Anvil Range Mine Complex Terrestrial Effects Study Design: Investigation into Metal Concentrations in Vegetation, Wildlife and Soils

Preliminary Study Design

prepared for:
Deloitte & Touche Inc.

prepared by:
Gartner Lee Limited

in association with:
C.E. Jones & Associates

reference: **GLL 23842**

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Deloitte & Touche Inc.
Gartner Lee Limited
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Gartner Lee

Gartner Lee Limited

June 15, 2004

Mr. Joe Solly
Senior Manager
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Deloitte & Touche Inc.
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Windsor, Ontario N8X 1L9

Dear Mr. Solly:

Re: 23842 – Anvil Range Mine Complex Terrestrial Effects Study Design: Investigation into Metal Concentrations in Vegetation, Wildlife and Soils, Preliminary Study Design, June 15, 2004

Please find enclosed our *Preliminary Study Design* of the *Anvil Range Mine Complex Terrestrial Effects Study Design: An Investigation into Metal Concentrations in Vegetation, Wildlife and Soils.*

This report was developed using the results of a 2002 preliminary study (CE Jones and Associates 2003), meetings and discussions with Selkirk First Nation, Ross River Dena Council, Faro residents, various federal and territorial government groups, and other experts in the field of contaminants. This report has also been reviewed by Senes Consultants Limited (June 10, 2004) and found suitable for application to the data requirements of ecological and human health risk assessments. Once this report has your approval, we understand that it will be reviewed by Ross River Dena Council, Selkirk First Nation, Type II Mines Office, and other government agencies and experts. These comments will then be incorporated into a *Final Study Design*.

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We look forward to your comments. If you have any questions, please feel free to contact me (867.633.6474, ext. 34).

Yours very truly,
GARTNER LEE LIMITED

Leslie Gomm, Ph.D., P.Eng.
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Executive Summary

Gartner Lee Limited was retained to develop a Terrestrial Effects Study Design for the Anvil Range Mine Complex. This project was initiated under the recommendation of the Environmental Assessment conducted in support of the application for Water Licence Renewal for ongoing care and maintenance activities at the Anvil Range Mine Complex (Deloitte & Touche Inc. and Gartner Lee Limited 2003). The findings of the Terrestrial Effects Study will feed into on site care and maintenance activities and into the development of the Final Closure and Reclamation Plan for the Anvil Range Mine Complex.

The general approach in developing the Terrestrial Effects Study Design consists of four main phases:

- Phase 1: Conceptual Study Design (to focus preliminary discussions);
- Phase 2: Information Sharing and Gathering / Stakeholder Involvement (in response to Conceptual Study Design);
- Phase 3: Preliminary Study Design and Review (integration of input and technical knowledge, *i.e.*, this report); and
- Phase 4: Final Study Design (incorporation of review of Preliminary Study Design).

This approach is iterative and allows for effective dialogue between federal, territorial, First Nation and consulting experts in providing input and feedback into the Terrestrial Effects Study Design.

The objectives and methods of the Terrestrial Effects Study can be defined as follows:

Objective One:

To improve characterization of the spatial distribution of elevated metal concentrations

Proposed sampling for the 2004 Terrestrial Effects Study has been designed to build on information collected in 2002 (CE Jones and Associates 2003). Data from 2002 show that elevated metal concentrations resulting from potential airborne contamination occur in a zone that extends at a minimum of 2 to 3 km in all directions from potential mine-site contaminant dust sources, and that the highest concentrations appear to extend northwest to north of the tailings impoundments and mill complex. The 2004 Terrestrial Effects Study aims:

1. To provide additional information on near-source contamination and improve characterization and prediction of these patterns; and
2. To determine the extent of potential contamination, or the maximum distance from the mine complex of identifiable effects.

Proposed sample sites have been located to meet these objectives through increased sample point density within the projected affected areas, and through extending lengths of existing transects by 1 to 2 data points past the anticipated extent of potential contamination (Figure 3). Additional sampling sites have been proposed for the Grum / Vangorda mine areas and along the haul road between the Faro and Grum / Vangorda mine areas and between the Town of Faro and the haul road to expand on the preliminary data collected in this area in 2002. There are also a number of outlying sample locations that have been incorporated into this sampling program in response to specific public input, *e.g.*, at the confluence of Anvil Creek and the Pelly River and within the Town of Faro. Proposed sample points on Rose Creek and Anvil Creek have been paired, with one sample point on the creek floodplain and one on the adjacent northern side slope at each location in an attempt to differentiate between potential contamination on the floodplain (relating to the historical tailings dam breach) and that on the adjacent till side slope.

Proposed sample locations for 2004 are designated as either "Lichen / Opportunistic" (sampled for lichen, species of importance to human or wildlife and soils where vascular plant samples are collected) or "Complete" (sampled for lichen, species of importance to human or wildlife, soils (all sites), moss bags and small mammals at a subset of locations).

The determination of spatial distribution of potential contamination in the 2004 data collection program is based primarily on lichen sampling. Lichen samples will be collected on all complete sample sites and lichen / opportunistic sites. It is proposed that all lichen samples collected be analyzed by ICP Mass Spectrometry for a full 26 suite of metals (Table 3). Sampling soils will provide confirmation of lichen results; enable interpretations of sources of elevated element concentrations in vascular plants; and enable evaluation of the presence of natural surficial material mineralization unrelated to mine operations through sampling of surface organic, subsurface organic and subsurface mineral samples. Soil samples will be collected on all complete sample sites and on sites where vascular vegetation is opportunistically sampled (*i.e.*, selected lichen / opportunistic sites). It is proposed that a sub-set of collected soil samples be analyzed by ICP Mass Spectrometry for the full 26 suite of metals plus pH. Organic carbon will be analyzed on a further subset of analyzed samples, to allow interpretation of variability in observed concentrations and on potential mobility based on organic matter content. This subset of samples will also be analyzed for metals mobility (using a standard extraction such as acid ammonium oxalate), to provide information on potential uptake in vegetation and transport in surface water and groundwater of metals deposited at surface in off-site locations. Duplicate soil and lichen samples will be collected and analyzed for QA / QC purposes.

Objective Two:

To improve characterization of reference metal concentrations

Reference sampling locations for the 2002 study (CE Jones and Associates 2003) were carefully chosen in an attempt to reference areas of natural mineralization free from additional mine site impacts. Geological reports on the Anvil Range area indicated a zone of mineralization trending from north west of the Faro pit, through the mined deposits and to the southeast as far as the Swim Lake basin. This information suggested the Swim Lake basin as the most representative retrospective reference sampling location. Preliminary attempts have since been made (this study) to locate additional suitable reference locations, *i.e.*, referencing an undisturbed area with the exact mineralization type and concentrations as found in the area of the Anvil Range Mine Complex, with similar sediment and soil types, and where similar climatic (*i.e.*, weathering) and geological (*i.e.*, erosion or sedimentation) processes would result in similar near surface soil chemistry. Although, these preliminary attempts have not, to date, indicated additional candidate reference sampling locations, a more extensive search will proceed in early summer 2004. This will include researching mining company and government records for any information on terrestrial sampling of pre-mining metals concentrations for exploration purposes. In the potential situation that Swim Lake basin remains the best available reference sampling location, sampling efforts in this area will be increased and the sampling area expanded to cover the entire identified mineralized zone.

Objective Three:

To determine if deposition is ongoing

The 2002 metals in soils and vegetation reconnaissance study indicated that likely off-site contamination from mine operations exists, but did not provide any information on the likely timing of this contamination. Moss bag sampling will be employed to investigate whether there is any current contamination of off-site locations from mine-site sources. If the results of the 2004 moss bag sampling program suggest that airborne deposition is ongoing, more precise information on individual mine-site contaminant sources can be obtained through use of standard air-quality monitoring equipment in 2005, *i.e.*, monitoring of total suspended particulate (TSP) using Hi-Vol sampling methods. This method can also be supplemented by analysis of lead isotopes to help identify individual mine-site contaminant sources, if required.

Moss bags will be deployed at all complete samples locations following standard methods for preparation and set up outlined in Temple *et al.*, (1981). Two sets of moss bags will be deployed at each site: the first set will be left in place for approximately 4 months (between June and October 2004) and the second set will be left in place for an additional 7 - 8 months (between October 2004 and May 2005) to provide data on potential winter aerial deposition. The same analytical parameters described above for lichen will be performed on moss materials both pre- and post-exposure.

Objective Four:

To investigate element uptake by plant species / soil

Vegetation species of importance to wildlife and / or humans will be sampled and analyzed. Soils from known mineral lick sites will also be sampled. These data can then be used to investigate the extent of elevated metal concentrations in the food chain by feeding into a future terrestrial risk analysis and will also assist in predicting possible current and future impacts on local land-users from elevated metals resulting from care and maintenance operations.

Samples of vegetation of importance to wildlife and / or humans will be collected opportunistically where they occur at all complete and lichen / opportunistic sample locations and at selected sites identified with First Nation elders and other individuals with local or traditional knowledge. Samples of soils from mineral lick sites will be collected at selected sites identified with individuals with local or traditional knowledge.

Vegetation species (Table 4) proposed for collection and analysis were selected from an expanded list of species documented to occur in the area of the Anvil Range Mine Complex. The selection relies heavily on both scientific knowledge and input from the First Nations community regarding species that are important to wildlife and humans. The selection of vegetation species representing wildlife forage aims to sample broad vegetation groups that are representative of the major food types available and of importance to wildlife in the Anvil Range Mine Complex area. Wildlife forage samples will be collected and analyzed as composite (by species group) and individual species samples. Vegetation species selectively consumed by humans will be collected and analyzed as individual species samples. Storage, handling and analysis protocols will follow those outlined for lichen, soils and moss bags.

Objective Five:

To investigate existing metal concentrations in tissues of wildlife species

Tissues from selected wildlife species will be sampled and analyzed. These data can then be used to investigate the extent of elevated metal concentrations in the food chain by feeding into a future terrestrial risk analysis and will also assist in predicting possible current and future impacts on local land-users from elevated metals resulting from care and maintenance operations.

Trapping for small mammals (*i.e.*, mice, voles and shrews) will be conducted at a subset of complete sample sites. Carcasses of furbearers and hunter killed small game will be collected from members and associates of the Ross River Trapping Group. Organs (liver and kidneys) and tissue (muscle) samples from hunter killed large mammals will be collected from First Nation and non-aboriginal hunters.

Small Mammal Trapping

According to interpretation of range information a number of voles, mice and shrew species could potentially occur within the area of the Anvil Range Mine Complex. Small mammal trapping will be

conducted in the fall with a sampling effort 900 trap nights (*i.e.*, 30 traps / transect at 30 transects set for one night). Given fluctuations in small mammal populations and variations in trapping success trapping success cannot be predicted at present but it is anticipated that at least 75 small mammal carcasses will be available for analysis. Handling protocols will follow those outlined for lichen, soils and moss bags and will also include precautions against Hanta virus infection. Stored carcasses will be frozen to at least minus 20 degrees Celsius at the end of each day and bulk transported for processing in Whitehorse. The liver and kidneys of processed animals will be removed, weighed (for future calculation of body burden) and transported frozen to Soilcon Laboratories Ltd. for analysis. Analysis protocols will follow those outlined for lichen, soils and moss bags, *i.e.*, a full ICP scan of 26 elements. Tissues for blind and duplicate samples will be analyzed for the purposes of QA / QC.

Trapped / Hunted Animals

According to interpretation of range information a number of furbearers, game birds and large mammals could potentially occur within the area of the Anvil Range Mine Complex. It is anticipated that the carcasses of many of the furbearers, small and large game found in the area of the Anvil Range Mine Complex will be available from fall through winter 2004 / 2005 from trapping and hunting activities in this area. In addition, beaver will be trapped for the sole purpose of this study in coordination with Ross River Dena Council Group Trapping Group and YTG Conservation Officer Services.

Submitted carcasses and tissues will be collected and stored through coordination with Ross River, Faro and Whitehorse Conservation Officers. Upon receipt of carcasses or tissues, samples will be immediately frozen to at least minus 20 degrees Celsius and a member of the Conservation Officer Service will record data (*e.g.*, date, species and location of trapped / hunted animal) on a pre-designed data form. Selected carcasses will be regularly bulk transported for tissue processing in Whitehorse. Liver, kidneys and muscle tissue of large game will be sampled from organs and muscle samples that have been removed by hunters in the field in accordance with the Northern Contaminants country foods program methodology.

The liver and kidneys of processed furbearers and small game will be removed and weighed for future calculation of body burden. All liver, kidneys and muscle tissue from furbearers, game birds and large mammals will be transported frozen to Elemental Research for ICP analysis. Analysis protocols will follow those outlined for lichen, soils and moss bags, *i.e.*, a full ICP scan of 26 elements. Duplicate samples of all tissues will be stored for the purposes of QA / QC.

Community Involvement

It will be important to provide the local communities, with regular updates on the Terrestrial Effects Study. As part of this study it is proposed that updates be provided through briefings to Chief and Council (Ross River Dena Council and Selkirk First Nation), Community Open Houses, radio announcements, mailing brochures and posters.

It is anticipated that one local assistant from Selkirk First Nation and one from Ross River Dena Council will be hired to assist the team with field sampling. Once the local assistants have been hired, it is proposed that one day of training be held to provide background to the project and also exposure to required field and post-field procedures. The study design requires the assistance of Elders in the field in the form of leading field personnel in identification and location of plant species of importance and mineral lick sites for contribution to the 2004 summer field sampling program. It is proposed that one Elder from Selkirk First Nation and one Elder from Ross River Dena Council will be required for approximately two days each.

1. Introduction & Background

Gartner Lee Limited was retained to develop a Terrestrial Effects Study Design for the Anvil Range Mine Complex. This study was initiated under the recommendation of the Environmental Assessment conducted in support of the application for Water Licence Renewal for ongoing care and maintenance activities at the Anvil Range Mine Complex (Deloitte & Touche Inc. and Gartner Lee Limited 2003). The findings of the Terrestrial Effects Study will feed into on site care and maintenance activities and into the development of the Final Closure and Reclamation Plan for the Anvil Range Mine Complex.

The Anvil Range Mine Complex (including both the Faro and Vangorda Plateau mine sites) has been in existence since 1968 / 69 under various owners and has been managed in a care and maintenance state by the Interim Receiver (Deloitte & Touche Inc.) of the last mine owner, Anvil Range Mining Corporation, since April 1998. Project funding is now provided by the Department of Indian Affairs and Northern Development (DIAND). The federal and territorial governments formally recognized, in January 2003, that the Anvil Range Mine Complex was not economically operable and would not be operated again. They committed to jointly develop a Final Closure and Reclamation Plan for the mine property, in concert with First Nations. A Type II Mines Office, managed jointly by DIAND and the Yukon Government (YG), is managing the development of the Final Closure and Reclamation Plan. One of the information needs identified was the development of closure objectives for several technical topic areas (*e.g.*, water quality, flood design, economic issues). One of the topic areas identified was terrestrial resources related to potential elevated metal concentrations in vegetation, soils and wildlife in the vicinity of the Anvil Range Mine Complex.

The Terrestrial Effects Study is intended to include two summer / fall field seasons, 2004 and 2005. This report focuses on sampling required in the 2004 summer / fall season; however, some sampling (trapping) is proposed during the winter of 2004 / 2005. The 2005 summer / fall methods and sampling locations are not provided as these will be best determined at the conclusion of the 2004 / 2005 program (*i.e.*, in order to optimize any future sampling based on 2004 / 2005 program results). According to the water licence requirements, a final report on the results of the Terrestrial Effects Study is required to be filed to the Water Board by December 2005.

The study design assumes that a human and ecological risk assessment will take place as part of the closure planning of the mine.

2. General Approach

The general approach in developing the study design consists of four main phases:

- Phase 1: Conceptual Study Design;
- Phase 2: Information Sharing and Gathering / Stakeholder Involvement;
- Phase 3: Preliminary Study Design and Review; and
- Phase 4: Final Study Design.

This approach is iterative and allows for effective dialogue between federal, territorial, First Nation and consulting experts in providing input and feedback into the Terrestrial Effects Study Design.

Phase I involved the development of a Conceptual Study Design (December 8, 2003 Technical Memorandum, Gartner Lee Limited), which presented our initial thoughts on the Terrestrial Effects Study Design, the purpose of which was to form a preliminary discussion tool for review with affected First Nations, and federal and territorial government agencies.

Phase 2 involved initial face-to-face meetings in which the Conceptual Study Design was presented and discussed. Feedback on the Conceptual Study Design was sought at each of the meetings. These initial meetings included the following:

- Selkirk First Nation (February 3, 2004);
- Ross River Dena Council (February 4, 2004);
- Town of Faro - staff (February 5, 2004);
- Mine site personnel (February 4, 2004);
- YTG, Department of Environment, Habitat and Environmental Affairs Section (February 2, 2004, March 17, 2004)
- YTG, Department of Energy, Mines and Resources, Minerals Management Branch (February 6, 2004) and Agriculture Branch (February 2, 2004)
- YTG, Executive Council Office (February 2, 2004)
- Environment Canada, Environmental Contaminants Division (February 6, 2004)
- DIAND, Northern Contaminants Program (March 17, 2004)
- Yukon Contaminants Specialist (M. Gamberg, Environmental Consultant) (March 17, 2004)

In addition to the above noted initial meetings, the following also occurred:

- Open House, Town of Faro (March 15, 2004);
- Site tour and follow-up meeting with mine site personnel (March 15, 2004);

- Two-day workshop in Pelly Crossing with the Selkirk First Nation (April 21-22, 2004); and,
- One-day workshop in Ross River with Ross River Dena Council (May 5, 2004).

Several phone discussions were also held with the Senior and District (Faro) Conservation Officers. Other professionals in the fields of contaminants, air quality, and vegetation and wildlife sampling were also contacted. It should be noted that YTG Health & Social Services was contacted, but felt that their input would be more appropriate at a later stage in the project.

A list of issues, questions, and recommendations made during the above meetings, discussions and workshops is contained in Appendix A. General information provided to the study team is incorporated directly into the text of this report.

Phase 3 involved the integration of the information and suggestions gathered through Phase 2 with the technical knowledge of Gartner Lee's team into a Preliminary Study Design (this report). Gartner Lee's technical team included professionals with expertise in wildlife, vegetation, contaminants, and air quality.

Phase 4 will incorporate the comments from the review of the Preliminary Study Design developed in Phase 3, to complete a Final Study Design. Full implementation of the design will occur in 2004 and 2005.

3. Objectives

In order to prepare a study or sampling design to investigate the metal concentrations in wildlife, vegetation and soils in the vicinity of the Anvil Range Mine Complex, it was necessary to determine the objectives of the study itself.

Table 1 summarizes the objectives of the Terrestrial Effects Study. The table also outlines the broad methods and rationale for each objective and lists the sections in the report that provide the detailed methodology for each objective. In general, the objectives aim to address the spatial extent of the potential contamination, improve characterization of reference metal concentrations, determine the timing of potential contamination, and to investigate current metal concentrations in plant and wildlife tissue.

Table 1. Objectives of Terrestrial Effects Study

	Objective [1]	How will the Objectives be Addressed?	What will be Achieved?	Section Reference
1	**To improve characterization of the spatial distribution of elevated metal concentrations**	• Use non-random sampling design overlain on a grid network to provide more comprehensive coverage of study area; • Sample *Cladina mitis*, a lichen (2002 study showed lichen to be a reliable receptor species and *Cladina sp*. also winter forage for woodland caribou); • Sample surface (moss), h-horizon, b-horizon at a subset of sites.	• Will verify spatial extent of zone of elevated metal concentrations. The preliminary 2002 study did not define these zones.	Section 4.1
2	**To improve characterization of reference metal concentrations**	• Conduct additional reference sampling • Results of interpolation will also assist in interpretation of where elevated metal concentrations level off	• Verify that the comparison of potentially influenced data points to reference concentrations is valid	Section 4.2
3	**To determine if ongoing deposition is occurring**	• Moss bag sampling	• Will assist in determining if the terrestrial environment is being exposed to ongoing sources of elevated metal concentrations, and will assist in determining mitigative options for final closure.	Section 4.3
4	**To investigate element uptake by plant species / soil**	• Sample vegetation species of interest or importance to humans (*e.g.*, species used for medicinal and / or consumption use) and wildlife (*e.g.*, forage species) • Sample soils at mineral lick sites	• Will assist in predicting possible current and future impacts on local land-users from elevated metals resulting from care and maintenance operations • Will assist in verification of the extent of elevated metal concentrations in food chain	Section 4.4
5	**To investigate existing metal concentrations in tissues of wildlife species**	• Collect tissue samples (liver, kidneys and muscle) from wildlife species in the vicinity of the mine	• Will assist in verification of the extent of elevated metal concentrations in food chain	Section 4.5

1 Objective 4 originally proposed in the conceptual plan for the detailed terrestrial effects study design (Technical Memorandum from GLL dated December 2, 2003) awaits results of 2004 moss bag sampling program before being considered for inclusion in future study designs. Originally proposed objectives 5 and 6 (Technical Memorandum from GLL dated December 2, 2003) were not incorporated into the 2004 design following suggestions from reviewers.

4. Study Design

The study design is presented below according to the objectives identified in Table 1.

It should be noted that although these methods have been presented by objective to facilitate understanding and review of study methodology, there is considerable overlap in methods to address different objectives. For instance, soil and vegetation sample points established primarily to determine spatial distribution of potential contamination will also be opportunistically sampled for important wildlife food species, while sample points established based on identified human or wildlife use may also have spatial indicator species sampled to fill in the spatial sampling grid. These overlaps are identified in the discussion below. It will be important that these overlaps are considered in the performance of individual field studies such that all of the required information is gathered in an efficient manner.

It should also be noted that the sampling locations discussed below are best approximations; slight changes to the locations may be required based on field assessment and site conditions.

4.1 Improve Characterization of Spatial Distribution of Potential Contamination

Proposed sampling for the 2004 Terrestrial Effects Study has been designed to build on information collected in 2002, including information to characterize the spatial distribution of potential contamination. Sample locations from the 2002 program are presented in Figure 1 (adapted from CE Jones and Associates 2003). Spatial distribution information was collected in 2002 via transect-based samples originating from the Rose Creek tailings impoundments, as a general means of investigating for metal contaminants from the tailings facility, plant site, Faro rock dumps and Faro pit. In general, the 2002 spatial data showed that elevated metal concentrations resulting from potential airborne contamination occur in a zone that extends at a minimum of 2 to 3 km in all directions from potential mine-site contaminant dust sources, and that the highest concentrations appear to extend northwest to north of the tailings impoundments and mill complex. Samples were also collected in the vicinity of the Grum and Vangorda sites in 2002, but were collected primarily to provide reconnaissance-level information on metals concentrations adjacent to other mine areas (*e.g.*, rock dumps, open pits) and were not collected at sufficient resolution to allow interpolation of spatial concentration patterns.

There are two components for the spatial distribution objective of the 2004 Terrestrial Effects Study:

1. To provide additional information on near-source (or within the already-identified affected zone discussed above) contamination and improve characterization and prediction (or interpolation between known data points) of these patterns; and
2. To determine the extent of potential contamination, or the maximum distance from the mine complex of identifiable effects.

The adequacy of the 2002 data set for characterizing the near-source affected area was assessed through geostatistical methods (Kriging, or interpolation of values between known data points), using lichen as the primary indicator species. Lichen was chosen as the most reliable indicator for this analysis because: a) they are perennial vegetation (do not shed tissues annually) and thus provide a cumulative record of airborne deposition; and, b) they are dependent on airborne or precipitation sources for nutrition, and are therefore not subject to confounding influences from surface soils as are vascular plants.

An example of this analysis (lead in lichen) is presented in Figure 2, which displays 2002 transect results centred on the Rose Creek impoundment, with south in the foreground and north in the background. In this example, the analysis was constrained so that concentration contours are only displayed if the standard error of the estimate is less than 500 ppm; thus, areas without contours (both near-source and at greater distances) indicate areas where further sampling is required for accurate interpolation of concentrations. A similar pattern exists for zinc levels in lichen. These results indicate that there are significant data gaps in the east, southeast, and west through northeast, as well as in all areas more distant from the Faro mine site. An additional data gap exists in the area of the Grum / Vangorda mine site. That is, additional sampling (over and above 2002 sampling) is required to begin characterization of spatial patterns of potential contamination.

To determine additional sampling requirements for defining the extent of potential contamination, distance-concentrations curves from the 2002 data set were used to extrapolate probable distance from the mine to metals concentrations equivalent to reference locations. Note that this comparison requires accurate background information, which is discussed below in Section 4.2. This extrapolation, combined with Kriging results (as presented in Figure 2) provides two primary findings:

1. Evidence suggests preferential metals deposition in the northwest (in downstream Rose Creek valley) to north direction. This is believed to reflect summer or non snow-covered prevailing wind direction on site, and is supported by anecdotal observations of weather conditions on the mine. Meteorological data recording began on-site in December 2003 and will be used in 2004 data analysis. Preliminary examination of this data indicates that in the vicinity of the Faro pit, prevailing winter winds are primarily from the southeast (40% of observations) and northeast (27% of observations) quadrants, with strong winds (> 5 m/s) distributed roughly equally between these directions. The weather station from the Grum pit area reports roughly equal distribution of wind in the southeast (44% of observation) and northwest (41%) quadrants, with strong winds coming primarily from the southeast quadrant. These data are consistent with airborne metals deposition in

the directions observed in the 2002 data set, but are occurring in primarily snow-covered conditions. The longer-term wind data set, including snow free months, is needed to correlate with observed elevated metals concentrations and interpret the effects of local climatic conditions on any observed spatial patterns of potential contamination. Wind data available for the 2002 data analysis were from the Faro airport, and may not accurately reflect on-site conditions. It is noted that observations of airborne contamination in the Rose Creek valley in 2002 may have been confounded by a tailings breach in the early 1970s that deposited mine waste materials downstream in the Rose Creek drainage. Measures will be taken in the 2004 program in an attempt to differentiate this potential influence (see Section 4.1.1).

2. Despite transect lengths extending 2 to 6 km from the centre of the Rose Creek intermediate impoundment, Swim Lake reference concentrations of lead and zinc in lichen were not reached at the farthest extent of the 2002 transects. This suggests that although there is evidence of preferential contamination to the northwest to north of the tailings and mill complex, the zone of potential contamination may extend farther than the 2002 data set in all directions.

4.1.1 2004 Sampling Locations

Proposed sampling locations for the 2004 Terrestrial Effects Study are presented in Figure 3. Sampling locations from 2002 are also shown in Figure 3 to give an indication of the anticipated total data set. As discussed above, the 2004 sample locations have been selected to improve geostatistical interpolation for the projected affected areas, and to define the extent of potential contamination, based on evidence of preferential transport. To accomplish this latter objective, sample points have been located to provide 1 to 2 data points past the anticipated extent of potential contamination. The anticipated extent of potential contamination was estimated using a combination of distance-concentration relationship extrapolation (where these relationships indicate end-of-transect concentrations approaching reference concentrations), and interpretation of topographic information. The latter is based on the preliminary assumption that significant transport of airborne contaminants is unlikely further than topographic high-elevation divides 10 km from the mine site. This extrapolation and assumption will be tested and verified or rejected based on data collected in 2004. Sampling has been extended past the currently estimated extent of potential contamination in order to improve spatial data analysis, as geostatistical methods are more useful in interpolation than in extrapolation.

Data collected from 2002 transects extending south and southwest of the Rose Creek impoundment showed near-reference concentrations at the most distant points (approximately 6 km) from the mine, so these transects have been extended only marginally. Transects to the north to northwest and downstream on Rose Creek have been extended farther, in an attempt to reach reference concentrations near transect end. Proposed sampling locations were selected at regular intervals along Rose Creek down to the confluence of Anvil Creek and also at the confluence of Anvil Creek and the Pelly River. The proposed

points on Rose Creek and Anvil Creek have been paired, with one sample point on the creek floodplain and one on the adjacent northern side slope at each location. This has been done in an attempt to differentiate between potential contamination on the floodplain (which has different underlying fluvial materials, may be subjected to waterborne metal dispersion, and has no forest overstory to intercept airborne particles) and that on the adjacent till side slope (which is more comparable to the majority of other sampling locations). This pairing of sample points in this direction is important, as 2002 data indicated substantially elevated metals concentrations in the downstream Rose Creek zone. Sampling of the floodplain alone could lead to extrapolation of observed elevated concentrations to adjacent side slope locations, and thus overestimation of potential contamination, while sampling of the side slope locations alone could lead to missing potential contamination on the downstream floodplain. Sampling paired points should allow documentation of potential contamination on the floodplain zone, but ensure that any elevated concentrations observed in this zone are not erroneously extended to adjacent locations.

There are a number of outlying sample locations that have been incorporated into this sampling program in response to specific public input. The paired samples at the confluence of Anvil Creek and the Pelly River were included in the design as a result of input from Selkirk First Nation (SFN Traditional Knowledge Workshop, April 2004) and Ross River Dena Council (RRDC Terrestrial Effects Workshop, May 2004). Two sample locations within the area of the Town of Faro were included in the design as a result of input from Faro Residents (Town of Faro Open House, March 2004). Care will be taken in the specific location of these sampling locations to guard against contamination of samples with non-native soils used in gardening. There is also flexibility within the study design (see Section 4.4.1) to include additional sites that may be identified during fieldwork through public input.

Additional sampling sites have been proposed for the Grum / Vangorda mine areas. The intent of this sampling is to provide information on metals concentrations between the Grum and Faro pits, on the sheep range habitat on the southern slopes of Mount Mye, and in the directions of the Faro town site and Swim Lake reference sampling sites. Sampling locations are also proposed along the haul road between the Faro and Grum / Vangorda mine areas and along the access road between the Town of Faro and the haul road to expand on the preliminary data collected in this area in 2002. Initial results showed slightly elevated concentrations of metals along the haul road, compared to Swim Lake reference locations.

The goal of the sample design proposed here is to adequately characterize the probable contamination zone based on current information, but to err on the side of under-sampling, so that resources and effort are not expended on sampling "clean" sites. If analysis of 2004 data indicates the need for minor additional sampling, this would be completed in 2005, and would be much more precisely directed based on 2004 information than it can be at this time.

Proposed sample locations for 2004 are designated as either "Lichen / Opportunistic" or "Complete". This distinction is presented below in Table 2 and will be discussed in Sections 4.3 to 4.5. "Lichen / Opportunistic" sites will be sampled primarily for lichen alone, but will include opportunistic sampling of

important human or wildlife use species where found (and of soils where vascular plant samples are collected). "Complete" sites will include lichen sampling, opportunistic vegetation sampling, soil sampling, and moss bag sampling.

Table 2. Sampling Parameters at Complete and Lichen / Opportunistic Sampling Locations

Sample Type	Lichen	Soils[1]	Moss Bags	Opportunistic Vegetation[2]	Small Mammals[3]
Complete	X	X	X	X	X
Lichen / Opportunistic	X	X		X	

4.1.2 2004 Sampling Methods

Lichen Sampling

It is proposed that the determination of spatial distribution of potential contamination in the 2004 data collection program be based primarily on lichen sampling. Lichen are long-lived perennial accumulators (do not annually renew "foliar" tissue, as deciduous species do) that are entirely dependent on airborne or precipitation sources of nutrients (and metals), and thus are isolated from underlying soil mineralization. A study of the till geochemistry in the area of the Anvil Range Mine Complex (Bond, 2001) indicates a dispersal train of mineralized till (soil B horizon) trending north and west from the Faro deposits towards Next Creek and Rose Creek. This coincides with the primary direction of airborne dispersal indicated by the 2002 vegetation and soils metals study. Thus, in the 2004 study, every precaution needs to be taken to ensure that elevated metals concentrations resulting from natural mineralization are not misattributed to effects of airborne contamination generated by mining operations. To this end, it is proposed that lichen (*Cladina mitis*) be sampled at all sample sites shown on Figure 3, in addition to opportunistically sampled species identified as species of interest for human or wildlife consumption (see Section 4.4).

Lichen samples will be collected utilizing un-powdered latex gloves, with new gloves used at each sample site. Non-lichen material will be removed from the samples at each sample site, to ensure comparability of samples. Samples will be collected in metalized polyester Kapak bags or other product designed to be trace element-free, and isolated from other potential contaminant sources prior to lab analysis.

[1] Soil samples collected at three depths: surface organic (0-2 cm of F horizon), subsurface organic (lower F/H horizon), and subsurface mineral sample (B horizon).
[2] Vegetation of importance to wildlife and / or humans collected opportunistically at these sites. Soil samples will also be collected wherever vegetation of importance to wildlife and / or humans is collected.
[3] Small mammals will be trapped at a sub-set of complete sample locations.

It is proposed that lichen samples be analyzed by ICP Mass Spectrometry for a full suite of metals, as presented below in Table 3 (note that mercury is typically analyzed separately, by cold-vapour atomic absorption).

Table 3. ICP-MS Analytical Parameters and Detection Limits

Element	ICP - MS Reported Detection Limit
Aluminum Al	0.5
Antimony Sb	0.1
Arsenic As	0.1
Barium Ba	0.1
Beryllium Be	0.02
Boron B	2
Cadmium Cd	0.02
Calcium Ca	1
Chromium Cr	0.1
Cobalt Co	0.1
Copper Cu	0.1
Iron Fe	5
Lead Pb	0.1
Magnesium Mg	0.5
Manganese Mn	0.1
Mercury Hg	0.01
Molybdenum Mo	0.1
Nickel Ni	0.1
Phosphorus PO_4	0.5
Potassium K	1
Selenium Se	0.2
Silver Ag	0.01
Sodium Na	1
Strontium Sr	0.05
Sulphur S	-
Thallium Tl	0.02
Tin Sn	0.1
Titanium Ti	0.3
Uranium U	0.04
Vanadium V	0.5
Zinc Zn	0.5

Duplicate lichen samples will also be collected and analyzed for QA / QC purposes.

Soil Sampling

In addition to lichen samples, it is proposed that soil samples be collected on all sample sites labeled "Complete" (Figure 3) and on sites where vascular vegetation is opportunistically sampled. Soils are also perennial accumulators, and through airborne contamination may affect other species through root uptake

(in vascular plants), or through direct consumption (in grazing ungulates). However, as discussed above, mineral soils are also subject to confounding influences through natural mineralization and glacial transport. Sampling soils as part of the spatial distribution program will provide:

- Confirmation of lichen results;
- Enable interpretations of sources of elevated element concentrations in vascular plants; and,
- Enable evaluation of the presence of natural surficial material mineralization unrelated to mine operations.

In order to allow this latter evaluation, it proposed that soils be sampled by horizon / parent material: surface organic (0-2 cm of F horizon), subsurface organic (lower F / H horizon), and subsurface mineral sample (B horizon). Differentiation of results by parent material or depth will provide some interpretative power (*e.g.*, elevated element concentrations in surface organics in comparison to sub-surface organics would support the airborne deposition hypothesis, whereas elevated concentrations throughout the organic and mineral profile would suggest mineralization pre-dating mining operations).

Although soil influence on lichen element concentrations is negligible, vascular vegetation has the potential to be influenced both by airborne contamination and pre-existing mineralization. One objective of the 2004 data analysis and interpretation program will be to identify sources of observed elevated metals concentrations, and ensure that elevated concentrations are not erroneously attributed to mine operations if this conclusion is incorrect. Comparison of sub-surface soil element concentrations will be the primary mechanism for evaluating whether appropriate reference locations have been sampled.

In an attempt to differentiate effects (to the extent possible) occurring downstream on the Rose Creek floodplain (including differing underlying surficial materials[4], a non-existent or more open overstory than that found above the floodplain, and the tailings breach referred to above) paired samples will be collected on and off the floodplain of Rose Creek for both soil and lichen samples (*i.e.*, complete samples).

Soils will be collected using stainless-steel shovels to minimize metals contamination during sampling. It is proposed that a sub-set of collected soil samples be analyzed for the same suite of elements identified for lichen above (Table 3), plus pH. The remainder will be archived for future analysis if necessary. Selection of samples for immediate analysis will be based on the objectives noted above, and will be concentrated on higher contamination-potential sites (near-source and downstream Rose Creek valley sites as well as those identified through 2004 lichen analysis), and on sites where important vascular plant species are collected. Archived samples will be analyzed only if other site measurements indicate need (*i.e.*, if other analyzed materials show elevated contaminant concentrations). Organic carbon will be analyzed on a further subset of analyzed samples, to allow interpretation of variability in observed

[4] *e.g.,* fluvial materials, as opposed to the tills found on the majority of the project area

concentrations and on potential mobility based on organic matter content. This subset of samples will also be analyzed for metals mobility (using a standard extraction such as acid ammonium oxalate), to provide information on potential uptake in vegetation and transport in surface water and groundwater of metals deposited at surface in off-site locations.

Duplicate soil samples will also be collected and analyzed for QA / QC purposes.

4.2 Improve Characterization of Reference Concentrations

Selection of reference sampling locations is critical in conducting a retrospective study of mine impacts on soils and vegetation metal concentrations where pre-mining sampling does not exist. Near-surface ore bodies that can be mined by open-pit methods are frequently associated with more widespread mineralization of surficial materials and soils that can lead to naturally occurring elevated element concentrations in both soils and vegetation in areas surrounding a mineral deposit. It is important that such concentrations not be mistaken as evidence of contamination resulting from mining operations. For this reason, reference sampling locations for the 2002 study were carefully chosen to be located in areas of natural mineralization that would be free from additional mine site impacts. Geological reports on the Anvil Range area indicated a zone of mineralization trending from north west of the Faro pit, through the mined deposits and to the southeast as far as the Swim Lake basin. This information suggested the Swim Lake basin as the most representative retrospective reference sampling location.

The ideal reference sampling location is an undisturbed area with the exact mineralization type and concentrations as found in the area of the Anvil Range Mine Complex, with similar sediment and soil types, and where similar climatic (*i.e.*, weathering) and geological (*i.e.*, erosion or sedimentation) processes would result in similar near surface soil chemistry. However, a recent preliminary investigation of the near surface conditions did not indicate candidate reference sampling locations additional to the Swim Lake basin. A more extensive search will proceed in early summer 2004 to confirm these preliminary findings. This will include researching mining company and government records to see if they contain any information on terrestrial sampling of pre-mining metals concentrations for exploration purposes. This information will assist in establishing true pre-development reference characterization and also in the interpretation of program results.

Unless additional sites are identified through this more extensive search, all information indicates that the Swim Lake basin is the best available reference sampling location. In this case, proposed reference sampling efforts in the Swim Lake basin in 2004 will focus on an expanded program in this area, with the goal of increasing reference observations to approximately 30 from the 7 collected in 2002, and of expanding the area sampled to cover the entire identified mineralized zone in this location. Considerations in selecting specific sampling sites at the Swim Lake reference location will include vegetation cover characteristics, soil classification at the subgroup level (Agriculture and Agri-food Canada Soil Classification), soil texture, drainage class, drainage type, active or potential processes such as

cryoturbation, solifluction, and other permafrost-related processes, and erosion, sedimentation, and range of depth to bedrock.

4.3 Deposition Timing of Mine-Related Dust

The 2002 metals in soils and vegetation reconnaissance study indicated that likely off-site contamination from mine operations exists, but did not provide any information on the likely timing of this contamination. In 2004, one of the objectives will be to determine if ongoing deposition is contributing to the elevated metal concentrations in vegetation versus historical deposition of airborne mine-related dust. Understanding whether ongoing deposition exists at the mine complex is critical to determining whether measured contaminant concentrations are at their maxima, or will continue to increase. It will also provide an indication of the level of prioritization needed with respect to removing any current contaminant sources during the closure phase of the Anvil Range Mine Complex.

To investigate whether there is any current contamination of off-site locations from mine-site sources a "moss bag" sampling program is proposed. This methodology makes use of economic and low technology moss bags to allow widespread evaluation of current airborne deposition levels at a range of sites surrounding the mine. If the results of the 2004 moss bag sampling program suggest that airborne deposition is ongoing, more precise information on individual mine-site contaminant sources can be obtained through use of standard air-quality monitoring equipment in 2005, *i.e.*, monitoring of total suspended particulate (TSP) using Hi-Vol sampling methods. This method can also be supplemented by analysis of lead isotopes to help identify individual mine-site contaminant sources.

The observational logs recorded by mine site personnel regarding wind dispersal of tailings will also be an information source. Forms for these logs will be developed for this study program.

4.3.1 Moss Bag Passive Sampling

Establishment and analysis of moss bags is a standard low-technology method for assessing both dry and wet (*e.g.*, dust and precipitation-based) deposition of airborne contaminants (Temple *et al.*, 1981). Bags are constructed through acquisition of a standard or uncontaminated source of moss. Moss materials are rinsed, dried and analyzed for pre-exposure metal concentrations, and are then sewn into polypropylene mesh bags. These bags are held aerially in monitoring locations, and analyzed after determined exposure intervals. Detected increases in element concentrations from pre-exposure concentrations are indicative of airborne deposition.

It is proposed that a network of moss bags be established for the 2004 Terrestrial Effects Study on the Anvil Range Mine Complex. Moss will be sourced locally from the 2002 reference sampling locations in

the Swim Lakes area. Moss are rinsed and dried under laboratory conditions and samples sent for analysis to obtain pre-exposure metal concentrations. The remaining moss will be packaged into polypropylene mesh bags following standard construction specifications (Temple *et al.*, 1981).

Two sets of moss bags will be deployed at each "Complete" sampling site indicated on Figure 3. Moss bags will either be set up on plastic poles in open canopy positions (to maximize exposure to airborne contaminants), or suspended from tree branches if this first option proves impractical. The first set of moss bags will be left in place for approximately 4 months (between June and October 2004), then collected and sent for analysis, and compared to pre-exposure conditions. It should be noted that moss bag samples need not be "uncontaminated" but rather pre-exposure metal levels are compared to post-exposure levels. The second set of moss bags will be left in place for an additional 7 - 8 months (between October 2004 and May 2005) to provide data on potential winter aerial deposition.

Since the use of moss bags requires repeat access to the sample sites (once for set-up and again for each subsequent analysis), placement may be adjusted to more readily accessible sites than those marked on Figure 3, if site reconnaissance shows equivalent but more-readily accessible sites at alternate locations. The same analytical parameters described above for lichen will be performed on moss materials both pre- and post-exposure.

4.4 Characterization of Metals Concentrations in Vegetation Food Species

In order to investigate potential element uptake by vegetation species of importance to wildlife (*e.g.*, forage species) and / or humans (*e.g.*, species used for medicinal use and / or consumption) selected vegetation species will be sampled and analyzed. Soil samples will also be collected at known mineral lick sites. These data can then be used to investigate the extent of elevated metal concentrations in the food chain by feeding into a future terrestrial risk analysis and will also assist in predicting possible current and future impacts on local land-users from elevated metals resulting from care and maintenance operations.

4.4.1 Sampling Locations

Samples of vegetation of importance to wildlife and / or humans will be collected:

1) Opportunistically where they occur at sample locations identified in Figure 3 (including reference locations);

2) At selected sites identified with First Nation elders and other individuals with local or traditional knowledge, *e.g.*, areas within Vangorda Creek (Ross River Dena Council Terrestrial Effects Workshop May 2004).

Soil samples will be collected at all sites sampled for vegetation of importance to wildlife and / or humans (see Section 4.1.2). Samples of soils at mineral lick sites will be collected at selected sites identified with individuals with local or traditional knowledge of mineral lick locations. The location of mineral lick sites and the location of collection sites identified by First Nation elders and locals will remain confidential and will not be displayed on any published or publicly available maps.

4.4.2 Sampling Methods

Vegetation species were selected from an expanded list of species documented to occur in the area of the Anvil Range Mine Complex (MEC Ltd. 1976; Weinstein 1992; Staniforth 1998; C.E. Jones & Associates Ltd. 2003; Selkirk First Nation Traditional Knowledge Workshop April 2004; Ross River Dena Council Terrestrial Effects Workshop May 2004). The selection of species from the expanded list aims to sample species that are important to wildlife and / or humans. The selection relies heavily on scientific knowledge and input from the First Nations community regarding local wildlife food habits (Pearson 1976; Weinstein 1992; Schweinsburg 1990; Kuzyk and Farnell 1997; R. Ward, pers. comm., March 2004; Selkirk First Nation Traditional Knowledge Workshop April 2004; Ross River Dena Council Terrestrial Effects Workshop May 2004; McCann in prep.) and input from the First Nations on species of importance for human consumption and use. (Selkirk First Nation Traditional Knowledge Workshop April 2004; Ross River Dena Council Terrestrial Effects Workshop May 2004). Table 4 lists vegetation species that will aim to be collected for analysis in 2004.

Wildlife Forage

Vegetation species selection aims to sample broad vegetation groups that are representative of the major food types available and of importance to wildlife in the Anvil Range Mine Complex area. The abundance and availability of wildlife forage species in the area is presently not known, therefore all of the species listed in Table 4 will be collected at each sample location when encountered. Individual species will be collected and stored separately but upon analysis will be combined by species group (see Table 4 for species groups) to provide a composite sample representative of the forage available at each site. An estimate of relative vegetation abundance (percent plant cover) will be visually assessed at each sampling site to provide an approximation of the proportion of each forage species available. This proportion can then be used to determine the proportion each plant species should be represented in the composite sample. It is anticipated that approximately 10 composite samples will be submitted to represent each species group, *i.e.*, total of 100 samples.

Vegetation of Importance to Humans

Samples of individual vegetation species will be retained for separate analysis (Table 4) in order to sample vegetation species selectively consumed by humans. It is anticipated that approximately 30 samples of individual species will be sampled. All samples of individual species will be archived and if results of analyses show that further sampling is required, archived samples will then be available for future analysis.

Vegetation samples will be collected utilizing un-powdered latex gloves, with new gloves used at each sample site. Non-vegetation material will be removed from each sample at each site, to ensure comparability of samples. Samples will be collected in metalized polyester Kapak bags or other product designed to be trace element-free, and isolated from other potential contaminant sources prior to laboratory analysis. Storage, handling and analysis protocols will follow those outlined in Section 4.1.2.

4.5 Wildlife Tissue

In order to investigate potential element uptake by wildlife species and wildlife species of importance to humans (*e.g.*, species used for medicinal use and / or consumption) selected wildlife species will be sampled and analyzed. These data can then be used to investigate the extent of elevated metal concentrations in the food chain by feeding into a future terrestrial risk analysis and will also assist in predicting possible current and future impacts on local land-users from elevated metals resulting from care and maintenance operations.

4.5.1 Sampling Locations Small Mammal Trapping

Trapping for small mammals (*i.e.*, mice, voles and shrews) will be conducted at a subset of locations identified in Figure 3 as "complete" sampling stations, *i.e.*, where soil, lichen, moss bags and vegetation species will be sampled. Hair / fur samples (associated with each tissue sample) will be collected and stored to provide data necessary for future investigation of non-lethal methods of metal sampling, if required. Hair samples and tissue samples from the same animal can be analyzed to determine whether a correlation exists between metal concentration in the muscle tissue / organs and in the hair / fur. If a correlation exists, hair sampling could replace the necessity for killing small mammals when investigating concentrations of elements in small mammals during future monitoring programs.

Trapped / Hunted Animals

Carcasses of furbearers (*e.g.*, snow shoe hare, marten and ermine) and hunter killed small game (*e.g.*, grouse) will be collected from members and associates of the Ross River Trapping Group.

Organs (liver and kidneys) and tissue (muscle) samples from hunter killed large mammals will be collected from First Nation and non-aboriginal hunters. A similar donation program is carried out under the Northern Contaminants Program, in which the hunters remove the organs and tissue from the carcasses for analysis. Location of trapped / hunted animals will be recorded by grid cell (1 km by 1 km UTM grid) at the time of carcass submission (see Section 4.5.2). The exact location where animals were trapped / hunted will remain confidential and will not be displayed on any published or publicly available maps.

A radio announcement will be made immediately prior to the onset of the hunting and trapping season (late July) to alert local hunters and trappers to our need for tissue samples and required handling and storage protocols (Ross River Dena Council Terrestrial Effects Workshop May 2004).

Table 4. Proposed Vegetation Species and Groups for Collection and Analysis

Species Group	Selected Species	Plant Part	Wildlife Value	Food / Use for Humans
Grasses and Sedges	*Bromus spp; Calamagrostis spp. Festuca altaica; Carex spp.*	Leaves	Potential forage species of small mammals, game birds, ungulates and bears	Not documented
Aquatic grasses	*Beckmannia syzigachne*	Leaves	Potential forage for moose, black bear and muskrat	Not documented
Horsetails	*Equisetum spp.*	Stems	Potential forage for bears and ungulates	Not documented
Forbs	*Epilobium angustifolium, Petasites spp.* and *Artemisia spp.* (sage); *Achillea spp.* (yarrow); Water lily (*Nuphar spp.*)	Leaves and stems	Potential forage species of small mammals, game birds, ungulates and bears	Yes
Labrador tea	*Ledum groenlandicum*	Leaves	Not documented as forage species	Yes
Berries	*Empetrum nigrum* (crowberry)*; Arctostaphylos uva-ursi, Arctostaphylos rubra* and *Arctostaphylos alpina; Shepherdia canadensis; Vaccinium uliginosum* (bog blueberry)*; Vaccinium vitis-idea* (mountain cranberry*); Rosa acicularis; Viburnum edule; Ribes spp.* (currants and gooseberries); *Rubus spp.* (raspberries); *Juniperus spp.* (Juniper)	Berries	Potential forage for small mammals, game birds and bears	Yes
Willow	*Salix spp (S. pulchra* or any browsed species)	Tips	Potential winter forage of moose, snowshoe hare and bears	Yes
Trees	Poplar (*Populus balsamifera*)	Buds	Potential spring forage for bears	
Bear root	*Hedysarum alpinium* and *Hedysarum boreale*	Roots	Potential forage for bears	Yes
Mushroom spp.	Various species to be identified in field by First Nation elders	Above ground parts	Potential forage species of small mammals, ungulates and bears	Yes
Lichen	*Cladina mitis*[1]	Branchlets	Potential forage of caribou	Not documented

[1] Cladina mitis *will be collected at each sampling location to meet the objectives outlined in Section 4.1.*

4.5.2 Sampling Methods

Small Mammal Trapping

According to interpretation of range information the following species of small mammal could potentially occur within the area of the Anvil Range Mine Complex:

- Voles: *Clethrionomys rutilus* (red-backed); *Microtus pennsylvanicus* (meadow); *Phenacomys intermedius* (heather); *Microtus oeconomus* (tundra); *Microtus longicaudus* (long-tailed); *Microtus miurus* (singing) and *Microtus xanthognathus* (chestnut cheeked);
- Mice: *Peromyscus maniculatus* (deer); *Zapus hudsonius* (meadow jumping) and *Zapus princeps* (western jumping);
- Shrews: *Sorex cinereus* (masked); *Sorex obscurus* (dusky); *Sorex palustris* (water); *Sorex arcticus* (tundra) and *Microsorex hoyi* (pygmy).

Small mammal trapping will be conducted in the fall (September 2004) in an attempt to reduce the impact of mortality on the overall population. Small mammal populations fluctuate annually with low populations occurring in winter and high populations occurring after the breeding season, typically in fall (RIC 1998). Snap traps or museum special mousetraps will be used to target mice and voles (RIC 1998) while pit fall traps will be employed to sample shrews (RIC 1998).

Small mammal traps will be laid out on a 150 m long transect with 10 stations placed approximately 15 m apart beginning at each sample site. At each station two snap traps / museum special mousetraps and one pit fall trap will be deployed. Traps will be set for one 24-hour period and then removed. This will result in a total of 30 trap nights / transect (*i.e.*, 3 traps x 10 stations / transect). It is anticipated that an average of five transects will be laid and five transects removed each day. It is estimated that approximately 6 days of small mammal trapping will result in approximately 30 sites being sampled. The sampling effort of the entire small mammal trapping program is 900 trap nights (*i.e.*, 30 traps / transect at 30 transects set for one night). Given fluctuations in small mammal populations and variations in trapping success (*e.g.*, with habitat type), trapping success cannot be predicted at present. However, it is anticipated that at least 75 small mammal carcasses will be available for analysis. Any additional carcasses will be archived and if results of analyses show that further sampling is required, archived samples will then be available for future analysis.

Small mammal carcasses will be collected using un-powdered latex gloves, with new gloves used at each sample site and stored in metalized polyester Kapak bags or other products designed to be trace element-free, and isolated from other potential contaminant sources prior to laboratory analysis. Precautions against Hanta virus infection will be taken through following standard safety protocols, *e.g.*, wearing of

gloves, coveralls and half-mask respirator (see Appendix B – Health and Safety Plan). Field data collected at each trapping location will include:

- sample site number;
- trap site number;
- UTM coordinates;
- date;
- species;
- morphological measurements (including fresh weight, gender and age estimation); and
- comments / notes.

At the end of each field day carcasses will be immediately frozen to at least minus 20 degrees Celsius. At the end of the field session carcasses will be sorted and bulk transported for tissue processing in Whitehorse by a Yukon Wildlife Contaminant Specialist. An estimated 75 carcasses will be processed for tissue samples of liver, kidneys and muscle. Liver and kidneys will be removed and weighed for future calculation of body burden (*i.e.*, total amount of element / animal) and recorded by unique sample ID. Liver, kidneys and muscle tissue will be sampled and stored separately for analysis and processed samples will be transported frozen to Soilcon Laboratories Ltd. for ICP analysis using mass spectroscopy. This will result in an estimated 225 tissue samples for analysis (*i.e.*, sample of liver, kidney and muscle from 75 animals). Analysis protocols will follow those outlined in Section 4.1.1, *i.e.*, a full ICP scan of 26 elements will be conducted. Duplicate samples of all tissues will be stored for the purposes of QA / QC. Effort was made to ensure that methods of tissue handling and analysis are consistent with those of the Northern Contaminants Country Foods Program. The only deviation from these methods has been in the selection of the laboratory used for the analysis of small mammal samples, *i.e.*, Soilcon as opposed to Elemental Research. It should be noted that all samples of furbearer and hunter killed animals (*i.e.*, those more likely to be consumed by humans) will be analyzed by the laboratory used by the Northern Contaminants Country Foods Program (*i.e.*, Elemental Research Inc.) In order to compare accuracy and detection abilities of Soilcon and Elemental Research, ten liver and ten kidney samples (likely pooled) from small mammals will be sent to Elemental Research. Six blank (*i.e.*, known standard) samples obtained from the National Research Council will also be sent to Soilcon Laboratories Ltd. for analysis. This comparison of detection limits and resolution of analysis is necessary to that any wildlife tissues that could potentially be consumed by humans would be sampled using the methods of the Northern Contaminants Program so that results would be guaranteed to have similar detection levels and be comparable with previous human food analysis.

An application for a research permit for the purposes of small mammal trapping will be submitted to YTG Conservation Officer Service and YTG Fish and Wildlife Branch (K. Gustafson, pers. comm., April 27, 2004).

Trapped / Hunted Animals

According to interpretation of range information the following species of furbearers, game birds and large mammals could potentially occur within the area of the Anvil Range Mine Complex:

Furbearers
- Snowshoe hare
- Marten
- Ermine
- Fox
- Beaver
- Muskrat
- Wolverine
- Lynx
- Wolf

Small Game
- Hoary marmot
- Ground squirrel
- Grouse spp.
- Ptarmigan spp.

Large Game
- Moose
- Caribou
- Sheep
- Mule deer
- Grizzly bear
- Black bear

Others
- Least weasel
- Chipmunk
- Red squirrel
- Northern flying squirrel
- Collared pika
- Porcupine

It is anticipated that the carcasses of many of the furbearers, small and large game found in the area of the Anvil Range Mine Complex will be available from fall through winter 2004 / 2005 from trapping and hunting activities in this area (K. Meister, pers. comm., May 10, 2004). It is anticipated that those animals listed above as "others" will likely not be available for sampling; these species are not typically trapped or hunted. Beaver are not currently trapped in this area (Ross River Dena Council Terrestrial Effects Workshop May 2004). In order to facilitate the collection of beaver carcasses on site, it has been proposed that beaver be trapped for the sole purpose of this study (Ross River Dena Council Terrestrial Effects Workshop May 2004). This will be facilitated through coordination with RRDC Group Trapping Group and YTG Conservation Officer Services (K. Meister, pers. comm., May 10, 2004). The hunting of small game for the purpose of consumption would typically require a small game hunting license. However in this situation where complete carcasses of small game are required for processing (and therefore cannot be consumed) a research permit is required (K. Meister, pers. comm., May 10, 2004). An application for a research permit for the purposes of small game hunting on site will be submitted to YTG Conservation Officer Service and YTG Fish and Wildlife Branch (K. Gustafson, pers. comm., April 27, 2004).

In order to facilitate carcass and tissue submission, a radio announcement will be made by the Ross River and / or Faro Conservation Officer Services immediately prior to the onset of hunting / trapping season (mid to late July) informing members of RRDC, SFN and the public of our need for wildlife tissue samples (H. Jirousek, pers. comm., May 10, 2004; K. Meister, pers. comm., May 10, 2004). This effort will be supplemented by direct contact with trappers in the area, the placement of posters within the communities of Ross River and Faro and the inclusion of a project update and advertisement in the local newsletter in Faro (K. Meister, pers. comm., May 10, 2004).

Submitted carcasses and tissues will be collected and stored through coordination with Ross River and Faro Conservation Officer Services (H. Jirousek, pers. comm., May 10, 2004; K. Meister, pers. comm., May 10, 2004). Although Ross River and Faro Conservation Officer Service offices will be the focal point for carcass submissions, Whitehorse Conservation Officer office will also be provided with project details and materials (data forms and overview maps) in case trappers / hunters wish to submit samples to these offices (K. Gustafson, pers. comm., April 27, 2004). Upon receipt of carcasses or tissues a member of the Conservation Officer Service staff will record the following data on a pre-designed data form:

- contact information;
- date sample submitted;
- date animal trapped / hunted;
- species;
- gender;
- estimated age (and confidence in estimate); and
- location.

Location of trapped / hunted animals will be recorded using a grid overlay on an overview map of the Anvil Range Mine area and can be identified to the grid cell, *e.g.*, A13. These maps will be provided to the Conservation Officer Service offices. It should be noted that the completion of these data forms do not replace the requirement to complete Yukon kill report / biological submissions report or Yukon furbearer sealing certificate where the completion of these forms is applicable.

Upon receipt of carcasses or set of tissues samples (*i.e.*, kidneys, liver and muscle sample), a financial reimbursement will be given to the person who donated the carcass or tissue. It is estimated that this reimbursement could be in the order of $10 - $25 / animal (K. Gustafson, pers. comm., April 27, 2004). An application for a permit to purchase trapped / hunted animal carcasses will be submitted to YTG Conservation Officer Service in Faro, Kirby Meister (K. Gustafson, pers. comm., April 27, 2004).

Upon receipt of carcasses or tissues, samples will be immediately frozen to at least minus 20 degrees Celsius. All Conservation Officer Service offices contain a lockable freezer stored in a secure location. Selected carcasses will be regularly bulk transported for tissue processing in Whitehorse by a Yukon Wildlife Contaminant Specialist. Furbearer and small game carcasses will be processed for tissue samples of liver, kidneys and muscle. Liver and kidneys will be removed and weighed from the carcasses of furbearers and small game for future calculation of body burden (*i.e.*, total amount of element / animal) and recorded by unique sample ID. Liver, kidneys and muscle tissue of large game will be sampled from organs and muscle samples that have been removed by hunters in the field in accordance with the Northern Contaminants country foods program methodology.

All liver, kidneys and muscle tissue will be sampled and stored separately for analysis and processed samples will be transported frozen to Elemental Research for ICP analysis using mass spectroscopy. This

will result in an estimated 75 tissue samples for analysis (*i.e.*, sample of liver, kidney and muscle from 25 animals). Duplicate samples of all tissues will be stored for the purposes of QA / QC, if required. Analysis protocols will follow those outlined in Section 4.1.1, *i.e.*, a full ICP scan of 26 elements will be conducted.

4.6 2004 Sampling Logistics & Safety

Sampling in 2002 was conducted primarily on foot, with some limited 4-wheel-drive vehicle access. Due to an expanded program in 2004, additional means of site access will likely be required, potentially including both all-terrain vehicle and helicopter use. Site locations indicated on Figure 3 are approximate at this stage of project development, and will be adjusted in the field according to practical considerations and to avoid the need for clearing or ground disturbance. This will be accomplished through incorporation of local knowledge of access and use of recent air / orthophotos. It is likely that the more distant sites will require helicopter support. This support will be coordinated to be as efficient as possible.

Appendix B contains a Worker Health & Safety Plan for On-Site Work for the Terrestrial Effects Study.

5. Proposed Schedule

Appendix C outlines the proposed schedule for the 2004 / 2005 fiscal year.

6. Public / Community Participation

It will be important to provide the local communities, with regular updates on the Terrestrial Effects Study. As part of this study it is proposed that updates be provided via the following means:

- Briefings to Chief and Council just before the onset of the main session of field work in July 2004;
- Briefing to Chief and Council in September 2004, prior to set up of small mammal traps;
- Community Open House in February 2005;
- Radio announcements, mailing brochures, posters (*e.g.*, in band office, Conservation Officer Service offices, schools).

7. Employment & Training Opportunities

7.1 Local Assistants

For this project, it is anticipated that one local assistant from Selkirk First Nation and one from Ross River Dena Council will be hired to assist the team with field sampling. These individuals should preferably be Yukon College students following a related program. An interview process may be necessary depending on the general interest in the project. Advertisement of employment opportunities for Ross River Dena Council and Selkirk First Nation can be accomplished through postings in the community offices and Yukon College and using the local coordinators to build community awareness of the project.

The general duties of these individuals would include:

- Preparation and layout of moss bag samples;
- Assistance in collecting vegetation and soil samples; and
- Assistance with small mammal trapping program.

Once the local assistants have been hired, it is proposed that a one-day training session be held to cover the following topics:

- Construction / operation of passive (moss bags);
- Laboratory analysis coordination / chain-of-custody;
- Sampling methods and field QA / QC;
- Field logistics / helicopter safety;
- Hands-on field exercises;
- Basic soils description and plant identification;
- Background on mechanisms of airborne metals / trace element contamination;
- Data analysis / reporting; and
- Cartography for production of working maps and report maps.

The training would be accomplished through:

- Formal classroom session with Gartner Lee environmental specialists. This session would also include hands on field experience;
- A job shadowing / mentoring component for pre-field seasons and post-field season activities for local assistants will be considered. Upon completion of the classroom training program, it is recommended that a mentor be assigned to each student. Mentoring will be initiated prior to the

commencement of fieldwork and could last until reporting stage of project delivery. Post-field season activities could include training in reporting, analyses, and mapping activities.

7.2 Elders

The study design incorporates the necessary assistance of Elders in the field. The assistance would come in the form of leading field personnel in identification and location of plant species of importance (*e.g.*, berries) and mineral lick sites for contribution to the 2004 summer field sampling program, as per Section 4.4. It is proposed that one Elder from Selkirk First Nation and one Elder from Ross River Dena Council will be required for approximately two days each.

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Figures

Appendices

Appendix A

Issues, Questions and Recommendations Raised Over Course of the Terrestrial Effects Study

Table A.1. Issues, Questions and Recommendations Raised Over Course of the Terrestrial Effects Study

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
02 February, 2004: Gartner Lee office, Whitehorse	Yukon Government – Dept. of Environment, Dept. of Energy, Mines and Resources (Agriculture Branch) and the Executive Council Office	1) Some metals are essential to wildlife – need to consider this in the design; 2) Consider how widespread the contamination is in all areas where it was identified; 3) Consider the consumption of lichen by ungulates as an indicator; 4) Consider the ultimate fate or mobility of metals identified; 5) Study should include an assessment of fungus and mushrooms as these are used by First Nations. Sample garden vegetables in Town; 6) Address mineral licks traditionally used by wildlife in overall assessment.	1) Section 4.5 2) Section 4.1 3) Section 4.4 4) Section 4.1 5) Section 4.4 6) Section 4.4
03 February, 2004: Selkirk First Nation at Pelly Crossing	Selkirk First Nation (SFN)	1) Consider snow sampling to address winter patterns for dust; 2) Two Selkirk students are available for training/employment – George Magrum and Dean Gill. Selkirk wants to initiate a student training program for soil and water sampling; 3) Are there other studies beyond the Terrestrial Effects that Selkirk could be involved in. Selkirk wants a list of studies that are being undertaken in 2004 and how the community can be involved.	1) Section 4.3 2) Section 5.0. Water sampling is beyond the scope of this project, but coordination among the various studies regarding employment is recognized as being necessary. Comment will be passed to Type II Mines Office. 3) This comment was forwarded to Type II Mines Office (February 2004).
04 February, 2004: RRDC at Ross River	Ross River Dena Council (RRDC)	1) Consider using two of their students; 2) Killed moose had lumps in lungs, and should be considered as part of the study; 3) Concern was raised on the colour of downstream water in Anvil Creek from Rose Creek.	1) Section 5.0 2) Section 4.5; 4) Water quality in Rose Creek is continuously monitored and AMP in place to respond to significant changes. Comment will be past on to 2004 – 2008 Water Licence contact (E. Denholm, GLL).

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
04 February, 2004: Town of Faro	Mine Site Personnel	1) Offered initial information about wildlife patterns around the mine site; 2) Deloitte's mine site personnel have observations on dust migration; 3) Deloitte's mine site personnel have local information on trap lines, hunting areas, mineral licks and general wildlife areas.	1) Section 4.5 2) Section 4.1 and 4.3 3) Section 4.4 and 4.5
05 February, 2004: Town of Faro	Town of Faro	1) Concerned with dust contamination in homes and town site (will air monitoring in homes be available?); 2) Concerned about the exposure that current mine workers are possibly bringing into town; 3) Will soil sampling occur within the Town for lead-zinc (gardening).	1) Section 4.1 will partially address this issue by aiming to determine the spatial extent of potential contamination and Section 4.3 will address it through determination of whether deposition is ongoing. Air monitoring specifically in Faro homes will not be addressed in this study but could rather be addressed in a human health risk assessment. 2) Human health issues will be addressed in a human health risk assessment and through current Mine Health and Safety Protocols. 3) Section 4.4
06 February, 2004: Gartner Lee office, Whitehorse	Yukon Government, Dept. of Energy, Mines and Resources (Minerals Management Branch)	1) Consider the mineralogy of surface sediment with high metals values (may be useful from an impact perceptive (leachability of metal). Consider the inertness and solubility of metals; 2) Consider the initial exploration soil geochemisty or initial mine site studies for establishing baseline/background conditions; 3) Consider cyanide and ammonia from the blasting processes and the mill.	1) Section 4.1 2) Section 4.2 3) Ammonia and cyanide are considered issues that are primarily of concern in the aquatic environment (L. Gomm pers. comm., June 2004). Comment will be past on to 2004 – 2008 Water Licence contact (E. Denholm, GLL).

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
10 February, 2004: Written comments based on review of Technical Memorandum; Conceptual Study Design, Anvil Range Mine (Terrestrial Effects).	Yukon Government, Dept of Environment	1) What effects, if any are there on selected wildlife species that ingest plants with metal content at the observed concentrations? 2) How widespread contamination? Can lines be drawn to show concentration gradients and demarcate where toxic concentrations occur? 3) Some of the metals are trace elements required for animal nutrition. At what level does "contamination" occur? 4) Sampling should provide enough data to show concentration gradients to be drawn on the study area. 5) Wind patterns on site should be documented (airport may not be representative). 6) Sample mineral licks in study area to document background. 7) Sample twigs of selected shrubs (as well as leaves). 8) Sampling of vegetation and soils on mine waste or capped sites may indicate effects of pH on rate of metal uptake. Useful in mitigation (liming to raise pH if soil acidity occurring) 9) Coordinate wildlife tissue samples with existing contaminants/country food program. 10) Wildlife not consumed by humans (trapping) may also be important to sample.	1) Results of Sections 4.4 and 4.5 will be fed into a future ecological risk assessment that will address this issue. 2) Section 4.1 3) Section 4.5 will be fed into a future ecological risk assessment that will address this issue. 4) Section 4.1 5) Section 4.1 6) Section 4.4 7) Section 4.4 8) Section 4.1 and 4.4 will provide data that could be used to investigate this issue. However, comparison may be confounded by very low availability of vegetation on mine wastes. 9) Section 4.5 10) Section 4.5
11 February, 2004: Written comments based on review of Technical Memorandum; Conceptual Study Design, Anvil Range Mine (Terrestrial Effects).	Environment Canada	1) Distance of the transect to determine the spatial distribution should be determined as an exponential function through interpolation; 2) Lichen may be the only one to be concerned with for the spatial distribution; 3) Establish the reference location with the geological maps of the area and prevailing wind direction in mind. Looking at the preliminary survey, superimpose the contamination with the geological map and determine the area where contamination occurs. Find similar geological structure that is in the region but not subject to the influence of the mine. 4) Consider standard dry deposition monitoring in the	1) Section 4.1 2) Section 4.1 3) Section 4.2 4) Section 4.3 (determination of potential contaminant sources will await results of 2004 program to determine whether deposition historical or ongoing). 5) Section 4.3 (determination of potential contaminant sources will await results of 2004 program to determine whether deposition historical or

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		forest of the particulate concentration, e.g., Hi-Vol sampling. 5) Objective 4 (Conceptual Design, Dec 2, 2003) may be addressed through Objective 3 in that samplers can be set in places where sources of contaminants have the greatest potential, *i.e.*, tailings; 6) Long term trend will not show up until the reclamation of the tailings and other minor sources such as roads, therefore Objective 5 (Conceptual Design, Dec 2, 2003) is not realistic 7) Objective 6 (Conceptual Plan, Dec 2, 2003) is not necessary at this time. It would probably be better addressed through a literature survey or after reclamation of the site is completed. 8) Objective 7 (Conceptual Plan, Dec 2, 2003) can be determined by the Traditional Knowledge analysis; 9) Consider list of air quality biomonitoring references provided by EC; 10) Often metal scans (26 metals or more) are used for analysis of samples. The full reporting of this information should be provided in addition to metal concentrations.	ongoing). 6) Accepted and omitted from study objectives. 7) Accepted and omitted from study objectives. 8) Section 4.4 9) Information to be provided 10) All Sections
15 March, 2004: Town of Faro (open house), council chambers	Town of Faro	1) Commitment to deposit a copy of the CE Jones & Associates (2003) report to the Town of Faro Library; 2) The dump area on mine site has old car batteries, motors, etc. that may be contaminating soil (since 1970's); 3) Will soil sampling at depth be done - metals could be leached down by water; 4) Consider scat for sampling; 5) Weinstein (1992) – hard to get hold of, but may be useful for this study; 6) Consider increased precipitation / melting based on high snow base this year; 7) Consider insects/invertebrates that may be sensitive to metals such as zinc and lead; 8) Consider vertical coring of tree twigs; 9) Concern that further sampling should be conducted	1) A copy of the CE Jones & Associates (2003) report was deposited in each of the Town of Faro Library and the Town of Faro office (16 April 2004) 2) Soil remediation will be addressed in the closure plan. Comment will be passed on to Type II Mines Office. 3) Section 4.1 4) Section 4.5. Kidneys, liver and muscle are the standard for sampling and analysis of wildlife tissues. Use of hair / fur as a non-lethal method of metal sampling in wildlife

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		on sheep who frequent the mine site area to check levels of contaminants; 10) Concern reference sample locations are not far enough away and metal levels in the surface samples exceed subsurface samples.	will also be investigated. This requires correlation between metal levels in muscle, kidneys and liver with hair / fur from same individual. This is not possible with scat. 5) Sections 4.4 and 4.5 6) Section 4.1. Climate station data from Faro mine site and Faro airport will be available to assist in the interpretation of results. 7) Benthic invertebrates from streams at the Faro mine site have been previously analyzed for metals (Deloitte and Touche and Gartner Lee Ltd. 2003). Comment will be past on to 2004 – 2008 Water Licence contact (E. Denholm, GLL). 8) Section 4.3 aims to determine timing of potential contamination through moss bag sampling; tree coring will not be considered at this time. 9) Section 4.5 10) Section 4.2
15 March 2004: Anvil Range Mine Site Tour	Dan Duivenvoorden, Deloitte & Touche Inc.	1) Mr. Duivenvoorden provided information on the location of natural and artificial mineral licks; 2) Mr. Duivenvoorden provided information on habitat use patterns of wildlife in the area.	1) Section 4.4 2) Section 4.4
15 March 2004: Anvil Range Mine Site Personnel, Guest House Board Room, Town of Faro	Anvil Range Mine Site Personnel	1) Mine personnel provided information on the location of natural and artificial mineral licks; 2) Mine personnel provided information on habitat use patterns of wildlife in the area and areas of forage	1) Section 4.4 2) Section 4.4 3) Section 4.5

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		concentration; 3) Mine personnel provided information on trapline use in area.	
16 March, 2004: Meeting with Selkirk Representatives, GLL Whitehorse Office	Selkirk First Nation	1) Stewardship monitoring programs conducted by Selkirk FN could facilitate tissue sampling. Stewards are usually in the field during hunting season (fall). Tissue storage could be facilitated through Selkirk FN due to presence of freezer. Stewardship monitoring program is currently in the process of being reviewed by Chief and Council; 2) Coordination is needed with Northern Contaminants Program (NCP) and with other Bands (RRDC); 3) Look at results coming out of Red Dog Mine; 4) SFN asked if snow sampling was going to be done as part of the TE project; 5) Students (Yukon College) at SFN and Ross River are interested in working on this study; 6) SFN usually assigns Elders to projects.	1) Section 4.5 2) Section 4.5 3) All sections 4) Section 4.3. 5) Section 5.0 6) Section 5.0
17 March, 2004: Meeting with R. Ward, YTG Dept. of Environment	Yukon Government, Dept. of Environment (R. Ward)	1) R. Ward voiced concern with regards to placement of artificial licks near soda ash deposit on Faro site with aim of pulling moose away from contaminated site (as outlined in 2004 – 2008 Water License). Concern related to increased potential of moose mortality through harvesting of animals on site and chance of attracting more moose to the site. An aversive approach is considered more useful, *e.g.*, placement of electric fencing around soda ash deposit.	1) Comment will be passed on to 2004 – 2008 Water Licence contact (E. Denholm, GLL).
17 March, 2004: Meeting with Pat Roach and Mary Gamberg, GLL Whitehorse Office	Pat Roach/ Mary Gamberg	1) Hunter Survey Program – archived samples available but no money to analyze. Need to coordinate the TE project with this program – possibly add incentives; 2) Need to collect tissue from small mammals and large animals; 3) Agreed that it might be a good idea to collect tissue and hair samples (no fatality). Could archive the hair samples for later analyses, once a correlation has been found between tissue and hair samples;	1) Section 4.5 2) Sections 4.5 3) Section 4.5 4) Section 4.4 and 4.5 5) Section 4.5 6) It was decided that lead isotope analysis would not be included in the 2004 workplan but would be considered for future work if

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		4) Find out what the First Nations are eating; 5) Possible to involve communities in trapping efforts for this project; 6) Consider isotope analysis for samples from the tailings and link to soil, lichen, wildlife samples; 7) Consider analyzing for molybdenum; 8) Consider having the First Nations involved in berry collection; 9) Consider sediment cores in nearby lakes (*e.g.*, Eagle Lake) to determine timing of dust contamination. Fresh water supply dam not appropriate (pumped and volume low since 1969); 10) Consider conducting dispersion and depositional modelling to aid in defining aerial extent of elevated metal concentrations. Light elements may adhere to smaller particles, therefore dispersion predictions should be based on dispersal of the smallest elements; 11) Link Pelly and Tay monitoring into the study, although likely beyond zone of impact; 12) Lynx don't tend to accumulate contaminants, but may want to consider collecting a few samples of such species for reassurance; 13) Consider incentives for cooperation by communities in providing samples; 14) Contact Conservation Officers and ensure the Hunter Survey Program and Yukon Biological Submission Forms are completed; 15) Contact Helen Slama (Fur Harvest Technician at YTG Environment) for list of non-native trappers and source of information for trap lines.	the results of the 2004 program supported this, *i.e.*, if ongoing deposition is occurring, lead isotope analysis could further results of Hi-Vol sampling, if required, to prioritize reclamation activities (Section 4.3). 7) All sections. 8) Section 4.4 9) It was decided that sediment core analysis would not be included in the 2004 workplan but would be considered for future work if the results of the 2004 program supported this. It is thought that the methods outlined in Section 4.3 will provide information on timing of deposition necessary for input into closure plan. 10) Section 4.1 11) Sampling of lichen and soils will be conducted at confluence of Anvil Creek and Pelly River (Section 4.1). Await results of 2004 study before sampling farther, *e.g.*, Tay River. 12) Section 4.5 13) Section 4.5 14) Section 4.5 15) Section 4.5
April 21 – 22, 2004 Selkirk First Nation Traditional	Selkirk First Nation	1) Elders and other members of SFN provided information on food habits of wildlife that occur in	1) Sections 4.4 and 4.5 2) Section 4.5.

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
Knowledge Workshop, Selkirk		the area of the Upper Pelly River; 2) Elders and other members of SFN raised concerns that the fats on moose were once white and firm whereas this fat is now reddish colored and soft; 3) Elders and other members of SFN are disturbed by scientific study habits, specifically the collars and tags attached to wildlife, animals and fish; 4) Elders and other members of SFN raised concerns about the quality of fish as food nowadays, *e.g.*, a Chinook salmon was caught with blue colored flesh, there are worms in the salmon now with definite holes in the flesh and chinook are returning to spawn with a crooked back; 5) Elders and other members of SFN raised concerns that families of ducks, geese and swans are not as plentiful; 6) Elders and other members of SFN raised concerns that berries have been strange for the last 15 years; cranberries and strawberries displaying a white coloration and berries are drying prematurely and turning black; 7) Elders and other members of SFN raised concerns about general changes in air quality in the Upper Pelly; 8) Elders and other members of SFN raised concerns about general changes in water quality in the Upper Pelly; 9) Elders and other members of SFN raised concerns that the snow is a dry snow now with very little water content; 10) Elders and other members of SFN suggested the health of the people be investigated; 11) Elders and other members of SFN suggested that spruce and balsam pitch, the inner bark of birch trees, red willow leaves, wetland plants, flowering plants, soapberries be considered for inclusion into study design; 12) Elders and other members of SFN suggested training and hiring of SFN members;	3) Comment will be passed on to YTG Dept. of Environment. 4) Comment will be passed on to Department of Fisheries and Oceans (DFO). 5) Comment will be passed on to Canadian Wildlife Service (CWS). 6) Section 4.4 7) Section 4.3 8) Comment will be passed on to Type II Mines Office. 9) Comment will be passed on to YTG Water Resources. 10) Human health issues will be addressed in a future human health risk assessment. 11) Section 4.4 12) Section 5.0 13) Comment will be passed on to Type II Mines Office.

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		13) Elders and other members of SFN voiced concerns about the Rose Creek Diversion and tailings removal. Concerned that the removal of the tailings and any subsequent natural background materials may weaken the structure of the diversion channel, taking out any contaminants with a suddenly diverted stream flow.	
5 May 2004 Ross River Terrestrial Effects Workshop, Ross River	Ross River Dena Council (RRDC)	1) Elders and other members of RRDC provided information on habitat use patterns of wildlife in the area and areas of forage concentration; 2) Elders and other members of RRDC provided information on the location of natural mineral licks; 3) Elders and other members of RRDC suggested that we notify the public over the radio in late July (*i.e.*, just before most hunting begins and by July 20) of our need for wildlife tissue samples / carcasses. We may also want to remind folks just before trapping season too; 4) Elders and other members of RRDC suggested that we provide Helena Jirousik in Ross River with a map so that folks who submit carcasses can pinpoint the grid cell (UTM) in which they trapped / hunted the specimen. Also provide collector with a means of storing the samples, *i.e.*, bags etc.; 5) Elders and other members of RRDC provided information on vegetation species of importance to wildlife and humans in the area; 6) Elders and other members of RRDC suggested we should consider trapping beaver for the purposes of this study alone. Beaver are considered an appropriate study animal given their interface with the terrestrial and aquatic environments; 7) Elders and other members of RRDC mentioned the importance of hiring locally and provided us with the names of four students who would be very suitable for any training and field work:	1) Section 4.4 2) Section 4.4 3) Section 4.5 4) Section 4.5 5) Section 4.4 6) Section 4.5 7) Section 5.0 8) Section 5.0 and 6.0 9) Benthic invertebrates from streams at the Faro mine site have been previously analyzed for metals (Deloitte and Touche and Gartner Lee Ltd. 2003). 2004 – 2008 Water Licence contact (E. Denholm, GLL). 10) Comment will be passed on to Type II Mines Office. 11) Comment will be passed on to 2004 – 2008 Water Licence contact (E. Denholm, GLL). 12) Comment will be passed on to YTG Dept. of Environment. 13) Comment will be passed on Type II Mines Office. 14) Comment will be passed on to YTG Dept. of Environment 15) Comment will be passed on Type II Mines Office.

Reference/Meeting/Date	Organization	Issue/Question/ Recommendation	Action Taken
		Jason Acklack; Greg McLeod; Robert Olsen; Brian Ladue; 8) Elders and other members of RRDC suggested project team should return to Ross River periodically to update the RRDC and also to receive additional feedback to study design. And that this would be especially valuable after the traditional knowledge workshop planned for June 2004; 9) Members of RRDC asked whether we would be sampling insects as part of this study; 10) An elder from the RRDC commented that there used to be a lot more caribou on the Faro Mine Site than there are today. He believes that their displacement was caused by mine activities, *e.g.*, noise; 11) Elder from the RRDC mentioned that the colour of Rose Creek has changed from clear to milky and believes that this is a result of mine influence; 12) Members of RRDC voiced concern that sheep viewing activities at Sheep Mountain near Faro has resulted in the sheep being habituated by the viewing activities and are no longer wild; 13) Members of RRDC suggested, as a precautionary measure that a number of signs be placed around the mine site informing people harvesting there (vegetation and wildlife) that there is contamination in this area; 14) Elders and members of RRDC voiced concern that large game (especially moose) have been over hunted in the are of the Faro Mine; 15) Elders and members of RRDC told us that land was sacred and any significant changes, *e.g.*, dewatering of the freshwater reservoir should first be blessed by elder. RRDC should be kept more informed of activities such as these on the mine site.	

Appendix B

Worker Health & Safety Plan for On-Site Work

Introduction

This Site Specific Health and Safety Plan (HASP) is applicable for all on-site environmental work on the Anvil Range Mine Complex to be performed in 2004 as part of the Terrestrial Effects Study.

The purpose of the HASP is to provide reasonable protection to workers from foreseeable health and safety hazards as outlined below. This HASP also intends to limit the dissemination of potentially contaminated materials to the town of Faro.

Adherence to this HASP is a requirement of any and all contracts for on-site work awarded by Deloitte and Touche (in their capacity as Interim Receiver for Anvil Range Mining Corp.) or Gartner Lee Ltd. as part of this project.

This HASP applies to, but is not limited to, field personnel (First Nation Elders, scientists, assistants and technicians), government or other visitors to the work sites and mine employees who may visit the work sites.

A qualified first aid attendant will be available at the Faro guardhouse for the duration of this project. This person will be utilized as the initial response to any incident requiring first aid.

Hazard Assessment

The health and safety hazards that are likely to be encountered at the Anvil Range Mine Complex relate to the nature of working with and around helicopters, trucks and all terrain vehicles, working in isolated field environments (*i.e.*, maximum 30km straight line distance from the Anvil Range Mine Complex although typically within approximately 10km of the mine site), and the chemical contamination of some surficial materials and some surface water. The possible effects of the physical and chemical hazards are magnified by the remote location of the mine sites.

The physical hazards that may be encountered on site include the following:

- Injury related to walking and carrying equipment over tailings, waste rock and steep slopes of tailings, soil or rock;
- Wildlife encounters, especially bears;
- Windblown tailings injuring skin or eyes;
- Safety hazards in mine buildings and areas that may be visited for supplies;
- Vehicle damage or personal injury related to steep drop offs near open pits and rock dumps;
- Vehicle damage or personal injury due to rock falls or slides from overhanging rock faces rock slopes;
- Vehicle damage or personal injury related to collision with other traffic or fixed obstacles;

- Safety hazards around helicopters;
- Safety hazards of working in remote, rugged terrain.

The chemical hazards that may be encountered on site include the following:

- Sickness related to ingestion of contaminated water or soils / tailings;
- Inhalation of tailings dust or oxidation products;
- Transport of contaminated soil or tailings to the town of Faro where it may be disseminated to the public;
- All of the mine and creek water on the mine sites is subject to the presence of harmful bacteria that precludes the use of this water for drinking or washing regardless of the compliance for some chemical parameters.

Health and Safety Plan

The following health and safety requirements are to be adhered to by all workers for this project. Refusal to adhere to will be cause for dismissal and expulsion from the property at the sole discretion of the mine manager or his designate.

Fitness for Work

1. Project personnel will work and act in a safe, professional and responsible manner while on the mine site.

2. Any worker arriving for work intoxicated, under the influence of illegal drugs or otherwise physically unfit for work will be refused access to the mine site at the sole discretion of the mine manager or his designate.

Check-In Procedure and Mine Access

3. All personnel will check in and out at the Faro guardhouse upon arrival to and departure from the mine site in a manner acceptable to the Guardhouse attendant even when working in the tailings area or more remote locations (*e.g.*, sign out in the morning and provide a detailed description of their planned field itinerary and anticipated arrival time back at camp / field office).

Should a crew fail to arrive back at the main camp **1 hour** after the anticipated arrival time, the following will occur:

a) Attempt to establish radio communications with the crew;

b) If the above procedure fails to locate the crew, a vehicle-based search will be initiated from main camp / field office; and

c) If contact cannot be made through the above procedures, a formal search will be initiated. This may involve contacting local RCMP or any other action deemed necessary by the mine manager or his designate.

At all times during this sequence of events, one person will be designated to remain at the main camp / field office to monitor communications.

4. All access to the Vangorda Plateau mine site will be via the Faro guardhouse unless specifically authorized by the mine manager or his designate.

5. Project personnel will not enter or travel to areas of the mine site that are not specifically part of the project area unless authorized by the mine manager or his designate.

Personal Protective Equipment and Training

6. Paper dust masks and safety goggles will be worn when wind blown dust is deemed to be an annoyance or a health hazard in cases of wind blown tailings; the mine manager or his designate will have final authority regarding the wearing of dust masks and goggles.

7. Disposable latex gloves will be worn while collecting samples of soil and vegetation.

8. Project personnel will dress appropriately for the prevailing weather conditions including sunglasses and other appropriate protection from solar radiation. Shirts with sleeves and long pants must be worn at all times.

9. All field personnel will carry the following personal safety equipment:

    a) WCB First Aid Kit;
    b) bear spray;
    c) whistle;
    d) suitable clothing;
    e) small portion of high energy food; and
    f) waterproof matches and knife.

10. Mobile radios will be located in all field vehicles used by GLL. Proper radio protocol will be used at all times. This includes refraining from unnecessary discussions and the use of non-professional language.
11. All GLL field staff have completed WCB-endorsed Level 1 Standard First Aid and CPR training. This certification is kept active through re-certification as required.

12. If specialized equipment is required to complete a task / project, proper training has been provided to responsible staff.

Wildlife Protection

13. All GLL field staff have completed a Bear Awareness Course.

14. If a worker is working at a distance of greater than 50 metres from an unlocked vehicle, then that worker must be in possession of bear spray, bear bangers or a similar protective device.

15. Project personnel will remove all garbage or other debris from project work areas to designated disposal locations at the end of each work shift and shall maintain work areas in a neat manner that does not attract bears or other wildlife.

16. All small mammal trapping staff will wear protective field gear (rubber gloves, half-mask respirator with Hanta virus proof filters, full coveralls and safety glasses) to minimize exposure to Hanta Virus pathogens. Any further precautions necessary will be taken to minimize exposure of any known airborne pathogens potentially encountered during ecological studies of wildlife.

Working Alone

17. Field personnel will not work alone without first notifying a responsible party of their intentions. The responsible party could be a fellow field personnel or the Faro guardhouse attendant. They will check in with the responsible party at the start and completion of the work; and will not work alone for a period of longer than 2 hours without checking in. If a pre-arranged contact time is missed, then the responsible party will stop work immediately and initiate a search for the missing person.

Working Near Heavy Equipment

18. No worker will assist with the operation of heavy equipment or otherwise work directly on heavy equipment without the specific consent and only under the direction of the equipment operator.

19. All workers will follow the directions of equipment operators when working in the immediate vicinity of heavy equipment.

Vehicle Safety

20. Vehicles will not be parked in locations where the risk of rock falls or crumbling edges is present.

21. Vehicles will be operated on a safe and professional manner at all times within the mine and tailings areas.

22. Vehicle operators will obey posted speed limits on public roads within and in the vicinity of the town of Faro and will obey the following speed limits in the mine area:
    - Public road from Town of Faro to minesite: 90 km / hr or as otherwise posted
    - Vangorda Haul Road from Faro crusher area to Grum “hotline”: 80 km / hr
    - all other mine roads including tailings area access road: 50 km / hr

23. Vehicle operators will slow to 20 km / hr or come to a stop, as appropriate for safety, when passing through the Faro security gate.

24. Helicopter transportation will be used occasionally during this project. Prior to any helicopter-based fieldwork commencing, field crews, regardless of their level of helicopter experience, will undergo a pre-flight briefing from the contracted helicopter company.

25. All field vehicles will carry the following safety equipment:

    a) WCB Level 1 First Aid Kit;
    b) blankets;
    c) saw and shovel;
    d) fire extinguisher;
    e) portion of high energy food and water; and
    f) matches and flashlight

Prevention of Chemical Contamination

26. Smoking is not allowed while working on the tailings impoundments; this restriction also applies to vehicles parked on the tailings impoundments.

27. Workers will wash their hands and face in clean water prior to eating. Clean water can be obtained from the Faro guardhouse or the town of Faro; creek water may not be used for washing due to the possible presence of bacteria.

28. Project personnel will not drink or wash in water from mine seeps, local creeks, lakes or ponds.

29. Project personnel will not collect or eat berries or other vegetation in the immediate vicinity of the mine site or tailings areas.

Prevention of Contaminant Transport to Town of Faro

30. Workers will make reasonable attempts to prevent the transport of contaminated materials to the town of Faro by leaving dirty coveralls and boots at the minesite when appropriate and by washing hands before departing the mine site.

31. Workers will wash and change clothes prior to entering the restaurant or other public locations in the town of Faro if the worker's clothes, hands or other items are dirty from working at the minesite or tailings area.

32. Project vehicles will be kept reasonably clean during the project; it will be the responsibility of the primary operator of a vehicle to maintain the vehicle in a clean and professional manner.

Notification Procedure

All health and safety incidents must be reported to the mine manager or his designate even if they did not require or result in a response action.

In the case of a medical or first aid incident, the first contact should be with the Faro Guardhouse where a qualified first aid attendant is on duty 24 hours per day. The guardhouse attendant will then take control of the incident including further notifications.

Faro Mine Guardhouse	(867) 994 2600

In the event that notification to the Faro guardhouse is not possible or is otherwise unachievable, then the following public response numbers apply:

RCMP	(867) 994 5555 or 1 867 667 5555
Fire	(867) 994 2222
Ambulance	(867) 994 4444

To report a health and safety incident, the following numbers apply:

Mine Manager (Dana Haggar) home office	(867) 994 2647
Maintenance Manager (Mike Bryson) home office	(867) 994 2578
Guest House (Town of Faro)	(867) 994 2459
Deloitte (Toronto Office)	(416) 601 6147
Gartner Lee (Whitehorse Office)	(867) 633 6474
Gartner Lee (Yellowknife Office)	(867) 873 5808

The undersigned have reviewed the Worker Health and Safety Plan for 2004 Environmental Work at the Anvil Range Mine Complex and agree to adhere to all of the conditions therein.

NAME (printed)	SIGNATURE	ORGANIZATION	DATE

Appendix C

Proposed Schedule Terrestrial Effects Study 2004 / 2005

Gartner Lee

Table C.1. Proposed Schedule, Terrestrial Effects Study 2004/2005