 2005). Cows generally spend two weeks on the calving grounds and then move to high quality forage areas with their calves for the post-calving and summer seasons.

There appears to exist a trade-off between safety and forage availability; calving females may choose calving grounds that are relatively safe from predators but are not necessarily places where snow melts earlier nor where vegetation biomass is greatest (Wilson et al. 2012). For example, though forage availability was higher for Bathurst bulls and juveniles still near treeline than for females that migrated to the calving grounds, wolf densities were much lower on calving grounds (Heard, Williams, and Melton 1996).

Though forage availability may be lower, it is thought that calving grounds generally are located in areas where forage quality is high (Griffith et al. 2001; reviewed in Wilson et al. 2012). Green foliage is rarely available during calving (e.g. in only 3 years between 1985 and 2006) on the Bathurst calving grounds (Chen et al. 2009). Lichen provides caribou with additional nutrients before green-up (Ferguson, L. Gauthier, and F. Messier 2001). Lichen heath is one of the main vegetation cover types for the Bathurst herd calving grounds (Griffith et al. 2001; C. J. Johnson et al. 2005). Bathurst cows appear to compensate for low nitrogen intake on the calving grounds by digging for nitrogen-rich *Oxytropis* rhizomes (Griffith et al. 2001; Thorpe et al. 2001).

Post-Calving/Summer

Following calving, caribou move to their summer ranges. During this time, cows and calves may aggregate into large groups, ranging from hundreds to even thousands at times when populations are large (Gunn and D'Hont 2002). Access to high quality forage is likely the key driver of habitat selection in the post-calving period (Witter et al. 2012), as females need to acquire adequate nutrient reserves for lactation, which last for about three weeks. Later in the season, forage quality and access to habitat that facilitates escape from insects are thought to be the key determinates of habitat selection.

During the post-calving period, caribou select wetland areas for foraging as these areas contain high quantities of protein rich vegetation. Studies in Alaska show that female caribou with calves select areas with a high density of sedge meadows during the post-calving period, where they forage on highly nutritious cotton grass (*Eriophorum sp.*) and *C. aquatilis* (Wilson et al. 2012).

After the post-calving period, females expand their selection of vegetation from sedge meadows to include other vegetation types, but tend to remain in moist habitat where grasses, sedges, and willow and birch shrubs are abundant (Griffith et al. 2001; Thorpe et al. 2001; Wilson et al. 2012; Zamin and Grogan 2012). Inuit Qaujimajatuqangit indicates that cotton grass is important forage for newly weaned calves (Thorpe et al. 2001). Lichens may still be eaten in summer, but to a lesser extent than in winter (Bergerud 1974; Boertje 1984; Barten, Bowyer, and Jenkins 2001). Despite a wider selection during the post-calving period, foraging throughout summer probably predominately occurs in sedge meadows, where caribou can graze up to 50% of the net primary productivity (Jefferies 1992).

Caribou also select habitat that provides relief from insects and heat throughout the post-calving season and summer seasons (Curatolo 1975; Heard and Gray 1989; Russel 1998). Harassment by black and especially oestrid flies can cause significant disturbances to tundra caribou in July and August (Witter et al. 2012). Insects are abundant on warm days when wind speeds are low (Boulanger et al. 2004) especially for the two weeks spanning late June to early July (Thorpe et al. 2001). Caribou compensate for harassment by engaging in avoidance behaviours (on average 5% of the day) such as head tossing and erratic running when insects are active, from about 0800 to 2100 hours (Witter et al. 2012). Caribou are often seen swimming in lakes to escape the heat and insects (Thorpe et al. 2001). Caribou also attempt to avoid insects by moving for some part of the daytime to windier, cooler places, such as on top of eskers, at the edges of large rivers and lakes, and to higher elevation tundra where insects are less dense (Russell, Martell, and Nixon 1993; Skarin et al. 2008; Wilson et al. 2012; Witter et al. 2012).

Protection against predators is also required by caribou, and they often gather along lake shorelines, where they can enter the water to escape predators such as wolves (Thorpe et al. 2001). Habitats with extensive shrub cover (e.g., riparian shrub communities) may increase the vulnerability of caribou to predation because they conceal predators (Curatolo 1975; Heard and Gray 1989); however, caribou select these habitats for the relatively high quality of forage they provide (Axys Environmental Consulting and Penner & Associates 1998).

Fall

During the fall, caribou require habitats that provide abundant forage and facilitate travel. Caribou breed in the fall during the rut but implantation of the fertilized egg is delayed and can be aborted if animal condition is poor during the winter. Hence, high quality forage is important in the fall. Green forage becomes less available as the fall progresses and Bathurst caribou choose lichen veneer for foraging (C. J. Johnson et al. 2005). Sedge wetland and riparian tall shrub habitats may also be used depending on the availability of green forage. However, a habitat modelling study by Johnson et al. (2005) indicated that caribou may avoid areas dominated by sedge, peat bog, and heath tundra during the fall. Eskers, ridges, and other high points are selected for easy travel (Thorpe et al. 2001).

Ratings

A four class rating scheme was used to evaluate the quality of habitat for caribou in the Local Study Area (LSA) and Regional Study Area (RSA).

Rating Assumptions for Calving

Habitat use during the calving season is focused on pregnant and lactating cows searching for nitrogen and protein rich forage. Caribou actively search out emerging vegetation, typically in exposed areas that have early snow melt. Lichens continue to be an important food source. The following generalized assumptions were made to rate ecosystem units for caribou calving:

- High rated habitat (1) includes ecosystem units that are snow free early, and those that contain a significant cover of lichen and shrubs.
- Moderate rated habitat (2) includes a variety of ecosystem units that contain suitable early forage such as cottongrass flower buds, sedges, and various shrub species.
- Low rated habitat (3) includes ecosystem units that are more likely to retain snow packs or have limited suitable forage.
- Nil rated habitat (4) included vegetation associations that have a lack of forage or are disturbed.

Rating Assumptions for Post Calving / Summer

Habitat use during the post-calving/summer season is variable as caribou leave calving grounds and search out preferred habitat. In addition to forage, caribou require habitat that provides relief from insects, heat and predators. During this period forage includes willow, grass, sedges, cottongrass and other green vegetation that provides important protein sources (VanEgmond and Rowell 1998; Griffith, Gunn, and Russel 2001; Thorpe et al. 2001). Cool, moist areas are often selected, including riparian areas and wetlands. Insect and heat relief is important throughout the post-calving season, particularly late June and early July. Relief is found in cool, windy and shaded areas, and includes swimming in ponds and lakes (Thorpe et al. 2001). The following generalized assumptions were made to rate ecosystem units for caribou post-calving and summer:

- High rated habitat (1) includes areas that produce abundant and high quality forage (e.g., sedges and graminoids), in addition to those that provide insect or predator relief (e.g., lakes and esker).
- Moderate rated habitat (2) included ecosystem units that provide forage opportunities, but generally have limited insect and heat relief relative to the high value habitat.
- Low rated habitat (3) includes barren areas and rock outcrops that have limited vegetation and limited opportunities for relief (e.g., shallow water areas that are not deep enough to provide insect relief).
- Nil rated habitat (4) were those that lacked forage, or are disturbed.

Rating Assumptions for Fall Season (Including the Rut)

Habitat use during the fall and the rut is focused on ease of travel and opportunistic foraging. As herds move south towards wintering grounds, they feed on remaining high quality forage as it is available, such as shrubs, grasses, and lichens. Bathurst caribou, for example, choose lichen veneer for foraging in the fall (C. J. Johnson et al. 2005). Eskers, ridges, and other high points are selected for easy travel (Thorpe et al. 2001). The following general assumptions were made to define fall WHRs:

- High rated habitat (1) included vegetation associations that contained a diversity and abundance of forage species, as well as those that contain esker for ease of travel.
- Moderate rated habitat (2) included vegetation associations that contained some preferred forage species, but typically have a lower cover of lichens, sedges, and shrub species.
- Low rated habitat (3) included vegetation associations that contained limited forage opportunities.
- Nil rated habitat (4) included vegetation associations that contained sparse vegetation, or where travel was difficult.

Ratings Table

Caribou habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 2 contains habitat suitability ratings for caribou according to the TEM mapping conducted in the LSA, and Table 3 contains habitat suitability ratings for caribou according to the WKSS/GeoBase mapping within the RSA.

Table 2. Ratings Table for Caribou Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Calving	Post-calving and Summer	Fall
Bedrock	Bedrock outcrop	BR	4	2	2
Bedrock	Bedrock-lichen veneer	BL	2	1	1
Bedrock	Cliff	BC	4	4	4
Bedrock	Talus	BT	4	4	4
Bedrock	Blockfield	TB	4	4	4
Disturbed/Barren	Disturbed vegetation	DV	4	4	4
Disturbed/Barren	Exposed soil	ES	3	3	2
Disturbed/Barren	Mine camp	DR	4	4	4
Disturbed/Barren	Road surface	DZ	4	4	4
Esker	Dwarf shrub esker	EH	2	1	1
Esker	Shrubby esker	EW	2	1	2
Esker	Sparsely vegetated esker	EC	2	1	1
Freshwater	Lake	LA	4	3	3
Freshwater	Pond	PD	4	1	3
Freshwater	River	RI	4	1	2
Marine	Marine beach	MB	4	4	4
Marine	Old beach heads	MH	4	2	2
Marine	Saltwater	MW	4	4	4
Riparian	Low bench floodplain	RL	4	2	3
Riparian	Mid bench floodplain	RM	4	2	3
Riparian	Willow riparian	RW	2	1	2
Riparian (Marine)	Marine riparian shrub	MR	2	3	2
Tundra	Dry-sparse tundra	TH	2	2	1
Tundra	Mesic dwarf-shrub tundra	TL	1	2	1
Tundra	Shrubby tundra	TS	1	2	2
Tundra (Marine)	Marine dwarf shrub tundra	MT	1	2	1
Tundra (Marine)	Marine shrubby tundra	MS	1	3	2
Wetland	Cottongrass-sedge fen	WC	2	2	1
Wetland	Raised bog complex	WB	3	2	2
Wetland	Shallow open water	WO	4	1	3
Wetland	Tussock meadow	WT	3	2	2
Wetland	Undifferentiated fen	WF	2	2	2
Wetland	Water sedge marsh	WA	2	1	1
Wetland	Willow-sedge fen	WS	2	1	2
Wetland (Marine)	Saline Fen	MF	2	2	3
Wetland (Marine)	Saline Marsh	MM	2	1	2
Wetland (Marine)	Saline shallow open water	MO	4	3	3

Table 3. Ratings Table for Caribou Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Calving	Post-calving and Summer	Fall
Bedrock Association	4	4	4
Boulder Association	3	2	3
Heath/Bedrock	2	1	1
Lichen Veneer	2	1	1
Sparsely vegetated bedrock*	2	1	1
Sparsely vegetated till-colluvium*	2	1	1
Bare Ground	3	3	2
Barren/Non-vegetated*	3	4	4
Gravel Deposit	4	4	4
Esker Complex	2	1	1
Deep Water	4	3	3
Shallow Water	4	1	3
Water	4	1	3
Riparian Tall Shrub	2	1	2
Shrub tall*	2	2	2
Bare soil with cryptogam crust - frost boils*	2	1	1
Birch Seep	3	2	2
Heath Tundra	1	2	1
Heath/Boulder	1	2	1
Low Shrub	2	2	2
Moist to dry non-tussock graminoid/dwarf shrub tundra*	1	2	1
Prostrate dwarf shrub*	1	2	1
Shrub low*	2	2	2
Ice and Snow	4	4	4
No data*	N/A**	N/A**	N/A**
Unclassified	N/A**	N/A**	N/A**
Tussock graminoid tundra*	3	2	2
Tussock/Hummock	3	2	2
Wet sedge*	2	1	1
Wetland (Sedge Meadow)	2	1	1
Wetland*	2	1	1

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Appendix 2

Species Account for Muskox

Appendix 2. Species Account for Muskox

BACKGROUND INFORMATION

Common Name:	Muskox	
Scientific Name:	*Ovibos moschatus*	
Species Code:	M-OVMO	
Status:	**Global:**	G4 – Apparently Secure, Uncommon but not rare; some cause for long-term concern due to declines or other factors.
	National:	Muskox are not listed at federal level.
	Territorial:	Secure (CESCC 2010).

DISTRIBUTION

Range within Nunavut

Muskox are the only other large ungulates aside from caribou that live in tundra habitats year round. Muskox are found throughout most of Nunavut, with the exception of northeastern and western areas, and Baffin and Southampton Islands. Muskox are generally more abundant on the islands of the Arctic Archipelago relative to mainland Nunavut (Fournier and Gunn 1998).

Territorial Context

Muskox are large herbivores and a key species in the tundra trophic food chain. Muskox comprise an important food source for wolves and to a lesser degree, grizzly bears (Gunn and Miller 1982; Reynolds, Wilson, and Klein 2002; Wiebe et al. 2009; Mech 2010). Muskox are highly valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing.

Project Area

Muskox are found thought the Project area during all seasons of the year (Dumond 2006).

POPULATION TRENDS

In 2001, muskox numbers in Canada were estimated at 166,000 animals (Gunn and Adamczewski 2003). Populations are generally thought to be increasing on Arctic islands and decreasing on the mainland, potentially due to the parasite *Umingmakstrongylus pallikuukensi* (Dumond 2006).

Muskox were close to extinction in the late nineteenth and early twentieth centuries due to overhunting (Fournier and Gunn 1998; Campbell and Setterington 2001). A hunting moratorium was enacted by the Canadian Government in 1917, and then lifted in 1969 (Giroux et al. 2012). The Inuit have remarked on the expansion in distribution and numbers of muskox since the 1960s. In the last three decades, muskox numbers have increased and most populations have recovered throughout the historic range (Fournier and Gunn 1998; Campbell and Setterington 2001).

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

Muskox are relatively sedentary and have a relatively small home ranges; on average, summer home ranges are 223 km^2 and winter home ranges are 70 km^2. Muskox do not travel long distances between calving, rutting, and wintering habitats, and generally prefer areas with little terrain variation, at low altitude and with a southerly exposure throughout the year (Thing et al. 1987).

Seasonality of the arctic environment in combination with changing needs for energy and nutrients strongly influences muskox range relationships and grazing behaviour (Jingfors 1982). Muskox are found where amounts of plant biomass are limited through the long and hard winters (Klein and Bay 1990). Selection of actual feeding and resting/rumination sites by the animals is influenced by aspect and slope, floristic composition, vegetation distribution and diversity, insect harassment, duration of winter and depth of snow pack (Jingfors 1982; Thing et al. 1987; Nellemann and Reynolds 1997).

Muskox have adopted an energy-conservative lifestyle (Klein and Bay 1994). They have adapted to the foraging constraints of arctic winters by digesting low quality graminoid more efficiently than would other grazers and by maintaining body mass at lower intake (Adamczewski et al. 1994; Klein and Bay 1994). There is some evidence that high densities of grazers have a positive effect on plant productivity and possibly herbivores in Arctic ecosystems (Larter and Nagy 2001a).

For muskox, habitat suitability was assessed for winter and early spring (April to June) and summer and fall (rutting) seasons (August through September). Table 1 summarizes the seasonal life requisites of muskox used in the model development.

Table 1. Seasonal Life Requisites of Muskox

Season	Date	Life Requisite	Habitat Preference
Summer and Fall	June to September	Living	Wetlands, shrubby areas, eskers with graminoid cover.
Winter and Early Spring	October to May	Living, Reproducing	Windswept ridges and other areas that have low snow cover allowing for accessibility of forage.

Winter / Early Spring

Muskox rely on important adaptions such as a large rumen capacity and slow passage rates to survive winter foraging conditions in the Arctic (Adamczewski et al. 1994; Ihl and Barboza 2007). Old age, worn teeth, heavy parasite infestation, or bad weather conditions can result in death by starvation (CWS 1990). It is known that their body weight will decrease over the winter, yet they will still possess a considerable amount of unused fat reserves at the beginning of calving (Thing et al. 1987).

During winter months, muskox select for thin or soft snow cover with high food abundance (Schaefer and Messier 1995). In late winter, they prefer either foraging for sedge in rugged terrain, as snow cover tends to be shallower there, making foraging easier (Klein and Bay 1994; Nellemann and Reynolds 1997; Larter and Nagy 2001b), or foraging in willow communities (Raillard and Svoboda 2000; Tolvanen and Henry 2000). They may sometimes eat moss in winter, but moss is poorly digestible for them, and its consumption may result in a net loss of nutrients (Ihl and Barboza 2007). In late winter, wind-exposed, dry dwarf shrub heaths are also extremely important as feeding habitat (Thing et al. 1987).

Calving takes place in the early spring (between late March and late May), often before the snow has melted completely and vegetation has begun to green. Similar to caribou, muskox also show a high degree of selectivity for moist sedge meadow during the calving and post-calving periods; upland shrubs are also selected during this time, when emergent willow leaves are more nutritious than later in the season (Reynolds, Wilson, and Klein 2002).

Summer and Fall

Muskox must accumulate sufficient fat reserves during the summer and early fall months to survive the following winter (Reynolds, Wilson, and Klein 2002). The rut begins in late summer, when bulls challenge each other by engaging in fights to determine dominance and possession of a herd. Dominant males spend more time engaged in rutting activities than other bulls (Jingfors 1982). Pregnancy success is likely positively related to the fat reserves accumulated by a female during these months (White, Holleman, and Tiplady 1989; Adamczewski et al. 1998). As part of the natural weaning process, calves gradually acquire foraging activities similar to older individuals, after spending much of their time lying or suckling during their first week of life (Jingfors 1982). They are able to feed on vegetation, although milk may be part of their diet throughout the first year (CWS 1990).

During summer months and the rutting period, muskox keep using their preferred wet, highly productive sedge habitats. In addition, muskox may forage on graminoids such as grasses, willows and forbs which grow quickly, producing rich forage (Gunn and Sutherland 1997; Nellemann and Reynolds 1997; Gunn and Adamczewski 2003). Feeding and total active times in summer usually increase with latitude (Klein and Bay 1990).

Ratings

A four class rating system was used to evaluate muskox habitat within the Local Study Area and Regional Study Area.

Rating Assumptions for Winter / Early Spring

Habitat use during the winter/early spring season is focused on areas that provide accessible forage (e.g., low snowpacks and windswept areas) and/or early vegetation growth. Habitat studies have shown that actual late winter/early spring use is varied, ranging from rugged exposed terrain in the high Arctic, to lowland areas in Alaska, indicating that use may be site specific in a given landscape (Schaefer, Stevens, and Messier 1996; Nellemann and Reynolds 1997). Habitat preference is based on the need for low winter fat reserves to be replenished, and for pregnant or lactating cows' requirement for high quality forage (Reynolds, Wilson, and Klein 2002). The following general assumptions were made to rate muskox winter and early spring habitat:

- High rated habitat (1) included ecosystem units where limited snow packs are likely (e.g., windswept ridges) and areas with a significant amount of early vegetation.
- Moderate rated habitat (2) included habitats where foraging opportunities were available, but either were not as accessible or early in the season as ecosystem units rated as high.
- Low rated habitat (3) included habitat with limited with seasonal forage, or areas where the snowpack likely persists reducing foraging opportunities.
- Nil rated habitat (4) included ecosystem units with sparse vegetation including beach and marine, exposed soils, and disturbed areas, as well as those that occur in landscape positions that have a persistent snowpack.

Rating Assumptions for Summer / Fall

During the summer and fall, preference is given to habitat that provides abundant forage, primarily wetter areas dominated by sedges and willows. Muskox are commonly found near wetland and in wetter, shrubby tundra habitats in the summer (Gunn and Sutherland 1997). Gunn and Sutherland (1997) also found that single bulls and immature males used the immediate vicinity of waterbodies more often than any other age or sex class. The fringes of these waterbodies may support muskox forage such as sedges. By September snowfall may occur, requiring muskox to seek habitat with low snow cover that does not impact movement or feeding. The following general assumptions were made to rate muskox summer and fall habitat:

- High rated habitat (1) included ecosystem units characterized by an abundance of shrubs (particularly willow) and sedges.
- Moderate rated habitat (2) included habitat that provided ample foraging opportunities, but were assumed to have less abundant cover of preferred forage species, or where forage was not available in later parts of the season.
- Low rated habitat (3) included ecosystem units that contain limited forage opportunities.
- Nil rated habitat (4) were those that provide no forage for muskox, e.g., sparsely vegetated.

Ratings Table

Muskox habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 2 contains habitat suitability ratings for muskox according to the TEM mapping conducted in the LSA, and Table 3 contains habitat suitability ratings for muskox according to the WKSS/GeoBase mapping within the RSA.

Table 2. Ratings Table for Muskox Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Summer and Fall	Winter and Early Spring
Bedrock	Bedrock outcrop	BR	3	2
Bedrock	Bedrock-lichen veneer	BL	2	1
Bedrock	Cliff	BC	4	4
Bedrock	Talus	BT	4	4
Bedrock	Blockfield	TB	4	4
Disturbed/Barren	Disturbed vegetation	DV	4	4
Disturbed/Barren	Exposed soil	ES	4	3
Disturbed/Barren	Mine camp	DR	4	4
Disturbed/Barren	Road surface	DZ	4	4
Esker	Dwarf shrub esker	EH	1	1
Esker	Shrubby esker	EW	1	1
Esker	Sparsely vegetated esker	EC	2	1
Freshwater	Lake	LA	3	4
Freshwater	Pond	PD	2	4
Freshwater	River	RI	2	4
Marine	Marine beach	MB	4	4
Marine	Old beach heads	MH	3	2

(continued)

Table 2. Ratings Table for Muskox Habitat in the Local Study Area (completed)

Ecosystem Class	LSA Vegetation Association	Map Code	Summer and Fall	Winter and Early Spring
Marine	Saltwater	MW	4	4
Riparian	Low bench floodplain	RL	2	4
Riparian	Mid bench floodplain	RM	2	4
Riparian	Willow riparian	RW	1	3
Riparian (Marine)	Marine riparian shrub	MR	1	3
Tundra	Dry-sparse tundra	TH	3	2
Tundra	Mesic dwarf-shrub tundra	TL	3	3
Tundra	Shrubby tundra	TS	2	3
Tundra (Marine)	Marine dwarf shrub tundra	MT	2	2
Tundra (Marine)	Marine shrubby tundra	MS	2	3
Wetland	Cottongrass-sedge fen	WC	1	4
Wetland	Raised bog complex	WB	2	4
Wetland	Shallow open water	WO	2	4
Wetland	Tussock meadow	WT	2	4
Wetland	Undifferentiated fen	WF	2	4
Wetland	Water sedge marsh	WA	1	4
Wetland	Willow-sedge fen	WS	1	4
Wetland (Marine)	Saline Fen	MF	2	4
Wetland (Marine)	Saline Marsh	MM	1	4
Wetland (Marine)	Saline shallow open water	MO	2	4

Table 3. Ratings Table for Muskox Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Summer and Fall	Winter and Early Spring
Bedrock Association	4	4
Boulder Association	3	2
Heath/Bedrock	2	1
Lichen Veneer	2	1
Sparsely vegetated bedrock*	2	1
Sparsely vegetated till-colluvium*	2	1
Bare Ground	4	3
Barren/Non-vegetated*	4	4
Gravel Deposit	4	4
Esker Complex	2	1
Deep Water	3	4
Shallow Water	2	4
Water	3	4
Riparian Tall Shrub	1	3
Shrub tall*	1	3
Bare soil with cryptogam crust - frost boils*	2	1

(continued)

Table 3. Ratings Table for Muskox Habitat in the Regional Study Area (completed)

WKSS/GeoBase Land Classification	Summer and Fall	Winter and Early Spring
Birch Seep	2	3
Heath Tundra	3	3
Heath/Boulder	3	2
Low Shrub	2	3
Moist to dry non-tussock graminoid/dwarf shrub tundra*	3	3
Prostrate dwarf shrub*	3	2
Shrub low*	2	3
Ice and Snow	4	4
No data	NA	NA
Unclassified	NA	NA
Tussock graminoid tundra*	2	4
Tussock/Hummock	2	4
Wet sedge*	1	4
Wetland (Sedge Meadow)	1	4
Wetland*	1	4

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Appendix 3

Species Account for Grizzly Bear

Appendix 3. Species Account for Grizzly Bear

BACKGROUND INFORMATION

Common Name:	Grizzly Bear, western population	
Scientific Name:	*Ursus arctos*	
Species Code:	M-URAR	
Status:	**Global:**	G4 – Apparently Secure, Uncommon but not rare; some cause for long-term concern due to declines or other factors.
	National:	Listed as a population of Special Concern under COSEWIC (COSEWIC 2002), currently not listed under the Species at Risk Act.
	Territorial:	Secure (CESCC 2010).

Grizzly bears have low ecological resiliency, are sensitive to human activity and are frequently displaced by industrial developments (McLellan 1990; Weaver, Paquet, and Ruggiero. 1996; Ross 2002).

DISTRIBUTION

Range within Nunavut

Barren-ground grizzly bears of Nunavut are at the northern most range of grizzly bear populations in North America. Their range within Nunavut includes the Kivalliq, the Kitikmeot, and Baffin regions.

Territorial Context

Average annual ranges of male and female grizzly bears are approximately as 7,245 km^2 and 2,100 km^2, respectively (McLoughlin, Ferguson, and Messier 2000). Bears living in the central Canadian Arctic may be at relatively elevated risk of disturbance because they naturally occur at low densities and may be more vulnerable to disturbance on the open tundra landscape (Ross 2002; R. Mulders pers. comm.).

Project Area

Grizzly bears are known to occur within the RSA and LSA from satellite-collar data and observations made during baseline studies.

POPULATION TRENDS

There is no official estimate on grizzly bear population sizes for the West Kitikmeot region of Nunavut, which the Project is located within. However, a crude estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which does includes the Project area (Ross 2002). This estimate assumed a density of 4 bears per 1,000 km^2 based on grizzly bear densities in nearby areas (Ross 2002).

Barren-ground grizzly bears inhabit the northern edge of the grizzly bear range in North America. Habitats at these high latitudes are relatively low in productivity and quality. As a result, barren-ground grizzly bears utilize large home ranges and exist at low densities compared to other grizzly bear populations in more productive ecosystems. Average home range sizes vary from 2,100 km^2 for females to 7,245 km^2 for males, and home range overlap is relatively high (McLoughlin, Ferguson, and Messier 2000).

Grizzly bears in the Arctic exhibit low reproductive rates due to a late age of maturity, small litter sizes and long intervals between litters. Barren-ground grizzly bears would be expected to have relatively lower reproductive rates because they occupy areas of low productivity and high seasonality (Ferguson and McLoughlin 2000; McLoughlin, Ferguson, and Messier 2000). However, while barren-ground grizzly bears have a later age of maturity than other grizzly bear populations, they have larger litter sizes and higher birth rates (Case and Buckland 1998; McLoughlin et al. 2003). Furthermore, barren-ground grizzly bears have shorter intervals between litters than most northern populations and similar intervals to southern interior populations (McLoughlin et al. 2003)

HABITAT USE – LIFE REQUISITES AND SEASONS

The life requisites that will be rated for grizzly bear are living, reproducing, and hibernating. The specified seasons that will be rated for are spring, summer, fall, and denning (Table 1). Food is the most important aspect for this species during each of these seasons (except denning) and will be the focus of the ratings.

Table 1. Seasonal Life Requisites of Grizzly Bear

Season	Date	Life Requisite	Habitat Preference
Spring	May - June	Living	Esker, crowberry, blueberry, sedge, riparian shrub, caribou, ground squirrel
Summer	June – September	Living, Reproducing	Esker, blueberry, sedge, riparian shrub, ground squirrel
Fall	September - October	Living	Esker, blueberry, sedge, riparian shrub, caribou, ground squirrel
Denning	October - May	Hibernating, Reproducing	Eskers, lacustrine deposits

Overview

Habitat selection by barren-ground grizzly bears primarily reflects the availability and abundance of a wide variety of food items (McLoughlin et al. 2003). Habitat selection occurs at two spatial scales. On the landscape scale, grizzly bears select home ranges that have a higher proportion of eskers, tussock/hummock tundra, lichen veneer, birch seep, and riparian tall shrub habitat than surrounding areas. Habitat selection within the home ranges of grizzly bears varies by season, sex/reproductive status (McLoughlin et al. 2003). Females with cubs tend to avoid the most preferred habitats by males; females without cubs tend to prefer the same habitats as males. Research on the dietary patterns of barren-ground grizzly bears indicates that four time periods correlate with seasonal changes in resource selection (Table 2; Gau et al. 2002; Johnson et al. 2005): spring, summer, late summer, fall. Denning is assumed to take place outside of the dates defined by Gau et al. (2002) and Johnson et al. (2005).

Table 2. Timing of Grizzly Bear Resource Selection

Season	Start Date	End Date
Spring	16-May	20-Jun
Summer	21-Jun	31-Jul
Late Summer	01-Aug	09-Sep
Fall	10-Sep	15-Oct

Note: Dates used in habitat suitability modelling by Johnson et al. (2005) based on studies by Gau et al. (2002). Dates reflect shifts in grizzly bear diet throughout the season.

Barren-ground grizzly bears are opportunistically omnivorous, meaning that they eat a variety of vegetation and meat items depending on their availability and the physiological requirements of the bear. Caribou is the primary food item of barren-ground grizzly bears and grizzly bears may be proficient hunters of caribou (Gau et al. 2002). Berries (e.g., crowberry, *Empetrum nigrum*; blueberry, *Vaccinium uliginosum*; cranberry, *V. vitis-idaea*) are mostly consumed in spring and late summer when they are abundant. The summer diet of grizzly bears consists largely of emergent vegetation. Ground squirrels have varying importance in the diets of grizzly bears, depending on the time of year (Gau et al. 2002).

Habitat selection by barren-ground grizzly bears reflects the abundance and availability of the aforementioned food items. Overall, grizzly bears prefer eskers and riparian tall shrub habitats throughout the year (McLoughlin et al. 2002). Lichen veneer is selected by bears in the spring and fall seasons. Males prefer tussock/hummock tundra at varying times during the year. Females with cubs tend to avoid habitats that are ranked the highest for males in spring (e.g., tussock/hummock tundra), late summer (e.g., esker) and fall (e.g., riparian tall shrub; McLoughlin et al. (2002). Females may avoid habitats where there are higher chances of encountering males to avoid competition, or to protect cubs from occasional infanticide committed by males (McLellan 1994). The latter argument is supported by the fact that females without cubs tend not to avoid habitats preferred by males in the way that females with cubs do (McLoughlin et al. 2002).

Spring (May 14 to June 20)

Spring habitat is important because it provides the first forage for grizzly bears following winter hibernation. Upon emerging from dens, barren-ground grizzly bears feed primarily on caribou migrating north to their calving grounds (Gau et al. 2002). Overwintered berries and Arctic ground squirrels are also important food sources during this period, but are consumed to a lesser extent than are caribou (Gau et al. 2002).

Grizzly bears, including males, females with cubs and females without cubs, show the greatest preference for esker habitat during the spring. Lichen veneer and exposed bedrock habitats are also preferred by grizzly bears during this time (McLoughlin et al. 2002; Johnson et al. 2005). These habitat types provide relatively abundant sources of caribou, Arctic ground squirrel and over-wintered berries. Migrating caribou select eskers and lichen veneers for ease of travel and forage and Arctic ground squirrels preferentially burrow in eskers. Over-wintered berries are most accessible in eskers and exposed bedrock habitat because these habitats are the first to become snow-free in the spring. Male grizzly bears show an additional preference for tussock/hummock tundra, while females without cubs show additional preference for riparian tall shrub habitat (McLoughlin et al. 2002; Johnson et al. 2005).

Summer (June 21 to September 9)

The summer diet of barren-ground grizzly bears is highly variable. Early in the season, when caribou are scarce, grizzly bears feed primarily on horsetails, Arctic cottongrasses, and sedges. By mid-summer, caribou becomes the primary component of the grizzly bear diet as post-calving herds move southward. However, vegetation is still an important source of food. Grizzly bears resume consumption of Arctic ground squirrels in mid-summer (Gau et al. 2002).

During the summer, female grizzly bears (with and without cubs) show preference for eskers and riparian tall shrub habitat. Riparian tall shrub habitat is selected for its abundant vegetation and caribou. Females with young also prefer heath tundra. Males continue to show preference for tussock/hummock tundra in the summer (McLoughlin et al. 2002). A habitat modelling study by Johnson et al. (2005) shows that grizzly bears select esker and low shrub habitats in the summer.

In late summer, barren-ground grizzly bears increase foraging in order to fatten up for the winter denning season (Gau 1998). During this time, berries are the primary component of the grizzly bear diet and are essential for fat deposition. Caribou continue to be an important source of food during the late summer and Arctic ground squirrels are consumed to some extent (Gau et al. 2002).

Barren-ground grizzly bears prefer eskers and riparian tall shrub habitat in late summer (McLoughlin et al. 2002; Johnson et al. 2005). These habitats provide an abundance of fresh berries and caribou. Differences in habitat use among males, females with cubs and females without cubs are pronounced in late summer. Males and females without cubs prefer eskers, while females with cubs avoid this habitat type (McLoughlin et al. 2002). Males also continue to prefer tussock/hummock successional tundra and, to some extent, females with cubs express some preference for this. Females with cubs show preference for heath bedrock, while males and females without cubs avoid it. Generally, females with cubs are segregated from other demographic groups during the late summer period.

Fall (September 10 to October 15)

Fall is a critical season for barren-ground grizzly bears because individuals must gain weight rapidly in order to survive winter hibernation (Zager and Jonkel 1983). The fall diet of grizzly bears is similar to the spring diet. Barren-ground grizzly bears feed primarily on caribou that are migrating south towards the treeline for winter. Arctic ground squirrels are also an important food source. However, fewer berries are consumed in fall compared to the spring and summer seasons (Gau et al. 2002).

Important grizzly bear habitat in fall includes lichen veneer (by all groups), riparian tall shrub habitat for males and females without young (females with young significantly avoid this habitat), and eskers for females without young (McLoughlin et al. 2002). However, females with cubs significantly avoid riparian tall shrub habitat and select bedrock habitats, which are avoided by males. Again, habitats that provide grizzly bear with a relatively abundant source of caribou strongly influence their selection (Johnson et al. 2005). A habitat modelling study by Johnson et al. (2005) shows that fall habitat selection by grizzly bears is strongly influenced by the presence of esker, heath rock, low shrub, and peat bog vegetation types.

Denning (October 16 to May 14)

In general, denning lasts from late October to early May for most bears; some bears, males in particular, may den for shorter periods of time (McLoughlin, Cluff, and Messier 2002). McLoughlin, Cluff, and Messier (2002) visited 56 grizzly bear den sites to record physical characteristics of the den site such as the presence of vegetation and soil characteristics. Most den sites (60%) were located in heath tundra and heath-boulder habitats, with most of the remaining dens in riparian tall shrub and birch seep habitats. Although eskers accounted for only seven of 56 den sites studied, this habitat type was selected more than expected, given its low availability in the central Arctic.

Grizzly bear den sites in the study most commonly faced south (45%), followed by west (38%); dens facing east (18%) and north (14%) (McLoughlin, Cluff, and Messier 2002). Other researchers who have studied denning in Arctic grizzly bears have also found a pronounced tendency for den sites to have a more southerly aspect (Reynolds, Curatalo, and Quimby 1976; Banci and Moore 1997). The benefit of a southern exposure may be insulation (i.e., warmth) at emergence in the spring (and possibly at denning in the fall) or the accumulation of an insulating layer of snow that would result from the prevailing northerly winds.

Grizzly bears also select den sites based on slope. McLoughlin, Cluff, and Messier (2002) reported that grizzly bears chose den sites on relatively steep slopes, averaging 25°. Steep slopes may permit the bears to construct horizontal or even upward-sloping tunnels, which would result in a warm air “trap” in the hibernation chamber (Harding 1976).

The substrates of den sites are well-drained and contain a large amount of sand and coarse material, including cobble and boulder sized stones. The structural integrity of den sites is maintained through root mats from dwarf birch and other shrubby vegetation located in the ceilings of dens. The grizzly bear dens studied by McLoughlin, Cluff, and Messier (2002) did not last long; by mid-summer, about 80% (44/56) had partially or completely collapsed. Thus, it appears that bears usually dig new dens each year.

Ratings

A four class rating system was used to evaluate grizzly bear habitat within the Local Study Area and Regional Study Area.

Rating Assumptions for Spring

Spring habitat provides grizzly bears their first opportunity to feed after emerging from hibernation. Important habitat includes areas that become snow-free early, ecosystem units that contain last season's over-wintered berries, Arctic ground squirrel burrows, migrating caribou, and early vegetation (Gau et al. 2002; MacHutchon and Wellwood 2003). The following general assumptions were made to evaluate habitat for grizzly bears during the spring:

- High rated habitat (1) included ecosystem units that provided early season food sources, particularly those associated with upland areas that are generally windswept resulting is low snow packs. Overwintered berries from the previous season are available in these areas, as are Arctic ground squirrels.
- Moderate rated habitat (2) included vegetation associations that provide some food sources, but are generally not windswept and have limited over-wintered berries. Moderate ratings were also assigned to some wetland ecosystems based on a high occurrence of early forage production, winter weakened caribou, and caribou calves (as caribou forage within wetland areas post-calving).
- Low rated habitat (3) included vegetation associations that were considered to have low forage potential and was not preferred habitat for prey species.
- Nil rated habitat (4) were habitats that have a lack of forage and prey, or are disturbed.

Rating Assumptions for Summer

Summer habitat use by grizzly bears is highly variable. Grizzlies primarily feed on horsetails, sedges and cottongrass in the early summer when caribou are scarce, as well as berries if available. Caribou are considered to be their primary food source by mid-summer, as well as Arctic ground squirrels (Gau et al. 2002). Late summer use focuses on areas with high berry production. The following general assumptions were made to evaluate habitat for grizzly bears during the summer:

- High rated habitat (1) included shrub dominated ecosystem units, wetlands, and eskers based on the availability of forage. Important forage species in these ecosystem units include an abundance of berries, cottongrass and sedges which are important food sources when caribou are absent from the region.
- Moderate rated habitat (2) included areas where sedges and cottongrass are present in limited quantities, or where berries are only present later in the season (e.g., blueberries, bearberries).

- Low rated habitat (3) included areas that have low forage potential and are not preferred habitat for prey species.
- Nil rated habitat (4) represented habitat where suitable summer forage is limited or absent, such as habitats characterized by exposed soils, were barren, or encompassed lakes and rock outcrops.

Rating Assumptions for Fall

The fall season is critical for grizzlies as they must rapidly gain weight in order to survive the winter. Fall habitat selection is focused on areas of high caribou occurrence (Johnson et al. 2005). The following general assumptions were made to evaluate habitat for grizzly bears during the fall:

- High rated habitat (1) included ecosystem units that retain late season berries and have a relative high abundance of caribou.
- Moderate rated habitat (2) included areas that may contain limited quantities of berries, and to a lesser extent browning sedge and cottongrass forage.
- Low rated habitat (3) included habitat that had sparse vegetation cover, and thus would have low forage and hunting potential.
- Nil rated habitat (4) included vegetation associations that lacked forage and prey, and those that were disturbed.

Rating Assumptions for Denning

Based on the results of McLoughlin, Cluff, and Messier (2002), many habitats appear to have suitable soil texture and structure for denning, but eskers may be selected where available given the ease in which bears may excavate dens. Therefore, the following general assumptions were made to evaluate habitat for grizzly bears during the denning period:

- High rated habitat (1) included vegetation associations that provide terrain features that allow for denning opportunities, specifically parent materials that are easily excavated, have deep permafrost layers, and contain sufficient vegetative root masses to provide soil stability.
- Moderate rated habitat (2) included areas that are similar to high value habitat, but are more likely to contain limitations in the form of shallow permafrost layer or consolidated materials.
- Low rated habitat (3) was considered to have limited potential for successful den excavations (e.g., prevalence of boulders in soil).
- Nil rated habitat (4) included areas that were not suitable for excavation due to shallow soils, high permafrost layers, organic soils, or other conditions that would make a successful den excavation difficult.

Ratings Table

Grizzly bear habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 3 contains habitat suitability ratings for grizzly bear according to the TEM mapping conducted in the LSA, and Table 4 contains habitat suitability ratings for grizzly bear according to the WKSS/GeoBase mapping within the RSA.

Table 3. Ratings Table for Grizzly Bear Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Spring	Summer	Fall	Denning
Bedrock	Bedrock outcrop	BR	3	3	3	4
Bedrock	Bedrock-lichen veneer	BL	2	3	3	4
Bedrock	Cliff	BC	4	4	4	4
Bedrock	Talus	BT	4	4	4	4
Bedrock	Blockfield	TB	4	4	4	4
Disturbed/Barren	Disturbed vegetation	DV	4	4	4	4
Disturbed/Barren	Exposed soil	ES	4	4	4	4
Disturbed/Barren	Mine camp	DR	4	4	4	4
Disturbed/Barren	Road surface	DZ	4	4	4	4
Esker	Dwarf shrub esker	EH	1	2	1	1
Esker	Shrubby esker	EW	1	2	1	1
Esker	Sparsely vegetated esker	EC	1	2	2	1
Freshwater	Lake	LA	4	2	3	4
Freshwater	Pond	PD	4	2	3	4
Freshwater	River	RI	3	2	2	4
Marine	Marine beach	MB	3	2	2	3
Marine	Old beach heads	MH	4	4	4	3
Marine	Saltwater	MW	4	4	4	4
Riparian	Low bench floodplain	RL	3	3	3	4
Riparian	Mid bench floodplain	RM	3	2	2	3
Riparian	Willow riparian	RW	3	2	2	3
Riparian (Marine)	Marine riparian shrub	MR	3	2	2	3
Tundra	Dry-sparse tundra	TH	2	3	3	4
Tundra	Mesic dwarf-shrub tundra	TL	2	2	2	4
Tundra	Shrubby tundra	TS	3	2	2	4
Tundra (Marine)	Marine dwarf shrub tundra	MT	3	1	1	4
Tundra (Marine)	Marine shrubby tundra	MS	3	1	2	3
Wetland	Cottongrass-sedge fen	WC	2	2	2	4
Wetland	Raised bog complex	WB	2	2	2	4
Wetland	Shallow open water	WO	3	3	3	4
Wetland	Tussock meadow	WT	2	2	2	4
Wetland	Undifferentiated fen	WF	2	2	2	4
Wetland	Water sedge marsh	WA	1	1	2	4
Wetland	Willow-sedge fen	WS	3	2	3	4
Wetland (Marine)	Saline Fen	MF	3	2	3	4
Wetland (Marine)	Saline Marsh	MM	3	2	3	4
Wetland (Marine)	Saline shallow open water	MO	4	3	3	4

Table 4. Ratings Table for Grizzly Bear Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Spring	Summer	Fall	Denning
Bedrock Association	4	4	4	4
Boulder Association	3	3	3	4
Heath/Bedrock	2	3	3	4
Lichen Veneer	2	3	3	4
Sparsely vegetated bedrock*	2	3	3	4
Sparsely vegetated till-colluvium*	2	3	3	4
Bare Ground	4	4	4	4
Barren/Non-vegetated*	4	4	4	4
Gravel Deposit	4	4	4	3
Esker Complex	1	2	1	1
Deep Water	4	2	3	4
Shallow Water	3	3	3	4
Water	4	2	3	4
Riparian Tall Shrub	3	2	2	3
Shrub tall*	3	2	2	3
Bare soil with cryptogam crust - frost boils*	2	3	3	4
Birch Seep	3	2	2	4
Heath Tundra	2	2	2	4
Heath/Boulder	2	3	3	4
Low Shrub	3	2	2	4
Moist to dry non-tussock graminoid/dwarf shrub tundra*	2	2	2	4
Prostrate dwarf shrub*	2	3	3	4
Shrub low*	3	2	2	4
Ice and Snow	4	4	4	4
No data	NA	NA	NA	NA
Unclassified	NA	NA	NA	NA
Tussock graminoid tundra*	2	2	2	4
Tussock/Hummock	2	2	2	4
Wet sedge*	2	1	2	4
Wetland (Sedge Meadow)	2	1	2	4
Wetland*	2	1	2	4

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Personal Communication

Robert Mulders, GNWT ENR, personal communication

Appendix 4

Species Account for Grey Wolf

Appendix 4. Species Account for Grey Wolf

BACKGROUND INFORMATION

Common Name:	Grey wolf (northern grey wolf)	
Scientific Name:	*Canis lupus occidentalis*	
Species Code:	M-CALU	
Status:	**Global:**	G4 – Apparently Secure, Uncommon but not rare; some cause for long-term concern due to declines or other factors.
	National:	Grey wolf is listed as Not at Risk by COSEWIC (2009).
	Territorial:	Secure (CESCC 2010).

DISTRIBUTION

Range within Nunavut

The grey wolf is widespread throughout northern Canada, including Nunavut.

Territorial Context

Arctic wolves rely on migratory prey (i.e., barren-ground caribou) rather than resident prey (Walton et al. 2001; Cluff, Walton, and Paquet 2002). As a result, the annual home ranges of wolves in the Arctic are considerably larger than in more southerly latitudes. Typically, their patterns of distribution, densities, territory boundaries and dispersal movements will all be influenced by prey abundance and distribution and also interactions between packs.

Project Area

Numerous wolves and wolf dens have been observed in areas surrounding the Project area during baseline studies (Rescan 2012, 2013, 2014).

POPULATION TRENDS

Wolves are found in 90% of their original Canadian range, which is home to an estimated 60,000 individuals (Walton et al. 2001). Nunavut. Populations are stable or increasing across the majority of their Canadian range, except in northern Alberta and some areas of the Northwest Territories where they are experiencing declines (Hayes and Gunson 1995). In Nunavut, wolf populations are stable or increasing within their range (Hayes and Gunson 1995). Estimates of wolf numbers in Nunavut have not been made recently.

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

The specific habitat being rated for the grey wolf is living and reproducing and the respective season is denning (Table 1). Wolves breed once per year, typically during March or April. After a nine-week gestation period, litters remain in dens for up to two weeks. Throughout the late spring and early summer pups remain close to dens, while adults hunt nearby. By late summer to early fall they join the pack as it follows caribou and begin to participate in hunting activities.

Table 1. Seasonal Life Requisites of Grey Wolf

Season	Date	Life Requisite	Habitat Preference
Denning	Late April to September	Living and Reproducing	Eskers, near prey

Habitat Use and Diet

A study in the central Canadian Arctic estimated annual home range sizes of approximately 63,000 km^2 for males, and 45,000 km^2 for females (Walton et al. 2001). Winter ranges are much larger than summer ranges and show a clear seasonal separation from summer denning areas (Walton et al. 2001). The reason for these extraordinary home range sizes is that Wolves in the Canadian Arctic make long seasonal migrations every year to follow barren- ground caribou (Heard and Williams 1992; Walton et al. 2001; Frame et al. 2004). Satellite-collared wolves in the central Arctic showed a distinct migratory pattern whereby they leave the tundra denning areas in the fall, move over large areas throughout the winter, and then return to the tundra to give birth in the early spring (Walton et al. 2001). Wolves follow the caribou for most of the year, except while giving birth to pups in mid to late May, and until pups are able to travel with their mother in September to October. Between these periods, wolf movements are restricted to areas surrounding the den site with individuals often travelling large distances in search of prey (Frame et al. 2004).

At the level of the home range, tundra grey wolves in the central Canadian Arctic have shown to have a selective preference for eskers (McLoughlin et al. 2004). Although this link between habitat selection and ecosystem type was not conclusive when examined within the home range, the findings suggest that suitable denning habitat (i.e., eskers) may be an important limiting factor affecting habitat selection of arctic grey wolves (McLoughlin et al. 2004). Given that tundra wolves also hunt primarily migrating caribou would suggest why they tend to show no relative preference for habitat types within the home range.

The primary prey of wolves of this region and inhabiting the study area is barren-ground caribou, which they follow for hundreds of kilometres every year (Frame 2005). Caribou in the Canadian Arctic are the only species that occur at densities sufficient enough to support the wolf population (Walton et al. 2001). Tundra wolves also feed on muskox, small mammals such as hares, foxes, rodents, and even small amounts of plant material.

Denning Ecology

Wolves arrive at denning sites in mid- to late- May and give birth shortly thereafter. Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually sometime between September and October (Walton et al. 2001). After migrating long distances to follow caribou, wolves often return to the same den in subsequent years (Ballard and Dau 1983; Mech and Packard 1990).

Eskers are the preferred habitats for wolf den construction. Esker habitats are granular and sandy, facilitating soil excavation (McLoughlin et al. 2004). In the Canadian Arctic tundra, esker habitat only comprises about 1 to 2% of the landscape, therefore, suitable denning habitat for these wolves is likely a limiting factor and eskers should be considered ecologically sensitive (McLoughlin et al. 2004).

Ratings

A four class rating system was used to evaluate grey wolf habitat within the Local Study Area and Regional Study Area.

Rating Assumptions for Denning

The denning season is focused on the location of suitable dens (eskers and other surficial material such as gravel where the permafrost layer is deep and soils are relatively loose). Though the presence of suitable hunting habitat near the den is also important, it was not accounted for in the model. Wolves are known to make long distance forays for food during the denning period. The following general assumptions were made to evaluate habitat for wolf denning:

- High rated habitat (1) was restricted to eskers.
- Moderate rated habitat (2) included habitat similar to high value habitat, but that contain limitations in the form of shallow permafrost layer or consolidated materials.
- Low rated habitat (3) included vegetation associations that were considered to have limited potential for successful den excavations, such as dry upland shrubby areas.
- Nil rated habitat (4) included areas not suitable for excavation due to shallow soils, high permafrost layers, organic soils, or other conditions that would make a successful den excavation difficult.

Ratings Table

Grey wolf habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 2 contains habitat suitability ratings for grey wolf according to the TEM mapping conducted in the LSA, and Table 3 contains habitat suitability ratings for grey wolf according to the WKSS/GeoBase mapping within the RSA.

Table 2. Ratings Table for Grey Wolf Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Denning
Bedrock	Bedrock outcrop	BR	4
Bedrock	Bedrock-lichen veneer	BL	4
Bedrock	Cliff	BC	4
Bedrock	Talus	BT	4
Bedrock	Blockfield	TB	4
Disturbed/Barren	Disturbed vegetation	DV	4
Disturbed/Barren	Exposed soil	ES	4
Disturbed/Barren	Mine camp	DR	4
Disturbed/Barren	Road surface	DZ	4
Esker	Dwarf shrub esker	EH	1
Esker	Shrubby esker	EW	1
Esker	Sparsely vegetated esker	EC	1
Freshwater	Lake	LA	4
Freshwater	Pond	PD	4
Freshwater	River	RI	4
Marine	Marine beach	MB	3
Marine	Old beach heads	MH	3
Marine	Saltwater	MW	4
Riparian	Low bench floodplain	RL	4
Riparian	Mid bench floodplain	RM	3

(continued)

Table 2. Ratings Table for Grey Wolf Habitat in the Local Study Area (completed)

Ecosystem Class	LSA Vegetation Association	Map Code	Denning
Riparian	Willow riparian	RW	2
Riparian (Marine)	Marine riparian shrub	MR	2
Tundra	Dry-sparse tundra	TH	4
Tundra	Mesic dwarf-shrub tundra	TL	4
Tundra	Shrubby tundra	TS	4
Tundra (Marine)	Marine dwarf shrub tundra	MT	4
Tundra (Marine)	Marine shrubby tundra	MS	3
Wetland	Cottongrass-sedge fen	WC	4
Wetland	Raised bog complex	WB	4
Wetland	Shallow open water	WO	4
Wetland	Tussock meadow	WT	4
Wetland	Undifferentiated fen	WF	4
Wetland	Water sedge marsh	WA	4
Wetland	Willow-sedge fen	WS	4
Wetland (Marine)	Saline Fen	MF	4
Wetland (Marine)	Saline Marsh	MM	4
Wetland (Marine)	Saline shallow open water	MO	4

Table 3. Ratings Table for Grey Wolf Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Denning
Bedrock Association	4
Boulder Association	4
Heath/Bedrock	4
Lichen Veneer	4
Sparsely vegetated bedrock*	4
Sparsely vegetated till-colluvium*	4
Bare Ground	4
Barren/Non-vegetated*	4
Gravel Deposit	3
Esker Complex	1
Deep Water	4
Shallow Water	4
Water	4
Riparian Tall Shrub	3
Shrub tall*	3
Bare soil with cryptogam crust - frost boils*	4
Birch Seep	4
Heath Tundra	4
Heath/Boulder	4
Low Shrub	4

(continued)

Table 3. Ratings Table for Grey Wolf Habitat in the Regional Study Area (completed)

WKSS/GeoBase Land Classification	Denning
Moist to dry non-tussock graminoid/dwarf shrub tundra*	4
Prostrate dwarf shrub*	4
Shrub low*	4
Ice and Snow	2
No data	NA
Unclassified	NA
Tussock graminoid tundra*	4
Tussock/Hummock	4
Wet sedge*	4
Wetland (Sedge Meadow)	4
Wetland*	4

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Appendix 5

Species Account for Wolverine

Appendix 5. Species Account for Wolverine

BACKGROUND INFORMATION

Common Name:	Wolverine	
Scientific Name:	*Gulo gulo*	
Species Code:	M-GUGU	
Status:	**Global:**	G4 – Apparently Secure, Uncommon but not rare; some cause for long-term concern due to declines or other factors.
	National:	Listed as population of Special Concern by COSEWIC (COSEWIC 2003).
	Territorial:	Secure (CESCC 2010).

DISTRIBUTION

Range within Nunavut

In North America, the geographic range of the wolverine extends from Alaska throughout most of northern and western Canada, including the West Kitikmeot region of Nunavut (COSEWIC 2003; Slough 2007). Wolverines in Nunavut are at the northern most range of populations in North America. Their range within Nunavut includes the Kivalliq and the Kitikmeot regions, and all but the highest arctic islands in the Baffin region.

Territorial Context

Average home range size for wolverines on the tundra are 73-126 km^2 for breeding females and 404-666 km^2 for male (Magoun 1985; Mulders 2000). Home ranges of male wolverine are on average at least four times larger than female home ranges (Mulders, Boulanger, and Paetkau 2007; Persson, Wedholm, and Segerstrom 2010) and over-lap those of several females, in accordance with a polygynous mating system, but adult male-male and female-female home ranges rarely overlap, in accordance with territoriality (Persson, Wedholm, and Segerstrom 2010).

Project Area

Baseline studies indicate wolverine occur within the RSA and LSA. Additionally, Inuit TK indicates that wolverines use the Project area extensively. The southern end of the RSA near Contwoyto Lake is an important area for wolverines. Wolverines are also known to use the southern end of Bathurst Inlet.

POPULATION TRENDS

Wolverine populations in the central Arctic appear to be stable, though recent estimates are lacking (COSEWIC 2003). Population density is thought to be relatively high in the western Arctic (e.g., Yukon and NWT), moderate in western Nunavut (including the Kitikmeot region), and low in eastern Nunavut and on Arctic islands (Slough 2007). The total population size of wolverines in Nunavut is estimated as 2,000-2,500 individuals (COSEWIC 2003; Slough 2007).

Due primarily to low reproductive rates and low population densities, wolverines are susceptible to population declines (Slough 2007; Inman et al. 2012). For example, the eastern population may be near extinction, and wolverines have likely been extirpated from Vancouver Island (Slough 2007). Despite high pregnancy rates, fewer than half of pregnant females produce cubs – most females do not reproduce in consecutive years (Persson 2005; Inman et al. 2012). Reproductive failure occurs early, during gestation or just after birthing, and is thought to result primarily from poor nutritional status of females (Inman et al. 2012). Thus, food availability, especially during winter, is thought to be the main factor limiting reproduction and structuring the population dynamics of wolverines (Persson 2005). In some populations, mortality due to starving is also an important factor (Inman et al. 2012). Population modeling suggests that viable wolverine populations require at least 45 sexually mature females (> 3 years of age; Persson 2005).

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

Habitat suitability modelling for wolverine focussed on the identification of suitable natal and maternal denning habitat during the late winter (Table 1). Wolverines mate in the summer but implantation of the fertilized egg is delayed. The fertilized eggs do not implant into the wall of the uterus until sometime between November and March; the eggs will not implant if the female is in poor physical condition. The active period of gestation, or pregnancy, lasts 30 to 40 days following implantation. Birth occurs between February and May.

Table 1. Seasonal Life Requisites of Wolverine

Season	Date	Life Requisite	Habitat Preference
Denning	February to early May	Living and Reproducing	Landscape features that provide deep, persistent snow packs.

Habitat Use and Diet

Wolverine distribution and habitat selection are likely influenced mostly by the availability of food for females, and of food and mates for males (Banci 1994; Mulders, Boulanger, and Paetkau 2007; Persson, Wedholm, and Segerstrom 2010).

Wolverines are both scavengers and predators, and feed on a wide variety of prey and carrion throughout the year. Food caching is an important survival strategy, especially in winter, and may be one of the most critical factors affecting reproduction (Magoun 1987; Mulders 2000; Thorpe et al. 2001; Inman et al. 2012). Characteristics of good cache sites are structures that prevent access by competitors, and allow cold storage to prevent rot in spring and summer. Though wolverines use a variety of habitats while ranging over large tracts of land in search of food (Mulders 2000; Thorpe et al. 2001; COSEWIC 2003), they are often associated with rocky boulder fields which provide good sites for caching food (Johnson et al. 2005; Inman et al. 2012).

Adult ungulates (caribou and muskox) are eaten mostly in the form of carrion, but wolverines are the main predator of caribou calves in some regions (e.g., British Columbia; Gustine et al. 2006). The summer diet of wolverines is more varied than their winter diet, and contains more freshly killed prey (Magoun 1987). It is thought that wolverine foraging strategies switch from mostly scavenging and caching during winter, to hunting for birds and small mammals during summer (Inman et al. 2012). However, scavenging likely remains a key foraging strategy during summer, and is not limited to wolf kills as wolverine have been observed stealing goose carcasses from fox dens (Samelius et al. 2002). On the tundra during the summer, wolverine hunt mainly ground squirrels, Arctic hare, ptarmigan, geese and their eggs (Magoun 1987; Samelius et al. 2002).

Denning Ecology

Wolverines are unique among northern non-hibernating carnivores because they birth very early in the year (February to early April; Inman et al. 2012). Females usually move cubs from natal dens (where cubs were born) to one or more maternal dens (where cubs are nursed) until they are weaned at 7-10 weeks of age. Wolverines usually choose den sites within rocky boulder fields in snowdrifts where a deep insulating layer of snow will be maintained throughout the denning period (February to April); dens and den sites are often used for consecutive years (Lee and Niptanatiak 1996; May et al. 2012). The importance of sites with delayed snow melt in spring for denning is revealed by the strong relationship of wolverine distribution with snow cover – 100% of 562 den sites in North America and Fennoscandia were in sites where snow melted later during spring (Copeland et al. 2010). A den usually consists of snow tunnels within boulder fields terminating in a crevice. Proximity to habitat that provides small mammal prey for cubs also may be an important factor in den site selection (Magoun and Copeland 1998).

Ratings

A two class rating scheme was used to evaluate wolverine denning habitat in the Local Study Area and Regional Study Area.

Rating Assumptions for Late Winter/Denning

Wolverines have specific habitat requirements for den sites and often use dens for consecutive years (Lee and Niptanatiak 1996). Reproductive dens are found in rocky outcrops or snowdrifts, which must maintain a deep insulating layer of snow throughout the denning period (e.g., a snow tunnel within a boulder field terminating in a crevice; Magoun and Copeland 1998). Reproductive dens may be classified as either natal or maternal. Natal dens are used during parturition, while maternal dens are used subsequent to the natal den and before weaning (Magoun and Copeland 1998). Denning sites are located away from predators such as grizzly bears, wolves and other wolverines. Proximity to kit-rearing habitat is also an important factor in den site selection (Magoun and Copeland 1998). In general, the most important factors during this time period are denning and locating adequate food sources. The following general assumptions were used to evaluate habitat for wolverine denning:

- Suitable habitat (U) was limited to vegetation associations that provide potential deep, long-lasting snow packs dues to topography and/or physical structure (tall vegetation, boulders, etc.)
- Not suitable habitat (X) was all other vegetation associations due to a lack of features that provide deep snow packs.

Ratings Table

Wolverine habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 2 contains habitat suitability ratings for wolverine according to the TEM mapping conducted in the LSA, and Table 3 contains habitat suitability ratings for wolverine according to the WKSS/GeoBase mapping within the RSA.

Table 2. Ratings Table for Wolverine Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Denning
Bedrock	Bedrock outcrop	BR	U
Bedrock	Bedrock-lichen veneer	BL	X
Bedrock	Cliff	BC	X
Bedrock	Talus	BT	U

(continued)

Table 2. Ratings Table for Wolverine Habitat in the Local Study Area (completed)

Ecosystem Class	LSA Vegetation Association	Map Code	Denning
Bedrock	Blockfield	TB	U
Disturbed/Barren	Disturbed vegetation	DV	X
Disturbed/Barren	Exposed soil	ES	X
Disturbed/Barren	Mine camp	DR	X
Disturbed/Barren	Road surface	DZ	X
Esker	Dwarf shrub esker	EH	U
Esker	Shrubby esker	EW	U
Esker	Sparsely vegetated esker	EC	X
Freshwater	Lake	LA	X
Freshwater	Pond	PD	X
Freshwater	River	RI	X
Marine	Marine beach	MB	X
Marine	Old beach heads	MH	X
Marine	Saltwater	MW	X
Riparian	Low bench floodplain	RL	X
Riparian	Mid bench floodplain	RM	U
Riparian	Willow riparian	RW	U
Riparian (Marine)	Marine riparian shrub	MR	U
Tundra	Dry-sparse tundra	TH	X
Tundra	Mesic dwarf-shrub tundra	TL	U
Tundra	Shrubby tundra	TS	U
Tundra (Marine)	Marine dwarf shrub tundra	MT	X
Tundra (Marine)	Marine shrubby tundra	MS	U
Wetland	Cottongrass-sedge fen	WC	X
Wetland	Raised bog complex	WB	X
Wetland	Shallow open water	WO	X
Wetland	Tussock meadow	WT	X
Wetland	Undifferentiated fen	WF	X
Wetland	Water sedge marsh	WA	X
Wetland	Willow-sedge fen	WS	X
Wetland (Marine)	Saline Fen	MF	X
Wetland (Marine)	Saline Marsh	MM	X
Wetland (Marine)	Saline shallow open water	MO	X

Table 3. Ratings Table for Wolverine Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Denning
Bedrock Association	U
Boulder Association	U
Heath/Bedrock	X
Lichen Veneer	X

(continued)

Table 3. Ratings Table for Wolverine Habitat in the Regional Study Area (completed)

WKSS/GeoBase Land Classification	Denning
Sparsely vegetated bedrock*	X
Sparsely vegetated till-colluvium*	X
Bare Ground	X
Barren/Non-vegetated*	X
Gravel Deposit	X
Esker Complex	U
Deep Water	X
Shallow Water	X
Water	X
Riparian Tall Shrub	U
Shrub tall*	U
Bare soil with cryptogam crust - frost boils*	X
Birch Seep	U
Heath Tundra	U
Heath/Boulder	X
Low Shrub	U
Moist to dry non-tussock graminoid/dwarf shrub tundra*	U
Prostrate dwarf shrub*	X
Shrub low*	U
Ice and Snow	X
No data*	NA
Unclassified	NA
Tussock graminoid tundra*	X
Tussock/Hummock	X
Wet sedge*	X
Wetland (Sedge Meadow)	X
Wetland*	X

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Appendix 6

Species Account for Short-eared Owl

Appendix 6. Species Account for Short-eared Owl

BACKGROUND INFORMATION

Common Name:	Short-eared Owl	
Scientific Name:	*Asio flammeus*	
Species Code:	B-SEOW	
Status:	**Global:**	G5 – Globally secure; common, widespread, and abundant
	National:	Listed as a population of Special Concern on Schedule 1 of SARA (2002).
	Territorial:	Sensitive (CESCC 2010).

DISTRIBUTION

Range within Nunavut

Short-eared owls are present in all provinces and territories in Canada. The specific range of short-eared owl within Nunavut is not known, but the Arctic coast is an important breeding area in general. They are thought to be widely distributed in the NWT and Nunavut, with greater breeding numbers during years of abundant lemmings (COSEWIC 2008).

Territorial Context

The specific range of short-eared owl within Nunavut is not known. They occur throughout the territory during the breeding season, but are most abundant in flat, rolling coastal areas (COSEWIC 2008).

Project Area

Short-eared owls have been observed throughout the Project area. Active nesting sites are rarely found, as they are well concealed with shrub cover on the ground.

POPULATION TRENDS

Data on the population status and trends are not available in the NWT or Nunavut. The Canadian population of short-eared owls is estimated to be about 50,000, with an annual decline of 3.07% over the last 40 years, and a 27% decline over the last decade (COSEWIC 2008). Habitat loss and degradation, particularly on the wintering grounds, are believed to be the major threat to short-eared owl populations in North America (COSEWIC 2008).

In the Arctic, populations of short-eared owls fluctuate in numbers in cycles of about 4 years, along with populations of lemmings and voles (Clark 1975; Village 1987; Korpimaki and Norrdahl 1991; Oksanen and Henttonen 1996; Norrdahl and Korpimaki 2002a, 2002b). Climate change, through impacts on lemming and vole populations, may also threaten short-eared arctic populations in the future (Ims and Fuglei 2005).

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

Habitat suitability modelling for short-eared owl was conducted for the nesting season and for the living and reproducing life requisites during this time (Table 1). Nests are the focal point of activity until young have fledged (i.e., left the nest site).

Table 1. Seasonal Life Requisites of Short-eared Owl

Season	Date	Life Requisite	Habitat Preference
Nesting	May - July	Living and Reproducing	Dense vegetation close to water

Habitat Use and Diet

Short-eared owls are largely diurnal (Village 1987) and regularly hunt during crepuscular hours (Taylor 1984; Schmelzer 2005). They are small mammal specialists with a narrow, mainly mammalian, food niche made up almost exclusively of voles and lemmings, especially in the non-breeding season (Clark 1975; Taylor 1984; Holt 1993). Small birds, especially shorebirds, and insects and crustaceans have also been taken as prey (Holt 1993, 1994). Populations on islands feed more heavily on seabirds, while populations in the interior of the Arctic tundra rely more heavily on lemmings and voles (Holt 1993; Schmelzer 2005). Males usually do all the hunting, and bring back the food to the nest where the females will incubate the eggs or feed offspring (Clark 1975).

Breeding density and success of short-eared owls are linked to lemming cycles (Ims and Fuglei 2005). During the low phase of the lemming cycle, very few owls (or none at all) appear on the breeding grounds, while the opposite happens in lemming peak years (Ims and Fuglei 2005). The birds are nomadic, and they will move over vast areas in search of regions with high peak lemming populations (Gauthier et al. 2003), or drift through as non-breeders (Pitelka 1974).

Nesting

Short-eared owls live in open habitats and nest on the ground (Snyder and Wiley 1976). Female owls make a rudimentary nest on the ground by gathering leaves, feathers, or grass (Wiggins, Holt, and Leasure 2006). Nests are hidden in dense vegetation, often close to water, under low shrubs, reeds and grasses. The nestlings are nidicolous (Holt, Melvin, and Steele 1992). Females are attentive and stay with the nest until all the young have left (Clark 1975).

Courtship begins as early as April in Nunavut, and clutch sizes are larger when food is abundant (Schmelzer 2005). The nestlings leave the nest and begin flying after 24-27 days, but depend on their parents for feeding for about seven weeks.

Severe weather, changes in prey density and habitat alterations have all contributed to variations in nest productivity in North America (Holt and Leasure 1993).

The young are entirely dependent upon the parents for food even after they have fledged (Clark 1975). They begin to fly between 27 to 36 days after they hatch (Schmelzer 2005). Parental care patterns are poorly understood, but it appears that females brood and feed the young, while the males hunt and provide the majority of the food (Schmelzer 2005). The pair stay together until the young can fly and are self-sufficient and likely last for a single season only (Holt and Leasure 1993).

Ratings

A two class rating scheme was used to evaluate the quality of habitat for short-eared owl in the Local Study Area (LSA) and Regional Study Area (RSA).

Rating Assumptions for Nesting

The presence of shrub low or tall cover was assumed to be the most important characteristic for short-eared owl nesting habitat. However, this cover type is relatively abundant across the landscape. Thus, the habitat model for short-eared owl is acknowledged to overestimate the amount of usable habitat for owls. The following general assumptions were made to evaluate habitat for short-eared owl nesting:

- Suitable habitat (U) was limited to vegetation associations that were characterized by substantial low to tall shrub cover and no surface water (including seasonal seepages and inundation) to ensure nesting area nesting remained dry through the nesting period.
- Not suitable habitat (X) ratings was all other vegetation associations due to a lack of nesting cover, presence of water, or disturbance.

Ratings Table

Short-eared owl habitat models utilized ecosystem mapping and known dominant vegetation composition of the mapped ecosystem units. Table 2 contains habitat suitability ratings for short-eared owl according to the TEM mapping conducted in the LSA, and Table 3 contains habitat suitability ratings for short-eared owl according to the WKSS/GeoBase mapping within the RSA.

Table 2. Ratings Table for Short-eared Owl Habitat in the Local Study Area

Ecosystem Class	LSA Vegetation Association	Map Code	Nesting
Bedrock	Bedrock outcrop	BR	X
Bedrock	Bedrock-lichen veneer	BL	X
Bedrock	Cliff	BC	X
Bedrock	Talus	BT	X
Bedrock	Blockfield	TB	X
Disturbed/Barren	Disturbed vegetation	DV	X
Disturbed/Barren	Exposed soil	ES	X
Disturbed/Barren	Mine camp	DR	X
Disturbed/Barren	Road surface	DZ	X
Esker	Dwarf shrub esker	EH	X
Esker	Shrubby esker	EW	U
Esker	Sparsely vegetated esker	EC	X
Freshwater	Lake	LA	X
Freshwater	Pond	PD	X
Freshwater	River	RI	X
Marine	Marine beach	MB	X
Marine	Old beach heads	MH	X
Marine	Saltwater	MW	X
Riparian	Low bench floodplain	RL	X

(continued)

Table 2. Ratings Table for Short-eared Owl Habitat in the Local Study Area (completed)

Ecosystem Class	LSA Vegetation Association	Map Code	Nesting
Riparian	Mid bench floodplain	RM	X
Riparian	Willow riparian	RW	U
Riparian (Marine)	Marine riparian shrub	MR	U
Tundra	Dry-sparse tundra	TH	X
Tundra	Mesic dwarf-shrub tundra	TL	U
Tundra	Shrubby tundra	TS	U
Tundra (Marine)	Marine dwarf shrub tundra	MT	U
Tundra (Marine)	Marine shrubby tundra	MS	U
Wetland	Cottongrass-sedge fen	WC	X
Wetland	Raised bog complex	WB	U
Wetland	Shallow open water	WO	X
Wetland	Tussock meadow	WT	U
Wetland	Undifferentiated fen	WF	X
Wetland	Water sedge marsh	WA	X
Wetland	Willow-sedge fen	WS	U
Wetland (Marine)	Saline Fen	MF	X
Wetland (Marine)	Saline Marsh	MM	X
Wetland (Marine)	Saline shallow open water	MO	X

Table 3. Ratings Table for Short-eared Owl Habitat in the Regional Study Area

WKSS/GeoBase Land Classification	Nesting
Bedrock Association	X
Boulder Association	X
Heath/Bedrock	X
Lichen Veneer	X
Sparsely vegetated bedrock*	X
Sparsely vegetated till-colluvium*	X
Bare Ground	X
Barren/Non-vegetated*	X
Gravel Deposit	X
Esker Complex	X
Deep Water	X
Shallow Water	X
Water	X
Riparian Tall Shrub	U
Shrub tall*	U
Bare soil with cryptogam crust - frost boils*	X
Birch Seep	U
Heath Tundra	U

(continued)

Table 3. Ratings Table for Short-eared Owl Habitat in the Regional Study Area (completed)

WKSS/GeoBase Land Classification	Nesting
Heath/Boulder	X
Low Shrub	U
Moist to dry non-tussock graminoid/dwarf shrub tundra*	U
Prostrate dwarf shrub*	X
Shrub low*	U
Ice and Snow	X
No data	NA
Unclassified	NA
Tussock graminoid tundra*	U
Tussock/Hummock	U
Wet sedge*	X
Wetland (Sedge Meadow)	X
Wetland*	X

** GeoBase land cover class.*
*** The Unclassified and No data class were not assessed and were excluded from the modelling.*

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Appendix 7

Species Account for Peregrine Falcon

Appendix 7. Species Account for Peregrine Falcon

BACKGROUND INFORMATION

Common Name:	Peregrine falcon *tundruis* subspecies		
Scientific Name:	*Falco peregrinus tundrius*		
Species Code:	B-PEFA		
Status:	**Global:**	G4T3 – Peregrine falcon is considered Apparently Secure; however, the tundrius subspecies is considered Vulnerable.	
	National:	The tundruis subspecies is listed as Special Concern under Schedule 3 of *Species At Risk Act* (2002).	
	Territorial:	Secure (CESCC 2010).	

DISTRIBUTION

Range within Nunavut

There are three subspecies of peregrine falcon in Canada, each with distinct distributions. The highly migratory *tundrius* subspecies breeds in the tundra regions of Canada, Alaska and Greenland (SARA 2010). This subspecies travels as far south as Argentina and Chile and it has been found that the farther north a bird breeds, the farther south it migrates.

Territorial Context

The peregrine falcon occupies approximately 61 percent of Nunavut (Beckett et al. 2008). Nesting typically occurs along the coast and shore lines and the total number of nesting pairs known for Nunavut is at least 250 (Beckett et al. 2008).

Project Area

Peregrine falcons are known to occur in the RSA and LSA based on observations. Numerous active and abandoned nests are known to occur.

POPULATION TRENDS

The minimum population size for the tundra peregrine falcon is 199, based on 2005 national survey data by COSEWIC (2007), though the actual population is likely larger.

Peregrine falcon underwent a dramatic population decline during the mid to late 1900's. The primary factor contributing to the historic population decline was the use of organochlorine pesticides, most notably DDT, which would bioaccumulate in the falcon's tissue and affect reproductive survival and breeding (COSEWIC 2007; SARA 2010). Fortunately, populations appear to have recovered as the prolific use of DDT has since been restricted drastically, though the pre DDT population numbers are not well known.

HABITAT USE – LIFE REQUISITES AND SEASONS

Overview

The life requisites that will be rated for peregrine falcon are living and reproducing. The specified seasons that will be rated for are nesting (Table 1). These periods represent the majority of the time that this migratory species is present within the region.

Table 1. Seasonal Life Requisites of Peregrine Falcon

Season	Date	Life Requisite	Habitat Preference
Spring (Nesting	Late May - August	Living and Reproducing	Southern facing cliffs over 10 m, near water

The main habitat requirements for this species described by SARA (2010) are the nest site (most commonly scrapes on cliff ledges), the nesting territory (the defended area of approximately 1 km from the nest site), and the home range (the non-defended area in which the species hunts for food outside of the defended territory and can extend to 27 km from the nest site). The focus of the habitat model is the nest site and territory.

Habitat Use and Diet

Peregrines prey primarily on birds, which include waterfowl, seabirds, shorebirds, songbirds, and pigeons (COSEWIC 2007), and the avian diet is highly variable. Court et al. (1988) concluded that no one avian species constituted the majority of the arctic peregrine's diet. In the arctic, the local populations of avian species, and in some cases other taxa such as arctic ground squirrels (*Spermophilus parryii*) or lemmings (*Dicrostonyx torquatus*), are determinant of what constitutes a falcons diet (Court et al. 1988). For example, in a study near Rankin Inlet, the most common passerines and ptarmigans were the most important prey items (Court et al. 1988).

Nesting Ecology

Tundra peregrine falcons typically nest on cliff edges or in crevices situated near good foraging areas (i.e., water). Near Rankin Inlet, Nunavut, nest sites of peregrines located on 21 of 29 cliffs (72%) were bordered on the ocean or within 150 m of the shoreline (Court et al. 1988). The remaining cliffs were all within 300 m of a water body (Court et al. 1988). Nest cliffs have been found to range from 7 to 400 m in height; however, cliffs 50 to 200 m are typically preferred (Cade 1960; White and Cade 1971; White et al. 2002). Nest sites near Rankin Inlet were most commonly between 7 and 30 m in height and nests located on cliff faces typically had southern exposure (69%), although it was noted that the majority of cliffs regardless of nesting activity had southern exposure. However, other sources also report southern exposures as common in the tundra peregrine falcon (White et al. 2002). Selection for southern aspect has many advantages. South facing cliffs are snow free earlier in the year and become accessible nesting sites in comparison to areas with more northern aspects. Southern aspects are generally warmer as well, as they receive greater amounts of sunlight relative to northern aspects, which may be advantageous in keeping adults, eggs, and young birds warm.

In Nunavut, both sexes will typically arrive at nest sites in approximately mid-May (Court et al. 1988). Nests consist of scrapes in substrates usually consisting of dirt, sand, or fine gravel (White et al. 2002). Sometimes decomposed fecal material or decomposed lining materials of old stick nests of other birds, such as common raven (*Corvus corax*) and rough-legged hawk (*Buteo lagopus*), are used. Males will scrape the nest, sometimes making several options on the same ledge for the female to choose from. If a pair does not reuse a previous years nest, an alternative nest site is often selected on the same cliff or within a few kilometres (White et al. 2002). Other locations of nest sites may include tops of pingos (hills of soil covered ice in permafrost), road cuts, stone quarries, open pit mine, and on other anthropogenic structures (Cade 1960; White and Cade 1971; White et al. 2002)

On average, tundra peregrine falcons in Nunavut lay eggs in early to mid-June (Court et al. 1988; White et al. 2002). Clutch size in the arctic is typically 3 eggs per nest with an average hatch date of July 9 in Nunavut (62°N) (White et al. 2002). This species has only one brood per season and was not reported to re-nest in the northern latitudes.

Hatching of eggs in the region occurs between the beginning and latter part of July (the mean reported by Court et al. (1988) is July 9th, near Rankin Inlet, Nunavut). The female does the majority of the incubating, although it was been reported by White et al. (2002) that males will incubate a significant portion (33%). In the Alaskan interior adults were observed at the ledge of the nest 99% of the time until the young were 11 days old, after which most ledge visits were to deliver food or feed young (White et al. 2002).In Greenland, the estimated time for brooding ranged from 10 to 20 days (White et al. 2002). The female does the majority of the brooding and the fledglings leave the nest in approximately 40 days (SARA 2010). In Rankin Inlet, Court et al. (1988) reported that fledglings were seen in the air as early as August 19. The young may stay in the nest for another four to six weeks after fledging (COSEWIC 2007).

Ratings

A two class rating scheme was used to evaluate peregrine falcon habitat in the Local Study Area and Regional Study Area.

South facing cliffs and outcrops adjacent to or near bodies of water were assumed to be the most suitable nesting habitat for peregrine falcons in the study area. As cliff habitats were not specifically identified in the local or regional ecosystem mapping, additional modelling techniques were required to select areas with potential nesting ledges.

Digital elevation models (DEM) were obtained from Natural Resources Canada that covered the RSA. These data were used to identify all potential cliff habitats, and was used in conjunction with regional ecosystem mapping to identify suitable habitat. It was assumed that suitable nesting habitats for peregrine were cliffs that were a minimum of 10 m high and were within one kilometre of a waterbody. The one kilometre distance to a water feature was used as research suggests that the area within one kilometre of the nest site is the approximate size of the peregrine's nesting territory, or the area within which the adults actively defend from other peregrine falcons (SARA 2010). Therefore, the most important habitat features in addition to the nest site are likely contained within the nesting territory.

Raptor nests that were found during baseline studies for the Project were also incorporated into the peregrine nesting model (data from 2007, 2008, 2012, and 2013). These areas not only identify where there are cliffs, but also highlight areas that were selected and used by raptors and likely contain all the nesting habitat requirements (e.g., nearby hunting areas). All known raptor nesting sites (regardless of the species observed utilizing it) and the nesting territory (i.e., one kilometre radius from the nest site) were considered to be suitable nesting habitat in the model.

The remainder of habitat in each study area was assumed to be not suitable.

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Appendix 8

Summary of Amounts of Habitat Rated per Species per Season According to Local and Regional Ecosystem Mapping

Appendix 8. Summary of Amounts of Habitat Rated per Species per Season According to Local and Regional Ecosystem Mapping

	Amount of Habitat in the LSA				Amount of Habitat in the RSA	
	Local (TEM) Ecosystem Mapping		Regional (WKSS/GeoBase) Ecosystem Mapping		Regional (WKSS/GeoBase) Ecosystem Mapping	
Suitability Rating	**Area (ha)**	**% of LSA**	**Area (ha)**	**% of LSA**	**Area (ha)**	**% of RSA**
Caribou						
Calving						
High	71,492.97	53.2	38,466.69	28.7	355,417.77	28.3
Moderate	30,436.22	22.7	34,983.13	26.1	300,905.11	23.9
Low	7,140.63	5.3	27,683.85	20.7	301,581.58	24.0
Nil	25,299.49	18.8	32,796.64	24.5	299,248.12	23.8
Post-calving and Summer						
High	25,850.80	19.2	38,203.10	28.5	343,578.60	27.3
Moderate	88,824.94	66.1	75,805.34	56.6	738,800.73	58.8
Low	19,556.98	14.6	9,725.34	7.3	107,137.87	8.5
Nil	136.58	< 1	10,196.52	7.6	67,635.37	5.4
Fall (rut)						
High	100,265.28	74.6	63,053.51	47.1	562,764.43	44.8
Moderate	9,795.05	7.3	15,191.93	11.3	178,261.57	14.2
Low	24,177.80	18.0	45,488.34	34.0	448,491.21	35.7
Nil	131.17	< 1	10,196.52	7.6	67,635.37	5.4
Muskox						
Summer and Fall						
High	9,416.09	7.0	23,880.20	17.8	168,221.76	13.4
Moderate	37,545.98	27.9	25,921.18	19.4	314,380.74	25.0
Low	87,203.99	64.9	73,814.73	55.1	702,002.89	55.8
Nil	203.24	< 1	10,314.20	7.7	72,547.20	5.8
Winter and Early Spring						
High	10,371.54	7.7	5,119.91	3.8	69,629.33	5.5
Moderate	29,754.76	22.1	34,839.45	26.0	340,442.43	27.1
Low	58,950.99	43.9	37,032.33	27.7	330,149.21	26.3
Nil	35,292.03	26.3	56,938.61	42.5	516,931.61	41.1
Grizzly Bear						
Spring						
High	3,182.31	2.4	386.53	< 1	5,457.20	< 1
Moderate	87,405.09	65	67,341.78	50.3	637,044.63	50.7
Low	19,074.53	14.2	43,427.71	32.4	412,168.14	32.8
Nil	24,707.36	18.4	22,774.28	17.0	202,482.60	16.1
Summer						
High	11,887.54	8.8	19,466.91	14.5	137,717.33	10.9
Moderate	90,219.29	67.1	54,436.06	40.6	540,367.41	43
Low	31,740.05	23.6	49,713.13	37.1	506,521.65	40.3
Nil	518.18	< 1	10,314.20	7.7	72,547.20	5.8
Fall						
High	7,347.94	5.5	386.53	< 1	5,457.20	< 1
Moderate	70,011.78	52.1	61,056.36	45.6	542,692.12	43.2
Low	56,448.67	42	62,173.21	46.4	636,456.05	50.6
Nil	556.67	< 1	10,314.20	7.7	72,547.20	5.8
Denning						
High	942.09	< 1	386.53	< 1	5,457.20	< 1
Moderate	532.56	< 1	0.00	0.0	0	0
Low	2,242.55	1.7	4,833.97	3.6	49,677.98	3.9
Nil	130,652.11	97.2	128,709.80	96.1	1,202,017.39	95.6
Wolf						
Denning						
High	945.67	< 1	386.53	< 1	5,457.20	< 1
Moderate	825.07	< 1	8,598.22	6.4	33,355.98	2.6
Low	2,923.58	2.2	4,833.97	3.6	49,677.98	3.9
Nil	129,674.99	96.5	120,111.58	89.7	1,168,661.41	93
Wolverine						
Denning						
Suitable (Useable)	64,127.65	47.7	61,366.50	45.8	562,221.39	44.7
Not Suitable	70,241.65	52.3	72,563.80	54.2	694,931.19	55.3
Short-eared Owl						
Nesting						
Suitable (Useable)	69,804.67	51.9	41,589.45	31.1	404,974.79	32.2
Not Suitable	64,564.63	48.1	92,340.85	68.9	852,177.78	67.8

Peregrine Falcon is not presented here because the habitat model for peregrine falcon did not use local or regional ecosystem mapping.

Appendix V5-5B

2013 Habitat Selection by Bathurst Caribou during the Post-calving and Summer Periods

an ERM company

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
2013 Habitat Selection by Bathurst Caribou during the Post-calving and Summer Periods

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November 2013

BACK RIVER PROJECT

2013 HABITAT SELECTION BY BATHURST CARIBOU DURING THE POST-CALVING AND SUMMER PERIODS

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan™ Environmental Services Ltd., an ERM company
Vancouver, British Columbia

Executive Summary

Executive Summary

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. The Project consists of three main areas: the Goose Property Area, the George Property Area, and a Marine Laydown Area located on the southern part of Bathurst Inlet.

Caribou were selected as a VEC for the Draft Environmental Impact Statement (DEIS) for the Project. Three herds of caribou may occur in the terrestrial wildlife Regional Study Area (RSA) including the Bathurst herd, the Beverly herd, and Dolphin and Union herd. As outlined in the EIS guidelines (NIRB 2013), the Minister of Aboriginal Affairs and Northern Development Canada highlighted the importance of the Bathurst herd caribou in the region and identified the need to conduct a cumulative effects assessment for this herd (letter dated December 17, 2012). This herd primarily occurs in the wildlife RSA during the post-calving season. In order to address the potential cumulative effects on Bathurst herd caribou, resource selection function (RSF) modelling was conducted for this herd on their post-calving and summer ranges as these ranges have been identified as providing nutritional resources important to the survival of overwintering caribou and calving success in the following year.

Recent work conducted by the Canadian Centre for Remote Sensing has correlated the greenness of vegetation on the summer grounds of the Bathurst herd with overwinter survival of calves – suggesting that summer forage availability may be driving recruitment success (the number of new animals added to the population) and hence the population of this herd. Hence, this report summarizes the use of summer habitat by Bathurst caribou and evaluates whether vegetation greenness and other habitat features influence the locations of caribou during this period. Vegetation greenness was calculated using a simple ratio vegetation index (SRVI). Other variables evaluated in the analysis include vegetation class (using 12 landcover types), water, predators (wolves and bears), topographic features, eskers and existing camps and mining projects to evaluate if these features influenced distribution of caribou.

Four pooled RSF models were generated covering the period 2004-2010 during two seasons when caribou are most likely to interact with the Project, including post-calving within the 95% kernel herd range (PC95), post-calving within the 50% core herd range (PC50), summer within the 95% herd range (S95), and summer within the 50% core range (S50). A total of 24 models were generated and compared by Akaike's Information Criterion (AIC_c) to describe seasonal range use by caribou. With the exception of S50, ΔAIC and AIC weights indicated that a saturated model of the form *Habitat* + *RVI* + *Water* + *Industry* + *Predators* was the most likely model amongst the suite of candidate models. Predators were not a significant component in the S50 final model. Parameter coefficients were averaged from the top two candidate models in PC50 and PC95.

Selection for high RVI, a vegetation metric used as a broad scale index of habitat productivity, was consistent across both seasons and range extents.

There was variability in the use of specific landcover types. For example, within post-calving 95, caribou avoided non-vegetated, sparsely vegetated, and prostrate dwarf shrub cover types while selecting for tall shrub and forested areas. Caribou selected areas that were ranked as having low suitability for wolves, and avoided areas of low suitability for grizzly bears. Caribou were also generally found further from industrial development relative to random locations. Caribou in post-calving 50 similarly avoided dwarf shrub habitats, and tended to be found closer to operating mines but further from closed mines and exploration camps relative to random locations.

During the summer period, caribou selected sparsely vegetated, bryoid, graminoid tussock and non-tussock tundra, and all shrub cover types, while avoiding wetlands and forested cover types within the 95% seasonal range. Predators were an important factor during this season, as indicated by significant selection coefficients for habitats ranked as high value for wolves and concurrent avoidance of habitats ranked as high and moderate value for grizzly bears. Caribou additionally selected low and nil value habitat for grizzly bears, and avoided moderate, low, and nil valued habitat for wolves. The selection coefficient for operating mines was non-significant, but caribou tended to be found further from closed mines and exploration camps relative to random locations. Caribou in the core summer range selected sparsely vegetated, tall shrub, and graminoid tussock and non-tundra cover types, and avoided non-vegetated, low and dwarf shrub, and forested cover types. Caribou tended to be found further from operating and closed mines, but closer to exploration camps relative to random locations in the core summer range.

TK/IQ indicates that the Contwoyto Lake and Nose Lake regions have been important post-calving and summer ranges for the Bathurst herd since before development and prior to the deployment of radio collars on the Bathurst herd. The RSF model, which provides a spatial surface that indicates the likelihood of detecting caribou across the landscape, indicates that these areas continue to be important to the Bathurst herd. These results suggest that under the current distribution of existing and proposed developments, impacts to habitat conditions on the post-calving and summer ranges are expected to be minimal provided that the integrity of the Contwoyto Lake and Nose Lake region is maintained, and that movements along the Burnside, Mara, and Hackett River corridors are not impeded.

TK indicates that the Contwoyto Lake and Nose Lake regions have been important post-calving and summer ranges for the Bathurst herd since before development and prior to the deployment of radio collars on the Bathurst herd. The RSF model, which provides a spatial surface that indicates the likelihood of detecting caribou across the landscape, indicates that these areas continue to be important to the Bathurst herd.

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an ERM company

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BACK RIVER PROJECT

2013 HABITAT SELECTION BY BATHURST CARIBOU DURING THE POST-CALVING AND SUMMER PERIODS

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Glossary and Abbreviations

Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

CESCC	Canadian Endangered Species Conservation Council
COSEWIC	Committee on the Status of Endangered Wildlife in Canada - A federal committee of experts that assesses and designates the level of threat to wildlife and vegetation species in Canada
Ecosystem (terrestrial)	A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
GIS	Geographical Information System
Glacial-fluvial	Sediments deposited by glacial meltwater that form stratified layers of sand, gravel, and fines.
GN DOE	Government of Nunavut Department of Environment
GPS	Global Positioning System
Habitat	Land and water surface used by wildlife. This may include biotic and abiotic aspects such as vegetation, exposed bedrock, water and topography.
Hectare (ha)	10,000 m^2 or 0.01 km^2 or 2.47 acres
Migration	The regular seasonal or daily movement of animal populations to and from different areas, often considerable distances apart. Migration often occurs in corridors between preferred habitat types.
NLCA	Nunavut Land Claims Agreement
NPC	Nunavut Planning Commission
NWMB	Nunavut Wildlife Management Board
NWT	Northwest Territories
SARA	*Species at Risk Act* (2002) - A Canadian federal statute which is designed to meet one of Canada's commitments under the International Convention on Biological Diversity. The goal of the Act is to protect endangered or threatened organisms and their habitats. It also manages species which are not yet threatened, but whose existence or habitat is in jeopardy.
Slave Geological Province	A geological formation extending from Great Slave Lake to the Coronation Gulf, which lies between Victoria Island and mainland Nunavut
Standard Deviation (SD)	A statistical measure of the spread or variability of a set of data.
Standard Error (SE)	A statistical measure of the spread or variability of a set of data, equal to the standard deviation divided by the square root of the sample size.
The Project	The Back River Project

Topography	The configuration of a surface, including its relief and the position of its natural and person-made features.
UD	Utilization distribution
Universal Transverse Mercator (UTM)	A mapping system where the standard unit of measure is the metre.
Wetland	Sites dominated by hydrophytic vegetation where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development (MacKenzie and Moran 2004).

1. Introduction

1. Introduction

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut (Figure 1-1). This report presents the results of the Resource Selection Function Modelling of the Bathurst caribou herd post-calving and summer ranges developed in support of the caribou cumulative effects assessment for the Draft Environmental Impact Statement (DEIS; Volume 5; Chapter 5).

In order to support the potential cumulative effects assessment for caribou in the DEIS for the Project, a broad-scale Resource Selection Function (RSF) model was developed for the Bathurst caribou herd on their post-calving and summer ranges. The RSF model, which provides a spatial surface, indicates the likelihood of detecting caribou across the landscape. Results from this model are useful in determining where caribou are typically found in their ranges, what types of habitat they use while in these ranges, and deriving habitat quality ratings for various vegetation types on these ranges. In addition, results may indicate how caribou may interact with various industrial developments on their post-calving and summer ranges.

Specific objectives of the RSF modeling were to:

- assess habitat use by caribou during post-calving and summer;
- identify important features across the landscape that drive caribou habitat use during post-calving and summer such as lakes, eskers, vegetation communities and industrial sites; and
- provide baseline information that will contribute to cumulative effects assessment on caribou.

In Nunavut, companies have been asked to conduct research that addresses “holistic and cumulative” objectives, in lieu of conducting local-area programs for caribou such as aerial surveys. In lieu of aerial surveys, companies may opt to fund a caribou research program defined by the Government of the Northwest Territories Department of Environment and Natural Resources (ENR) and the Government of Nunavut Department of Environment (GN-DOE). One approach is to conduct resource selection function modeling using suite of model variables that describe habitat use by the Bathurst caribou herd across spatial and temporal scales.

Figure 1-1

Back River Project Location

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2. Background Information

2. Background Information

Barren-ground caribou (*Rangifer tarandus groenlandicus*) are a biologically and culturally important species in the Arctic. Caribou not only sustain wild predator populations such as wolves, grizzly bear and wolverine, but also provide a critical resource for human populations living in the North, particularly Aboriginal communities. Hunting, disease, and environmental variability can all affect caribou numbers, and the effects from industrial activities occurring within the species range are monitored for management of caribou.

Three barren-ground caribou herds have been identified, whose ranges overlap the area of the Project. The Bathurst herd is found in the wildlife Regional Study Area (RSA), primarily during the post-calving period. The Beverly herd (also known as the Ahiak herd) is found in the RSA, primarily during the late summer. The winter distribution of Dolphin and Union caribou likely overlaps the marine RSA to a small extent during the winter. This report focuses on the Bathurst caribou herd.

Bathurst caribou winter below the treeline and migrate to calving grounds currently to the west of Bathurst Inlet, the herd’s namesake. The size of the Bathurst caribou herd, as estimated from annual counts of the number of calving females, has declined from about 200,000 females in 1986 to 55,000 in 2006 (Nishi et al. 2010; Boulanger et al. 2011). The results of the 2009 calving ground survey suggests that the total herd size had declined to approximately 31,900 ± 11,000 individuals (GNWT ENR 2009). The population estimates suggest an average annual decline of about 6% per year from 1986 to 2006, and then a very rapid decline of 35% per year between 2006 and 2009 (Adamczewski et al. 2009; Boulanger et al. 2011).

These population trends have been attributed to declining calf survival, and concomitant declines in adult female fecundity, and survival in winter due to hunting (Boulanger et al. 2011). Annual monitoring of calf survival indicates that mean winter calf survival and calf-cow ratios for the Bathurst herd have declined by almost 50% from 2001 to 2004 compared with the 1985 to 1996 period (Gunn, Boulanger, and Williams 2005). More recently (2007-2009), indicators of breeding productivity such as cow-calf ratios, pregnancy rates, and body condition show improved conditions for the Bathurst herd (Adamczewski et al. 2009). A survey conducted in 2012 under ideal conditions reports that the population has remained stable, or may have increased to 35,000 individuals since 2009 (GNWT 2012).

Caribou abundance is thought to fluctuate with a periodicity of between 40 and 70 years (Gunn 2003). While the decline in caribou numbers may be a consequence of natural population cycles, current low numbers make the populations vulnerable to human harvest, disturbance, disease, and weather events. Caribou vary in their response to disturbances based on the time of year and age of calves. Caribou are most sensitive to population-level effects during calving and post-calving when calves are most susceptible to predation and disturbance (Russell, Kofinas, and Griffith 2002). Calving and post-calving areas are designated as important habitat for caribou in Nunavut (NPC 2012).

Since 1966 when the calving distribution started to be mapped during aerial surveys, the Bathurst calving grounds have had two periods totalling 30 years when the predictability of the calving ground's location was high. The two periods were separated by a 11-year period when the locations shifted from east to west of Bathurst Inlet (1986-1996) where calving had been recorded in the 1950s. Since 1996, the location of the calving ground has been relatively predictable and the annual use of post-calving and summer ranges based on the movements of satellite-collared cows has not shifted. The fall and winter ranges are the largest seasonal ranges and the least predictable on an annual basis. Since 1998, the southern boundary of the winter range has contracted.

Recent evidence suggests that over-winter survival of calves may be related to conditions on the summer range. Inadequate leaf biomass, late start date and early end date of green leaf biomass, and poor quality of leaf biomass in the summer range are generally believed to be detrimental to caribou growth and pregnancy rate during the summer-fall period and calf:cow ratio in the next year. By calculating a simple ratio vegetation index (SRVI) from broad scale advanced very high resolution radiometer data (AVHRR) over the summer range and correlating it to several demographic parameters of the Bathurst herd, Chen et al. (2013a) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate. Lag times were found to be one year for birth rate and calf survival rate, and two years for net productivity.

Given the vulnerability of calves during the post-calving period and the relationship between habitat quality and caribou demographics, there is interest in determining whether industrial activity on the post-calving and summer ranges contribute additional pressures on caribou. Understanding the relative contributions of natural and anthropogenic factors to population level changes in the Bathurst caribou herd is the goal of cumulative effects assessment, and fundamental to developing sound management practices to promote the long-term sustainability of the herd.

Satellite collar data is available for the Bathurst herd dating back to 1996. In the context of cumulative effects assessment and understanding herd-level population dynamics, it is important that habitat selection by caribou is modelled according to their seasonal ranges in relation to such factors as climate, changing habitat quality and productivity across regional scales, and the progression of development across the landscape.

Resource Selection Functions (RSF) are based on logistic regression equations that utilize use-availability data to infer habitat selection, or the likelihood of use. The method is particularly robust in being able to incorporate both categorical and continuous data. This is considered an important first step in identifying caribou-habitat relationships and developing linkages between habitat use and movement patterns with progressive development and changes in habitat quality associated with climate change throughout the Bathurst range.

RSFs are increasingly being used to provide information on essential resources needed to manage and conserve rare, threatened, and endangered species in complex socio-environmental landscapes (Johnson et al. 2006). RSFs provide an objective and explanatory framework to assess habitat selection and relative habitat quality at multiple scales and across individuals and populations (Johnson et al. 2006). RSF models rely heavily on geographic information systems (GIS) and satellite imagery that are available across large spatial extents.

The modeling exercise focused on Bathurst caribou GPS collar data between 2004 to 2010, and represents the most recent information on caribou seasonal habitat use since Johnson et al. 2005. The modeling effort also focused on the post-calving and summer ranges as these periods are when caribou are most likely to be present in the terrestrial wildlife RSA.

3. Methods

3. Methods

3.1 THE PROCESS OF RESOURCE SELECTION FUNCTION MODELLING

Resource Selection Functions (RSFs) provide a means to describe the inherently complex patterns of habitat use by the Bathurst herd across spatial and temporal scales. To do this, data were acquired that relate habitat characteristics within the extent of historic caribou seasonal ranges. These characteristics include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The data are a compilation of original data and data derived from pre-existing datasets. Vector data was downloaded from online repositories and AVHRR satellite data products were provided by the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada.

For each habitat characteristic, a spatial data layer was generated with coverage over the entire study area. Then, both caribou collar locations ('use points') and a set of random points ('availability points') were overlain onto the data layers and a value for each of the habitat characteristics was extracted for each of the data points. The motivation behind RSF modeling is to contrast environmental characteristics at locations where caribou were observed with characteristics at random points in the surrounding area. By comparing the habitat characteristics for these two datasets, models were developed that best represent habitat selection preferences using Akaike's Information Criterion (AIC_c). These models were then used to generate maps reflecting the relative likelihood of detecting caribou over their seasonal ranges with relatively large spatial extents.

The general steps involved in deriving likelihood of habitat use with RSFs were:

1. Identify the study area using historic caribou GPS locations;
2. Acquire data which reflect habitat characteristics (predictor variables) that are most likely to influence caribou habitat use and distribution;
3. For each predictor variable, generate a spatial data layer with coverage over the entire study area;
4. Assign a value for each predictor variable to each caribou collar location;
5. Create a dataset of random points and assign a value for each predictor variable to each random point;
6. Generate a series of models that consist of combinations of predictor variables;
7. Select the most appropriate resource selection model from the suite of candidate models using Akaike's Information Criterion (AIC_c);
8. Create a raster layer for each predictor variable; and,
9. Apply the model coefficients to each raster layer over the entire study area to create maps that represent the relative probability or likelihood of detecting caribou.

3.2 SOURCES OF DATA

Data for RSF modeling were acquired and calculated from a variety of sources, including:

1. Collar data from the Government of the Northwest Territories, Department of Environment and Natural Resources, under a data sharing agreement between Rescan and GNWT ENR;

2. AVHRR satellite data provided by the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada;
3. Land cover data based upon mapping by Agricultures and Agri-Food Canada (AAFC), Canada Centre for Remote Sensing (CCRT), and Canadian Forest Service (CFS);
4. Digital elevation models from Canadian Digital Elevation Data;
5. Esker delineation included in CanVec vector data produced by Natural Resources Canada;
6. Predator modelling carried out by Taara Environmental; and,
7. The locations of existing and proposed mining development from publicly available sources.

3.3 SPATIAL BOUNDARIES

3.3.1 Cumulative Effects Assessment Boundary

The spatial boundary for the cumulative effects assessment for Bathurst herd caribou is based on the post-calving and summer seasonal range of this herd (see Section 5.6 of Volume 5, Chapter 5).

Recent research by the Canadian Centre for Remote Sensing has examined the food availability on the post-calving and summer range of the Bathurst caribou herd. This research suggests that the forage availability on the post-calving and summer range may drive natural population change for the Bathurst herd. In years with poor biomass availability, the overwinter survival of calves the following winter is reduced and the growth rate of the herd declines or is negative (Chen et al. submitted). This work does not include the influence of hunting.

In order to examine the effects of habitat removal, disturbance, and other factors, the cumulative effects area was set to encompass the post-calving and summer range of the Bathurst herd (Figure 3.3-1). This area comprises approximately 8,100,050 hectares. With evidence that forage availability on the post-calving and summer range may drive the population growth rate of the Bathurst herd, this area was used to evaluate cumulative effects of all projects that occur in this area.

3.3.2 Defining the Spatial Boundaries for RSF Modelling

Resource selection function modelling was conducted within the cumulative effects assessment boundary for Bathurst caribou on the post-calving and summer ranges. The boundaries were defined based upon the distribution of collar data for the post calving and summer time periods and were further refined to the extent of the satellite imagery dataset.

The first step in the RSF modelling was to identify the area to be modelled using kernel utilization distributions (UDs) for the areas that contain 50% and 95% of the collar points and henceforth referred to as 50% and 95% kernel UDs. The kernel UDs were conducted for both post calving (Figures 3.3-2a and 3.3-2b and summer ranges (Figures 3.3-3a and 3.3-3b).

Fixed kernel density estimators were used to spatially define the post-calving and summer ranges of collared caribou based on pooled GPS collar data since 1996. The kernel density estimator is a non-parametric method that produces a probability distribution that estimates the likelihood of finding an animal at any particular location within its home range (Worton 1989). This method is a useful tool for ecologists to interpret wildlife habitat use from satellite collar data. The probability distribution produced through kernel methods provides an estimate of the true utilization distribution for an animal, which is described as the relative use of space or the relative amount of time that an animal spends in any place (Seaman and Powell 1996).

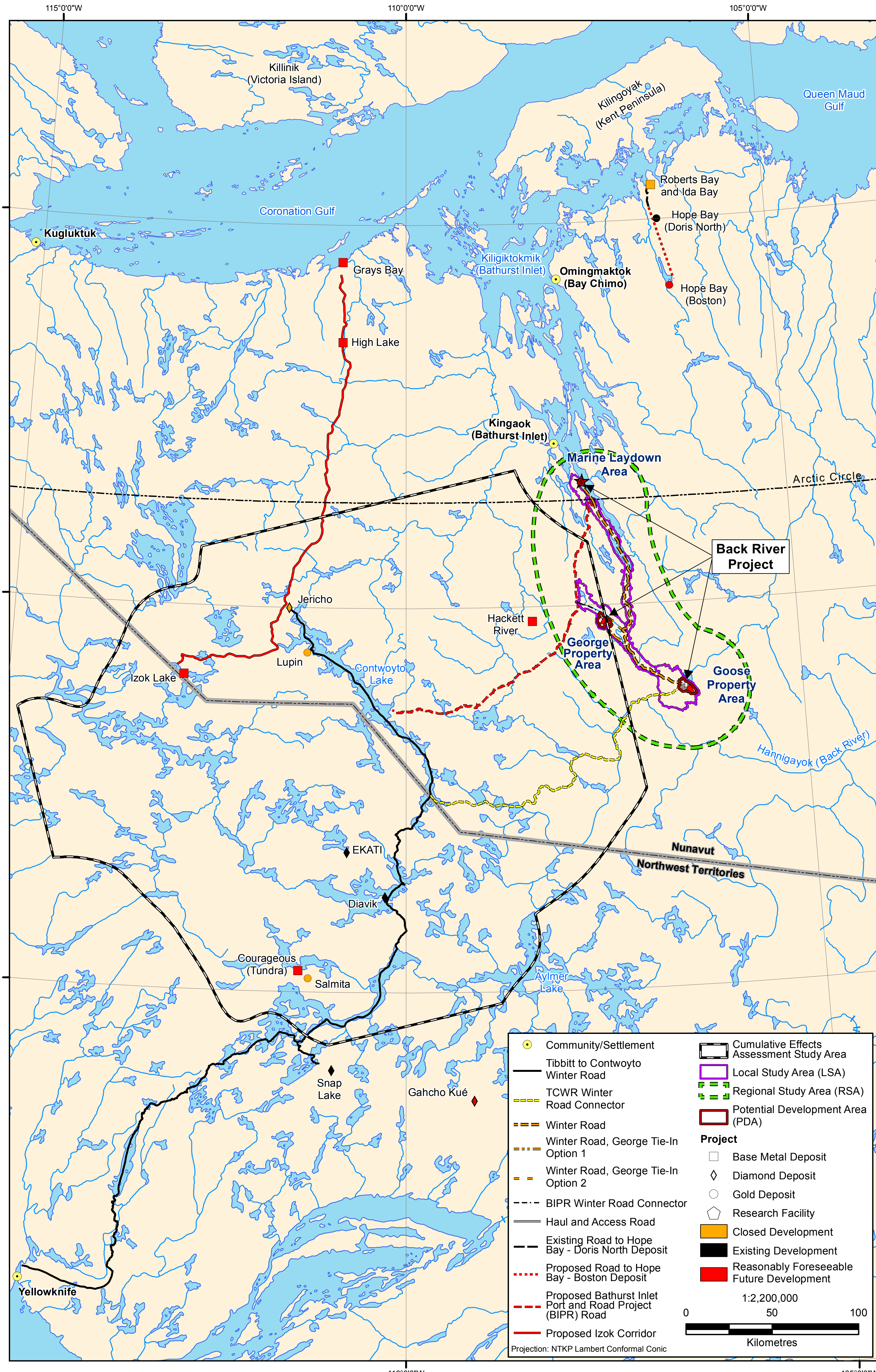

Figure 3.3-1

Sabina GOLD & SILVER CORP

Spatial Boundary for Bathurst Caribou Cumulative Effects Assessment

Figure 3.3-1

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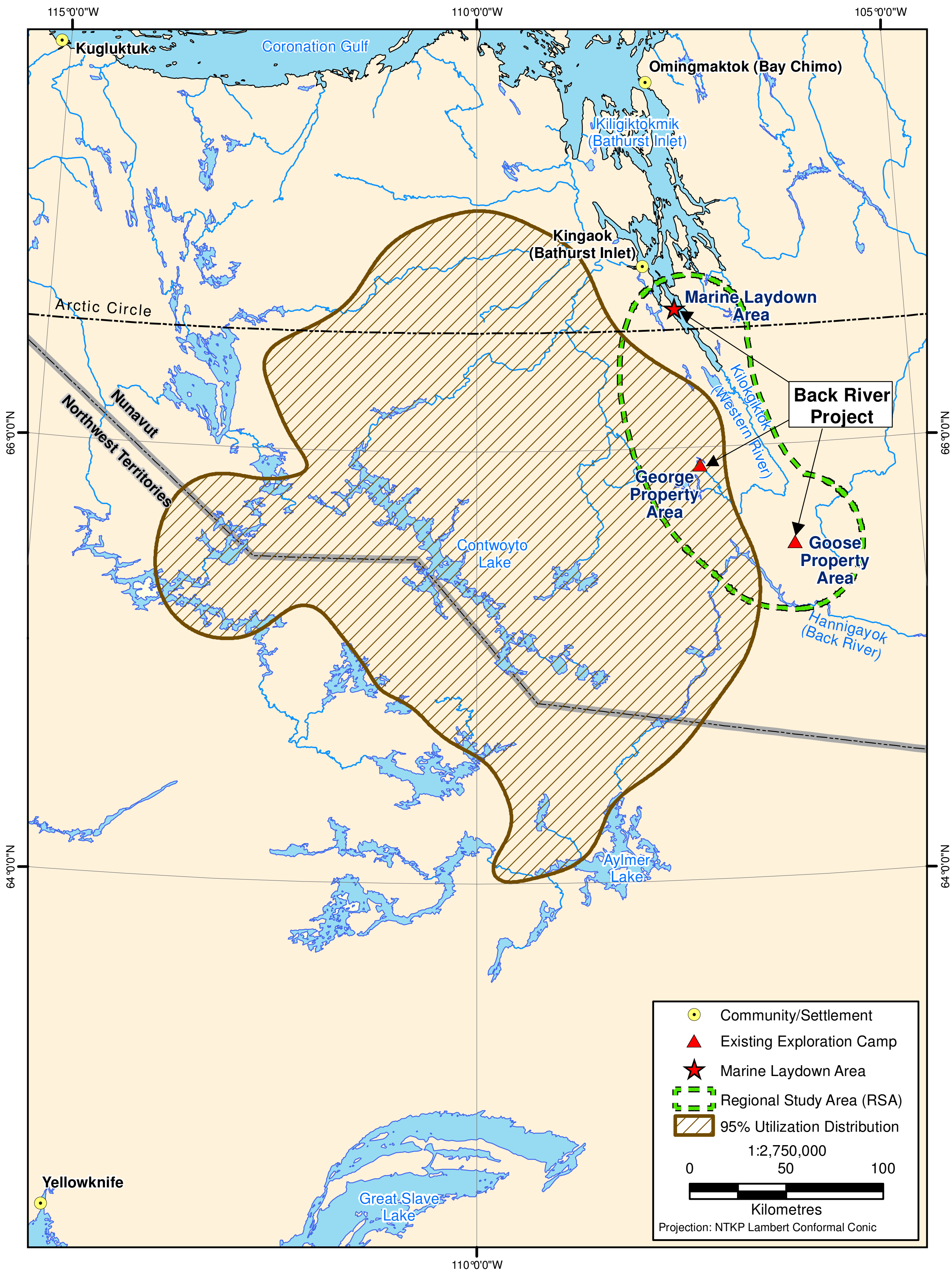

Figure 3.3-2a

Post-Calving 95% Utilization Distribution

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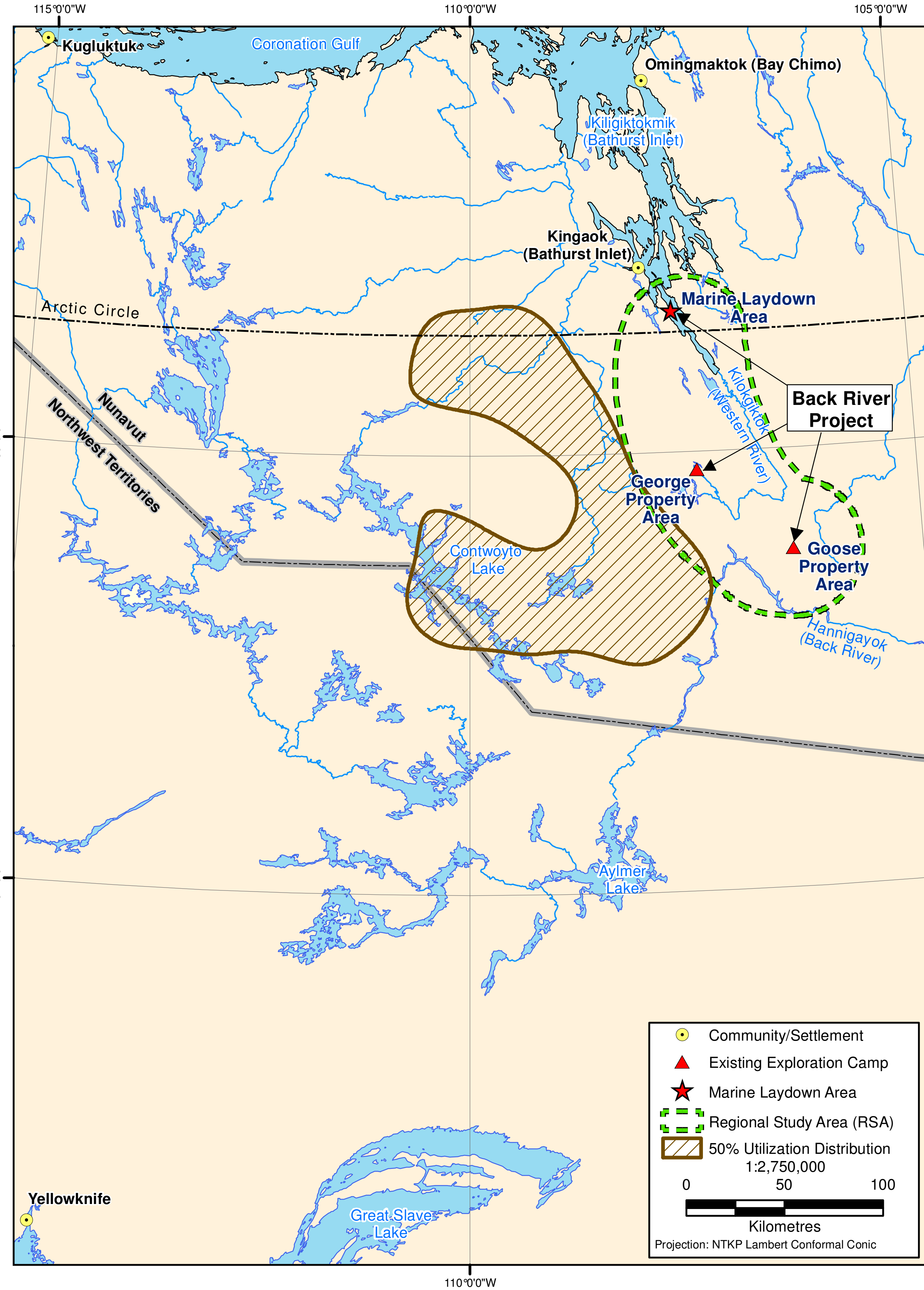

Figure 3.3-2b

Post-Calving 50% Utilization Distribution

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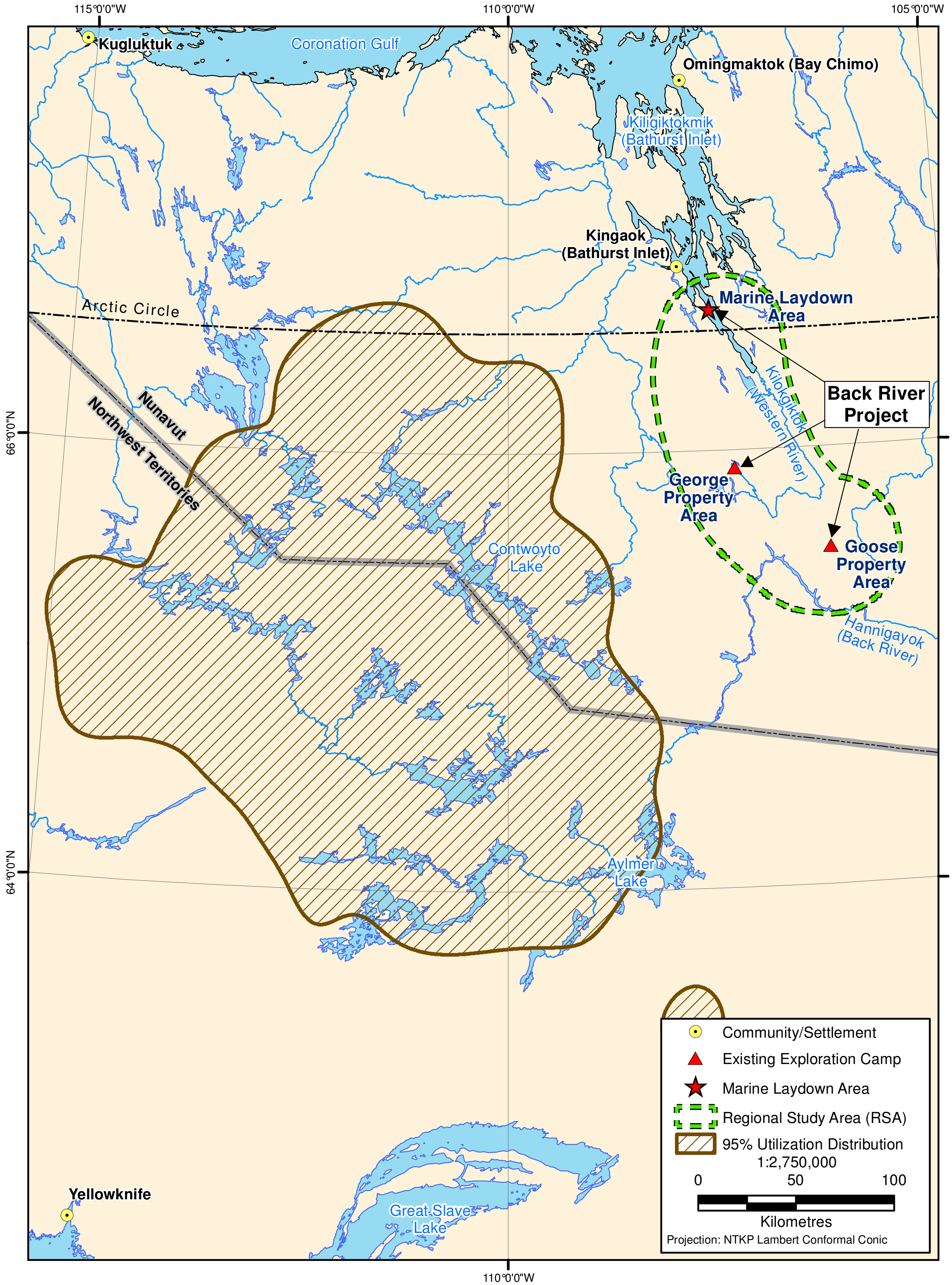

Figure 3.3-3a

Summer 95% Utilization Distribution

Sabina GOLD & SILVER CORP.

Rescan an ERM company

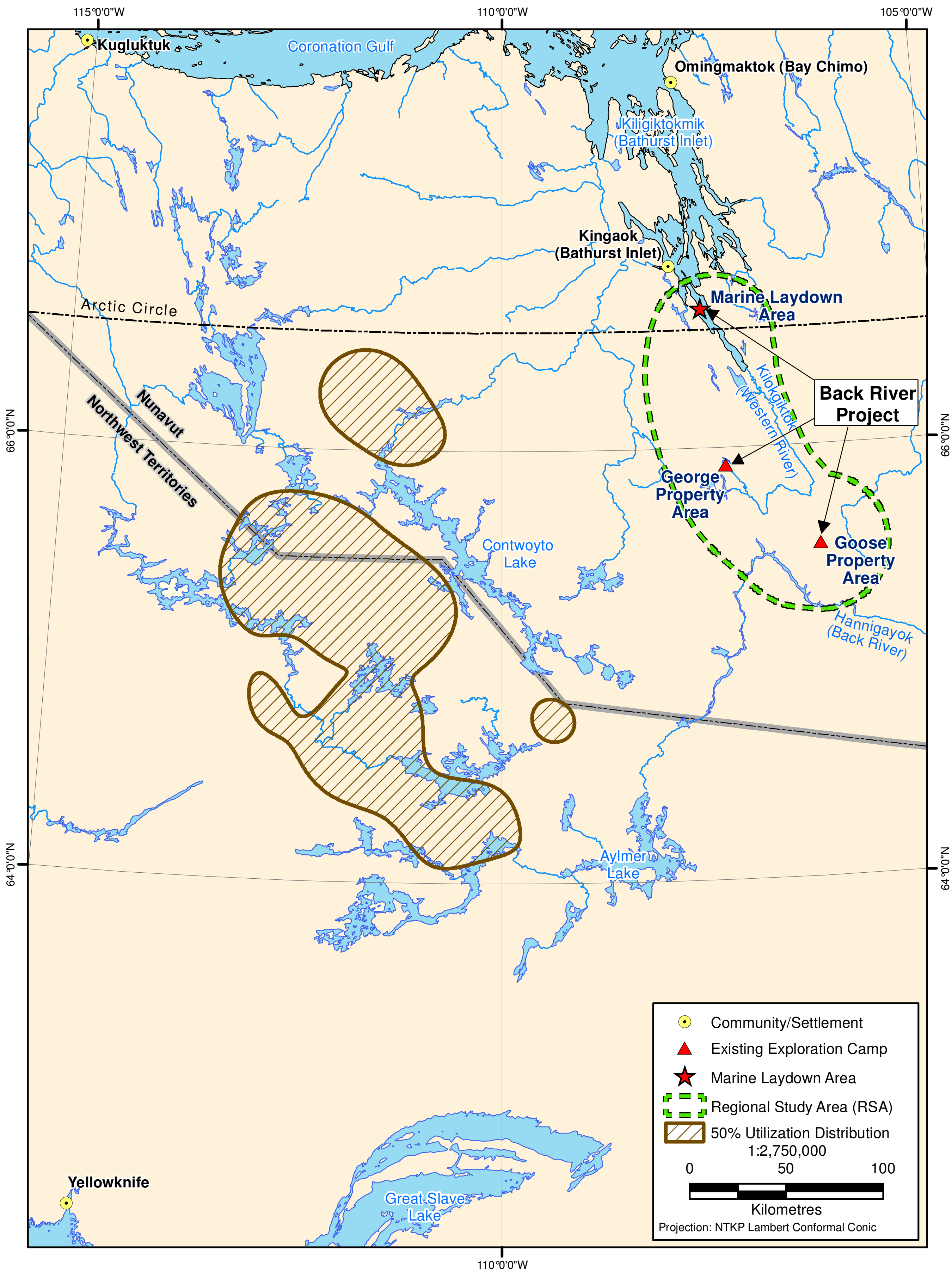

Figure 3.3-3b

Summer 50% Utilization Distribution

The 50% kernel UD encompasses the smallest area within which 50% of the overall density of the utilization distribution can be contained. In an ecological sense, it depicts the area within which there is a 50% likelihood of finding a collared caribou location across the entire distribution of collar location points (i.e., the area where collared caribou spend 50% of their time; Hemson et al. 2005). This represents an area where most location data points are clustered together (and therefore the chances of detecting caribou within that area are quite high). The 50% volume contour was used to delimit the "core use" area, as they appear to be used intensively based on the distribution of location points. The 95% kernel UD encompasses the areas surrounding the core use areas. It delimits the area within which there is a 95% likelihood of finding collared caribou. Selecting the 95% kernel UD eliminates location data point outliers that do not represent a consistent pattern of habitat use for the species (e.g., Powell 2000). Therefore, the 95% kernel UD is an estimate of the "range" of collared caribou.

Kernel density distributions, or alternatively kernel utilization distributions (UDs), were generated using Home Range Tools for ArcGIS 9. All estimations were generated using a fixed search radius, or bandwidth, to generate the density values for data points and grid cells. A raster output of each kernel UD was generated to show the overall density of collar locations. For this study, the kernel UDs contained within 50% and 95% volume contours were calculated for both the post-calving and summer seasons and used to delineate the maximum extent for modeling caribou habitat use.

3.4 COLLAR DATA

Collaring programs for several caribou herds in the Canadian Arctic have been established by the Government of Northwest Territories Department of Environment and Natural Resources (ENR) and Government of Nunavut Department of Environment (DOE). Satellite collars are fitted on female caribou, usually during the winter. A collaring program for the Bathurst herd has been in place since 1996 (GNWT ENR 2010). The number of collars that can be placed on Bathurst herd female caribou is restricted to 20. The data generated from these programs allow researchers to investigate seasonal trends in habitat use as well as track real time movement patterns of caribou herds. Unpublished satellite collar data from the Bathurst herd were obtained from GNWT ENR for analysis of habitat selection. Data were acquired from the GNWT ENR Wildlife Management Information System (WMIS) from 1996 to the end of September 2012.

Telemetry locations were used to estimate resource use, and compared to randomly sampled locations using logistic regression (Boyce and MacDonald 1999; Manly et al. 2002). Availability was defined as the 50% and 95% kernel UDs for the post-calving and summer ranges. To characterize availability, five availability points per individual use point (e.g., Gustine et al. 2006) were randomly generated within each seasonal kernel UD using a random point generator in ArcGIS. The post-calving period was defined as June 16 to July 20 and the summer period was defined as July 21 to August 31.

3.5 GIS AND REMOTE SENSING

Inputs to the RSF are predictor variables hypothesized to influence population distribution or those identified as important habitat characteristics in the literature. These variables include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The layers are a compilation of original data and data derived from pre-existing datasets. Most layers were comprised of multiple scenes or panels which were stitched together into a single image to provide coverage over the entire area of interest.

Patterns of selection or avoidance are defined relative to what is available to an animal. The use of resources proportionately more than might be expected based on availability is termed selection. The use of resources less than expected based on what is available is termed avoidance.

3.5.1 Simple Ratio Vegetation Index (SRVI)

In order to assess habitat quality and forage availability, vegetation productivity was quantified using a vegetation index. Vegetation indices provide a useful means to quantify vegetation quality and quantity and are typically derived from differences in reflectance in the visible and Near Infrared (NIR) wavelengths. In this study, the simple ratio vegetation index (SRVI) was used as an indicator of vegetation productivity, which has been shown to reasonably characterize Arctic vegetation (Chen et al. 2013a). The SRVI is based upon the observation that the spectral signature of healthy, dense vegetation is characterized by high near-infrared reflectance and comparatively lower red reflectance while bare surfaces or sparse vegetation is lower in the near-infrared wavelengths. The SRVI is calculated as:

$$SRVI = \frac{\rho_{NIR}}{\rho_R}$$

where ρ_{NIR} is the near-infrared reflectance and ρ_R is the red reflectance.

Higher SRVI values correspond to pixels representing more dense, green vegetation while low values correspond to pixels representing unvegetated or sparsely vegetated conditions.

SRVI maps were derived from Advanced Very High Resolution Radiometer (AVHRR) satellite imagery using the near infrared and red bands. AVHRR data has been widely used to monitor vegetation productivity and phenology due to its 1.1 km resolution and a data record that dates back to the 1980s (Myneni et al 1997; Tucker et al 2001; Stow et al 2007; Jia et al 2009; Beck and Goetz 2011). A robust AVHRR dataset was made available by the CCRT, which included a satellite image acquired every 10-days from May to November between 1985 and 2011. This dataset included 616 images, each providing coverage of an area of 2400 by 6400 kilometers. The AVHRR dataset was filtered to extract only images that were acquired during the post-calving and summer time periods. Only those images acquired after 1995 were used to minimize the influence of vegetation changes that may have occurred at the landscape level; therefore, SRVI layers were generated from 143 AVHRR scenes collected from 1996 to 2011 during the post-calving and summer (e.g., Figure 3.5-1) months (June to August). We chose to exclude 2011 and 2012 from the RSF study due to incomplete datasets for these years.

Image processing was carried out based upon methods described by Chen et. al. (2013b). To reduce errors associated with clouds and aerosols, pixels from each image that were associated with heavy cloud cover were removed. To do this a unique cloud mask was created for each individual AVHRR image based upon a cloud layer provided by the CCRT. The cloud layer represents the probability of cloud contamination of a given pixel. Pixels with a cloud contamination probability greater than 50% were removed (Chen et. al. 2013b). The resulting scenes were comprised of pixels minimally influenced by clouds but may also include some image gaps in the scene due to the removal of pixels with extensive cloud cover at the time of image acquisition.

Collar locations were matched with the AVHRR scene corresponding to the closest time period. In many cases, AVHRR data was not available on the day the collar location was recorded due to removal of cloud contaminated pixels or as a result of the 10 day return interval of the AVHRR satellite. In these cases, collar data points were matched with SRVI values that corresponded to the nearest AVHRR time step at the pixel location.

To derive the final probability maps, a representative AVHRR-derived SRVI image was chosen for both the post-calving and summer time periods. The images were chosen based on quality of data and extent of coverage following cloud removal. The post-calving period was represented by a SRVI scene acquired on June 21, 2006, and summer was represented by a scene acquired on August 1, 2006. Both images required bilinear resampling to the 30 m resolution of the Landsat basemap.

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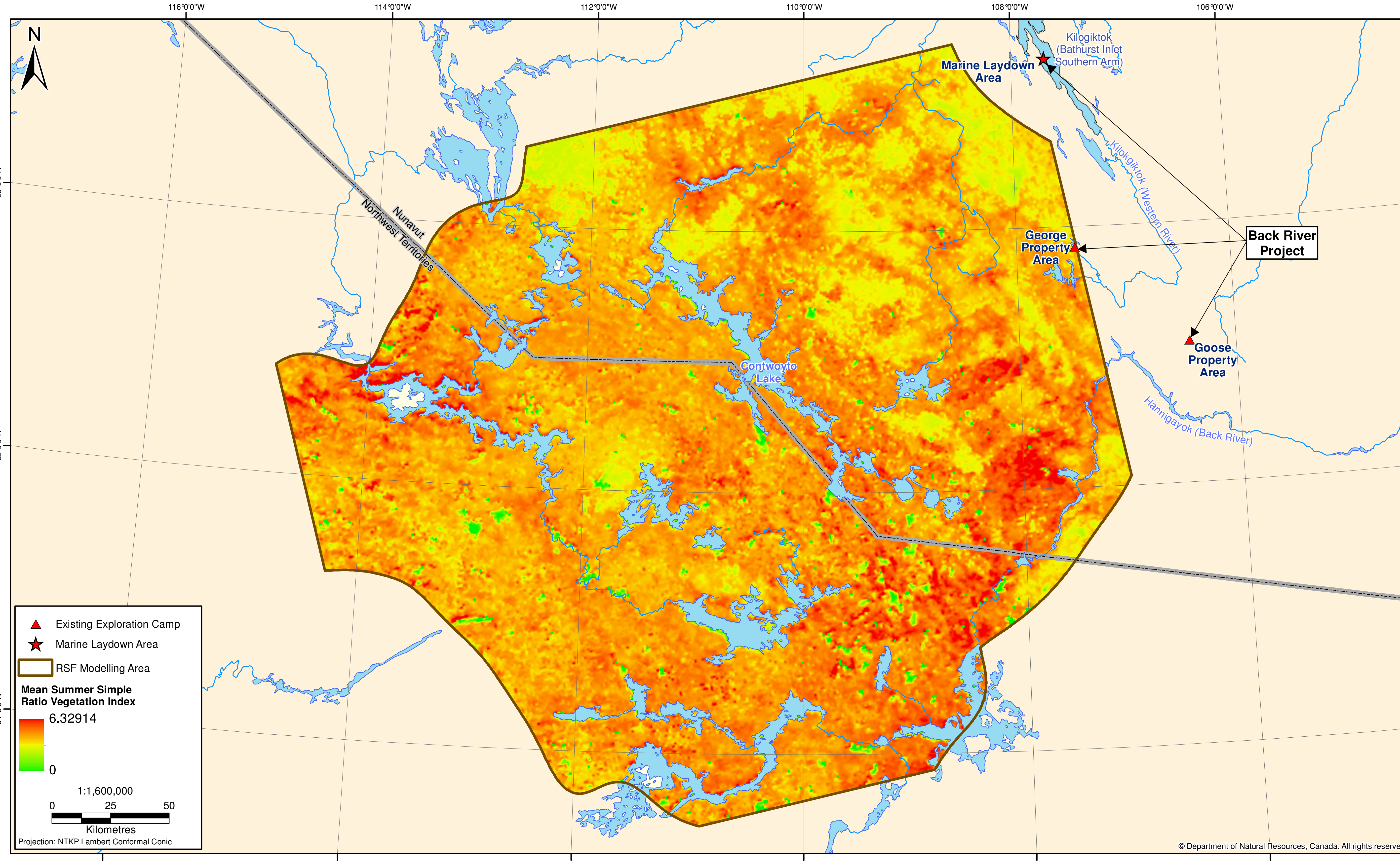

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Figure 3.5-1

Mean Summer Simple Ratio Vegetation Index in the RSF Modelling Area

3.5.2 Land Cover

Though the SRVI provides information regarding the productivity of an area, it does not distinguish between different surface cover types that may influence caribou habitat selection. As a result, land cover was also used as a predictor of caribou habitat use. Land cover information was derived from vectorized classification of satellite imagery. This classification was based upon 30 m resolution Landsat imagery collected in 2000. These land cover maps were generated by Agricultures and Agri-Food Canada (AAFC), Canada Center for Remote Sensing (CCRT), and Canadian Forest Service (CFS).

Within the RSF study area, land cover for Nunavut and the northern regions of Northwest Territories was classified by the CCRT. Land cover in the forested regions of the Northwest Territories was derived from forest cover mapping during the Earth Observation for Sustainable Development project (EOSD). Though a harmonized legend was created for the multiple data sources, some discrepancies and discontinuities exist due to differences in classification methods.

The original mapping was divided into 44 land cover codes that were consolidated into 12 land cover classes for this study (Table 3.5-1; Figure 3.5-2).

Table 3.5-1. Land Cover Classification Used to Model Habitat Use by Bathurst Caribou during Post-calving and Summer

RSF Land Cover Class	CCRT Land Cover Classes	Cover class description
Barren – Non-vegetated	Barren/Non-vegetated	Unvegetated; may include ice, snow, bedrock, soils, or developed regions
	Snow/ice	Glacier or snow
	Rock/rubble	Bedrock or other unconsolidated rock units
	Exposed land	Exposed soils or sediments
	Developed	Anthropogenically influenced areas
Sparsely Vegetated	Sparsely vegetated bedrock	<20% vegetation or bryoid cover on bedrock or boulder fields
	Sparsely vegetated till-colluvium	<20% vegetation or bryoid cover on till, colluvium, or other unconsolidated material
	Bare soil with cryptogam crust-frost boils	Bare or sparsely vegetated ecosystem with exposed, circular mineral soil upwellings due to upheaval from frost heave and cryoturbation; where present, vegetation typically consists of a thin layer of lichens, bryophytes and/or fungi
Bryoids	Bryoids	> 20% bryophytes or lichen
Tall Shrub	Tall Shrub	>20% shrub cover over 2m tall; often includes dwarf birch, Labrador tea, other dwarf shrubs, and lichens
Low Shrub	Low Shrub	>20% shrub cover under 2m tall; often includes dwarf birch, Labrador tea, bog blueberry, willows, and lichens
Prostrate Dwarf Shrub	Prostrate Dwarf Shrub	Comprised of mats of low growing shrubs with patches of bare soil; species include northern Labrador tea and scrub birch with forbs, grasses, and sedges also present
Wetlands	Wetland	Dominated by wetland or aquatic processes due to near surface water table; includes fens, bogs, and marshes
	Wetland - treed	Dominated by wetland or aquatic processes due to near surface water table with a canopy comprised of white spruce, paper birch, black spruce, or tamarack

(continued)

Table 3.5-1. Land Cover Classification Used to Model Habitat Use by Bathurst Caribou during Post-calving and Summer (continued)

RSF Land Cover Class	CCRT Land Cover Classes	Cover class description
Wetlands *(cont'd)*	Wetland - shrub	Dominated by wetland or aquatic processes due to near surface water table with a shrub layer of tea-leaved willow, Labrador tea, scrub birth, and/or bog blueberry
	Wetland - herb	Dominated by wetland or aquatic processes due to near surface water table with primarily sedges communities
Tussock Graminoid Tundra	Tussock Graminoid Tundra	Moist cottongrass and tussock tundra
Moist to Dry non-Tussock Graminoid Tundra	Moist to Dry non-Tussock Graminoid Tundra	Mesic tundra and meadow which may include willow, health, or sedge species
Forested (Conifer)	Coniferous forest	Conifers represent >75% of basal area, typically includes white spruce, black spruce, jack pine, and paper birch
	Coniferous dense	Conifers represent >75% of basal area and have >60% crown closure typically includes white spruce, black spruce, jack pine and paper birch
	Coniferous open	Conifers represent >75% of basal area and have 26-60% crown closure; commonly includes jack pine- lichen or spruce-alder dominated ecosystems
	Coniferous sparse	Conifers represent >75% of basal area and have 10-25% crown closure; commonly includes jack pine- lichen or spruce-alder dominated ecosystems
Forested (Broadleaf)	Deciduous forest	Broadleaf trees represent >75% of basal area; may include paper birch, scrub birch, as well as minor components of conifer species
	Broadleaf dense	Broadleaf trees represent >75% of basal area and have >60% crown closure; may include paper birch, scrub birch, as well as minor components of conifer species
	Broadleaf open	Broadleaf trees represent >75% of basal area and have 26-60% crown closure; may include paper birch, scrub birch, as well as minor components of conifer species
	Broadleaf sparse	Broadleaf trees represent >75% of basal area and have 10-25% crown closure, may include paper birch, scrub birch, as well as minor components of conifer species
Forests (Mixed)	Mixedwood forest	Forests where neither conifers nor broadleaf represent >75% of basal area; may include canopy of white spruce, black spruce, jack pine, or paper birch
	Mixedwood dense	Forests where neither conifers nor broadleaf represent >75% of basal area and have >60% crown closure; may include canopy of white spruce, black spruce, jack pine, or paper birch
	Mixedwood open	Forests where neither conifers nor broadleaf represent >75% of basal area and have 26-60% crown closure; may include canopy of white spruce, black spruce, jack pine, or paper birch
	Mixedwood sparse	Forests where neither conifers nor broadleaf represent >75% of basal area and have 10-25% crown closure; may include canopy of white spruce, black spruce, jack pine, or paper birch

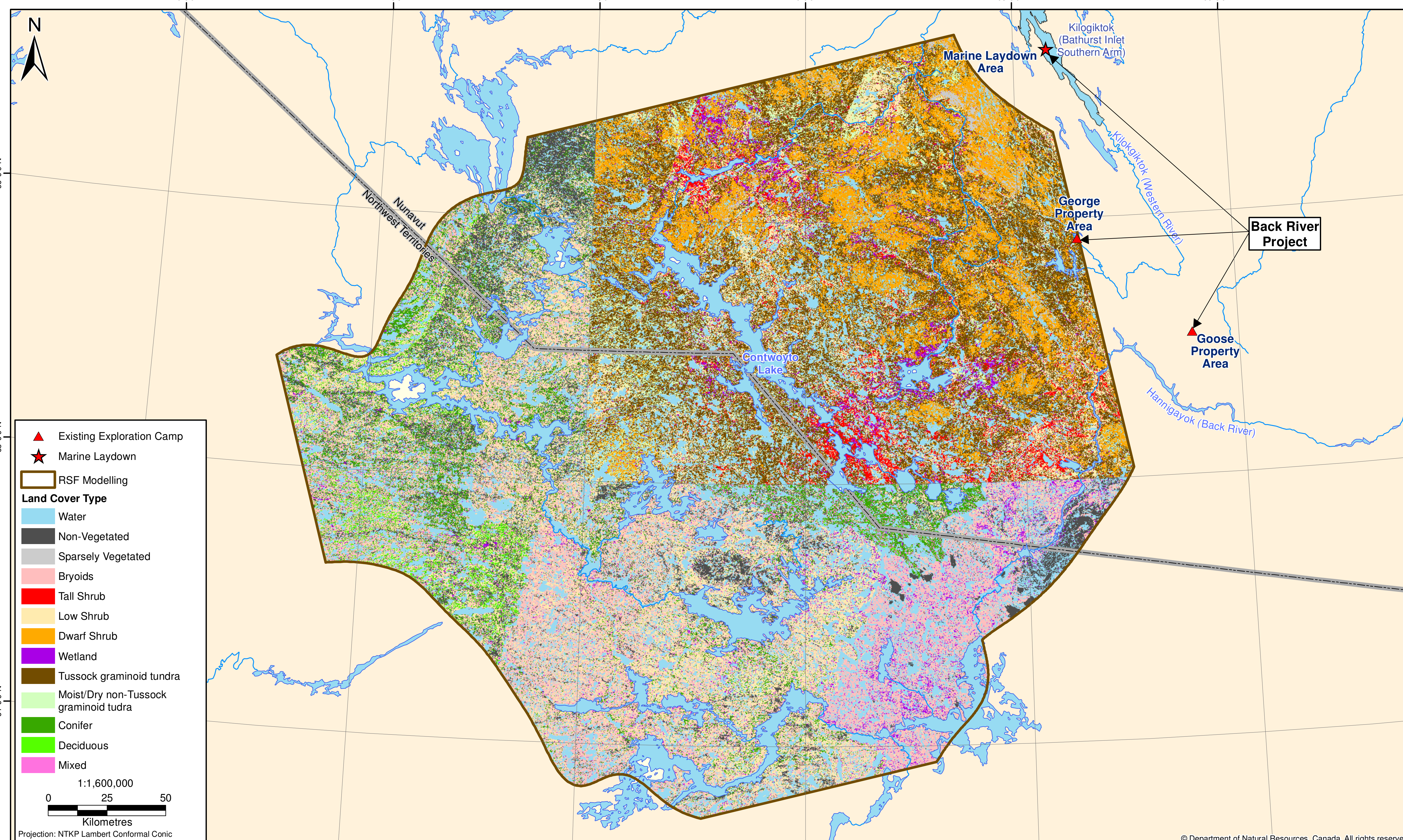

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Figure 3.5-2

Land Cover Types in
the RSF Modelling Area

A total of 23 map sheets were required to provide coverage over the entire study area. These map sheets were mosaicked and clipped to create a single land cover layer. A total of 1,029,814 individual land cover polygons are present within the study area. These land cover polygons ranged in size from less than one hectare to nearly 97,000 hectares (Contwoyto Lake).

A spatial join was used to assign a single land cover class to each collar location and random point. The land cover layer was then rasterized for use in the derivation of the final habitat use map. The vector land cover layer was converted to raster with a spatial resolution of 30 m and a grid based upon a Landsat composite basemap. From the rasterized land cover layer a binary mask for each of the 12 land cover classes was created. The masks were designed such that each pixel representing a particular land cover class was assigned a 1 and all other pixels were assigned a 0.

3.5.3 Topographic Features

Also considered were topographic factors that may influence the use of resources, including elevation, slope, and aspect. The elevation at each caribou observation was determined using digital elevation models (DEMs) from Canadian Digital Elevation Data. These were generated from 1:50,000 National Topographic Data Base maps and other available territorial data. Eighteen National Topographic Survey (NTS) map sheets were merged into a single DEM with spatial coverage over the area of interest (Figure 3.5-3) and a spatial resolution ranging from 8 to 23 meters. On the merged DEM some seams are visible, particularly on lakes, as a result of differing data sources.

From the merged DEM, slope (Figure 3.5-4), eastness (Figure 3.5-5), and northness (Figure 3.5-6) were calculated using ArcGIS. Slope served as the basis for determining both eastness and northness which relate to slope aspect. They were calculated as:

$$Eastness = \sin\frac{a \cdot \pi}{180}$$

and

$$Northness = \cos\frac{a \cdot \pi}{180}$$

where *a* is the aspect in degrees.

Preliminary analyses indicated that topographic features were not a significant component of resource use, likely due to the relatively uniform relief across the landscape; therefore, topographic features were omitted from the final model iterations.

3.5.4 Esker

Eskers were identified as a potentially important habitat feature due to their use as a travel corridor and for insect and heat relief. Esker locations are included in the relief and forms CanVec vector data produced by Natural Resources Canada. This vector data is consistent with overlapping regions of the terrain mapping for the Project LSA and RSA conducted as part of the baseline study program (Rescan 2013). From the CanVec esker delineation (Figure 3.5-7), a binary esker mask was generated using a 75 meter buffer. Regions within 75 meters of a mapped esker were classified as esker while areas further than 75 meters from mapped eskers were classified as non-esker features.

Preliminary analyses indicated zero use of eskers by caribou during the post-calving and summer periods (consistent with camera monitoring data); therefore, eskers were omitted from the final model iterations though eskers were incorporated into the predator habitat suitability index.

3.5.5 Water

Proximity to water (Figure 3.5-8) is used as a predictor variable because lakes have been found to provide caribou with relief from heat and insects. The availability of water across the landscape was quantified using the position and spatial extent of waterbodies. The waterbodies were defined based upon the water class in the land cover data.

A total of 70,399 lakes, rivers, ponds, and other waterbodies were identified within the study area. These ranged in size from <1 ha to the almost 97,000 hectare Contwoyto Lake. Polygons that were split as a result of imagery seams were manually merged when encountered. It some cases it was necessary to merge polygons representing water with polygons identified as ice when lakes were frozen at the time of mapping.

For each collar data point, the distance to the nearest body of water and its surface area was calculated using a spatial join. Each point is therefore associated with a single distance to the nearest water polygon and the area of that polygon. Where collar locations fell within a mapped body of water, the distance to water is zero. For these calculations, the waterbody data layer was clipped to 2 km beyond the study area boundary to minimize any edge effects.

Preliminary analyses indicated that the size of the nearest lake was not a significant component of resource use and thus the size of the lakes were not used in the final model iterations; therefore, a raster layer was generated representing the distance to the nearest waterbody using the Euclidean distance tool in ArcGIS 10.

3.5.6 Predators

Predation is considered an important component of caribou population dynamics. To incorporate predation risk as a predictor of caribou habitat use across the landscape, habitat suitability indices (HSI) were generated for 2 predator species during each modelled season. Predator modelling was completed for wolves [spring (Figure 3.5-9) and summer (Figure 3.5-10)] and grizzly bears [spring (Figure 3.5-11) and summer (Figure 3.5-12)]. The predator modelling used as a predictor variable is consistent with general trends presented in the grizzly bear assessment (DEIS; Volume 5; Chapter 6) and the wolverine and furbearers assessment (DEIS; Volume 5; Chapter 8). A four-class suitability rating system was used where:

- High suitability habitats were ecosystem and terrain types that were considered to have abundant hunting and/or foraging opportunities, as well as areas such as eskers that provide easy movement corridors.
- Moderate suitability habitats were ecosystem and terrain types that were considered to have some hunting or forage potential, but were not areas that the target species would actively seek.
- Low suitability habitats were ecosystem and terrain types that were considered to have limited hunting and forage potential that were generally avoided.
- Nil suitability habitats were areas that do not provide hunting or foraging opportunities, or contain features such as lakes, ocean and cliffs that obstruct movement.

There were also ranks of 0 for polygons that were unclassified or were called cloudy.

Land cover and a buffered (50 metre) esker polyline were obtained from the GeoBase National Landcover Data. Suitability ratings were applied to each ecosystem type and the esker buffer for both species and seasons based on wildlife suitability mapping and field surveys completed by ERM Rescan for multiple projects completed between 2009 and 2013 in Nunavut and NWT, including large portions of the RSF study area.

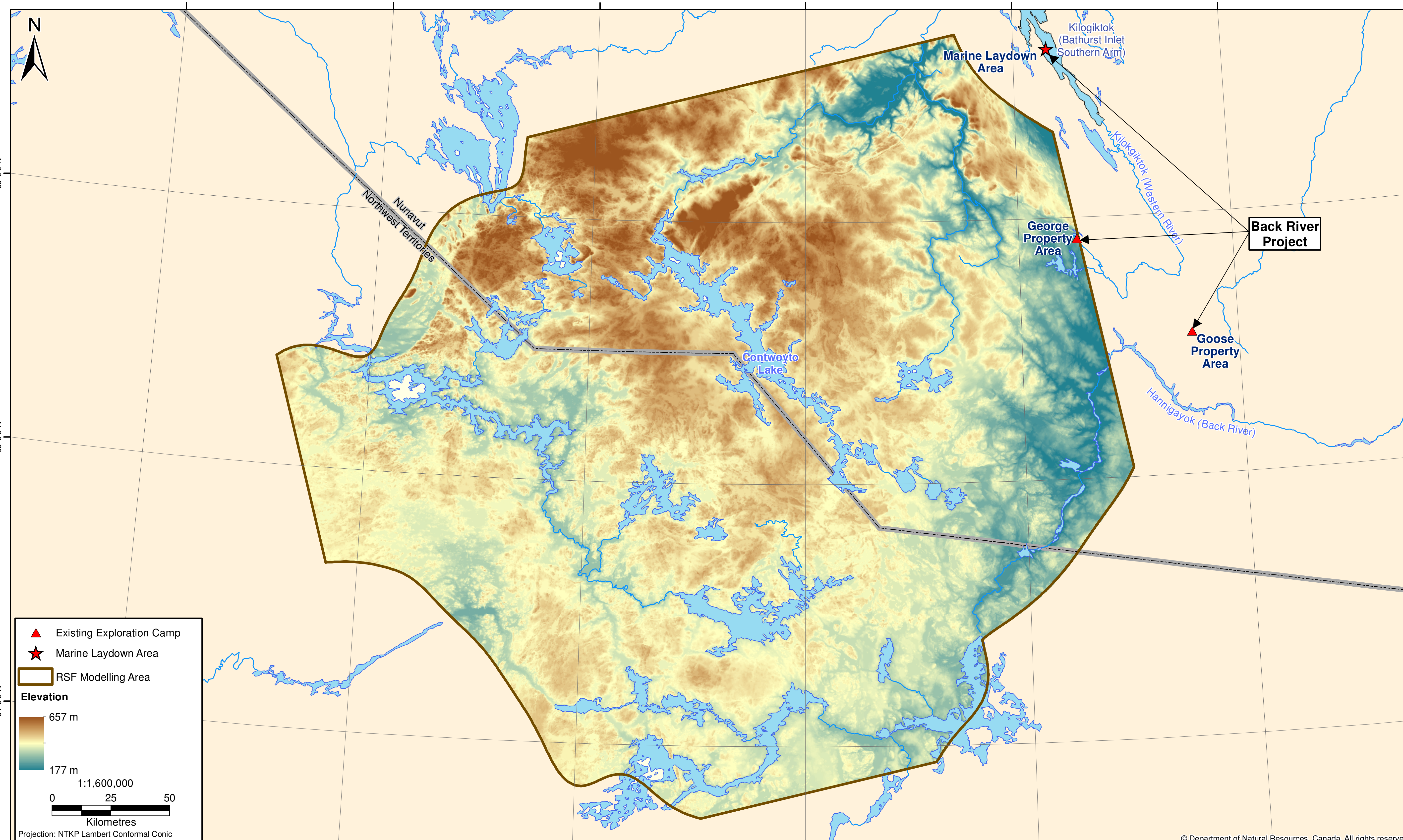

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Figure 3.5-3

Digital Elevation Model of the RSF Modelling Area

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Figure 3.5-4

Slope in the RSF Modelling Area

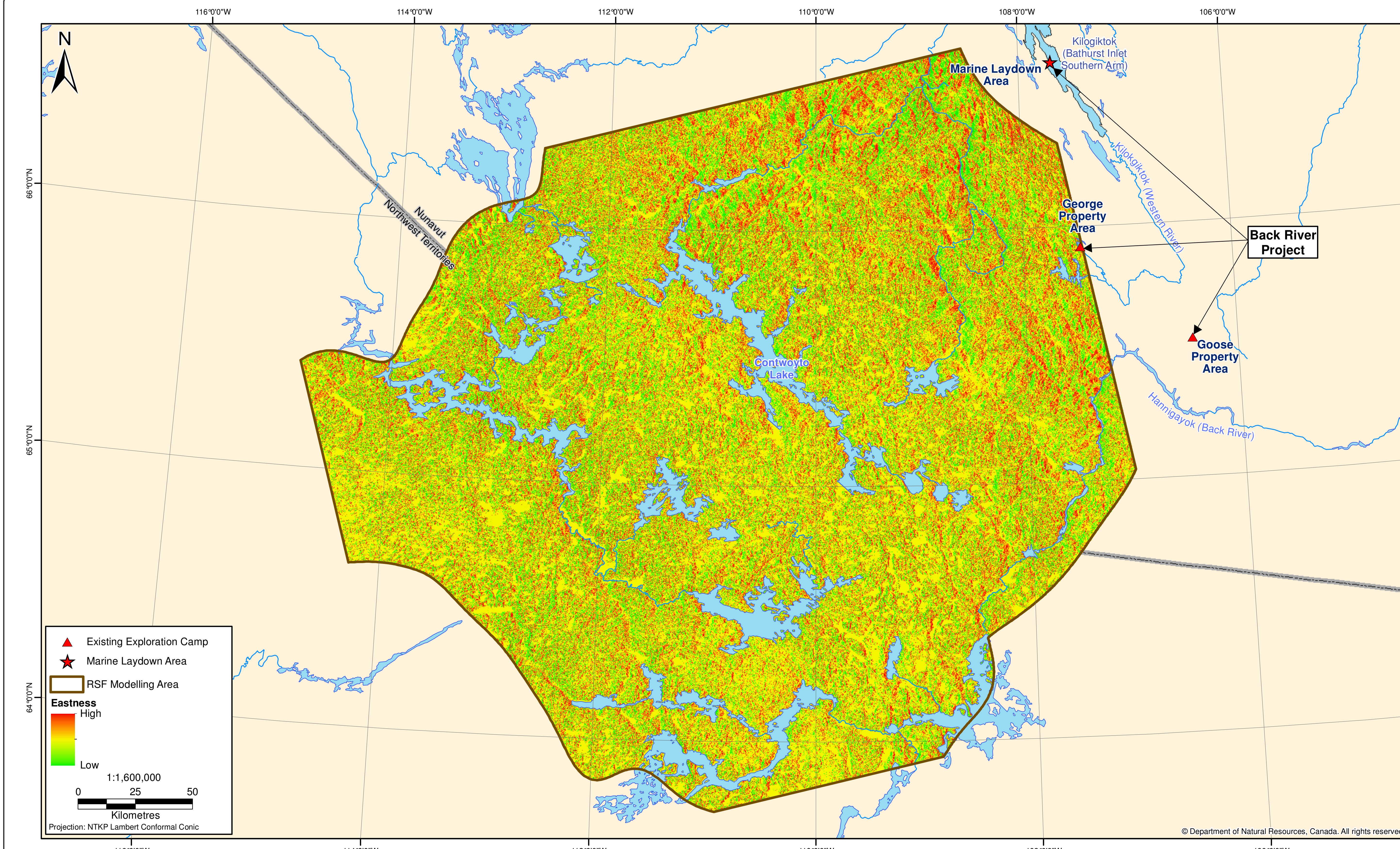

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Figure 3.5-5

Eastness in the RSF Modelling Area

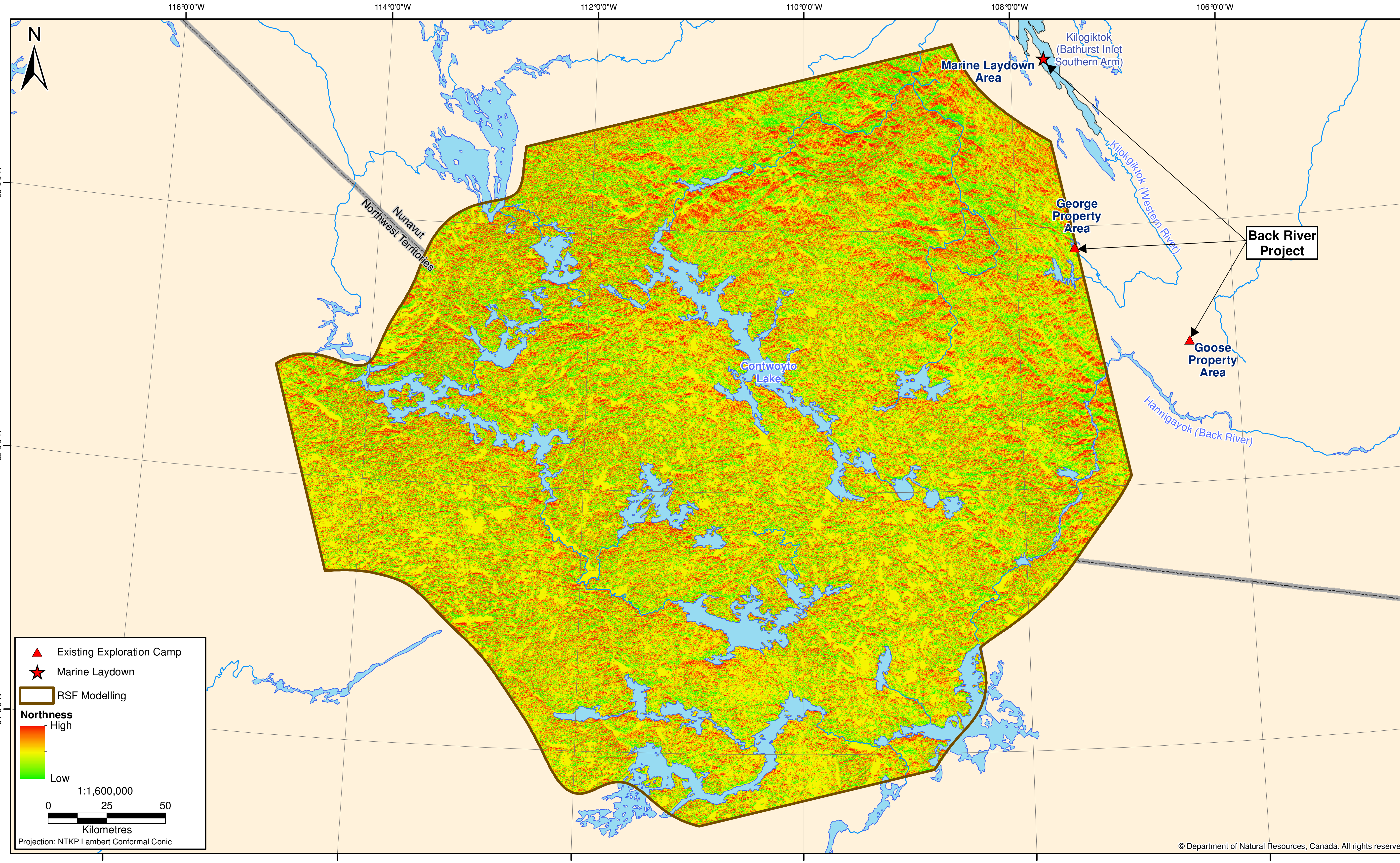

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Figure 3.5-6

Northness in the RSF Modelling Area

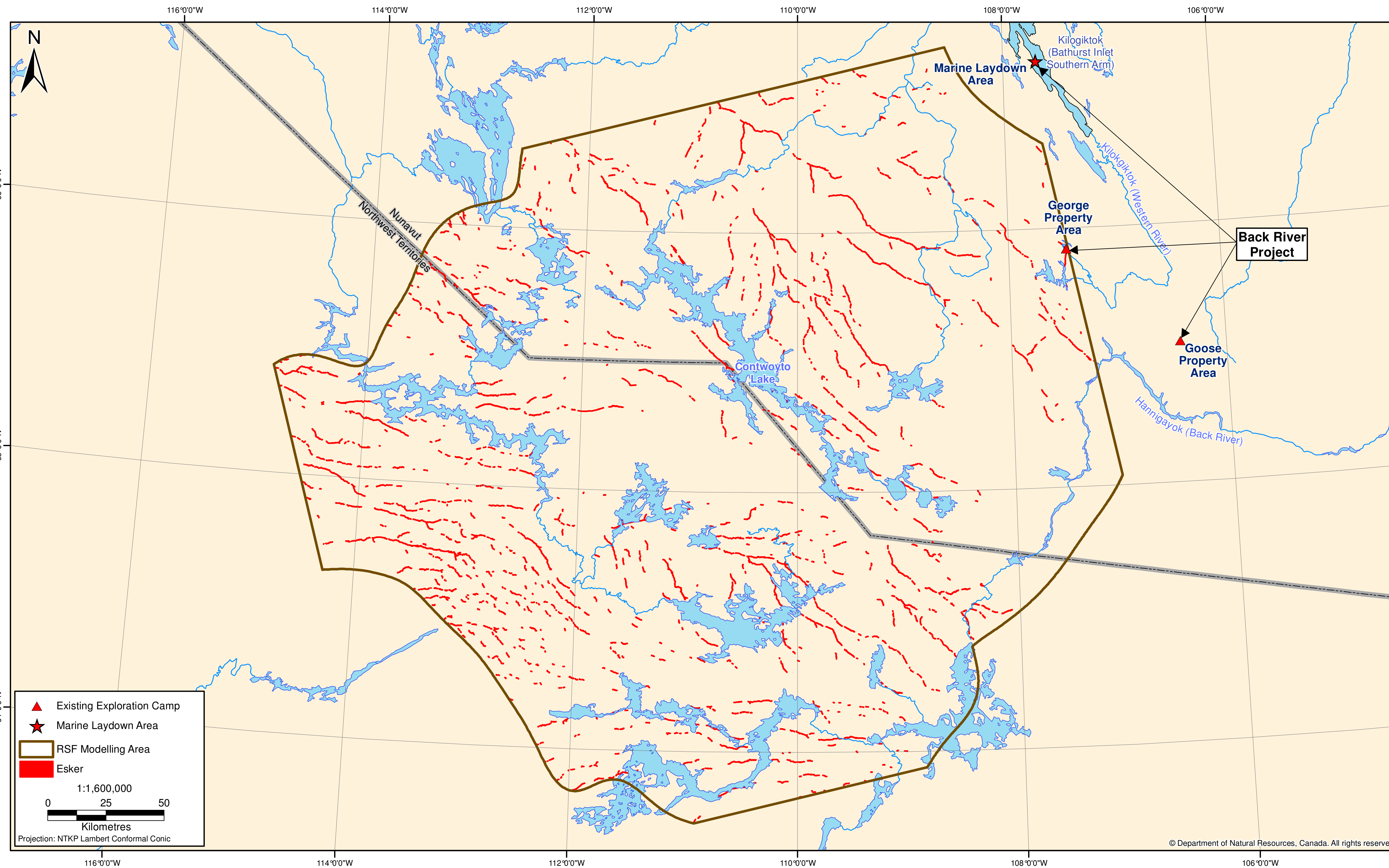

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Figure 3.5-7

Eskers in the RSF Modelling Area

PROJECT # 0194096-0039 GIS # BAC-23-253d

November 01, 2013

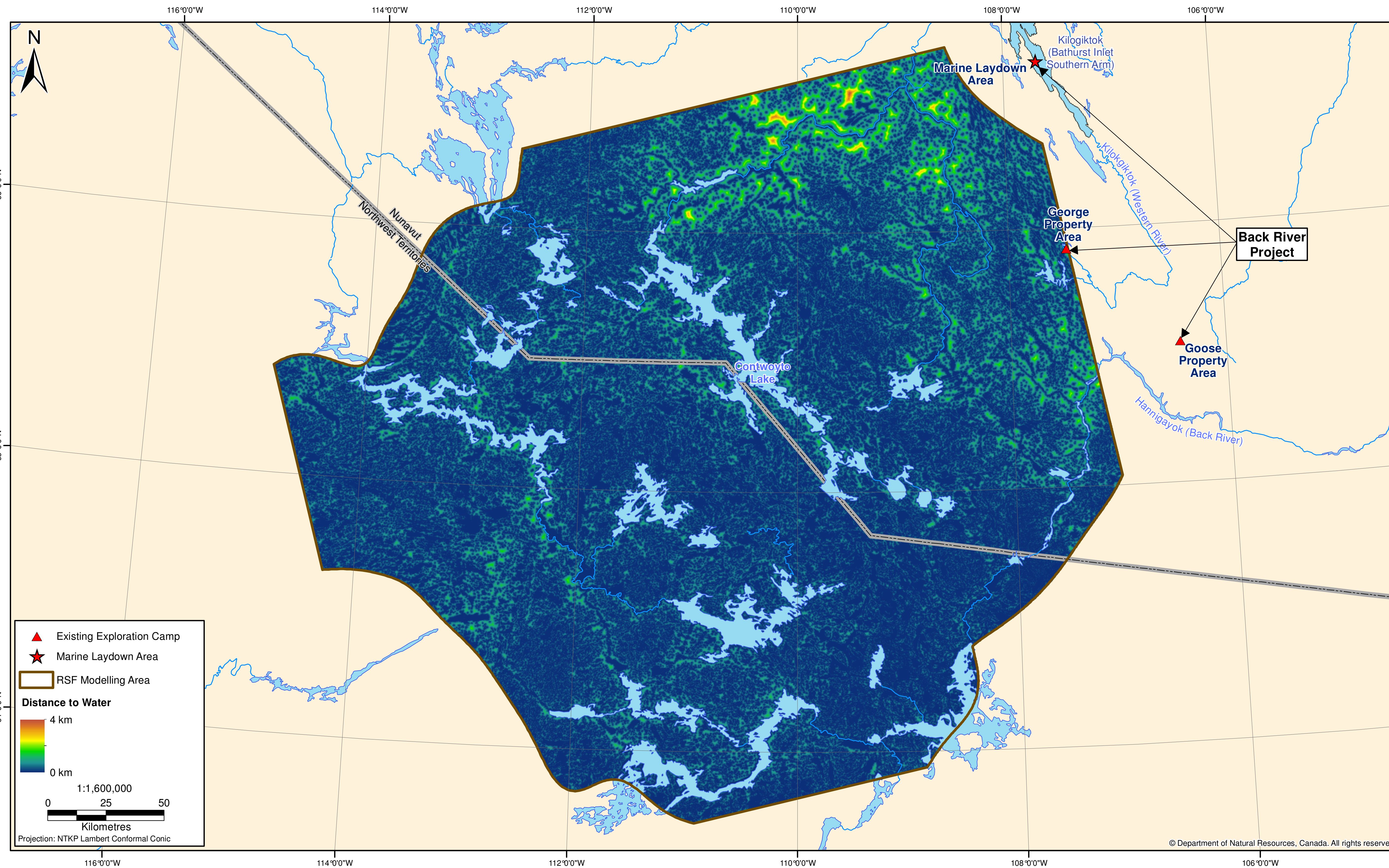

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Figure 3.5-8

Distance to Water in the RSF Modelling Area

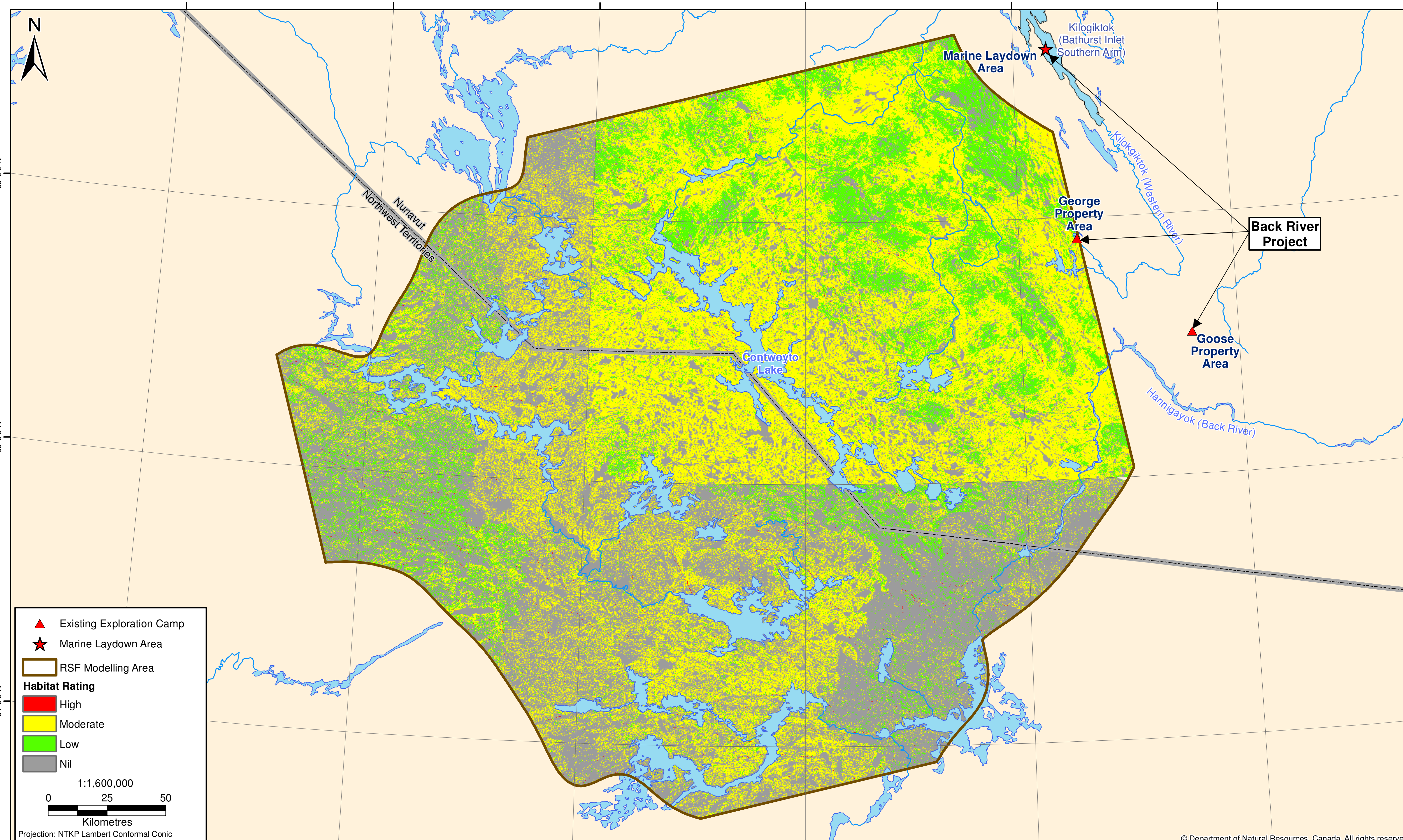

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Figure 3.5-9

Wolf Habitat Rating during Post-Calving in the RSF Modelling Area

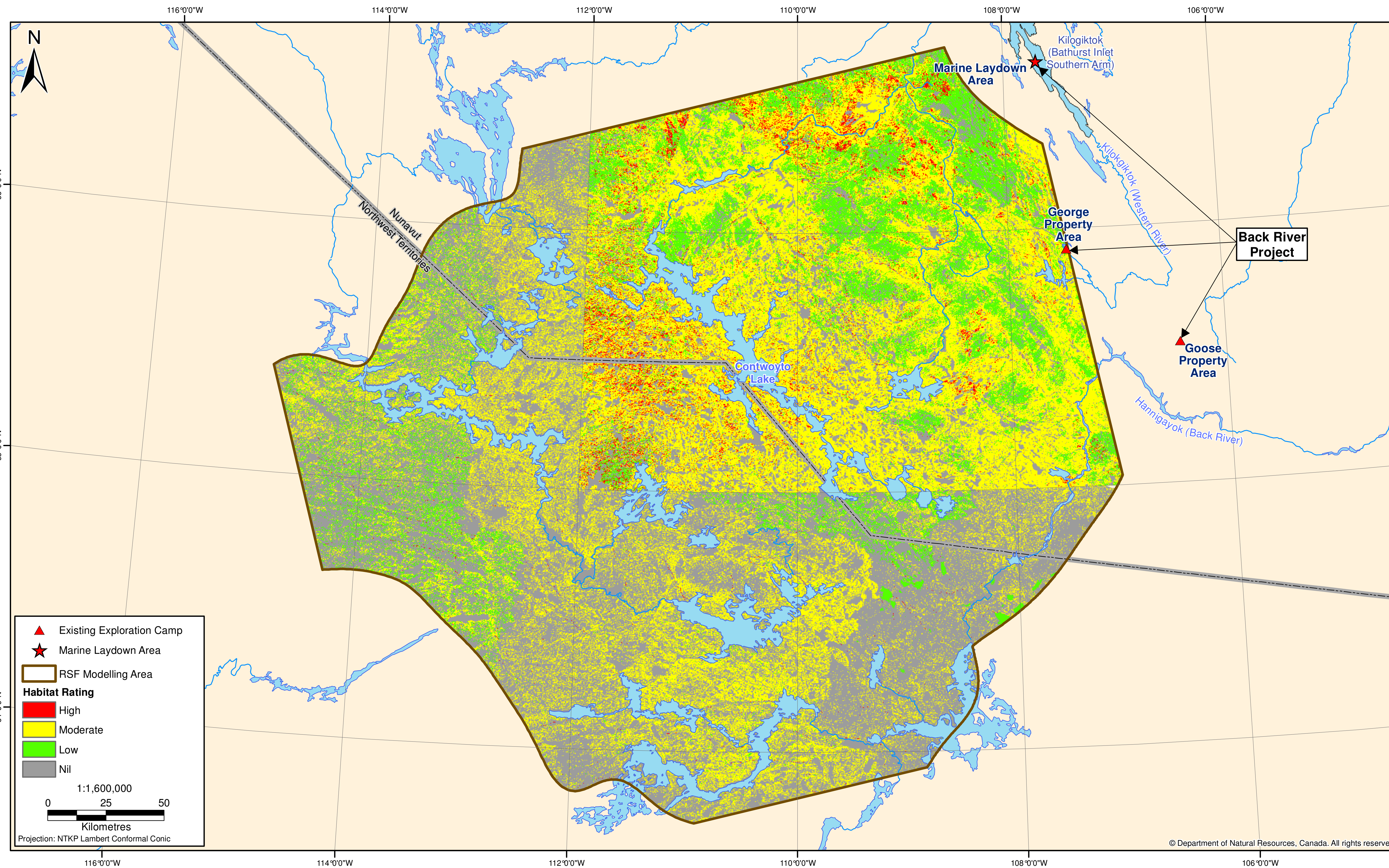

Figure 3.5-10

Wolf Habitat Rating during Summer in the RSF Modelling Area

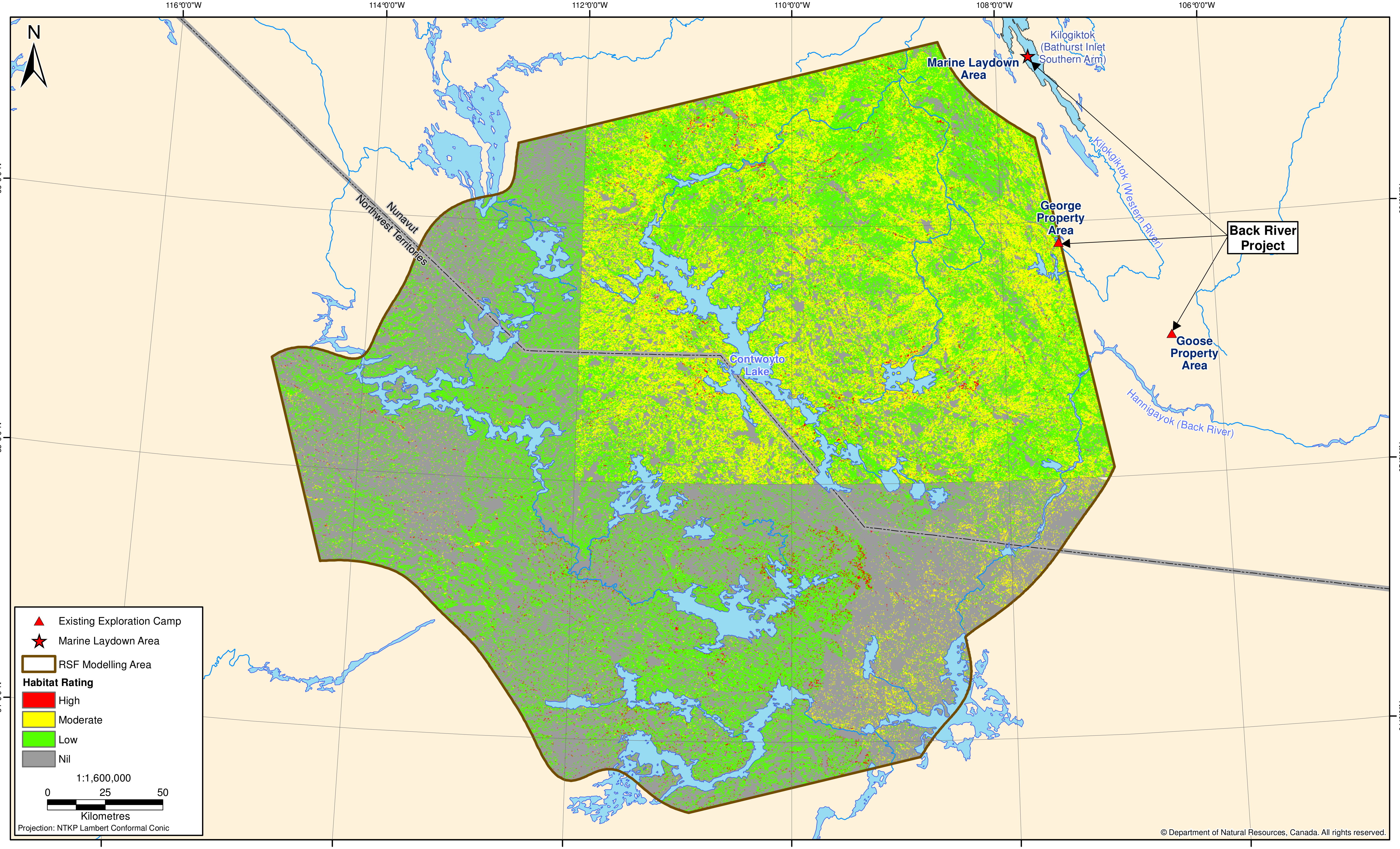

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Figure 3.5-11

Grizzly Bear Habitat Rating during Post-Calving in the RSF Modelling Area

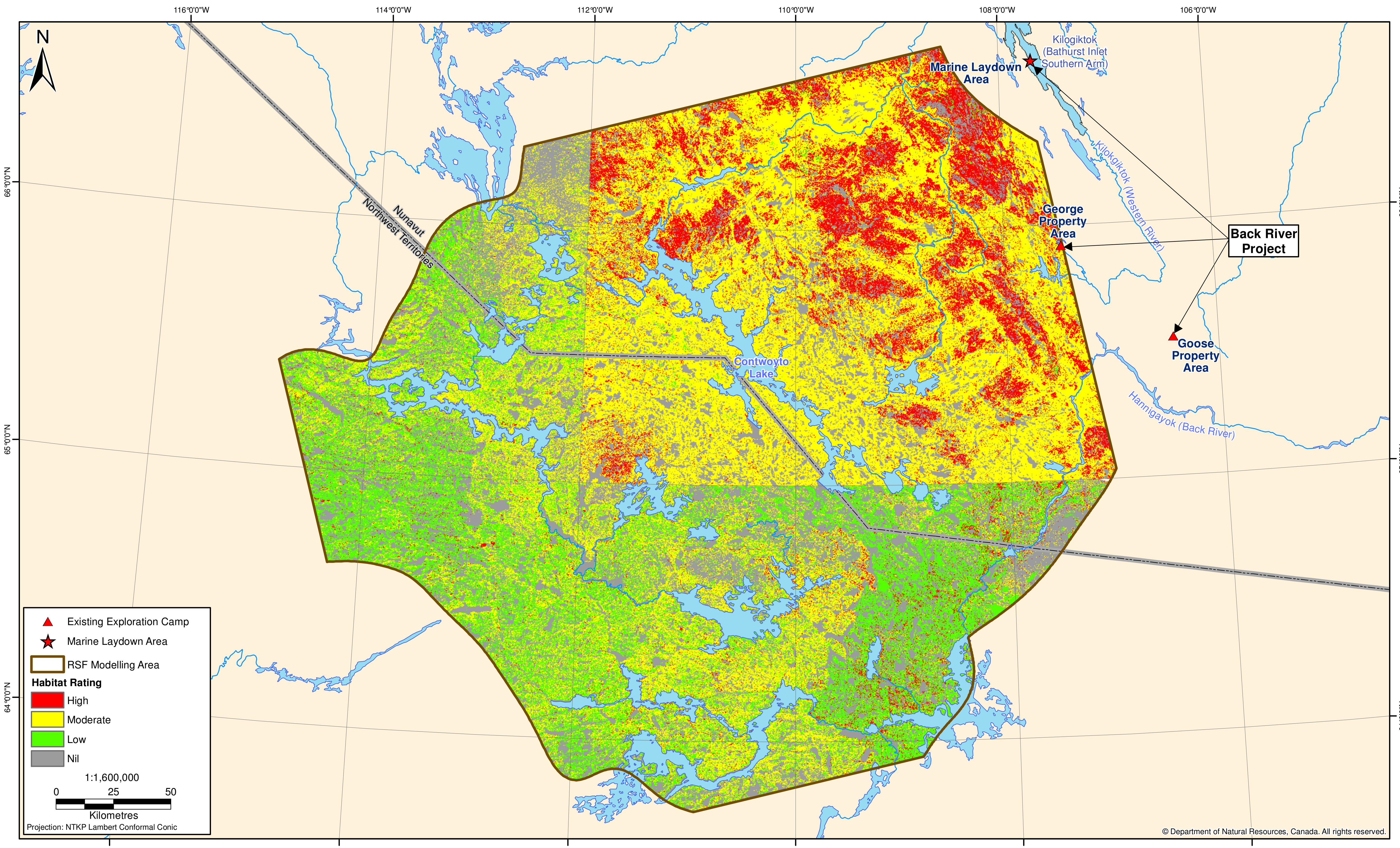

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Figure 3.5-12

Grizzly Bear Habitat Rating during Summer in the RSF Modelling Area

3.5.7 Mining Development

A development layer (Figure 3.5-13) was created to encompass the influence of mining activities, including drilling, camp, and helicopter disturbances. Development within the cumulative effects assessment boundary was divided into operating mines, closed mines, and exploration camps based on the assumption that each type of development is likely to interact with the herd in different ways. Through a literature search, the status of all camps and mines in the study area from 1996 to 2010 was determined (Table 3.5-2). At each collar data point, the distance to the nearest mine or camp was calculated for each of these development classes using the Euclidean Distance tool in ArcGIS 10.

Table 3.5-2. Summary of Mines and Camps Located in Study Area

Time Period	Number of Exploration Camps	Number of Open Mines	Number of Closed Mines
1996 to 2001	1	2	4
2002 to 2003	2	2	4
2004 to 2010	3	2	4

3.6 MODELLING PROCEDURES

An information theoretic approach was used to evaluate selection models (Burnham and Anderson 2002). Global models were constructed for each season and UD by pooling GPS locations across years. Categorical variables were coded with deviation contrasts (Menard 2002). To avoid inflating selection coefficients and associated standard errors (Menard 2002), collinearity among habitat variables was assessed. Given the high number of parameters in the model sets and the number of models generated, a conservative tolerance score of <0.3 was used to assess collinearity (Sokal and Rohlf 2000). No collinearity was identified.

Akaike's Information Criterion (AIC_c) corrected for small sample sizes (n/K < 40) to rank the model sets for caribou in each season and UD. The differences in AIC_c (Δ_i) provide an estimate of the distance that a candidate model is from the true model (Burnham and Anderson 2002). Akaike's weights (w_i) provide an estimate of the relative probability that the top model is the best amongst the suite of candidate models. A single model was selected as the likely top model if its $w_i \geq 0.90$. If the top model had an associated $w_i < 0.90$, selection coefficients were averaged from the suite of top models for which the sum of their respective w_i's was ≥ 0.95 (Burnham and Anderson 2002). A *k*-fold cross validation procedure averaged across five random subsets and a Spearman's rank correlation (r_s) was used to determine the predictive ability of each top model; values of $r_s > 0.70$ indicate good model performance (Boyce et al. 2002).

3.7 FINAL PROBABILITY MAPS

A series of maps that represent the likelihood of habitat use by caribou were produced based on parameter coefficients from the top models. Models of resource selection are based on logistic regression, which takes the form:

$$W(x) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots)}$$

In each equation, the habitat use probability surface ($W(x)$) is defined by a series of habitat characteristics (x) and associated coefficients (β). To produce the probability surface, the raster layers for each of the predictor variables were projected to a common 30 m raster size and Albers Equal Area Conical coordinate system. Each respective raster data layer was multiplied by its respective coefficient that was derived during model development. Each pixel has a value defined by the logistic regression equation.

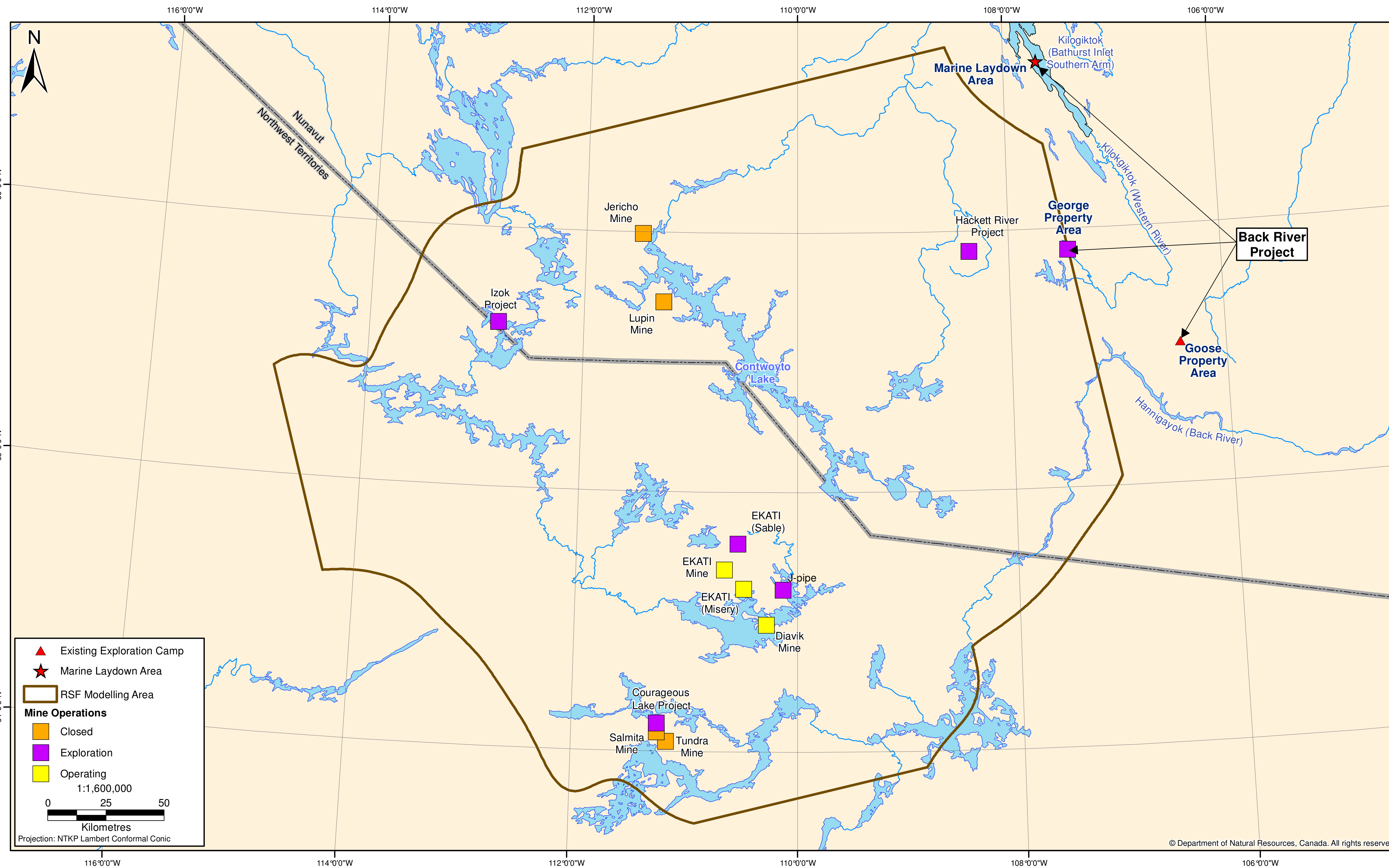

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Figure 3.5-13

Mine Operations in the RSF Modelling Area

4. Results

4. Results

4.1 RSF OUTPUTS

A total of 41,097 GPS locations were acquired from satellite collars deployed on 102 female caribou in the Bathurst herd. These locations were specific to the post calving and summer periods between 2004 and 2010. Gaps in GPS information and remote sensing imagery precluded the inclusion of 2011 and 2012 data. Statistically significant selection for SRVI was consistent across the post-calving and summer seasons. Seasonal differences in selection of different cover types and habitat use relative to industrial sites was also evident. All final models had values of $r > 0.70$ indicating good model performance.

4.1.1 Post Calving

Global models that best described resource selection by caribou within the post calving range (95% UD) included land cover class, habitat productivity as measured by SRVI, distance to industrial activity, and a measure of predation risk (Table 4.1-1). Water was included in the final model, but its coefficient was not statistically significant.

Table 4.1-1. Top Three Candidate Models Describing Habitat Selection by Bathurst Caribou during Post-calving

Model	AIC	ΔAIC	AIC *w*
95% UD			
*Land Cover + SRVI + Water + Industry + Predator	15425.89	0	0.68
*LandCover + SRVI + Industry + Predator	15427.47	1.58	0.31
Land Cover + SRVI + Water + Industry	15436.11	10.22	0.004
50% UD			
*Land Cover + SRVI + Industry + Predators	8792.66	0	0.52
*Land Cover + SRVI + Water + Industry + Predators	8792.81	0.14	0.48
SRVI + Industry + Predators	8805.64	12.98	0.001

Across the post calving range, caribou tended to avoid barren and sparsely vegetated cover types, as well as prostrate dwarf shrub and tussock graminoid tundra areas, relative to the availability of these cover types (Table 4.1-2). In contrast, caribou tended to select tall shrub and forested habitats. Habitat suitability for predators, used as an indicator of potential predation risk, was included in the final model. There was evidence for selection of low quality wolf habitat and avoidance of low quality grizzly bear habitat. There was zero use of high quality wolf habitat, which resulted in the removal of this parameter from the final model.

Selection coefficients across industrial activities imply some level of influence of these activities on caribou habitat use at the herd scale relative to random locations; however, while statistically significant, the magnitude of the coefficients suggests industrial effects cannot be considered in isolation of other factors. For example, the raw averages indicate the caribou tend to be slightly further from closed mines (101.1 km) compared to random locations (98.3 km), but closer to operating mines (116.5 km) and exploration camps (86.8 km) compared to random use points (133.9 km and 89.3 km, respectively).

Table 4.1-2. Model Parameters and Selection Coefficients Describing Habitat Selection by Bathurst Caribou during Post-calving

Parameter	[1]Post-Calving 95% UD	[1]Post-Calving 50% UD
Barren – Non-vegetated	-1.08 ± 0.25*	-
Sparsely Vegetated	-0.95 ± 0.23 *	0.73 ± 0.42
Bryoids	-0.03 ± 0.19	-
Tall Shrub	0.52 ± 0.20*	0.02 ± 0.25
Low Shrub	0.26 ± 0.19	-0.37 ± 0.24
Prostrate Dwarf Shrub	-0.86 ± 0.20*	-0.57 ± 0.23*
Wetlands	-0.47 ± 0.35	0.34 ± 0.33
Tussock Graminoid Tundra	-0.68 ± 0.21*	0.04 ± 0.20
Moist to Dry non-Tussock Graminoid Tundra	0.18 ± 0.21	-0.19 ± 0.25
Forested – Conifer	0.43 ± 0.24	-
Forested – Deciduous	1.69 ± 0.36*	-
Forests – Mixed	1.77 ± 0.26*	-
RVI	0.26 ± 0.02*	0.35 ± 0.09*
Water	-0.01 ± 0.004*	-0.005 ± 0.003
Distance to Operating Mine	-0.008 ± 0.001*	0.006 ± 0.001*
Distance to Closed Mine	-0.003 ± 0.001*	-0.01 ± 0.001*
Distance to Exploration Camp	-0.012 ± 0.001*	-0.02 ± 0.001*
Wolf Moderate Habitat	-0.28 ± 0.24	0.15 ± 0.19
Wolf Low Habitat	0.28 ± 0.12*	-0.15 ± 0.19
Wolf Nil Habitat	-0.001 ± 0.28	-
Bear High Habitat	0.53 ± 0.29	-0.46 ± 0.34
Bear Moderate Habitat	0.16 ± 0.14	0.11 ± 0.16
Bear Low Habitat	-0.56 ± 0.15*	0.35 ± 0.26
Bear Nil Habitat	-0.13 ± 0.31	-
Intercept	0.57 ± 0.21*	-0.76 ± 0.38*

[1]:model coefficients are the weighted average of the top two models.
** Indicates statistically significant coefficient.*

Similarly to the 95% UD, global models that best described resource use by caribou in the core post-calving range (50% UD) was an averaged saturated model with 18 parameters, including land cover, RVI, water, industrial activities, and habitat quality for predators (Table 4.1-1).

In the post-calving core range, caribou tended to select for highly productive areas, as indicated by the significant positive coefficient for RVI, and avoided prostrate dwarf shrub cover types (Table 4.1-2). As with the 95% UD, industrial activity was a significant component of the model and suggests avoidance activity, but the magnitude of the coefficients points to a small overall effect size. For instance, raw averages indicate that caribou were on average closer to closed (100.4 km) and operating mines (67.2 km) compared to random locations (110.6 km and 93.2 km, respectively), and further away from exploration camps (134.8 km versus 112.8 km). These results indicate that industrial activity is a significant component of herd level selection within the seasonal range, but their effects cannot be considered in isolation of other concurrent factors across the landscape.

The RSF model found a response curve (an increase in the probability of detection of caribou with distance from disturbance) of approximately 35 km from operating mines during the post-calving season, comparable to Johnson et al. (2005), which is likely beyond the sensory limits of caribou. While the direction of selection coefficients suggest some avoidance, the size of the selection coefficients and similar mean distances from disturbance between collar and random locations suggest that the response curves may be more a function of the number of collar locations combined with a low density of developments relative to the size of the study area. With a similar result, Johnson et al (2005) concluded the influence with industry warranted further investigation.

The respective coefficients for the post-calving range (95% UD) and the post-calving core use area (50% UD) were combined to generate habitat selection surfaces that represent the relative likelihood of detecting caribou across the landscape. These maps are not interpreted in the same way as habitat suitability. Rather, they are intended to describe the anticipated distribution of caribou given the relative availability of features thought to influence caribou habitat use within the identified spatial extent. Note that the 95% UD and 50% UD selection surfaces are not directly comparable. As the spatial boundary changes, so too does the suite of use points and the underlying availability of predictor variables.

Across the post-calving range, caribou are most likely to occur around the Contwoyto Lake region, with the highest likelihood of detection located in an area bounded by Contwoyto Lake, Lac de Gras, and Exeter Lake (Figure 4.1-1a). This pattern is consistent with observed movements of caribou from recent GPS collar data, as well as incidental observations recorded during monitoring programs of several mining projects in the region that suggest areas around Contwoyto Lake may provide important staging areas for the Bathurst herd prior to its southern migration to the wintering grounds (e.g., Ekati, Rescan 2013). Within the core use area where 50% of all GPS locations between 2004 and 2010 were found, caribou are most likely to be detected south of the Burnside River, and particularly along the Mara River and Hackett River corridors (Figure 4.1-1b). Movement patterns from GPS collar data indicate that the Mara River provides an important movement corridor for caribou as they travel southeast off the calving grounds (e.g., BIPR, Rescan 2012, unpub. data).

4.1.2 Summer

The global model that best described resource selection by caribou within the summer range (95% UD) was a saturated model that included all the predictor variables and 26 parameters (Table 4.1-3). Within the core summer range (50% UD), all predictor variables were included, with the exception of habitat suitability for predators, which was used as an index of predation risk. Water was included in both final models, and in contrast to the post-calving models, its coefficient was statistically significant.

Table 4.1-3. Top Three Candidate Models Describing Habitat Selection by Bathurst Caribou during Summer

Model	AIC	ΔAIC	AIC *w*
95% UD			
Habitat + RVI + Water + Industry + Predators	17992.97	0	1
Habitat + RVI + Industry + Predators	18045.95	52.98	$3x10^{-12}$
Habitat + Water + Industry + Predators	18126.94	133.97	$8x10^{-30}$
50% UD			
Habitat + RVI + Water + Industry	6518.59	0	0.92
Habitat + RVI + Water + Industry + Predators	6523.43	4.84	0.08
Habitat + RVI + Industry	6550.17	31.58	$1.3x10^{-07}$

Across the entire summer range (95% UD), caribou tended to select for areas with low lying vegetation relative to their availability across the landscape, such as barren and sparsely vegetated areas (which may include eskers) and shrub cover types (Table 4.1-4). Caribou tended to avoid wetter areas, such as wetlands and moist non-tussock graminoid tundra, and forested cover types. In the core use area (50% UD), caribou tended to avoid barren and bryoid cover types, low and dwarf shrub areas, and forested areas, but selected for sparsely vegetated (including eskers) cover types, tall shrub areas, and graminoid tundra cover types.

Table 4.1-4. Model Parameters and Selection Coefficients Describing Habitat Selection by Bathurst Caribou during Summer

Parameter	[1]Summer 95% UD	[1]Summer 50% UD
Barren – Non-vegetated	0.72 ± 0.29*	-1.29 ± 0.16*
Sparsely Vegetated	0.68 ± 0.21*	1.56 ± 0.24*
Bryoids	0.41 ± 0.19*	-0.81 ± 0.09*
Tall Shrub	1.23 ± 0.12*	1.63 ± 0.17*
Low Shrub	0.87 ± 0.10*	-0.65 ± 0.08*
Prostrate Dwarf Shrub	0.77 ± 0.24*	-0.49 ± 0.14*
Wetlands	-0.25 ± 0.18	0.09 ± 0.22
Tussock Graminoid Tundra	0.85 ± 0.10*	0.54 ± 0.07*
Moist to Dry non-Tussock Graminoid Tundra	-4.25 ± 0.38*	0.72 ± 0.11*
Forested – Conifer	-0.34 ± 0.16*	-1.30 ± 0.17*
Forests – Mixed	-0.70 ± 0.36	-
RVI	0.17 ± 0.01*	0.46 ± 0.02*
Water	-0.09 ± 0.01*	-0.08 ± 0.008*
Distance to Operating Mine	-0.001 ± 0.001	-0.009 ± 0.001*
Distance to Closed Mine	-0.004 ± 0.001*	-0.018 ± 0.002*
Distance to Exploration Camp	-0.02 ± 0.001*	0.004 ± 0.001*
Wolf High Habitat	3.99 ± 0.35*	-
Wolf Moderate Habitat	-0.15 ± 0.22	-
Wolf Low Habitat	-1.74 ± 0.22*	-
Wolf Nil Habitat	-2.1 ± 0.28*	-
Bear High Habitat	-0.55 ± 0.20*	-
Bear Moderate Habitat	-1.23 ± 0.27*	-
Bear Low Habitat	1.36 ± 0.19*	-
Bear Nil Habitat	0.43 ± 0.34*	-
Intercept	1.17 ± 0.20*	-1.89 ± 0.32*

[1]: Model coefficients are the weighted average of the top two models.
** Indicates statistically significant coefficient.*

Selection coefficients for industrial activities suggest some level of influence on habitat use by caribou in both the core use area and across the entire summer range. As with the post-calving models, the magnitude of the coefficients and the distances being considered suggest that the influence of mining activities may occur at broad scales (as opposed to a “zone of influence” around a particular project, for example) and cannot be considered in isolation of other factors. Relative to the entire range, there was no difference in distances to closed mining operations (57.5 km) compared to random locations (57.2 km). Raw averages show caribou further from operating mines (95.8 km) relative to random points (91.7 km), and closer to exploration camps (138.6 km) compared to random locations (177.2 km).

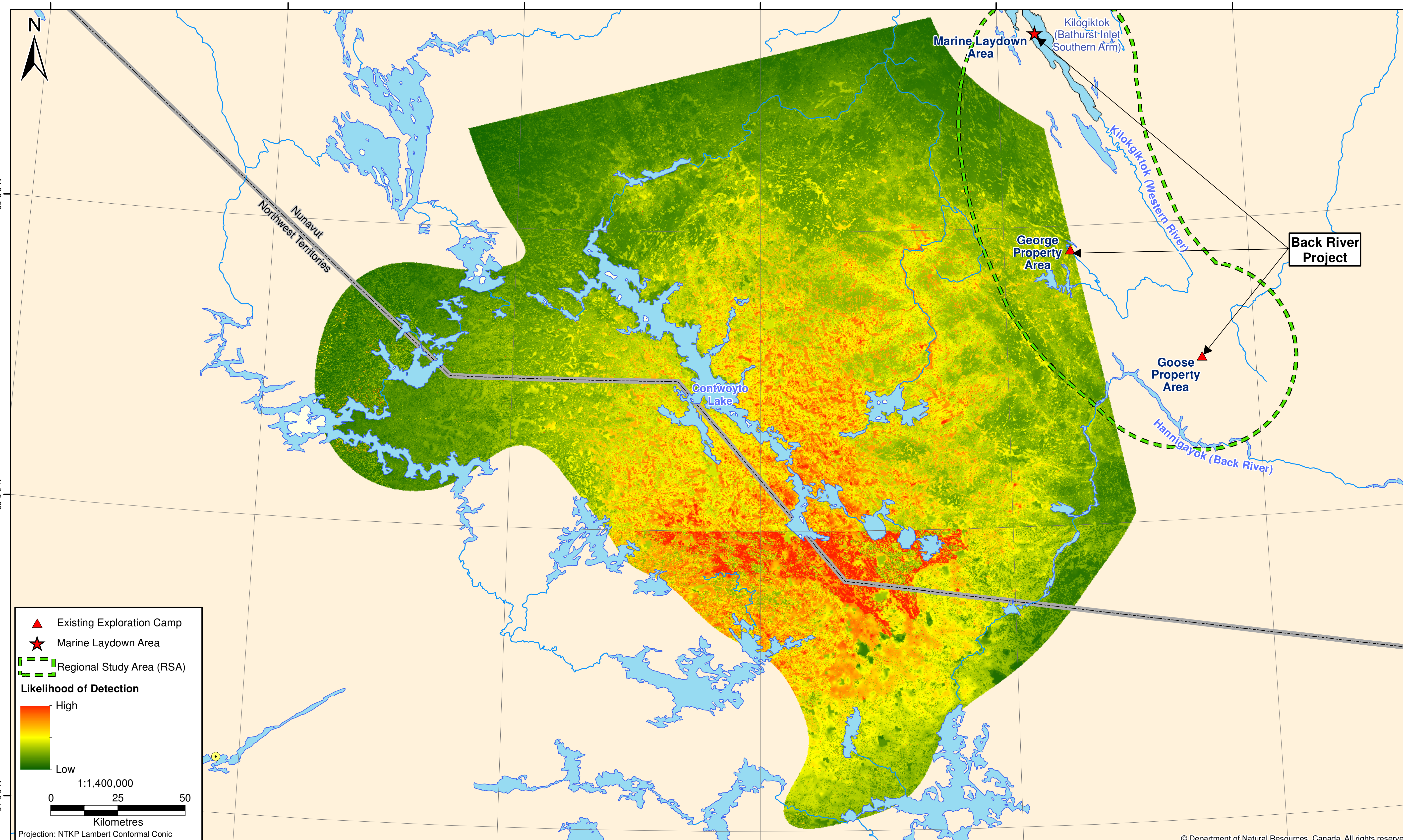

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Figure 4.1-1a

Habitat Selection Surface for Bathurst Caribou during Post-Calving, 95% Kernel

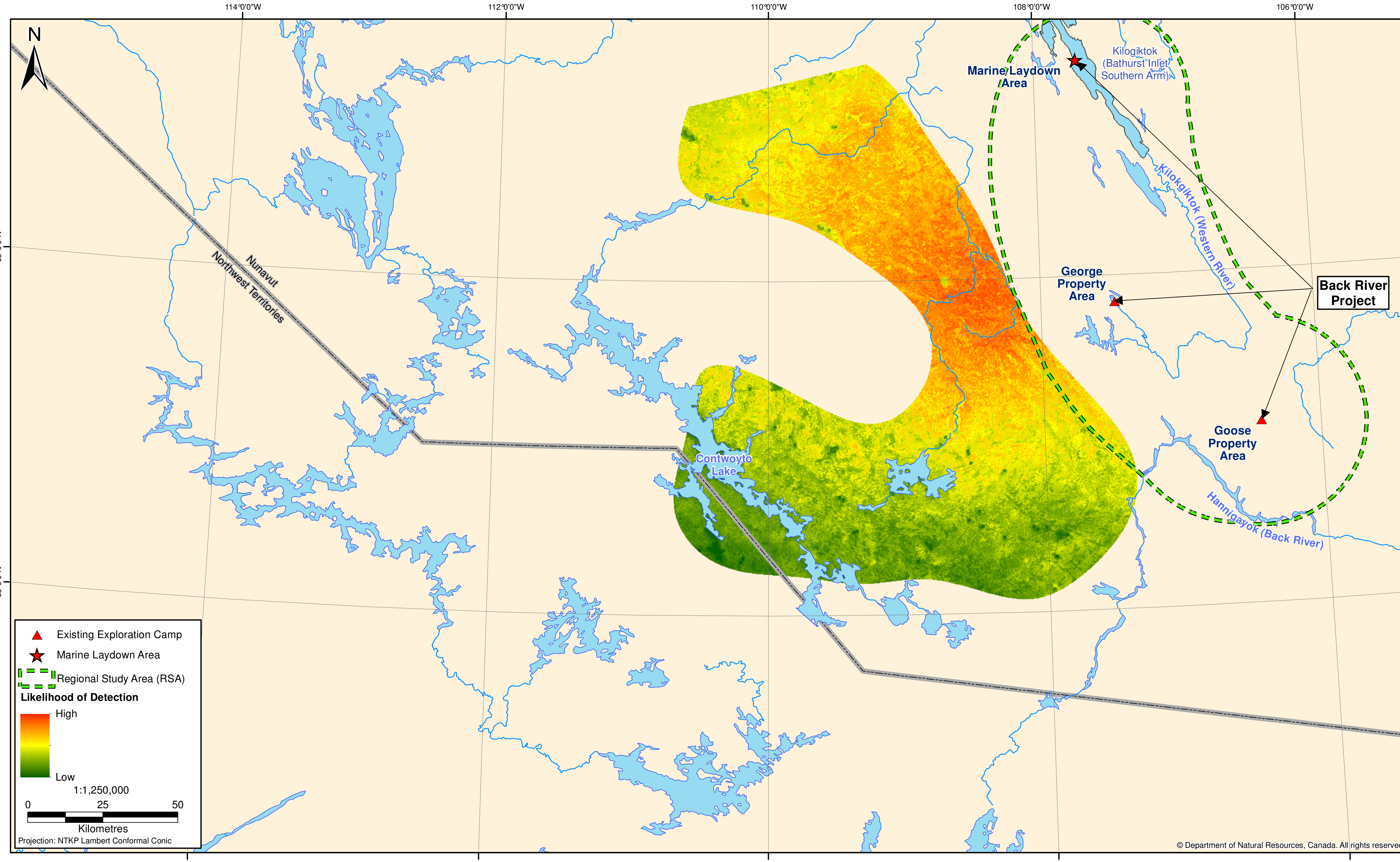

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Figure 4.1-1b

Habitat Selection Surface for Bathurst Caribou during Post-Calving, 50% Kernel

The RSF model found a response curve (an increase in the probability of detection of caribou with distance from disturbance) of approximately 50 km from operating mines during the summer, which is likely beyond the sensory limits of caribou. While the direction of selection coefficients suggest some avoidance, the size of the selection coefficients and similar mean distances from disturbance between collar and random locations suggest that the response curves may be more a function of the number of collar locations combined with a low density of developments relative to the size of the study area.

There was evidence for strong selection for high quality wolf habitat and strong avoidance of both high and moderate value grizzly bear habitats by caribou across the full summer range. Habitat quality for predators, as an indicator of predation risk, was not a component of the final model describing habitat use by caribou in the summer core use area.

The respective coefficients for the entire summer range (95% UD) and the summer core use area (50% UD) were combined to generate habitat selection surfaces that represent the relative likelihood of detecting caribou across the landscape. These maps are not interpreted in the same way as habitat suitability. Rather, they are intended to describe the anticipated distribution of caribou given the relative availability of features thought to influence caribou habitat use within the identified spatial extent. As with the post-calving selection surfaces, the 95% UD and 50% UD selection surfaces are not directly comparable. As the spatial boundary changes, so too does the suite of use points and the underlying availability of predictor variables.

As with the post-calving results, the Contwoyto Lake region continues to be an area where caribou are most likely to be detected during the summer period relative to their historic range (Figure 4.1-2a). This result is consistent with their current known summer distribution. The habitat surface for the core summer use area, the boundary for which was based on pooled historic data covering 1996-2012, illustrates a high likelihood of detection in several areas, including McKay Lakes and Lac de Gras in the southern portion, an area north of Exeter Lake and west of Contwoyto Lake, and at the west end of the Burnside River (Figure 4.1-2b).

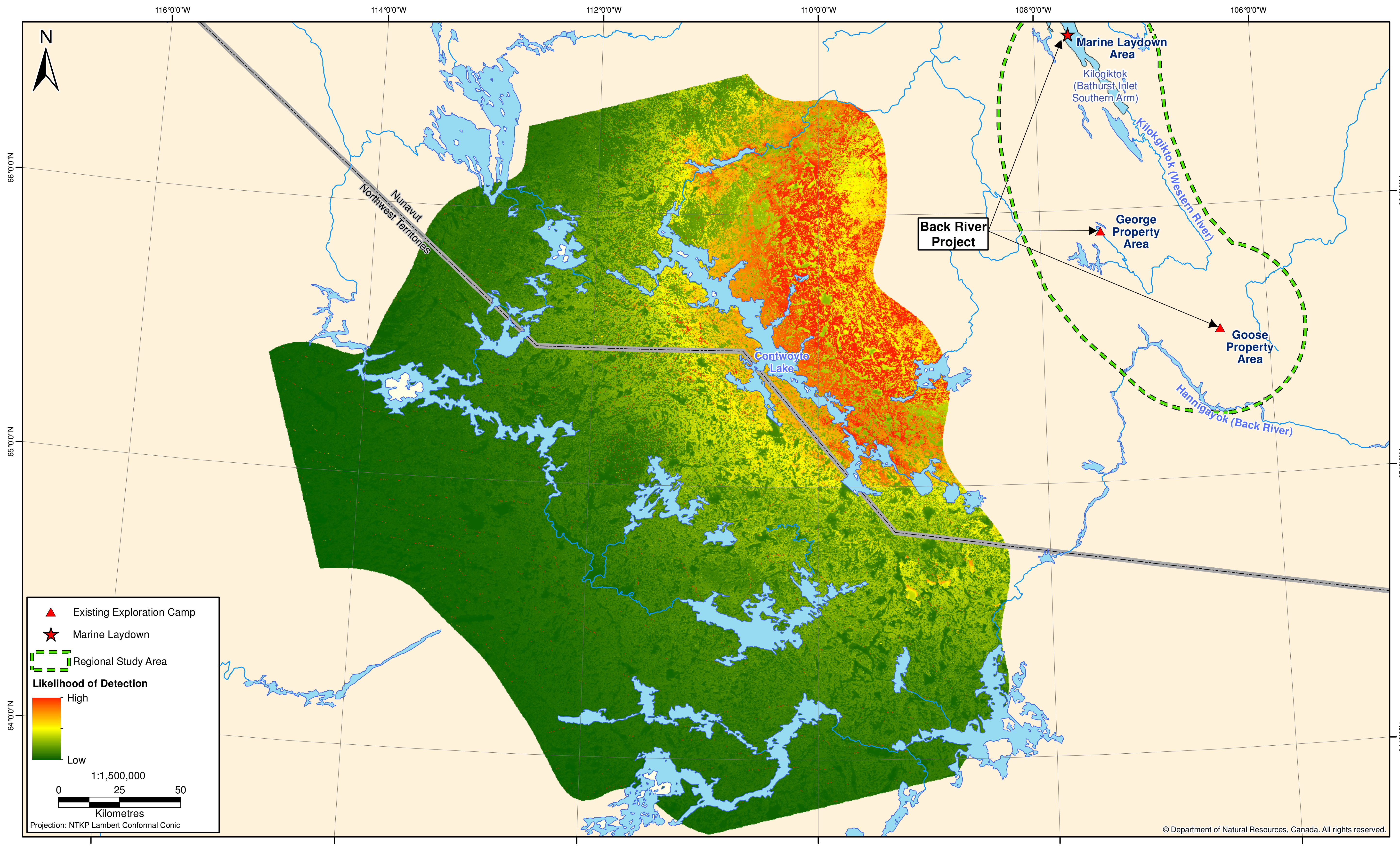

Figure 4.1-2a

Habitat Selection Surface for Bathurst Caribou during Summer, 95% Kernel

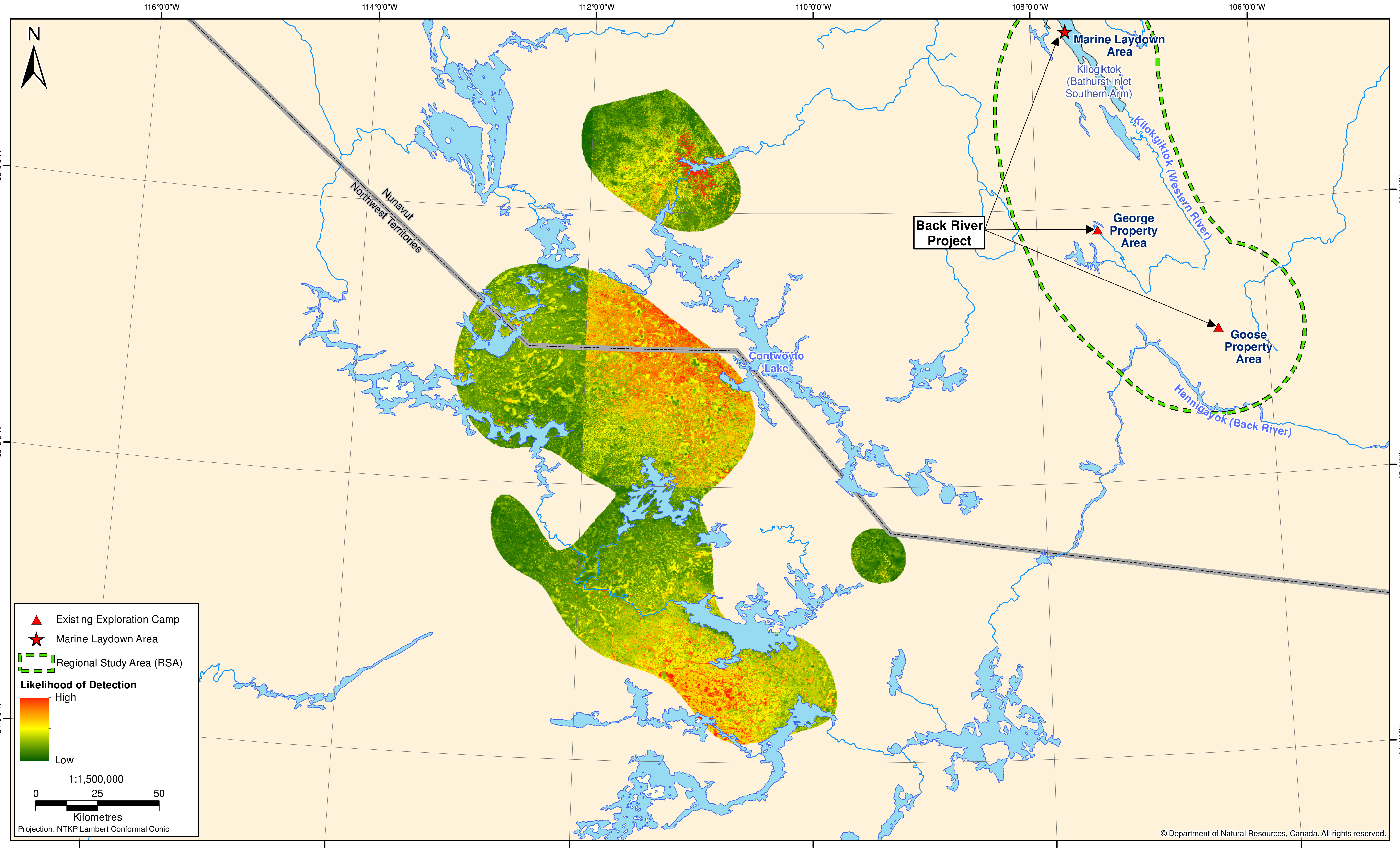

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Figure 4.1-2b

Habitat Selection Surface for Bathurst Caribou during Summer, 50% Kernel

5. Discussion

5. Discussion

The social, cultural, and economic value of barren-ground caribou to residents of Nunavut (NU) and the Northwest Territories (NWT) is immense. Across the Arctic, barren-ground caribou herds in the NWT declined between 26 and 91% from the 1990’s to the late 2000’s. The Bathurst herd of barren-ground caribou was one of the largest herds of migratory tundra caribou in northern Canada in the 1980’s. The Bathurst herd appears to have stabilized in recent years; however, to ensure the long term sustainability of this herd (and barren-ground caribou in general) requires an understanding of the underlying mechanisms that influence movement patterns and habitat use across spatial and temporal scales. Quantifying the relative contribution of a suite of factors enables effective cumulative effects assessment that in turn provides potential management scenarios.

This model assessed habitat use and selection by the Bathurst caribou herd at a broad spatial scale during the post-calving and summer seasons to support the potential cumulative effects assessment for the DEIS (Volume 5, Chapter 5). It is one of the most recent studies of this scope on the Bathurst herd since Johnson et al. (2005), which assessed cumulative effects on caribou and their predators covering the period 1995-2000. The Back River Project is currently located outside both the 50% and 95% UD post-calving and summer range boundaries as determined from pooled GPS collar location data collected between 1996 and 2012. Although GPS locations and predictor variables were matched by year (with the exception of land cover), individual or annual variation was not examined because fidelity to the post-calving and summer ranges has been relatively consistent and predictable since 1996, unlike migration routes and winter ranges that can be highly variable (Gunn et al. 2008). Changes in land cover are likely to have occurred since the last land cover classification in the early 2000’s, but those changes were assumed to be minimal relative to the size of the study areas. During the preparation of this report, the Canadian Centre for Remote Sensing was in the process of developing an updated land cover classification for Arctic Canada, which will be a useful tool to examine changes in habitat use.

During both the post-calving and summer periods, the Contwoyto Lake region was identified as an area that is heavily used by caribou based on models that included habitat, SRVI (an index of habitat productivity), distance to industrial activities, distance to water, and habitat quality ratings for predators (used as an index of predation risk). This result assumes that the current post-calving and summer distributions can be explained by pooled GPS collar data spanning 2004-2010, and that changes in land cover types are unlikely to have changed significantly since the land cover classification developed in the late 1990’s. The selection surfaces are consistent with current GPS collar data as well as anecdotal evidence collected during regional monitoring programs at other mining operations (e.g., Rescan 2013).

A steep decline in the Bathurst herd in the 2000’s corresponded to reduced calf survival, fecundity, and adult female survival (Boulanger et al. 2011). Chen et al. (2013a) demonstrated these patterns could at least partially be explained by broad patterns of habitat productivity on the summer range. Strong and consistent selection for high SRVI, an indicator of overall habitat productivity, supports the hypothesis that caribou require high habitat quality during the post-calving and summer periods. During these times, female caribou are nutritionally stressed, recovering from pregnancy and parturition, and requiring added resources during nursing and preparing for the upcoming winter. Focusing on areas with high quality forage will maximize opportunities to meet energy demands, and may potentially buffer years of high insect harassment. In Alaska, the condition of cows and calves of the Porcupine herd at the end of June predicts their condition during the autumn breeding season. If animals are in poor condition in fall, then pregnancy rate is reduced, age of first reproduction may be delayed, and winter mortality will increase (Russell and McNeil 2005). In northern Quebec, significant differences in body condition and subsequent demographic parameters were found between the Riviere George and Riviere aux Feuilles herds related to density-dependent habitat conditions on the respective summer ranges (Crete and Huot 1993).

Post-calving habitat use was characterized by avoidance of barren areas and selection for tall shrub and forested cover types. During summer, habitat use shifted to selection of a broad suite of cover types and avoidance of wetter and forested habitat types. During post-calving, caribou females may be seeking security cover at a time when calves may not yet be as mobile as adults. As the season progresses to the summer, nutritional requirements necessitate access to forage opportunities to recover body condition, as well as cover types that may provide some insect relief (e.g., barren or sparsely vegetated areas that may include eskers).

Johnson et al. (2005) modeled habitat selection by caribou during the post-calving period from 1995-2000. Comparable to this study, they found that the model that best explained habitat use by caribou included vegetation patch (individual cover types), vegetation density (regional distribution of cover types), major development, and mineral exploration. Predation risk was not included as a predictor variable. Their study included 190,000 km^2 of the Taiga Shield and Southern Arctic ecozones, approximately twice the size of the spatial extent used in this study. In addition, their combination of cover types differed from this study, resulting in 10 broad vegetation classes, including esker. These difference make direct comparisons difficult; however, there were some similarities. For example, Johnson et al. (2005) reported strong selection for riparian shrub patch and density, analogous to the tall shrub class used here. In contrast, they found avoidance of forested cover types. This difference is primarily due to the lower proportion of available forested cover relative to their larger study area.

One of the important results from this study is the influence of apparent predation risk on caribou habitat use across the summer range. Strong selection for high quality wolf habitat (which includes eskers for insect relief) may be counter intuitive; however, during this time, wolves are typically attending to pups at the den and may be more opportunistic in their hunting strategies (e.g., focusing on small mammals) than at other times of the year when they may follow the herd. Grizzly bears are known to frequent the calving and summer ranges of caribou (Russell and McNeil 2005), and recent DNA evidence from the Lac de Gras region in NWT and in Nunavut indicate that grizzly bear densities north of Lac de Gras (i.e., throughout the Bathurst herd summer range) may be relatively high compared to neighboring areas. Avoidance of high and moderate quality grizzly bear habitat may be a strategy used by caribou to minimize encounters.

Potential effects associated with industrial development are difficult to quantify. There is growing evidence to support the assertion that caribou respond negatively to human disturbance (sic. Johnson et al. 2005); however, the extent of potential effects is unclear because the implications to vital rates and ultimately to populations are not well understood (Wolfe et al. 2000), caribou can adjust behaviorally to accommodate some levels of disturbance (Colman et al. 2001), and disturbance responses do not always infer considerable energetic costs (Tyler 1991). This study demonstrated general apparent avoidance of industrial activities, but an examination of the raw data suggests this result may in part be due to the definition of availability. It is unlikely that caribou respond to development in a strictly linear fashion, as was defined for this study. Rather, disturbance is likely apparent out to a certain distance or threshold, beyond which sensory effects no longer apply. Johnson et al. (2005) similarly found avoidance of major developments across seasons, which included towns and large mining operations, and less equivocal results for mineral explorations. They attributed the weak relationship to the low density of developments and the poor collar coverage relative to the size of the study area. The mechanistic links to industry bears further investigation given that the current post-calving and summer ranges are centred on a relatively pristine and highly productive area encircled at some distance by operating mines and exploration activities.

It should be noted that this study cannot separate two hypotheses describing caribou distribution relative to industrial activity: 1) caribou are avoiding industrial activity on a landscape scale, or 2) caribou prefer the Contwoyto Lake and Nose Lake regions due to vegetation quantity and quality and industry is not located in these areas. Both hypotheses have the same predictions – that caribou will be further from industrial activity than average in the study area. One of the confounding features in the data is that most camps and active mines predate the existing high quality GPS collar information, so the distribution of caribou before and after industrial activity cannot be compared.

TK indicates that the Contwoyto Lake and Nose Lake regions have been important post-calving and summer ranges for the Bathurst herd since before development and prior to the deployment of radio collars on the Bathurst herd. The RSF model, which provides a spatial surface that indicates the likelihood of detecting caribou across the landscape, indicates that these areas continue to be important to the Bathurst herd. A portion of the terrestrial wildlife RSA overlaps the eastern edge of the post-calving range, and only the George property is found at the edge of the range, which is comprised or primarily low and moderate value habitat (i.e., lower detection rates relative to the rest of the range). During summer there is no overlap by any components of the Back River Project, either in the total range or the core use area.

Other projects in the region have the potential to influence post-calving and summer habitat conditions and subsequent distribution and habitat use by caribou. Current ranges and habitat use are likely integrated over time by conditions on the landscape. The Ekati and Diavik diamond mines are the only operators in the region, and occur at the edge of very high value habitat during post-calving, and in the centre of moderate and high value habitat during summer, but falls outside the core use areas during both seasons. Amongst potential future developments, the neighboring proposed Hackett River project is found within both the post-calving range and the post-calving core use area, but not in the summer range or core use area. The Courageous Lake property does not occur in the post-calving range or core use area. Both the Courageous Lake and Izok properties are located in low to moderate value habitat relative to the entire summer range, and only Izok is located in moderate valued core summer habitat (relative to the rest of the core use area).

Caribou populations fluctuate on decadal cycles (Gunn et al. 2008), and the Bathurst herd appears to have stabilized at their current low levels. The causes of population variation in Arctic ungulate populations are complex (Joly et al. 2011), which can confound cumulative effects assessment. Population trajectories are thought to respond to summer range condition (Chen et al. 2013a), winter range condition (Parker et al. 2005), predation rates (Bergerud 1980), snow conditions (Dau 2005), human activity (Vors and Boyce 2009), disease, parasites, and insect harassment (Hughes et al. 2009), stochastic events (Hummel and Ray 2008), density-dependent factors (Couturier et al. 2009), and density independent factors (Vors and Boyce 2009). Climate is thought to be the primary driver that can influence all of these factors, but the influence of climate will not impact caribou populations uniformly (Joly et al. 2011).

Changes in the distributions of the Bathurst herd were found in response to climate change variables (McNeil et al. 2005). For the Bathurst herd, the summers have become slightly warmer and wetter (Zhang et al. 2000). With an increase in temperate and precipitation, insect harassment on caribou is expected to increase. As a consequence, McNeil et al. (2005) speculated that more Bathurst caribou would be exposed to mining developments, such as the Ekati-Diavik mining zone, for possible insect relief, which may require additional monitoring and mitigation measures by mining operations. Large scale climate oscillations, such as the Arctic Oscillation (AO) and the Pacific Decadal Oscillation (PDO), have been linked to population trends of caribou herds in Arctic Alaska through corresponding effects on several important aspects of caribou ecology, including snow depth, icing, predation rates, and forage quantity and quality during both summer and winter (Jolly et al. 2011). The AO and PDO can also affect the frequency of wildfires (Duffy et al. 2005), the summer growing conditions of winter forage (e.g. lichen) (Joly et al. 2007), and the levels of insect harassment and infestations of parasitic flies (Callaghan et al. 2004).

6. Conclusions

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Estimating resource selection patterns for a herd can reveal what habitat features are selected or avoided on the landscape. RSFs are a valuable tool for identifying important areas for a population so that the quantity and distribution of those areas across a population's range can be assessed (Wilson et al. 2012). Results from RSFs can then be used to help predict and minimize potential negative effects to caribou habitat from development, especially during periods of enhanced sensitivity to human activity associated with development (Cameron et al. 2005). If RSF-based studies are conducted, it is important that they be estimated before development begins because patterns of resource selection can be altered in the presence of infrastructure (Harju et al. 2011). Estimates obtained prior to development can be used to assess how patterns change once development exists (Wilson et al. 2012).

This study demonstrated that several large scale processes may be interacting to influence the post calving and summer distributions of Bathurst caribou, and that the Contwoyto Lake region may be particularly important to the long-term persistence of the herd. This study expanded on earlier work by Johnson et al. (2005) to include more recent information, and differed from that study by examining habitat use within seasonal ranges specific to the Bathurst herd as defined by their GPS collar locations. The methods and results presented here provide a meaningful contribution to understanding the dynamics of the Bathurst herd at broad spatial scales. The information was used to support the Bathurst herd cumulative effects assessment in the DEIS (Volume 5, Chapter 5).

Access to high quality forage at a time when cows are nutritionally stressed appears to be one of the most important components to the sustainability of Bathurst caribou. Consistent selection for habitat productivity by Bathurst caribou, as indexed by the Simple Ratio Vegetation Index (SRVI), during post calving and summer supports this conclusion. Selection and avoidance of different habitat types by season and range extent suggests shifts in habitat use patterns in response to nutritional and security requirements. The distribution of high quality forage and subsequent habitat use by caribou can be moderated by predation, hunting, industrial activities, and climate. The weak avoidance of industrial activities at broad spatial scales may be a function of available collar data and the low density of industrial activity relative to the size of the seasonal range. Nevertheless, whether the distribution of caribou around the Contwoyto Lake region is a function of pre-existing preference for high quality forage in the area relative to other areas, or whether the distribution is the result of increasing human activity cannot currently be distinguished with these data, although Inuit TK suggests that Contwoyto and Nose Lakes have long been important for the herd.

It has been suggested that habitat productivity and climate change may ultimately be the most important components that drive caribou distribution and habitat use in the Arctic (Joly et al. 2011). Habitat productivity has recently been linked to changes in demographic indicators at the population level (Chen et al. 2013a). Under the current distribution of existing and proposed developments, potential effects to habitat conditions on the post-calving and summer ranges are expected to be minimal provided that the integrity of the Contwoyto Lake and Nose Lake region is maintained, and that movements along the Burnside, Mara, and Hackett River corridors are not impeded.

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