Gartner Lee Limited

April 29, 2008

Valerie Chort
Deloitte and Touche Inc.
79 Wellington Street
Suite 1900
P.O. Box 29
Toronto, ON M5K 1B9

Dear Valerie:

Re: GLL 80086 – Additional Baseline Studies (Project #23), Status and Summary Report

We are pleased to provide a summary of the work completed for the Additional Baseline Studies project in preparation of the Environmental Assessment of the Faro Closure and Remediation Plan. The scope of this work entailed digitizing Government of Yukon wildlife (sheep) data and analyses of ungulate tissues from specimens collected between 2005 and 2007.

Digitizing of Sheep Data

Sheep data in the form of visual sightings and other reference documents were obtained from the Government of Yukon and spatial files created for mapping purposes. A summary of this work is provided in the appended report titled, "*Faro Area Thinhorn Sheep – Additional Baseline Data Summary*" (March 2008).

Ungulate Tissue Contaminant Analyses

Tissue samples collected from moose and caribou specimens harvested near the Faro Mine site were analysed for metal content for the purpose of evaluating contaminant levels and to facilitate comparison of metal concentrations to other reference areas in the Yukon. The results of this study are summarized in the appended report titled, *"Contaminants in Moose and Caribou in the Anvil Range Area".*

The tissue samples were analysed by Cantest Laboratories Ltd. in early March. Upon receipt of the analytical results, it was noted that the reported data for selenium and mercury were outside of the normal acceptable accuracy range. In response, the lab undertook a quality control procedure by re-analyzing random samples for comparison with the original data. The results of this quality control procedure prompted the re-analyses of the tissue samples for selenium, but not for mercury. The selenium re-analyses data has been incorporated into the appended report.

The information collected through these two programs will be incorporated into the Environmental Baseline Report, which is currently being developed as part of a comprehensive Project Proposal for Assessment of the Faro Closure and Remediation Plan. The Project Proposal is scheduled to be submitted to the Yukon Environmental and Socio-economic Assessment Board in February 2009.

We thank you for the opportunity to conduct this work. If you have any questions please contact the undersigned.

Yours very truly,
GARTNER LEE LIMITED

H. Badry

Heather Badry, B.Sc.
Sr. Environmental Scientist

Attachments: "*Faro Area Thinhorn Sheep – Additional Baseline Data Summary*" (March 2008)
"Contaminants in Moose and Caribou in the Faro Mine Complex Area" (April 2008)

cc Stephen Mead, Sr. Project Manager, Faro Closure Office

Faro Area Thinhorn Sheep – Additional Baseline Data Summary

Prepared for
Deloitte and Touche Inc.
Interim Receiver for Anvil Range Mining Corp.

On behalf of
Faro Project Management Team

Submitted by
Gartner Lee Limited

March 2008

Gartner Lee

Faro Area Thinhorn Sheep – Additional Baseline Data Summary

Prepared for

Deloitte and Touche Inc.
Interim Receiver for Anvil Range Mining Corp.

On behalf of

Faro Project Management Team

March 2008

Reference: **GLL 80086**

Distribution:

1 Deloitte and Touch Inc.
2 Faro Project Management Team
2 Gartner Lee Limited

Gartner Lee

Executive Summary

Baseline information for thinhorn (fannin) sheep (*Ovis dalli*) has been previously summarized for the Faro Project in the east central Yukon Territory (Gartner Lee Limited 2008). That baseline summary includes a review of current literature, from published and government sources, and information from local authorities to assess the distribution and abundance wildlife species near to the Project, including fannin sheep. To support the baseline documentation of the distribution and ecology of fannin sheep, this report summarizes the work to examine, digitized, and subsequently map additional known telemetry and observation data near the Faro Mine Closure Project.

Studies on fannin sheep in the Faro area began in the early 1970's. However, owing to changing technology and inventory standards, in addition to differing survey objectives and observers, most sheep observation records that took place prior to the mid-1990's resources have not been recorded in a digital format. This report adds to the knowledge base of sheep distribution and movement patterns by digitizing and mapping both observation records and telemetry locations held by the Yukon Territorial Government. It summarizes the role of topographical features that may influence the distribution of fannin sheep in the Faro area, and provides insight into seasonal use of topographical features and movement patterns.

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1. Introduction and Approach

The intent of this work was to examine and digitize known observation and telemetry data available for thinhorn (fannin) sheep (*Ovis dalli*) near the Faro Mine Closure Project (the Project) in the east central Yukon. These data are meant to support the baseline documentation of the distribution and ecology of thinhorn sheep near to the Project.

As detailed in Gartner Lee Limited (2008), thinhorn sheep in the Yukon include two recognized subspecies; dall sheep (*Ovis dalli dalli*) and the generally darker stone sheep (*Ovis dalli stonei*). A colour variant of thinhorn sheep that are somewhat intermediate between dall and stone sheep occurs near to the Project area, and are known as fannin sheep. Fannin sheep in the Project area generally occur on Sheep Mountain, Rose Mountain, and Mount Mye, although presence varies by season. Fannin sheep have high socioeconomic value in the Yukon as a game and subsistence species, and for their non-consumptive value (wildlife viewing), locally demonstrated by the sheep and sandhill crane (*Grus canadensis*) viewing festival currently supported by the Town of Faro.

Studies on fannin sheep in the Faro area began in the early 1970's, and several studies have taken place to document population and habitat use parameters (Montreal Engineering Company Ltd. 1976; McLeod 1981; Hoeffs 1988, 1990; Horejsi 1988; Schweinsburg 1990; Department of Renewable Resources, Government of Yukon 2002). Owing to changing technology and inventory standards, in addition to differing survey objectives and observers, most sheep observation records that took place prior to the mid-1990's resources have not been recorded in a digital format. This work adds to the knowledge base of sheep distribution and movement patterns, by digitizing and mapping both observation records and telemetry locations held by the Yukon Territorial Government.

2. Methods and Data Sources

2.1 Identifying and Acquiring Data Sources

Data on fannin sheep were accumulated from published reports and unpublished observation records provided by the Yukon Territorial Government. Two types of information were available within the accumulated reports and unpublished data from Yukon Renewable Resources (now Yukon Department of Envirobment): Telemetry data and records of observed sightings. The telemetry data showed the movement paths of individual animals, from November 1989 to May 1990, through the use of VHF (Very High Frequency) radio-collars attached to each animal. The observed sightings showed the spatial locations where an individual or group of animals where sited and recorded.

2.2 Digitizing Telemetry and Observed Sightings

For the purposes of this report, only the information that had spatial information (i.e. locations recorded on a map) was included and digitized. Information that had less detailed spatial information (i.e. where only verbal descriptions of observed sightings were provided, such as 'on the blind creek road') were not included in the report or database as it we were unable to map these observations with any spatial accuracy.

Data was converted to digital form for use in a Geographical Information System (GIS) using a method called on-screen digitizing. This method displays spatially explicit data, for the purpose of analysis and integrates spatial and non-spatial information identifying relationships over space and time. Attribute information associated with each location was entered into a database that was linked to each spatial location within the GIS environment. This attribute information included: UTM Northing and Easting, source, observers, date, season, number of rams, number of ewes, number of lambs, number of yearlings, number of unclassified, total, notes, sheep ID, and age class. All data was digitized at 1:10,000 scale in projection NAD 83, Zone 8N.

The telemetry and observed sightings information digitized is reproduced in Appendix A and B.

2.3 Production of Final Maps

Once all of the spatial information was compiled and input into the GIS, maps were prepared to show the location of seasonal observations captured in the database and telemetry movements of the 9 individual animals.

3. Results

3.1 Observation Records

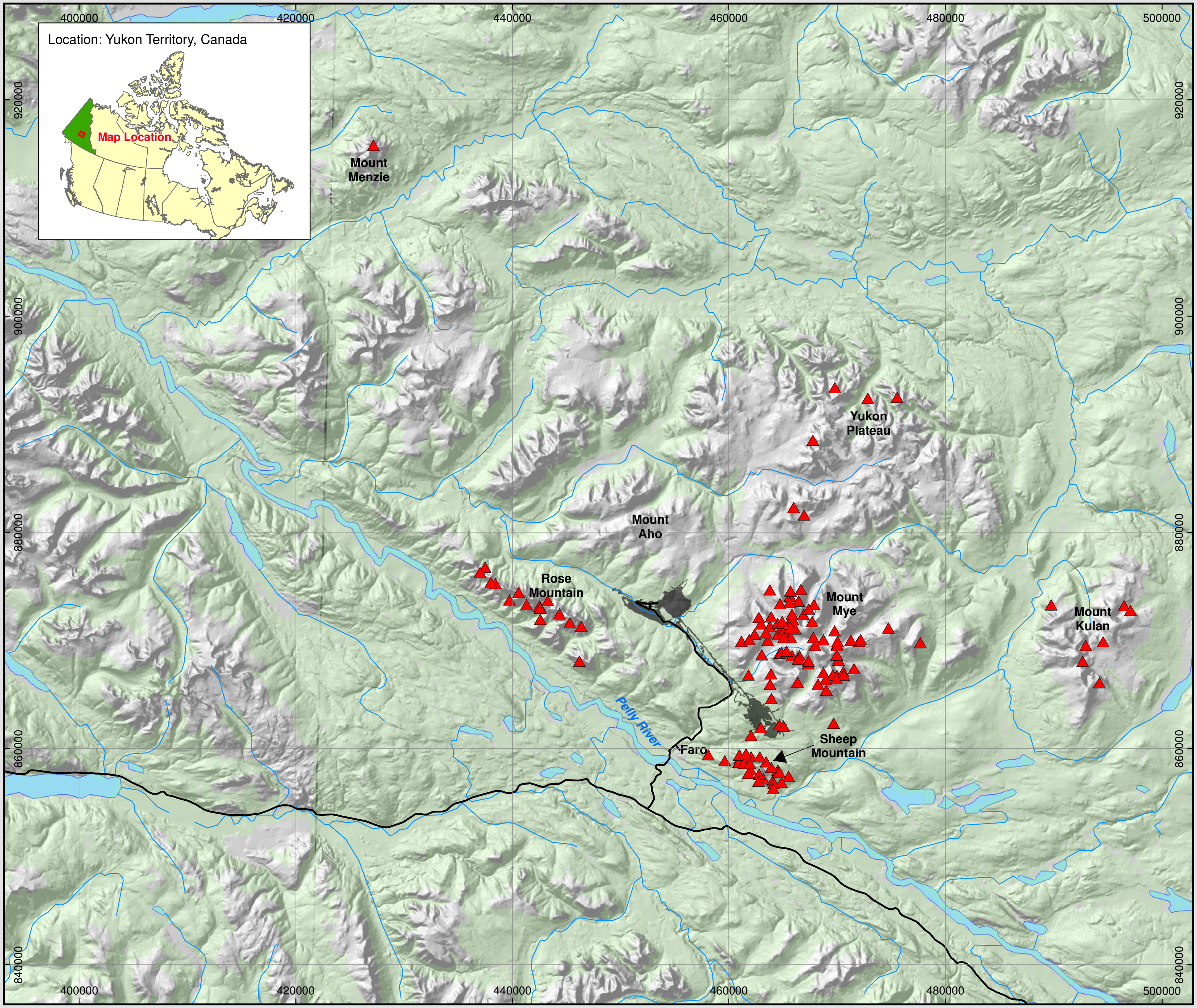
A total of 132 observational locations were obtained from 3 different sources over a span of 18 years (Table 1). A total of 1427 sheep were observed (327 Rams, 765 Ewes, 199 Lambs, 26 yearlings and 110 of unknown gender or age) using mostly aerial and some ground surveys. Ground surveys were used in additional to aerial observations to count sheep in the fall season of 1987. Observations were recorded during all seasons (spring, fall, summer and winter). Spring observations ranged from May 11 to June 26 with observations recorded in 1981 and 1997. The majority of observational data was summer observations from 11 years of records (Appendix A). Summer counts ranged from July 11 to August 25. The only fall data available was from 1987 and ranged from September 16 to October 10. Winter data was available from October 20 to March 12 in 1980 and 1987, respectively.

The majority of sheep observational locations were found on Mount Mye, Sheep Mountain and Rose Mountain, with a few occurrences on Mount Kulan and Yukon Plateau (Figure 1). Observations of sheep during the spring season was clumped in distribution with the majority of occurrences on Sheep Mountain although a few observations were made on Mount Mye and Rose Mountain (Figure 2). Summer sheep observations occurred on Mount Mye and Rose Mountain and were relatively dispersed distribution. Sheep were observed using Mount Mye, Sheep Mountain and the migration corridor between the two mountains during the fall season. Few observations of winter distribution were obtained, however sheep occurred widely dispersed on Mount Mye, Rose Mountain, Sheep Mountain and lower elevations around these mountains (Figure 2).

Table 1. Fannin Sheep Sources for Telemetry and Observation Data

Telemetry Data Sources	Year
Schweinsberg, R.E.	1990
Observation Data Sources	**Year**
Horejsi, B.L.	1998
McLeod, H.	1981
Yukon Renewable Resources. Unpublished data.	1987
Yukon Renewable Resources. Unpublished data.	1988
Yukon Renewable Resources. Unpublished data.	1989
Yukon Renewable Resources. Unpublished data.	1992
Yukon Renewable Resources. Unpublished data.	1995
Yukon Renewable Resources. Unpublished data.	1996
Yukon Renewable Resources. Unpublished data.	1997a
Yukon Renewable Resources. Unpublished data.	1997b
Yukon Renewable Resources. Unpublished data.	1998
Yukon Renewable Resources. Unpublished data.	1999

File: 70384_C1_Fig_1_AerialGroundSheepObservations_05Mar08.mxd



Legend

Existing Features
- Community
- Road

Sheep Observations
- Sighting

Boundaries
- Project Footprint
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Map Sources/Notes:
Base data obtained from the Yukon Department of Environment, Information Management & Technology Department.
Project footprint delineated by Gartner Lee Limited.
Sheep observations compiled by Gartner Lee Limited from unpublished data provided byYukon Renewable Resources.

N S W E

2.5 0 2.5 5 7.5 10 Km

1:500,000

NAD 83, Albers

Closure and Remediation Plan
For The Faro Mine Complex

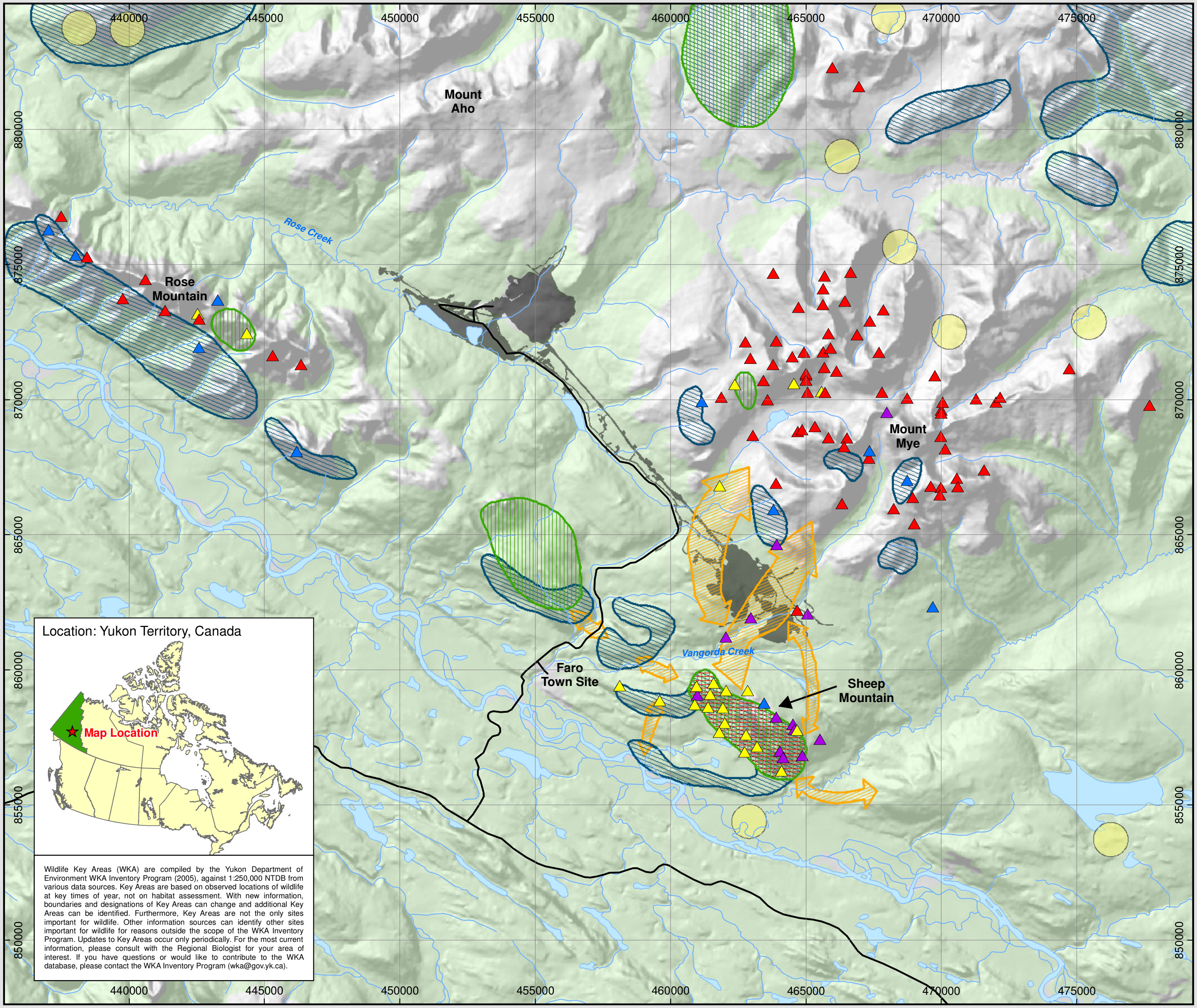
Aerial and Ground Thinhorn Sheep Observations, 1987-1999

05 March 2008

Gartner Lee

Figure 1
Version 1

File: 70384_C1_Fig_2_SeasonalSheepObservations_04Mar08.mxd



Legend

Existing Features
- Road

Seasonal Sheep Observations
- Spring
- Summer
- Fall
- Winter

Thinhorn Sheep Key Areas
- Spring Lambing
- Early Winter Rut
- Winter Range
- Movement Corridor
- Mineral Lick

Boundaries
- Project Footprint
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:250,000 scale.
Hillshade imagery and sheep key areas obtained from the Yukon Department of Environment, Information Management & Technology Department.
Project footprint delineated by Gartner Lee Limited.
Seasonal observations compiled from existing reports and unpublished data provided by Yukon Renewable Resources.

N W E S

1 0.5 0 1 2 3 4 Km

1:200,000

Yukon Albers

Closure and Remediation Plan
For The Faro Mine Complex

Seasonal Sheep Observations

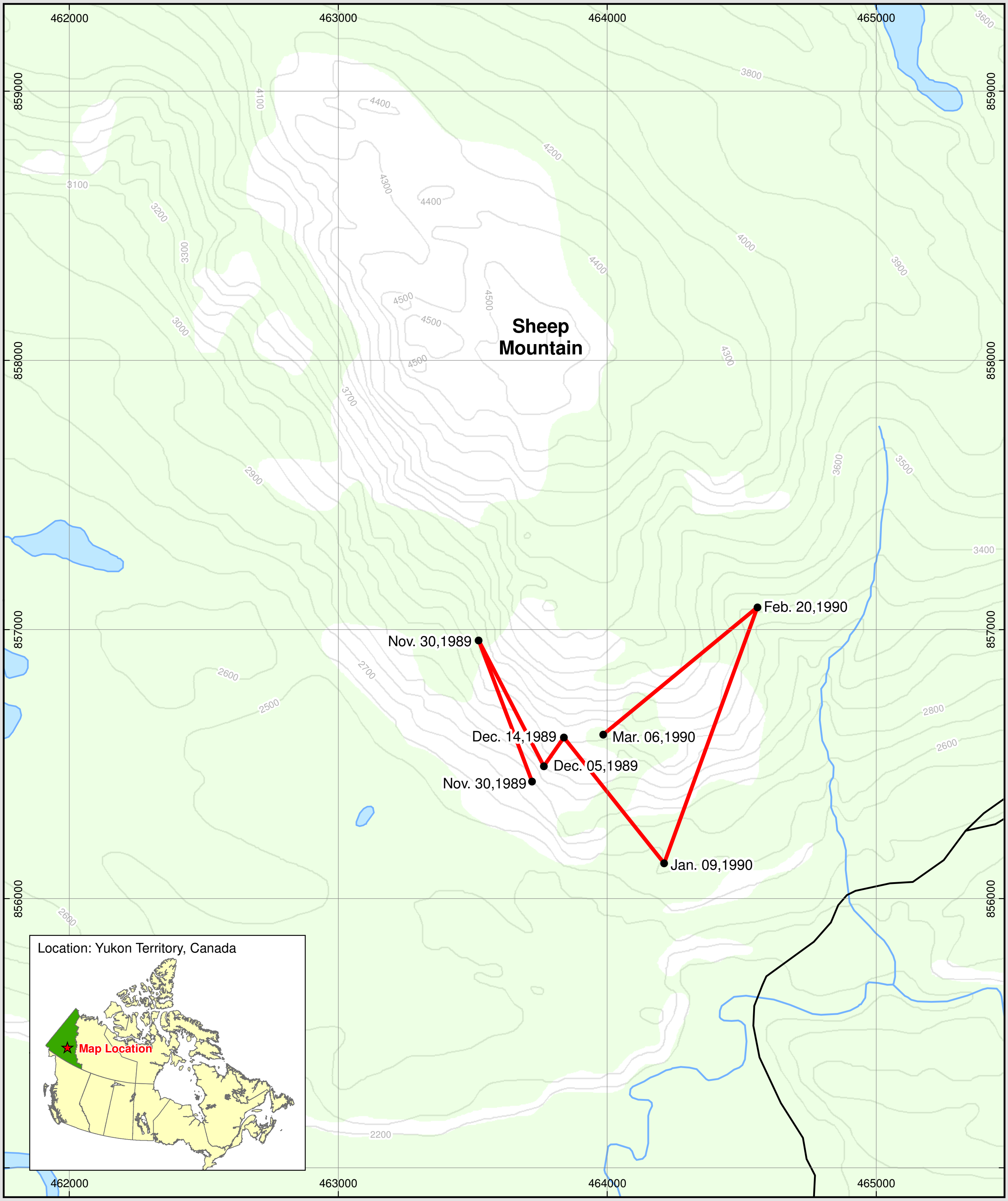
04 March 2008

Gartner Lee

Figure 2
Version 1

3.2 Telemetry Records

A total of 118 telemetry locations were obtained from 9 collared ewes (Appendix B). Age class of these individuals ranged from 4.5 to 12 years of age with telemetry data ranging from November 1989 to May 1990. Of the nine ewes collared, only one had data solely from winter season (Figure 3). This individual's distribution over the winter months was relatively clumped and occurred on the southern slopes of Sheep Mountain. Four sheep were tracked during spring season (Figure 4 to Figure 7). All these individuals were found using the southern slopes of Sheep Mountain during early spring. Two of these ewes were tracked moving to the western portion of Sheep Mountain and moving slightly higher elevations on Sheep Mountain during lambing season (Figure 4 and Figure 6). Telemetry data was obtained during winter to spring season for four ewes (Figures 8 to Figure 11). Again the majority of the movement of these collared ewes showed use of southern slopes of Sheep Mountain and clumped distribution in spring.



Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Green Collared Individual, Winter, 1989-1990

05 March 2008

Gartner Lee

Figure 3
Version 1

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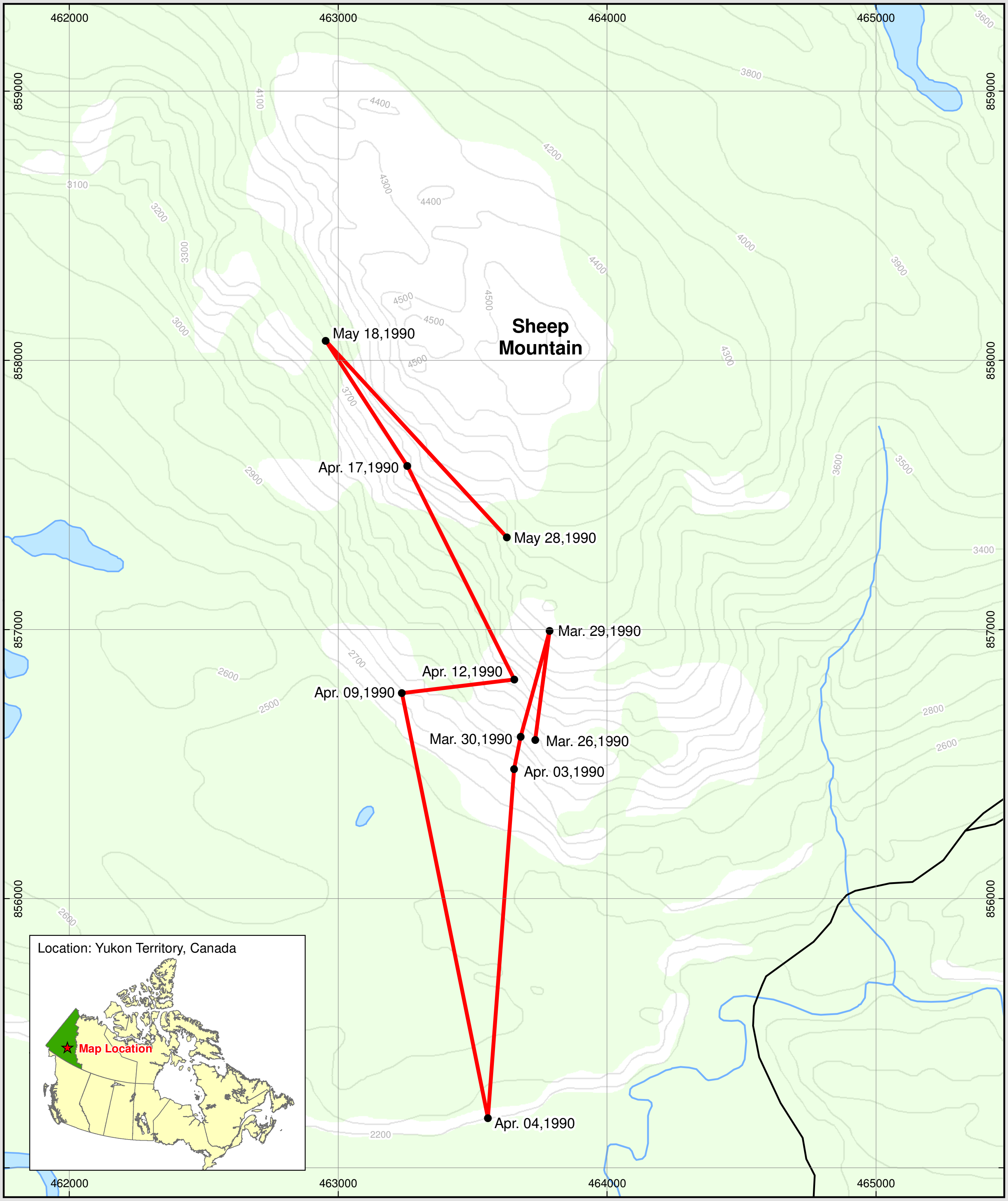


Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

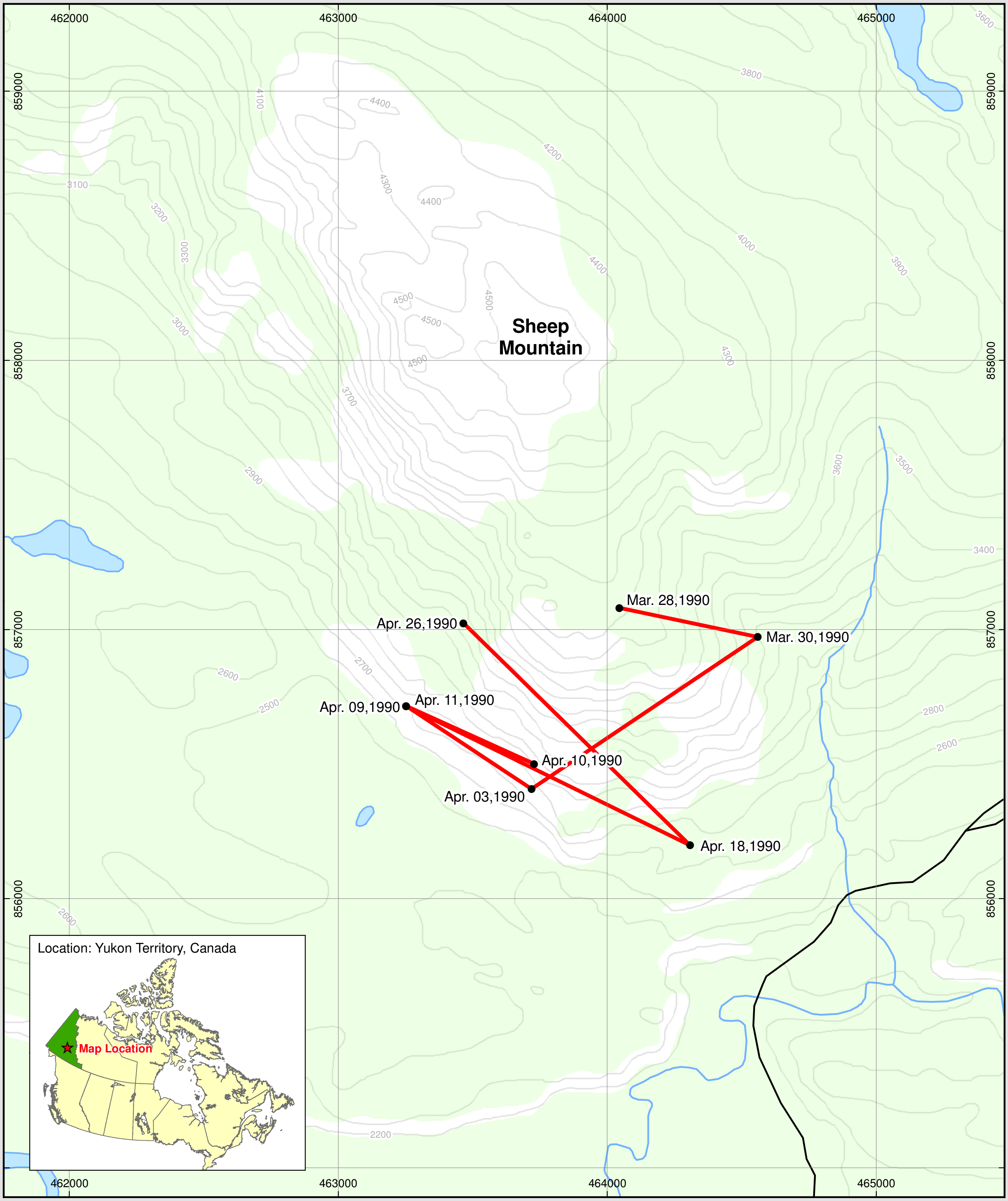
Radio-telemetry Locations, Yellow 3 Collared Individual, Spring, 1990

05 March 2008

Gartner Lee

Figure 4
Version 1

File: 70384_C1_Fig_4_Yellow3Sheep_05Mar08.mxd



Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

N
W E
S

100 0 100 200 300 400 500 Meters

1:20,000

Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Yellow 2 Collared Individual, Spring, 1990

05 March 2008

Gartner Lee

Figure 5
Version 1

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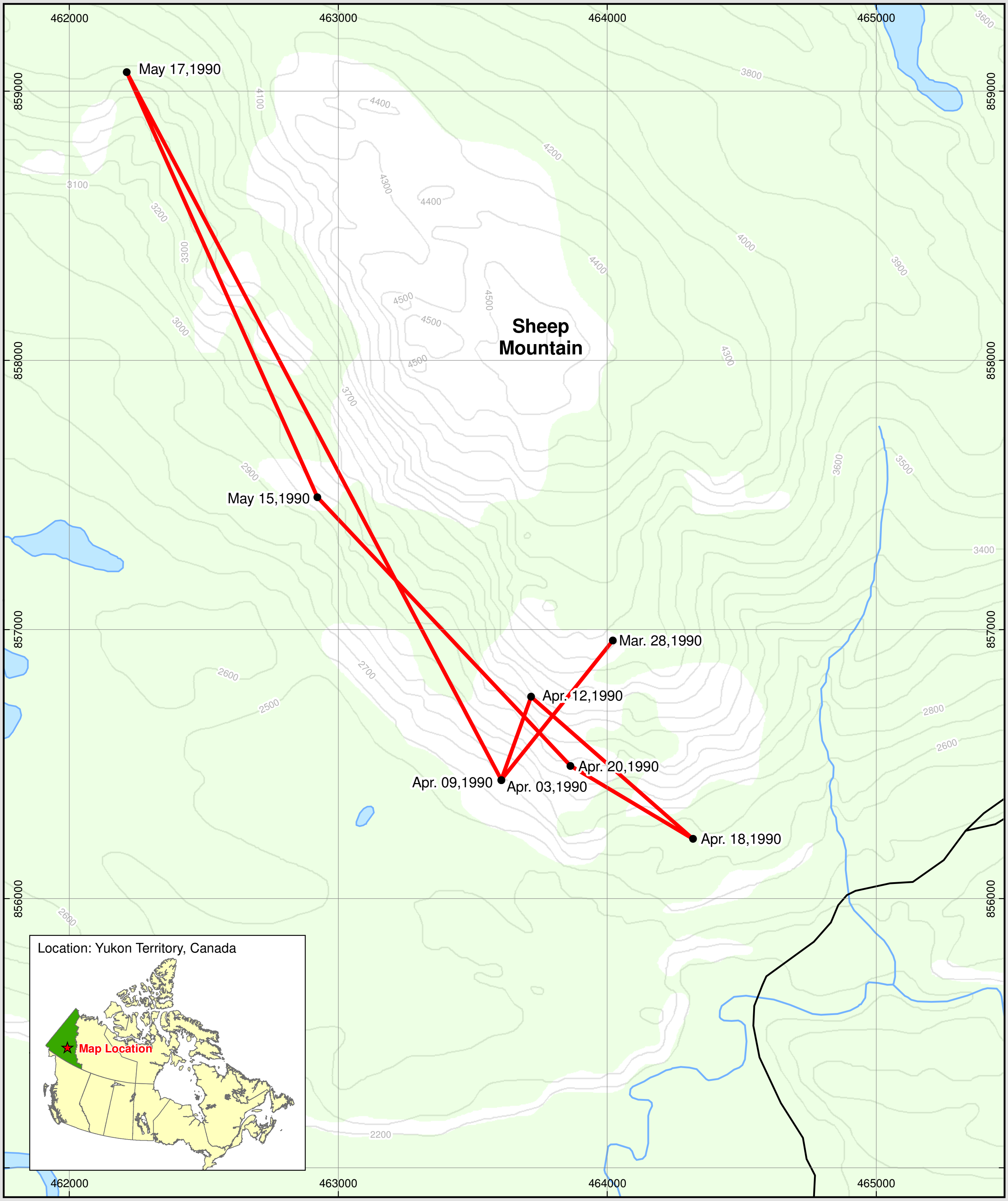

Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Yellow 0 Collared Individual, Spring, 1990

05 March 2008

Gartner Lee

Figure 6
Version 1

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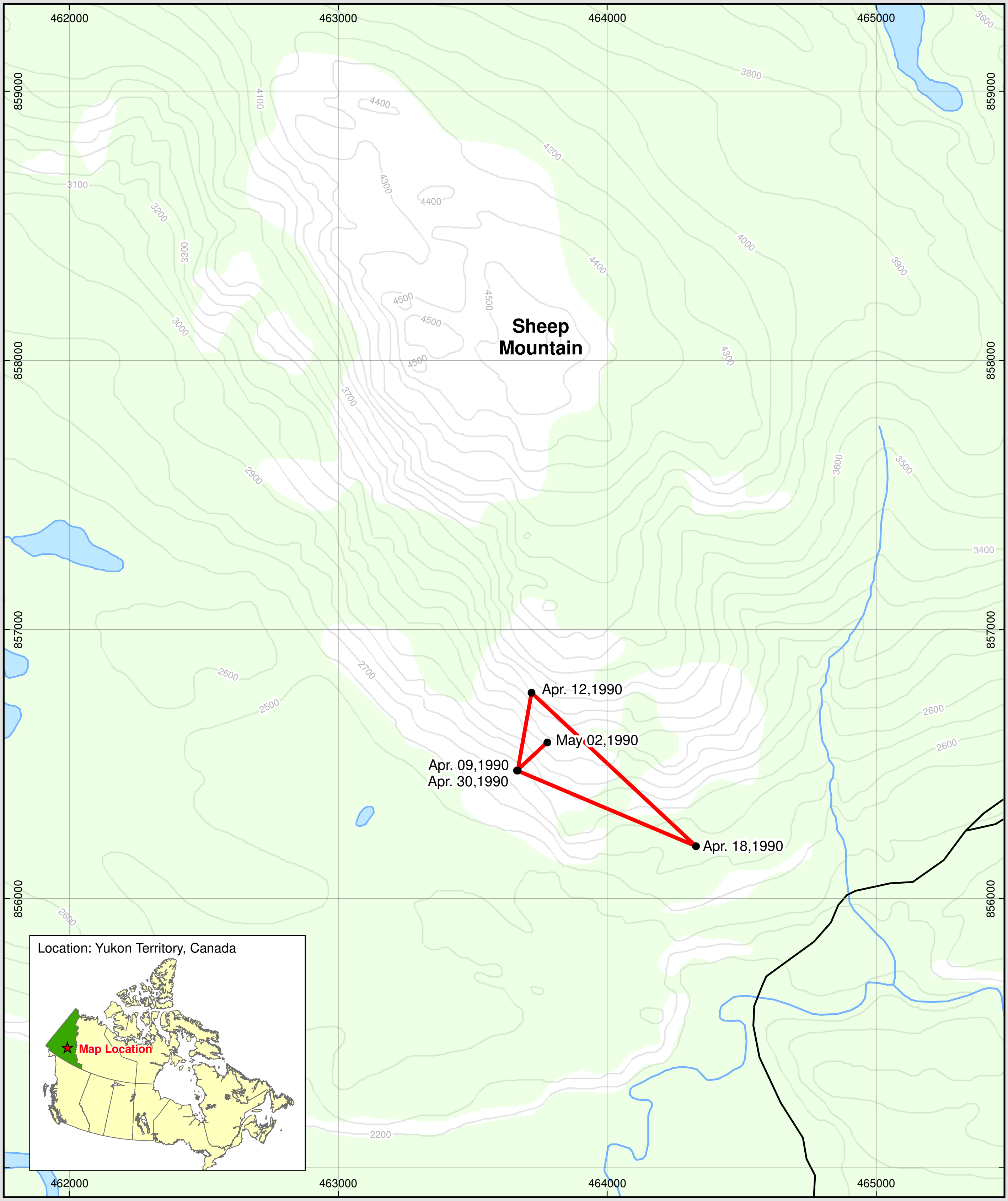

Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Yellow 4 Collared Individual, Spring, 1990

05 March 2008

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Figure 7
Version 1

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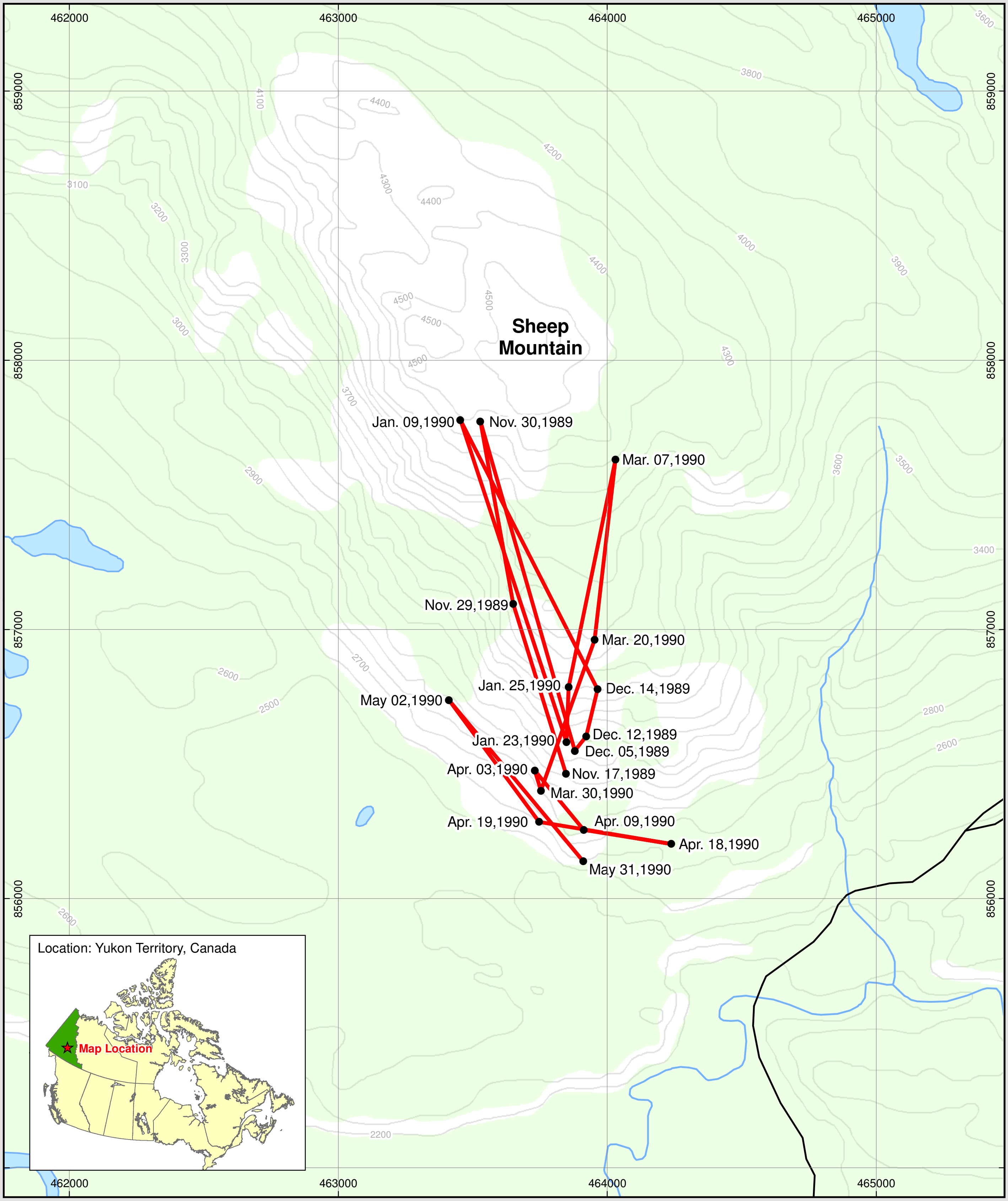

Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Yellow Collared Individual, Winter-Spring, 1989-1990

05 March 2008

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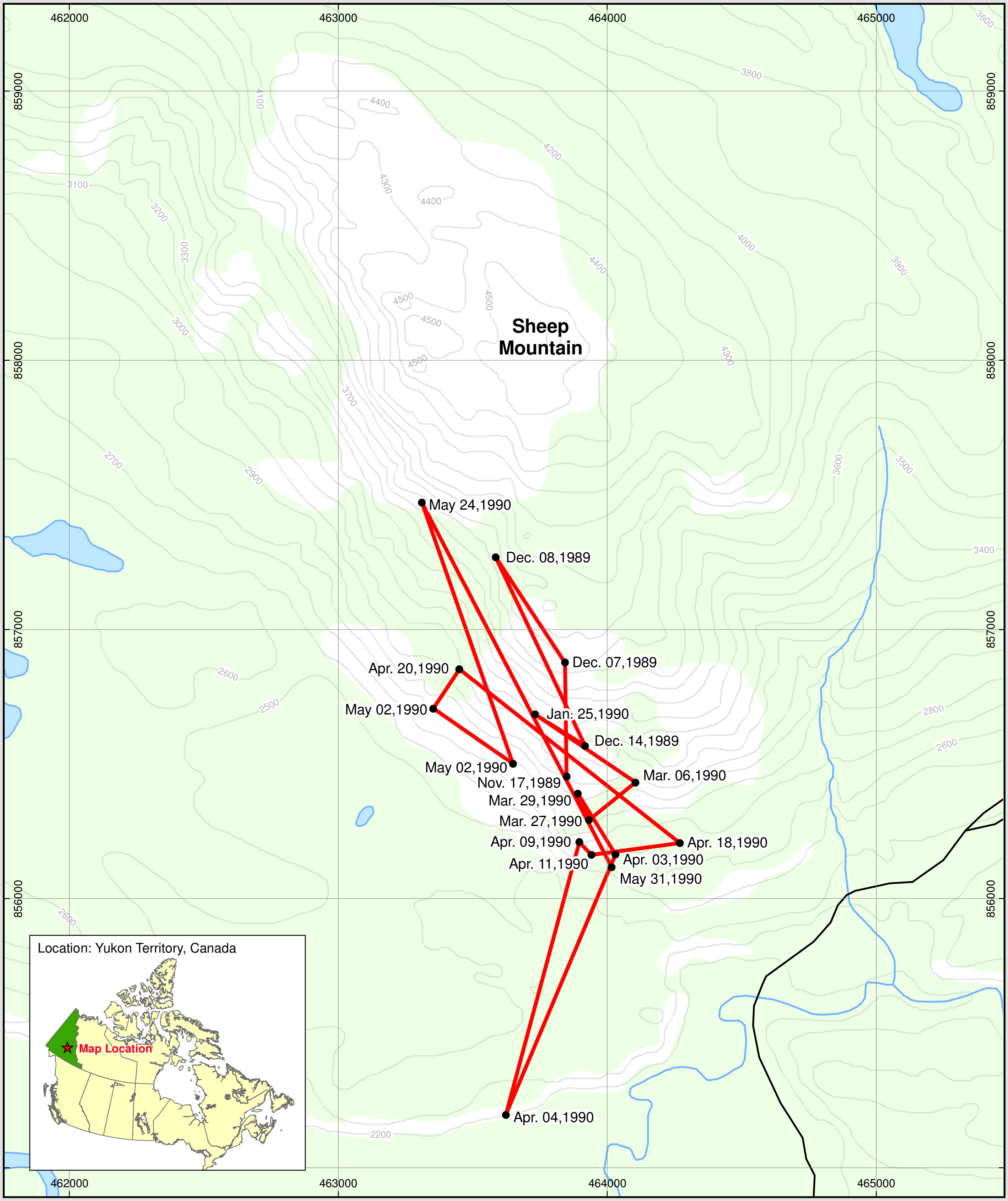
Figure 8
Version 1

File: 70384_C1_Fig_8_YellowSheep_05Mar08.mxd



Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

N
W E
S

100 0 100 200 300 400 500 Meters

1:20,000

Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Black Collared Individual, Winter-Spring, 1989-1990

05 March 2008

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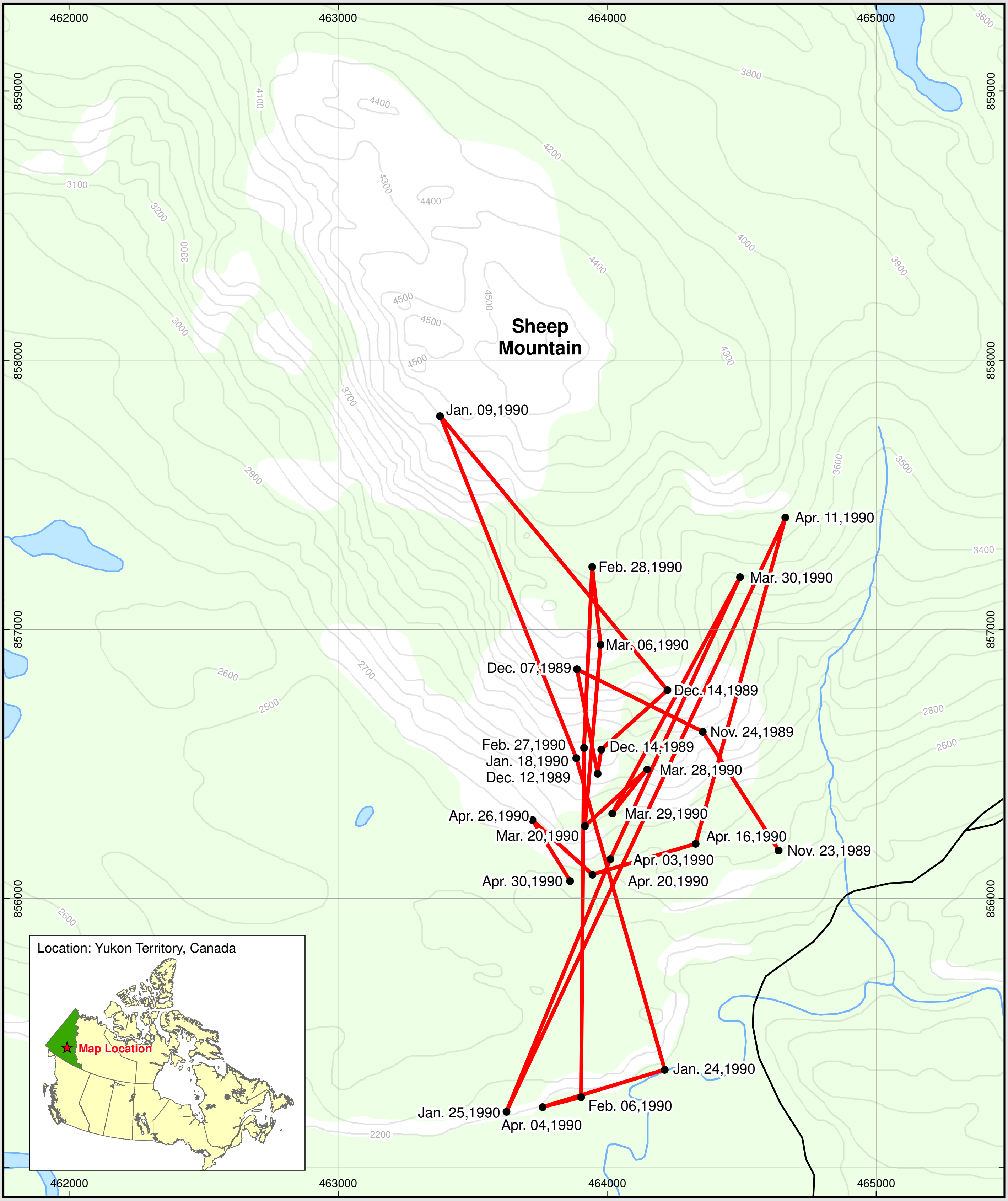
Figure 9
Version 1

File: 70384_C1_Fig_9_BlackSheep_05Mar08.mxd



Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Telemetry data reproduced from Schweinsberg, R.E., 1990.

1:20,000
Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Red Collared Individual, Winter-Spring, 1989-1990

05 March 2008

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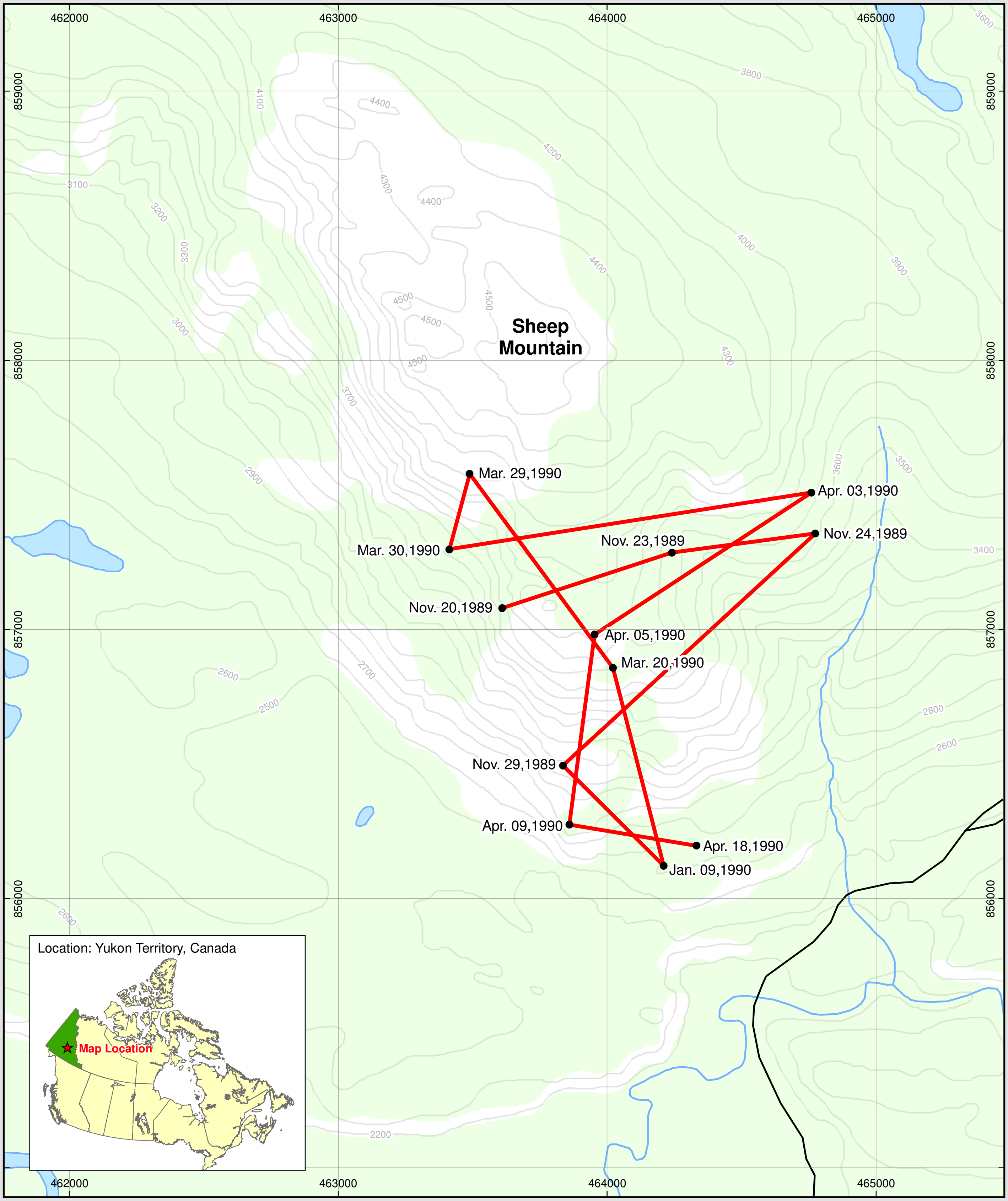
Figure 10
Version 1

File: 70384_C1_Fig_10_RedSheep_05Mar08.mxd



Map Sources/Notes:
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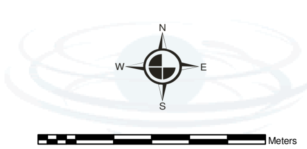
Telemetry data reproduced from Schweinsberg, R.E., 1990.



1:20,000

Yukon Albers

Legend

Existing Features
- Road

SheepTelemetry
- Sheep Location
- Sheep Movement Path

Boundaries
- Vegetation

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Radio-telemetry Locations, Yellow-green Collared Individual, WInter-Spring, 1989-1990

05 March 2008

Gartner Lee

Figure 11

Version 1

File: 70384_C1_Fig_11_YellowGreenSheep_05Mar08.mxd

4. Summary and Interpretation

4.1 Movements and Distribution

Fannin sheep in the Study Area occupy relatively distinct seasonal ranges during the early winter and rut, mid to late winter, lambing, and summer, and several identified migratory routes have been documented that link these areas in the Study Area (Gartner Lee Limited 2008). Most migratory routes and winter, early winter and rut, and spring lambing ranges have been identified as Key Wildlife Areas by the Fish and Wildlife Branch of the Department of Environment (Figure 12).

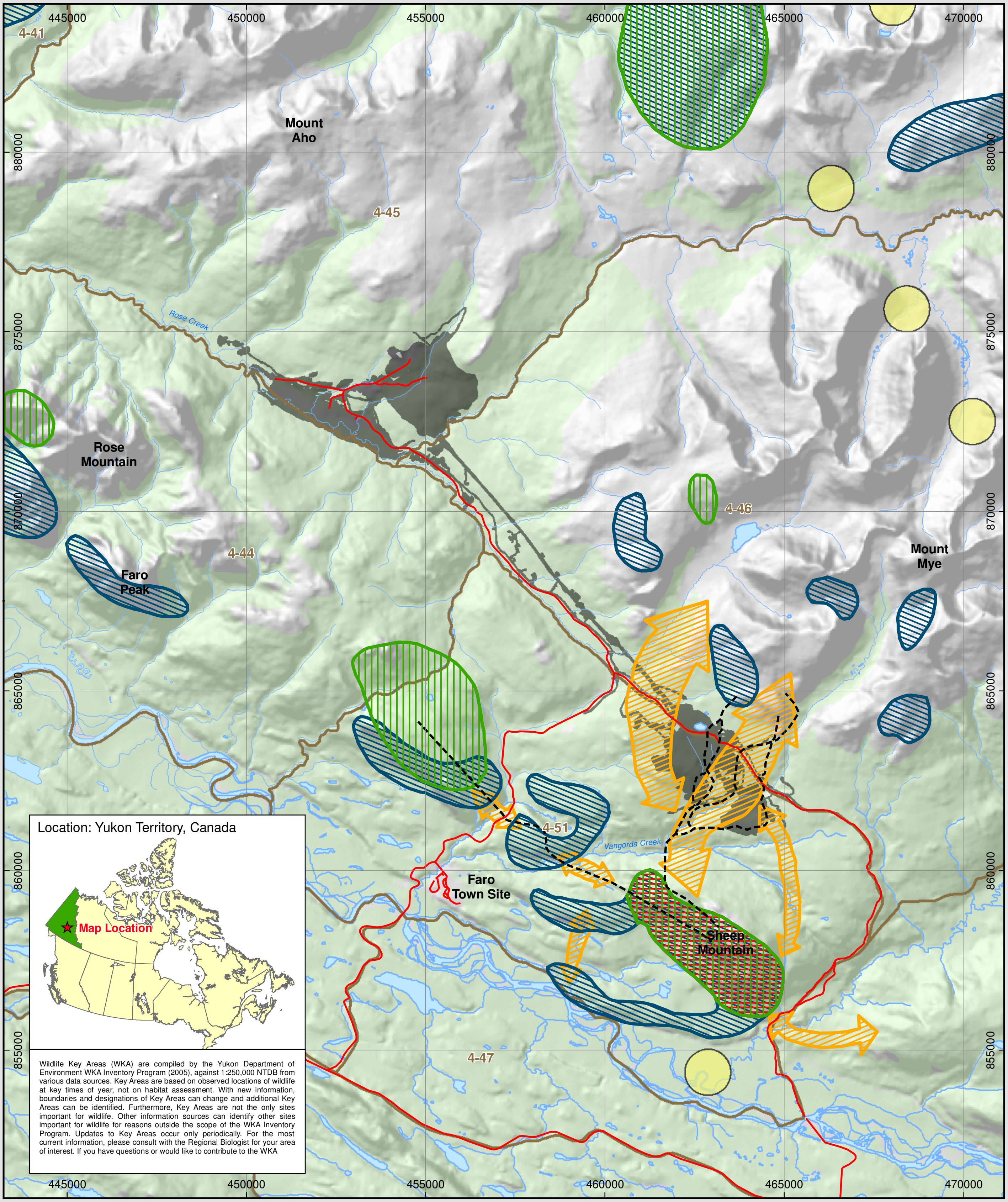
4.1.1 Seasonal Ranges

4.1.1.1 Winter Range

Winter habitat use patterns have been determined from: inferences based on habitat characteristics and local knowledge (Montreal Engineering Company Ltd. 1976); aerial counts of sheep during winter (Department of Renewable Resources, Government of Yukon 1980, 1987); inferences based on the interpretation of field sign and observations made by field worker and locals (McLeod 1981), radio tracking (nine ewes were radio tracked between 1989 and 1990), and visual observations of sheep and interviews with locals (Schweinsburg 1990).

The southern slopes of Sheep Mountain have been identified as an area of sheep winter range (Figure 12; Montreal Engineering Company Ltd. 1976; Department of Renewable Resources, Government of Yukon 1980; McLeod 1981; Department of Renewable Resources, Government of Yukon 1987; Schweinsburg 1990). Telemetry locations and field observations indicate that nursery sheep (ewes, lambs and yearlings) spent early winter on the upper slopes of Sheep Mountain while rams spent this time on the western edge of Sheep Mountain. The sheep distribution and movement patterns digitized and mapped in this report provide further support of the importance of Sheep Mountain during winter and spring season.

The southern slopes of Mount Mye have also been designated as winter range, and are the closest wintering areas to the project, within 1 km of the Grum pit. Additional wintering areas include: the windswept slopes near Blind and Swim Lakes (Schweinsburg 1990), Pelly River Bluff, 2.5km east of Faro (Schweinsburg 1990), Rose Mountain (GMS 4-43 and 4-44), and potentially areas north-east of Faro on Vangorda Creek (McLeod 1981; Schweinsburg 1990).



Map Sources/Notes:
National Topographic Database (NTDB) provided by the Government of Canada, Natural Resources Canada at 1:50,000 scale.
Hillshade imagery obtained from the Yukon Department of Environment, Information Management & Technology Department.
Project footprint delineated by Gartner Lee Limited.
Sheep key areas and game management subzones obtained from the Yukon Department of Environment, Information Management & Technology Department.

N W E S

0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 Km

1:150,000

Yukon Albers

Legend

Existing Features
- Road

Thinhorn Sheep Key Areas
- Spring Lambing
- Early Winter Rut
- Winter Range
- Movement Corridor
- Mineral Lick

Migration Routes
- Sheep Migration Route

Boundaries
- Project Footprint
- Vegetation
- Game Management Subzones

Hydrological Features
- Watercourse
- Waterbody

Closure and Remediation Plan
For The Faro Mine Complex

Key Wildlife Areas for Thinhorn Sheep

19 February 2008

Gartner Lee

Figure 12
Version 1

File: 70384_C1_Fig_12_KWAThinhornSheep_19Feb08.mxd

4.1.1.2 Lambing Range

The location of lambing areas was determined from aerial surveys; inferences based on the interpretation of field sign and observations made by field worker and locals (McLeod 1981), radio tracking (nine ewes were radio tracked between 1989 and 1990), visual observations of sheep and interviews with locals (Schweinsburg 1990).

Initial studies indicated that lambing areas on Sheep Mountain were found downslope of the early winter range (Montreal Engineering Company 1976). Schweinsburg (1990) later argued that ewes move from the lower slopes of Sheep Mountain in late winter, to lamb at higher elevations. Telemetry and observational data digitized and mapped in this report provide further evidence that the lower slopes of Sheep Mountain are used in winter and early spring whereas during late spring sheep are found at higher elevations during lambing season. There is also some indication that ewes may lamb on Mount Mye as a few observational data mapped show the use of this mountain during spring season (Schweinsburg 1990).

4.1.1.3 Summer Range

Summer distribution of sheep has also been described based on aerial surveys, radio tracking, and visual observations of sheep (Schweinsburg 1990). Sheep were generally dispersed more widely over their summer range than the winter range. A large area has been identified as summer range and includes Mount Mye (Montreal Engineering Company Ltd. 1976, McLeod 1981, Hoeffs 1988, Schweinsburg 1990), Rose Mountain (McLeod 1981), Blind Creek and Swim Lakes area (Schweinsburg 1990), Sheep Mountain and the Anvil Mine Complex (Schweinsburg 1990). The summer range is not identified as a Wildlife Key Area, perhaps because of the more general and wider distribution of sheep.

4.1.1.4 Early Winter and Rutting

Location of rutting areas was determined from visual field observations (Schweinsburg 1990). Rams were observed rutting on Sheep Mountain (Schweinsburg 1990) presumably during fall/early winter. Other rutting areas may be possible, as less study and observations have taken place during the rut, and given the relatively wide distribution of sheep in summer and the documented winter ranges, rutting is very likely not limited to Sheep Mountain.

4.1.2 Migratory/Movement Routes and Timing

Twice a year Fannin sheep migrate through the infrastructure of the Vangorda/Grum area of the Faro Mine Complex. Spring migration occurs between mid-May and late June, when Sheep migrate from their winter ranges to summering areas, often on Mount Mye (McLeod 1981; Schweinsburg 1990). Fall migration takes place in mid-September to mid-October, when sheep move from summer range to early winter and rutting areas on Sheep Mountain.

Several migration routes have been documented by studies in the area, as described in Gartner Lee Limited (2008), and depicted in Figure 12. Three such routes navigate terrain between Mount Mye and Sheep Mountain, and are used in both spring and fall (Figure 12). They include:

- The main migration route (termed Route E in McLeod (1981)) between Mount Mye and Sheep Mountain for spring and fall migration goes from Sheep Mountain to the confluence of Shrimp Lake and Vangorda Creek, crosses the haul road 1 km west of Vangorda Creek and then continues to the base of Mount Mye (Montreal Engineering Company Ltd. 1976; McLeod 1981; Horejsi 1988; Schweinsburg 1990). This route directly passes between the Vangorda and Grum deposits.

- A second route (Route F in McLeod (1981)) was also identified by Montreal Engineering Company Ltd. (1976), McLeod (1981), and Schweinsburg (1990). From Sheep Mountain, this route goes to the confluence of Shrimp Lake and Vangorda Creek, it then follows a cat road, crosses the airstrip to the site of the proposed Vangorda open pit and continues to Mount Mye via the west side of Vangorda Creek.

- A third route (Route D in McLeod (1981)) was also identified by McLeod (1981), Horejsi (1988), and Schweinsburg 1990). From Mount Mye, this route goes south from Mount Mye and crosses the haul road 1 km east of the Grum Camp. The route then follows down to the confluence of Shrimp Lake and Vangorda Creek to on to Sheep Mountain.

McLeod (1981) also identified one addition migration route (route A), which is southwest of the Study Area and runs parallel to the project, following west from Sheep Mountain along the ridge to Rose Mountain.

The observation data and telemetry data mapped within this report do not yield sufficient detail to either refute or support these mapped movement corridors described above. Data recorded in a format less spatially-specific data may have be used to document these movement corridors, and indeed four observations are noted among the fall or spring seasons that do occur within a mapped movement corridor.

5. Closing Signature Blocks

Report Prepared By:	**Report Reviewed By:**
	
Kathleen Lawrence, M.Sc.	Jesse Dunford, M. Sc., P. Biol.

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Appendix A

Aerial and Ground Observation Data of Thinhorn Sheep in the Faro Region of East Central Yukon Territory, 1980-1999

Appendix A

Aerial and Ground Observation Data of Thinhorn Sheep in the Faro Region of East Central Yukon Territory, 1980-1999

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
1	594086	6898418	Horejsi 1998.	18-Sep-87	Fall	8	0	4	3	1	0	AS	1 yearling ewe
2	594211	6898181	Horejsi 1998.	18-Sep-87	Fall	4	0	1	1	2	0	AS	2 yearling ewes
3	594532	6899434	Horejsi 1998.	18-Sep-87	Fall	22	1	14	3	4	0	AS	2 yearling ewes; 2 yearling rams; 1 ram (I)
4	594589	6899232	Horejsi 1998.	18-Sep-87	Fall	1	0	1	0	0	0	AS	
5	597542	6911090	Horejsi 1998.	18-Sep-87	Fall	13	13	0	0	0	0	AS	12 (I and II); 1 (III)
6	554943	6955715	McLeod 1981.	15-Jul-81	Summer	5	5	0	0	0	0	AS	
7	567794	6915678	McLeod 1981.	16-Jul-81	Summer	2	0	2	0	0	0	AS	
8	569172	6914194	McLeod 1981.	16-Jul-81	Summer	22	0	17	5	0	0	AS	
9	596586	6930031	McLeod 1981.	14-Jul-81	Summer	14	0	14	0	0	0	AS	
10	598430	6934974	McLeod 1981.	14-Jul-81	Summer	29	0	24	5	0	0	AS	
11	601510	6934126	McLeod 1981.	14-Jul-81	Summer	31	2	22	7	0	0	AS	
12	595555	6898909	Horejsi 1998.	16-Sep-87	Fall	14	0	8	5	1	0	GO	1 yearling ram; Some yearling ewes
13	593676	6906043	Horejsi 1998.	17-Sep-87	Fall	1	0	1	0	0	0	GO	
14	590959	6900368	Horejsi 1998.	21-Sep-87	Fall	4	0	3	0	0	1	GO	

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
15	593901	6899673	Horejsi 1998.	22-Sep-87	Fall	24	1	14	3	4	2	GO	2 yearling ewes; 2 yearling rams, 1 ram (I)
16	594521	6903651	Horejsi 1998.	10-Sep-87	Summer	2	2	0	0	0	0	GO	Unclassified ageclass
17	592819	6903304	Horejsi 1998.	22-Sep-87	Fall	3	3	0	0	0	0	GO	Unclassified ageclass
18	591924	6902559	Horejsi 1998.	05-Oct-87	Fall	2	2	0	0	0	0	GO	Unclassified ageclass
19	594912	6903525	Horejsi 1998.	10-Oct-87	Fall	3	3	0	0	0	0	GO	Unclassified ageclass
20	594923	6898286	Horejsi 1998.	18-Sep-87	Fall	2	0	1	0	1	0	AS	1 yearling ewe
21	604203	6934310	McLeod 1981.	14-Jul-81	Summer	38	0	29	9	0	0	AS	
22	595039	6923760	McLeod 1981.	14-Jul-81	Summer	1	1	0	0	0	0	AS	
23	596052	6923097	McLeod 1981.	14-Jul-81	Summer	26	26	0	0	0	0	AS	
24	599555	6911249	McLeod 1981.	14-Jul-81	Summer	4	0	3	1	0	0	AS	
25	619148	6915676	McLeod 1981.	14-Jul-81	Summer	2	0	1	1	0	0	AS	
26	623902	6908657	McLeod 1981.	14-Jul-81	Summer	6	6	0	0	0	0	AS	
27	599646	6908396	McLeod 1981.	09-Aug-80	Summer	1	1	0	0	0	0	AS	
28	601570	6911626	McLeod 1981.	09-Aug-80	Summer	13	0	8	5	0	0	AS	
29	607240	6911729	McLeod 1981.	09-Aug-80	Summer	1	1	0	0	0	0	AS	
30	604216	6912966	McLeod 1981.	09-Aug-80	Summer	5	0	3	2	0	0	AS	
31	594514	6912348	McLeod 1981.	09-Aug-80	Summer	14	0	12	2	0	0	AS	1 adult caribou
32	595435	6910065	McLeod 1981.	09-Aug-80	Summer	8	0	6	2	0	0	AS	
33	572681	6914279	McLeod 1981.	20-Oct-80	Winter	3	3	0	0	0	0	AS	
34	572064	6912506	McLeod 1981.	20-Oct-80	Winter	25	1	17	7	0	0	AS	
35	593432	6900171	McLeod 1981.	20-Oct-80	Winter	55	0	55	0	0	0	AS	Ewes,lambs,yearlings scattered across Sheep Mtn
36	588075	6900605	McLeod 1981.	11-May-81	Spring/Lambing	1	1	0	0	0	0	AS	
37	589583	6900111	McLeod 1981.	11-May-81	Spring/Lambing	1	0	1	0	0	0	AS	

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
38	591421	6900417	McLeod 1981.	11-May-81	Spring/Lambing	2	2	0	0	0	0	AS	
39	592010	6899380	McLeod 1981.	11-May-81	Spring/Lambing	4	0	4	0	0	0	AS	
40	593235	6898556	McLeod 1981.	11-May-81	Spring/Lambing	14	0	0	0	0	14	AS	Mixed Band of 14
41	594696	6899215	McLeod 1981.	11-May-81	Spring/Lambing	2	0	1	0	1	0	AS	1 yearling unclassified
42	590879	6900016	McLeod 1981.	17-May-81	Spring/Lambing	8	0	5	0	3	0	AS	3 yearlings unclassified
43	592811	6898980	McLeod 1981.	17-May-81	Spring/Lambing	2	2	0	0	0	0	AS	2 young rams
44	594178	6897684	McLeod 1981.	17-May-81	Spring/Lambing	6	0	4	0	2	0	AS	2 yearlings unclassified
45	591822	6899027	McLeod 1981.	17-May-81	Spring/Lambing	7	0	5	0	2	0	AS	2 yearlings unclassified
46	592788	6898343	McLeod 1981.	17-May-81	Spring/Lambing	6	1	3	0	2	0	AS	1 young ram, 2 yearlings unclassified
47	571966	6913739	McLeod 1981.	17-May-81	Spring/Lambing	8	0	5	0	3	0	AS	3 yearlings unclassified
48	590926	6900700	McLeod 1981.	26-May-81	Spring/Lambing	18	0	18	0	0	0	AS	Some yearlings
49	592010	6900582	McLeod 1981.	26-May-81	Spring/Lambing	14	0	14	0	0	0	AS	Some rams
50	591374	6899946	McLeod 1981.	26-May-81	Spring/Lambing	10	0	8	2	0	0	AS	Some yearlings
51	591539	6900841	McLeod 1981.	17-Jun-81	Spring/Lambing	19	0	15	4	0	0	AS	
52	591892	6911903	McLeod 1981.	17-Jun-81	Spring/Lambing	20	7	9	4	0	0	AS	7 young rams
53	573805	6913087	McLeod 1981.	17-Jun-81	Spring/Lambing	9	0	7	2	0	0	AS	
54	591921	6899944	McLeod 1981.	26-Jun-81	Spring/Lambing	19	0	15	4	0	0	AS	15 adults
55	599272	6912512	McLeod 1981.	14-Jul-81	Summer	4	0	3	1	0	0	AS	
56	570754	6913812	McLeod 1981.	16-Jul-81	Summer	22	5	17	0	0	0	AS	
57	566783	6917143	McLeod 1981.	16-Jul-81	Summer	2	0	2	0	0	0	AS	
58	575858	6912018	McLeod 1981.	16-Jul-81	Summer	4	4	0	0	0	0	AS	
59	592807	6900607	1997a*	11-Jun-97	Spring/Lambing	25	4	12	9	0	0	AS	Poor timing. Migrating from winter-summer range
60	591483	6908137	1997a*	11-Jun-97	Spring/Lambing	2	0	2	0	0	0	AS	Moving through the mining area

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
61	594074	6912024	1997a*	11-Jun-97	Spring/Lambing	2	1	1	0	0	0	AS	
62	595111	6911765	1997a*	11-Jun-97	Spring/Lambing	27	0	21	6	0	0	AS	
63	597271	6914875	1997b*	21-Aug-97	Summer	6	6	0	0	0	0	AS	3=legal; 3=3/4 curl
64	595845	6915134	1997b*	21-Aug-97	Summer	1	0	1	0	0	0	AS	
65	596018	6916214	1997b*	21-Aug-97	Summer	8	8	0	0	0	0	AS	2=legal; 6=3/4 curl
66	595025	6915566	1997b*	21-Aug-97	Summer	1	1	0	0	0	0	AS	3/4 curl
67	592217	6913493	1997b*	21-Aug-97	Summer	2	2	0	0	0	0	AS	1=1/2 curl; 1=3/4 curl
68	592433	6912888	1997b*	21-Aug-97	Summer	6	6	0	0	0	0	AS	1=legal; 5=3/4 curl
69	594506	6912413	1997b*	21-Aug-97	Summer	2	2	0	0	0	0	AS	2=3/4 curl
70	595111	6913234	1997b*	21-Aug-97	Summer	15	15	0	0	0	0	AS	
71	595629	6912542	1997b*	21-Aug-97	Summer	8	0	8	0	0	0	AS	No lambs with them
72	594290	6910253	1997b*	21-Aug-97	Summer	2	0	1	1	0	0	AS	
73	593556	6908310	1997b*	21-Aug-97	Summer	4	0	2	2	0	0	AS	
74	599273	6908420	1996*	11-Jul-96	Summer	4	3	1	0	0	0	AS	young males
75	600228	6908755	1996*	11-Jul-96	Summer	4	4	0	0	0	0	AS	young males
76	595380	6913388	1996*	11-Jul-96	Summer	34	1	25	8	0	0	AS	
77	593279	6912695	1996*	11-Jul-96	Summer	5	5	0	0	0	0	AS	young males
78	594138	6914844	1996*	11-Jul-96	Summer	13	13	0	0	0	0	AS	all legal
79	596025	6907656	1992*	25-Aug-92	Summer	9	0	6	3	0	0	AS	
80	598723	6907011	1992*	25-Aug-92	Summer	7	0	5	2	0	0	AS	
81	600276	6908444	1992*	25-Aug-92	Summer	13	13	0	0	0	0	AS	4=legal; 9=young rams
82	599559	6911143	1992*	25-Aug-92	Summer	30	0	25	5	0	0	AS	
83	597171	6913292	1992*	25-Aug-92	Summer	2	2	0	0	0	0	AS	2=legal
84	595285	6913913	1992*	25-Aug-92	Summer	3	3	0	0	0	0	AS	2=legal; 1=young ram
85	595237	6911740	1992*	25-Aug-92	Summer	23	2	19	2	0	0	AS	2=young rams
86	592634	6910044	1992*	25-Aug-92	Summer	8	0	7	1	0	0	AS	

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
87	622494	6912067	1989*	16-Aug-89	Summer	25	0	18	7	0	0	AS	
88	624092	6912456	1989*	16-Aug-89	Summer	4	0	4	0	0	0	AS	
89	625906	6915868	1989*	16-Aug-89	Summer	5	5	0	0	0	0	AS	2=legal; 3=sublegal
90	599594	6911541	1989*	16-Aug-89	Summer	7	0	5	2	0	0	AS	
91	595055	6916035	1989*	16-Aug-89	Summer	3	3	0	0	0	0	AS	2=legal; 1=sublegal
92	594519	6912167	1989*	16-Aug-89	Summer	4	4	0	0	0	0	AS	3=legal; 1=sublegal
93	596956	6909373	1989*	16-Aug-89	Summer	36	0	29	7	0	0	AS	Incl. a red and a black collared ewe
94	597939	6907540	1989*	16-Aug-89	Summer	25	0	19	6	0	0	AS	Incl. a yellow collared ewe
95	596342	6913915	1988*	20-Jul-88	Summer	5	5	0	0	0	0	AS	
96	594594	6911724	1988*	20-Jul-88	Summer	18	18	0	0	0	0	AS	
97	598622	6907984	1988*	20-Jul-88	Summer	51	0	33	18	0	0	AS	
98	599751	6909821	1988*	20-Jul-88	Summer	3	1	2	0	0	0	AS	
99	569983	6914937	1988*	20-Jul-88	Summer	46	0	0	0	0	46	AS	
100	572033	6913552	1988*	20-Jul-88	Summer	8	0	6	2	0	0	AS	
101	574789	6912303	1988*	20-Jul-88	Summer	3	2	1	0	0	0	AS	
102	622278	6910599	1988*	20-Jul-88	Summer	19	0	13	6	0	0	AS	
103	626511	6915479	1988*	20-Jul-88	Summer	14	3	10	1	0	0	AS	
104	599528	6903974	1987*	12-Mar-87	Winter	28	0	19	9	0	0	AS	
105	598398	6908607	1987*	12-Mar-87	Winter	14	8	1	5	0	0	AS	
106	596964	6909642	1987*	12-Mar-87	Winter	4	0	4	0	0	0	AS	
107	593506	6907337	1987*	12-Mar-87	Winter	8	8	0	0	0	0	AS	4=1/2 curl; 2=3/4 curl; 2=4/4 curl
108	590707	6911218	1987*	12-Mar-87	Winter	9	9	0	0	0	0	AS	5=1/2 curl; 2=3/4 curl; 2=4/4 curl
109	575817	6908796	1987*	12-Mar-87	Winter	11	0	9	2	0	0	AS	

LOCATION	EASTING	NORTHING	SOURCE	DATE	SEASON	TOTAL	RAM	EWE	LAMB	YEARLING	UNKNOWN	SURVEY METHOD	NOTES
110	567373	6915735	1987*	12-Mar-87	Winter	5	5	0	0	0	0	AS	1=1/2 curl; 4=3/4 curl
111	566338	6916629	1987*	12-Mar-87	Winter	7	7	0	0	0	0	AS	4=1/2 curl; 1=3/4 curl; 2=4/4 curl
112	599622	6908114	1995*	13-Jul-95	Summer	11	0	8	3	0	0	AS	
113	599575	6910278	1995*	13-Jul-95	Summer	6	0	4	2	0	0	AS	
114	600821	6911712	1995*	13-Jul-95	Summer	5	0	4	1	0	0	AS	
115	601715	6911806	1995*	13-Jul-95	Summer	11	0	9	2	0	0	AS	
116	598281	6911642	1995*	13-Jul-95	Summer	4	4	0	0	0	0	AS	
117	597340	6911830	1995*	13-Jul-95	Summer	2	2	0	0	0	0	AS	
118	593976	6913006	1995*	13-Jul-95	Summer	14	14	0	0	0	0	AS	
119	593130	6911383	1995*	13-Jul-95	Summer	1	1	0	0	0	0	AS	
120	594447	6910325	1995*	13-Jul-95	Summer	3	0	2	1	0	0	AS	
121	594400	6913194	1998*	18-Aug-98	Summer	3	3	0	0	0	0	AS	3=full curl
122	595176	6912653	1998*	18-Aug-98	Summer	4	4	0	0	0	0	AS	All 1/2 curl to 3/4 curl
123	594917	6910466	1998*	18-Aug-98	Summer	47	0	0	0	0	47	AS	
124	596117	6910089	1998*	18-Aug-98	Summer	6	0	5	1	0	0	AS	
125	596023	6909760	1999*	23-Jul-99	Summer	14	0	11	3	0	0	AS	
126	601221	6909101	1999*	23-Jul-99	Summer	7	0	5	2	0	0	AS	
127	596799	6914441	1999*	23-Jul-99	Summer	14	0	12	2	0	0	AS	
128	595035	6914982	1999*	23-Jul-99	Summer	2	2	0	0	0	0	AS	
129	593153	6916064	1999*	23-Jul-99	Summer	12	12	0	0	0	0	AS	
130	593365	6913571	1999*	23-Jul-99	Summer	3	3	0	0	0	0	AS	
131	591412	6911407	1999*	23-Jul-99	Summer	9	9	0	0	0	0	AS	
132	592941	6912089	1999*	23-Jul-99	Summer	11	11	0	0	0	0	AS	

AS = Aerial Survey; * Note: This sheep died on March 29, 1990.

Appendix B

Radio-telemetry Data of 9 Collared Ewes in the Faro Region of East Central Yukon Territory, 1989-1990

Appendix B

Radio-telemetry Data of 9 Collared Ewes in the Faro Region of East Central Yukon Territory, 1989-1990

LOCATION	EASTING	NORTHING	DATE	SHEEPID	SEX	AGECLASS	SOURCE
1	593794	6897853	30-Nov-89	Green	Ewe	4.5	Schweinsberg 1990
2	593575	6898369	30-Nov-89	Green	Ewe	4.5	Schweinsberg 1990
3	593836	6897912	05-Dec-89	Green	Ewe	4.5	Schweinsberg 1990
4	593906	6898020	14-Dec-89	Green	Ewe	4.5	Schweinsberg 1990
5	594298	6897569	09-Jan-90	Green	Ewe	4.5	Schweinsberg 1990
6	594607	6898532	20-Feb-90	Green	Ewe	4.5	Schweinsberg 1990
7	594052	6898038	06-Mar-90	Green	Ewe	4.5	Schweinsberg 1990
8	593920	6897887	17-Nov-89	Yellow	Ewe	6	Schweinsberg 1990
9	593699	6898510	29-Nov-89	Yellow	Ewe	6	Schweinsberg 1990
10	593550	6899182	30-Nov-89	Yellow	Ewe	6	Schweinsberg 1990
11	593950	6897974	05-Dec-89	Yellow	Ewe	6	Schweinsberg 1990
12	593990	6898028	12-Dec-89	Yellow	Ewe	6	Schweinsberg 1990
13	594025	6898205	14-Dec-89	Yellow	Ewe	6	Schweinsberg 1990
14	593476	6899185	09-Jan-90	Yellow	Ewe	6	Schweinsberg 1990
15	593917	6898005	23-Jan-90	Yellow	Ewe	6	Schweinsberg 1990
16	593918	6898209	25-Jan-90	Yellow	Ewe	6	Schweinsberg 1990
17	594059	6899061	07-Mar-90	Yellow	Ewe	6	Schweinsberg 1990
18	594007	6898388	20-Mar-90	Yellow	Ewe	6	Schweinsberg 1990
19	593829	6897821	30-Mar-90	Yellow	Ewe	6	Schweinsberg 1990
20	593803	6897894	03-Apr-90	Yellow	Ewe	6	Schweinsberg 1990
21	593994	6897681	09-Apr-90	Yellow	Ewe	6	Schweinsberg 1990
22	594322	6897641	18-Apr-90	Yellow	Ewe	6	Schweinsberg 1990
23	593827	6897705	19-Apr-90	Yellow	Ewe	6	Schweinsberg 1990
24	593473	6898142	02-May-90	Yellow	Ewe	6	Schweinsberg 1990
25	593997	6897564	31-May-90	Yellow	Ewe	6	Schweinsberg 1990
26	594725	6897633	23-Nov-89	Red	Ewe	5-6	Schweinsberg 1990
27	594424	6898063	24-Nov-89	Red	Ewe	5-6	Schweinsberg 1990
28	593947	6898276	07-Dec-89	Red	Ewe	5-6	Schweinsberg 1990
29	594039	6897892	12-Dec-89	Red	Ewe	5-6	Schweinsberg 1990

LOCATION	EASTING	NORTHING	DATE	SHEEPID	SEX	AGECLASS	SOURCE
30	594049	6897981	14-Dec-89	Red	Ewe	5-6	Schweinsberg 1990
31	594287	6898212	14-Dec-89	Red	Ewe	5-6	Schweinsberg 1990
32	593401	6899196	09-Jan-90	Red	Ewe	5-6	Schweinsberg 1990
33	593957	6897947	18-Jan-90	Red	Ewe	5-6	Schweinsberg 1990
34	594332	6896803	24-Jan-90	Red	Ewe	5-6	Schweinsberg 1990
35	593883	6896646	25-Jan-90	Red	Ewe	5-6	Schweinsberg 1990
36	594024	6896688	06-Feb-90	Red	Ewe	5-6	Schweinsberg 1990
37	593985	6897986	27-Feb-90	Red	Ewe	5-6	Schweinsberg 1990
38	593990	6898659	28-Feb-90	Red	Ewe	5-6	Schweinsberg 1990
39	594032	6898371	06-Mar-90	Red	Ewe	5-6	Schweinsberg 1990
40	593999	6897696	20-Mar-90	Red	Ewe	5-6	Schweinsberg 1990
41	594223	6897914	28-Mar-90	Red	Ewe	5-6	Schweinsberg 1990
42	594100	6897746	29-Mar-90	Red	Ewe	5-6	Schweinsberg 1990
43	594540	6898641	30-Mar-90	Red	Ewe	5-6	Schweinsberg 1990
44	594099	6897577	03-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
45	593749	6896624	04-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
46	594702	6898869	11-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
47	594414	6897646	16-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
48	594034	6897517	20-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
49	593803	6897711	26-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
50	593952	6897490	30-Apr-90	Red	Ewe	5-6	Schweinsberg 1990
51	593660	6898492	20-Nov-89	Yellow/Green*	Ewe	12	Schweinsberg 1990
52	594282	6898723	23-Nov-89	Yellow/Green*	Ewe	12	Schweinsberg 1990
53	594813	6898815	24-Nov-89	Yellow/Green*	Ewe	12	Schweinsberg 1990
54	593908	6897917	29-Nov-89	Yellow/Green*	Ewe	12	Schweinsberg 1990
55	594297	6897559	09-Jan-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
56	594080	6898286	20-Mar-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
57	593518	6898986	29-Mar-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
58	593454	6898703	30-Mar-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
59	594793	6898966	03-Apr-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
60	594007	6898408	05-Apr-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
61	593940	6897698	09-Apr-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
62	594416	6897639	18-Apr-90	Yellow/Green*	Ewe	12	Schweinsberg 1990
63	593923	6897877	17-Nov-89	Black	Ewe	8	Schweinsberg 1990
64	593900	6898299	07-Dec-89	Black	Ewe	8	Schweinsberg 1990
65	593627	6898681	08-Dec-89	Black	Ewe	8	Schweinsberg 1990
66	593987	6897994	14-Dec-89	Black	Ewe	8	Schweinsberg 1990
67	593796	6898103	25-Jan-90	Black	Ewe	8	Schweinsberg 1990
68	594181	6897865	06-Mar-90	Black	Ewe	8	Schweinsberg 1990

LOCATION	EASTING	NORTHING	DATE	SHEEPID	SEX	AGECLASS	SOURCE
69	594012	6897718	27-Mar-90	Black	Ewe	8	Schweinsberg 1990
70	593967	6897815	29-Mar-90	Black	Ewe	8	Schweinsberg 1990
71	594116	6897595	03-Apr-90	Black	Ewe	8	Schweinsberg 1990
72	593746	6896612	04-Apr-90	Black	Ewe	8	Schweinsberg 1990
73	593979	6897635	09-Apr-90	Black	Ewe	8	Schweinsberg 1990
74	594027	6897589	11-Apr-90	Black	Ewe	8	Schweinsberg 1990
75	594354	6897646	18-Apr-90	Black	Ewe	8	Schweinsberg 1990
76	593508	6898259	20-Apr-90	Black	Ewe	8	Schweinsberg 1990
77	593416	6898110	02-May-90	Black	Ewe	8	Schweinsberg 1990
78	593722	6897917	02-May-90	Black	Ewe	8	Schweinsberg 1990
79	593344	6898872	24-May-90	Black	Ewe	8	Schweinsberg 1990
80	594104	6897547	31-May-90	Black	Ewe	8	Schweinsberg 1990
81	594074	6898388	28-Mar-90	Yellow 0	Ewe	9	Schweinsberg 1990
82	593679	6897855	03-Apr-90	Yellow 0	Ewe	9	Schweinsberg 1990
83	593779	6898167	12-Apr-90	Yellow 0	Ewe	9	Schweinsberg 1990
84	594401	6897664	18-Apr-90	Yellow 0	Ewe	9	Schweinsberg 1990
85	593935	6897917	20-Apr-90	Yellow 0	Ewe	9	Schweinsberg 1990
86	592955	6898877	15-May-90	Yellow 0	Ewe	9	Schweinsberg 1990
87	592183	6900428	17-May-90	Yellow 0	Ewe	9	Schweinsberg 1990
88	593679	6897855	09-Apr-90	Yellow 0	Ewe	9	Schweinsberg 1990
89	594094	6898510	28-Mar-90	Yellow 2	Ewe	12	Schweinsberg 1990
90	594612	6898423	30-Mar-90	Yellow 2	Ewe	12	Schweinsberg 1990
91	593794	6897825	03-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
92	593315	6898115	09-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
93	593799	6897918	10-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
94	593315	6898115	11-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
95	594391	6897639	18-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
96	593516	6898430	26-Apr-90	Yellow 2	Ewe	12	Schweinsberg 1990
97	593739	6897892	09-Apr-90	Yellow 4	Ewe	8	Schweinsberg 1990
98	593779	6898183	12-Apr-90	Yellow 4	Ewe	8	Schweinsberg 1990
99	594414	6897636	18-Apr-90	Yellow 4	Ewe	8	Schweinsberg 1990
100	593736	6897892	30-Apr-90	Yellow 4	Ewe	8	Schweinsberg 1990
101	593846	6898001	02-May-90	Yellow 4	Ewe	8	Schweinsberg 1990
102	593801	6898008	26-Mar-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
103	593839	6898415	29-Mar-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
104	593746	6898018	30-Mar-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
105	593727	6897897	03-Apr-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
106	593680	6896598	04-Apr-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
107	593297	6898162	09-Apr-90	Yellow 3	Ewe	8.5	Schweinsberg 1990

LOCATION	EASTING	NORTHING	DATE	SHEEPID	SEX	AGECLASS	SOURCE
108	593714	6898229	12-Apr-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
109	593285	6899006	17-Apr-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
110	592963	6899459	18-May-90	Yellow 3	Ewe	8.5	Schweinsberg 1990
111	593666	6898755	28-May-90	Yellow 3	Ewe	8.5	Schweinsberg 1990

* Note: This sheep died on March 29, 1990.

Contaminants in Moose and Caribou in the Faro Mine Complex Area

April 30, 2008

Mary Gamberg
Gamberg Consulting
Box 10460
Whitehorse, Yukon
Y1A 7A1

Prepared for

Gartner Lee Limited
Whitehorse, Yukon

1.0 INTRODUCTION

Moose and caribou tissue samples from the Faro Mine Complex area were requested from the Arctic Moose and Caribou Contaminants Monitoring Program, based in Whitehorse, Yukon. This work, in addition to previous tissue analyses conducted as part of the *Anvil Range Mine Complex – Terrestrial Effects Study* (Gartner Lee 2006), will be integrated into the environmental assessment of the Faro Mine Complex Closure Plan being carried out by Gartner Lee Limited. All available archived (frozen) kidney, liver and muscle samples from hunting zones 4-42 to 4-46 were selected and sent to CanTest Laboratories in Burnaby BC for analysis for a suite of 26 elements.

2.0 METHODS

2.1 Samples

A total of 8 kidney, 9 liver and 8 muscle samples collected from 2005-2007 were analyzed by CanTest as summarized in Table 1.(details presented in Appendix 1).

Table 1. Numbers of Samples Analyzed

	Tay Caribou			Moose		
Year	**Kidney**	**Liver**	**Muscle**	**Kidney**	**Liver**	**Muscle**
2005	4	4	3	0	0	0
2006	2	2	2	1	2	2
2007	1	1	1	0	0	0
Total	**7**	**7**	**6**	**1**	**2**	**2**

2.2 Tissue Processing and Analysis

Kidney capsules were removed from all kidneys. In cases where the capsule was missing or torn, the kidney was rinsed with distilled water. Archived liver and muscle samples were subsampled for these analyses. All samples were kept frozen at $-20^{o}C$ until analyzed. Entire kidneys were homogenized thoroughly before being analyzed. Approximately 1 g of sample was weighed into a Teflon [TM] digestion vessel and reacted with nitric acid on a hot plate. The digested solution was then made to a final volume of 25 ml with distilled/de-ionized water. A similar amount of sample was used in the determination of sample moisture. The samples were analyzed by conventional ICP-MS, at a dilution factor of five. Each element was fully quantified against a certified standard using single point calibration. All results are provided on a dry weight basis.

2.3 Quality Assurance /Quality Control(QA/QC)

All preparation blanks should be below detection limits. Appendix 2 indicates that concentrations of aluminum, barium, calcium, magnesium and molybdenum were above detection limits. While this may cause reported values to be higher than true values, cases where the % overestimation has the potential to be high are generally when concentrations are very low, and these are only of concern if the element is toxic. For this reason, of these five elements, only aluminum needs to be viewed with some caution due to the blank data.

Standard reference materials (SRMs) should be recovered at 100%, but generally, 80-120% is considered acceptable. Appendix 3 shows several elements for which recoveries fall outside this range. Arsenic, lead and selenium had high recoveries for one of the two SRMs, but the average of each is acceptable. The recovery of silver was unacceptably high. CanTest explained the high silver recovery is due to contamination of the Teflon vessel used for digestion of the SRM. They did not expect that contamination to extend to the samples, and the low levels in the analyzed moose and caribou samples support this assumption.

Table 2. Average element concentrations in ungulates collected from the Faro Mine Complex Area (µg/g dry weight)

	Tay Caribou						**Moose**					
	Muscle		**Liver**		**Kidney**		**Muscle**		**Liver**		**Kidney**	
Years	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**
N	3	6	4	7	4	7	9	2	7	2	5	1
Aluminum	1.5	0.6	0.6	0.3	6.4	0.3	0.8	2.7	0.4	0.5	0.7	0.2
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Arsenic	0.01	0.07	0.01	0.05	0.05	0.12	<0.01	0.06	<0.01	0.08	0.05	0.29
Barium	0.17	0.14	0.33	0.28	2.04	1.58	0.11	0.24	0.34	0.59	1.20	1.38
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	<0.5	1.5	0.9	1.2	1.1	1.4	<0.5	1.6	<0.5	1.7	1.1	1.5
Cadmium	0.01	0.05	3.37	5.39	37.70	47.86	0.07	0.12	24.07	21.09	130.64	269.37
Calcium	194	188	148	146	374	369	146	203	143	114	432	398
Chromium	<0.2	<0.2	<0.2	<0.2	0.6	<0.2	0.3	<0.2	<0.2	<0.2	0.9	0.4
Cobalt	<0.01	0.02	0.29	0.31	0.29	0.30	0.02	0.04	0.29	0.17	0.28	0.29
Copper	8.42	7.72	45.10	54.68	22.63	22.7	4.65	4.57	99.73	109.69	14.58	16.60
Iron	179	121	376	271	159	147	150	110	312	397	235	194
Lead	0.06	0.05	1.67	1.05	2.49	2.86	0.01	0.34	0.05	0.08	0.07	0.14
Magnesium	753	889	571	563	692	725	832	892	488	423	749	702
Manganese	0.70	1.22	12.59	13.41	7.61	6.8	0.80	0.60	7.85	4.45	9.12	7.00
Mercury	<0.05	<0.05	0.11	0.23	0.82	1.76	<0.05	<0.05	<0.05	<0.05	0.10	0.07
Molybdenum	<0.01	0.08	1.98	1.88	0.63	0.62	0.01	0.11	2.95	2.18	1.35	1.73
Nickel	<0.05	<0.05	0.10	<0.05	0.13	<0.05	<0.05	0.11	<0.05	<0.05	0.29	<0.05
Selenium	0.6	0.5	1.1	1.1	4.9	4.0	1.4	0.5	9.9	2.9	6.0	3.6
Silver	0.098	0.160	2.181	1.389	0.096	0.58	0.079	0.716	0.601	0.172	0.063	0.184
Strontium	0.24	0.16	0.15	0.16	0.61	0.58	0.14	0.15	0.15	0.10	0.67	0.48
Thallium	<0.01	<0.01	<0.01	<0.01	0.09	0.11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Tin	<0.01	0.15	<0.01	0.03	<0.01	0.02	<0.01	0.28	<0.01	<0.01	<0.01	0.01
Uranium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vanadium	0.06	<0.05	<0.05	<0.05	0.17	0.06	<0.05	<0.05	<0.05	<0.05	0.16	0.11
Zinc	204	208	57	80	99	116.1	223	226	62	207	123	268

Table 3. Maximum element concentrations in ungulates collected from the Faro Mine Complex Area (µg/g dry weight)

	Tay Caribou						**Moose**					
	Muscle		**Liver**		**Kidney**		**Muscle**		**Liver**		**Kidney**	
Years	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**	**2004-5**	**2005-7**
N	4	6	4	7	4	7	9	2	7	2	5	1
Aluminum	2.7	2.1	1.1	0.9	21.6	0.7	1.7	3.0	1.3	1.0	1.3	0.2
Antimony	0.02	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Arsenic	0.04	0.17	0.03	0.10	0.06	0.23	0.02	0.09	0.03	0.13	0.10	0.29
Barium	0.28	0.16	0.70	0.41	2.42	2.34	0.22	0.25	0.44	0.62	1.58	1.38
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	0.8	2.1	1.1	1.8	1.3	1.7	0.9	1.7	1.2	1.8	1.5	1.5
Cadmium	0.03	0.09	6.58	9.19	84.00	87.03	0.24	0.14	68.50	36.28	182.00	269.37
Calcium	213	275	173	160	453	421	174	220	228	127	682	398
Chromium	0.4	0.3	0.2	0.3	0.7	0.4	2.3	0.2	0.7	<0.2	1.6	0.4
Cobalt	0.02	0.04	0.39	0.39	0.47	0.41	0.03	0.05	0.54	0.19	0.37	0.29
Copper	9.18	11.20	70.20	107.18	24.90	24.4	8.19	5.63	177.00	124.06	16.60	16.60
Iron	211	163	586	397	180	279	186	133	446	588	307	194
Lead	0.10	0.07	2.38	1.57	3.22	5.44	0.05	0.61	0.09	0.15	0.13	0.14
Magnesium	845	969	611	594	736	804	984	978	575	427	854	702
Manganese	2.79	2.27	14.60	15.51	8.67	7.9	2.39	0.63	15.30	5.40	19.40	7.00
Mercury	<0.05	<0.05	0.26	0.31	1.37	3.31	<0.05	<0.05	<0.05	<0.05	0.37	0.07
Molybdenum	<0.01	0.26	2.55	2.58	1.00	1.00	0.03	0.23	4.35	2.59	2.01	1.73
Nickel	0.05	<0.05	0.16	<0.05	0.22	0.08	0.05	0.22	0.12	<0.05	0.88	<0.05
Selenium	0.8	0.8	1.4	1.4	5.6	4.9	2.9	0.6	23.6	4.9	8.6	3.6
Silver	0.149	0.394	3.210	1.798	0.205	1.84	0.393	1.165	1.450	0.210	0.120	0.184
Strontium	0.38	0.19	0.19	0.20	0.78	0.79	0.34	0.17	0.27	0.11	1.40	0.48
Thallium	<0.01	<0.01	<0.01	0.02	0.10	0.23	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Tin	0.02	0.72	<0.01	0.13	<0.01	0.07	0.03	0.51	0.02	<0.01	0.00	0.01
Uranium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.000	<0.005
Vanadium	0.11	0.08	0.08	0.08	0.19	0.11	0.09	0.05	0.10	<0.05	0.22	0.11
Zinc	245	276	71	94	131	128.2	271	256	105	360	130	268

3.0 RESULTS AND DISCUSSION

Element concentrations in kidney, liver and muscle of moose and caribou analyzed in this project are presented in Appendix 4 and a comparison between previously collected data (2004-5) and current data (2005-7) are presented in Tables 2 and 3. Reported concentrations below the detection limit were taken at a randomly generated number between zero and the detection limit for statistical analyses.

Although low sample numbers precluded a reasonable statistical comparison, most elements did not change from levels found in moose and caribou from this area collected in 2004-5 (Tables 2 and 3). Beryllium and uranium remained below detection limits in all samples. Average vanadium and chromium remained the same or declined slightly. Average antimony, barium, boron, calcium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, thallium and tin all varied slightly between collections in one or more tissues, but not consistently, and all remained close to the range shown by the nearby Finlayson caribou and moose collected from the Yukon in general (Tables 4 and 5).

Aluminum in moose muscle increased from the previous collection (0.8 μg/g) to the current collection (2.7 μg/g). However, no increases were seen in other moose tissues or in any caribou tissues. Noting that the laboratory analytical blank did have a measurable aluminum concentration and that there are only two moose muscle samples for this analysis suggests that this may be an anomaly.

Arsenic increased slightly in all tissues from both moose and caribou (Tables 2 and 3). Although these increases were slight, the consistency of the trend suggests that it may be useful to monitor this element in these species. It should be noted that the concentrations measured in the latest analysis are still less than seen in Finlayson caribou and moose collected from the Yukon in general (Tables 4 and 5).

Cadmium increased in all tissues except moose liver (Tables 2 and 3). This may be due to an increase in cadmium intake from the environment, but is more likely related to the average age of the animals. Cadmium is known to accumulate with age in animals (Kjellström 1986). In the previous collection, the average caribou age was 3 years and in the current collection was 4 years and the increase in cadmium was relatively small. In the previous collection, the average moose age was 4 years and in the current collection it was 8. The corresponding increase in cadmium concentrations was somewhat larger. It should be noted that the concentrations measured in the latest analysis are still less than seen in Finlayson caribou and moose collected from the Yukon in general (Tables 4 and 5).

Previous work on the terrestrial effects of the Faro Mine Complex concluded that lead was significantly elevated in the tissues of wildlife living near the mine complex and that caribou appeared to be the ungulate species most affected by lead (Gartner Lee 2006). However, the current analyses shows an increase in lead concentrations in all moose tissues from the previous collection and moreover shows that the current lead concentrations in moose from the mine area are higher than the average for Yukon-wide moose (Table 5). Lead concentrations declined slightly in caribou muscle and liver, but increased slightly in caribou kidney, suggesting that the levels are relatively stable (Tables 2 and 3). It is difficult to draw strong conclusions based on the current moose data because there are so few data (N=2). It is recommended to continue to monitor moose and caribou in this area for lead.

Table 4. Average element concentrations in Tay caribou collected from the Faro Mine Complex Area compared with Finlayson caribou (μg/g dry weight)

	Woodland Caribou								
	Muscle			**Liver**			**Kidney**		
	Tay		**Finlayson**	**Tay**		**Finlayson**	**Tay**		**Finlayson**
Years	**2004-5**	**2005-7**		**2004-5**	**2005-7**		**2004-5**	**2005-7**	
Antimony	<0.01	<0.01	0.164	<0.01	<0.01	0.06	<0.01	<0.01	0.083
Arsenic	0.01	0.07	0.34	0.01	0.05	0.142	0.05	0.12	0.254
Barium	0.17	0.14	0.408	0.33	0.28	0.452	2.04	1.58	3.85
Cadmium	0.01	0.05	0.121	3.37	5.39	10.687	37.70	47.86	148.46
Chromium	<0.2	<0.2	0.496	<0.2	<0.2	0.781	0.6	<0.2	0.80
Cobalt	<0.01	0.02	0.204	0.29	0.31	0.384	0.29	0.30	0.307
Copper	8.42	7.72	10.942	45.10	54.68	73.638	22.63	22.7	23.31
Iron	179	121	161.5	376	271	947	159	147	177.2
Lead	0.06	0.05	0.198	1.67	1.05	0.589	2.49	2.86	0.67
Mercury	<0.05	<0.05	0.05	0.11	0.23	0.595	0.82	1.76	3.488
Nickel	<0.05	<0.05	0.451	0.10	<0.05	0.186	0.13	<0.05	0.45
Selenium	0.6	0.8	1.283	1.1	1.4	1.395	4.9	4.9	5.78
Silver	0.098	0.160	0.014	2.181	1.389	1.868	0.096	0.58	0.04
Thallium	<0.01	<0.01	0.22	<0.01	<0.01	0.052	0.09	0.11	0.091
Zinc	204	208	171.167	57	80	87.164	99	116.1	135.9

Table 5. Average element concentrations in moose collected from the Faro Mine Complex Area compared with moose collected around the Yukon (μg/g dry weight)

	Moose								
	Muscle			**Liver**			**Kidney**		
	Faro Mine		**Yukon**	**Faro Mine**		**Yukon**	**Faro Mine**		**Yukon**
Years	**2004-5**	**2005-7**		**2004-5**	**2005-7**		**2004-5**	**2005-7**	
Antimony	<0.01	0.02	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	<0.01	0.06	0.17	<0.01	0.08	0.08	0.05	0.29	0.31
Barium	0.11	0.24	0.15	0.34	0.59	0.69	1.20	1.38	1.2
Cadmium	0.07	0.12	0.11	24.07	21.09	14.6	130.64	269.37	136
Chromium	0.3	<0.2	1.03	<0.2	<0.2	1.5	0.9	0.4	1.07
Cobalt	0.02	0.04	0.08	0.29	0.17	0.36	0.28	0.29	0.48
Copper	4.65	4.57	5.74	99.73	109.69	105.3	14.58	16.60	17.1
Iron	150	110	130	312	397	497	235	194	242
Lead	0.01	0.34	0.16	0.05	0.08	0.07	0.07	0.14	0.1
Mercury	<0.05	<0.05	0.09	<0.05	<0.05	0.06	0.10	0.07	<0.05
Nickel	<0.05	0.11	0.19	<0.05	<0.05		0.29	<0.05	0.54
Selenium	1.4	0.6	1.1	9.9	4.9	4.6	6.0	3.6	5
Silver	0.079	0.716	<0.005	0.601	0.172	0.326	0.063	0.184	<0.005
Thallium	<0.01	<0.01	0.07	<0.01	<0.01	0.01	<0.01	<0.01	0.03
Zinc	223	226	210	62	207	98.7	123	268	141

Mercury remained virtually the same in all moose tissues and in caribou muscle, but increased in both caribou liver and kidney (Tables 2 and 3). This may reflect a global increase in atmospheric mercury that has been reflected in a number of wildlife species, including the Porcupine caribou (CACAR 2003). This increase was not seen in moose, which are at a lower risk of mercury contamination because they do not eat lichen (a major route of contamination for caribou).

Although selenium is known to decrease with increasing concentrations of mercury in tissues (Weiner et al. 2002), these data do not demonstrate that relationship. Selenium concentrations remained the same, or decreased since the first sampling period (Tables 2 and 3). Current selenium concentrations in moose and caribou from this area fall in the 'adequate to high' range for domestic cattle (Puls 1994). Although it is difficult to extrapolate from domestic to wild animals, this suggests at least that selenium is likely not deficient in the diet of the caribou, and is likely adequate for their physiological requirements. There is a possibility that selenium concentrations may be high enough to be of concern in terms of toxicity in the caribou, but given the lack of toxicity data on selenium and caribou specifically, it would be a tenuous conclusion.

Silver concentrations were somewhat erratic, particularly in kidney tissue, but were more consistent in liver tissue (Appendix 4). For both caribou and moose, the average concentrations of silver in liver tissue were lower than the levels found in the Finlayson caribou and Yukon-wide moose respectively (Tables 4 and 5).

Zinc concentrations increased in all tissues from both moose and caribou from the previous collection to the current one (Tables 2 and 3). Zinc levels from the current collections exceeded concentrations found in Yukon-wide moose for all moose tissues (Tables 4 and 5). Although little data exists for toxicity levels of elements in wildlife, the concentrations measured in moose and caribou from this fall into the high/toxic range for domestic cattle (Puls 1994) and are therefore of concern. It is recommended to continue to monitor moose and caribou in this area for zinc.

4.0 CONCLUSIONS and RECOMMENDATIONS

Concentrations of arsenic and zinc appear to be increasing in moose and caribou from the Faro Mine area. Lead concentrations appear to be increasing in moose, while mercury concentrations seem to be increasing in caribou from the area. It is recommended to continue monitoring moose and caribou from the Faro Mine Complex for arsenic, lead, mercury and zinc.

5.0 REFERENCES

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Appendix 1. Collection data for analyzed samples.

ID	Species	Tissue	Year	Gender	Age	Zone	Subzone
22591	Caribou	Kidney	2005	M	3	4	45
22592	Caribou	Kidney	2005	M	5	4	45
22593	Caribou	Kidney	2005	M	3	4	45
22615	Caribou	Kidney	2005	M		4	45
26293	Caribou	Kidney	2006	M		4	45
26531	Caribou	Kidney	2006	M		4	46
27589	Caribou	Kidney	2007	M		4	46
22591	Caribou	Liver	2005	M	3	4	45
22592	Caribou	Liver	2005	M	5	4	45
22593	Caribou	Liver	2005	M	3	4	45
22615	Caribou	Liver	2005	M		4	45
26293	Caribou	Liver	2006	M		4	45
26531	Caribou	Liver	2006	M		4	46
27589	Caribou	Liver	2007	M		4	46
22591	Caribou	Muscle	2005	M	3	4	45
22592	Caribou	Muscle	2005	M	5	4	45
22593	Caribou	Muscle	2005	M	3	4	45
26293	Caribou	Muscle	2006	M		4	45
26531	Caribou	Muscle	2006	M		4	46
27589	Caribou	Muscle	2007	M		4	46
26627	Moose	Kidney	2006	M	8	4	42
25660	Moose	Liver	2006	M		4	42
26627	Moose	Liver	2006	M	8	4	42
25660	Moose	Muscle	2006	M		4	42
26627	Moose	Muscle	2006	M	8	4	42

Appendix 2. Detection limits and element concentrations of preparation blanks.

Element	Detection limit (µg/l)	Prep. Blank
Aluminum	0.10	0.17
Antimony	0.01	<0.01
Arsenic	0.01	<0.01
Barium	0.01	0.05
Beryllium	0.01	<0.01
Boron	0.5	<0.5
Cadmium	0.01	<0.01
Calcium	1.0	8.8
Chromium	0.2	<0.2
Cobalt	0.01	<0.01
Copper	0.06	0.06
Iron	0.5	<0.5
Lead	0.01	<0.01
Magnesium	0.10	0.13
Manganese	0.01	<0.01
Mercury	0.05	<0.05
Molybdenum	0.01	0.03
Nickel	0.05	<0.05
Selenium	0.1	<0.1
Silver	0.005	<0.005
Strontium	0.01	<0.01
Thallium	0.01	<0.01
Tin	0.01	<0.01
Uranium	0.005	<0.005
Vanadium	0.05	<0.05
Zinc	0.1	<0.1

Appendix 3. Recoveries of Standard Reference Materials (DL = Detection limit). Recoveries calculated only when measured value was greater than 10 x DL.

		DOLT 3			NIST 2976			
Element	**DL**	**AN81dolt**	**Certified values**	**% Recovery**	**AN81 nist 2976**	**Certified values**	**% Recovery**	**Average % Recovery**
Arsenic	0.01	10.96	10.2	**107**	16.63	13.3	**125**	**116**
Cadmium	0.01	18.97	19.4	**98**	0.83	0.82	**101**	**100**
Copper		30.65	31.2	**98**	3.91	4.02	**97**	**98**
Iron	0.5	1590.00	1484	**107**	201.43	171	**118**	**112**
Lead	0.01	0.39	0.319	**122**	1.19	1.19	**100**	**111**
Mercury	0.05	3.37	3.37	**100**	0.11	0.061		**100**
Nickel	0.05	2.41	2.72	**89**	0.72			**89**
Selenium	0.1	7.60	7.06	**108**	2.30	1.8	**128**	**118**
Silver	0.005	42.91	1.2	**3576**	0.17			**3576**
Zinc	0.1	86.97	86.6	**100**	132.14	137	**96**	**98**

Appendix 4. Element concentrations in moose and caribou tissues (μg/g dry weight).

Sample ID	Species	Tissue	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium
22591	Caribou	Kidney	<0.1	<0.01	0.08	1.57	<0.01	1.3	26.0	323	0.3
22592	Caribou	Kidney	0.7	<0.01	0.09	1.53	<0.01	1.0	53.5	421	<0.2
22593	Caribou	Kidney	0.2	<0.01	0.12	1.95	<0.01	1.3	36.7	351	0.2
22615	Caribou	Kidney	0.5	<0.01	0.07	1.03	<0.01	1.5	87.0	324	0.2
26293	Caribou	Kidney	<0.2	<0.01	0.05	2.34	<0.01	1.3	45.6	419	<0.2
26531	Caribou	Kidney	0.4	<0.01	0.23	1.35	<0.01	1.4	63.1	392	0.2
27589	Caribou	Kidney	0.6	<0.01	0.17	1.30	<0.01	1.7	23.0	354	0.4
22591	Caribou	Liver	0.6	<0.01	0.06	0.37	<0.01	0.8	3.03	160	<0.2
22592	Caribou	Liver	<0.1	<0.01	0.06	0.16	<0.01	1.3	5.88	146	0.2
22593	Caribou	Liver	0.2	<0.01	0.04	0.28	<0.01	1.2	4.74	147	<0.2
22615	Caribou	Liver	<0.1	<0.01	0.04	0.16	<0.01	1.3	7.27	135	<0.2
26293	Caribou	Liver	0.3	<0.01	0.03	0.41	<0.01	1.8	4.56	130	<0.2
26531	Caribou	Liver	0.9	<0.01	0.10	0.23	<0.01	1.0	9.19	152	0.3
27589	Caribou	Liver	0.4	<0.01	0.06	0.35	<0.01	1.1	3.04	154	<0.2
22591	Caribou	Muscle	0.1	<0.01	0.05	0.14	<0.01	1.2	0.02	149	<0.2
22592	Caribou	Muscle	<0.1	<0.01	0.03	0.12	<0.01	1.2	0.09	185	<0.2
22593	Caribou	Muscle	0.5	<0.01	0.02	0.13	<0.01	1.7	0.07	275	<0.2
26293	Caribou	Muscle	0.8	<0.01	0.08	0.16	<0.01	1.4	0.04	135	<0.2
26531	Caribou	Muscle	2.1	<0.01	0.17	0.16	<0.01	2.1	0.03	220	0.3
27589	Caribou	Muscle	<0.1	<0.01	0.08	0.14	<0.01	1.6	0.03	162	0.2
26627	Moose	Kidney	0.2	<0.01	0.29	1.38	<0.01	1.5	269	398	0.4
25660	Moose	Liver	<0.1	<0.01	0.02	0.62	<0.01	1.6	5.90	101	<0.2
26627	Moose	Liver	1.0	<0.01	0.13	0.56	<0.01	1.8	36.3	127	<0.2
25660	Moose	Muscle	3.0	0.01	0.03	0.23	<0.01	1.5	0.14	186	0.2
26627	Moose	Muscle	2.3	0.03	0.09	0.25	<0.01	1.7	0.10	220	<0.2

Appendix 4. (continued)

Sample ID	Species	Tissue	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel
22591	Caribou	Kidney	0.25	23.9	141	3.25	735	7.12	1.94	0.29	<0.05
22592	Caribou	Kidney	0.33	22.3	150	5.44	675	7.90	1.57	0.45	<0.05
22593	Caribou	Kidney	0.18	21.6	101	4.72	699	6.13	3.31	0.41	<0.05
22615	Caribou	Kidney	0.40	22.3	279	0.97	637	6.80	1.89	0.82	<0.05
26293	Caribou	Kidney	0.21	21.5	143	2.54	783	5.98	0.75	0.48	<0.05
26531	Caribou	Kidney	0.41	24.4	98.5	1.74	743	7.48	1.53	0.85	0.08
27589	Caribou	Kidney	0.32	22.6	120	1.35	804	5.92	1.34	1.00	<0.05
22591	Caribou	Liver	0.28	79.4	388	1.23	580	12.0	0.24	1.35	<0.05
22592	Caribou	Liver	0.39	53.6	172	1.57	594	15.5	0.19	1.79	<0.05
22593	Caribou	Liver	0.16	107	147	1.18	521	13.8	0.23	1.32	<0.05
22615	Caribou	Liver	0.38	19.6	343	0.42	508	11.1	0.31	2.20	<0.05
26293	Caribou	Liver	0.26	39.1	190	1.27	581	13.6	0.13	1.91	<0.05
26531	Caribou	Liver	0.38	38.1	262	0.92	575	12.6	0.24	1.98	<0.05
27589	Caribou	Liver	0.35	45.9	397	0.79	583	15.3	0.29	2.58	<0.05
22591	Caribou	Muscle	0.01	6.96	109	0.04	848	0.81	<0.05	<0.01	<0.05
22592	Caribou	Muscle	0.02	4.98	92.1	0.04	814	0.94	<0.05	<0.01	<0.05
22593	Caribou	Muscle	0.02	7.19	123	0.03	969	0.95	<0.05	0.09	<0.05
26293	Caribou	Muscle	0.03	9.87	163	0.07	937	1.38	<0.05	0.01	<0.05
26531	Caribou	Muscle	0.04	6.11	96.2	0.06	890	0.96	<0.05	0.26	<0.05
27589	Caribou	Muscle	0.02	11.2	142	0.05	876	2.27	<0.05	0.09	<0.05
26627	Moose	Kidney	0.29	16.6	194	0.14	702	7.00	0.07	1.73	<0.05
25660	Moose	Liver	0.16	95.3	207	0.02	427	3.49	<0.05	1.77	<0.05
26627	Moose	Liver	0.19	124	588	0.15	420	5.40	<0.05	2.59	<0.05
25660	Moose	Muscle	0.05	3.52	86.6	0.07	805	0.56	<0.05	<0.01	<0.05
26627	Moose	Muscle	0.04	5.63	133	0.61	978	0.63	<0.05	0.23	0.22

Appendix 4. (continued)

Sample ID	Species	Tissue	Selenium	Silver	Strontium	Thallium	Tin	Uranium	Vanadium	Zinc	Sample Moisture %
22591	Caribou	Kidney	4.0	0.053	0.53	0.12	0.02	<0.005	0.10	115	0.80
22592	Caribou	Kidney	3.4	0.076	0.61	0.23	<0.01	<0.005	<0.05	111	0.76
22593	Caribou	Kidney	4.3	1.84	0.60	0.13	0.07	<0.005	0.08	113	0.79
22615	Caribou	Kidney	4.9	1.25	0.40	0.08	0.02	<0.005	0.06	117	0.76
26293	Caribou	Kidney	3.4	0.051	0.79	0.04	<0.01	<0.005	<0.05	124	0.76
26531	Caribou	Kidney	4.4	0.350	0.65	0.11	0.03	<0.005	0.06	128	0.78
27589	Caribou	Kidney	3.9	0.409	0.48	0.07	0.01	<0.005	0.11	105	0.79
22591	Caribou	Liver	1.0	1.59	0.16	<0.01	0.13	<0.005	<0.05	94.4	0.67
22592	Caribou	Liver	1.0	1.24	0.14	0.01	0.01	<0.005	<0.05	86.2	0.68
22593	Caribou	Liver	1.3	1.11	0.20	0.02	0.05	<0.005	<0.05	74.4	0.68
22615	Caribou	Liver	0.9	1.12	0.13	<0.01	0.02	<0.005	<0.05	66.7	0.68
26293	Caribou	Liver	0.5	1.57	0.18	<0.01	<0.01	<0.005	<0.05	84.4	0.67
26531	Caribou	Liver	1.4	1.30	0.18	<0.01	0.01	<0.005	0.08	75.3	0.65
27589	Caribou	Liver	1.3	1.80	0.17	<0.01	0.01	<0.005	<0.05	78.9	0.67
22591	Caribou	Muscle	0.2	0.036	0.13	<0.01	0.01	<0.005	<0.05	224	0.74
22592	Caribou	Muscle	0.3	0.109	0.16	<0.01	0.03	<0.005	<0.05	241	0.73
22593	Caribou	Muscle	0.7	0.394	0.17	<0.01	0.72	<0.005	0.05	276	0.75
26293	Caribou	Muscle	0.4	0.148	0.14	<0.01	0.06	<0.005	<0.05	159	0.73
26531	Caribou	Muscle	0.8	0.189	0.19	<0.01	0.04	<0.005	0.08	189	0.72
27589	Caribou	Muscle	0.7	0.086	0.19	<0.01	0.02	<0.005	<0.05	162	0.73
26627	Moose	Kidney	3.6	0.184	0.48	<0.01	0.01	<0.005	0.11	268	0.80
25660	Moose	Liver	3.3	0.133	0.10	<0.01	<0.01	<0.005	<0.05	54.2	0.58
26627	Moose	Liver	2.5	0.210	0.11	<0.01	<0.01	<0.005	<0.05	360	0.59
25660	Moose	Muscle	0.6	0.266	0.17	<0.01	0.05	<0.005	0.05	256	0.74
26627	Moose	Muscle	0.3	1.17	0.14	<0.01	0.51	<0.005	<0.05	196	0.73