AQUATIC EFFECTS TECHNOLOGY EVALUATION (AETE) PROGRAM

1996 Preliminary Field Survey
Dome Mine Site,
Ontario

AETE Project 4.1.2

1996 Preliminary Field Survey
Dome Mine Site, Ontario

Sponsored by :

Canada Centre for Mineral and Energy Technology (CANMET)
Mining Association of Canada (MAC)

on Behalf of :

Aquatic Effects Technology Evaluation (AETE) Program

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AQUATIC EFFECTS TECHNOLOGY EVALUATION PROGRAM

Notice to Readers

Aquatic Effects Monitoring
1996 Preliminary Field Surveys

The Aquatic Effects Technology Evaluation (AETE) program was established to review appropriate technologies for assessing the impacts of mine effluents on the aquatic environment. AETE is a cooperative program between the Canadian mining industry, several federal government departments and a number of provincial governments; it is coordinated by the Canada Centre for Mineral and Energy Technology (CANMET). The program is designed to be of direct benefit to the industry, and to government. Through technical evaluations and field evaluations, it will identify cost-effective technologies to meet environmental monitoring requirements. The program includes three main areas: acute and sublethal toxicity testing, biological monitoring in receiving waters, and water and sediment monitoring. The program includes literature-based technical evaluations and a comprehensive three year field program.

The program has the mandate to do a field evaluation of water, sediment and biological monitoring technologies to be used by the mining industry and regulatory agencies in assessing the impacts of mine effluents on the aquatic environment; and to provide guidance and to recommend specific methods or groups of methods that will permit accurate characterization of environmental impacts in the receiving waters in as cost-effective a manner as possible. A pilot field study was conducted in 1995 to fine-tune the study design.

A phased approach has been adopted to complete the field evaluation of selected monitoring methods as follows:

Phase I: 1996- Preliminary surveys at seven candidate mine sites, selection of sites for further work and preparation of study designs for detailed field evaluations.

Phase II: 1997-Detailed field and laboratory studies at selected sites.

Phase III: 1998- Data interpretation and comparative assessment of the monitoring methods: report preparation.

Phase I is the focus of this report. The overall objective of this project is to conduct a preliminary field/laboratory sampling to identify a short-list of mines suitable for further detailed monitoring, and recommend study designs. The objective is NOT to determine the detailed environmental effects of a particular contaminant or extent and magnitude of effects of mining at the sites.

In Phase I, the AETE Technical Committee has selected seven candidates mine sites for the 1996 field surveys:

1) Myra Falls, Westmin Resources (British Columbia)
2) Sullivan, Cominco (British Columbia)
3) Lupin, Contwoyto Lake, Echo Bay (Northwest Territories)
4) Levack/Onaping, Inco and Falconbridge (Ontario)
5) Dome, Placer Dome Canada (Ontario)
6) Gaspé Division, Noranda Mining and Exploration Inc. (Québec)
7) Heath Steele Division, Noranda Mining and Exploration Inc. (New-Brunswick)

Study designs were developed for four sites that were deemed to be most suitable for Phase II of the field evaluation of monitoring methods (Myra Falls, Dome, Heath Steele, Lupin). Lupin was subsequently dropped based on additional reconnaissance data collected in 1997. Mattabi Mine, (Ontario) was selected as a substitute site to complete the 1997 field surveys.

For more information on the monitoring techniques, the results from their field application and the final recommendations from the program, please consult the *AETE Synthesis Report* to be published in September 1998.

Any comments regarding the content of this report should be directed to:

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PROGRAMME D'ÉVALUATION DES TECHNIQUES DE MESURE D'IMPACTS EN MILIEU AQUATIQUE

Avis aux lecteurs

Surveillance des effets sur le milieu aquatique
Études préliminaires de terrain - 1996

Le Programme d'évaluation des techniques de mesure d'impacts en milieu aquatique (ÉTIMA) vise à évaluer les différentes méthodes de surveillance des effets des effluents miniers sur les écosystèmes aquatiques. Il est le fruit d'une collaboration entre l'industrie minière du Canada, plusieurs ministères fédéraux et un certain nombre de ministères provinciaux. Sa coordination relève du Centre canadien de la technologie des minéraux et de l'énergie (CANMET). Le programme est conçu pour bénéficier directement aux entreprises minières ainsi qu'aux gouvernements. Par des évaluations techniques et des études de terrain, il permettra d'évaluer et de déterminer, dans une perspective coût-efficacité, les techniques qui permettent de respecter les exigences en matière de surveillance de l'environnement. Le programme comporte les trois grands volets suivants : évaluation de la toxicité aiguë et sublétale, surveillance des effets biologiques des effluents miniers en eaux réceptrices, et surveillance de la qualité de l'eau et des sédiments. Le programme prévoit également la réalisation d'une série d'évaluations techniques fondées sur la littérature et d'évaluation globale sur le terrain.

Le Programme ÉTIMA a pour mandat d'évaluer sur le terrain les techniques de surveillance de la qualité de l'eau et des sédiments et des effets biologiques qui sont susceptibles d'être utilisées par l'industrie minière et les organismes de réglementation aux fins de l'évaluation des impacts des effluents miniers sur les écosystèmes aquatiques; de fournir des conseils et de recommander des méthodes ou des ensembles de méthodes permettant, dans une perspective coût-efficacité, de caractériser de façon précise les effets environnementaux des activités minières en eaux réceptrices. Une étude-pilote réalisée sur le terrain en 1995 a permis d'affiner le plan de l'étude.

L'évaluation sur le terrain des méthodes de surveillance choisies s'est déroulée en trois étapes:

Étape I 1996 - Évaluation préliminaire sur le terrain des sept sites miniers candidats, sélection des sites où se poursuivront les évaluations et préparation des plans d'étude pour les évaluations sur le terrain.

Étape II 1997- Réalisation des travaux en laboratoire et sur le terrain aux sites choisis

Étape III 1998 -Interprétation des données, évaluation comparative des méthodes de surveillance; rédaction du rapport.

Ce rapport vise seulement les résultats de l'étape I. L'objectif du projet consiste à réaliser des échantillonnages préliminaires sur le terrain et en laboratoire afin d'identifier les sites présentant les caractéristiques nécessaires pour mener les évaluations globales des méthodes de surveillance en 1997 et de développer des plans d'études. Son objectif N'EST PAS de déterminer de façon détaillée les effets d'un contaminant particulier, ni l'étendue ou l'ampleur des effets des effluents miniers dans les sites.

À l'étape I, le comité technique ÉTIMA a sélectionné sept sites miniers candidats aux fins des évaluations sur le terrain:

1) Myra Falls, Westmin Resources (Colombie-Britannique)
2) Sullivan, Cominco (Colombie-Britannique)
3) Lupin, lac Contwoyto, Echo Bay (Territoires du Nord-Ouest)
4) Levack/Onaping, Inco et Falconbridge (Ontario)
5) Dome, Placer Dome Mine (Ontario)
6) Division Gaspé, Noranda Mining and Exploration Inc.(Québec)
7) Division Heath Steele Mine, Noranda Mining and Exploration Inc.(Nouveau-Brunswick)

Des plans d'études ont été élaborés pour les quatres sites présentant les caractéristiques les plus appropriées pour les travaux prévus d'évaluation des méthodes de surveillance dans le cadre de l'étape II (Myra Falls, Dome, Heath Steele, Lupin). Toutefois, une étude de reconnaissance supplémentaire au site minier de Lupin a révélé que ce site ne présentait pas les meilleures possibilités. Le site minier de Mattabi (Ontario) a été choisi comme site substitut pour compléter les évaluations de terrain en 1997.

Pour des renseignements sur l'ensemble des outils de surveillance, les résultats de leur application sur le terrain et les recommandations finales du programme, veuillez consulter le *Rapport de synthèse ÉTIMA* qui sera publié en septembre 1998.

Les personnes intéressées à faire des commentaires sur le contenu de ce rapport sont invitées à communiquer avec M^{me} Diane E. Campbell à l'adresse suivante :

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EXECUTIVE SUMMARY

Information relevant to specific study elements for the Dome mine site are summarized in the following table.

Element	Sampled 1996	Summary/Comments
1.0 Historical Data Review 1.1 Effluent Characterization	N/A	Placer Dome has detailed effluent chemistry and toxicity data available
1.2 Water Chemistry	N/A	1989 data available from Exposure Area and just upstream of effluent discharge in EAG Report
1.3 Sediment Chemistry	N/A	1989 data available from Exposure Area and just upstream of effluent discharge in EAG Report
1.4 Benthos	N/A	same data available from Exposure Area and just upstream of effluent discharge in EAG Report
1.5 Fisheries 1.5.1 Population	N/A	qualitative numbers available on catch data but no population estimates
1.5.2 Tissue	N/A	some tissue data available for Exposure area only, only muscle tissue sampled
2.0 Study Area 2.1 Site Access	Y	site is accessible in both Reference and Exposure Areas
2.2 Availability of Multiple Reference and Exposure Areas	Y	multiple Exposure Areas are available but limited Reference Areas are available on this river system
2.3 Confounding Discharges	--	old inactive tailings areas influence water quality in this system
3.0 Effluent/Sublethal Toxicity 3.1 Frequency of Effluent Discharge	Y	effluent is available June to October
3.2 Sublethal Toxicity 3.2.1 *Ceriodaphrine dubia*	Y	no effects in 1996 but effluent has displayed acute toxicity in the past
3.2.2 Fathead minnow	Y	no effects in 1996 but effluent has displayed acute toxicity in the past
3.2.3 *Selenastrum capricornatum*	Y	toxic in 1996
3.2.4 *Lemna minor*	Y	toxic in 1996
3.2.5 Trout embryo	Y	test invalid
4.0 Habitats	Y	Reference and Exposure Areas very similar in habitat
5.0 Water Chemistry	Y	water chemical concentration is statistically greater in Exposure area relative to Reference area for several metals and for general chemistry parameters
6.0 Sediments	Y	Sediments are available. Concentration of metals (arsenic, copper, cobalt, nickel) are statistically greater in Exposure area relative to Reference area.

Element	Sampled 1996	Summary/Comments
7.0 Benthic Invertebrate	Y	Significant difference exists between Reference and Exposure area with respect to density, pooled number of taxa and indicator species
8.0 Fisheries 8.1 Communities	Y	Pearl Dace, Northern Redbelly Dace were used as sentinel species in 1996 and were abundant Insufficient data collected in 1996 to determine differences in fish communities and relative abundance between Reference and Exposure areas. However, based on the preliminary survey, the minnow CPUE was greater in the Reference area compared with the Exposure area. The 1996 results indicate that one sentinel species (Pearl Dace) grew faster in the Exposure area. Potential to use yellow perch in 1997 if lakes used for Reference and Exposure areas
8.2 Fish Tissue	Y	No significant difference in MT levels between Reference and Exposure areas Tissue metal levels were significantly higher in Pearl Dace from the Exposure area Barriers to fish migration occur throughout the system

SOMMAIRE

Le tableau ci-dessous résume l'information concernant certains éléments de l'étude relative à la mine Dome.

Élément	Échantillons prélevés en 1996	Sommaire/remarques
1.0 Revue des données historiques 1.1 Caractérisation de l'effluent	s.o.	Placer Dome inc. possède des données détaillées sur la composition chimique et la toxicité de l'effluent.
1.2 Chimie de l'eau	s.o.	Données de 1989 disponibles dans le rapport d'évaluation environnementale concernant la zone d'exposition et le secteur juste en amont du point de rejet de l'effluent.
1.3 Chimie des sédiments	s.o.	Données de 1989 disponibles dans le rapport d'évaluation environnementale concernant la zone d'exposition et le secteur juste en amont du point de rejet de l'effluent.
1.4 Benthos	s.o.	Données similaires disponibles dans le rapport d'évaluation environnementale concernant la zone d'exposition et le secteur juste en amont du point de rejet de l'effluent.
1.5 Pêches 1.5.1 Population	s.o.	Estimations qualitatives disponibles concernant les prises, mais pas d'estimations des populations.
1.5.2 Tissus	s.o.	Certaines données disponibles sur les tissus concernant la zone d'exposition seulement; seuls des échantillons de tissus musculaires ont été prélevés.
2.0 Zone d'étude 2.1 Accès au site	Oui	Endroit accessible dans la zone d'exposition et dans la zone de référence.
2.2 Disponibilité de plusieurs zones de référence et d'exposition	Oui	Plusieurs zones d'exposition mais peu de zones de référence sont disponibles dans le réseau hydrographique.
2.3 Rejets au même endroit	—	D'anciens secteurs comportant des résidus nuisent à la qualité de l'eau dans le réseau hydrographique.
3.0 Effluent et toxicité sublétale 3.1 Fréquence des rejets d'effluent	Oui	Rejet d'effluent de juin à octobre.
3.2 Toxicité sublétale 3.2.1 *Ceriodaphnia dubia*	Oui	Aucun effet observé en 1996, mais l'effluent a présenté une toxicité aiguë par le passé.
3.2.2 Tête-de-boule	Oui	Aucun effet observé en 1996, mais l'effluent a présenté une toxicité aiguë par le passé.
3.2.3 *Selenastrum capricornutum*	Oui	Toxique en 1996.
3.2.4 *Lemna minor*	Oui	Toxique en 1996.
3.2.5 Embryon de truite	Oui	Test non valide.
4.0 Habitats	Oui	Les habitats sont très similaires dans les zones de référence et d'exposition.
5.0 Chimie de l'eau	Oui	Statistiquement, les concentrations de plusieurs métaux sont plus élevées dans l'eau de la zone d'exposition que dans la zone de référence; même situation pour la chimie de l'eau en général.
6.0 Sédiments	Oui	On peut obtenir des sédiments. Les concentrations de métaux (arsenic, cuivre, cobalt, nickel) sont statistiquement plus élevées dans la zone d'exposition que dans la zone de référence.

Élément	Échantillons prélevés en 1996	Sommaire/remarques
7.0 Invertébrés benthiques	Oui	Il existe des différences importantes entre les zones de référence et d'exposition relativement à la densité et au nombre global de taxons et d'espèces indicatrices.
8.0 Pêches 8.1 Communautés	Oui	En 1996, le mulet perlé et le ventre rouge du nord, qui étaient abondants, ont été utilisés comme espèces indicatrices. Il n'y a pas eu suffisamment de données recueillies en 1996 permettant de déterminer les différences dans les communautés de poissons et l'abondance relative entre les zones de référence et d'exposition. Cependant, d'après l'étude préliminaire, les prises par unité d'effort relatives à la tête-de-boule dans la zone de référence ont été supérieures à celles enregistrées dans la zone d'exposition. Les résultats de 1996 indiquent que la croissance chez une espèce indicatrice (le mulet perlé) a été plus rapide dans la zone d'exposition . La perchaude pourrait être utilisée si l'on établit des zones d'exposition et de référence dans des lacs en 1997.
8.2 Tissus de poissons	Oui	Aucune différence importante entre les zones de référence et d'exposition relativement aux concentrations de métallothionéine (MT). Les teneurs tissulaires en métaux ont été beaucoup plus élevées chez le mulet perlé de la zone d'exposition. Il y a des obstacles à la migration des poissons dans tout le réseau hydrographique.

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1. INTRODUCTION

The Aquatic Effects Technology Evaluation (AETE) Program was established to conduct field and laboratory evaluation and comparison of selected environmental effects monitoring technologies for assessing impacts of mine effluents on the aquatic environment. The focus of the Program is on robustness, costs, and the suitability of monitoring sites.

Building upon previous work, which includes literature reviews, technical evaluations, and pilot field studies, the AETE Program sponsored preliminary evaluations of aquatic effects monitoring at seven candidate mine sites in 1996. Based on the results of these preliminary evaluations, some of these sites have been recommended for further work in 1997.

This final field survey report provides detailed information on work conducted at the Placer Dome gold mine in South Porcupine, Ontario. Separate reports are provided for each of the other six sites. Recommendations regarding selection of sites for 1997 work are provided under separate cover together with a field study design for each of the recommended sites.

2. SITE SPECIFIC BACKGROUND INFORMATION

2.1 Site Description

The Dome mine encompasses some 1448 ha near South Porcupine, several km. east of Timmins, Ontario. The mine has been in operation since 1910. It was expanded considerably a few years ago to include the new Dome super pit. Gold production is approximately 300,000 oz, per year. The mill processes approximately 4.2 million tons of ore annually of which 1.3 million tons is supplied from the underground operation and the remainder from the open pit.

The operation discharges into the South Porcupine River, which flows into the Porcupine River (Figure 2.1). There are several abandoned mines along the South Porcupine river that are thought to still influence water quality. The Porcupine River receives effluent from several active mine operations along its length.

The Dome operation utilizes gravity settling to produce a clear pond where effluent is recycled back to the mill for re-use. Excess effluent is treated through an effluent treatment plant prior to being discharged to the environment. Treatment consists of ferric sulphate and lime for the treatment of heavy metals. A cyanide destruction component, utilizing SO2, will be added to the plant in 1996/1997. Cyanide is used during the gold leaching process and residual CN is present in the final effluent.

2.2 Historical Data Review

There was relatively little background data available for this site (see Table 2.1) despite the long history of mine operations along the South Porcupine River. The most pertinent report was an aquatic inventory of the South Porcupine River undertaken by the Environmental Applications Group (EAG) in 1989. That study collected water, sediments, benthos and fish below the Dome effluent (roughly corresponding to our Exposure Area) with some limited sampling above the Dome effluent. The EAG "upstream" site was immediately above the Dome effluent, but downstream of old inactive tailings. As part of this 1996 study we also collected water samples at this upstream site (our Ref. B station) for historical comparison. However, our actual Reference area was established further upriver. The results of the EAG study are summarized in Table 2.2.

Additional background data were also provided by Placer Dome regarding effluent toxicity test results. The effluent is routinely sampled to assess acute toxicity to rainbow trout and *Daphnia magna* under the Ontario Ministry of Environment and Energy (MOEE) MISA (Municipal Industrial Strategy for Abatement) program.

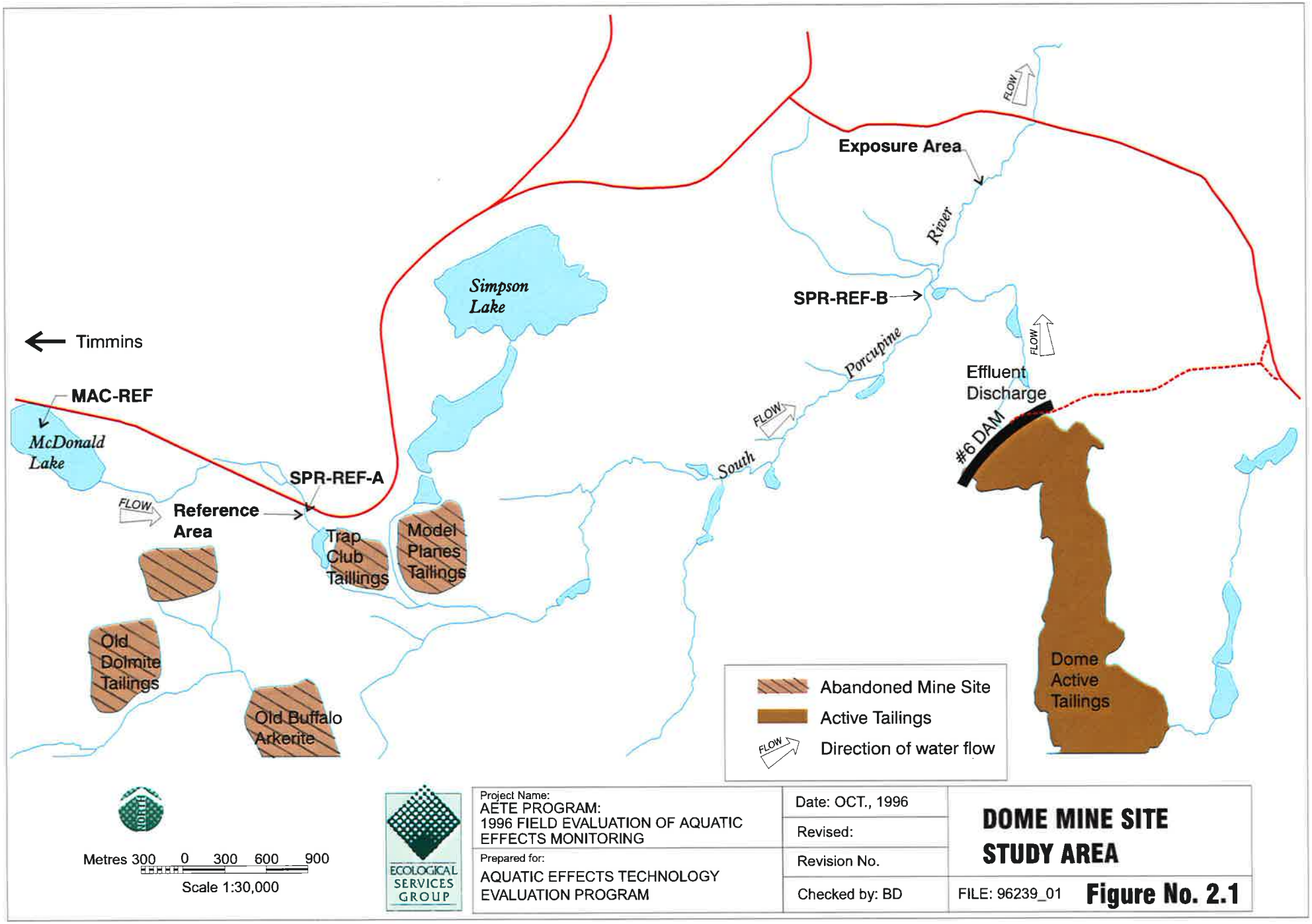
Timmins
MAC-REF
McDonald Lake
SPR-REF-A
FLOW
Reference Area
Trap Club Taillings
Model Planes Tailings
Old Dolmite Tailings
Old Buffalo Arkerite
Simpson Lake
Exposure Area
River
SPR-REF-B
Porcupine
South
FLOW
Effluent Discharge
#6 DAM
Dome Active Tailings
Abandoned Mine Site
Active Tailings
Direction of water flow
NORTH
Metres 300 0 300 600 900
Scale 1:30,000
ECOLOGICAL SERVICES GROUP
Project Name:
AETE PROGRAM:
1996 FIELD EVALUATION OF AQUATIC EFFECTS MONITORING
Prepared for:
AQUATIC EFFECTS TECHNOLOGY EVALUATION PROGRAM
Date: OCT., 1996
Revised:
Revision No.
Checked by: BD
DOME MINE SITE STUDY AREA
FILE: 96239_01
Figure No. 2.1

Table 2.1 List of Background Reports Provided for the Dome Site, Timmins

HBT Agra. 1994. Excerpts from environmental study of South Porcupine River and adjacent lands for road construction (Title, other details unknown). Prepared for Placer Dome Canada Ltd.
Riordan, B. 1992. Porcupine Lake wetland complex evaluation. Unpublished report. Ministry of Natural Resources. Timmins, Ontario.
Klohn, Leonoff. 1992. Dome mine hydrology study. Report to Placer Dome Canada Ltd., South Porcupine. Report by Klohn Leonoff, Richmond, B.C. 23 pp + appendices.
EAG. 1989. Aquatic impact survey, Porcupine River System upstream of Porcupine Lake. Report prepared for Placer Dome Inc. - ERG Resources Inc. by The Environmental Applications Group Ltd. Toronto, Ontario. 34 pp + appendices.
Placer Dome - unpublished results of effluent toxicity tests for MISA program.

The 1989 survey showed that water quality was notably affected by the Dome effluent for a few select metals. The concentrations of copper, zinc and nickel were elevated in the South Porcupine River below the effluent compared with concentrations upstream of the effluent (Table 2.3). Other supporting data show that water quality at the upstream site is influenced by old inactive tailings that border the river. For example, mean sulphate levels in the river were in the order of 175 mg/L, while background for the area would be expected to be < 30 mg/L. The concentrations of lead and copper above the effluent exceeded Provincial Water Quality Objectives (PWQOs).

Sediment quality was not notably affected by the Dome discharge for most parameters except for copper (Table 2.3). The mean concentration of copper was elevated below the effluent (619 ug/g) compared with above the effluent (285 ug/g) but the levels of the other metals were similar both upstream and downstream.

The benthic community in the South Porcupine River generally reflected conditions expected in a slow moving stream with soft highly organic sediments. The benthic community in the river and in the EAG reference area (Bell Creek watershed) was dominated by chironomids. There were some differences noted between upstream and downstream of the Dome effluent. The number of organisms/sq. m. was greater upstream (mean = 706) compared with downstream (mean = 262) samples. The number of taxa was the same (11) both above and below the effluent, however, the species composition was somewhat different. Upstream samples contained amphipods (*Gammarus* sp.) and fingernail clams (*Pisidium* sp) and members of the Trichoperta order, which were absent from downstream samples. Downstream samples contained more groups of annelids than upstream.

Table 2.2 Summary of Background Information for the Dome Site, Timmins

Source	Water Quality	Sediment Quality	Toxicity Bioassays	Fish	Benthos	Plankton	Summary
HBT Agra. 1994	no	no	no	habitat only	no	no	Only partial extracts of study available. No maps provided. Focus is on fish habitat compensation for proposed new road to Tailings Dam #6
Riordan, B. 1992	some	no	no	no	no	no	Wetland evaluation of entire complex. No direct fish surveys as part of this evaluation. Fish habitat scored 0 out of 10. Suggested wetland functions included filtering nutrients and other chemicals from mine effluent
EAG. 1989	yes	yes	no	yes	yes	no	Habitat descriptions include Exposure Area for this (AETE, 1996) study. No fisheries work in our Reference Area. Report states water levels of copper, zinc and nickel elevated below Dome effluent. Several fish species caught below effluent, very few fish caught above. Downstream benthos samples characterized by lower number of organisms and greater proportion of annelids (worms) than upstream station. Downstream sediments contained higher levels of copper but other metals similar
Klohn-Leonoff. 1992	no	no	no	no	no	no	The study evaluated site hydrology and storm runoff for tailings pond management.

Table 2.3 Summary of Background Water and Sediment Quality for Dome Mine, Timmins (from EAG, 1989). Values are means of replicate samples

	Upstream	Downstream	
Water (mg/l)			PWQO
Cu	.021	.13	.005
Zn	.017	.074	.030
Ni	.024	.120	.025
Pb	.063	.058	.025
Sediments (µg/g)			PSQG
Cd	1.17	1.37	10
Cu	285	619	110
Fe	50019	48757	40000
Pb	30.8	27.0	250

Table 2.3 Summary of Background Water and Sediment Quality for Dome Mine, Timmins (from EAG, 1989). Values are means of replicate samples

	Upstream	Downstream	
Hg	0.11	0.106	2.0
Ni	96.5	119.8	75
Zn	132.8	119.6	820
TOC (%)	4.41	4.69	10

PSQG = Provincial Sediment Quality Guideline

Fisheries surveys in August and October of 1989 caught relatively few fish. The only species caught in sufficient numbers above and below the effluent that would have satisfied sampling requirements for metal and metallothionein analysis for this study was Pearl Dace. In fact, more fish were caught downstream than upstream of the Dome effluent. The fish species catch in 1989 is summarized as:

Downstream	Upstream
White sucker	White sucker
Pearl dace	Pearl dace
Brook stickleback	Brook stickleback
Yellow perch	Red belly dace
Northern pike	
Mottled sculpin	
Fine scale dace	

Metal analysis was only conducted on muscle tissue of yellow perch and white sucker collected below the effluent. The concentrations of arsenic and copper may have been slightly higher in these samples than fish caught in other areas of the watershed, but were not notably higher than in fish tissues from other Ontario locations. Levels of zinc, cadmium, copper and lead were generally very low. The low metal levels is not surprising since metals, with the exception of mercury, do not generally accumulate in muscle tissue. Liver or kidney tissue is a better indicator of exposure to metals.

Historical data indicate that the acute toxicity of the Dome effluent has been variable. Figures 2.1.1 and 2.1.2 show the reported LC50s for Rainbow trout (96 hr) and *Daphnia magna* (48 hr) tests from 1990 to 1996. It can be seen that the effluent did not induce acute toxicity (eg. LC50 > 100% effluent) in the last two tests in 1996. However, previous samples exhibited quite marked toxicity on several occasions.

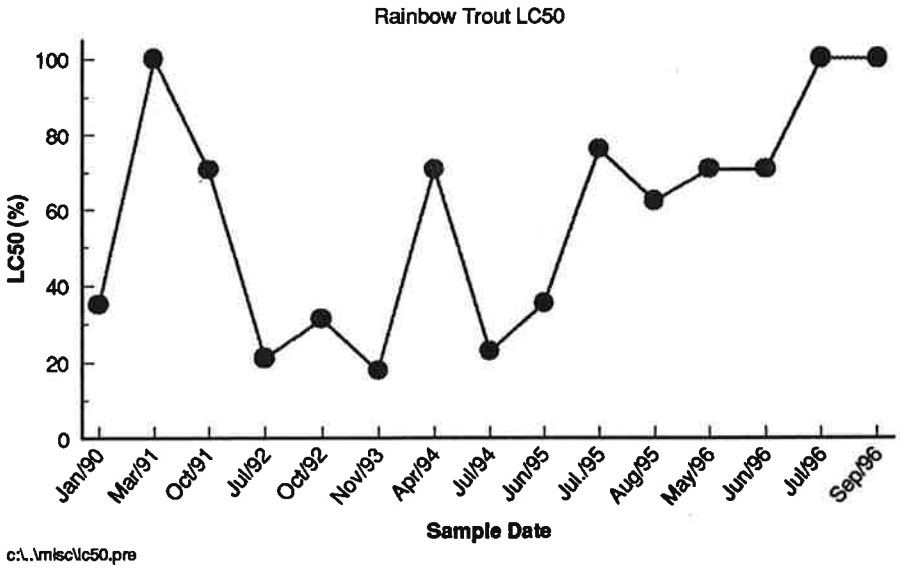

Figure 2.2a. **Estimated acute toxicity (LC50 as % volume) of Dome effluent to rainbow trout (static 96 hr test) from 1990 to 1996**

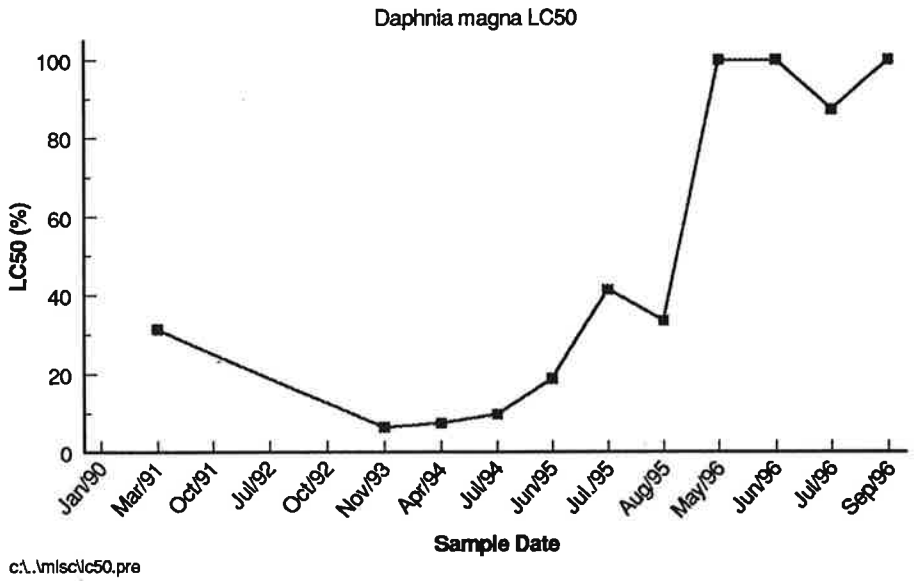

Figure 2.2b. **Estimate acute toxicity (LC50 as % volume) of Dome effluent to *Daphnia magna* (static 96 hr test) from 1990 to 1996**

3. METHODS

3.1 Study Area

The study area generally consisted of marshy, low lying areas. Photographs of sampling locations in the Reference and Exposure areas are provided in Appendix B.

3.2 Effluent Characterization and Sublethal Toxicity

Grab samples of the effluent were collected for chemical analysis and for sublethal toxicity testing. The biological assays were conducted by BAR Environmental in Guelph, and Eco-CNFS, Montreal.

The sublethal toxicity tests performed by BAR Environmental are as follows: *Lemna minor* growth inhibition, *Ceriodaphnia dubia* survival and reproduction, fathead minnow survival and growth inhibition, and salmonid embryo tests. The sublethal toxicity test performed by Eco-CNFS was *Selenastrum capricornutum* microplate growth inhibition test.

Methods for receiving water and effluent collection are specified in Project # 4.1.2a, Extrapolation Study (August 23, 1996). Receiving water samples for acclimation were collected from the reference station at McDonald Lake. These samples were used to determine if receiving waters (upstream of effluent discharge) cause toxicity to either *Ceriodaphnia dubia* or fathead minnow and if so, to acclimate these organisms to the water before toxicity evaluation.

Approximately 420L of water was collected from MacDonald Lake on September 19, and shipped cooled to BAR Environmental to be used for dilution water in the toxicity bioassays. Collection of effluent was delayed until October 16. Effluent was collected at the Dome-MISA sampling location. All effluent samples were delivered within 72 hours of sampling to BAR Environmental (139 L) and Eco-CNFS (0.2 L). All sample containers, chain of custody forms were provided by BAR Environmental.

3.3 Habitat Characterization, Classification and Sample Station Selection

Objective
Habitat characterization and classification was conducted to identify substrate types in both reference and exposure areas. This information was used to select benthic and fish sampling stations of uniform habitat type. Habitat characterization at each mine site also included identification of depositional areas for sediment sampling.

Habitat Classification Methods
Habitat was classified following the guidelines described in the New Brunswick Stream Survey and Habitat Assessment Guide (DFO/NBDNR, 1994) which is included in Appendix F1. The approach to site selection and subsequent habitat characterization followed a watershed approach.

Habitat was classified for the reference and exposure sections in detail within the stream and extended 15 m on either bank. The linear extent of habitat classification contained all sampling sites for each Reference and exposure area. Stream type was determined from a list of fast water or pools as described in the guidelines. Channel type was described as main channel, side channel, split or bogan. The length of individual units were from 3-10 m and was directly dependent on the length of the reference and exposure areas. If, for example, a reference section was 18 m long, the 6 sampling sites would be set up to contain 3 m each of characterizable habitat. The average net width was measured from wetland perimeters perpendicular to flow at the point of sampling and was also measured at points where width varied greatly within the unit. The width at the high water mark was measured when feasible. Depth was measured at 1/4, 1/2, 3/3 of net channel width.

Substrate was measured with a gauging rod with spot samples taken throughout each unit. Area per substrate type was estimated and particle size was confirmed during sediment sampling. Where possible, substrate surrounding larger particles (boulders) was quantified to determine embeddedness. Banks were examined for undercuts and overhanging vegetation and were quantified per bank. The surrounding land uses were documented within the reach and generalized for the surrounding area.

Dissolved oxygen was measured at each station using a YSI model dissolved oxygen meter. Similarly, pH was measured in each station using hand-held meters. Flow was measured with a Marsh-McBirney Flowmate 2000 velocity meter at locations suitable to quantify discharge. Road crossings with culverts near the reference and exposure reaches were used as sites of discharge measurement.

Sample Station Selection

The exposure area was selected from background mapping and then investigated in the field. The mixing zone and downstream exposure area were found to be a large diffuse cattail dominated wetland. Visual determination of where the Placer Dome effluent actually entered the South Porcupine River was not possible. Investigations were carried out with the aid of a hand-held conductivity meter. The investigation focused on a study area upstream of the Placer Dome Mine Road crossing of the South Porcupine River. All effluent and receiving water should have mixed prior to direction through the culverts of the mine road. From this point it was determined approximately where the effluent entered the wetland/South Porcupine River (highest conductivity).

The exposure area was selected at a location some 200-400m below the approximate location where the Dome effluent entered the South Porcupine River. It was accessible directly from a heavily travelled road on the Dome property. Access to the river was down a steep 5m embankment.

Two riparian types were present in the exposure area, cattail wetland and alder/sedge wetland. Exposure sites were set up in an area of alder/sedge because of a more diverse riparian community. With the exposure sites chosen, the habitat features

(width, depth, gradient, substrate, aquatic and terrestrial plants) were then used as criterion for reference site determination.

A reconnaissance of the Dome site and review of background information showed that several inactive tailings areas were situated on the South Porcupine river above the Dome effluent. Previous studies showed that these old tailings did affect water quality. To avoid potential complications from other sources, a reference area was selected as far upstream as possible above all inactive tailings.

With a large reference area determined, the next step was to find an appropriate study section with the greatest degree of similarity to the exposure section. A hierarchical approach was taken to determine suitability of the reference site. Stream channel characteristics of width, depth, gradient and substrate were of primary importance. Of secondary importance were aquatic and terrestrial vegetation similarity criteria. Channel and vegetation similarities appeared to be a function of a faunal influence (beaver) which was common to both the exposure and reference stations.

Photographs and detailed field notes were taken at each sampling station during the habitat characterization.

3.4 Water Samples

The key consideration to locating reference and exposure stations is to maximize the probability of detecting significant differences in the parameters of interest between these two locations. Therefore, for the Dome site a total of six water samples were collected in the exposure area.

Collection of reference samples was more problematic. We were confident that McDonald Lake was above all other external influences, but it was a lake, and did not possess the characteristics of the exposure area in the South Porcupine River.

Therefore, we collected 3 water samples from McDonald Lake for analysis. In addition, 3 water samples were collected from the South Porcupine River below McDonald Lake corresponding to the benthic and sediment sites (Ref-A). Also, three water samples were collected in the river immediately above the Dome effluent to correspond to a historical sampling location. This was designated as Ref-B in our study.

In the river situation, water samples were collected by submerging the container, removing the cap below the surface to avoid any surface contamination, and completely filling. In McDonald Lake, sub-surface (i.e., either mid-depth from bottom) grab samples were collected using a Van Dorn-bottle sampler.

For each station, 7 different sampling containers were filled to coincide with different analysis requested. The bottles and preservatives used for water chemistry sampling are described in Table 3.1. Unfiltered water samples were analyzed for total metal levels. Dissolved metal levels were analyzed on water filtered through a 0.45 µm

filter. The dissolved sample was filtered through Whatman ashless #42 filters in the field according to standard methods (APHA 1995 -Section 3030B). Prior to use, each filter was washed with nitric acid and rinsed with distilled water.

Both metals samples (total and dissolved) were acidified with ultrapure nitric acid HNO3 (provided by the analytical laboratory) to a pH <2. All samples were cooled and shipped on ice to MDS Laboratories for analysis.

In the laboratory, samples were analyzed for the following parameters: total and dissolved metals (a ICP_MS low level metals scan was conducted), cations and anions, nutrients, hardness, alkalinity, dissolved organic and inorganic carbon, turbidity, and total suspended solids.

Field measurements of temperature, conductivity, dissolved oxygen, and pH were recorded at each station using a YSI meter. Conductivity measurements were routinely taken to characterize mixing zones and exposure zones, and to identify other possible sources of contaminants to the receiving environment.

Data Analysis

Several general water chemistry and water metal concentration parameters were selected for statistical analysis. The data were tested for assumptions of homogeneity of variances and normal distribution using Bartlett's test for homogeneity of variance and by examining scatter plots of the predicted versus residual values using SYSTAT (Wilkinson, 1988). Parameters which failed the assumptions of homogeneity of variance and normal distribution were log transformed ($\log base_{10}$). The Bartlett's test was reapplied and the scatter plot of predicted versus residual values for the transformed data was re-examined. If the Barlett's value and the scatter plot of predicted versus residual values were improved by the log transformation of the data, log transformed values were used in further analysis.

Exposure station data were statistically compared with Reference station data using a two sample (or independent) two tailed Student's t-tests for each parameter examined. Means were considered significantly different when the probability level of the t-value was less than 0.05.

Quality Assurance/Quality Control

In addition to regular laboratory QA/QC procedures (described separately), field QA/QC measures included:

1) field replicate sample
2) analysis of one transport or trip blank,
3) one filter blank
4) for sub-surface samples collected using a Van Dorn-type sampler, then a sampler blank (e.g., distilled water run through the Van-Dorn) was also collected and submitted.

Replicate Samples

Sample bottles for unfiltered samples (6 per site) were dip samples taken 15 cm below the water surface for EXP 1-6, REF B1-B3 and REF 1-6. Sample bottles were lowered to 15 cm, opened and allowed to fill completely and immediately capped and sealed. Replicate samples were taken at EXP 6 with same methods. Samples for filtered metal (1 per site) analysis were taken with a 500ml, plastic jar (MDS "C" type). The container was filled 15 cm below the surface, rinsed 3 times and then a sample taken. The filter apparatus (flask, stopper and funnel) were thoroughly rinsed with distilled water. One filter was removed from its sterile package, cover and grid paper removed and the filter rinsed thoroughly with 5% nitric acid and the cover replaced. Approximately 400ml of sample water stored in a "C" type plastic jar was poured and filtered through the pump, filter and collection apparatus. The sample was then transferred to an MDS "D", 125ml plastic bottle with HNO3 preservative. The complete set of 7 bottles per sample site were then labelled, stored and maintained on ice until transfer to MDS. Replicate samples (i.e. EXP 6 and EXP 6 replicate) were obtained in the same manner, except that filtered metals samples were split samples from filtering through one 500ml "C" plastic jar using the same filter.

McDonald Lake samples (MAC 1-3) were taken with a Van Dorn sampler at 1/2 lake depth at the sampling site. The sampler was rinsed three times at the surface and then lowered to the predetermined 1/2 d (also flushing the sampler). The sampler was triggered and the sample brought to the surface. Each non-filtered sample (7 bottles) was decanted from the sampler. The filtered metals sample was decanted into a "C" jar which was rinsed 3 times with sample water, filled, then put through the filtering process. The filter apparatus (flask, stopper and funnel) were thoroughly rinsed with distilled water. One filter was removed from its sterile package, cover and grid paper removed and the filter rinsed thoroughly with 5% nitric acid and the cover replaced. Approximately 400ml of sample water stored in a "C" type plastic jar was poured and simultaneously filtered through the pump, filter and collection apparatus. The sample was then transferred to an MDS "D", 125ml plastic bottle with HNO3 preservative. The complete set of 7 bottles per sample site were then labelled, stored and maintained on ice until transfer to MDS.

Van Dorn Blank Samples

The Van Dorn blank was taken in the laboratory. The Van Dorn sampler was rinsed with distilled water 3 times and then filled with distilled water. The 6 non-filtered samples were decanted from the sampler. A "C" jar was rinsed 3 times with the sample water and then filled. The filter apparatus (flask, stopper and funnel) were thoroughly rinsed with distilled water. One filter was removed from its sterile package, cover and grid paper removed and the filter rinsed thoroughly with 5% nitric acid and the cover replaced. Approximately 400ml of sample water stored in a "C" type plastic jar was poured and simultaneously filtered through the pump, filter and collection apparatus. The sample was then transferred to an MDS "D", 125ml plastic bottle with HNO3 preservative. The complete set of 7 bottles per sample site were then labelled, stored and maintained on ice until transfer to MDS.

Table 3.1 Summary of Bottles and Preservatives Used and Analyses Conducted on Water Chemistry Samples Collected at Each Sampling Station

Sample Bottle	Preservative	Analyses
1 - 500 mL HDPE	none	Total Suspended Solids (TSS) (Onaping/Levack only)
1 - 1 500 mL HDPE	none	General Chemistry Cations and Anions (*Alkalinity as $CaC0_3$, Chloride, Sulphate, Anion Sum., Bicarbonate as $CaC0_3$, Carbonate as $CaC0_3$, Cation Sum., Colour, Conductivity, Hardness as $CaC0_3$, Ion Balance, Langelier Index at 20°C, Saturation pH at 4°C, Total Dissolved Solids, Turbidity)*
1 - 100 mL glass	none	Dissolved organic carbon (DOC) Dissolved inorganic carbon (DIC)
1 - 250 mL glass	$H2S0_4$	Nutrients *(Nitrate, Nitrite, Ammonia, Total Kjeldahl Nitrogen, Phosphorus, Orthophosphate)*
1 - 250 mL HDPE	$HN0_3$	Total Metals *(Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Chromium, Cobalt, Copper, Calcium, Free and Total Cyanide, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Reactive Selenium, Silica ($Si0_2$), Silver, Sodium, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc)*
1 - 250 mL HDPE	$HN0_3$	Dissolved Metals (as for total metals)

Travel Blanks

Travel blanks were received from MDS for all requested analyses except filtered metals (i.e. 6 bottles). These six samples were taken to the shore of McDonald Lake where they were opened and immediately closed. These samples (already labelled "Blank" by MDS) were then stored and maintained on ice prior to transfer to MDS.

Filter Blanks

One filter blank was processed in the lab using distilled water. The filter apparatus (flask, stopper and funnel) were thoroughly rinsed with distilled water. One filter was removed from its sterile package, cover and grid paper removed and the filter rinsed thoroughly with 5% nitric acid and the cover replaced. Approximately 200ml of distilled water was poured and simultaneously filtered through the pump, filter and collection apparatus. The sample was then transferred to an MDS "D", 125ml plastic bottle with HNO3 preservative. These samples were also taken to McDonald Lake and opened as a travel blank (the 7th bottle).

3.5 Sediment Samples

Collection of sediments was not a problem at the Dome site. The study area is very depositional in nature including most reaches of the South Porcupine River. Six sediment samples were collected in each of the reference (Ref-A) and exposure areas of the South Porcupine River at stations coinciding with benthic collections.

Samples were collected using an Ekman grab. Only the upper two cm of the sediment column was retained from each grab. A composite sample was prepared for each station by mixing 5 replicate grab samples. The upper two cm of substrate from each of the 5 grabs was placed in a glass mixing bowl and homogenized using a plastic spoon.

Mixing bowls and plastic utensils were cleaned between sampling stations using the following protocol: a) water rinse, b) phosphate-free soap wash, c) deionized water rinse, d) 20% HNO3 rinse, and e) deionized water rinse. The following guidelines were used to determine the acceptability of a grab sample: a) the sampler is not over-filled, b) overlying water is present indicating minimal leakage, c) overlying water is not excessively turbid indicating minimal disturbance, d) the desired penetration depth is achieved (i.e., 4-5 cm for a 2 cm deep surficial sample).

All samples were cooled and shipped to MDS Laboratories for analyses. Each sample was analyzed for site specific metals, total organic carbon, particle size and loss on ignition.

Data Analysis

Metals tend to have a greater affinity for smaller size particles. Therefore, to correct sediments for potential bias due to different particle sizes between samples, all sediment metal data were normalized to percent fines using the following equation:

$$Metal_{NF} = \frac{Metal}{Fines}$$

where: $Metal_{NF}$ = Metal concentration normalized to fines
Metal = Reported sediment metal concentration (mg/kg)
Fines = Proportion of fines (silt + clay fractions) in sediment

The normalized metal data for selected metals were tested for assumptions of homogeneity of variances and normal distribution using Bartlett's test for homogeneity of variance and by examining scatter plots of the predicted versus residual values using SYSTAT (Wilkinson, 1988). Parameters which failed the assumptions of homogeneity of variance and normal distribution were log transformed ($logbase_{10}$). The Bartlett's test was reapplied and the scatter plot of predicted versus residual values for the transformed data was re-examined. If the Barlett's value and the scatter plot of predicted versus residual values were improved by the log transformation of the data, log transformed values were used in further analysis.

Exposure station data were statistically compared with Reference station data using a two sample (or independent) two tailed Student's t-tests for each parameter examined. Means were considered significantly different when the probability level of the t-value was less than 0.05.

Quality Assurance/Quality Control
QA/QC for sediment sampling included: a) a split sample from the exposure station, b) grab samplers are cleaned between samples and stations using a phosphate-free detergent wash and a rinse with de-ionized water, and c) a swipe blank was collected to determine the effectiveness of field decontamination procedures (e.g., an acid-wetted, ashless filter paper was used to wipe down any sampler and mixing bowl/spoon surfaces likely to contact sample media). Details of the QA/QC procedures are included in the Quality Management Plan (Appendix A).

3.6 Benthos Samples

3.6.1 Sample Collection

One replicate benthic sample was collected from 6 Ref-A stations and 6 exposure stations. Samples from each station were collected from similar habitat types using an Ekman sampler. The samples were passed through a 250 µm mesh sieve.

All benthic samples were placed into plastic containers and preserved in 10% buffered formalin as recommended by our selected taxonomist, Danuta Zaranko.

3.6.2 Sorting and Taxonomy

Sample Processing
Upon arrival at the laboratory, benthic macroinvertebrate samples were logged and inspected as a quality control measure. Samples were checked for proper labelling and cross-checked with submission sheets. In addition, a subset of samples was randomly opened and checked for proper preservation.

To expedite sorting all samples were stained with a protein dye that is absorbed by aquatic organisms but not by organic material such as detritus and algae. Samples were gently washed using a 500 µm sieve. The material retained on the sieve was set aside in a petri dish for further processing. A small amount of material was retrieved from the petri dish and placed in a gridded tray. An adequate amount of water was added to the gridded tray so that the material was evenly distributed and suspended. Using a 10X stereomicroscope, the petri dish was sorted along the grid lines and quickly scanned a second time to ensure that all organisms had been removed. The sorted material was discarded into a holding tray and the procedure repeated for the next amount of debris until all material was processed.

Sorted organisms were placed in glass vials and represerved in 80% ethanol. Each bottle was labelled internally with the survey name, date, station and replicate number.

Detailed Identification

All invertebrates were identified to the lowest practical level, usually genus, with the exception of bivalves (*Sphaerium* and Unionidae), snails, leeches, oligochaetes, the amphipod *(Hyalella)*, and phantom midge (*Chaoborus*). In some cases identification of individuals to the genus or species level was not possible, (i.e., early instar and immature forms). As a result, these individuals were enumerated under the next higher level of identification, (i.e., usually family). Chironomids and oligochaetes were mounted on glass slides in a clearing media prior to identification using a compound microscope. In samples with large numbers of oligochaetes, a random sample of no less than 20% of the picked individuals from each group were removed for identification, up to a maximum of 100 individuals. Similarly, in samples with a large number of chironomids, individuals that could be identified using a dissecting scope, (e.g., *Cryptochironomus,* and *Chironomus*), were enumerated and removed from the sample. The remaining individuals were sorted into three groups: Tanypodinae, Orthocladiinae (with Diamesinae), and Chironominae. A random sample of no less than 10% of the individuals from each group were removed for identification, up to a maximum of 50 individuals.

Subsampling

Subsampling to 1/4 was necessary in all twelve samples due to high sample volume (large amounts of loose organic matter and algae). In these cases, samples were first washed through a large mesh sieve to remove all coarse detritus, leaves, etc. Large organisms such as leeches, crayfish and molluscs retained in the sieve were removed from the associated debris.

The remaining sample fraction was distributed evenly on a 500 µm sieve and divided in two. The procedure was repeated until an appropriate subsample fraction remained. The taxonomic list of benthic invertebrates (table of results) has been corrected for subsampling.

Data Analysis

The total number of benthic invertebrates in each sample was divided by the area of the Eckman grab to give a measurement of organism density in each sample. The data were tested for assumptions of homogeneity of variances and normal distribution using Bartlett's test for homogeneity of variance and by examining scatter plots of the predicted versus residual values using SYSTAT (Wilkinson, 1988). Parameters which failed the assumptions of homogeneity of variance and normal distribution were log transformed (logbase_{10}). The Bartlett's test was reapplied and the scatter plot of predicted versus residual values for the transformed data was re-examined. If the Barlett's value and the scatter plot of predicted versus residual values were improved by the log transformation of the data, log transformed values were used in further analysis.

Exposure station data were statistically compared with Reference station data using a two sample (or independent) two tailed Student's t-tests for each parameter examined. Means were considered significantly different when the probability level of the t-value was less than 0.05.

Quality Assurance/Quality Control
As part of the QA/QC measures, the sorted sediments and debris were represerved.

In conjunction with invertebrate sample processing, the following QA/QC procedures were provided.

1) For a confirmation of sorting efficiency, 10% of the processed samples were resorted by a second taxonomist to confirm 95% recovery of all organisms. In most cases, 95% recovery of organisms is desirable and a reachable target, however, exceptions exist to this target recovery. For example, when a sample contains a large volume of organic matter (> 1/2 litre) and a low density of organisms. In such a sample, if the sorter was to miss 1 or 2 out of 10 organisms, this would mean a recovery of only 90% and 80% of the organisms respectively. In this case, it is doubtful if this lesser recovery would make much difference in the interpretation of the data. In addition, if the subsampling error greatly overshadows the error associated with sorting efficiency, then leniency in sorting recovery is permissable. Approximately ninety-five percent recovery of organisms was achieved in the samples selected for resorting (Appendix E2).

2) A second fraction was sorted from two samples, therefore sorting and identification was completed on half of each of these two samples. Table 1 in Appendix E2 summarizes the differences in total number of organisms between the two fractions in each sample.

3) A voucher collection was prepared for all identified taxa to ensure continuity of taxonomy.

3.7 Fisheries

The fisheries survey was originally conducted in September. However, tissues sent to Winnipeg for metal and metallothionen analysis arrived partially thawed. Therefore, a second fisheries survey was conducted.

3.7.1 Collection

The fish communities in proximity to the exposure and reference locations were sampled using minnow trap and gill nets. Minnow traps were used in the exposure and reference areas within the creek channel of the South Porcupine River. Two sizes of minnow traps were used, standard, with an opening of 1-2 cm and modified, with an opening of 5-7 cm. The stream size and depths (unstable banks, ~ 1-1.5 m deep) of these reaches restricted the type of gear. Minnow traps were baited with a combination of baits and set at a range of depths. Traps were placed with the opening parallel to any present current. Traps were checked daily and any fish removed for analysis. Gill net sets in the South Porcupine River were of single IJM panels which were set perpendicular to flow and completely closed off the entire channel. Mesh size was 1.5" to minimize mortality during overnight sets. Gill nets were used in McDonald Lake (reference) which was deep enough (>18 m) to allow this type of

fishing gear. Gill nets were made up of two 15 m panels of 1.5 and 2.5" mesh sizes. Nets were set from shore and stretched out perpendicular to shore to depths of 3-6 m. Nets were fished overnight and checked every morning and live fish removed for analysis.

3.7.2 Tissue Processing for Metal and Metallothionein Analysis

The fisheries survey was originally conducted during the week of September 19, and tissue samples were sent to Dr. Jack Klaverkamp in Winnipeg for metallothionein analysis. Unfortunately, some of the tissues thawed during transport, rendering subsequent results questionable. Therefore, a second fisheries survey was conducted in October.

Processing of fish followed the revised protocol of 29 August 1996. If the fish was large enough (> 15 cm), tissue samples were dissected out and divided for metals and metallothionein analyses. Fish less than 10 cm were frozen whole, while fish between 10-15 cm were not kept. The detailed protocol for tissue processing is presented in Appendix F3.

A considerable amount of effort was spent processing fish tissues that were not subsequently sent for analysis. During the second fisheries survey, any large fish captured in the reference or exposure area was processed immediately. This was necessary since candidate fish for MT analysis could not simply be frozen whole to wait to see what the final catch was. Therefore, the final selection of tissues was not made until the end of the survey. Eight specimens of pearl dace and eight specimens of northern redbelly dace from each of the reference and exposure areas were frozen whole and sent to Dr. J.F. Klaverkamp at the Freshwater Institute for analysis of MT and metal levels in the tissue.

Scale samples from each fish were sent to Dr. John Tost, Northshore Environmental for aging analysis.

Data Analysis

All data were summarized and analyzed for homogeneity of variance before statistical analysis. Normality plots were completed and variance subject to Bartletts test. Where appropriate, data were log transformed prior to conducting T tests to determine whether means were significantly different between Reference and Exposure areas.

4. RESULTS

4.1 Dates of Sample Collection and Analysis

Table 4.1 Dates of Sample Collection

Sample Element	Date Samples Collected	
	Reference Stations	Exposure Stations
Water Chemistry	Sept. 19.20	Sept. 20
Sediment Chemistry	Sept. 20	Sept. 20
Sediment Particle Size	Sept. 20	Sept. 20
Swab Analysis	Sept. 20	Sept. 20
Benthos Taxonomy	Sept. 17	Sept. 19
Fish Tissue Analysis	September 19-26, October 8-18	
Sublethal Toxicity		
i) Acclimation Water	Sept. 19	
ii) Dilution Water Chemistry	Sept. 25	
iii) Effluent Chemistry	Oct. 16	
iv) Toxicity Assays (BAR)	Oct. 16	

4.2 Effluent Characterization and Sublethal Toxicity

4.2.1 Chemistry

General water chemistry parameters for the effluent and dilution water are presented in Table 4.2.1. Total and dissolved metal concentrations for the effluent and dilution water are presented in Table 4.2.2.

As would be expected, the effluent contains elevated concentrations of several elements that would be naturally present in the orebody, eg. metals, as well as parameters associated with the ore crushing and processing (sulphates, nitrogen and cyanide complexes). The concentration of some parameters (eg. copper, cobalt) are several times greater than their respective Freshwater Quality guidelines. The concentration of these substances in the dilution water collected from MacDonald Lake is either very low, or below detectable limits.

The concentration of dissolved metals slightly exceeded the concentration of total metals in the effluent for some elements (eg. calcium, copper, magnesium and zinc). From a chemical speciation perspective, this is not possible, and the results may be due to contamination from the filters (see Section 4.5.1). The effect does not mask any trends or influence data interpretation, but this potential source of error should be addressed in the 1997 study if relationships between biology and total or dissolved metal levels are being investigated.

Table 4.2.1: General Water Chemistry Analysis (mg/L) of Effluent and Dilution Water From the Dome Mine Site

Parameter	LOQ	Effluent	Effluent Lab Rep	MacDonald Lake	Mac Donald Lake Lab Rep
Nitrate	0.05	3.99	3.99	nd	nd
Nitrite	0.01	0.19	0.19	nd	nd
Ammonia	0.05	13.4	-	nd	nd
TKN	0.05	15	-	0.59	-
Phosphorus	0.1	nd	-	nd	nd
Orthophosphate	0.01	0.28	0.28	nd	nd
Alkalinity	1	33	33	95	93
Chloride	1	40	40	24	24
Sulphate	2	318	318	7	7
Bicarbonate	1	30	-	94	-
Carbonate	1	2	-	nd	-
Colour (TCU)	5	nd	nd	14	14
Conductivity (us/cm)	1	897	900	279	280
Hardness	0.1	135	-	118	-
Turbidity	0.1	nd	nd	0.2	0.2
Anion Sum (meq/L)	na	8.71	-	2.72	-
Cation Sum (meq/L)	na	8.83	-	3.01	-
Ion Balance	0.01	0.65	-	4.99	-
pH (units)	0.1	8.9	8.4	8	8.1
DIC	0.5	8.9	-	23.6	-
DOC	0.5	3.5	-	6.4	-
TDS	1	596	-	148	-
TSS	5	nd	-		

Table 4.2.2: Dissolved and Total Metals (mg/L) in Effluent and Dilution Water From the Dome Mine Site

Metal (mg/L)	LOQ	Effluent			Mac Donald Lake		
		Dissolved	Total	Total Lab Replicate	Dissolved	Dissolved Lab Replicate	Total
Aluminum	0.01	0.02	0.02	0.03	nd	nd	nd
Antimony	0.002	nd	nd	nd	nd	nd	nd
Arsenic	0.002	nd	nd	nd	nd	nd	nd
Barium	0.005	nd	nd	nd	0.007	0.007	0.007
Beryllium	0.005	nd	nd	nd	nd	nd	nd
Bismuth	0.002	nd	nd	nd	nd	nd	nd
Boron	0.005	0.201	0.2	0.198	nd	nd	0.007
Cadmium	0.0005	nd	nd	nd	nd	nd	nd
Calcium	0.1	46.3	44.8	44.5	35.5	32.1	35.9
Chromium	0.002	0.002	nd	nd	0.002	0.002	nd
Cobalt	0.001	0.119	0.121	0.118	nd	nd	nd
Copper	0.002	0.069	0.064	0.063	nd	nd	nd
Iron	0.02	0.04	0.07	0.08	nd	0.02	nd
Lead	0.0001	0.0049	0.0047	0.005	nd	nd	nd
Magnesium	0.1	4.6	4.3	4.3	7.2	6.5	7.2
Manganese	0.002	0.004	0.003	0.003	nd	nd	0.003
Mercury (ug/L)	0.1	nd	-	nd	nd	-	-
Molybdenum	0.002	0.027	0.027	0.028	nd	nd	nd
Nickel	0.002	0.029	0.03	0.029	nd	nd	nd
Potassium	0.5	29.3	29.8	28.6	0.8	nd	nd
Reactive Silica	0.5	nd	-	-	2.4	2.4	-
Selenium	0.002	nd	nd	nd	nd	nd	nd
Silver	0.0003	0.0013	0.0013	0.0012	nd	nd	nd
Sodium	0.1	102	101	100	14.4	13.1	14.6
Strontium	0.005	0.141	0.13	0.129	0.04	0.04	0.039
Thallium	0.0001	nd	nd	nd	0.0002	0.0002	nd
Tin	0.002	nd	nd	nd	nd	nd	nd
Titanium	0.002	nd	nd	nd	nd	nd	nd
Uranium	0.0001	nd	nd	nd	nd	nd	nd
Vanadium	0.002	nd	nd	nd	nd	nd	nd
Zinc	0.002	0.016	nd	nd	nd	nd	nd
Total Cyanide	0.005	0.119	-	-			
Free Cyanide	0.002	0.076	-	-			

4.2.2 Toxicity

The results of the sublethal toxicity tests performed by BAR Environmental and Eco-CNFS are presented in Table 4.2.3.

Preliminary toxicity tests conducted on dilution water from MacDonald Lake showed that the receiving water itself showed no toxicity to the test organisms. Therefore, no acclimation was required.

The results of the 1996 effluent sublethal toxicity tests are equivocable. No effects were observed on Fathead minnows or *Ceriodaphnia,* effects were observed on *Lemna* and *Selanastrum*, while the Rainbow trout embryo tests were considered invalid. The results of the *Selanastrum* test show a large difference between the IC_{50} value (>100% effluent) and the IC_{25} value (2.8% effluent).

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Table 4.2.3 Summary of Results of Bioassay Conducted with Dome Mining Effluent. Sublethal Toxicity Test Results are Expressed as % v/v of effluent

Test Organism		Effect Value	Effect?
Selenastrum capricornutum		IC_{25} = 2.8% IC_{50} = >100%	Yes No
Lemna minor		IC_{25} = 21.7% IC_{50} = 42.2%	Yes Yes
Ceriodaphnia dubia		LC_{50} = >100% LC_{25} = >100% IC_{50} = >100%	No No No
Fathead Minnow	Survival	LC_{50} = >100% IC_{50} = >100%	No No
	Growth	IC_{50} = >100% IC_{25} = 100%	No No
Rainbow Trout Embryo		test invalid	

4.3 Habitat Characterization and Classification

Habitat characterization and classification for the exposure and reference areas was concluded using the DFO/NBDNR stream survey and habitat assessment forms. Completed forms are included in Appendix F1. Habitat was assessed September 17, 1996 in the exposure area and on September 19, 1996 in the reference area.

4.3.1 Reference Area

Habitat features of the Reference area in the South Porcupine River are shown in Figure 4.1. Stream type in the reference area of the South Porcupine River was a beaver created pool. Channel type was a main channel with no riffle areas. Average net width of the channel was 7.1 m. Average net depth was 0.9 m. Mean substrate particle size was fine (0.0005-0.05 mm) organic material with little underlying sand. No large woody debris was present.

No undercut banks were present. The left bank averaged 10% overhanging vegetation and the right bank averaged 1% providing approximately 6% shade through the reference area. Banks were well vegetated with 10-40% grasses, 15-35% shrubs and 45-75% trees. Bank stability totalled near 100% for the reference area. Surrounding land use attributes included active beaver dam, buffer strip present, road crossing (culvert) and abundant aquatic plants.

Field measurements are presented in Table C3-6 of Appendix C. Air temperature ranged from 13.0-20.0°C and water temperature was 14.0°C. Dissolved oxygen ranged between 2.9 and 3.2 mg/L and pH ranged between 7.8 and 7.9. Discharge was not

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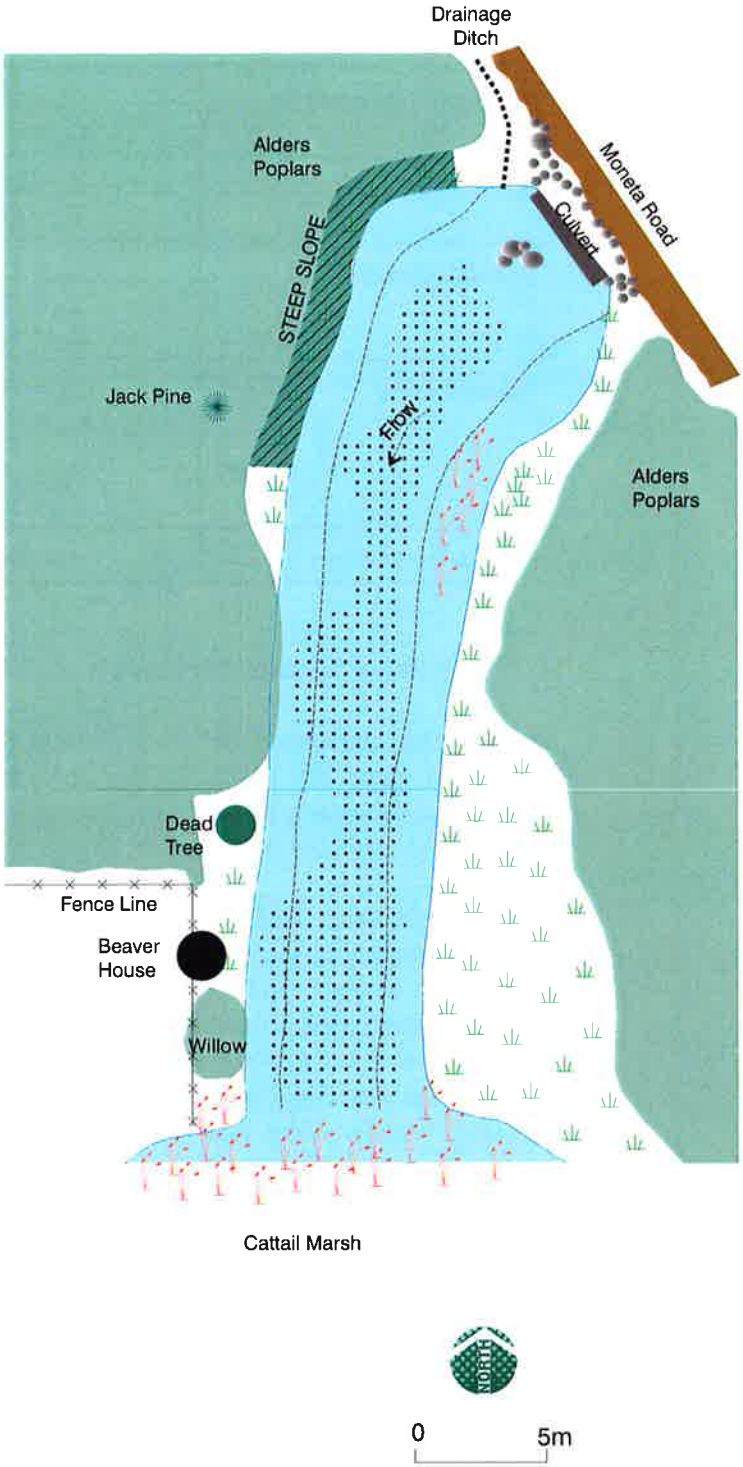
- Cattails
- Sedges/grasses
- Alders
- Extent of Aquatic Macrophytes
- Logs
- Woody Debris
- Flow
- Boulders/Cobble/Gravel
- Sand/Fines (muck)
- X Fine muck/silt along margin (1-2m out)
- Spruce
- Steep banks
- Riffle



Date: OCT., 1996	**DOME MINE SITE REFERENCE AREA-A**
Revised:	**SOUTH PORCUPINE RIVER**
Revision No.	**HABITAT MAPPING**
Checked by: BD	FILE: 96239_27 **Figure No. 4.1**

measured within the reference section of the South Porcupine River. Discharge was calculated at 3 L/s below the outflow of McDonald Lake.

4.3.2 Exposure Area

Habitat features in the exposure area are presented in Figure 4.2. Stream type included a beaver pool with no riffle areas. Channel type was a main meandering channel. Average net width of the channel was 6.1 m. Average wet depths was 1.59 m (Figure 4.2.1). Mean substrate particle size was fine (0.0005-0.05 mm) organic material with little underlying sand. No large woody debris was present.

No undercut banks were present. Each bank had 10% overhanging vegetation providing less than 2% shade to the exposure area. Banks were well vegetated by 50-80% grasses and 20-50% shrubs and were each 50% stable. Surrounding land use attributes included active beaver dam, mining and abundant aquatic plants.

Field measurements are presented in Table C3-6 of Appendix C. Air temperature was 18°C and water temperature was 14°C. Dissolved oxygen ranged from 2.0-2.4 mg/L and pH ranged between 7.9 and 8.0. Discharge at a location 200 m downstream of the exposure area was approximately 96 L/s.

4.3.3 Summary

The selection of an appropriate reference area was limited by non-point sources from inactive tailings above the Dome effluent discharge area. Both the reference and exposure areas consisted of beaver-created pool stream types. Slight differences were noted in depth and net channel width. Substrates were very similar in both areas although differences in amount of overhanging vegetation was noted.

4.4 Sample Station Selection

Sampling locations in the Exposure and Reference areas in the South Porcupine River are shown in Figures 4.3 and 4.4, respectively. Sample stations in McDonald Lake are shown in Figure 4.5.

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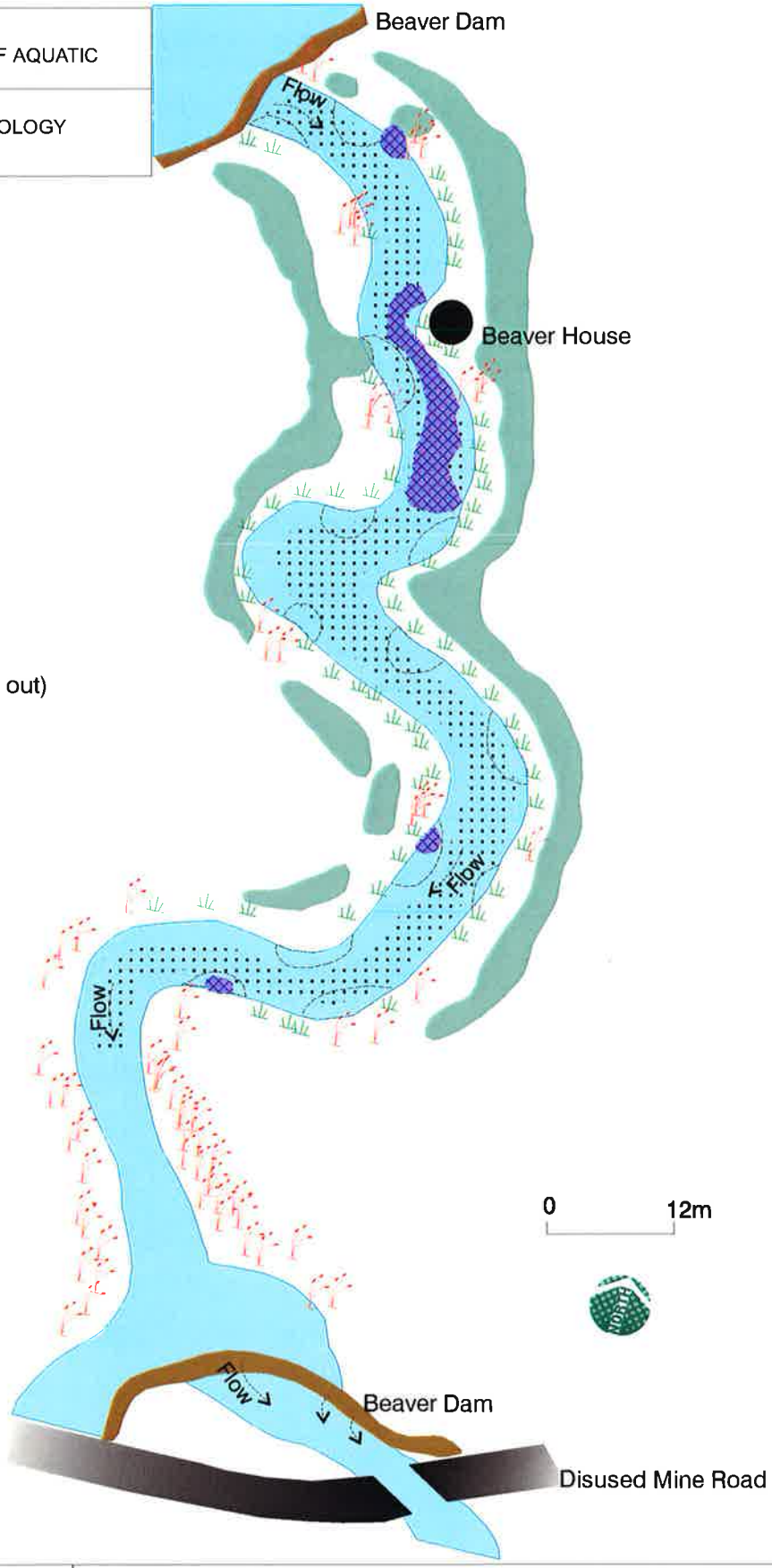
- Cattails
- Sedges/grasses
- Alders
- Extent of Aquatic Macrophytes
- Logs
- Woody Debris
- Flow
- Boulders/Cobble/Gravel
- Sand/Fines (muck)
- X Fine muck/silt along margin (1-2m out)
- Spruce
- Steep banks
- Riffle



Date: OCT., 1996	**DOME MINE SITE EXPOSURE AREA** **SOUTH PORCUPINE RIVER** **HABITAT MAPPING**
Revised:	
Revision No.	
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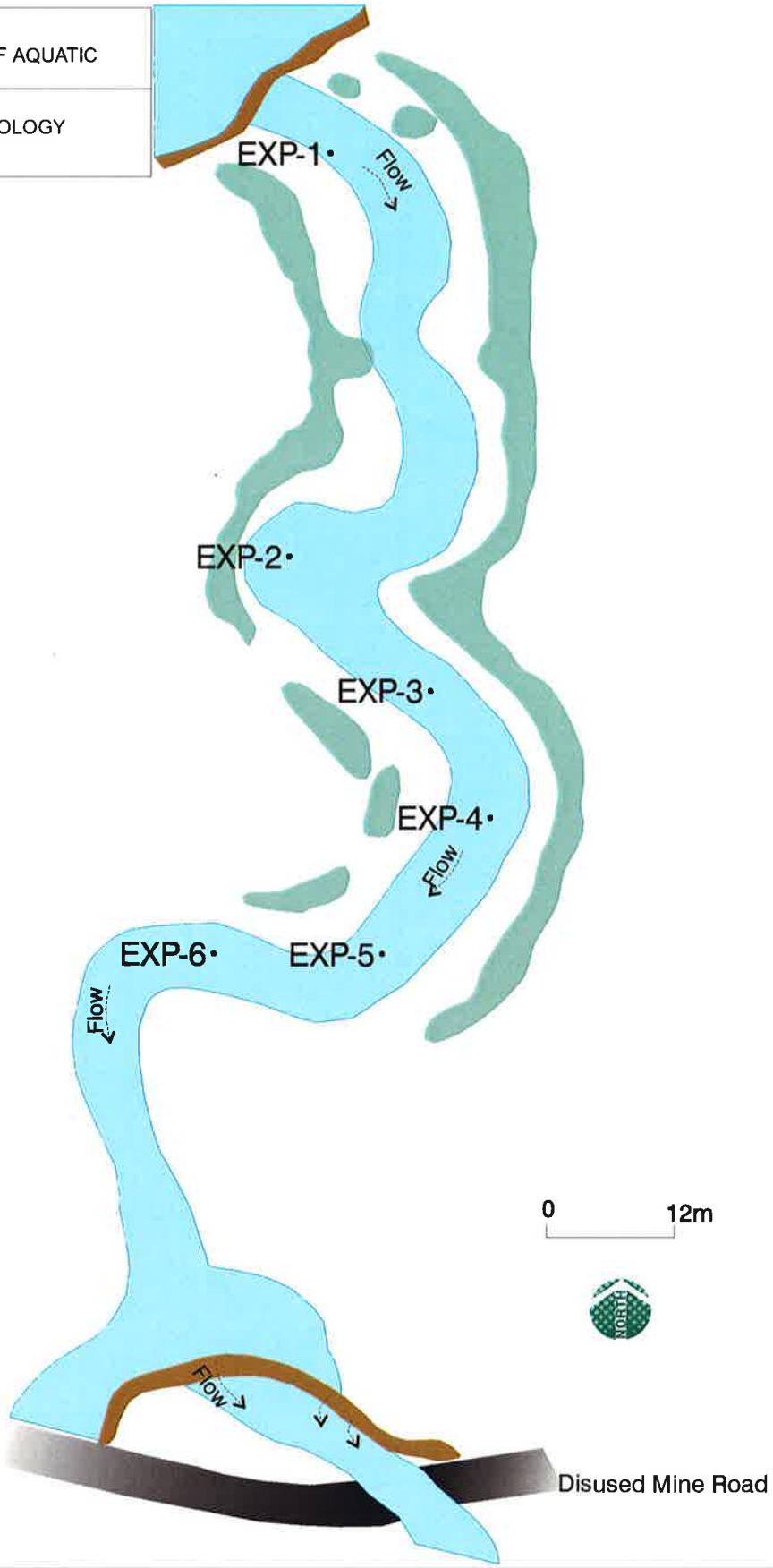

EXP-1 Sampling Station

NORTH

Date: OCT., 1996	**DOME MINE SITE EXPOSURE AREA**
Revised:	**SOUTH PORCUPINE RIVER**
Revision No.	**SAMPLING LOCATIONS**
Checked by: BD	FILE: 96239_28 **Figure No. 4. 3**

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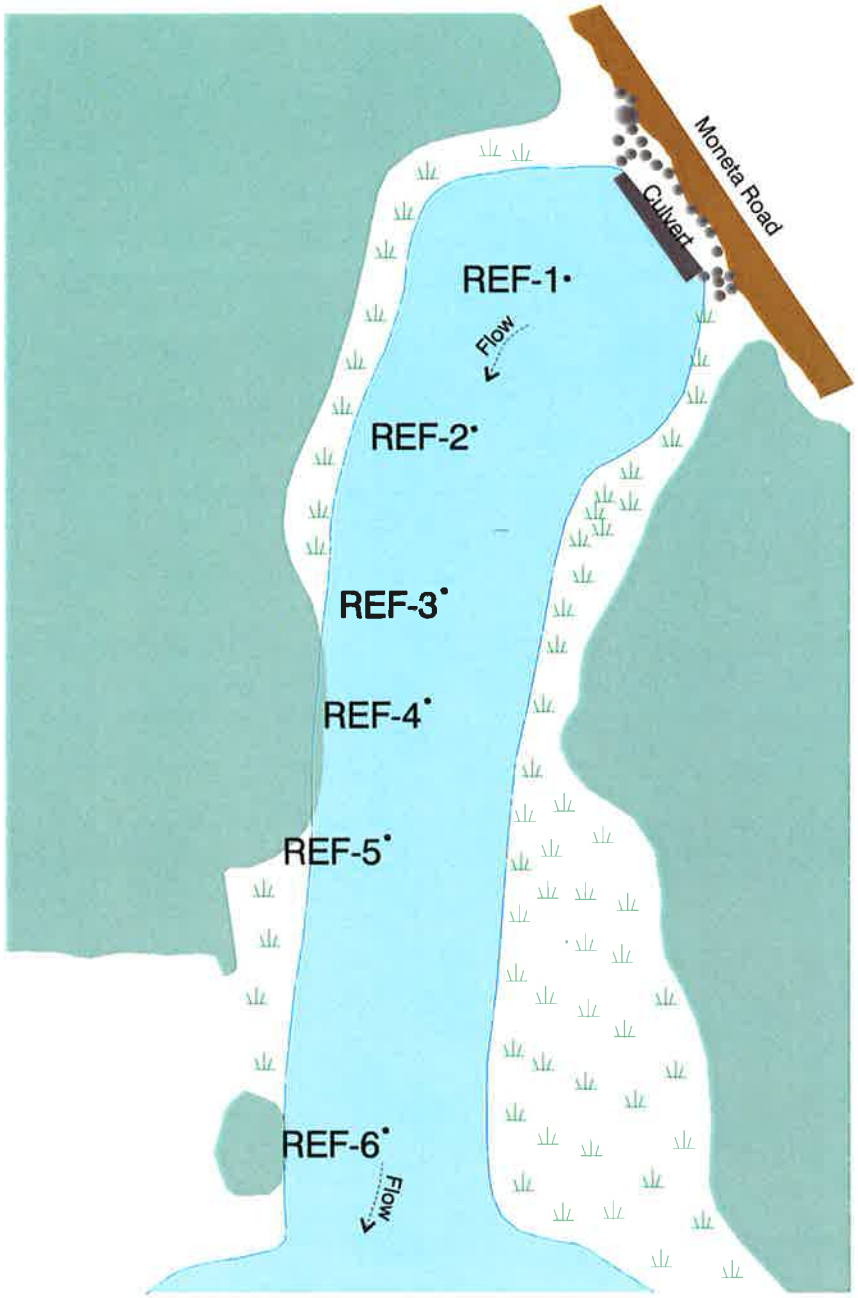

REF-1 Sampling Station

Date: OCT., 1996	**DOME MINE SITE REFERENCE AREA-A SOUTH PORCUPINE RIVER SAMPLING LOCATIONS**
Revised:	
Revision No.	
Checked by: BD	FILE: 96239_27 **Figure No. 4. 4**

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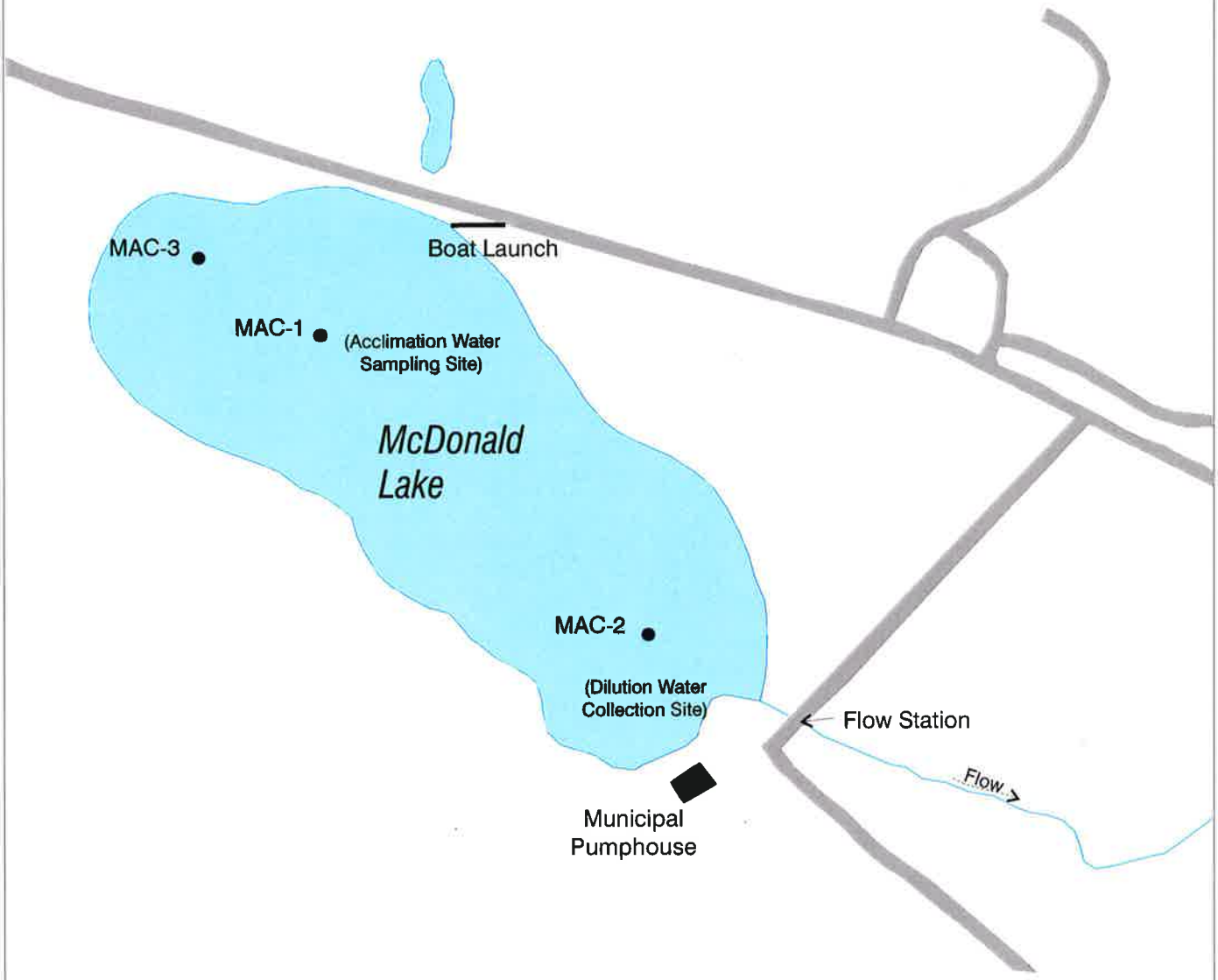
Prepared for:
AQUATIC EFFECTS TECHNOLOGY EVALUATION PROGRAM



MAC-1 Sampling Station

NORTH

0 5m

Date: OCT., 1996	**DOME MINE SITE REFERENCE AREA**
Revised:	**McDONALD LAKE**
Revision No.	**SAMPLING LOCATIONS**
Checked by: BD	FILE: 96239_29 **Figure No. 4. 5**

4.5 Water Chemistry

4.5.1 Water QA/QC

The findings of the water chemistry QA/QC program are discussed in this section, with the detailed QA/QC results being presented in Appendix C2.

Field QA/QC Checks

Replicate Samples

Results of the field replicate general water chemistry parameters (Table C3-1, Appendix C3) and total metal levels (Table C3-2) are excellent.

Van Dorn Blank Samples

Trace amounts of copper and nickel (total and dissolved) were present in the Van Dorn Sampler Blank (Tables C3-2, C3-3) and confirmed in the lab replicate. Dissolved iron, lead, magnesium, sodium and zinc were also detected (Table C3-3). It is unusual, however, that the distilled water used in the Van Dorn blanks was much higher in copper (0.088 mg/L) than the lake water sampled with the Van Dorn (nd-0.005 mg/L). In examining the QA/QC data further, similar concentrations of copper were present in the Field Filter Blank (0.084 mg/L) which used the same distilled water to rinse the Van Dorn. The other chemicals (e.g. Fe, Pb, Na, Ni) present in the Van Dorn blank (Table C3-3) were also present in the Field Filter Blank.

Commercially bought distilled water was used in both the Van Dorn and Field Filter Blank samples, which we now suspect to be contaminated. As a further QA/QC check samples of the distilled water were later analyzed and it was confirmed that the distilled water contained zinc (0.18 mg/L), copper (0.101 mg/L) and nickel (0.019 mg/L).

Based on the McDonald Lake results, it would be our opinion that the Van Dorn bottle itself did not contribute any contamination to the samples.

Travel Blanks

The Travel Blanks for general water chemistry (Table F1) and Total metals (Table F2) did not reveal any contaminants with the exception of trace boron levels. The travel blanks for these two tests were provided by MDS.

Filter Blanks for Dissolved Metals

The Field Filter Blank revealed the presence of Al, Ca, Cu, Fe, Pb, Mg, Ni, Na, Ti and Zn. This analysis was conducted on the commercially purchased distilled water. Results of our dissolved metal levels are in a number of cases higher than the total metal levels, which intuitively, does not make sense. We have had extensive discussions with MDS Laboratories on this matter. There are a few potential explanations:

a) data or sample entry error so that total and dissolved metal results are reversed;
b) contaminated filters; or

c) contaminated nitric acid used to rinse the filters.

This matter has been investigated further and subsequent analysis revealed that Al, Ca, Cu, Fe, Mg, Mn, K, Zn, Ba, St and U appeared to be leached from the filters. The nitric acid did not contain any contaminants.

Laboratory QA/QC Checks

Replicate Analysis
The laboratory replicate analyses appear satisfactory.

Spike Samples
QA/QC results from MDS are presented in Appendix C2. The analytical results of spiked samples was generally within ±10% of the target value which is acceptable.

4.5.2 Water Chemistry

Results of the general water chemistry analysis are summarized in Table 4.5.1 which presents the mean concentrations and standard errors for the Reference and Exposure areas for several parameters of interest. Total and dissolved metal concentrations are summarized in Table 4.5.2 and 4.5.3, respectively. Individual sample results are presented in Appendix C3.

Water samples were collected in the Exposure area of the South Porcupine River when effluent was being discharged ("Exp-on") and when effluent was not being discharged ("Exp-off").

The results of statistical analysis for selected water quality parameters in the reference and exposure areas are presented in Table 4.5.4. It was not possible to perform t-tests on total cobalt and dissolved cobalt, copper and nickel due to the lack of variance around the mean values in the reference samples. The lack of variance invalidates the use of a t-test. Although parametric statistical analysis was not possible for these four variables, it is apparent that the exposure area had "significantly" higher levels of these metals.

Note that mean values were calculated for essentially three upstream "Reference" areas: McDonald Lake, the South Porcupine River far above the Dome discharge (REF A), and the South Porcupine River immediately above the Dome discharge (Tables 4.5.5, 4.5.6) but below all the old tailings (REF B). The results should be examined separately. Benthos and sediments were collected from the South Porcupine River REF A area.

Shaded numbers in the following tables indicate an exceedance of the relevant CCREM guideline. Where a CCREM freshwater guideline does not exist, but an Ontario Provincial Water Quality Objective (PWQO) is available, the PWQO is used for guidance.

Conductivity and sulphate concentrations were significantly ($p<0.05$) higher in the Exposure Area. Total copper and total nickel concentrations were also significantly higher in the Exposure Area compared with the McDonald Lake Reference Area.

Power analysis was conducted on several water chemistry parameters to show expected effect sizes based on different sample sizes (n=5,10,30) using the 1996 study data. Those results are presented in the 1997 Site Selection Report.

General water chemistry and metals data are presented in separate tables (Tables 4.5.5 and 4.5.6) for the REF-B area. No benthos or sediment data were collected here. The purpose of collecting water samples here was twofold: a) it was used as a previous water sampling location in 1989, and b) these data provide a measure of potential input of chemicals from the abandoned tailings area along the South Porcupine River when results are compared with McDonald Lake and REF A.

The data at Ref-B indicate that water quality of the South Porcupine River is influenced by historical tailings above the Dome discharge.

Some spatial trends and historical comparisons are presented in the Discussion, Section 5.1 and 5.2.

Table 4.5.1 General Water Chemistry at Reference and Exposure Areas at Dome Mine (all units mg/L unless otherwise indicated)

Parameter	LOQ	CCME Guideline+	REFERENCE				EXPOSURE			
			MAC REF		SPR-REF-A		EXP ON		EXP OFF	
			Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error
Nitrate	0.05	na	nd	na	0.06	0.03	0.51	0.04	0.28	0.05
Nitrite	0.01	0.06	nd	na	nd	na	nd	na	nd	na
Ammonia	0.05	1.5**	nd	na	nd	na	3.75	0.28	3.09	0.32
TKN	0.05	na	0.54	0.01	0.86	0.10	4.26	0.17	3.57	0.21
Phosphorus	0.1	na	nd	na	nd	na	nd	na	nd	na
Orthophosphate	0.01	na	nd	na	nd	na	nd	na	nd	na
Total Phosphorus	0.004	0.03*	-	-	-	-	0.025	0.001	0.028	0.001
Alkalinity	1	na	113	5.3	189.0	3.0	106.3	2.6	127.3	8.2
Chloride	1	na	25	0.6	38.0	0.6	34.0	0.0	32.3	0.3
Sulphate	2	na	7.67	0.3	15.3	0.3	239.0	4.9	208.7	10.8
Bicarbonate	1	na	113	5.3	189.0	3.0	106.3	2.6	127.0	8.0
Carbonate	1	na	nd	na	nd	na	nd	na	nd	na
Colour (TCU)	5	na	11	0.6	25.3	0.9	24.3	1.5	29.3	1.2
Conductivity (us/cm)	1	na	271.7	28.6	415.3	32.1	776.0	11.5	746.0	10.1
Hardness	0.1	na	137	11.2	221.3	0.3	214.3	3.2	219.3	1.2
Turbidity	0.1	10% change	0.2	0.1	0.6	0.0	0.2	0.0	0.3	0.0
Anion Sum (meq/L)	na	na	3.12	0.1	5.2	0.1	8.1	0.1	7.8	0.1
Cation Sum (meq/L)	na	na	3.32	0.1	5.5	0.0	8.7	0.0	8.5	0.1
Ion Balance	0.01	na	3.11	0.4	3.3	0.6	3.6	0.5	4.4	0.4
pH (units)	0.1	6.5 - 9.0	7.2	0.2	7.4	0.0	7.5	0.0	7.6	0.1
DIC	0.5	na	24.6	0.9	43.2	0.5	29.6	1.0	35.1	1.6
DOC	0.5	na	6.1	0.1	8.3	0.1	6.2	0.2	7.9	0.6
TDS	1	na	167	6.7	279.3	2.0	532.3	3.3	508.0	8.4
TSS	5	increase of 10	-	-	-	-	nd	na	nd	na

Table 4.5.2 Total Metals (mg/L) in Samples Collected from Reference and Exposure Areas at Dome Mine

Metal (mg/L)	LOQ	CCME Guideline+	REFERENCE				EXPOSURE			
			MAC-REF		SPR-REF-A		EXP ON		EXP OFF	
			Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error
Aluminum	0.01	0.1	0.007	0.002	0.007	0.002	nd	na	nd	na
Antimony	0.002	0.02*	nd	na	nd	na	nd	na	nd	na
Arsenic	0.002	0.05	0.002	0.000	0.071	0.007	0.015	0.002	0.020	0.002
Barium	0.005	na	0.007	0.000	0.013	0.000	0.029	0.001	0.029	0.001
Beryllium	0.005	1.1*	nd	na	nd	na	nd	na	nd	na
Bismuth	0.002	na	nd	na	nd	na	nd	na	nd	na
Boron	0.005	0.2*	0.004	0.002	0.010	0.003	0.176	0.002	0.159	0.004
Cadmium	0.0005	0.0018	nd	na	nd	na	nd	na	nd	na
Calcium	0.1	na	37.7	1.6	63.0	0.09	69.1	0.75	68.3	1.39
Chromium	0.002	0.002	0.004	0.001	0.007	0.000	0.002	0.001	nd	na
Cobalt	0.001	0.0006*	nd	na	0.001	0.000	0.051	0.003	0.037	0.004
Copper	0.002	0.004	0.004	0.001	nd	na	0.013	0.001	0.018	0.002
Iron	0.02	0.3	0.02	0.003	1.14	0.16	0.28	0.012	0.32	0.048
Lead	0.0001	0.007	nd	na	nd	na	0.0002	0.000	0.0002	0.000
Magnesium	0.1	na	8.2	0.32	15.7	0.00	12.7	0.32	13.43	0.41
Manganese	0.002	na	0.010	0.005	0.184	0.063	0.369	0.039	0.477	0.090
Mercury (ug/L)	0.1	0.0001	-	-	-	-	-		-	
Molybdenum	0.002	0.01*	nd	na	nd	na	0.004	0.000	0.004	0.000
Nickel	0.002	0.15	0.002	0.001	0.006	0.001	0.029	0.002	0.037	0.004
Potassium	0.5	na	0.8	0.12	1.2	0.32	25.5	0.20	24.1	0.42
Reactive Silica	0.5	na	-		-	-	-	-	-	-
Selenium	0.002	0.001	nd	na	nd	na	nd	na	nd	na
Silver	0.0003	0.0001	nd	na	nd	na	nd	na	nd	na
Sodium	0.1	na	15.4	0.55	24.4	0.03	85.2	0.67	79.2	1.44
Strontium	0.005	na	0.043	0.001	0.082	0.001	0.128	0.002	0.123	0.003
Thallium	0.0001	0.0003*	nd	na	0.0002	0.000	0.0001	0.0000	nd	na
Tin	0.002	na	nd	na	nd	na	nd	na	nd	na
Titanium	0.002	na	nd	na	0.001	0.000	0.009	0.005	0.004	0.000
Uranium	0.0001	0.005*	nd	na	nd	na	nd	na	nd	na
Vanadium	0.002	0.005*	nd	na	nd	na	0.004	0.003	0.001	0.000
Zinc	0.002	0.03	0.006	0.002	nd	na	0.003	0.001	0.002	0.001
Total Cyanide	0.002	na	-	-						
Free Cyanide	0.002	0.005	-	-						

Table 4.5.3 Dissolved Metals (mg/L) in Water Collected from Reference and Exposure Areas at Dome Mine

Metal (mg/L)	LOQ	CCME Guideline+	REFERENCE				EXPOSURE			
			MAC-REF		SPR-REF-A		EXP ON		EXP OFF	
			Mean	Std Error	Mean	Std Error	Mean	Std Error	Mean	Std Error
Aluminum	0.01	0.1	0.02	0.003	0.01	0.003	0.01	0.003	0.01	0.003
Antimony	0.002	0.02*	nd	na	nd	na	nd	na	nd	na
Arsenic	0.002	0.05	0.001	0.0003	0.055	0.001	0.019	0.002	0.023	0.003
Barium	0.005	na	0.009	0.0000	0.015	0.000	0.019	0.000	0.019	0.000
Beryllium	0.005	1.1*	nd	na	nd	na	nd	na	nd	na
Bismuth	0.002	na	nd	na	nd	na	nd	na	nd	na
Boron	0.005	0.2*	nd	na	0.006	0.002	0.150	0.001	0.148	0.003
Cadmium	0.0005	0.0018	nd	na	nd	na	nd	na	nd	na
Calcium	0.1	na	40.3	1.6	66.1	0.55	59.4	0.45	59.7	0.64
Chromium	0.002	0.002	0.003	0.0003	0.005	0.000	nd	na	nd	na
Cobalt	0.001	0.0006*	nd	na	nd	na	0.046	0.002	0.034	0.004
Copper	0.002	0.004	0.008	0.0000	0.006	0.000	0.016	0.001	0.020	0.002
Iron	0.02	0.3	0.05	0.007	0.75	0.01	0.22	0.003	0.26	0.027
Lead	0.0001	0.007	0.0004	0.0001	0.0003	0.000	0.0002	0.0001	0.0009	0.0004
Magnesium	0.1	na	8.0	0.32	14.9	0.15	11.1	0.15	11.8	0.33
Manganese	0.002	na	0.007	0.003	0.090	0.015	0.38	0.05	0.464	0.051
Mercury (ug/L)	0.1	0.0001	nd	na	nd	na	nd	na	nd	na
Molybdenum	0.002	0.01*	nd	na	nd	na	0.004	0.000	0.003	0.000
Nickel	0.002	0.15	0.002	0.000	0.005	0.000	0.024	0.002	0.030	0.003
Potassium	0.5	na	0.6	0.03	0.9	0.120	21.8	0.29	21.1	0.19
Reactive Silica	0.5	na	2.8	0.2	8.0	0.03	5.4	0.15	6.7	0.27
Silver	0.0003	0.001	nd	na	nd	na	nd	na	nd	na
Selenium	0.002	0.0001	nd	na	nd	na	nd	na	nd	na
Sodium	0.1	na	16.6	0.5	25.6	0.2	72.6	0.35	69.6	0.52
Strontium	0.005	na	0.045	0.001	0.085	0.000	0.152	0.000	0.152	0.001
Thallium	0.0001	0.0003*	0.0001	0.0000	0.0002	0.0000	nd	na	nd	na
Tin	0.002	na	nd	na	nd	na	nd	na	nd	na
Titanium	0.002	na	nd	na	nd	na	nd	na	nd	na
Uranium	0.0001	0.005*	0.0002	0.000	0.0001	0.000	nd	na	0.0001	0.0000
Vanadium	0.002	0.005*	nd	na	nd	na	nd	na	nd	na
Zinc	0.002	0.03	0.034	0.012	0.018	0.004	0.017	0.005	0.015	0.002
Total Cyanide	0.002	na	0.001	0.000	0.002	0.000	0.009	0.001	0.008	0.001
Free Cyanide	0.002	0.005	0.001	0.000	0.002	0.000	nd	na	nd	na

Table 4.5.4 Statistical Analysis Results for Selected Water Chemistry Parameters from Reference and Exposure Areas at Dome Mine Site

Parameter[1]	McDonald Lake Reference Area	Exposure Area					
	Mean (±s.e.)	Mean Effluent On (±s.e.)	t-Value (d.f.=4)	p-value	Mean Effluent Off (±s.e.)	t-value (d.f.=4)	p-value
Conductivity (µs/cm)	271.7 (±28.6)	776.1 (±11.5)	16.345	0.000	746.0 (±10.1)	15.626	0.000
Sulphate	7.67 (±0.3)	239.0 (±4.9)	70.092[a]	0.000	208.7 (±10.8)	48.566[a]	0.000
Total Cobalt	nd	0.051 (±0.003)	na		0.037 (±0.004)	na	
Dissolved Cobalt	nd	0.046 (±0.002)	na		0.034 (±0.004)	na	
Total Copper	0.004 (±0.001)	0.013 (±0.001)	7.155	0.002	0.018 (±0.002)	6.364	0.003
Dissolved Copper	0.008 (±0.000)	0.016 (±0.001)	na		0.020 (±0.002)	na	
Total Nickel	0.002 (±0.001)	0.029 (±0.002)	15.041	0.000	0.037 (±0.004)	7.998	0.001
Dissolved Nickel	0.002 (±0.000)	0.024 (±0.002)	na		0.030 (±0.003)	na	

[1] all values in mg/L unless otherwise stated
[a] +- value calculated from log transformed data
na +- test not valid due to no variance in reference area

Table 4.5.5 General Water Chemistry Data for Ref-B Immediately Upstream of Dome Effluent Pipe

Parameter	LOQ	CCME Guideline+	B1,B2,B3	
			Mean	Std Error
Nitrate	0.05	na	nd	na
Nitrite	0.01	0.06	nd	na
Ammonia	0.05	1.5**	0.17	0.04
TKN	0.05	na	0.87	0.04
Phosphorus	0.1	na	nd	na
Orthophosphate	0.01	na	nd	na
Alkalinity	1	na	250.7	6.9
Chloride	1	na	12.7	0.7
Sulphate	2	na	60.7	4.3
Bicarbonate	1	na	246.7	6.4
Carbonate	1	na	4.0	0.6
Colour (TCU)	5	na	30.0	3.0
Conductivity (us/cm)	1	na	569.0	2.1
Hardness	0.1	na	324.0	4.4
Turbidity	0.1	10% change	0.6	0.0
Anion Sum (meq/L)	na	na	6.66	0.04
Cation Sum (meq/L)	na	na	7.24	0.04
Ion Balance	0.01	na	4.17	0.31
pH (units)	0.1	6.5 - 9.0	8.3	0.0
DIC	0.5	na	59.7	1.3
DOC	0.5	na	9.6	0.6
TDS	1	na	360.7	4.1
TSS	5	increase of 10	nd	na

Table 4.5.6 Dissolved and Total Metals (mg/L) at Ref-B Immediately Upstream of Dome Effluent Pipe

Metal (mg/L)	LOQ	CCME Guideline+	Dissolved Metals B1,B2,B3		Total Metals B1,B2,B3	
			Mean	Std Error	Mean	Std Error
Aluminum	0.01	0.1	0.008	0.002	0.007	0.002
Antimony	0.002	0.02*	nd	na	nd	na
Arsenic	0.002	0.05	0.055	0.005	0.055	0.006
Barium	0.005	na	0.015	0.001	0.024	0.001
Beryllium	0.005	1.1*	nd	na	nd	na
Bismuth	0.002	na	nd	na	nd	na
Boron	0.005	0.2*	0.080	0.002	0.091	0.002
Cadmium	0.0005	0.0018	nd	na	nd	na
Calcium	0.1	na	67.1	0.8	80.9	0.7
Chromium	0.002	0.002	nd	na	0.001	0.000
Cobalt	0.001	0.0006*	0.004	0.002	0.003	0.002
Copper	0.002	0.004	0.011	0.000	0.006	0.001
Iron	0.02	0.3	0.39	0.05	0.64	0.09
Lead	0.0001	0.007	0.0004	0.000	0.0013	0.0010
Magnesium	0.1	na	29.5	0.9	35.3	0.9
Manganese	0.002	na	0.091	0.009	0.096	0.011
Mercury (ug/L)	0.1	0.0001	nd	na	-	-
Molybdenum	0.002	0.01*	nd	na	nd	na
Nickel	0.002	0.15	0.011	0.000	0.015	0.001
Potassium	0.5	na	1.5	0.296	1.9	0.5
Reactive Silica	0.5	na	8.8	0.173	-	-
Selenium	0.002	0.001	nd	na	nd	na
Silver	0.0003	0.0001	nd	na	nd	na
Sodium	0.1	na	14.5	1.2	17.0	1.6
Strontium	0.005	na	0.144	0.001	0.124	0.003
Thallium	0.0001	0.0003*	nd	na	nd	na
Tin	0.002	na	nd	na	nd	na
Titanium	0.002	na	nd	na	0.004	0.000
Uranium	0.0001	0.005*	0.0001	0.0000	nd	na
Vanadium	0.002	0.005*	nd	na	nd	na
Zinc	0.002	0.03	0.012	0.004	0.003	0.002
Total Cyanide	0.005	na	0.013	0.001	-	-
Free Cyanide	0.002	0.005	nd	na	-	-

4.6 Sediment Chemistry

4.6.1 QA/QC

The sediment chemistry QA/QC results are discussed below with detailed information presented in Appendix D2.

Field QA/QC Checks

Replicate Samples

A replicate field sediment sample was collected at Exposure site-1. The results of analysis of the duplicate samples are presented in Appendix D3 along with the individual sample results. The comparison of results with replicate sediment samples appears consistent. There are some differences as would be expected with sediment samples which can be quite heterogenous, however, it would seem that the technique of compositing 5 grab samples was quite effective. For many parameters, the differences between replicate field samples was no greater than the difference observed between laboratory replicate analysis of the same sample indicating excellent representation of the actual sediment characteristics.

Results of Swab Analysis

Results of the Swab samples are presented in Table 4.6.1. The concentrations of most swab samples were less than detection limit with the exception of trace levels of barium and copper. However, the concentration of zinc in the swabs was notable, with levels ranging from 10.4 to 39.3 ug/g. Since only zinc was present in significant quantities, we are confident that our methods of field washing the sampling and homogenizing equipment was effective, however, some source of zinc contamination was present.

The most likely source is the powder present in the latex gloves used by field personnel. The talc powder is known to contain some metals, notably zinc which is used for medicinal purposes. To test this potential source we rinsed the latex gloves with distilled water and submitted the solution for analysis. The results revealed the potential for contamination by calcium, magnesium, potassium, sodium and zinc (data presented in Appendix C).

The swab zinc levels are < 30% of the zinc levels measured in the actual sediments. Therefore, we do not feel that potential contamination from the powder would be able to mask any real trends between Reference and Exposure areas pertaining to zinc

MDS provided the results of their routine analysis of the swab blanks (unused swabs) since the swabs were provided by the laboratory (Table 4.6.1). These results indicate that trace levels of barium, boron, copper and zinc are present in the swabs. However, the levels are much lower than the sediment concentrations, or zinc levels observed in our used swabs.

Table 4.6.1: Swab Analysis of Sediment Mixing Bowls After Cleaning from Reference and Exposure Stations at Dome Mine

		Reference Stations			Exposure Stations						
Metal (ug/tot)	LOQ	REF 1 COMP	REF 3 COMP	REF 5 COMP	EXP 3 COMP	EXP 3 COMP Lab Replicate	EXP 5 COMP	EXP 6 COMP	Swab Blank 1	Swab Blank 1 Lab Replicate	Swab Blank 2
Barium	0.1	0.2	0.1	0.1	0.3	0.3	0.2	0.3	0.2	0.4	0.2
Beryllium	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Boron	0.5	nd	nd	nd	nd	nd	nd	nd	2.2	2.4	0.9
Cadmium	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	0.3	nd	nd	nd	nd	nd	0.4	nd	nd	nd	nd
Cobalt	0.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Copper	0.2	0.4	0.4	0.2	0.6	0.6	0.5	0.6	0.6	0.5	0.4
Lead	1.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Molybdenum	0.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Nickel	0.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Silver	0.2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium	0.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	0.3	20.3	33.8	11.4	39.2	42.0	27.9	10.4	1.0	1.2	1.1

Laboratory QA/QC Checks

Replicate Analysis

The results of replicate analysis of sediments at Exp-1 are well within reason and indicate good precision of the methods used by the analytical laboratory.

4.6.2 Chemistry

Results of the sediment analyses are summarized in Table 4.6.2 which provides the mean concentration and standard error of 6 replicate samples within the Reference and Exposure areas. Results are provided for both raw data and metal levels normalized for % fines. Correcting for % fines did not change any patterns. Full results of the chemical analysis for each individual sample are provided in Appendix D3.

The normalized mean concentrations of the following metals are substantially higher in the Exposure area relative to the Reference area: arsenic, cobalt, copper, nickel, silver and zinc. The Total Organic Carbon (TOC) content of the sediments in the exposure area is also approximately twice as high (5.4%) as the TOC content of sediments in the Reference area (2.9%). The normalized concentration of chromium, molybdenum and mercury was similar in both the Reference and Exposure areas. The levels of lead and zinc appear lower in the Exposure area relative to the Reference area.

Table 4.6.2 Mean Metal Concentrations in Sediment (mg/kg) from the South Porcupine River, Dome Mine Site

	Reference				Exposure			
	Mean	SE	Normalized (% fines)		Mean	SE	Normalized (% fines)	
			Mean	SE			Mean	SE
Arsenic	182.33	8.69	293.9	25.6	430.17	0.69	549.0	57.7
Cadmium	0.13	0.02	0.21	0.02	0.00	na	nd	na
Chromium	55.38	6.47	91.2	16.5	78.07	5.93	99.2	8.3
Cobalt	17.02	0.92	27.5	2.6	72.78	7.51	92.4	9.8
Copper	238.17	19.0	379.8	33.9	1056.83	59.39	1339.4	81.2
Lead	14.62	1.51	23.7	3.6	8.85	0.71	11.2	1.0
Mercury	0.14	0.05	0.21	0.07	0.15	0.01	0.18	0.01
Molybdenum	3.23	0.40	5.0	0.4	6.92	0.53	8.8	0.8
Nickel	45.37	2.98	73.7	8.5	433.33	19.60	549.2	28.8
Silver	0.25	0.04	0.39	0.05	4.14	0.33	5.25	0.45
Zinc	201.67	19.37	319.6	24.5	103.80	5.45	131.9	9.0
Total Organic Carbon	2.92	0.21	n/a	n/a	5.43	1.11	na	na

n/a = not applicable

Several metals were selected for statistical analysis to confirm the difference between the Reference and Exposure areas in sediment metal concentration. The results of statistical analysis of arsenic, cobalt and copper levels in the sediment samples (corrected for per cent fine material) are presented in Table 4.6.3. For all three metals, there were significantly higher levels ($p<0.01$) in the exposure area compared with the reference area.

Table 4.6.3 Statistical Analysis Results from Selected Sediment Parameters from Reference and Exposure Areas at Dome Mine Site

Parameter[1]	Reference Mean (±s.e.)	Exposure Mean (±s.e.)	t-value (log transformed) (d.f. = 10)	p-value
Arsenic	293.9 (±25.6)	549.0 (±57.7)	4.494	0.001
Cobalt	27.5 (±2.6)	92.4 (±9.8)	8.230	0.000
Copper	379.8 (±33.9)	1339.4 (±81.2)	12.055	0.000

[1] All parameter means normalized to mg/kg fines

4.7 Benthic Invertebrate Community Structure

4.7.1 QA/QC

Each of the 12 benthic samples were subsampled in the laboratory due to the large number of organisms present. In most cases a 1/4 sample was taken for sorting and enumeration (Appendix E2). Two of the samples (Ref2-1, Ref5-1), representing approximately 20% of the samples, were divided, and then both fractions processed to determine potential subsampling error. In both cases the coefficient of variation between the sorted fractions was about 8% indicating very good representation of the subsamples.

The remaining material from two samples (Ref3-1, Ref6-1) was sorted a second time by a different person to determine if organisms were missed during the first sorting process. The second resort showed that the original sorting was >95% complete, indicating excellent recovery of organisms by the benthic technician.

4.7.2 Community Structure

The total number of taxa observed was high in the reference (35) than in the exposure area (30) (Table 4.7.1). Similarly, the density was significantly higher ($p < 0.05$) in the reference (mean = 18,130 organisms/m^2) compared with the exposure area (mean = 6,319 organisms/m^2). However, the differences in other common indicators (eg. EPT richness) or diversity were not pronounced between the two areas (Appendix E).

The mean number of taxa for the Reference and Exposure areas were 15.3 and 11.3, respectively (Table 4.7.1). No statistics were conducted on this value as it has

relatively little meaning. As discussed below, two samples could have the same number of taxa present, but if they are totally different taxa, then the number has little to no ecological relevance.

The benthic community in the South Porcupine River is not particulary rich or diverse even in the reference area. This can be largely attributed to the soft, highly, organic bottom substrate in this slow, meandering stream. Therefore, differences in the benthic community between the reference and exposure areas are more subtle. The absence of several species in the exposure area compared with the reference area is a good indication that the benthos community is different between the two areas.

For example, the following groups of organisms are well represented in the reference area but are almost or totally absent in the exposure area:

	Exposure	**Reference**
Family Tubificidae	0	583
Phyla Arthropoda		
O. Harpacticoids	0	20
Cl. Ostracoda	8	82
Order Diptera		
F. Ceratopogonidae	8	202
S.F. Chironomidae		
Chironomus	4	70
Cladopelma	0	252
Einfeldia	0	766
P. Mollusca		
Cl. Gastropoda	0	8
Cl. Pelecypoda	0	30

The groups of chironomids that disappear between the reference and exposure area are all primarily burrowing organisms. These are replaced to some extent by different chrionomids that are cleaners and scrapers and live on top of the sediments. For example, there were many more *Endochironomus* (88 in Exp. vs. 40 in Ref.) and *Parachironomus* (112 in Exp. vs. 12 in Ref.) below the effluent than upstream. This pattern suggests that the in-sediment quality below the outfall is affecting several groups of organisms. Similarly, although not present in large numbers in the Reference area, molluscs (clams and snails) were totally absent below the effluent.

Table 4.7.1 Summary of Benthic Invertebrate Data from Dome Mine Site, September, 1996

	Reference (n=6)	Exposure (n=6)	t-value[1]	p-value
Mean organism density (#/m^2) (±s.e.)	18,130 ± 4441	6,319 ±1848	-2.523	0.03
Total Number of Taxa	35	30	na	na
Mean # taxa	15.3	11.5	na	na
# Chironomid taxa	14	15	na	na

[1] t- test performed using log transformed data

4.8 Fisheries

4.8.1 Community

The relative composition of the small fish community in the Reference and Exposure areas in the South Porcupine River is presented in Figure 4.8.1.

The fish community in the Exposure area consisted of minnows, sticklebacks and perches. Specifically, catches included pearl dace (*Margariscus margarita)*, northern redbelly dace (*Phoxinus eos)*, brook stickleback (*Culea inconstans)*, white sucker (*Catostomus commersoni)* and yellow perch (*Perca flavescens)*. All fish were generally within the smaller size range (<10 cm) with some fish (pearl dace) slightly larger.

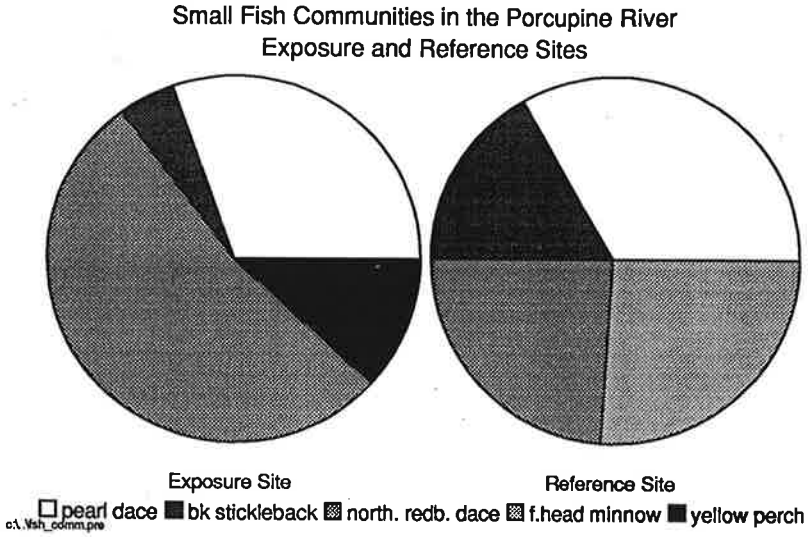


Figure 4.8.1 Small Fish Community in the Porcupine River

The Reference area of the South Porcupine River contained a similar community which included Pearl dace, northern redbelly dace and brook stickleback. Fathead minnow (*Pimephales promelas)* were also present.

Gill net catches in McDonald Lake indicated the presence of yellow perch, rock bass (*Ambloplites rupistris)*, smallmouth bass (*Micropterus dolomieui)* and white sucker.

All species caught with minnow traps were generally small (<10 cm) and were kept for analysis. Most fish caught by gill net were in the 10-15 cm range and were discarded. Some yellow perch were within the acceptable range (<10 cm or >15 cm) and were kept as were all white suckers and one smallmouth bass but small sample sizes precluded their use for subsequent analysis.

Exposure Site

The relative abundance of fish species caught in the exposure area by minnow trap are presented in Table 4.8.1. Northern redbelly dace made up 52.9% of the total catch and pearl dace, yellow perch and brook stickleback made up the remaining 30.4, 11.8 and 4.9 respective percentages.

Table 4.8.1 Relative Abundance of Fish Species Captured by Minnow Trap in the Exposure Site, South Porcupine River, September and October, 1996

Species	# Caught	Method of Capture	Effort (hours)	Relative Abundance (%)
Pearl dace	31	minnow trap	259	30.4
Yellow perch	12	minnow trap	259	11.8
Brook stickleback	5	minnow trap	259	4.9
Northern redbelly dace	54	minnow trap	259	52.9
Total	**102**			**100**

* 72 hours effort was expended with modified minnow traps with no catch and was not used in effort calculation

The relative abundance of fish captured by gill net in the exposure area are presented in Table 4.8.2. Yellow perch made up 67% of the catch and white sucker made up the remaining 33%.

Table 4.8.2. Relative Abundance of Fish Species Captured by Gill Net in the Exposure Area, South Porcupine River, October, 1996

Species	# Caught	Method of Capture	Effort (hours)	Relative Abundance (%)
Yellow perch	2	15 m 1.5" gill net	89	66.7
White sucker	1	15 m 1.5" gill net	89	33.3
Total	**3**			**100**

Reference Site

The relative abundance of fish species caught by minnow trap in the South Porcupine River of the reference area are presented in Table 4.8.3. Pearl dace made up 33.3% of the total catch and fathead minnow, northern redbelly dace and brook stickleback made up the remaining 26.0, 24.0 and 16.7 respective percentages.

Table 4.8.3. Relative Abundance of Fish Species Captured by Minnow Trap in the Reference Site, South Porcupine River, September and October, 1996

Species	# Caught	Method of Capture	Effort (hours)	Relative Abundance (%)
Pearl dace	50	minnow trap	184	33.3
Brook stickleback	25	minnow trap	184	16.7
Northern redbelly dace	36	minnow trap	184	24.0
Fathead minnow	39	minnow trap	184	26.0
Total	**150**			**100**

* 27 hours effort was expended with modified minnow traps with no catch and was used in effort calculation

The relative abundance of fish captured by gill net in McDonald Lake of the reference site are presented in Table 4.8.4. Rock bass made up 79.0% of the catch and yellow perch, white sucker and smallmouth bass made up the remaining 10.9, 9.2 and 0.9 respective percentages.

Table 4.8.4. Relative Abundance of Fish Species Captured by Gill Net in the Reference Site, McDonald Lake, September and October, 1996

Species	# Caught	Method of Capture	Effort (hours)	Relative Abundance (%)
Yellow perch	13	15 m 1.5" gill net 15 m 2.5" gill net	56	10.9
Rock bass	94	15 m 1.5" gill net 15 m 2.5" gill net	56	79.0
White sucker	11	15 m 1.5" gill net 15 m 2.5" gill net	56	9.2
Smallmouth bass	1	15 m 1.5" gill net 15 m 2.5" gill net	56	0.9
Total	**119**			**100**

The mean size (fork length and weight) of Pearl Dace and Northern redbelly Dace are summarized in Table 4.8.5. The data show that the length of Pearl Dace from the Exposure Area (mean = 8.5 cm) was significantly longer ($p < 0.05$) than Pearl Dace from the Reference Area (mean = 7.1 cm). The mean age of Pearl Dace from the Reference (1.37 yrs) and Exposure Areas (1.0 yrs) was similar. Dr. Jon Tost who conducted the scale age analysis commented that the annuli in fish from the Exposure area were much closer together and suggested they appeared to be growing faster than fish from the Reference area. The length results support this observation. The weight of Pearl Dace from the Exposure area (mean = 6.2 g) was also somewhat greater ($p< 0.10$) than fish from the Reference area (mean wt. = 4.1 g).

The size of Northern Redbelly dace were not significantly different ($p > 0.05$) between the two areas (Table 4.8.5).

Table 4.8.5 Summary of Fish Size in Study Areas

Species/Parameter	Reference	Exposure	P	T Statistic
Pearl Dace				
Mean fork length (cm)	7.1 (0.48)	8.5 (0.38)	0.043 **	2.22
Mean weight (g)	4.1 (0.81)	6.2 (0.85)	0.087 *	1.84
Northern Redbelly Dace				
Mean fork length (cm)	5.3 (0.29)	5.6 (0.28)	0.401	0.87
Mean weight (g)	1.9 (0.39)	2.0 (0.35)	0.811	0.24

** sig diff at p=0.05
* sig diff at p=0.10

4.8.2 Tissue Analysis

The results of metal and metallothionein analysis in the whole fish samples are summarized in Table 4.8.6 (raw data Appendix F3). Tissue metallothionein levels in the Reference and Exposure areas were not significantly different ($p>0.05$) for either the pearl dace or northern redbelly dace.

Table 4.8.6 Summary of Metal and Metallothionein Results (means ± SE)

Species/Parameter	Reference	Exposure	P Value
Pearl Dace			
Metallothionein (μg/g)	99±27	112±19	0.67
Metals (μM/g)	0.84±0.11	1.87±0.21*	0.001
Northern Redbelly Dace			
Metallothionein (μg/g)	207±65	218±28	0.88
Metals (μM/g)	0.78±0.13	1.45±0.18*	0.018

* Indicates significantly different ($p<0.05$)

Detailed results of metal analysis provided by Dr. Jack Klaverkamp are presented in Appendix F3 and summarized in Table 4.8.6. The metal values in Table 4.8.6 are expressed as uMoles/g of tissue. This value represents the sum of the concentrations of zinc, cadmium and copper which were analyzed separately. The sum of these three metals was significantly greater ($p < 0.05$) in both Pearl Dace and Northern redbelly Dace from the Exposure area compared with the Reference Area.

4.9 Level of Effort

The relative level of effort (person hours) for different study components is summarized in Table 4.9.1. Table 4.9.2 presents expenses and disbursements incurred during the study. The effort summarized below does not include time spent comparing the Dome site for suitability for testing hypotheses in 1997, scoring the site criteria or completing the 1997 study design.

Table 4.9.1 Estimated Level of Effort for Each Program Element at the Dome Mine Sites

Task			Level Effect (person hours)
Project Initiation Meeting			11.0
Literature Review and 1996 Study Design			36.0
Field Surveys	Planning and Preparation of Field Logistics		102
	Site Reconnaissance, Habitat Characterization and Station Selection		55
	Sublethal Toxicity Sample Collection		25
	Water Chemistry		30
	Sediment Chemistry		24
	Benthos		18
	Fish	Population	99
		Tissue Processing	30.5
Data Analysis Interpretation			58.0
Preliminary Surveys and Recommendations Report			75.0
Final Reports Survey			80.0
Progress Reports			10.5
Conference Calls			13.5

Table 4.9.2 Expenses and Disbursements for the Preliminary Field Survey at the Dome Mine Site

Expense	Sublethal Toxicity Sample Collection	Water Chemistry	Sediment Chemistry	Benthos	Fish
Travel	2195				
Accommodations[1]	655				
Meals[1]	360				
Miscellaneous Supplies	2350				
Shipping	793				
Analyses		5542	1825	2400	

5. DISCUSSION

5.1 Comparison of Results with Historical Data

Comparison of the 1989 survey results with our study results indicates that some metal concentrations in the Porcupine River, notably copper and zinc, have decreased downstream of the Dome effluent since 1989 (Figure 5.1.1). The concentration of these metals immediately upstream of the Dome effluent (Ref-B) also appear to have decreased, but to a lesser degree. The average sulphate concentration has increased in the exposure area since 1989.

The concentration of copper and nickel in sediments in the exposure area have increased appreciably since 1989, while the level of zinc is somewhat lower. Interestingly, the concentration of zinc is approximately twice as high in our Ref-A sediments compared with the Exposure area sediments (Figure 5.2.1).

The 1989 study collected "upstream" sediment samples that roughly coincided with our Ref-B area.

5.2 Comparison of Reference Versus Exposure Areas

The water chemistry results display a clear downstream gradient for several general water chemistry parameters. Sulphate and conductivity are used to illustrate this trend in Figure 5.2.1. Some metals such as copper and cobalt are also notably higher in the exposure area relative to the reference area (Figure 5.2.1). In contrast, the concentrations of zinc and arsenic are lower below the Dome discharge.

The sediment concentration of several metals is elevated in the Exposure area relative to the Reference area (e.g. Figure 5.1.2).

Biological parameters (benthos and fish) appear to show some response to the Dome effluent based on the preliminary 1996 results.

As noted in the results section, the species composition of the benthos changed quite markedly below the Dome site with several burrowing species of chironomids, as well as pea clams and snails disappearing. In a study of a copper stressed stream in southern Ohio, Winner et.al. (1980) also observed that the bivalve Pisidium and the gastropod Physella were absent. The density of organisms in the Exposure area was also greatly reduced compared with the Reference area.

The benthos community may be responding to conditions in the water and/or sediments. Sediment toxicity tests in 1997 would be useful to assist to identify the potential sources of stress to the benthic community in the Porcupine River.

Pearl Dace and Northern Redbelly Dace in the Exposure area contained greater concentrations of metals than fish in the Reference area. This is consistent with the water and sediment chemical results, and suggests that metal levels in these fish are

Figure 5.1.1 Comparison of EAG (1989) and ESP (1996) water chemistry in the South Porcupine River

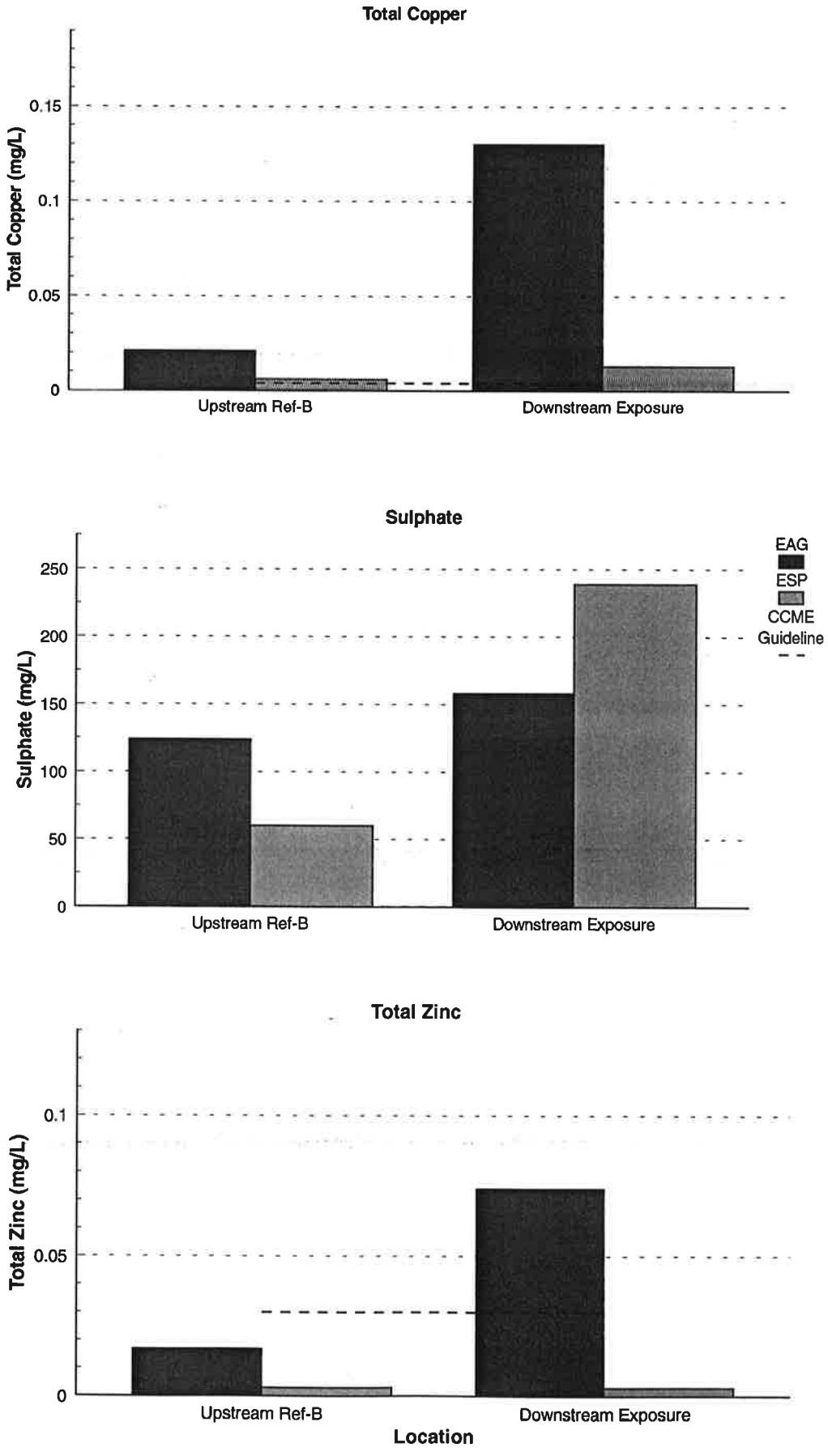


Figure 5.1.2 Comparison of EAG (1989) and ESP (1996) sediment chemistry in the South Porcupine River

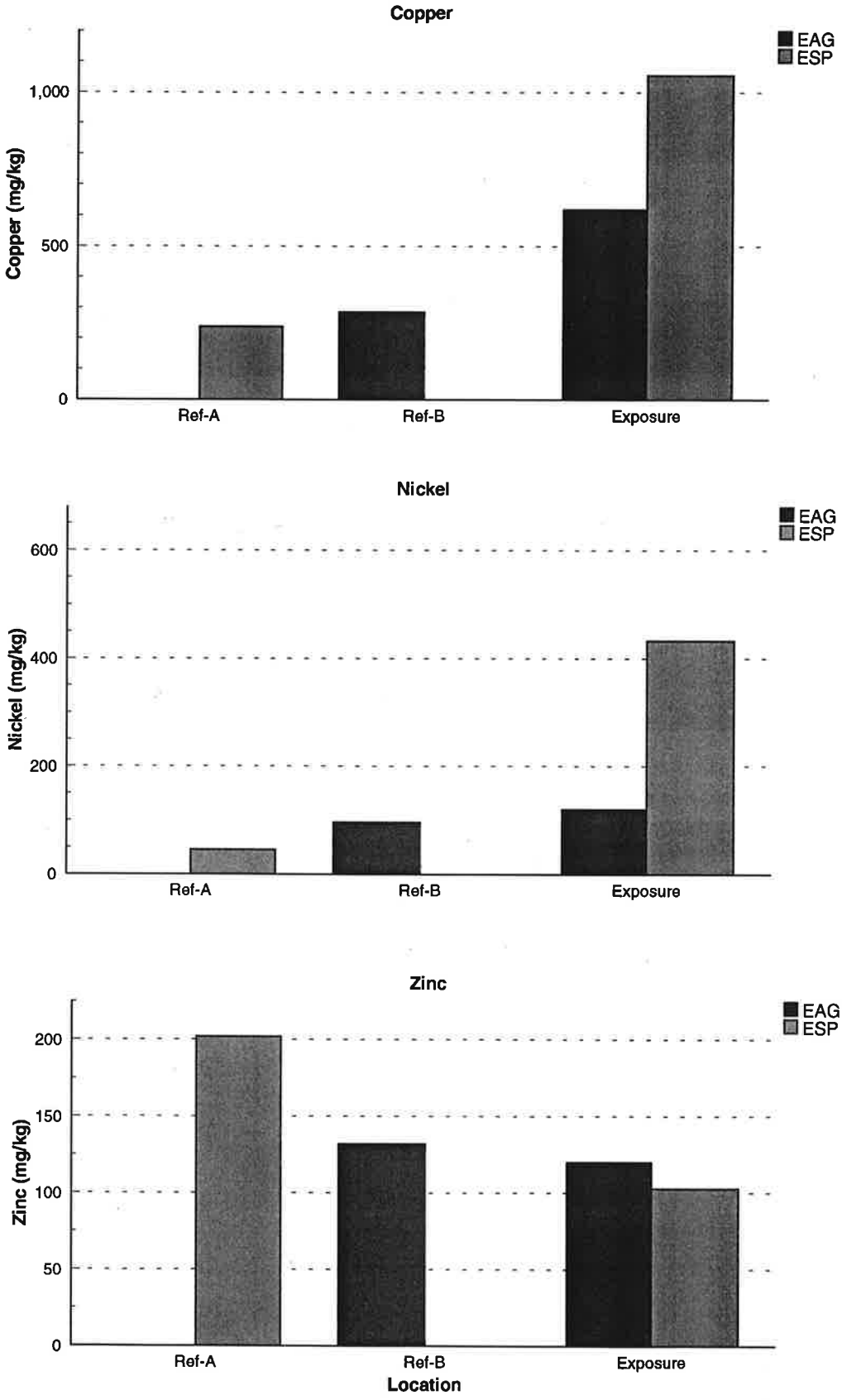


Figure 5.2.1 Spatial comparison of Dome site water chemistry

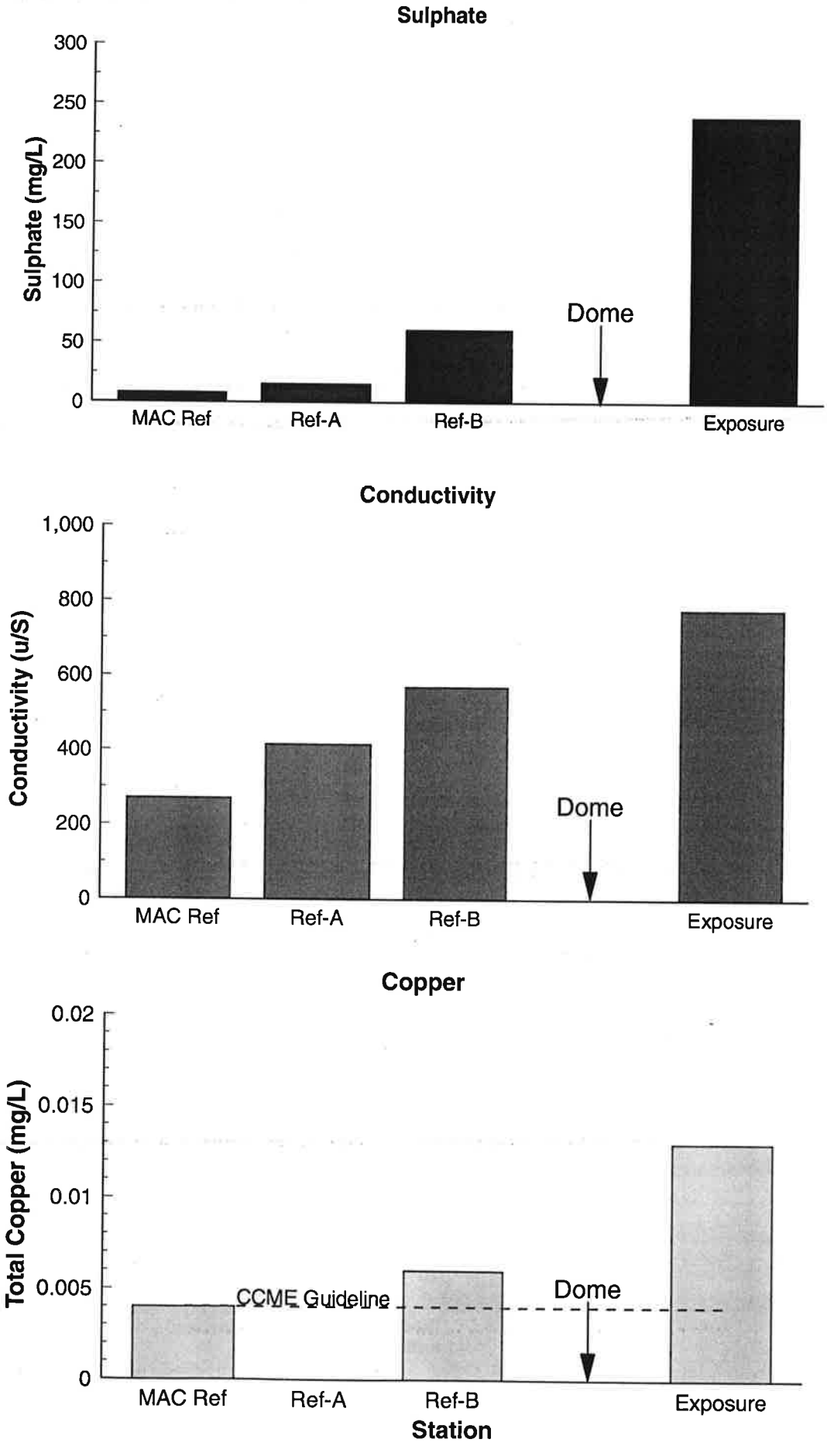
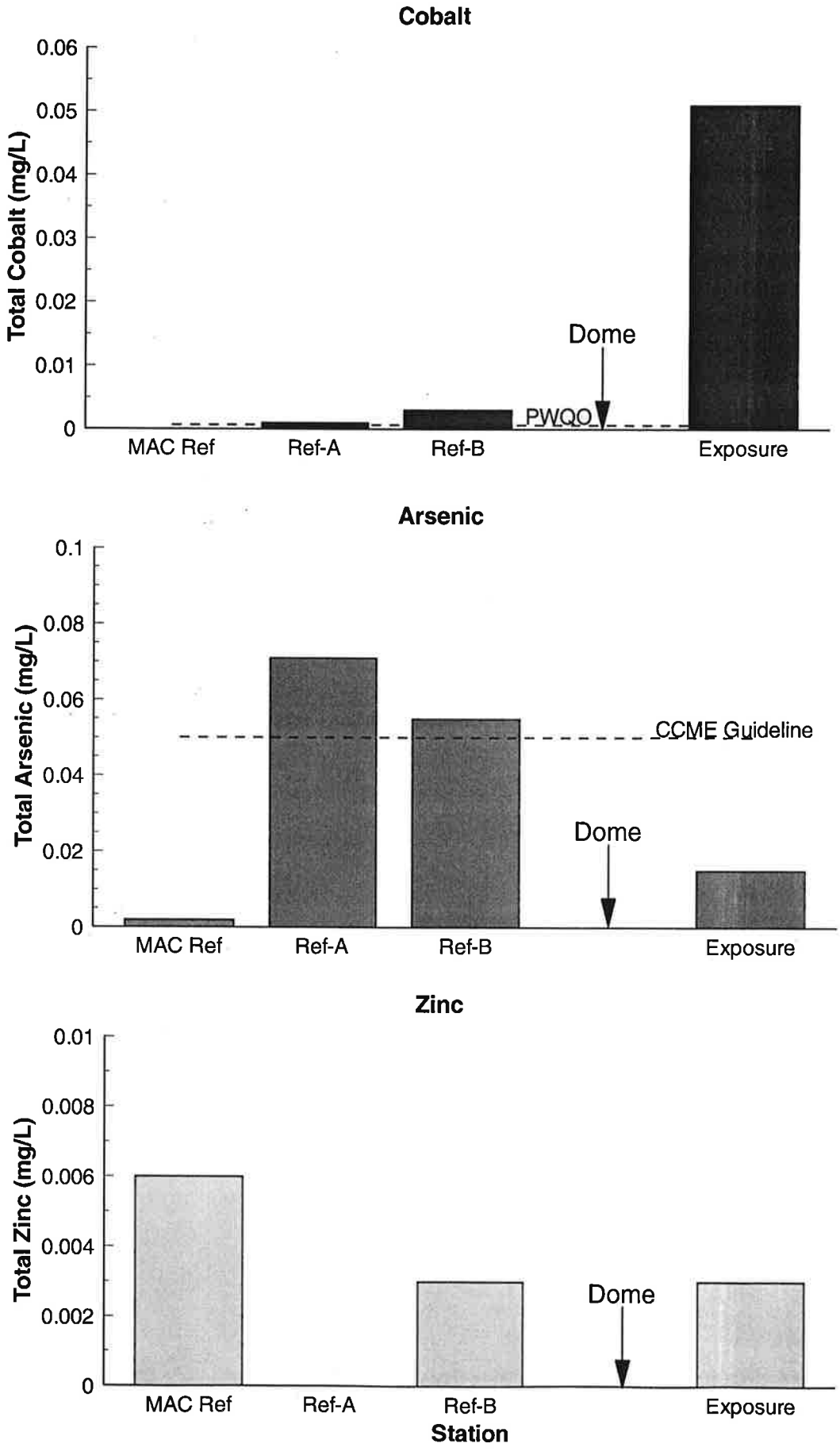


Figure 5.2.1 (continued)
Spatial comparison of Dome site water chemistry



responding to environmental loading. The results of the metallothionien analysis were not conclusive, however, as differences between the sampling areas were not observed.

Pearl Dace from the Exposure area appear to exhibit faster growth than fish from the Reference area, although no differences in size were observed for Northern Redbelly Dace. The relative catch per unit effort (CPUE) for minnow species was also greater in the Reference area (0.81 fish/hr) compared with the Exposure area (0.39 fish/hr).

In summary, the results indicate clear differences in the concentrations of several chemical substances in water and sediments between the Exposure and Reference areas. Furthermore, some biological measures including benthos, fish growth, fish metal levels and relative fish abundance give some indication of responding to effluent exposure.

6. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE SAMPLING

The Exposure Area in the South Porcupine River contained clearly elevated concentrations of several chemical variables and metals in both water and sediments as a result of effluent discharge from the Dome mine operation. Depositional sediments are abundant in this branch of the Porcupine River.

The Exposure and Reference areas are readily accessible for future studies. Multiple sampling areas are possible, although a combination of lake and river habitats may be required to maximize results.

The effluent contains elevated concentrations of several elements that would be naturally present in the orebody, eg. metals, as well as parameters associated with the ore crushing and processing (sulphates, nitrogen and cyanide complexes).

In water and effluent samples the concentration of dissolved metals sometimes exceeded the concentration of total metals (eg. calcium, copper, magnesium and zinc). From a chemical speciation perspective, this is not possible, and the results may be due to contamination from the filters used in the 1996 study. The effect does not mask any trends or influence data interpretation, but this potential source of error should be addressed in the 1997 study if relationships between biology and total or dissolved metal levels are being investigated.

Preliminary toxicity tests conducted on dilution water from MacDonald Lake showed that the receiving water itself showed no toxicity to the test organisms. Therefore, no acclimation was required.

The Dome effluent did not exhibit sublethal toxicity to either fathead minnows or *Ceriodaphnia.* Sublethal effects were observed on growth of the two plant test organisms, *Selenastrum* and *Lemna*, while the results of the Rainbow trout embyro tests were considered invalid. Effluent samples processed by Dome for the MISA program during the same period also did not display acute toxicity (see Section 2). However, the effluent has, historically been toxic, and the concentrations of several substances are elevated in the effluent. Therefore, additional sublethal toxicity testing in 1997 is recommended to better characterize the toxicity of the Dome effluent. Repeated toxicity testing at different times of the year is especially recommended to determine if there is seasonal or temporal variability associated with effluent quality.

The species composition of the benthos changed quite markedly from the Reference to the Exposure area with several burrowing species of chironomids, as well as pea clams and snails, dissappearing. The density of organisms in the Exposure area was also greatly reduced compared with the Reference area.

The benthos community may be responding to conditions in the water and/or sediments. Sediment toxicity tests in 1997 would be useful to assist to identify the potential sources of stress to the benthic community in the Porcupine River.

Pearl Dace from the Exposure area appear to exhibit faster growth than fish from the Reference area, although no differences in size were observed for Northern Redbelly Dace. The relative catch per unit effort (CPUE) for minnow species was also greater in the Reference area (0.81 fish/hr) compared with the Exposure area (0.39 fish/hr).

Pearl Dace and Northern Redbelly Dace in the Exposure area contained greater concentrations of metals than fish in the Reference area. This is consistent with the water and sediment chemical results, and suggests that metal levels in these fish are responding to environmental loading. The results of the metallothionein analysis were not conclusive as differences between the sampling areas were not observed. Since there are established differences in water, sediment and fish metal levels at this site, additional sampling in 1997 would be very useful to assess whether MT levels in small forage fish are a potential tool for future mine monitoring studies.

In sumary, the results indicate clear differences in the concentrations of several chemical substances in water and sediments between the Exposure and Reference areas. Furthermore, some biological measures including benthos, fish growth, fish metal levels and relative fish abundance give some indication of responding to effluent exposure. The site is suitable for further evaluation of tools under the AETE program in 1997.

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APPENDIX A

Quality Management Plan

INTRODUCTION

Appropriate quality assurance and quality control (QA/QC) protocols are essential to ensure that environmental data achieve a high level of quality commensurate with the intended use of the data. This quality management plan (QMP) served as a general set of protocols covering both laboratory and field operations to be used by all members of the EVS-ESP-JWEL consortium. Use of this QMP ensured both a high quality of data as well as uniformity and comparability in the data generated at each study site.

DATA QUALITY OBJECTIVES

For all field and laboratory measurements, data quality objectives (DQOs) have been set where applicable. Data quality objectives are defined by the US EPA as "qualitative and quantitative statements of the level of uncertainty that a decision maker is willing to accept in decisions made with environmental data" (QUAMS; 1986, 1990). The DQOs define the degree to which the total error in the results derived from the data must be controlled to achieve an acceptable confidence in a decision that will be made with the data. In terms of this project, the AETE committee has already stipulated that analytical measurements will achieve a detection limit of 1/10 that of the CCME guidelines for protection of the aquatic environment. The quality control officer ensured that the required detection limits were made known to the analytical laboratory well in advance. In this way, the correct methodology, volume of samples and methods of preservation were established before the field work was underway. Detection limits for field instruments (Hydrolab, YSI etc.) and the gravimetric measurements for biological analyses (e.g. fish organ weights) were also sent to each team.

QUALITY CONTROL OFFICER

The quality control officer (QCO) for the project (Ms. Monique Dubé) has the following responsibilities:

- to ensure that all data quality objectives are known to both field personnel and the chosen analytical laboratory
- to ensure that standard operating procedures (SOPs) are followed for each field component at each study site
- to ensure that both the toxicity and analytical laboratories follow established SOPs for each analysis
- to ensure the all analyses were under statistical control during each analytical run. This requires that the quality control data for each analysis be reviewed and compared with historic control limits to be requested from the analytical and toxicity laboratories. The QC

data will include percent recoveries of spiked samples, and results for blanks, replicates and certified reference materials. Logical checks of the data will also be conducted, especially for toxicity.

The quality control officer (QCO) has authority for requiring corrective actions (e.g., repetition of the analysis) if the SOPs were not followed or the analytical systems were not under control. The QCO will also be made aware of all outliers.

FIELD PROTOCOLS FOR WATER, SEDIMENT AND BENTHIC SAMPLING

RESPONSIBILITIES AND TRAINING

For each field team, a team leader was chosen with authority to make decisions in the field related to implementation of the study plan. The team leader was responsible for ensuring that all field personnel were trained and competent in use of each field instrument, that all SOPs were followed and that adequate heath and safety measures were followed.

STANDARD OPERATING PROCEDURES

Whenever feasible, water, sediment and benthic samples were taken at the same sampling stations. The location of each station was recorded either as a GPS reading or with reference to a large scale map and known landmarks. The location of each station was known to the nearest 20 m. At each station the field information to be reported included:

- station location
- date and time
- field crew members
- habitat descriptions
- sampling methods
- depth
- wind and climatic conditions
- water temperature
- substrate type (sand/gravel/cobble/silt/clay)
- water velocity (rivers)

This information was recorded on field data sheets.

BENTHIC SAMPLING

Benthic collections were made by Eckman, standard (or petite) ponar grab, Hess sampler, Surber sampler or hand-inserted core tubes depending on substrate type. The Eckman is used primarily on soft sediments in deep water (>2 m), although a pole mounted version can be used in harder substrates and shallower waters. The ponar grab is used for substrates consisting of hard and soft sediments such as clay, hard pan, sand, gravel and mud where penetration of the substrate by the sampler is possible. The standard ponar is set with a spring loaded pin, lowered to the bottom and allowed to penetrate the substrate. When the ponar penetrates the sediment, the pin is released and the jaws are allowed to close on the sediment sample when the sampler is withdrawn. The ponar (plus sample) is then pulled through the water column and placed in a plastic basin on the bottom of the boat. Because of the weight of the standard ponar a frame and electrically driven winch should be used to raise and lower the grab. After the sample has been removed and whenever the ponar is not being used, the safety pin must be inserted into the lever bar to prevent the bar from closing on the operator. Care must also be taken when using the winch to avoid catching hands and clothes. The petit ponar is considerably lighter, safer and easier to use. A winch may not be necessary under most conditions.

Both the Eckman and ponar samplers were made of stainless steel rather than brass. The choice of using an Eckman or ponar sampler depends on the nature of the sediment and the depth of the water column. In hard sediments, use of the Eckman sampler is limited as penetration is poor. The pole mounted Eckman is able to penetrate some hard substrate, but its use is limited to shallow depths. If sediments are very soft, the Eckman may be preferable to the ponar because the latter tends to fill entirely with sediments, thereby obliterating the sediment-water interface. At depths greater than 20 m the ponar may be more successful because of its greater weight and stability in the water column. If both samplers are available, a certain amount of trial and error may be required to determine the most appropriate sampler.

The Surber sampler was used in shallow (<32 cm), flowing waters on rocky substrates where a grab sample cannot be taken. The Surber sampler consists of two square frames hinged together; one frame rests on the surface while the other remains upright and holds a nylon collecting net and bucket. A base extension is used when sampling areas of fine, loose sediments or rubble. The base frame fits into the base extension which is pushed into the sediments to decrease the lateral movement of invertebrates out of the area to be sampled. The sampler is positioned with its net mouth open facing upstream. When in use, the two frames are locked at right angles, the base frame (and base extension) marking off the area of substrate to be sampled and the other frame supporting a net to strain out organisms washed into it from the sample area.

The Hess sampler is especially useful for sampling gravel and cobble bottoms in streams. The Hess sampler consists of a stainless steel cylinder with two large windows and a pair of handles for pushing the cylinder while rotating it into the gravel or cobble. Penetration depths of 75 or 150 mm can be varied by attaching the handles to either end of the

sampler. Water flows in through the upstream window of the Hess sampler and out through the downstream window and into the collecting net and bucket.

General operating procedures for the Surber and Hess samplers were as follows:

- Position the sampler securely to the bottom substrate, parallel to the water flow with the net pointing downstream.

- The sampler is brought down quickly to reduce the escape of rapidly-moving organisms.

- There should be no gaps under the edges of the frame that would allow for washing of water under the net and loss of benthic organisms. Eliminate gaps that may occur along the edge of the Hess/Surber sampler frame by shifting of rocks and gravel along the outside edge of the sampler.

- To avoid excessive drift into the sampler from outside the sample area, the substrate upstream from the sampler should not be disturbed.

- Once the sampler is positioned on the stream bottom, it should be maintained in position during sampling so that the area delineated remains constant.

- Hold the sampler with one hand or brace with the knees from behind.

- Heavy gloves should be required when handling dangerous debris; for example, glass or other sharp objects present in the sediment.

- Turn over and examine carefully all rocks and large stones and rub carefully in front of the net with the hands or a soft brush to dislodge the organisms and pupal cases, etc., clinging to them before discarding.

- Wash larger components of the substrate within the enclosure with stream water; water flowing through the sampler should carry dislodged organisms into the net.

- Stir the remaining gravel and sand vigorously with the hands to a depth of 5-10 cm where applicable, depending upon the substrate, to dislodge bottom-dwelling organisms.

- It may be necessary to hand pick some of the heavier mussels and snails that are not carried into the net by the current.

- Remove the sample by washing out the sample bucket, if applicable, into the sample container (wide-mouthed jar) with 10% buffered formalin fixative.

- Examine the net carefully for small organisms clinging to the mesh, and remove them (preferably with forceps to avoid damage) for inclusion in the sample.

- Rinse the sampler net after each use.

In the case of soft sediments at shallow depths, plastic core tubes (2.5 " ID) can be inserted by hand into the sediments. Stoppers are placed at each end as the tube is withdrawn.

Sieving of Benthic Samples

Samples were sieved in the field using a mesh size of 250 µm, and preserved with sufficient buffered formalin to produce a 10 % concentration. If further sieving was required (e.g., 500 µm sieve) to allow for data collected to be comparable across studies, then this additional step was done in the field, and both sized fractions were preserved and identified.

Quality Control Protocols for Benthic Identification

Invertebrate samples were sorted on a low power microscope and keyed to the generic level. A reference collection of identified organisms will be maintained for both the receiving and reference environments. Taxonomy will be verified by an independent expert. Sorting efficiency will be estimated by recounts of the sorted material on 10% of the samples. If subsampling is deemed necessary, an estimate will be made of the subsampling error. All unsorted and sorted fractions of the samples will be retained until taxonomy and sorting efficiency are confirmed. All data transcriptions will be checked for accuracy.

WATER CHEMISTRY

As indicated in the study plan, water quality samples were taken as grab samples at 12 sampling stations plus the effluent. In shallow receiving environments (<2m) 1 grab sample was collected at the surface from each station with clean bottles prepared by the analytical laboratory. Samples were collected by removing the cap below the surface (approximately 15 cm depth) to avoid any surface contamination. Latex (or nitryl) gloves were used during this procedure to avoid all contamination. In deeper receiving environments (> 2 m), one sub-surface grab were collected at each station using a Van Dorn-type sampler. Separate samples will be collected for total and dissolved metals. The dissolved sample will be field filtered according to standard methods (APHA 1995 -Section 3030B). Both metals samples (total and dissolved) were acidified with ultrapure HNO_3 (provided by the analytical laboratory) to a pH <2. Samples were also taken in separate bottles for analysis of other water quality parameters.

Field measurements of temperature, conductivity, dissolved oxygen and pH were also taken at each station using a Hydrolab H_20 or YSI meters. The analytical methods for calibration and use of each field instrument were those outlined in each respective instruction manual.

A log was kept of each field instrument indicating its usage and any problems encountered. In using an oxygen electrode, care was taken to change the membrane on a regular basis, or if it became dried out, torn or damaged in any way. Certain chemicals found in effluent discharge can interfere with oxygen measurements. Conductivity was used where appropriate to characterize mixing zones and exposure zones. All values including calibration readings were recorded on the field sheets.

Quality Control Protocols for Water Chemistry

At each mine site quality control samples for water chemistry included collection and analysis of one transport or trip blank, one filter blank and one field replicate (collected at the exposure station). If subsurface samples were collected using a Van Dorn-type sampler, then a sampler blank were also collected. The transport blank and filter blank water were provided by the analytical laboratory. The transport blank consisted of a sample bottle filled with distilled deionized water in the laboratory. The transport blank was brought to the field, opened, then shut immediately. A filter blank consisted of a field-filtered sample of distilled, deionized water provided by the analytical laboratory. When a van Dorn type bottle was used to collect samples, a sampler blank was also taken in which distilled, deionized water was poured into the sampler and then taken as a normal sample. One field replicate from a station in the affected area was taken using a separate bottle and separate filtration. These field QC samples were excusive of those analysed routinely in the laboratory as part of normal laboratory QC.

QC Requirements for Choice of an Analytical Laboratory

A common analytical laboratory was selected for all three regions (West, Ontario, East). The laboratory was certified by CAEAL and the project QCO ensured that the laboratory followed these quality control practices :

- Written (or referenced) SOPs for each analytical system
- Instrument calibration and maintenance records
- Clearly enunciated responsibilities of Q/A officer
- Adequate and training of personnel
- Good Laboratory Practices (GLPs)
- Sample preservation and storage protocols
- Sample tracking system (e.g., LIMS system)
- Use of QC samples to ensure control of precision and accuracy (Blanks, replicates, spikes, certified reference materials (minimum effort should be 15-20%)
- Maintenance of control charts and control limits on each QC sample
- Data handling and reporting (blanks, replicates, spike recovery, significant figures)
- Policy for reporting low level data (e.g., ASTM L,W)
- Participation in external audits and round robbins.

The QCO requested that all QC data (including control limits) be contained in the analytical reports and ensured that all analytical runs were under statistical control at the time of analysis. The QCO also ensured that the analytical laboratory attained the required detection limits or had a valid technical reason when these limits were not attained. These values were flagged in the analytical report. The QCO examined all outliers and can request repeat analysis if the data are questionable.

SEDIMENT SAMPLING

Sediment samples were collected only if a station had an area > 1 m^2 of depositional habitat. If not, detailed notes on the site were made and pictures taken to provide evidence that the station was not suitable for sediment collection (This information is important to indicate the occurrence or the non-occurrence of depositional sediments for the sediment toxicity testing in the 1997 field program). The sampling device to be used (Eckman or ponar samplers) depended on the nature of the substrate and depth of water (see benthic sampling). Again, all sampling devices were of stainless steel construction. Only the upper two cm of the sediment column were used and the sampler penetration was a minimum of 4-5 cm depth to ensure the upper two cm was not disturbed. One composite sediment sample, consisting of five grab samples was collected per station. The upper two cm of substrate from each of the 5 grabs were placed in a glass or plastic mixing bowl. The composite sample was then homogenized in the bowl with a plastic spoon. Sample jars provided by the laboratory (i.e., pre-cleaned glass with teflon-lined lids) were filled to the top to minimize air space. Duplicate jars were collected at all stations in case of breakage and suspected contamination.

Quality Control Protocols for Sediment Sampling

The following guidelines were used to determine the acceptability of a grab sample: a) the sampler is not over-filled, b) overlying water is present indicating minimal leakage, c) overlying water is not excessively turbid indicating minimal disturbance, d) the desired penetration depth is achieved (i.e., 4-5 cm for a 2 cm deep surficial sample). If any of the above criteria were not met, the sample was rejected. The samples were placed in sample jars provided by the analytical laboratory (precleaned glass, teflon lined lids). The grab samplers were cleaned between stations using a phosphate-free detergent wash and a rinse with deionized water. The plastic utensils and bowls were cleaned between sampling stations using the following protocol: 1) a water rinse, 2) a phosphate-free soap wash, 3) a deionized water rinse, 4) a 5% HNO_3 rinse and 5) a final rinse in deionized water. Three swipe blanks were collected, each in the reference and affected areas, to determine the effectiveness of field decontamination procedures. The swipes consisted of acid-wetted, ashless filter paper wiped along the inside of the sampler and mixing bowl/spoon surfaces that are likely to contact sample media. These samples were placed in whirl-pack bags and sent to the analytical laboratory for extraction and metals analysis. One of the duplicate samples taken at each station was analyzed as a field replicate.

All samples were cooled and shipped to the designated laboratory for analysis. Each sample was analyzed for site specific metals, total organic carbon (TOC), particle size and loss on ignition. The quality control procedures to be followed by the analytical laboratory and the review of the quality of the data were the same as outlined above for the water quality parameters.

TOXICITY SAMPLES

The laboratory (B.A.R.) has already been chosen for the sublethal toxicity analyses. The samples were taken with sample pails provided by the laboratory. The procedures for effluent sampling followed those outlined in the document *Aquatic Effects Technology Evaluation Program Project #4.1.2a Extrapolation Study*. B.A.R. is expected to comply with the following QA/QC protocols:

- Written or referenced SOPs for each test
- Adequate training of personnel
- Appropriate instrument calibration and maintenance
- GLPs
- Dilution water controls
- Test record sheets
- Dose selection
- Reference toxicants
- Control charts
- Adequate data handling and reporting procedures.

The QCO will review all the reports and determine whether the reference toxicants fall within control limits, control mortality is limited etc.

FISH SAMPLES

Metallothionein and metals analysis were, where possible and appropriate, conducted on a minimum of 8 fish of 2 species at both the reference and exposure areas (total of 32 fish for each mine site). Where possible, 4 females and 4 males of each species were collected. Only fish collected for metallothionein and metals analysis were sacrificed in the study and all measurements were conducted on these fish. No field splitting of organs for metallothionein and metals analysis (kidney, gill, liver) was done with whole tissue samples forwarded to Dr. Klaverkamp's laboratory for processing and handling. Where fish larger than 20 cm were not available, whole fish (i.e., 10-15 cm length) were used for analyses with no dissection of fish attempted. Fish smaller than 10 cm were not targeted for metallothionein and metals analysis. Tissue and whole fish samples were frozen on dry ice and forwarded to the laboratory for analysis.

Standard operating procedures for gill netting, trap netting and backpack electrofishing are presented below. The maximum effort to be expended on electrofishing was 1 full day per station (reference and exposed; total 2 days). The maximum fishing effort for gill netting was 2 days per station (reference and exposed; total 4 days). Gill nets were checked frequently to collect living fish.

Protocol for Gill Netting

The protocol employed during gill netting was as follows:

1) Individual panels of various mesh sizes were assembled to comprise a gang of nets of required sizes. The order of assembly of sizes was the same for each gang. A bridle was attached to each end, and anchor/float lines were attached to the bridle appropriate for the water depth in which the nets were deployed. The section of rope between the anchor and the bridle was of sufficient length that the anchor could be placed on bottom before any netting is deployed.

2) Netting locations were selected that were free of major bottom irregularities or obstructions (steep drop-offs, tree stumps, etc). Upon selection of the preferred site, the net was deployed in a continuous fashion along the selected route. Care was taken to avoid tangles or twists of the net, and to ensure that marker buoys at each end were visible (i.e., above water) after setting. Water temperatures were taken on the bottom and at 2 m above the bottom at each end of the net if other than isothermal conditions were present. The location and orientation of the net relative to shoreline features were marked on an appropriate map and/or obtained by electronic positioning equipment (GPS). The above

noted information, the water depth at each end of the net, the date, time of day and other relevant information (wind direction and weather conditions, wave height, etc) were recorded in the field book for each netting location.

3) Upon retrieval, the same information as noted above (as applicable) was recorded. All fish collected were identified and enumerated. Those fish not required for further testing/analysis were live released provided they were in good condition. The remaining fish were analyzed, packaged and preserved, or disposed of according to the requirements of the sampling program.

Protocol for Trap Netting

The protocol for trap netting was as follows:

1) Prior to use in the water, the net was spread out on land and examined for holes and signs of excessive wear (broken and/or frayed lines or attachment points) if the condition of the net could not be determined from previous users. The lead, wings, house and all attachment lines were examined, as well as the house access point opening. All damages were repaired, the house opening was secured and the net was repacked to facilitate ease of deployment.

2) Netting sites were selected that are relatively smooth bottomed, of a substrate suitable for anchoring (i.e. mud, sand, and/or gravel; smooth bedrock not suitable) and free of major irregularities (large boulders, tree stumps or snags, etc.). If water visibility permitted, the selected location was examined from above to confirm its suitability.

3) The net was set perpendicular to shore such that the lead was in shallow water near shore and the house was in deeper water offshore. The net was continuously deployed from the bow of the boat, while backing offshore, until all parts of the net and all anchors were in the water. Upon setting the house anchor, the net was then tensioned. The wing anchors were then lifted and repositioned such that the wings were aligned at a 45° angle to the lead, and lightly tensioned. The date, time of day, water temperature and other appropriate information were recorded in the field book.

4) When servicing the net, the house float was lifted and the boat was pulled under the anchor line between the house and the house anchor. The boat was then manually pulled sideways to the house of the net, which was then passed over the boat until all fish were concentrated at the near shore end of the house. The house access point was then opened and the fish were removed, identified and enumerated. The fish required for analysis were retained, while the remainder were released live. The catch and the ancillary environmental data (as above) were recorded in the field book. The house opening was then closed and the boat backed out from beneath the net. Anchors were lifted and reset to re-tension the net as required.

Protocols for Back-Pack Electrofishing

The operators of the electrofishing gear will follow procedures outlined in standard fisheries text books. Before the electrofishing operations began, the amount of effort, either by distance, time or desired sample size was agreed upon in order to calculate catch per unit effort.

Health and safely procedures were followed strictly. These are also outlined in standard text books.

Analysis of Fish

At least 8 (preferably adult) fish of each sentinel species were, where possible and appropriate, collected from the reference and exposure areas. The biological variables measured on large (i.e., >20 cm) fish included, where possible and appropriate:

- fork length
- fresh weight
- external/internal conditions
- sex
- age
- gonad weight
- kidney weight
- egg size and mass (if appropriate)
- liver weight

No internal variables were measured on fish of less than 20 cm in length. Information on each fish species were recorded on the data logging sheets provided.

Length was measured to the nearest ±2 mm. Fork length is the length from the tip of the snout to the depth of the fork in the tail. Fish were towel dried and weighed to the nearest 1 g or 5% of total body weight.

An external examination was conducted for lumps and bumps, secondary sexual characteristics, missing fins or eyes, opercular, fin or gill damage, external lesions, presence of parasites, and other anomalous features. All external lesions were recorded as to position, shape, size, colour, depth, appearance on cut surface and any other features of note. Photographs were taken of lesions to aid in their interpretation. The external conditions were assessed according to the health assessment index of Adams et al. (1993); or Goede (1993) on data logging sheets.

Age were determined by the appropriate structure (scales, otoliths, pectoral spines) following established protocols. A single person (John Tost; North Shore Environmental) will perform the age determinations on all the fish. Aging structures were archived for future reference. Fish age will be confirmed by a second expert (minimum 10%).

The body cavity were opened to expose the internal organs. The internal examination of each fish included the recording and/or photographing of evident tumors, neoplasms and lesions in major organs including the liver and skin. The internal conditions will be assessed according to the health assessment index of Adams et al. (1993) or Goede and Barton (1990) on data logging sheets.

All internal organs were examined for lumps, bumps or abnormal features. The lower intestine and oesophagus were cut to allow total removal of the gastrointestinal tract. The liver was removed and weighed on pre-weighed aluminum pans. The liver samples must be weighed immediately to avoid loss of water. Care was taken to avoid rupturing the gall bladder and to remove the spleen before weighing. If the liver tissue was diffuse, it was teased from the intestines starting from the posterior and proceeding anteriorly. The liver was weighed, divided in half and frozen in separate plastic bags for metals and metallothionein analysis (see latest protocols from AETE).

The gonads were removed from the dorsal wall of the body cavity from the anterior to the posterior and weighed on a pre-weighed pan to the nearest 0.01 g or ±1% of the total organ weight. Care was taken to remove external mesenteries and visceral lipid deposits before weighing the gonads; gonadal membranes, however, remained intact. Egg volume and mass were measured on fresh eggs. One hundred eggs were counted in a stereoscopic microscope and added to a small graduated cylinder containing a known volume of water. The cylinder was placed on a balance so that the mass of the 100 eggs could be measured. The volume of the eggs was then determined from the displacement of the water in the cylinder.

The kidneys were removed by making lengthwise incisions along each edge of the tissue and then detached using the spoon end of a stainless steel weighing spatula by applying firm but gentle pressure against the upper abdominal cavity wall (dorsal aorta). In this procedure the kidney was scraped away from the dorsal aorta and associated connective tissue. The kidney was divided in half, placed in separate whirlpack bags and frozen on dry ice for both metals and metallothionein analysis.

The gills arches and attached filaments were removed by severing the dorsal and ventral cartilaginous attachment of the arches to the surrounding oral cavity. The gill arches were placed in whirlpack bags and frozen on dry ice for metals and metallothionein analysis.

REFERENCES

Adams, S.M., A.M. Brown and R.W. Goede. 1993. A quantitative health assessment index for rapid evaluation of fish condition in the field. Transactions of the American Fisheries Society. 122:63-73.

APHA (American Public Health Association). 1995. Standard methods for the examination of water and wastewater. APHA, American Water Works Association, Water Environment Federation.

Goede, R.W. 1993. Fish health/condition assessment procedures. Utah Division of Wildlife Resources, Fisheries Experiment Station, Logan, UT.

QAMS. 1986. Development of data quality objectives. Description of Stages I and II (draft). Quality Assurance Management Staff. Environmental Protection Agency, Washington, D.C.

QAMS. 1990. Proposed glossary of quality assurance related terms. Quality Assurance Management Staff. Environmental Protection Agency, Washington, D.C.

APPENDIX B

Selected Site Photographs

Photo 1. McDonald Lake - Reference

Photo 2. Inactive tailings (Trap Club) adjacent to South Porcupine River upstream of Dome Site

Photo 3. South Porcupine River beside old tailings (Model Plane Club) upstream of Dome

Photo 4. South Porcupine River below Moneta Road - Reference Sites 1-6

Photo 5. South Porcupine River upstream of Dome effluent - Reference B1

Photo 6. South Porcupine River upstream of Dome effluent - Reference B2

Photo 7. South Porcupine River upstream of Dome effluent - Reference B3

Photo 8. Flow measured at road culverts at lower end of exposure area

Photo 9. South Porcupine River - Exposure Site 1

Photo 10. South Porcupine River - Exposure Site 3

Photo 11. South Porcupine River - Exposure Site 6

APPENDIX C

Water Quality and Chemistry

APPENDIX C1

Detailed Methods

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 15/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Invoice received #26252

Certificate of Analysis

Analysis Performed:

30 ELEMENT ICPAES AND ICP-MS SCAN
Alkalinity
Anions(Cl,NO2,NO3,o-PO4 & SO4)
RCAP MS Package, 8 Element ICPAES Scan
Reactive Silica
RCAP MS Package, 22 Element ICP-MS Scan
RCAP Calculations
Manual Conventionals(pH,Turbidity,Conductivity,Color)
Mercury, Cold Vapour AA, Digestion Required
Cyanide, Free
Ammonia
Total Kjeldahl Nitrogen, Digestion Required
Total Phosphorous, Autoanalyzer
Dissolved Inorganic Carbon, as Carbon(Autoanalyzer)
Dissolved Organic Carbon, as Carbon(Autoanalyzer)
Total Suspended Solids
Cyanide, Total(UV-Visible)
Acid Digestion

Methodology:

1) Determination of alkalinity in water by automated colorimetry.
U.S. EPA Method No. 310.2

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 15/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Certificate of Analysis

Methodology: (Cont'd)

8) Cold Vapour Atomic Absorption Analysis of water for mercury.
U.S. EPA Method No. 245.2
(Reference - Varian Method No. AA-51)

9) Analysis of free cyanide in water by distillation followed by colourimetric determination in a continuous liquid flow.
ASTM Method No. D2036-91
(Refer-Method No. 11002202 Issue 122989)

10) Analysis of ammonia in water by colourimetry in a continuous liquid flow.
ASTM Method No. D1426-79 C
Refer - Method No. 1100106 Issue 122289

11) Analysis of total Kjeldahl Nitrogen in water by colourimetric determination in a continuous liquid flow.
ASTM Method No. D3590-84AFD
Refer - Method No. 1100106 Issue 122289

12) Analysis of total phosphorus in water by colourimetry in a continuous liquid flow.
U.S. EPA Method No. 365.1
Refer - Method No. 1100205 Issue 122289

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 15/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Certificate of Analysis

Instrumentation:

1) Cobas Fara Centrifugal Analyzer
2) Dionex Ion Chromatograph, 4500i/4000i or Cobas Fara II Analyzer
3, 4) Thermo Jarrell Ash ICAP 61E Plasma Spectrophotometer
5) PE Sciex ELAN 6000 ICP-MS Spectrometer
6) Calculation from existing results; no instrumentation required.
7) Orion pH meter/Radiometer Conductometer/Turbidity meter/UV-Visible
8) Varian SpectrAA 400 Plus AA/VGA 76/MCA 90 Mercury Analyzer
9,11,12,13,14) Technicon Autoanalyzer
10) Skalar Segmented Flow Analyzer, Model SA 20/40
15) Precision Mechanical Convention Oven/Sartorius Basic Balance
16) Hach UV - Visible Spectrophotometer, Model DR/3000
17) Thermolyne Hotplate/Hot Block

Sample Description: Water

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

Certified By
T. Munshaw, M.Sc.,C.Chem
Director, Laboratory Operations

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted: September 22/96
Date Reported: October 15/96
MDS Ref#: 966496
MDS Quote#: 96-697-GS
Client PO#: 5693
Client Ref#: G96239
Sampled By: Mike Zimmer

Invoice received
25860

Certificate of Analysis

Analysis Performed:

30 ELEMENT ICPAES AND ICP-MS SCAN
Alkalinity
Anions(Cl,NO2,NO3,o-PO4 & SO4)
RCAP MS Package, 8 Element ICPAES Scan
Reactive Silica
RCAP MS Package, 22 Element ICP-MS Scan
RCAP Calculations
Manual Conventionals(pH,Turbidity,Conductivity,Color)
Mercury, Cold Vapour AA, Digestion Required
Cyanide, Free
Cyanide, Total(Autoanalyzer)
Ammonia
Total Kjeldahl Nitrogen, Digestion Required
Dissolved Inorganic Carbon, as Carbon(Autoanalyzer)
Dissolved Organic Carbon, as Carbon(Autoanalyzer)
Acid Digestion

Methodology:

1) Determination of alkalinity in water by automated colorimetry.
U.S. EPA Method No. 310.2

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted:	September 22/96
Date Reported:	October 15/96
MDS Ref#:	966496
MDS Quote#:	96-697-GS
Client PO#:	5693
Client Ref#:	G96239
Sampled By:	Mike Zimmer

Certificate of Analysis

Methodology: (Cont'd)

8) Cold Vapour Atomic Absorption Analysis of water for mercury.
U.S. EPA Method No. 245.2
(Reference - Varian Method No. AA-51)

9) Analysis of free cyanide in water by distillation followed by colourimetric determination in a continuous liquid flow.
ASTM Method No. D2036-91
(Refer-Method No. 11002202 Issue 122989)

10) Total cyanide analysis by distillation and colourimetry. This method is approved by the Ontario MOEE for cyanide analysis. It is not a NYSDOH approved procedure.
ASTM Method No. D2036-91
(Refer-Method No. 11022002 Issue 122989)

11) Analysis of ammonia in water by colourimetry in a continuous liquid flow.
ASTM Method No. D1426-79 C
Refer - Method No. 1100106 Issue 122289

12) Analysis of total Kjeldahl Nitrogen in water by colourimetric determination in a continuous liquid flow.
ASTM Method No. D3590-84AFD
Refer - Method No. 1100106 Issue 122289

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted:	September 22/96
Date Reported:	October 15/96
MDS Ref#:	966496
MDS Quote#:	96-697-GS
Client PO#:	5693
Client Ref#:	G96239
Sampled By:	Mike Zimmer

Certificate of Analysis

Instrumentation:

9,10,12,13,14) Technicon Autoanalyzer
11) Skalar Segmented Flow Analyzer, Model SA 20/40
15) Thermolyne Hotplate/Hot Block

Sample Description: Water

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

Certified By
T. Munshaw, M.Sc.,C.Chem
Director, Laboratory Operations

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: October 17/96
Date Reported: October 28/96
MDS Ref#: 967332
MDS Quote#: 96-697-GS

Client Ref#: G96239
Sampled By: MP

Certificate of Analysis

Analysis Performed:

Alkalinity
Anions(Cl,NO2,NO3,o-PO4 & SO4)
30 ELEMENT ICPAES AND ICP-MS SCAN
RCAP MS Package, 8 Element ICPAES Scan
Reactive Silica
RCAP MS Package, 22 Element ICP-MS Scan
RCAP Calculations
Manual Conventionals(pH,Turbidity,Conductivity,Color)
Mercury, Cold Vapour AA, Digestion Required
Cyanide, Free
Ammonia
Total Kjeldahl Nitrogen, Digestion Required
Dissolved Inorganic Carbon, as Carbon(Autoanalyzer)
Dissolved Organic Carbon, as Carbon(Autoanalyzer)
Total Suspended Solids
Cyanide, Total(UV-Visible)

Methodology:

1) Determination of alkalinity in water by automated colorimetry.
U.S. EPA Method No. 310.2

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: October 17/96
Date Reported: October 28/96
MDS Ref#: 967332
MDS Quote#: 96-697-GS

Client Ref#: G96239
Sampled By: MP

Certificate of Analysis

Methodology: (Cont'd)

8) Cold Vapour Atomic Absorption Analysis of water for mercury.
U.S. EPA Method No. 245.2
(Reference - Varian Method No. AA-51)

9) Analysis of free cyanide in water by distillation followed by colourimetric determination in a continuous liquid flow.
ASTM Method No. D2036-91
(Refer-Method No. 11002202 Issue 122989)

10) Analysis of ammonia in water by colourimetry in a continuous liquid flow.
ASTM Method No. D1426-79 C
Refer - Method No. 1100106 Issue 122289

11) Analysis of total Kjeldahl Nitrogen in water by colourimetric determination in a continuous liquid flow.
ASTM Method No. D3590-84AFD
Refer - Method No. 1100106 Issue 122289

12) The determination of dissolved inorganic carbon by converting species to carbon dioxide and measuring the decrease in absorbance of a colour reagent.
MOE Method No. ROM - 102AC2.1
(Refer Method No. 1102106 Issue 122989)

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Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted:	October 17/96
Date Reported:	October 28/96
MDS Ref#:	967332
MDS Quote#:	96-697-GS
Client Ref#:	G96239
Sampled By:	MP

Certificate of Analysis

15) Hach UV - Visible Spectrophotometer, Model DR/3000

Sample Description: Water

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

for Certified By
M. Hartwell, M.Sc.
Director, Laboratory Operations

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted: September 26/96
Date Reported: October 15/96
MDS Ref#: 966657

Client Ref#: G96239
Sampled By: George Lajeunes

Invoice # 25978

Certificate of Analysis

Analysis Performed:

Alkalinity
Ammonia
Anions(Cl,NO2,NO3,o-PO4 & SO4)
RCAP MS Package, 8 Element ICPAES Scan
Reactive Silica
RCAP MS Package, 22 Element ICP-MS Scan
RCAP Calculations
Manual Conventionals(pH,Turbidity,Conductivity,Color)
Mercury, Cold Vapour AA, Digestion Required
Cyanide, Free
Cyanide, Total(Autoanalyzer)
Ammonia
Total Kjeldahl Nitrogen, Digestion Required
Dissolved Inorganic Carbon, as Carbon(Autoanalyzer)
Dissolved Organic Carbon, as Carbon(Autoanalyzer)
Acid Digestion

Methodology:

1) Determination of alkalinity in water by automated colorimetry.
U.S. EPA Method No. 310.2

6850 Goreway Drive, Mississauga, Ontario, Canada L4V 1P1
Tel: 905•673•7255 Fax: 905•673•7825 Toll Free: 1•800•363•7092

59

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted: September 26/96
Date Reported: October 15/96
MDS Ref#: 966657

Client Ref#: G96239
Sampled By: George Lajeunes

Certificate of Analysis

Methodology: (Cont'd)

8) Analysis of water for pH(by electrode), conductivity(by measuring resistance in micro siemens/cm), turbidity(by nephelometry) and color(by UV Visible Spectrometry).
U.S. EPA Method No. 150.1, 120.1, 180.1 and 110.3

9) Cold Vapour Atomic Absorption Analysis of water for mercury.
U.S. EPA Method No. 245.2
(Reference - Varian Method No. AA-51)

10) Analysis of free cyanide in water by distillation followed by colourimetric determination in a continuous liquid flow.
ASTM Method No. D2036-91
(Refer-Method No. 11002202 Issue 122989)

11) Total cyanide analysis by distillation and colourimetry. This method is approved by the Ontario MOEE for cyanide analysis. It is not a NYSDOH approved procedure.
ASTM Method No. D2036-91
(Refer-Method No. 11022002 Issue 122989)

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted: September 26/96
Date Reported: October 15/96
MDS Ref#: 966657

Client Ref#: G96239
Sampled By: George Lajeunes

Certificate of Analysis

Instrumentation:

1, 2) Cobas Fara Centrifugal Analyzer
3) Dionex Ion Chromatograph, 4500i/4000i or Cobas Fara II Analyzer
4, 5) Thermo Jarrell Ash ICAP 61E Plasma Spectrophotometer
6) PE Sciex ELAN 6000 ICP-MS Spectrometer
7) Calculation from existing results; no instrumentation required.
8) Orion pH meter/Radiometer Conductometer/Turbidity meter/UV-Visible
9) Varian SpectrAA 400 Plus AA/VGA 76/MCA 90 Mercury Analyzer
10,11,13,14,15) Technicon Autoanalyzer
12) Skalar Segmented Flow Analyzer, Model SA 20/40
16) Thermolyne Hotplate/Hot Block

Sample Description: Water

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

Certified By
T. Munshaw, M.Sc.,C.Chem
Director, Laboratory Operations

6850 Goreway Drive, Mississauga, Ontario, Canada L4V 1P1
Tel: 905•673•3255 Fax: 905•673•7399 Toll Free: 1•800•668•7082

60

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Chris Wren, PhD.

Date Submitted: November 11/96
Date Reported: November 21/96
MDS Ref#: 968374
MDS Quote#: CANMET Investig

Client Ref#: 96239-QA/QC
Sampled By: Mike Zimmer

Certificate of Analysis

Analysis Performed:

Aqueous extraction
RCAP MS Package, 8 Element ICPAES Scan
RCAP MS Package, 22 Element ICP-MS Scan

Methodology:

1) Aqueous extraction of a filter for the determination of soluble cations and/or anions.
MDS Internal Method 95-1
2) Analysis of trace metals in water by inductively coupled plasma atomic emission spectrometry.
U.S. EPA Method No. 200.7
3) Analysis of trace metals in water by Inductively Coupled Plasma Mass Spectrophotometry.
U.S. EPA Method No. 200.8(Modification)

Instrumentation:

1) Rotorack at 10 RPM/Filtration Apparatus
2) Thermo Jarrell Ash ICAP 61E Plasma Spectrophotometer
3) PE Sciex ELAN 6000 ICP-MS Spectrometer

APPENDIX C2

QA/QC

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 15/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Alkalinity(as CaCO3)	na	1	mg/L	nd	2	yes	99	87	113	yes	na	na	na	na	na	yes
Chloride	na	1	mg/L	nd(b)	2	yes	112	90	113	yes	na	na	na	na	na	yes
Nitrate(as N)	EXP1-E.O.	0.05	mg/L	nd(b)	0.1	yes	109	88	114	yes	0.30	0.30	0.18	0.42	yes	yes
Nitrite(as N)	na	0.01	mg/L	nd(b)	0.03	yes	84	80	116	yes	na	na	na	na	na	yes
Orthophosphate(as P)	EXP1-E.O.	0.01	mg/L	nd(b)	0.03	yes	103	90	110	yes	0.75	1.0	0.6	1.4	yes	yes
Sulphate	na	2	mg/L	nd(b)	3	yes	104	90	113	yes	na	na	na	na	na	yes
Boron	EXP1-E.O. [total]	0.005	mg/L	nd(b)	0.02	yes	106	85	115	yes	1.12	1.00	0.60	1.40	yes	yes
Boron	Q3 76551	0.005	mg/L	nd(b)	0.02	yes	100	85	115	yes	1.07	1.00	0.60	1.40	yes	yes
Calcium	EXP1-E.O. [total]	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	0.3	1.0	0.2	1.8	yes	yes
Calcium	Q3 76551	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	*	*	*	*	*	yes
Iron	EXP1-E.O. [total]	0.02	mg/L	nd(b)	0.03	yes	101	85	115	yes	1.09	1.00	0.60	1.40	yes	yes
Iron	Q3 76551	0.02	mg/L	nd(b)	0.03	yes	100	85	115	yes	1.10	1.00	0.60	1.40	yes	yes
Magnesium	EXP1-E.O. [total]	0.1	mg/L	nd(b)	0.2	yes	110	85	115	yes	0.9	1.0	0.2	1.6	yes	yes
Magnesium	Q3 76551	0.1	mg/L	nd(b)	0.2	yes	99	85	115	yes	*	*	*	*	*	yes
Phosphorus	EXP1-E.O. [total]	0.1	mg/L	nd(b)	0.2	yes	91	85	115	yes	1.0	1.0	0.4	1.6	yes	yes
Phosphorus	Q3 76551	0.1	mg/L	nd(b)	0.2	yes	91	85	115	yes	1.1	1.0	0.4	1.6	yes	yes
Potassium	EXP1-E.O. [total]	0.5	mg/L	nd(b)	1.0	yes	92	85	115	yes	5.1	5.0	1.0	8.0	yes	yes
Potassium	Q3 76551	0.5	mg/L	nd(b)	1.0	yes	104	85	115	yes	*	*	*	*	*	yes
Sodium	EXP1-E.O. [total]	0.1	mg/L	nd(b)	0.2	yes	103	85	115	yes	*	*	*	*	*	yes
Sodium	Q3 76551	0.1	mg/L	nd(b)	0.2	yes	101	85	115	yes	*	*	*	*	*	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 15/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Zinc	EXP1-E.O. [total]	0.002	mg/L	0.003(b	0.02	yes	102	85	115	yes	1.07	1.00	0.60	1.40	yes	yes
Zinc	Q3 76551	0.002	mg/L	0.004(b	0.02	yes	101	85	115	yes	1.01	1.00	0.60	1.40	yes	yes
Reactive Silica(SiO2)	na	0.5	mg/L	nd(b)	1.0	yes	99	80	120	yes	na	na	na	na	na	yes
Aluminum	EXP1-E.O. [total]	0.01	mg/L	nd(b)	0.03	yes	108	85	115	yes	0.08	0.100	0.050	0.140	yes	yes
Aluminum	na	0.01	mg/L	nd(b)	0.03	yes	113	85	115	yes	na	na	na	na	na	yes
Antimony	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	98	85	115	yes	0.136	0.100	0.050	0.140	yes	yes
Antimony	na	0.002	mg/L	nd(b)	0.004	yes	108	85	115	yes	na	na	na	na	na	yes
Arsenic	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	104	85	115	yes	0.085	0.100	0.050	0.140	yes	yes
Arsenic	na	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	na	na	na	na	na	yes
Barium	EXP1-E.O. [total]	0.005	mg/L	nd(b)	0.01	yes	102	85	115	yes	*	*	*	*	*	yes
Barium	na	0.005	mg/L	nd(b)	0.01	yes	112	85	115	yes	na	na	na	na	na	yes
Beryllium	EXP1-E.O. [total]	0.005	mg/L	nd(b)	0.01	yes	103	85	115	yes	0.137	0.100	0.050	0.140	yes	yes
Beryllium	na	0.005	mg/L	nd(b)	0.01	yes	97	85	115	yes	na	na	na	na	na	yes
Bismuth	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.109	0.100	0.050	0.140	yes	yes
Bismuth	na	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	na	na	na	na	na	yes
Cadmium	EXP1-E.O. [total]	0.0005	mg/L	nd(b)	0.0010	yes	101	85	115	yes	0.1240	0.100	0.050	0.140	yes	yes
Cadmium	na	0.0005	mg/L	nd(b)	0.0010	yes	106	85	115	yes	na	na	na	na	na	yes
Chromium	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.126	0.100	0.050	0.140	yes	yes
Chromium	na	0.002	mg/L	0.004(b	0.004	yes	110	85	115	yes	na	na	na	na	na	yes
Cobalt	EXP1-E.O. [total]	0.001	mg/L	nd(b)	0.002	yes	103	85	115	yes	0.137	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 15/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Cobalt	na	0.001	mg/L	nd(b)	0.002	yes	109	85	115	yes	na	na	na	na	na	yes
Copper	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	*	*	*	*	*	yes
Copper	na	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	na	na	na	na	na	yes
Lead	EXP1-E.O. [total]	0.0001	mg/L	nd(b)	0.002	yes	100	85	115	yes	0.1060	0.100	0.050	0.140	yes	yes
Lead	na	0.0001	mg/L	nd(b)	0.002	yes	101	85	115	yes	na	na	na	na	na	yes
Manganese	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.127	0.100	0.050	0.140	yes	yes
Manganese	na	0.002	mg/L	nd(b)	0.004	yes	111	85	115	yes	na	na	na	na	na	yes
Molybdenum	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Molybdenum	na	0.002	mg/L	nd(b)	0.004	yes	103	85	115	yes	na	na	na	na	na	yes
Nickel	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.138	0.100	0.050	0.140	yes	yes
Nickel	na	0.002	mg/L	nd(b)	0.004	yes	112	85	115	yes	na	na	na	na	na	yes
Selenium	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.081	0.100	0.050	0.140	yes	yes
Selenium	na	0.002	mg/L	0.00 l(b	0.004	yes	106	85	115	yes	na	na	na	na	na	yes
Silver	EXP1-E.O. [total]	0.0003	mg/L	nd(b)	0.0006	yes	106	85	115	yes	0.1390	0.100	0.050	0.140	yes	yes
Silver	na	0.0003	mg/L	nd(b)	0.0006	yes	104	85	115	yes	na	na	na	na	na	yes
Strontium	EXP1-E.O. [total]	0.005	mg/L	nd(b)	0.01	yes	102	85	115	yes	0.087	0.100	0.050	0.140	yes	yes
Strontium	na	0.005	mg/L	nd(b)	0.01	yes	107	85	115	yes	na	na	na	na	na	yes
Thallium	EXP1-E.O. [total]	0.0001	mg/L	nd(b)	0.0002	yes	101	85	115	yes	0.1110	0.100	0.050	0.140	yes	yes
Thallium	na	0.0001	mg/L	nd(b)	0.0002	yes	100	85	115	yes	na	na	na	na	na	yes
Tin	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	98	85	115	yes	0.132	0.100	0.050	0.140	yes	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 15/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Tin	na	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	na	na	na	na	na	yes
Titanium	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.116	0.100	0.050	0.140	yes	yes
Titanium	na	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	na	na	na	na	na	yes
Uranium	EXP1-E.O. [total]	0.0001	mg/L	nd(b)	0.0002	yes	98	85	115	yes	0.1030	0.100	0.050	0.140	yes	yes
Uranium	na	0.0001	mg/L	nd(b)	0.0002	yes	96	85	115	yes	na	na	na	na	na	yes
Vanadium	EXP1-E.O. [total]	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.131	0.100	0.050	0.140	yes	yes
Vanadium	na	0.002	mg/L	0.002(b	0.004	yes	110	85	115	yes	na	na	na	na	na	yes
Colour	na	5	TCU	nd(b)	10	yes	88	85	115	yes	na	na	na	na	na	yes
Conductivity - @25°C	na	1	us/cm	na(b)	na	na	98	91	109	yes	na	na	na	na	na	yes
pH	na	0.1	Units	na(b)	na	na	99	98	102	yes	na	na	na	na	na	yes
Turbidity	na	0.1	NTU	nd(b)	0.5	yes	97	81	129	yes	na	na	na	na	na	yes
Mercury	na	0.1	ug/L	nd	0.2	yes	102	79	120	yes	na	na	na	na	na	yes
Cyanide, Free	na	0.002	mg/L	nd	0.004	yes	105	77	127	yes	na	na	na	na	na	yes
Ammonia(as N)	na	0.05	mg/L	0.08	0.1	yes	96	79	119	yes	na	na	na	na	na	yes
Ammonia(as N)	na	0.05	mg/L	0.09	0.1	yes	95	79	119	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	93	77	122	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	93	77	122	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	98	77	122	yes	na	na	na	na	na	yes
Phosphorus, Total	na	0.004	mg/L	0.006	0.008	yes	100	84	126	yes	na	na	na	na	na	yes
Dissolved Inorganic Carbon(as C)	na	0.5	mg/L	nd	1.0	yes	na	na	na	na	na	na	na	na	na	yes

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Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 15/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Analysis of Water

Client Ref#: 96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Dissolved Organic Carbon(DOC)	na	0.5	mg/L	nd	1.0	yes	104	80	116	yes	na	na	na	na	na	yes
Total Suspended Solids	na	5	mg/L	nd	2	yes	98	82	118	yes	na	na	na	na	na	yes
Cyanide, Total	na	0.005	mg/L	nd	0.010	yes	100	82	115	yes	na	na	na	na	na	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Alkalinity(as CaCO3)	na	1	mg/L	nd(b)	2	yes	100	87	113	yes	na	na	na	na	na	yes
Ammonia(as N)	ML	0.05	mg/L	nd(b)	0.10	yes	106	81	118	yes	1.11	1.00	0.60	1.40	yes	yes
Chloride	na	1	mg/L	nd(b)	2	yes	112	90	113	yes	na	na	na	na	na	yes
Nitrate(as N)	ML	0.05	mg/L	nd(b)	0.1	yes	109	88	114	yes	0.33	0.30	0.18	0.42	yes	yes
Nitrite(as N)	na	0.01	mg/L	nd(b)	0.03	yes	84	80	116	yes	na	na	na	na	na	yes
Orthophosphate(as P)	ML	0.01	mg/L	nd(b)	0.03	yes	103	90	110	yes	0.73	1.0	0.6	1.4	yes	yes
Sulphate	na	2	mg/L	nd(b)	3	yes	104	90	113	yes	na	na	na	na	na	yes
Boron	ML	0.005	mg/L	nd(b)	0.02	yes	100	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Calcium	ML	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	*	*	*	*	*	yes
Iron	ML	0.02	mg/L	nd(b)	0.03	yes	98	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Magnesium	ML	0.1	mg/L	nd(b)	0.2	yes	105	85	115	yes	1.3	1.0	0.2	1.6	yes	yes
Phosphorus	ML	0.1	mg/L	nd(b)	0.2	yes	107	85	115	yes	0.9	1.0	0.4	1.6	yes	yes
Potassium	ML	0.5	mg/L	nd(b)	1.0	yes	109	85	115	yes	5.9	5.0	1.0	8.0	yes	yes
Sodium	ML	0.1	mg/L	nd(b)	0.2	yes	98	85	115	yes	1.6	1.0	0.2	1.6	yes	yes
Zinc	ML	0.002	mg/L	0.002(b)	0.02	yes	100	85	115	yes	1.07	1.00	0.60	1.40	yes	yes
Reactive Silica(SiO2)	na	0.5	mg/L	nd(b)	1.0	yes	99	80	120	yes	na	na	na	na	na	yes
Aluminum	ML	0.01	mg/L	nd(b)	0.03	yes	112	85	115	yes	0.10	0.100	0.050	0.140	yes	yes
Antimony	ML	0.002	mg/L	nd(b)	0.004	yes	97	85	115	yes	0.097	0.100	0.050	0.140	yes	yes
Arsenic	ML	0.002	mg/L	nd(b)	0.004	yes	96	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Barium	ML	0.005	mg/L	nd(b)	0.01	yes	96	85	115	yes	0.096	0.100	0.050	0.140	yes	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Beryllium	ML	0.005	mg/L	nd(b)	0.01	yes	109	85	115	yes	0.113	0.100	0.050	0.140	yes	yes
Bismuth	ML	0.002	mg/L	nd(b)	0.004	yes	91	85	115	yes	0.094	0.100	0.050	0.140	yes	yes
Cadmium	ML	0.0005	mg/L	nd(b)	0.0010	yes	96	85	115	yes	0.0996	0.100	0.050	0.140	yes	yes
Chromium	ML	0.002	mg/L	nd(b)	0.004	yes	99	85	115	yes	0.103	0.100	0.050	0.140	yes	yes
Cobalt	ML	0.001	mg/L	nd(b)	0.002	yes	100	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Copper	ML	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Lead	ML	0.0001	mg/L	0.0001(b)	0.002	yes	91	85	115	yes	0.0947	0.100	0.050	0.140	yes	yes
Manganese	ML	0.002	mg/L	nd(b)	0.004	yes	99	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Molybdenum	ML	0.002	mg/L	nd(b)	0.004	yes	97	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Nickel	ML	0.002	mg/L	nd(b)	0.004	yes	99	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Selenium	ML	0.002	mg/L	nd(b)	0.004	yes	95	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Silver	ML	0.0003	mg/L	nd(b)	0.0006	yes	92	85	115	yes	0.0997	0.100	0.050	0.140	yes	yes
Strontium	ML	0.005	mg/L	nd(b)	0.01	yes	98	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Thallium	ML	0.0001	mg/L	nd(b)	0.0002	yes	90	85	115	yes	0.0936	0.100	0.050	0.140	yes	yes
Tin	ML	0.002	mg/L	nd(b)	0.004	yes	94	85	115	yes	0.096	0.100	0.050	0.140	yes	yes
Titanium	ML	0.002	mg/L	nd(b)	0.004	yes	99	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Uranium	ML	0.0001	mg/L	nd(b)	0.0002	yes	94	85	115	yes	0.0984	0.100	0.050	0.140	yes	yes
Vanadium	ML	0.002	mg/L	nd(b)	0.004	yes	98	85	115	yes	0.103	0.100	0.050	0.140	yes	yes
Colour	na	5	TCU	na(b)	na	na	88	85	115	yes	na	na	na	na	na	yes
Conductivity - @25°C	na	1	us/cm	na(b)	na	na	97	91	109	yes	na	na	na	na	na	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

Parameter	SAMPLE ID (spike)	LOQ	Units	Process Blank			Process % Recovery				Matrix Spike					Overall QC Acceptable
				Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	
pH	na	0.1	Units	na(b)	na	na	99	98	102	yes	na	na	na	na	na	yes
Turbidity	na	0.1	NTU	na(b)	na	na	96	81	129	yes	na	na	na	na	na	yes
Mercury	na	0.1	ug/L	nd	0.2	yes	95	79	120	yes	na	na	na	na	na	yes
Cyanide, Free	na	0.002	mg/L	nd	0.004	yes	105	77	127	yes	na	na	na	na	na	yes
Cyanide, Total	na	0.002	mg/L	nd	0.004	yes	100	82	115	yes	na	na	na	na	na	yes
Ammonia(as N)	na	0.05	mg/L	nd	0.1	yes	104	79	119	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	98	77	122	yes	na	na	na	na	na	yes
Dissolved Inorganic Carbon(as C)	na	0.5	mg/L	nd	1.0	yes	na	na	na	na	na	na	na	na	na	yes
Dissolved Organic Carbon(DOC)	na	0.5	mg/L	nd	1.0	yes	104	80	116	yes	na	na	na	na	na	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: October 15/96
MDS Ref # : 966496
MDS Quote#: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Alkalinity(as CaCO3)	na	1	mg/L	nd(b)	2	yes	100	87	113	yes	na	na	na	na	na	yes
Chloride	na	1	mg/L	nd(b)	2	yes	106	90	113	yes	na	na	na	na	na	yes
Nitrate(as N)	Sampler Blank	0.05	mg/L	nd(b)	0.1	yes	108	88	114	yes	0.32	0.30	0.18	0.42	yes	yes
Nitrite(as N)	Sampler Blank	0.01	mg/L	nd(b)	0.03	yes	87	80	116	yes	0.16	0.20	0.12	0.28	yes	yes
Orthophosphate(as P)	Sampler Blank	0.01	mg/L	nd(b)	0.03	yes	101	90	110	yes	0.94	1.0	0.6	1.4	yes	yes
Sulphate	na	2	mg/L	nd(b)	3	yes	103	90	113	yes	na	na	na	na	na	yes
Boron	Sampler Blank	0.005	mg/L	nd(b)	0.02	yes	110	85	115	yes	1.08	1.00	0.60	1.40	yes	yes
Boron	Sampler Blank	0.005	mg/L	nd(b)	0.02	yes	106	85	115	yes	1.14	1.00	0.60	1.40	yes	yes
Calcium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	104	85	115	yes	1.1	1.0	0.2	1.8	yes	yes
Calcium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	1.1	1.0	0.2	1.8	yes	yes
Iron	Sampler Blank	0.02	mg/L	nd(b)	0.03	yes	107	85	115	yes	1.06	1.00	0.60	1.40	yes	yes
Iron	Sampler Blank	0.02	mg/L	nd(b)	0.03	yes	101	85	115	yes	1.14	1.00	0.60	1.40	yes	yes
Magnesium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	108	85	115	yes	1.1	1.0	0.2	1.6	yes	yes
Magnesium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	110	85	115	yes	1.1	1.0	0.2	1.6	yes	yes
Phosphorus	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	90	85	115	yes	0.9	1.0	0.4	1.6	yes	yes
Phosphorus	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	91	85	115	yes	1.0	1.0	0.4	1.6	yes	yes
Potassium	Sampler Blank	0.5	mg/L	nd(b)	1.0	yes	99	85	115	yes	4.6	5.0	1.0	8.0	yes	yes
Potassium	Sampler Blank	0.5	mg/L	nd(b)	1.0	yes	92	85	115	yes	6.0	5.0	1.0	8.0	yes	yes
Sodium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	106	85	115	yes	1.1	1.0	0.2	1.6	yes	yes
Sodium	Sampler Blank	0.1	mg/L	nd(b)	0.2	yes	103	85	115	yes	1.2	1.0	0.2	1.6	yes	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Analysis of Water

Date Reported: October 15/96
MDS Ref # : 966496
MDS Quote#: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Zinc	Sampler Bl ank	0.002	mg/L	nd(b)	0.02	yes	99	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Zinc	Sampler Bl ank	0.002	mg/L	0.003(b	0.02	yes	102	85	115	yes	1.13	1.00	0.60	1.40	yes	yes
Reactive Silica(SiO2)	na	0.5	mg/L	nd(b)	1.0	yes	96	80	120	yes	na	na	na	na	na	yes
Aluminum	Sampler Bl ank	0.01	mg/L	nd(b)	0.03	yes	103	85	115	yes	0.11	0.100	0.050	0.140	yes	yes
Aluminum	Sampler Bl ank	0.01	mg/L	nd(b)	0.03	yes	107	85	115	yes	*	*	*	*	*	yes
Antimony	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.103	0.100	0.050	0.140	yes	yes
Antimony	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	98	85	115	yes	0.111	0.100	0.050	0.140	yes	yes
Arsenic	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Arsenic	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	104	85	115	yes	0.114	0.100	0.050	0.140	yes	yes
Barium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	106	85	115	yes	0.105	0.100	0.050	0.140	yes	yes
Barium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	102	85	115	yes	0.130	0.100	0.050	0.140	yes	yes
Beryllium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	108	85	115	yes	0.109	0.100	0.050	0.140	yes	yes
Beryllium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	103	85	115	yes	0.111	0.100	0.050	0.140	yes	yes
Bismuth	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Bismuth	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.106	0.100	0.050	0.140	yes	yes
Cadmium	Sampler Bl ank	0.0005	mg/L	nd(b)	0.0010	yes	107	85	115	yes	0.1030	0.100	0.050	0.140	yes	yes
Cadmium	Sampler Bl ank	0.0005	mg/L	nd(b)	0.0010	yes	101	85	115	yes	0.1190	0.100	0.050	0.140	yes	yes
Chromium	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.109	0.100	0.050	0.140	yes	yes
Chromium	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.120	0.100	0.050	0.140	yes	yes
Cobalt	Sampler Bl ank	0.001	mg/L	nd(b)	0.002	yes	107	85	115	yes	0.107	0.100	0.050	0.140	yes	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: October 15/96
MDS Ref # : 966496
MDS Quote#: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Cobalt	Sampler Bl ank	0.001	mg/L	nd(b)	0.002	yes	103	85	115	yes	0.119	0.100	0.050	0.140	yes	yes
Copper	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.105	0.100	0.050	0.140	yes	yes
Copper	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	*	*	*	*	*	yes
Lead	Sampler Bl ank	0.0001	mg/L	0.0014(	0.002	yes	101	85	115	yes	0.0998	0.100	0.050	0.140	yes	yes
Lead	Sampler Bl ank	0.0001	mg/L	nd(b)	0.002	yes	100	85	115	yes	0.1160	0.100	0.050	0.140	yes	yes
Manganese	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	108	85	115	yes	0.107	0.100	0.050	0.140	yes	yes
Manganese	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.130	0.100	0.050	0.140	yes	yes
Molybdenum	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Molybdenum	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	101	85	115	yes	0.110	0.100	0.050	0.140	yes	yes
Nickel	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.106	0.100	0.050	0.140	yes	yes
Nickel	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	*	*	*	*	*	yes
Selenium	Sampler Bl ank	0.002	mg/L	0.002(b	0.004	yes	107	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Selenium	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.118	0.100	0.050	0.140	yes	yes
Silver	Sampler Bl ank	0.0003	mg/L	nd(b)	0.0006	yes	109	85	115	yes	0.1050	0.100	0.050	0.140	yes	yes
Silver	Sampler Bl ank	0.0003	mg/L	nd(b)	0.0006	yes	106	85	115	yes	0.1380	0.100	0.050	0.140	yes	yes
Strontium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	108	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Strontium	Sampler Bl ank	0.005	mg/L	nd(b)	0.01	yes	102	85	115	yes	*	*	*	*	*	yes
Thallium	Sampler Bl ank	0.0001	mg/L	nd(b)	0.0002	yes	103	85	115	yes	0.1020	0.100	0.050	0.140	yes	yes
Thallium	Sampler Bl ank	0.0001	mg/L	nd(b)	0.0002	yes	101	85	115	yes	0.1120	0.100	0.050	0.140	yes	yes
Tin	Sampler Bl ank	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.104	0.100	0.050	0.140	yes	yes

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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Analysis of Water

Date Reported: October 15/96
MDS Ref # : 966496
MDS Quote#: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

				Process Blank			Process % Recovery				Matrix Spike					Overall QC
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	Acceptable
Tin	Sampler Blank	0.002	mg/L	nd(b)	0.004	yes	98	85	115	yes	0.113	0.100	0.050	0.140	yes	yes
Titanium	Sampler Blank	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.105	0.100	0.050	0.140	yes	yes
Titanium	Sampler Blank	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.118	0.100	0.050	0.140	yes	yes
Uranium	Sampler Blank	0.0001	mg/L	nd(b)	0.0002	yes	103	85	115	yes	0.0993	0.100	0.050	0.140	yes	yes
Uranium	Sampler Blank	0.0001	mg/L	nd(b)	0.0002	yes	98	85	115	yes	0.1120	0.100	0.050	0.140	yes	yes
Vanadium	Sampler Blank	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.106	0.100	0.050	0.140	yes	yes
Vanadium	Sampler Blank	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.117	0.100	0.050	0.140	yes	yes
Colour	na	5	TCU	nd(b)	10	yes	100	85	115	yes	na	na	na	na	na	yes
Conductivity - @25°C	na	1	us/cm	na(b)	na	na	99	91	109	yes	na	na	na	na	na	yes
pH	na	0.1	Units	na(b)	na	na	102	98	102	yes	na	na	na	na	na	yes
Turbidity	na	0.1	NTU	nd(b)	0.5	yes	97	81	129	yes	na	na	na	na	na	yes
Mercury	na	0.1	ug/L	nd	0.2	yes	109	79	120	yes	na	na	na	na	na	yes
Cyanide, Free	na	0.002	mg/L	nd	0.004	yes	87	77	127	yes	na	na	na	na	na	yes
Cyanide, Total	na	0.002	mg/L	nd	0.004	yes	87	82	115	yes	na	na	na	na	na	yes
Ammonia(as N)	na	0.05	mg/L	nd	0.1	yes	95	79	119	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	95	77	122	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	nd	0.1	yes	96	77	122	yes	na	na	na	na	na	yes
Dissolved Inorganic Carbon(as C)	na	0.5	mg/L	nd	1.0	yes	na	na	na	na	na	na	na	na	na	yes
Dissolved Organic Carbon(DOC)	na	0.5	mg/L	nd	1.0	yes	97	80	116	yes	na	na	na	na	na	yes

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

Parameter	LOQ	Units	ML	ML Replicate	ML Unfiltered		
Alkalinity(as CaCO3)	1	mg/L	95	93	-		
Ammonia(as N)	0.05	mg/L	nd	nd	-		
Chloride	1	mg/L	24	24	-		
Nitrate(as N)	0.05	mg/L	nd	nd	-		
Nitrite(as N)	0.01	mg/L	nd	nd	-		
Orthophosphate(as P)	0.01	mg/L	nd	nd	-		
Sulphate	2	mg/L	7	7	-		
Boron	0.005	mg/L	nd	nd	0.007		
Calcium	0.1	mg/L	35.5	32.1	35.9		
Iron	0.02	mg/L	nd	0.02	nd		
Magnesium	0.1	mg/L	7.2	6.5	7.2		
Phosphorus	0.1	mg/L	nd	nd	nd		
Potassium	0.5	mg/L	0.8	nd	nd		
Reactive Silica(SiO2)	0.5	mg/L	2.4	2.4	-		
Sodium	0.1	mg/L	14.4	13.1	14.6		
Zinc	0.002	mg/L	nd	nd	nd		
Aluminum	0.01	mg/L	nd	nd	nd		
Antimony	0.002	mg/L	nd	nd	nd		
Arsenic	0.002	mg/L	nd	nd	nd		
Barium	0.005	mg/L	0.007	0.007	0.007		
Beryllium	0.005	mg/L	nd	nd	nd		
Bismuth	0.002	mg/L	nd	nd	nd		
Cadmium	0.0005	mg/L	nd	nd	nd		
Chromium	0.002	mg/L	0.002	0.002	nd		
Cobalt	0.001	mg/L	nd	nd	nd		
Copper	0.002	mg/L	nd	nd	nd		
Lead	0.0001	mg/L	nd	nd	nd		

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

Parameter	LOQ	Units	ML	ML Replicate	ML Unfiltered		
Manganese	0.002	mg/L	nd	nd	0.003		
Molybdenum	0.002	mg/L	nd	nd	nd		
Nickel	0.002	mg/L	nd	nd	nd		
Selenium	0.002	mg/L	nd	nd	nd		
Silver	0.0003	mg/L	nd	nd	nd		
Strontium	0.005	mg/L	0.040	0.040	0.039		
Thallium	0.0001	mg/L	0.0002	0.0002	nd		
Tin	0.002	mg/L	nd	nd	nd		
Titanium	0.002	mg/L	nd	nd	nd		
Uranium	0.0001	mg/L	nd	nd	nd		
Vanadium	0.002	mg/L	nd	nd	nd		
Anion Sum	na	meq/L	2.72	-	-		
Bicarbonate(as CaCO3, calculated)	1	mg/L	94	-	-		
Carbonate(as CaCO3, calculated)	1	mg/L	nd	-	-		
Cation Sum	na	meq/L	3.01	-	-		
Colour	5	TCU	14	14	-		
Conductivity - @25°C	1	us/cm	279	280	-		
Hardness(as CaCO3)	0.1	mg/L	118	-	-		
Ion Balance	0.01	%	4.99	-	-		
Langelier Index at 20°C	na	na	0.119	-	-		
Langelier Index at 4°C	na	na	-0.281	-	-		
pH	0.1	Units	8.0	8.1	-		
Saturation pH at 20°C	na	units	7.92	-	-		
Saturation pH at 4°C	na	units	8.32	-	-		
Total Dissolved Solids(Calculated)	1	mg/L	148	-	-		
Turbidity	0.1	NTU	0.2	0.2	-		
Mercury	0.1	ug/L	nd	-	-		

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966657

Analysis of Water

Client Ref#: G96239

Parameter	LOQ	Units	ML	ML Replicate	ML Unfiltered		
Cyanide, Free	0.002	mg/L	nd	-	-		
Cyanide, Total	0.002	mg/L	0.004	-	-		
Ammonia(as N)	0.05	mg/L	nd	-	-		
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	0.59	-	-		
Dissolved Inorganic Carbon(as C)	0.5	mg/L	23.6	-	-		
Dissolved Organic Carbon(DOC)	0.5	mg/L	6.4	-	-		

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP1	EXP1 [total]	EXP1-E.O.	EXP1-E.O. Replicate	EXP1-E.O. [total]	EXP1-E.O. [total] Replicate	EXP1-E.O. Rep. [t.]	EXP1-E.O. Replicate
Alkalinity(as CaCO3)	1	mg/L	111	-	102	105	-	-	-	106
Chloride	1	mg/L	33	-	34	34	-	-	-	33
Nitrate(as N)	0.05	mg/L	0.38	-	0.57	0.58	-	-	-	0.60
Nitrite(as N)	0.01	mg/L	nd	-	nd	nd	-	-	-	nd
Orthophosphate(as P)	0.01	mg/L	nd	-	nd	nd	-	-	-	nd
Sulphate	2	mg/L	229	-	247	247	-	-	-	244
Boron	0.005	mg/L	0.154	0.164	0.148	-	0.172	0.178	0.176	-
Calcium	0.1	mg/L	58.6	67.2	58.5	-	68.2	68.8	68.1	-
Iron	0.02	mg/L	0.31	0.36	0.22	-	0.26	0.28	0.26	-
Magnesium	0.1	mg/L	11.2	12.8	10.8	-	12.2	12.9	12.5	-
Phosphorus	0.1	mg/L	nd	nd	nd	-	nd	nd	nd	-
Potassium	0.5	mg/L	21.5	24.3	21.3	-	25.1	26.8	25.7	-
Reactive Silica(SiO2)	0.5	mg/L	6.2	-	5.1	5.2	-	-	-	5.1
Sodium	0.1	mg/L	70.6	80.4	72.3	-	84.3	86.4	84.3	-
Zinc	0.002	mg/L	0.018	nd	0.027	-	nd	nd	nd	-
Aluminum	0.01	mg/L	0.02	nd	0.02	-	nd	nd	nd	-
Antimony	0.002	mg/L	nd	nd	nd	-	nd	nd	nd	-
Arsenic	0.002	mg/L	0.018	0.017	0.015	-	0.012	0.012	0.012	-

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP1	EXP1 [total]	EXP1-E.O.	EXP1-E.O. Replicate	EXP1-E.O. [total]	EXP1-E.O. [total] Replicate	EXP1-E.O. Rep. [t.]	EXP1-E.O. Replicate
Barium	0.005	mg/L	0.018	0.028	0.018	-	0.028	0.027	0.027	-
Beryllium	0.005	mg/L	nd	nd	nd	-	nd	nd	nd	-
Bismuth	0.002	mg/L	nd	nd	nd	-	nd	nd	nd	-
Cadmium	0.0005	mg/L	nd	nd	nd	-	nd	nd	nd	-
Chromium	0.002	mg/L	nd	nd	nd	-	0.005	0.007	nd	-
Cobalt	0.001	mg/L	0.043	0.044	0.050	-	0.056	0.064	0.052	-
Copper	0.002	mg/L	0.017	0.014	0.015	-	0.013	0.015	0.011	-
Lead	0.0001	mg/L	0.0003	nd	0.0004	-	nd	nd	nd	-
Manganese	0.002	mg/L	0.397	0.376	0.290	-	0.302	0.316	0.260	-
Molybdenum	0.002	mg/L	0.003	0.003	0.004	-	0.004	0.004	0.004	-
Nickel	0.002	mg/L	0.025	0.029	0.020	-	0.027	0.032	0.023	-
Selenium	0.002	mg/L	nd	nd	nd	-	nd	nd	nd	-
Silver	0.0003	mg/L	nd	nd	nd	-	nd	nd	nd	-
Strontium	0.005	mg/L	0.151	0.123	0.152	-	0.125	0.125	0.128	-
Thallium	0.0001	mg/L	nd	nd	nd	-	nd	nd	0.0001	-
Tin	0.002	mg/L	nd	nd	nd	-	nd	nd	nd	-
Titanium	0.002	mg/L	nd	0.004	nd	-	0.019	0.019	0.004	-
Uranium	0.0001	mg/L	0.0001	nd	nd	-	nd	nd	nd	-

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP1	EXP1 [total]	EXP1-E.O.	EXP1-E.O. Replicate	EXP1-E.O. [total]	EXP1-E.O. [total] Replicate	EXP1-E.O. Rep. [t.]	EXP1-E.O. Replicate
Vanadium	0.002	mg/L	nd	nd	nd	-	0.009	0.012	nd	-
Anion Sum	na	meq/L	7.94	-	8.18	-	-	-	-	8.18
Bicarbonate(as CaCO3, calculated)	1	mg/L	111	-	102	-	-	-	-	106
Carbonate(as CaCO3, calculated)	1	mg/L	nd	-	nd	-	-	-	-	nd
Cation Sum	na	meq/L	8.63	-	8.62	-	-	-	-	8.64
Colour	5	TCU	27	-	27	27	-	-	-	23
Conductivity - @25°C	1	us/cm	764	-	798	800	-	-	-	796
Hardness(as CaCO3)	0.1	mg/L	217	-	208	-	-	-	-	208
Ion Balance	0.01	%	4.17	-	2.66	-	-	-	-	2.73
Langelier Index at 20°C	na	na	-0.150	-	-0.142	-	-	-	-	-0.126
Langelier Index at 4°C	na	na	-0.550	-	-0.542	-	-	-	-	-0.526
pH	0.1	Units	7.5	-	7.5	7.6	-	-	-	7.5
Saturation pH at 20°C	na	units	7.63	-	7.68	-	-	-	-	7.67
Saturation pH at 4°C	na	units	8.03	-	8.08	-	-	-	-	8.07
Total Dissolved Solids(Calculated)	1	mg/L	522	-	537	-	-	-	-	536
Turbidity	0.1	NTU	0.2	-	0.2	0.2	-	-	-	0.2
Mercury	0.1	ug/L	nd	-	nd	-	-	-	-	nd
Cyanide, Free	0.002	mg/L	nd	-	nd	-	-	-	-	nd

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP1	EXP1 [total]	EXP1-E.O.	EXP1-E.O. Replicate	EXP1-E.O. [total]	EXP1-E.O. [total] Replicate	EXP1-E.O. Rep. [t.]	EXP1-E.O. Replicate
Ammonia(as N)	0.05	mg/L	3.72	-	4.29	-	-	-	-	4.27
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	3.98	-	4.59	-	-	-	-	4.54
Phosphorus, Total	0.004	mg/L	0.030	-	0.024	-	-	-	-	0.023
Dissolved Inorganic Carbon(as C)	0.5	mg/L	32.0	-	27.8	-	-	-	-	29.3
Dissolved Organic Carbon(DOC)	0.5	mg/L	6.7	-	6.1	-	-	-	-	6.2
Total Suspended Solids	5	mg/L	nd	-	nd	-	-	-	-	nd
Cyanide, Total	0.005	mg/L	0.007	-	0.009	-	-	-	-	0.007

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP2	EXP2 [total]	EXP2-E.O.	EXP2-E.O. [total]	EXP3	EXP3 Replicate	EXP3 [total]	EXP3-E.O.
Alkalinity(as CaCO3)	1	mg/L	137	-	106	-	134	-	-	111
Chloride	1	mg/L	32	-	34	-	32	-	-	34
Nitrate(as N)	0.05	mg/L	0.25	-	0.52	-	0.21	-	-	0.44
Nitrite(as N)	0.01	mg/L	nd	-	nd	-	nd	-	-	nd
Orthophosphate(as P)	0.01	mg/L	nd	-	nd	-	nd	-	-	nd
Sulphate	2	mg/L	205	-	240	-	192	-	-	230
Boron	0.005	mg/L	0.147	0.152	0.151	0.176	0.143	-	0.162	0.150
Calcium	0.1	mg/L	59.8	66.7	59.9	68.5	60.8	-	71.1	59.8
Iron	0.02	mg/L	0.22	0.26	0.23	0.29	0.24	-	0.37	0.22
Magnesium	0.1	mg/L	12.0	13.3	11.2	12.6	12.3	-	14.2	11.3
Phosphorus	0.1	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Potassium	0.5	mg/L	21.0	23.3	22.3	25.8	20.9	-	24.7	21.7
Reactive Silica(SiO2)	0.5	mg/L	6.9	-	5.4	-	7.1	-	-	5.6
Sodium	0.1	mg/L	69.2	76.3	73.3	84.8	68.9	-	80.8	72.2
Zinc	0.002	mg/L	0.013	0.004	0.008	0.004	0.013	-	nd	0.017
Aluminum	0.01	mg/L	0.01	nd	0.01	nd	0.01	-	nd	0.01
Antimony	0.002	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Arsenic	0.002	mg/L	0.024	0.019	0.020	0.016	0.027	-	0.024	0.021

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP2	EXP2 [total]	EXP2-E.O.	EXP2-E.O. [total]	EXP3	EXP3 Replicate	EXP3 [total]	EXP3-E.O.
Barium	0.005	mg/L	0.019	0.027	0.019	0.028	0.019	-	0.031	0.019
Beryllium	0.005	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Chromium	0.002	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Cobalt	0.001	mg/L	0.032	0.033	0.047	0.049	0.028	-	0.033	0.042
Copper	0.002	mg/L	0.022	0.018	0.017	0.012	0.022	-	0.021	0.017
Lead	0.0001	mg/L	0.0007	0.0004	0.0001	0.0004	0.0016	-	0.0002	nd
Manganese	0.002	mg/L	0.432	0.399	0.391	0.369	0.564	-	0.657	0.454
Molybdenum	0.002	mg/L	0.003	0.004	0.004	0.004	0.003	-	0.004	0.004
Nickel	0.002	mg/L	0.032	0.039	0.025	0.027	0.034	-	0.044	0.027
Selenium	0.002	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Strontium	0.005	mg/L	0.153	0.118	0.151	0.128	0.151	-	0.128	0.152
Thallium	0.0001	mg/L	nd	nd	nd	0.0001	nd	-	nd	nd
Tin	0.002	mg/L	nd	nd	nd	nd	nd	-	nd	nd
Titanium	0.002	mg/L	nd	0.004	nd	0.004	nd	-	0.005	nd
Uranium	0.0001	mg/L	nd	nd	nd	nd	nd	-	nd	nd

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MDS Environmental Services Limited.

Report of Analysis

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Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP2	EXP2 [total]	EXP2-E.O.	EXP2-E.O. [total]	EXP3	EXP3 Replicate	EXP3 [total]	EXP3-E.O.
Vanadium	0.002	mg/L	nd	nd	nd	nd	nd	-	0.002	nd
Anion Sum	na	meq/L	7.91	-	8.10	-	7.59	-	-	7.98
Bicarbonate(as CaCO3, calculated)	1	mg/L	136	-	106	-	134	-	-	111
Carbonate(as CaCO3, calculated)	1	mg/L	nd	-	nd	-	nd	-	-	nd
Cation Sum	na	meq/L	8.53	-	8.74	-	8.43	-	-	8.70
Colour	5	TCU	30	-	22	-	31	-	-	24
Conductivity - @25°C	1	us/cm	745	-	771	-	729	-	-	759
Hardness(as CaCO3)	0.1	mg/L	221	-	218	-	220	-	-	217
Ion Balance	0.01	%	3.73	-	3.79	-	5.23	-	-	4.27
Langelier Index at 20°C	na	na	0.138	-	-0.125	-	0.016	-	-	-0.136
Langelier Index at 4°C	na	na	-0.262	-	-0.525	-	-0.384	-	-	-0.536
pH	0.1	Units	7.7	-	7.5	-	7.6	-	-	7.5
Saturation pH at 20°C	na	units	7.53	-	7.64	-	7.54	-	-	7.63
Saturation pH at 4°C	na	units	7.93	-	8.04	-	7.94	-	-	8.03
Total Dissolved Solids(Calculated)	1	mg/L	509	-	534	-	493	-	-	526
Turbidity	0.1	NTU	0.3	-	0.2	-	0.3	-	-	0.2
Mercury	0.1	ug/L	nd	-	nd	-	nd	-	-	nd
Cyanide, Free	0.002	mg/L	nd	-	nd	-	nd	-	-	nd

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP2	EXP2 [total]	EXP2-E.O.	EXP2-E.O. [total]	EXP3	EXP3 Replicate	EXP3 [total]	EXP3-E.O.
Ammonia(as N)	0.05	mg/L	2.91	-	3.37	-	2.65	-	-	3.58
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	3.44	-	4.13	-	3.28	-	-	4.06
Phosphorus, Total	0.004	mg/L	0.026	-	0.026	-	0.027	-	-	0.026
Dissolved Inorganic Carbon(as C)	0.5	mg/L	35.8	-	29.8	-	37.5	-	-	31.1
Dissolved Organic Carbon(DOC)	0.5	mg/L	8.5	-	5.9	-	8.5	-	-	6.6
Total Suspended Solids	5	mg/L	nd	-	nd	-	nd	-	-	nd
Cyanide, Total	0.005	mg/L	0.007	-	0.007	-	0.009	-	-	0.010

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: 96239

Parameter	LOQ	Units	EXP3-E.O. [total]	REF B1	REF B1 [total]	REF B2	REF B2 Replicate	REF B2 [total]	REF B3	REF B3 [total]
Alkalinity(as CaCO3)	1	mg/L	-	259	-	256	-	-	237	-
Chloride	1	mg/L	-	12	-	12	-	-	14	-
Nitrate(as N)	0.05	mg/L	-	nd	-	nd	-	-	0.87	-
Nitrite(as N)	0.01	mg/L	-	nd	-	nd	-	-	nd	-
Orthophosphate(as P)	0.01	mg/L	-	nd	-	nd	-	-	nd	-
Sulphate	2	mg/L	-	58	-	55	-	-	69	-
Boron	0.005	mg/L	0.179	0.080	0.093	0.077	-	0.092	0.083	0.088
Calcium	0.1	mg/L	70.6	68.4	80.4	67.3	-	82.3	65.7	79.9
Iron	0.02	mg/L	0.30	0.43	0.65	0.44	-	0.79	0.30	0.47
Magnesium	0.1	mg/L	13.3	30.9	36.1	29.9	-	36.3	27.8	33.6
Phosphorus	0.1	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Potassium	0.5	mg/L	25.5	1.4	1.1	1.1	-	1.8	2.1	2.8
Reactive Silica(SiO2)	0.5	mg/L	-	8.5	-	8.8	-	-	9.1	-
Sodium	0.1	mg/L	86.5	13.2	15.1	13.4	-	15.8	17.0	20.2
Zinc	0.002	mg/L	0.002	0.003	nd	0.014	-	nd	0.018	0.006
Aluminum	0.01	mg/L	nd	nd	nd	0.01	-	0.01	0.01	nd
Antimony	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Arsenic	0.002	mg/L	0.018	0.060	0.059	0.059	-	0.062	0.046	0.044

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Client Ref#: 96239

Analysis of Water

Parameter	LOQ	Units	EXP3-E.O. [total]	REF B1	REF B1 [total]	REF B2	REF B2 Replicate	REF B2 [total]	REF B3	REF B3 [total]
Barium	0.005	mg/L	0.030	0.016	0.024	0.016	-	0.026	0.014	0.021
Beryllium	0.005	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Chromium	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	0.002
Cobalt	0.001	mg/L	0.047	nd	0.001	0.002	-	0.002	0.006	0.007
Copper	0.002	mg/L	0.015	0.010	0.006	0.011	-	0.007	0.011	0.005
Lead	0.0001	mg/L	nd	0.0002	nd	0.0004	-	0.0005	0.0005	0.0032
Manganese	0.002	mg/L	0.436	0.086	0.090	0.109	-	0.118	0.078	0.081
Molybdenum	0.002	mg/L	0.004	nd	nd	nd	-	nd	nd	nd
Nickel	0.002	mg/L	0.032	0.011	0.014	0.012	-	0.016	0.011	0.014
Selenium	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Strontium	0.005	mg/L	0.132	0.143	0.124	0.146	-	0.129	0.143	0.120
Thallium	0.0001	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Tin	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Titanium	0.002	mg/L	0.004	nd	0.004	nd	-	0.004	nd	0.004
Uranium	0.0001	mg/L	nd	0.0001	nd	0.0002	-	nd	0.0001	nd

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Client Ref#: 96239

Analysis of Water

Parameter	LOQ	Units	EXP3-E.O. [total]	REF B1	REF B1 [total]	REF B2	REF B2 Replicate	REF B2 [total]	REF B3	REF B3 [total]
Vanadium	0.002	mg/L	nd	nd	nd	nd	-	nd	nd	nd
Anion Sum	na	meq/L	-	6.74	-	6.61	-	-	6.62	-
Bicarbonate(as CaCO3, calculated)	1	mg/L	-	254	-	252	-	-	234	-
Carbonate(as CaCO3, calculated)	1	mg/L	-	5	-	4	-	-	3	-
Cation Sum	na	meq/L	-	7.26	-	7.17	-	-	7.29	-
Colour	5	TCU	-	27	-	27	-	-	36	-
Conductivity - @25°C	1	us/cm	-	566	-	568	-	-	573	-
Hardness(as CaCO3)	0.1	mg/L	-	331	-	325	-	-	316	-
Ion Balance	0.01	%	-	3.74	-	4.01	-	-	4.77	-
Langelier Index at 20°C	na	na	-	1.13	-	1.06	-	-	0.940	-
Langelier Index at 4°C	na	na	-	0.726	-	0.656	-	-	0.540	-
pH	0.1	Units	-	8.3	-	8.3	-	-	8.2	-
Saturation pH at 20°C	na	units	-	7.18	-	7.19	-	-	7.23	-
Saturation pH at 4°C	na	units	-	7.58	-	7.59	-	-	7.63	-
Total Dissolved Solids(Calculated)	1	mg/L	-	360	-	354	-	-	368	-
Turbidity	0.1	NTU	-	0.6	-	0.6	-	-	0.5	-
Mercury	0.1	ug/L	-	nd	-	nd	-	-	nd	-
Cyanide, Free	0.002	mg/L	-	nd	-	nd	-	-	nd	-

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
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Report Date: October 15/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Client Ref#: 96239

Analysis of Water

Parameter	LOQ	Units	EXP3-E.O. [total]	REF B1	REF B1 [total]	REF B2	REF B2 Replicate	REF B2 [total]	REF B3	REF B3 [total]
Ammonia(as N)	0.05	mg/L	-	0.10	-	0.20	-	-	0.21	-
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	-	0.79	-	0.91	-	-	0.91	-
Phosphorus, Total	0.004	mg/L	-	0.029	-	0.023	-	-	0.021	-
Dissolved Inorganic Carbon(as C)	0.5	mg/L	-	61.7	-	60.1	-	-	57.2	-
Dissolved Organic Carbon(DOC)	0.5	mg/L	-	10.0	-	10.3	-	-	8.5	-
Total Suspended Solids	5	mg/L	-	nd	-	nd	-	-	nd	-
Cyanide, Total	0.005	mg/L	-	0.011	-	0.014	-	-	0.014	-

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 1 96/09/09	MAC 1 [total] 96/09/09	MAC 2 96/09/09	MAC 2 [total] 96/09/09	MAC 3 96/09/09
Alkalinity(as CaCO3)	1	mg/L	121	-	103	-	115
Chloride	1	mg/L	26	-	24	-	25
Nitrate(as N)	0.05	mg/L	nd	-	nd	-	nd
Nitrite(as N)	0.01	mg/L	nd	-	nd	-	nd
Orthophosphate(as P)	0.01	mg/L	nd	-	nd	-	nd
Sulphate	2	mg/L	8	-	7	-	8
Boron	0.005	mg/L	nd	nd	nd	nd	nd
Calcium	0.1	mg/L	43.1	40.6	37.5	35.0	40.3
Iron	0.02	mg/L	0.06	0.03	0.06	0.02	0.04
Magnesium	0.1	mg/L	8.5	8.8	7.4	7.7	8.0
Phosphorus	0.1	mg/L	nd	nd	nd	nd	nd
Potassium	0.5	mg/L	0.7	0.8	0.6	1.0	0.6
Reactive Silica(SiO2)	0.5	mg/L	3.2	-	2.4	-	2.9
Sodium	0.1	mg/L	17.5	16.5	15.8	14.7	16.4
Zinc	0.002	mg/L	0.035	0.008	0.054	0.003	0.014
Aluminum	0.01	mg/L	0.02	nd	0.02	0.01	0.01
Antimony	0.002	mg/L	nd	nd	nd	nd	nd
Arsenic	0.002	mg/L	nd	nd	0.002	0.002	nd
Barium	0.005	mg/L	0.009	0.008	0.009	0.007	0.009
Beryllium	0.005	mg/L	nd	nd	nd	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	nd
Chromium	0.002	mg/L	0.004	0.003	0.003	0.003	0.003
Cobalt	0.001	mg/L	nd	nd	nd	nd	nd
Copper	0.002	mg/L	0.008	nd	0.008	0.005	0.008
Lead	0.0001	mg/L	0.0004	nd	0.0005	nd	0.0003
Manganese	0.002	mg/L	0.012	0.019	0.004	0.005	0.004

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Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 1 96/09/09	MAC 1 [total] 96/09/09	MAC 2 96/09/09	MAC 2 [total] 96/09/09	MAC 3 96/09/09
Molybdenum	0.002	mg/L	nd	nd	nd	nd	nd
Nickel	0.002	mg/L	0.002	nd	0.002	nd	0.002
Selenium	0.002	mg/L	nd	nd	nd	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	nd
Strontium	0.005	mg/L	0.048	0.045	0.043	0.041	0.045
Thallium	0.0001	mg/L	0.0002	nd	0.0001	nd	0.0001
Tin	0.002	mg/L	nd	nd	nd	nd	nd
Titanium	0.002	mg/L	nd	nd	nd	nd	nd
Uranium	0.0001	mg/L	0.0002	nd	0.0002	nd	0.0001
Vanadium	0.002	mg/L	nd	nd	nd	nd	nd
Anion Sum	na	meq/L	3.33	-	2.88	-	3.15
Bicarbonate(as CaCO3, calculated)	1	mg/L	121	-	103	-	115
Carbonate(as CaCO3, calculated)	1	mg/L	nd	-	nd	-	nd
Cation Sum	na	meq/L	3.53	-	3.12	-	3.31
Colour	5	TCU	12	-	11	-	10
Conductivity - @25°C	1	us/cm	307	-	215	-	293
Hardness(as CaCO3)	0.1	mg/L	139	-	122	-	130
Ion Balance	0.01	%	2.96	-	3.94	-	2.43
Langelier Index at 20°C	na	na	-0.994	-	-0.656	-	-0.322
Langelier Index at 4°C	na	na	-1.39	-	-1.06	-	-0.722
pH	0.1	Units	6.8	-	7.2	-	7.5
Saturation pH at 20°C	na	units	7.75	-	7.88	-	7.80
Saturation pH at 4°C	na	units	8.15	-	8.28	-	8.20
Total Dissolved Solids(Calculated)	1	mg/L	178	-	155	-	168
Turbidity	0.1	NTU	0.3	-	0.2	-	0.1
Mercury	0.1	ug/L	nd	-	nd	-	nd
Cyanide, Free	0.002	mg/L	nd	-	nd	-	0.002

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 1 96/09/09	MAC 1 [total] 96/09/09	MAC 2 96/09/09	MAC 2 [total] 96/09/09	MAC 3 96/09/09
Cyanide, Total	0.002	mg/L	nd	-	nd	-	0.002
Ammonia(as N)	0.05	mg/L	nd	-	nd	-	nd
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	0.54	-	0.55	-	0.53
Dissolved Inorganic Carbon(as C)	0.5	mg/L	26.3	-	23.5	-	24.1
Dissolved Organic Carbon(DOC)	0.5	mg/L	6.3	-	6.0	-	5.9

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 3 [total] 96/09/09	REF 1 96/09/09	REF 1 Replicate	REF 1 [total] 96/09/09	REF 4 96/09/09
Alkalinity(as CaCO3)	1	mg/L	-	186	-	-	186
Chloride	1	mg/L	-	37	-	-	39
Nitrate(as N)	0.05	mg/L	-	nd	-	-	nd
Nitrite(as N)	0.01	mg/L	-	nd	-	-	nd
Orthophosphate(as P)	0.01	mg/L	-	nd	-	-	nd
Sulphate	2	mg/L	-	16	-	-	15
Boron	0.005	mg/L	0.007	0.006	-	0.015	0.010
Calcium	0.1	mg/L	37.4	67.2	-	63.2	65.8
Iron	0.02	mg/L	0.02	0.73	-	1.45	0.74
Magnesium	0.1	mg/L	8.1	15.2	-	15.7	14.9
Phosphorus	0.1	mg/L	nd	nd	-	nd	nd
Potassium	0.5	mg/L	0.6	1.1	-	1.2	0.7
Reactive Silica(SiO2)	0.5	mg/L	-	8.0	-	-	8.0
Sodium	0.1	mg/L	15.1	25.9	-	24.4	25.8
Zinc	0.002	mg/L	0.007	0.015	-	nd	0.013
Aluminum	0.01	mg/L	nd	0.01	-	0.01	0.01
Antimony	0.002	mg/L	nd	nd	-	nd	nd
Arsenic	0.002	mg/L	0.002	0.053	-	0.085	0.055
Barium	0.005	mg/L	0.007	0.015	-	0.014	0.015
Beryllium	0.005	mg/L	nd	nd	-	nd	nd
Bismuth	0.002	mg/L	nd	nd	-	nd	nd
Cadmium	0.0005	mg/L	nd	nd	-	nd	nd
Chromium	0.002	mg/L	0.006	0.005	-	0.007	0.005
Cobalt	0.001	mg/L	nd	nd	-	0.001	nd
Copper	0.002	mg/L	0.002	0.006	-	nd	0.006
Lead	0.0001	mg/L	nd	0.0003	-	nd	0.0003
Manganese	0.002	mg/L	0.006	0.068	-	0.310	0.083

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 3 [total] 96/09/09	REF 1 96/09/09	REF 1 Replicate	REF 1 [total] 96/09/09	REF 4 96/09/09
Molybdenum	0.002	mg/L	nd	nd	-	nd	nd
Nickel	0.002	mg/L	0.003	0.005	-	0.005	0.005
Selenium	0.002	mg/L	nd	nd	-	nd	nd
Silver	0.0003	mg/L	nd	nd	-	nd	nd
Strontium	0.005	mg/L	0.042	0.085	-	0.083	0.085
Thallium	0.0001	mg/L	nd	0.0001	-	0.0002	0.0002
Tin	0.002	mg/L	nd	nd	-	nd	nd
Titanium	0.002	mg/L	nd	nd	-	nd	nd
Uranium	0.0001	mg/L	nd	0.0001	-	nd	0.0001
Vanadium	0.002	mg/L	nd	nd	-	nd	nd
Anion Sum	na	meq/L	-	5.10	-	-	5.13
Bicarbonate(as CaCO3, calculated)	1	mg/L	-	186	-	-	186
Carbonate(as CaCO3, calculated)	1	mg/L	-	nd	-	-	nd
Cation Sum	na	meq/L	-	5.50	-	-	5.56
Colour	5	TCU	-	24	-	-	27
Conductivity - @25°C	1	us/cm	-	359	-	-	417
Hardness(as CaCO3)	0.1	mg/L	-	222	-	-	221
Ion Balance	0.01	%	-	3.78	-	-	3.95
Langelier Index at 20°C	na	na	-	0.015	-	-	-0.036
Langelier Index at 4°C	na	na	-	-0.385	-	-	-0.436
pH	0.1	Units	-	7.4	-	-	7.4
Saturation pH at 20°C	na	units	-	7.40	-	-	7.40
Saturation pH at 4°C	na	units	-	7.80	-	-	7.80
Total Dissolved Solids(Calculated)	1	mg/L	-	276	-	-	279
Turbidity	0.1	NTU	-	0.6	-	-	0.7
Mercury	0.1	ug/L	-	nd	-	-	nd
Cyanide, Free	0.002	mg/L	-	0.002	-	-	0.002

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
na = Not Applicable
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	MAC 3 [total] 96/09/09	REF 1 96/09/09	REF 1 Replicate	REF 1 [total] 96/09/09	REF 4 96/09/09
Cyanide, Total	0.002	mg/L	-	0.002	-	-	0.002
Ammonia(as N)	0.05	mg/L	-	nd	-	-	nd
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	-	0.76	-	-	1.06
Dissolved Inorganic Carbon(as C)	0.5	mg/L	-	42.7	-	-	42.7
Dissolved Organic Carbon(DOC)	0.5	mg/L	-	8.4	-	-	8.3

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	REF 4 [total] 96/09/09	REF 6 96/09/09	REF 6 [total] 96/09/09	Sampler Blank 96/09/09	Sampler Blank Replicate
Alkalinity(as CaCO3)	1	mg/L	-	195	-	nd	nd
Chloride	1	mg/L	-	38	-	nd	nd
Nitrate(as N)	0.05	mg/L	-	0.12	-	nd	nd
Nitrite(as N)	0.01	mg/L	-	nd	-	nd	nd
Orthophosphate(as P)	0.01	mg/L	-	nd	-	nd	nd
Sulphate	2	mg/L	-	15	-	nd	nd
Boron	0.005	mg/L	0.010	nd	0.005	nd	nd
Calcium	0.1	mg/L	62.9	65.4	63.0	1.2	1.2
Iron	0.02	mg/L	1.01	0.77	0.96	0.02	0.03
Magnesium	0.1	mg/L	15.7	14.7	15.7	0.1	0.1
Phosphorus	0.1	mg/L	nd	nd	nd	nd	nd
Potassium	0.5	mg/L	0.7	1.0	1.8	nd	nd
Reactive Silica(SiO2)	0.5	mg/L	-	7.9	-	nd	nd
Sodium	0.1	mg/L	24.5	25.2	24.4	0.2	0.2
Zinc	0.002	mg/L	nd	0.026	nd	0.020	0.017
Aluminum	0.01	mg/L	nd	0.02	nd	0.01	0.01
Antimony	0.002	mg/L	nd	nd	nd	nd	nd
Arsenic	0.002	mg/L	0.064	0.057	0.063	nd	nd
Barium	0.005	mg/L	0.013	0.015	0.013	nd	nd
Beryllium	0.005	mg/L	nd	nd	nd	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	nd
Chromium	0.002	mg/L	0.006	0.006	0.007	nd	nd
Cobalt	0.001	mg/L	nd	nd	nd	nd	nd
Copper	0.002	mg/L	nd	0.006	nd	0.036	0.037
Lead	0.0001	mg/L	nd	0.0003	nd	0.0004	0.0003
Manganese	0.002	mg/L	0.119	0.120	0.124	nd	nd

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	REF 4 [total] 96/09/09	REF 6 96/09/09	REF 6 [total] 96/09/09	Sampler Bl ank 96/09/09	Sampler Bl ank Replicate
Molybdenum	0.002	mg/L	nd	nd	nd	nd	nd
Nickel	0.002	mg/L	0.007	0.005	0.005	0.003	0.003
Selenium	0.002	mg/L	nd	nd	nd	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	nd
Strontium	0.005	mg/L	0.081	0.086	0.082	nd	nd
Thallium	0.0001	mg/L	0.0002	0.0002	0.0002	nd	nd
Tin	0.002	mg/L	nd	nd	nd	nd	nd
Titanium	0.002	mg/L	nd	nd	0.002	nd	nd
Uranium	0.0001	mg/L	nd	0.0001	nd	nd	nd
Vanadium	0.002	mg/L	nd	nd	nd	nd	nd
Anion Sum	na	meq/L	-	5.29	-	0.004	0.008
Bicarbonate(as CaCO3, calculated)	1	mg/L	-	195	-	nd	nd
Carbonate(as CaCO3, calculated)	1	mg/L	-	nd	-	nd	nd
Cation Sum	na	meq/L	-	5.52	-	0.003	NCALC
Colour	5	TCU	-	25	-	nd	nd
Conductivity - @25°C	1	us/cm	-	470	-	2	2
Hardness(as CaCO3)	0.1	mg/L	-	221	-	0.1	0.2
Ion Balance	0.01	%	-	2.18	-	18.4	NCALC
Langelier Index at 20°C	na	na	-	0.004	-	-6.28	NCALC
Langelier Index at 4°C	na	na	-	-0.396	-	-6.68	NCALC
pH	0.1	Units	-	7.4	-	7.4	7.4
Saturation pH at 20°C	na	units	-	7.38	-	13.6	NCALC
Saturation pH at 4°C	na	units	-	7.78	-	14.0	NCALC
Total Dissolved Solids(Calculated)	1	mg/L	-	283	-	nd	NCALC
Turbidity	0.1	NTU	-	0.6	-	nd	nd
Mercury	0.1	ug/L	-	nd	-	nd	-
Cyanide, Free	0.002	mg/L	-	nd	-	nd	-

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
na = Not Applicable
NCALC = Not Calculated
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	REF 4 [total] 96/09/09	REF 6 96/09/09	REF 6 [total] 96/09/09	Sampler Blank 96/09/09	Sampler Blank Replicate
Cyanide, Total	0.002	mg/L	-	nd	-	nd	-
Ammonia(as N)	0.05	mg/L	-	nd	-	nd	-
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	-	0.76	-	0.40	-
Dissolved Inorganic Carbon(as C)	0.5	mg/L	-	44.1	-	0.6	-
Dissolved Organic Carbon(DOC)	0.5	mg/L	-	8.2	-	1.8	-

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	Sampler Blank [tot.] 96/09/09	Sampler Blank [tot.] Replicate	Travel\Filter B. [t] 96/09/09	Travel\Filter Blank 96/09/09	
Alkalinity(as CaCO3)	1	mg/L	-	-	-	nd	
Chloride	1	mg/L	-	-	-	nd	
Nitrate(as N)	0.05	mg/L	-	-	-	nd	
Nitrite(as N)	0.01	mg/L	-	-	-	nd	
Orthophosphate(as P)	0.01	mg/L	-	-	-	nd	
Sulphate	2	mg/L	-	-	-	nd	
Boron	0.005	mg/L	nd	nd	0.008	nd	
Calcium	0.1	mg/L	nd	nd	nd	1.2	
Iron	0.02	mg/L	nd	nd	nd	0.02	
Magnesium	0.1	mg/L	nd	nd	nd	0.2	
Phosphorus	0.1	mg/L	nd	nd	nd	0.1	
Potassium	0.5	mg/L	nd	nd	nd	nd	
Reactive Silica(SiO2)	0.5	mg/L	-	-	-	nd	
Sodium	0.1	mg/L	nd	nd	nd	0.3	
Zinc	0.002	mg/L	nd	nd	nd	0.107	
Aluminum	0.01	mg/L	nd	nd	nd	0.02	
Antimony	0.002	mg/L	nd	nd	nd	nd	
Arsenic	0.002	mg/L	nd	nd	nd	nd	
Barium	0.005	mg/L	nd	nd	nd	nd	
Beryllium	0.005	mg/L	nd	nd	nd	nd	
Bismuth	0.002	mg/L	nd	nd	nd	nd	
Cadmium	0.0005	mg/L	nd	nd	nd	nd	
Chromium	0.002	mg/L	nd	nd	nd	nd	
Cobalt	0.001	mg/L	nd	nd	nd	nd	
Copper	0.002	mg/L	0.088	0.089	nd	0.084	
Lead	0.0001	mg/L	nd	nd	nd	0.0009	
Manganese	0.002	mg/L	nd	nd	nd	nd	

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	Sampler Blank [tot.] 96/09/09	Sampler Blank [tot.] Replicate	Travel\Filter B. [t] 96/09/09	Travel\Filter Blank 96/09/09	
Molybdenum	0.002	mg/L	nd	nd	nd	nd	
Nickel	0.002	mg/L	0.006	0.006	nd	0.009	
Selenium	0.002	mg/L	nd	nd	nd	nd	
Silver	0.0003	mg/L	nd	nd	nd	nd	
Strontium	0.005	mg/L	nd	nd	nd	nd	
Thallium	0.0001	mg/L	nd	nd	nd	nd	
Tin	0.002	mg/L	nd	nd	nd	nd	
Titanium	0.002	mg/L	nd	nd	nd	nd	
Uranium	0.0001	mg/L	nd	nd	nd	0.0001	
Vanadium	0.002	mg/L	nd	nd	nd	nd	
Anion Sum	na	meq/L	-	-	-	0.001	
Bicarbonate(as CaCO3, calculated)	1	mg/L	-	-	-	nd	
Carbonate(as CaCO3, calculated)	1	mg/L	-	-	-	nd	
Cation Sum	na	meq/L	-	-	-	0.001	
Colour	5	TCU	-	-	-	nd	
Conductivity - @25°C	1	us/cm	-	-	-	nd	
Hardness(as CaCO3)	0.1	mg/L	-	-	-	nd	
Ion Balance	0.01	%	-	-	-	26.4	
Langelier Index at 20°C	na	na	-	-	-	-7.48	
Langelier Index at 4°C	na	na	-	-	-	-7.88	
pH	0.1	Units	-	-	-	7.2	
Saturation pH at 20°C	na	units	-	-	-	14.7	
Saturation pH at 4°C	na	units	-	-	-	15.1	
Total Dissolved Solids(Calculated)	1	mg/L	-	-	-	nd	
Turbidity	0.1	NTU	-	-	-	nd	
Mercury	0.1	ug/L	-	-	-	nd	
Cyanide, Free	0.002	mg/L	-	-	-	nd	

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
na = Not Applicable
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: October 15/96
MDS Ref # : 966496
MDS Quote #: 96-697-GS
Client PO#: 5693
Client Ref#: G96239

Analysis of Water

Parameter / Date Sampled >	LOQ	Units	Sampler Blank [tot.] 96/09/09	Sampler Blank [tot.] Replicate	Travel\Filter B. [t] 96/09/09	Travel\Filter Blank 96/09/09	
Cyanide, Total	0.002	mg/L	-	-	-	nd	
Ammonia(as N)	0.05	mg/L	-	-	-	nd	
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	-	-	-	0.40	
Dissolved Inorganic Carbon(as C)	0.5	mg/L	-		-	nd	
Dissolved Organic Carbon(DOC)	0.5	mg/L	-	-	-	0.5	

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 28/96
MDS Ref # : 967332
MDS Quote#: 96-697-GS

Client Ref#: G96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Alkalinity(as CaCO3)	na	1	mg/L	nd(b)	2	yes	91	87	113	yes	na	na	na	na	na	yes
Chloride	na	1	mg/L	nd(b)	2	yes	110	90	113	yes	na	na	na	na	na	yes
Nitrate(as N)	Dome Effl.	0.05	mg/L	nd(b)	0.1	yes	109	88	114	yes	0.27	0.30	0.18	0.42	yes	yes
Nitrite(as N)	na	0.01	mg/L	nd(b)	0.03	yes	85	80	116	yes	na	na	na	na	na	yes
Orthophosphate(as P)	na	0.01	mg/L	nd(b)	0.03	yes	102	90	110	yes	na	na	na	na	na	yes
Sulphate	na	2	mg/L	nd(b)	3	yes	101	90	113	yes	na	na	na	na	na	yes
Boron	Dome Effl. [total]	0.005	mg/L	nd(b)	0.02	yes	103	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Calcium	Dome Effl. [total]	0.1	mg/L	nd(b)	0.2	yes	97	85	115	yes	*	*	*	*	*	yes
Iron	Dome Effl. [total]	0.02	mg/L	nd(b)	0.03	yes	99	85	115	yes	0.98	1.00	0.60	1.40	yes	yes
Magnesium	Dome Effl. [total]	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	0.8	1.0	0.2	1.6	yes	yes
Phosphorus	Dome Effl. [total]	0.1	mg/L	nd(b)	0.2	yes	95	85	115	yes	0.9	1.0	0.4	1.6	yes	yes
Potassium	Dome Effl. [total]	0.5	mg/L	nd(b)	1.0	yes	90	85	115	yes	3.5	5.0	1.0	8.0	yes	yes
Sodium	Dome Effl. [total]	0.1	mg/L	nd(b)	0.2	yes	98	85	115	yes	*	*	*	*	*	yes
Zinc	Dome Effl. [total]	0.002	mg/L	nd(b)	0.02	yes	100	85	115	yes	0.971	1.00	0.60	1.40	yes	yes
Reactive Silica(SiO2)	na	0.5	mg/L	nd(b)	1.0	yes	99	80	120	yes	na	na	na	na	na	yes
Aluminum	Dome Effl. [total]	0.01	mg/L	nd(b)	0.03	yes	97	85	115	yes	0.09	0.100	0.050	0.140	yes	yes
Antimony	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	104	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Arsenic	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Barium	Dome Effl. [total]	0.005	mg/L	nd(b)	0.01	yes	109	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Beryllium	Dome Effl. [total]	0.005	mg/L	nd(b)	0.01	yes	106	85	115	yes	0.105	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 28/96
MDS Ref # : 967332
MDS Quote#: 96-697-GS

Analysis of Water

Client Ref#: G96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Bismuth	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	104	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Cadmium	Dome Effl. [total]	0.0005	mg/L	nd(b)	0.0010	yes	109	85	115	yes	0.1010	0.100	0.050	0.140	yes	yes
Chromium	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Cobalt	Dome Effl. [total]	0.001	mg/L	nd(b)	0.002	yes	108	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Copper	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.099	0.100	0.050	0.140	yes	yes
Lead	Dome Effl. [total]	0.0001	mg/L	0.0003(b)	0.002	yes	105	85	115	yes	0.1020	0.100	0.050	0.140	yes	yes
Manganese	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Molybdenum	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Nickel	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Selenium	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.096	0.100	0.050	0.140	yes	yes
Silver	Dome Effl. [total]	0.0003	mg/L	nd(b)	0.0006	yes	101	85	115	yes	0.0987	0.100	0.050	0.140	yes	yes
Strontium	Dome Effl. [total]	0.005	mg/L	nd(b)	0.01	yes	110	85	115	yes	0.098	0.100	0.050	0.140	yes	yes
Thallium	Dome Effl. [total]	0.0001	mg/L	nd(b)	0.0002	yes	105	85	115	yes	0.1020	0.100	0.050	0.140	yes	yes
Tin	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Titanium	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Uranium	Dome Effl. [total]	0.0001	mg/L	nd(b)	0.0002	yes	106	85	115	yes	0.1020	0.100	0.050	0.140	yes	yes
Vanadium	Dome Effl. [total]	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.102	0.100	0.050	0.140	yes	yes
Colour	na	5	TCU	na(b)	na	na	96	85	115	yes	na	na	na	na	na	yes
Conductivity - @25°C	na	1	us/cm	na(b)	na	na	100	91	109	yes	na	na	na	na	na	yes
pH	na	0.1	Units	na(b)	na	na	100	98	102	yes	na	na	na	na	na	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
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na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 28/96
MDS Ref # : 967332
MDS Quote#: 96-697-GS

Client Ref#: G96239

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Turbidity	na	0.1	NTU	na(b)	na	na	96	81	129	yes	na	na	na	na	na	yes
Mercury	na	0.1	ug/L	nd	0.2	yes	106	79	120	yes	na	na	na	na	na	yes
Cyanide, Free	na	0.002	mg/L	nd	0.004	yes	84	77	127	yes	na	na	na	na	na	yes
Ammonia(as N)	na	0.05	mg/L	nd	0.1	yes	94	79	119	yes	na	na	na	na	na	yes
Total Kjeldahl Nitrogen(as N)	na	0.05	mg/L	0.09	0.1	yes	109	77	122	yes	na	na	na	na	na	yes
Dissolved Inorganic Carbon(as C)	na	0.5	mg/L	nd	1.0	yes	na	na	na	na	na	na	na	na	na	yes
Dissolved Organic Carbon(DOC)	na	0.5	mg/L	nd	1.0	yes	104	80	116	yes	na	na	na	na	na	yes
Total Suspended Solids	na	5	mg/L	nd	2	yes	100	82	118	yes	na	na	na	na	na	yes
Cyanide, Total	na	0.005	mg/L	nd	0.010	yes	100	82	115	yes	na	na	na	na	na	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 28/96
MDS Ref # : 967332
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: G96239

Parameter / Date Sampled >	LOQ	Units	Dome Effl. 96/10/16	Dome Effl. Replicate	Dome Effl. [total] 96/10/16	Dome Effl. [total] Replicate	
Alkalinity(as CaCO3)	1	mg/L	33	33	-	-	
Chloride	1	mg/L	40	40	-	-	
Nitrate(as N)	0.05	mg/L	3.99	3.99	-	-	
Nitrite(as N)	0.01	mg/L	0.19	0.19	-	-	
Orthophosphate(as P)	0.01	mg/L	0.28	0.28	-	-	
Sulphate	2	mg/L	318	318	-	-	
Boron	0.005	mg/L	0.201	-	0.198	0.200	
Calcium	0.1	mg/L	46.3	-	44.5	44.8	
Iron	0.02	mg/L	0.04	-	0.08	0.07	
Magnesium	0.1	mg/L	4.6	-	4.3	4.3	
Phosphorus	0.1	mg/L	nd	-	nd	nd	
Potassium	0.5	mg/L	29.3	-	28.6	29.8	
Reactive Silica(SiO2)	0.5	mg/L	nd	nd	-	-	
Sodium	0.1	mg/L	102	-	100	101	
Zinc	0.002	mg/L	0.016	-	nd	nd	
Aluminum	0.01	mg/L	0.02	-	0.03	0.02	
Antimony	0.002	mg/L	nd	-	nd	nd	
Arsenic	0.002	mg/L	nd	-	nd	nd	
Barium	0.005	mg/L	nd	-	nd	nd	
Beryllium	0.005	mg/L	nd	-	nd	nd	
Bismuth	0.002	mg/L	nd	-	nd	nd	
Cadmium	0.0005	mg/L	nd	-	nd	nd	
Chromium	0.002	mg/L	0.002	-	nd	nd	
Cobalt	0.001	mg/L	0.119	-	0.118	0.121	
Copper	0.002	mg/L	0.069	-	0.063	0.064	
Lead	0.0001	mg/L	0.0049	-	0.0050	0.0047	
Manganese	0.002	mg/L	0.004	-	0.003	0.003	

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 28/96
MDS Ref # : 967332
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: G96239

Parameter / Date Sampled >	LOQ	Units	Dome Effl. 96/10/16	Dome Effl. Replicate	Dome Effl. [total] 96/10/16	Dome Effl. [total] Replicate	
Molybdenum	0.002	mg/L	0.027	-	0.028	0.027	
Nickel	0.002	mg/L	0.029	-	0.029	0.030	
Selenium	0.002	mg/L	nd	-	nd	nd	
Silver	0.0003	mg/L	0.0013	-	0.0012	0.0013	
Strontium	0.005	mg/L	0.141	-	0.129	0.130	
Thallium	0.0001	mg/L	nd	-	nd	nd	
Tin	0.002	mg/L	nd	-	nd	nd	
Titanium	0.002	mg/L	nd	-	nd	nd	
Uranium	0.0001	mg/L	nd	-	nd	nd	
Vanadium	0.002	mg/L	nd	-	nd	nd	
Anion Sum	na	meq/L	8.71	-	-	-	
Bicarbonate(as CaCO3, calculated)	1	mg/L	30	-	-	-	
Carbonate(as CaCO3, calculated)	1	mg/L	2	-	-	-	
Cation Sum	na	meq/L	8.83	-	-	-	
Colour	5	TCU	nd	nd	-	-	
Conductivity - @25°C	1	us/cm	897	900	-	-	
Hardness(as CaCO3)	0.1	mg/L	135	-	-	-	
Ion Balance	0.01	%	0.65	-	-	-	
Langelier Index at 20°C	na	na	0.595	-	-	-	
Langelier Index at 4°C	na	na	0.195	-	-	-	
pH	0.1	Units	8.9	8.4	-	-	
Saturation pH at 20°C	na	units	8.32	-	-	-	
Saturation pH at 4°C	na	units	8.72	-	-	-	
Total Dissolved Solids(Calculated)	1	mg/L	596	-	-	-	
Turbidity	0.1	NTU	nd	nd	-	-	
Mercury	0.1	ug/L	nd	-	nd	-	
Cyanide, Free	0.002	mg/L	0.076	-	-	-	

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 28/96
MDS Ref # : 967332
MDS Quote #: 96-697-GS

Analysis of Water

Client Ref#: G96239

Parameter / Date Sampled >	LOQ	Units	Dome Effl. 96/10/16	Dome Effl. Replicate	Dome Effl. [total] 96/10/16	Dome Effl. [total] Replicate	
Ammonia(as N)	0.05	mg/L	13.4	-	-	-	
Total Kjeldahl Nitrogen(as N)	0.05	mg/L	15.0	-	-	-	
Dissolved Inorganic Carbon(as C)	0.5	mg/L	8.9	-	-	-	
Dissolved Organic Carbon(DOC)	0.5	mg/L	3.5	-	-	-	
Total Suspended Solids	5	mg/L	nd	-	-	-	
Cyanide, Total	0.005	mg/L	0.119	-	-	-	

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
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MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: November 21/96
MDS Ref # : 968374
MDS Quote#: CANMET Investig

Client Ref#: 96239-QA/QC

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Boron	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.02	yes	98	85	115	yes	0.980	1.00	0.60	1.40	yes	yes
Calcium	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	99	85	115	yes	1.0	1.0	0.2	1.8	yes	yes
Iron	Q5 FILTRAT E	0.02	mg/L	nd(b)	0.03	yes	96	85	115	yes	1.00	1.00	0.60	1.40	yes	yes
Magnesium	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	1.0	1.0	0.2	1.6	yes	yes
Phosphorus	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	94	85	115	yes	0.8	1.0	0.4	1.6	yes	yes
Potassium	Q5 FILTRAT E	0.5	mg/L	nd(b)	1.0	yes	106	85	115	yes	4.5	5.0	1.0	8.0	yes	yes
Sodium	Q5 FILTRAT E	0.1	mg/L	0.1(b)	0.2	yes	91	85	115	yes	0.9	1.0	0.2	1.6	yes	yes
Zinc	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.02	yes	97	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Aluminum	Q5 FILTRAT E	0.01	mg/L	nd(b)	0.03	yes	91	85	115	yes	0.12	0.100	0.050	0.140	yes	yes
Antimony	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	102	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Arsenic	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.091	0.100	0.050	0.140	yes	yes
Barium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	99	85	115	yes	0.110	0.100	0.050	0.140	yes	yes
Beryllium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	104	85	115	yes	0.112	0.100	0.050	0.140	yes	yes
Bismuth	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Cadmium	Q5 FILTRAT E	0.0005	mg/L	nd(b)	0.0010	yes	106	85	115	yes	0.0985	0.100	0.050	0.140	yes	yes
Chromium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	94	85	115	yes	0.054	0.100	0.050	0.140	yes	yes
Cobalt	Q5 FILTRAT E	0.001	mg/L	nd(b)	0.002	yes	104	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Copper	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Lead	Q5 FILTRAT E	0.0001	mg/L	nd(b)	0.002	yes	91	85	115	yes	0.0902	0.100	0.050	0.140	yes	yes
Manganese	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.099	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
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na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: November 21/96
MDS Ref # : 968374
MDS Quote#: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

				Process Blank			Process % Recovery				Matrix Spike					Overall QC
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	Acceptable
Molybdenum	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.096	0.100	0.050	0.140	yes	yes
Nickel	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	103	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Selenium	Q5 FILTRAT E	0.002	mg/L	0.004(b	0.004	yes	111	85	115	yes	0.085	0.100	0.050	0.140	yes	yes
Silver	Q5 FILTRAT E	0.0003	mg/L	nd(b)	0.0006	yes	94	85	115	yes	0.0672	0.100	0.050	0.140	yes	yes
Strontium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	112	85	115	yes	0.090	0.100	0.050	0.140	yes	yes
Thallium	Q5 FILTRAT E	0.0001	mg/L	0.0002(	0.0002	yes	101	85	115	yes	0.1010	0.100	0.050	0.140	yes	yes
Tin	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.099	0.100	0.050	0.140	yes	yes
Titanium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.103	0.100	0.050	0.140	yes	yes
Uranium	Q5 FILTRAT E	0.0001	mg/L	nd(b)	0.0002	yes	102	85	115	yes	0.0993	0.100	0.050	0.140	yes	yes
Vanadium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.104	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter / Date Sampled >	LOQ	Units	Q1 96/11/08	Q2 96/11/08	Q3 96/11/08	Q4 FILTRATE	Q5 FILTRATE
Boron	0.005	mg/L	nd	nd	0.005	nd	nd
Calcium	0.1	mg/L	1.4	0.4	2.1	3.4	3.6
Iron	0.02	mg/L	nd	nd	nd	0.21	0.21
Magnesium	0.1	mg/L	nd	nd	nd	0.5	0.5
Phosphorus	0.1	mg/L	nd	nd	nd	nd	nd
Potassium	0.5	mg/L	nd	nd	nd	1.1	nd
Sodium	0.1	mg/L	nd	nd	nd	1.3	1.3
Zinc	0.002	mg/L	0.018	0.019	0.042	0.021	0.035
Aluminum	0.01	mg/L	nd	nd	nd	0.08	0.08
Antimony	0.002	mg/L	nd	nd	nd	nd	nd
Arsenic	0.002	mg/L	nd	nd	nd	nd	nd
Barium	0.005	mg/L	nd	nd	nd	0.008	0.008
Beryllium	0.005	mg/L	nd	nd	nd	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	nd
Chromium	0.002	mg/L	nd	nd	nd	nd	nd
Cobalt	0.001	mg/L	nd	nd	nd	nd	nd
Copper	0.002	mg/L	0.101	0.098	nd	0.036	0.025
Lead	0.0001	mg/L	nd	nd	nd	nd	nd
Manganese	0.002	mg/L	nd	nd	nd	0.004	0.004
Molybdenum	0.002	mg/L	nd	nd	nd	nd	nd
Nickel	0.002	mg/L	0.019	0.018	nd	nd	nd
Selenium	0.002	mg/L	nd	nd	nd	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	nd
Strontium	0.005	mg/L	nd	nd	nd	0.015	0.016
Thallium	0.0001	mg/L	nd	nd	nd	nd	nd
Tin	0.002	mg/L	nd	nd	nd	nd	nd

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Report Date: November 21/96
MDS Ref # : 968374
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Analysis of Water

Client Ref#: 96239-QA/QC

Parameter / Date Sampled >	LOQ	Units	Q1 96/11/08	Q2 96/11/08	Q3 96/11/08	Q4 FILTRATE	Q5 FILTRATE
Titanium	0.002	mg/L	nd	nd	nd	nd	nd
Uranium	0.0001	mg/L	nd	nd	nd	0.0005	0.0005
Vanadium	0.002	mg/L	nd	nd	nd	nd	nd

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Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter	LOQ	Units	Q5 FILTRATE Replicate	Q6 96/11/08			
Boron	0.005	mg/L	nd	nd			
Calcium	0.1	mg/L	3.5	8.0			
Iron	0.02	mg/L	0.21	nd			
Magnesium	0.1	mg/L	0.5	0.5			
Phosphorus	0.1	mg/L	nd	nd			
Potassium	0.5	mg/L	1.2	1.7			
Sodium	0.1	mg/L	1.3	1.0			
Zinc	0.002	mg/L	0.033	0.410			
Aluminum	0.01	mg/L	0.07	nd			
Antimony	0.002	mg/L	nd	nd			
Arsenic	0.002	mg/L	nd	nd			
Barium	0.005	mg/L	0.008	nd			
Beryllium	0.005	mg/L	nd	nd			
Bismuth	0.002	mg/L	nd	nd			
Cadmium	0.0005	mg/L	nd	nd			
Chromium	0.002	mg/L	nd	nd			
Cobalt	0.001	mg/L	nd	nd			
Copper	0.002	mg/L	0.024	nd			
Lead	0.0001	mg/L	nd	nd			
Manganese	0.002	mg/L	0.003	nd			
Molybdenum	0.002	mg/L	nd	nd			
Nickel	0.002	mg/L	nd	nd			
Selenium	0.002	mg/L	nd	nd			
Silver	0.0003	mg/L	nd	nd			
Strontium	0.005	mg/L	0.015	0.007			
Thallium	0.0001	mg/L	nd	nd			
Tin	0.002	mg/L	nd	nd			

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter	LOQ	Units	Q5 FILTRATE Replicate	Q6 96/11/08			
Titanium	0.002	mg/L	nd	0.003			
Uranium	0.0001	mg/L	0.0004	nd			
Vanadium	0.002	mg/L	nd	nd			

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
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November 8, 1996

In house QA/QC of our lab supplies used in the field.

Client I.D.#	Description
Q1	Store bought "Equality" distilled water
Q2	5% Nitric Acid solution made with original Nitric acid in the lab and the store bought "Equality" distilled water.
Q3	Milli 9 Water (Millipore "Milli 9" system-deionized water feed) University of Waterloo
Q4	One filter moistened with the above 5% Nitric Acid as done in the field and then removed with forceps (as should have been done in the field) and placed in Whirl pak bag
Q5	Two filters moistened with the above 5% nitric acid as done in the field and removed with gloves and placed in Whirl pak bag
Q6	Glove dipped in Milli 9 distilled water from the University of Waterloo

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: November 21/96
MDS Ref # : 968374
MDS Quote#: CANMET Investig

Client Ref#: 96239-QA/QC

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Boron	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.02	yes	98	85	115	yes	0.980	1.00	0.60	1.40	yes	yes
Calcium	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	99	85	115	yes	1.0	1.0	0.2	1.8	yes	yes
Iron	Q5 FILTRAT E	0.02	mg/L	nd(b)	0.03	yes	96	85	115	yes	1.00	1.00	0.60	1.40	yes	yes
Magnesium	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	102	85	115	yes	1.0	1.0	0.2	1.6	yes	yes
Phosphorus	Q5 FILTRAT E	0.1	mg/L	nd(b)	0.2	yes	94	85	115	yes	0.8	1.0	0.4	1.6	yes	yes
Potassium	Q5 FILTRAT E	0.5	mg/L	nd(b)	1.0	yes	106	85	115	yes	4.5	5.0	1.0	8.0	yes	yes
Sodium	Q5 FILTRAT E	0.1	mg/L	0.1(b)	0.2	yes	91	85	115	yes	0.9	1.0	0.2	1.6	yes	yes
Zinc	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.02	yes	97	85	115	yes	1.02	1.00	0.60	1.40	yes	yes
Aluminum	Q5 FILTRAT E	0.01	mg/L	nd(b)	0.03	yes	91	85	115	yes	0.12	0.100	0.050	0.140	yes	yes
Antimony	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	102	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Arsenic	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.091	0.100	0.050	0.140	yes	yes
Barium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	99	85	115	yes	0.110	0.100	0.050	0.140	yes	yes
Beryllium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	104	85	115	yes	0.112	0.100	0.050	0.140	yes	yes
Bismuth	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.101	0.100	0.050	0.140	yes	yes
Cadmium	Q5 FILTRAT E	0.0005	mg/L	nd(b)	0.0010	yes	106	85	115	yes	0.0985	0.100	0.050	0.140	yes	yes
Chromium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	94	85	115	yes	0.054	0.100	0.050	0.140	yes	yes
Cobalt	Q5 FILTRAT E	0.001	mg/L	nd(b)	0.002	yes	104	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Copper	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.104	0.100	0.050	0.140	yes	yes
Lead	Q5 FILTRAT E	0.0001	mg/L	nd(b)	0.002	yes	91	85	115	yes	0.0902	0.100	0.050	0.140	yes	yes
Manganese	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	107	85	115	yes	0.099	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Date Reported: November 21/96
MDS Ref # : 968374
MDS Quote#: CANMET Investig

Client Ref#: 96239-QA/QC

Analysis of Water

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Molybdenum	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	109	85	115	yes	0.096	0.100	0.050	0.140	yes	yes
Nickel	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	103	85	115	yes	0.100	0.100	0.050	0.140	yes	yes
Selenium	Q5 FILTRAT E	0.002	mg/L	0.004(b	0.004	yes	111	85	115	yes	0.085	0.100	0.050	0.140	yes	yes
Silver	Q5 FILTRAT E	0.0003	mg/L	nd(b)	0.0006	yes	94	85	115	yes	0.0672	0.100	0.050	0.140	yes	yes
Strontium	Q5 FILTRAT E	0.005	mg/L	nd(b)	0.01	yes	112	85	115	yes	0.090	0.100	0.050	0.140	yes	yes
Thallium	Q5 FILTRAT E	0.0001	mg/L	0.0002(	0.0002	yes	101	85	115	yes	0.1010	0.100	0.050	0.140	yes	yes
Tin	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	100	85	115	yes	0.099	0.100	0.050	0.140	yes	yes
Titanium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	105	85	115	yes	0.103	0.100	0.050	0.140	yes	yes
Uranium	Q5 FILTRAT E	0.0001	mg/L	nd(b)	0.0002	yes	102	85	115	yes	0.0993	0.100	0.050	0.140	yes	yes
Vanadium	Q5 FILTRAT E	0.002	mg/L	nd(b)	0.004	yes	106	85	115	yes	0.104	0.100	0.050	0.140	yes	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter / Date Sampled >	LOQ	Units	Q1 96/11/08	Q2 96/11/08	Q3 96/11/08	Q4 FILTRATE	Q5 FILTRATE
Boron	0.005	mg/L	nd	nd	0.005	nd	nd
Calcium	0.1	mg/L	1.4	0.4	2.1	3.4	3.6
Iron	0.02	mg/L	nd	nd	nd	0.21	0.21
Magnesium	0.1	mg/L	nd	nd	nd	0.5	0.5
Phosphorus	0.1	mg/L	nd	nd	nd	nd	nd
Potassium	0.5	mg/L	nd	nd	nd	1.1	nd
Sodium	0.1	mg/L	nd	nd	nd	1.3	1.3
Zinc	0.002	mg/L	0.018	0.019	0.042	0.021	0.035
Aluminum	0.01	mg/L	nd	nd	nd	0.08	0.08
Antimony	0.002	mg/L	nd	nd	nd	nd	nd
Arsenic	0.002	mg/L	nd	nd	nd	nd	nd
Barium	0.005	mg/L	nd	nd	nd	0.008	0.008
Beryllium	0.005	mg/L	nd	nd	nd	nd	nd
Bismuth	0.002	mg/L	nd	nd	nd	nd	nd
Cadmium	0.0005	mg/L	nd	nd	nd	nd	nd
Chromium	0.002	mg/L	nd	nd	nd	nd	nd
Cobalt	0.001	mg/L	nd	nd	nd	nd	nd
Copper	0.002	mg/L	0.101	0.098	nd	0.036	0.025
Lead	0.0001	mg/L	nd	nd	nd	nd	nd
Manganese	0.002	mg/L	nd	nd	nd	0.004	0.004
Molybdenum	0.002	mg/L	nd	nd	nd	nd	nd
Nickel	0.002	mg/L	0.019	0.018	nd	nd	nd
Selenium	0.002	mg/L	nd	nd	nd	nd	nd
Silver	0.0003	mg/L	nd	nd	nd	nd	nd
Strontium	0.005	mg/L	nd	nd	nd	0.015	0.016
Thallium	0.0001	mg/L	nd	nd	nd	nd	nd
Tin	0.002	mg/L	nd	nd	nd	nd	nd

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
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Analysis of Water

Client Ref#: 96239-QA/QC

Parameter / Date Sampled >	LOQ	Units	Q1 96/11/08	Q2 96/11/08	Q3 96/11/08	Q4 FILTRATE	Q5 FILTRATE
Titanium	0.002	mg/L	nd	nd	nd	nd	nd
Uranium	0.0001	mg/L	nd	nd	nd	0.0005	0.0005
Vanadium	0.002	mg/L	nd	nd	nd	nd	nd

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter	LOQ	Units	Q5 FILTRATE Replicate	Q6 96/11/08			
Boron	0.005	mg/L	nd	nd			
Calcium	0.1	mg/L	3.5	8.0			
Iron	0.02	mg/L	0.21	nd			
Magnesium	0.1	mg/L	0.5	0.5			
Phosphorus	0.1	mg/L	nd	nd			
Potassium	0.5	mg/L	1.2	1.7			
Sodium	0.1	mg/L	1.3	1.0			
Zinc	0.002	mg/L	0.033	0.410			
Aluminum	0.01	mg/L	0.07	nd			
Antimony	0.002	mg/L	nd	nd			
Arsenic	0.002	mg/L	nd	nd			
Barium	0.005	mg/L	0.008	nd			
Beryllium	0.005	mg/L	nd	nd			
Bismuth	0.002	mg/L	nd	nd			
Cadmium	0.0005	mg/L	nd	nd			
Chromium	0.002	mg/L	nd	nd			
Cobalt	0.001	mg/L	nd	nd			
Copper	0.002	mg/L	0.024	nd			
Lead	0.0001	mg/L	nd	nd			
Manganese	0.002	mg/L	0.003	nd			
Molybdenum	0.002	mg/L	nd	nd			
Nickel	0.002	mg/L	nd	nd			
Selenium	0.002	mg/L	nd	nd			
Silver	0.0003	mg/L	nd	nd			
Strontium	0.005	mg/L	0.015	0.007			
Thallium	0.0001	mg/L	nd	nd			
Tin	0.002	mg/L	nd	nd			

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

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MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Chris Wren, PhD.

Report Date: November 21/96
MDS Ref # : 968374
MDS Quote #: CANMET Investig

Analysis of Water

Client Ref#: 96239-QA/QC

Parameter	LOQ	Units	Q5 FILTRATE Replicate	Q6 96/11/08			
Titanium	0.002	mg/L	nd	0.003			
Uranium	0.0001	mg/L	0.0004	nd			
Vanadium	0.002	mg/L	nd	nd			

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS
Environmental Services Limited

November 21, 1996

Mr. Chris Wren
Ecological Services for Planning
361 Southgate Drive
Guelph, Ontario
N1G 3M5

Dear Chris:

Attached is the data for the water and filter samples for QC checks on the Canmet project. As agreed, there is no charge for these tests. A few comments on the data:

1.0 The samples were analyzed using cleaned and proofed glassware. All glassware was pre-cleaned (as it was for the original Canmet projects from ESP, EVS, and Jacques Whitford) and the final pure water rinse solutions were analyzed as our lab blanks (reported in the "Certificate of Quality Control" as "Process Blank").

2.0 The water used by MDSE was Type 1 ASTM 18 megaohm water, which is the cleanest available water we have been able to source.

3.0 All samples were analyzed by ICP-MS and ICP-ES. The results for boron to zinc (the first eight elements) are reported from the ICP-ES data. The remainder are from ICP-MS. The data are very comparable for both ES and MS for all samples, all parameters.

4.0 The filters were wet on arrival at MDSE; we assume this means they had been pre-washed/rinsed.

5.0 The filters were analyzed as follows:

- 50 ml of pure water was put through each filter.
- The filtrate (50 ml) was analyzed by ICP-MS and ICP-ES.
- The data reported is for the water. To obtain the mass loading on the filters, multiply the result by 50 ml. For example, for Q4, the Ca level is 3.4 mg/L, therefore there were 50 ml x 3.4 mg/L = 170.0 mg of Ca removed by 50 ml of water from the filter.

6.0 Sample Q5 had two filters; we used one for the sample and the other as a replicate.

6859 Glenway Drive, Mississauga, Ontario, Canada L4V 1P1
Tel: 905•673•3255 Fax: 905•673•7399 Toll Free: 1•800•701•7092

7.0 The filters contain some metals residues. The pattern of Ca, Mg, Ba, Sr, Na, and K, and of Fe, Al, Zn, Cu, and Mn is consistent with the background of metals in glass fibre filters.

8.0 The filter data show some variation, which is also consistent with our experience with most available filter media.

9.0 The water samples show some metals that one would not expect in a high quality grade of lab water. The presence of Cu and Ni is unusual.

10.0 All of these samples were analyzed by both ICP-ES and ICP-MS. The positive results for the metals are corroborated and confirmed.

Chris, I hope these comments are helpful, and that the data helps you interpret the earlier results. If I can assist in any way, please let me know.

Yours very truly,

J.N. Bishop
Vice President
New Business Development

JNB/no

6835 Goreway Drive, Mississauga, Ontario, Canada L4V 1P1
Tel: 905•673•3255 Fax: 905•673•7399 Toll Free: 1•800•701•7092

APPENDIX C3

Results

Legend of codes and symbols for water and sediment quality data	
LOQ	Limit of Quantification
+	Guideline for the protection of freshwater aquatic life (where available)
*	Interim Ontario Provincial Water Quality Objective
**	ammonia concentration at pH 7.5 and 20°C
nd	not detected at LOQ (n.b. for statistics, nd converted to ½ LOQ)
na	not applicable/not available
-	not requested
TKN	Total Kjeldahl Nitrogen
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
NCALC	Not Calculated

Table C3-1: General Water Chemistry Analyses of Samples Collected From Reference and Exposure Areas at Dome Mine (all units mg/L unless otherwise indicated)

Parameter	LOQ	Reference Stations								Exposure Stations								Field Blank
		MAC 1	MAC 2	MAC 3	Van Dorn Sampler Blank	Van Dorn Sampler Blank Lab Replicate	REF 1	REF 4	REF 6	EXP 1 E. on	EXP 1 E. on Field Replicate	EXP 1 E. on Lab Replicate	EXP 2 E. on	EXP 3 E. on	EXP 1 E. off	EXP 2 E. off	EXP 3 E. off	
Nitrate	0.05	nd	nd	nd	nd	nd	nd	nd	0.12	0.57	0.6	0.58	0.52	0.44	0.38	0.25	0.21	nd
Nitrite	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ammonia	0.05	nd	nd	nd	nd	-	nd	nd	nd	4.29	4.27	-	3.37	3.58	3.72	2.91	2.65	nd
TKN	0.05	0.54	0.55	0.53	0.4	-	0.76	1.06	0.76	4.59	4.54	-	4.13	4.06	3.98	3.44	3.28	nd
Phosphorus	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Orthophosphate	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total Phosphorus	0.004	-	-	-	-	-	-	-	-	0.024	0.023	-	0.026	0.026	0.03	0.026	0.027	-
Alkalinity	1	121	103	115	nd	nd	186	186	195	102	106	105	106	111	111	137	134	nd
Chloride	1	26	24	25	nd	nd	37	39	38	34	33	34	34	34	33	32	32	nd
Sulphate	2	8	7	8	nd	nd	16	15	15	247	244	247	240	230	229	205	192	nd
Bicarbonate	1	121	103	115	nd	nd	186	186	195	102	106	-	106	111	111	136	134	nd
Carbonate	1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	nd	nd	nd	nd	nd	nd
Colour (TCU)	5	12	11	10	nd	nd	24	27	25	27	23	27	22	24	27	30	31	nd
Conductivity (us/cm)	1	307	215	293	2	2	359	417	470	798	796	800	771	759	764	745	729	nd
Hardness	0.1	159	122	130	0.1	0.2	222	221	221	208	208	-	218	217	217	221	220	nd
Turbidity	0.1	0.3	0.2	0.1	nd	nd	0.6	0.7	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	nd
Anion Sum (meq/L)	na	3.33	2.88	3.15	0.004	0.008	5.1	5.13	5.29	8.18	8.18	-	8.1	7.98	7.94	7.91	7.59	0.001
Cation Sum (meq/L)	na	3.53	3.12	3.31	0.003	NCALC	5.5	5.56	5.52	8.62	8.64	-	8.74	8.7	8.63	8.53	8.43	0.001
Ion Balance	0.01	2.96	3.94	2.43	18.4	NCALC	3.78	3.95	2.18	2.66	2.73	-	3.79	4.27	4.17	3.73	5.23	26.4
pH (units)	0.1	6.8	7.2	7.5	7.4	7.4	7.4	7.4	7.4	7.5	7.5	7.6	7.5	7.5	7.5	7.7	7.6	7.2
DIC	0.5	26.3	23.5	24.1	0.6	-	42.7	42.7	44.1	27.8	29.3	-	29.8	31.1	32	35.8	37.5	nd
DOC	0.5	6.3	6	5.9	1.8	-	8.4	8.3	8.2	6.1	6.2	-	5.9	6.6	6.7	8.5	8.5	0.5
TDS	1	178	155	168	nd	NCALC	276	279	283	537	536	-	534	526	522	509	493	nd
TSS	5	-	-	-	-	-	-	-	-	nd	nd	-	nd	nd	nd	nd	nd	-

Table C3-2: Total Metals (mg/L) in Water Chemistry Samples Collected from Reference and Exposure Areas at Dome Mine

		Reference Stations								Exposure Stations								Travel
Metal (mg/L)	LOQ	MAC 1	MAC 2	MAC 3	Van Dorn Sampler Blank	Van Dorn Sampler Blank Lab Replicate	REF 1	REF 4	REF 6	EXP 1 E. on	EXP 1 E. on Field Replicate	EXP 1 E. on Lab Replicate	EXP 2 E. on	EXP 3 E. on	EXP 1 E. off	EXP 2 E. off	EXP 3 E. off	Blank
Aluminum	0.01	nd	0.01	nd	nd	nd	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Antimony	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	0.002	nd	0.002	0.002	nd	nd	0.085	0.064	0.063	0.012	0.012	0.012	0.016	0.018	0.017	0.019	0.024	nd
Barium	0.005	0.008	0.007	0.007	nd	nd	0.014	0.013	0.013	0.028	0.027	0.027	0.028	0.03	0.028	0.027	0.031	nd
Beryllium	0.005	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Bismuth	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Boron	0.005	nd	nd	0.007	nd	nd	0.015	0.01	0.005	0.172	0.176	0.178	0.176	0.179	0.164	0.152	0.162	0.008
Cadmium	0.0005	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Calcium	0.1	40.6	35	37.4	nd	nd	63.2	62.9	63	68.2	68.1	68.8	68.5	70.6	67.2	66.7	71.1	nd
Chromium	0.002	0.003	0.003	0.006	nd	nd	0.007	0.006	0.007	0.005	nd	0.007	nd	nd	nd	nd	nd	nd
Cobalt	0.001	nd	nd	nd	nd	nd	0.001	nd	nd	0.056	0.052	0.064	0.049	0.047	0.044	0.033	0.033	nd
Copper	0.002	nd	0.005	0.002	0.088	0.089	nd	nd	nd	0.013	0.011	0.015	0.012	0.015	0.014	0.018	0.021	nd
Iron	0.02	0.03	0.02	0.02	nd	nd	1.45	1.01	0.96	0.26	0.26	0.28	0.29	0.3	0.36	0.22	0.37	nd
Lead	0.0001	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.0004	nd	nd	0.0004	0.0002	nd
Magnesium	0.1	8.8	7.7	8.1	nd	nd	15.7	15.7	15.7	12.2	12.5	12.9	12.6	13.3	12.8	13.3	14.2	nd
Manganese	0.002	0.019	0.005	0.006	nd	nd	0.31	0.119	0.124	0.302	0.26	0.316	0.369	0.436	0.376	0.399	0.657	nd
Mercury (ug/L)	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	0.002	nd	nd	nd	nd	nd	nd	nd	nd	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.004	nd
Nickel	0.002	nd	nd	0.003	0.006	0.006	0.005	0.007	0.005	0.027	0.023	0.032	0.027	0.032	0.029	0.039	0.044	nd
Potassium	0.5	0.8	1	0.6	nd	nd	1.2	0.7	1.8	25.1	25.7	26.8	25.8	25.5	24.3	23.3	24.7	nd
Reactive Silica	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	nd
Selenium	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Silver	0.0003	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Sodium	0.1	16.5	14.7	15.1	nd	nd	24.4	24.5	24.4	84.3	84.3	86.4	84.8	86.5	80.4	76.3	80.8	nd
Strontium	0.005	0.045	0.041	0.042	nd	nd	0.083	0.081	0.082	0.125	0.128	0.125	0.128	0.132	0.123	0.118	0.128	nd
Thallium	0.0001	nd	nd	nd	nd	nd	0.0002	0.0002	0.0002	nd	0.0001	nd	0.0001	nd	nd	nd	nd	nd
Tin	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Titanium	0.002	nd	nd	nd	nd	nd	nd	nd	0.002	0.019	0.004	0.019	0.004	0.004	0.004	0.004	0.005	nd
Uranium	0.0001	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium	0.002	nd	nd	nd	nd	nd	nd	nd	nd	0.009	nd	0.012	nd	nd	nd	nd	0.002	nd
Zinc	0.002	0.008	0.003	0.007	nd	nd	nd	nd	nd	nd	nd	nd	0.004	0.002	nd	0.004	nd	nd
Total Cyanide	0.002	-	-	-	-	-												-
Free Cyanide	0.002	-	-	-	-	-												-

Table C3-3: Dissolved Metals (mg/L) in Water Chemistry Samples Collected from Reference and Exposure Areas at Dome Mine

		Reference Stations																
Metal (mg/L)	LOQ	MAC 1	MAC 2	MAC 3	Van Dorn Sampler Blank	Van Dorn Sampler Blank Lab Replicate	REF 1	REF 4	REF 6	EXP 1 E. on	EXP 1 E. on Field Replicate	EXP 1 E. on Lab Replicate	EXP 2 E. on	EXP 3 E. on	EXP 1 E. off	EXP 2 E. off	EXP 3 E. off	Filter Blank
Aluminum	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	-	-	0.01	0.01	0.02	0.01	0.01	0.02
Antimony	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Arsenic	0.002	nd	0.002	nd	nd	nd	0.053	0.055	0.057	0.015	-	-	0.02	0.021	0.018	0.024	0.027	nd
Barium	0.005	0.009	0.009	0.009	nd	nd	0.015	0.015	0.015	0.018	-	-	0.019	0.019	0.018	0.019	0.019	nd
Beryllium	0.005	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Bismuth	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Boron	0.005	nd	nd	nd	nd	nd	0.006	0.01	nd	0.148	-	-	0.151	0.15	0.154	0.147	0.143	nd
Cadmium	0.0005	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Calcium	0.1	43.1	37.5	40.3	1.2	1.2	67.2	65.8	65.4	58.5	-	-	59.9	59.8	58.6	59.8	60.8	1.2
Chromium	0.002	0.004	0.003	0.003	nd	nd	0.005	0.005	0.006	nd	-	-	nd	nd	nd	nd	nd	nd
Cobalt	0.001	nd	nd	nd	nd	nd	nd	nd	nd	0.05	-	-	0.047	0.042	0.043	0.032	0.028	nd
Copper	0.002	0.008	0.008	0.008	0.036	0.037	0.006	0.006	0.006	0.015	-	-	0.017	0.017	0.017	0.022	0.022	0.084
Iron	0.02	0.06	0.06	0.04	0.02	0.03	0.73	0.74	0.77	0.22	-	-	0.23	0.22	0.31	0.22	0.24	0.02
Lead	0.0001	0.0004	0.0005	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0004	-	-	0.0001	nd	0.0003	0.0007	0.0016	0.0009
Magnesium	0.1	8.5	7.4	8	0.1	0.1	15.2	14.9	14.7	10.8	-	-	11.2	11.3	11.2	12	12.3	0.2
Manganese	0.002	0.012	0.004	0.004	nd	nd	0.068	0.083	0.12	0.29	-	-	0.391	0.454	0.397	0.432	0.564	nd
Mercury (ug/L)	0.1	nd	nd	nd	nd	-	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Molybdenum	0.002	nd	nd	nd	nd	nd	nd	nd	nd	0.004	-	-	0.004	0.004	0.003	0.003	0.003	nd
Nickel	0.002	0.002	0.002	0.002	0.003	0.003	0.005	0.005	0.005	0.02	-	-	0.025	0.027	0.025	0.032	0.034	0.009
Potassium	0.5	0.7	0.6	0.6	nd	nd	1.1	0.7	1	21.3	-	-	22.3	21.7	21.5	21	20.9	nd
Reactive Silica	0.5	3.2	2.4	2.9	nd	nd	8	8	7.9	5.1	5.1	5.2	5.4	5.6	6.2	6.9	7.1	nd
Silver	0.0003	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Selenium	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Sodium	0.1	17.5	15.8	16.4	0.2	0.2	25.9	25.8	25.2	72.3	-	-	73.3	72.2	70.6	69.2	68.9	0.3
Strontium	0.005	0.048	0.043	0.045	nd	nd	0.085	0.085	0.086	0.152	-	-	0.151	0.152	0.151	0.153	0.151	nd
Thallium	0.0001	0.0002	0.0001	0.0001	nd	nd	0.0001	0.0002	0.0002	nd	-	-	nd	nd	nd	nd	nd	nd
Tin	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Titanium	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Uranium	0.0001	0.0002	0.0002	0.0001	nd	nd	0.0001	0.0001	0.0001	nd	-	-	nd	nd	0.0001	nd	nd	0.0001
Vanadium	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	-	-	nd	nd	nd	nd	nd	nd
Zinc	0.002	0.035	0.054	0.014	0.02	0.017	0.015	0.013	0.026	0.027	-	-	0.008	0.017	0.018	0.013	0.013	0.107
Total Cyanide	0.002	nd	nd	0.002	nd	-	0.002	0.002	nd	0.009	0.007	-	0.007	0.01	0.007	0.007	0.009	nd
Free Cyanide	0.002	nd	nd	0.002	nd	-	0.002	0.002	nd	nd	nd	-	nd	nd	nd	nd	nd	nd

Table C3-4: General Water Chemistry Analysis of Reference Area B Samples Dome Mine Site				
Parameter	LOQ	REF B1	REF B2	REF B3
Nitrate	0.05	nd	nd	nd
Nitrite	0.01	nd	nd	nd
Ammonia	0.05	0.10	0.20	0.21
TKN	0.05	0.79	0.91	0.91
Phosphorus	0.1	nd	nd	nd
Orthophosphate	0.01	nd	nd	nd
Alkalinity	1	259	256	237
Chloride	1	12	12	14
Sulphate	2	58	55	69
Bicarbonate	1	254	252	234
Carbonate	1	5	4	3
Colour (TCU)	5	27	27	36
Conductivity (us/cm)	1	566	568	573
Hardness	0.1	331	325	316
Turbidity	0.1	0.6	0.6	0.5
Anion Sum (meq/L)	na	6.74	6.61	6.62
Cation Sum (meq/L)	na	7.26	7.17	7.29
Ion Balance	0.01	3.74	4.01	4.77
pH (units)	0.1	8.3	8.3	8.2
DIC	0.5	61.7	60.1	57.2
DOC	0.5	10.0	10.3	8.5
TDS	1	360	354	368
TSS	5	nd	nd	nd

Table C3-5 : Dissolved and Total Metals (mg/L) of Reference Area B Samples; Dome Mine Site

Metal (mg/L)	LOQ	Dissolved Metals			Total Metals		
		REF B1	REF B2	REF B3	REF B1	REF B2	REF B3
Aluminum	0.01	nd	0.01	0.01	nd	0.01	nd
Antimony	0.002	nd	nd	nd	nd	nd	nd
Arsenic	0.002	0.060	0.059	0.046	0.059	0.062	0.044
Barium	0.005	0.016	0.016	0.014	0.024	0.026	0.021
Beryllium	0.005	nd	nd	nd	nd	nd	nd
Bismuth	0.002	nd	nd	nd	nd	nd	nd
Boron	0.005	0.080	0.077	0.083	0.093	0.092	0.088
Cadmium	0.0005	nd	nd	nd	nd	nd	nd
Calcium	0.1	68.4	67.3	65.7	80.4	82.3	79.9
Chromium	0.002	nd	nd	nd	nd	nd	0.002
Cobalt	0.001	nd	0.002	0.006	0.001	0.002	0.007
Copper	0.002	0.010	0.011	0.011	0.006	0.007	0.005
Iron	0.02	0.43	0.44	0.30	0.65	0.79	0.47
Lead	0.0001	0.0002	0.0004	0.0005	nd	0.0005	0.0032
Magnesium	0.1	30.9	29.9	27.8	36.1	36.3	33.6
Manganese	0.002	0.086	0.109	0.078	0.090	0.118	0.081
Mercury (ug/L)	0.1	nd	nd	nd	-	-	-
Molybdenum	0.002	nd	nd	nd	nd	nd	nd
Nickel	0.002	0.011	0.012	0.011	0.014	0.016	0.014
Potassium	0.5	1.4	1.1	2.1	1.1	1.8	2.8
Reactive Silica	0.5	8.5	8.8	9.1	-	-	-
Selenium	0.002	nd	nd	nd	nd	nd	nd
Silver	0.0003	nd	nd	nd	nd	nd	nd
Sodium	0.1	13.2	13.4	17.0	15.1	15.8	20.2
Strontium	0.005	0.143	0.146	0.143	0.124	0.129	0.120
Thallium	0.0001	nd	nd	nd	nd	nd	nd
Tin	0.002	nd	nd	nd	nd	nd	nd
Titanium	0.002	nd	nd	nd	0.004	0.004	0.004
Uranium	0.0001	0.0001	0.0002	0.0001	nd	nd	nd
Vanadium	0.002	nd	nd	nd	nd	nd	nd
Zinc	0.002	0.003	0.014	0.018	nd	nd	0.006
Total Cyanide	0.005	0.011	0.014	0.014	-	-	-
Free Cyanide	0.002	nd	nd	nd	-	-	-

Table C3-6 : Field Measurements Taken at Reference and Exposure Stations; Dome Mine Site

Measurement	Reference Stations						Exposure Stations					
	MAC 1	MAC 2	MAC 3	REF 1	REF 4	REF 6	EXP 1 E. on	EXP 2 E. on	EXP 3 E. on	EXP 1 E. off	EXP 2 E. off	EXP 3 E. off
pH (units)	8.3	8.8	8.5	7.9	7.9	7.8	7.9	8	8	8	7.9	7.8
Conductivity (us/cm)	278	229	228	507	517	497	829	803	845	908	864	828
Air Temperature (°C)	19	19	20	21	21	21	19	19	19	25	25	25
Water Temperature (°C)	10	18	16	15	16	14	13	13	13	16	18	18
Dissolved Oxygen (mg/L)	6.5	6.3	6.7	1.9	1.9	2.2	2.4	2	2	2	2.1	1.9
Depth (m)	6.5	3	5	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Velocity (m/s)	still	still	still	nm	nm	nm	nm	nm	nm	nm	nm	nm
Substrate Type	unk	unk	unk	ho	o	o	s/m	s/m	s/m	s/m	s/m	s/m

Measurement	Reference Stations Immediately Above Dome Effluent Pipe					
	REF	REF	REF			
pH (units)	8.3	8.1	8.3			
Conductivity (us/cm)	649	633	619			
Air Temperature (°C)	25	25	25			
Water Temperature (°C)	16	16	11			
Dissolved Oxygen (mg/L)	5.5	3.6	3.7			
Depth (m)	0.15	0.15	0.15			
Velocity (m/s)	nm	nm	nm			
Substrate Type	org silt	org silt	org silt			

nm = not measured
ho = high organic
unk = unknown
s/m = silt/muck
org sil = organic silt

APPENDIX D

Sediment Chemistry

APPENDIX D1

Detailed Methods

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 16/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Invoice received #26252

Certificate of Analysis

Analysis Performed:

Boron(hot water soluble) by ICP
ICP-MS, Contaminated Sites Guidelines
Mercury, Cold Vapour AA, Digestion Required
Loss on Ignition
Acid Digestion
Moisture Content

Methodology:

1) Analysis of hot water soluble boron in soil by performing a hot aqueous extraction prior to the analysis using ICPAES.
U.S. EPA Method No. 6010
Canadian Council Min.Environ. Criteria
2) Analysis of trace metals in soil by Inductively Coupled Plasma Mass Spectrophotometry.
U.S. EPA Method No. 6020(Modification)
3) Analysis of mercury in soil by Cold Vapour Atomic Absorption.
U.S. EPA Method No. 7471
(Reference - Varian Method No. AA-51)

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

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MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Certificate of Analysis

Methodology: (Cont'd)

4) The determination of the loss on ignition of organic matter by heating to constant weight @420°C. McKeague Methods of Soil Analysis # 3.81
5) Acid digestion of soils for metals determination by inductively coupled plasma atomic emission spectrometry and/or flame or furnace atomic absorption spectroscopy. U.S. EPA Method No. 3050(Modification)
6) Determination of the moisture content of soil by weight. ASTM Method No. D2216-80

Instrumentation:

1) Thermo Jarrell Ash ICAP 61E Plasma Spectrophotometer
2) PE Sciex ELAN 6000 ICP-MS Spectrometer
3) Varian SpectrAA 400 Plus AA/Vapour Accessory VGA 76
4) Precision Mechanical Convention Oven/Neytech Furnace
5) Thermolyne Hotplate/Hot Block
6) Precision Mechanical Convention Oven/Sartorius Basic Balance

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted:	September 25/96
Date Reported:	October 16/96
MDS Ref#:	966572
MDS Quote#:	96-697-GS
Client Ref#:	96239
Sampled By:	Geoff Carnenie

Certificate of Analysis

Instrumentation: (Cont'd)

Sample Description: Soil

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

Certified By
T. Munshaw, M.Sc.,C.Chem
Director, Laboratory Operations

MDS
Environmental Services Limited

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 16/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Invoice received # 2625

Certificate of Analysis

Analysis Performed:

20 Element ICP Scan(18 Scan + Ti and P)
ICP Alkaline Scan(Ca,Mg,Na,K,Sr), Digestion Required
Acid Digestion

Methodology:

1) Analysis of trace metals on a swab by Inductively Coupled Plasma Spectrophotometry, following an acidic extraction.
MDS Internal Method No. 96-MET-1
(Reference - NIOSH Method No. 7300)
2) Analysis of alkaline metals in a swab by Inductively Coupled Plasma Spectrophotometry.
U.S. EPA Method No. 6010
(Ministry of Environment ELSCAN)
3) Acid digestion of swabs for metals determination by inductively coupled plasma atomic emission spectrometry and/or flame or furnace atomic absorption spectroscopy.
U.S. EPA Method No. 3050(Modification)

Instrumentation:

1, 2) Thermo Jarrell Ash ICAP 61E Plasma Spectrophotometer
3) Thermolyne Hotplate/Hot Block

Client: Ecological Services for Planning
361 Southgate Drive
Guelph, ONT, CANADA
N1G 3M5

Fax: 519-836-2493

Attn: Barbara Dowsley

Date Submitted: September 25/96
Date Reported: October 16/96
MDS Ref#: 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239
Sampled By: Geoff Carnenie

Certificate of Analysis

Sample Description: Swab

QA/QC: Refer to CERTIFICATE OF QUALITY CONTROL report.

Results: Refer to REPORT of ANALYSIS attached.

Certified By
Brad Newman
Service Manager

Certified By
T. Munshaw, M.Sc.,C.Chem
Director, Laboratory Operations

APPENDIX D2

QA/QC

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 16/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Analysis of Soil, expressed on a dry weight basis

Client Ref#: 96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Boron(Hot water soluble)	na	0.2	mg/kg	nd(b)	2.0	yes	108	80	120	yes	na	na	na	na	na	yes
Antimony	EXP1-Comp Rep	2.0	mg/kg	nd(b)	4.0	yes	95	80	120	yes	12.2	12.5	7.5	17.5	yes	yes
Arsenic	EXP1-Comp Rep	2.0	mg/kg	nd(b)	4.0	yes	94	80	120	yes	10.1	12.5	7.5	17.5	yes	yes
Barium	EXP1-Comp Rep	0.5	mg/kg	nd(b)	1.0	yes	89	80	120	yes	10.9	12.5	7.5	17.5	yes	yes
Beryllium	EXP1-Comp Rep	0.5	mg/kg	nd(b)	1.0	yes	114	80	120	yes	13.4	12.5	7.5	17.5	yes	yes
Cadmium	EXP1-Comp Rep	0.1	mg/kg	nd(b)	1.0	yes	97	80	120	yes	12.1	12.5	7.5	17.5	yes	yes
Chromium	EXP1-Comp Rep	0.5	mg/kg	nd(b)	1.0	yes	108	80	120	yes	12.9	12.5	7.5	17.5	yes	yes
Cobalt	EXP1-Comp Rep	0.8	mg/kg	nd(b)	1.6	yes	108	80	120	yes	12.4	12.5	7.5	17.5	yes	yes
Copper	EXP1-Comp Rep	0.5	mg/kg	nd(b)	1.0	yes	108	80	120	yes	*	*	*	*	*	yes
Lead	EXP1-Comp Rep	2.5	mg/kg	nd(b)	5.0	yes	95	80	120	yes	12.0	12.5	7.5	17.5	yes	yes
Molybdenum	EXP1-Comp Rep	1.0	mg/kg	nd(b)	2.0	yes	96	80	120	yes	12.5	12.5	7.5	17.5	yes	yes
Nickel	EXP1-Comp Rep	1.5	mg/kg	nd(b)	3.0	yes	110	80	120	yes	9.7	12.5	7.5	17.5	yes	yes
Selenium	EXP1-Comp Rep	1.0	mg/kg	nd(b)	2.0	yes	96	80	120	yes	12.0	12.5	7.5	17.5	yes	yes
Silver	EXP1-Comp Rep	0.15	mg/kg	nd(b)	1.0	yes	93	80	120	yes	11.9	12.5	7.5	17.5	yes	yes
Thallium	EXP1-Comp Rep	0.1	mg/kg	nd(b)	1.0	yes	94	80	120	yes	12.1	12.5	7.5	17.5	yes	yes
Vanadium	EXP1-Comp Rep	0.5	mg/kg	nd(b)	1.0	yes	105	80	120	yes	12.9	12.5	7.5	17.5	yes	yes
Zinc	EXP1-Comp Rep	0.8	mg/kg	1.0(b)	1.6	yes	112	80	120	yes	12.9	12.5	7.5	17.5	yes	yes
Mercury	na	0.01	mg/kg	nd	0.02	yes	93	80	123	yes	na	na	na	na	na	yes
Loss on Ignition	na	0.1	%	nd	0.2	yes	100	74	138	yes	na	na	na	na	na	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 16/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Soil, expressed on a dry weight basis

Client Ref#: 96239

Parameter	LOQ	Units	EXP1-Comp	EXP1-Comp Rep	EXP1-Comp Rep Replicate	EXP2-Comp	EXP3-Comp
Boron(Hot water soluble)	0.2	mg/kg	3.8	3.8	4.0	1.9	2.5
Antimony	2.0	mg/kg	nd	nd	nd	nd	nd
Arsenic	2.0	mg/kg	460	438	468	295	415
Barium	0.5	mg/kg	28.7	27.5	28.5	16.2	22.5
Beryllium	0.5	mg/kg	nd	nd	nd	nd	nd
Cadmium	0.1	mg/kg	nd	nd	nd	nd	nd
Chromium	0.5	mg/kg	66.9	63.5	70.0	76.5	76.3
Cobalt	0.8	mg/kg	96.4	91.8	102	47.0	65.4
Copper	0.5	mg/kg	1190	1160	1270	824	1060
Lead	2.5	mg/kg	8.5	9.6	8.3	8.0	8.0
Molybdenum	1.0	mg/kg	7.4	7.1	7.7	4.9	6.7
Nickel	1.5	mg/kg	480	464	508	365	427
Selenium	1.0	mg/kg	nd	1.1	2.3	nd	nd
Silver	0.15	mg/kg	4.57	4.89	4.80	2.90	3.90
Thallium	0.1	mg/kg	nd	nd	nd	nd	nd
Vanadium	0.5	mg/kg	26.5	24.9	26.7	28.3	30.1
Zinc	0.8	mg/kg	96.0	91.7	104	88.8	101
Mercury	0.01	mg/kg	0.21	0.16	-	0.14	0.12
Loss on Ignition	0.1	%	17.6	14.4	-	7.4	10.9
Moisture Content	0.01	%	84.8	82.5	81.0	69.2	78.8

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 16/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Soil, expressed on a dry weight basis

Client Ref#: 96239

Parameter	LOQ	Units	EXP4-Comp	EXP5-Comp	EXP6-Comp	REF1-Comp	REF2-Comp
Boron(Hot water soluble)	0.2	mg/kg	4.2	4.9	4.9	1.0	0.8
Antimony	2.0	mg/kg	nd	nd	nd	nd	nd
Arsenic	2.0	mg/kg	363	340	508	190	157
Barium	0.5	mg/kg	18.9	26.3	43.4	35.3	66.4
Beryllium	0.5	mg/kg	nd	nd	nd	nd	0.5
Cadmium	0.1	mg/kg	nd	nd	nd	0.2	0.1
Chromium	0.5	mg/kg	66.6	79.1	103	62.7	83.8
Cobalt	0.8	mg/kg	69.3	66.7	91.9	19.7	18.7
Copper	0.5	mg/kg	1170	947	1150	274	168
Lead	2.5	mg/kg	8.0	8.2	12.4	15.9	20.1
Molybdenum	1.0	mg/kg	7.1	6.5	8.9	3.9	2.0
Nickel	1.5	mg/kg	437	399	492	52.6	55.2
Selenium	1.0	mg/kg	1.1	nd	nd	nd	nd
Silver	0.15	mg/kg	4.75	3.66	5.03	0.26	0.21
Thallium	0.1	mg/kg	nd	nd	nd	nd	nd
Vanadium	0.5	mg/kg	26.1	30.4	41.6	35.3	38.9
Zinc	0.8	mg/kg	107	102	128	221	176
Mercury	0.01	mg/kg	0.13	0.13	0.14	0.14	0.06
Loss on Ignition	0.1	%	11.6	7.9	10.9	7.1	8.1
Moisture Content	0.01	%	76.6	77.2	79.2	61.6	54.4

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 16/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Soil, expressed on a dry weight basis

Client Ref#: 96239

Parameter	LOQ	Units	REF3-Comp	REF4-Comp	REF5-Comp	REF6-Comp	REF6-Comp Replicate
Boron(Hot water soluble)	0.2	mg/kg	0.6	0.8	2.3	0.7	-
Antimony	2.0	mg/kg	nd	nd	nd	nd	-
Arsenic	2.0	mg/kg	205	156	201	185	-
Barium	0.5	mg/kg	30.6	32.5	28.3	26.8	-
Beryllium	0.5	mg/kg	nd	nd	nd	nd	-
Cadmium	0.1	mg/kg	0.1	0.1	0.1	0.2	-
Chromium	0.5	mg/kg	44.5	41.4	46.5	53.4	-
Cobalt	0.8	mg/kg	15.8	13.5	18.1	16.3	-
Copper	0.5	mg/kg	269	203	228	287	-
Lead	2.5	mg/kg	10.7	10.6	13.6	16.8	-
Molybdenum	1.0	mg/kg	3.1	2.3	3.5	4.6	-
Nickel	1.5	mg/kg	40.0	36.1	44.5	43.8	-
Selenium	1.0	mg/kg	nd	nd	nd	nd	-
Silver	0.15	mg/kg	0.19	0.17	0.20	0.46	-
Thallium	0.1	mg/kg	nd	nd	nd	nd	-
Vanadium	0.5	mg/kg	27.8	27.2	28.2	32.6	-
Zinc	0.8	mg/kg	179	153	194	287	-
Mercury	0.01	mg/kg	0.08	0.07	0.09	0.41	-
Loss on Ignition	0.1	%	6.4	6.1	6.8	7.5	-
Moisture Content	0.01	%	51.4	48.0	61.5	60.4	-

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
- = Not Requested
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 16/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Analysis of Swab

Client Ref#: 96239

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Aluminum	na	1.0	ug/totl	2.3(b)	4.0	yes	92	80	120	yes	na	na	na	na	na	yes
Barium	na	0.1	ug/totl	nd(b)	0.3	yes	100	80	120	yes	na	na	na	na	na	yes
Beryllium	na	0.3	ug/totl	nd(b)	0.6	yes	101	80	120	yes	na	na	na	na	na	yes
Bismuth	na	2.5	ug/totl	nd(b)	5.0	yes	101	80	120	yes	na	na	na	na	na	yes
Boron	na	0.5	ug/totl	nd(b)	1.5	yes	91	80	120	yes	na	na	na	na	na	yes
Cadmium	na	0.2	ug/totl	nd(b)	0.4	yes	104	80	120	yes	na	na	na	na	na	yes
Chromium	na	0.3	ug/totl	nd(b)	0.6	yes	102	80	120	yes	na	na	na	na	na	yes
Cobalt	na	0.3	ug/totl	nd(b)	0.6	yes	100	80	120	yes	na	na	na	na	na	yes
Copper	na	0.2	ug/totl	nd(b)	0.4	yes	99	80	120	yes	na	na	na	na	na	yes
Iron	na	0.3	ug/totl	0.9(b)	0.9	yes	95	80	120	yes	na	na	na	na	na	yes
Lead	na	1.3	ug/totl	nd(b)	2.6	yes	102	80	120	yes	na	na	na	na	na	yes
Manganese	na	0.3	ug/totl	nd(b)	0.6	yes	98	80	120	yes	na	na	na	na	na	yes
Molybdenum	na	0.5	ug/totl	nd(b)	1.0	yes	102	80	120	yes	na	na	na	na	na	yes
Nickel	na	0.5	ug/totl	nd(b)	1.0	yes	104	80	120	yes	na	na	na	na	na	yes
Phosphorus	na	3.0	ug/totl	nd(b)	9.0	yes	95	70	130	yes	na	na	na	na	na	yes
Silver	na	0.2	ug/totl	nd(b)	0.4	yes	97	80	120	yes	na	na	na	na	na	yes
Tin	na	2.5	ug/totl	nd(b)	5.0	yes	104	80	120	yes	na	na	na	na	na	yes
Titanium	na	2.5	ug/totl	nd(b)	5.0	yes	99	80	120	yes	na	na	na	na	na	yes
Vanadium	na	0.5	ug/totl	nd(b)	1.0	yes	102	80	120	yes	na	na	na	na	na	yes
Zinc	na	0.3	ug/totl	0.6(b)	0.9	yes	96	80	120	yes	na	na	na	na	na	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ
(b) = Analyte results on REPORT of ANALYSIS have been background corrected for the process blank.

MDS Environmental Services Limited.

Certificate of Quality Control

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Date Reported: October 16/96
MDS Ref # : 966572
MDS Quote#: 96-697-GS

Client Ref#: 96239

Analysis of Swab

				Process Blank			Process % Recovery				Matrix Spike					Overall
Parameter	SAMPLE ID (spike)	LOQ	Units	Result	Upper Limit	Accept	Result	Lower Limit	Upper Limit	Accept	Result	Target	Lower Limit	Upper Limit	Accept	QC Acceptable
Calcium	na	0.5	ug/swb	0.8(b)	2.0	yes	96	80	120	yes	na	na	na	na	na	yes
Magnesium	na	1.0	ug/swb	nd(b)	4.0	yes	108	80	120	yes	na	na	na	na	na	yes
Potassium	na	20	ug/swb	nd(b)	80.0	yes	87	80	120	yes	na	na	na	na	na	yes
Sodium	na	0.5	ug/swb	1.1(b)	2.0	yes	106	80	120	yes	na	na	na	na	na	yes
Strontium	na	0.3	ug/swb	nd(b)	1.2	yes	98	80	120	yes	na	na	na	na	na	yes

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence
* = Unavailable due to dilution required for analysis
na = Not Applicable
ns = Insufficient Sample Submitted
nd = parameter not detected
TR = trace level less than LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 16/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Swab

Client Ref#: 96239

Parameter	LOQ	Units	EXP3-Comp	EXP3-Comp Replicate	EXP5-Comp	EXP6-Comp	REF1-Comp
Aluminum	1.0	ug/tot	7.8	7.7	10.8	8.6	2.3
Barium	0.1	ug/tot	0.3	0.3	0.2	0.3	0.2
Beryllium	0.3	ug/tot	nd	nd	nd	nd	nd
Bismuth	2.5	ug/tot	nd	nd	nd	nd	nd
Boron	0.5	ug/tot	nd	nd	nd	nd	nd
Cadmium	0.2	ug/tot	nd	nd	nd	nd	nd
Calcium	0.5	ug/swb	1380	1400	620	234	228
Chromium	0.3	ug/tot	nd	nd	0.4	nd	nd
Cobalt	0.3	ug/tot	nd	nd	nd	nd	nd
Copper	0.2	ug/tot	0.6	0.6	0.5	0.6	0.4
Iron	0.3	ug/tot	27.6	27.9	32.1	31.6	11.3
Lead	1.3	ug/tot	nd	nd	nd	nd	nd
Magnesium	1.0	ug/swb	25.7	26.0	23.5	19.1	9.2
Manganese	0.3	ug/tot	2.9	2.9	3.0	5.8	1.0
Molybdenum	0.5	ug/tot	nd	nd	nd	nd	nd
Nickel	0.5	ug/tot	nd	nd	nd	nd	nd
Phosphorus	3.0	ug/tot	3.2	3.2	nd	nd	nd
Potassium	20	ug/swb	nd	nd	nd	nd	nd
Silver	0.2	ug/tot	nd	nd	nd	nd	nd
Sodium	0.5	ug/swb	46.1	46.8	45.6	58.1	35.0
Strontium	0.3	ug/swb	0.6	0.7	0.3	nd	nd
Tin	2.5	ug/tot	nd	nd	nd	nd	nd
Titanium	2.5	ug/tot	nd	nd	nd	nd	nd
Vanadium	0.5	ug/tot	nd	nd	nd	nd	nd
Zinc	0.3	ug/tot	39.2	42.0	27.9	10.4	20.3

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

MDS Environmental Services Limited.

Report of Analysis

Client : Ecological Services for Planning
Contact: Barbara Dowsley

Report Date: October 16/96
MDS Ref # : 966572
MDS Quote #: 96-697-GS

Analysis of Swab

Client Ref#: 96239

Parameter	LOQ	Units	REF3-Comp	REF5-Comp			
Aluminum	1.0	ug/tot	2.6	2.2			
Barium	0.1	ug/tot	0.1	0.1			
Beryllium	0.3	ug/tot	nd	nd			
Bismuth	2.5	ug/tot	nd	nd			
Boron	0.5	ug/tot	nd	nd			
Cadmium	0.2	ug/tot	nd	nd			
Calcium	0.5	ug/swb	702	171			
Chromium	0.3	ug/tot	nd	nd			
Cobalt	0.3	ug/tot	nd	nd			
Copper	0.2	ug/tot	0.4	0.2			
Iron	0.3	ug/tot	12.4	12.6			
Lead	1.3	ug/tot	nd	nd			
Magnesium	1.0	ug/swb	10.7	8.8			
Manganese	0.3	ug/tot	0.8	0.9			
Molybdenum	0.5	ug/tot	nd	nd			
Nickel	0.5	ug/tot	nd	nd			
Phosphorus	3.0	ug/tot	nd	nd			
Potassium	20	ug/swb	nd	nd			
Silver	0.2	ug/tot	nd	nd			
Sodium	0.5	ug/swb	25.1	33.7			
Strontium	0.3	ug/swb	0.3	nd			
Tin	2.5	ug/tot	nd	nd			
Titanium	2.5	ug/tot	nd	nd			
Vanadium	0.5	ug/tot	nd	nd			
Zinc	0.3	ug/tot	33.8	11.4			

LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.
nd = parameter not detected ! = LOQ higher than listed due to dilution ( ) Adjusted LOQ

13

APPENDIX D3

Results

Legend of codes and symbols for water and sediment quality data	
LOQ	Limit of Quantification
+	Guideline for the protection of freshwater aquatic life (where available)
*	Interim Ontario Provincial Water Quality Objective
**	ammonia concentration at pH 7.5 and 20°C
nd	not detected at LOQ (n.b. for statistics, nd converted to ½ LOQ)
na	not applicable/not available
-	not requested
TKN	Total Kjeldahl Nitrogen
DIC	Dissolved Inorganic Carbon
DOC	Dissolved Organic Carbon
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
NCALC	Not Calculated

Table D3-1: Sediment Chemistry (mg/kg) from Reference and Exposure Areas, Dome Mine

Metal (mg/kg)	LOQ	Reference Stations						Exposure Stations							
		REF 1	REF 2	REF 3	REF 4	REF 5	REF 6	EXP 1	EXP 1 Field Replicate	EXP 1 Lab Replicate	EXP 2	EXP 3	EXP 4	EXP 5	EXP 6
Antimony	2.0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	2.0	190	157	205	156	201	185	460	438	468	295	415	363	540	508
Barium	0.5	35.3	66.4	30.6	32.5	28.3	26.8	28.7	27.5	28.5	16.2	22.5	18.9	26.3	45.4
Beryllium	0.5	nd	0.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Boron	0.2	1.0	0.8	0.6	0.8	2.3	0.7	3.8	3.8	4.0	1.9	2.5	4.2	4.9	4.9
Cadmium	0.1	0.2	0.1	.0.1	0.1	0.1	0.2	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	0.5	62.7	83.8	44.5	41.4	46.5	53.4	66.9	63.5	70.0	76.5	76.3	66.6	79.1	103.0
Cobalt	0.8	19.7	18.7	15.8	13.5	18.1	16.3	96.4	91.8	102.0	47.0	65.4	69.3	66.7	91.9
Copper	1	274	168	269	203	228	287	1190	1160	1270	824	1060	1170	947	1150
Lead	2.5	15.9	20.1	10.7	10.6	13.6	16.8	8.5	9.6	8.5	8.0	8.0	8.0	8.2	12.4
Mercury	0.01	0.14	0.06	0.08	0.07	0.09	0.41	0.21	0.16	-	0.14	0.12	0.13	0.13	0.14
Molybdenum	1.0	3.9	2.0	3.1	2.3	3.5	4.6	7.4	7.1	7.7	4.9	6.7	7.1	6.5	8.9
Nickel	1.5	52.6	55.2	40.0	36.1	44.5	43.8	480	464	508	365	427	437	399	492
Selenium	1.0	nd	nd	nd	nd	nd	nd	nd	1.1	2.3	nd	nd	1.1	nd	nd
Silver	0.15	0.26	0.21	0.19	0.17	0.20	0.46	4.57	4.89	4.80	2.90	3.90	4.75	3.66	5.03
Thallium	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium	0.5	35.3	38.9	27.8	27.2	28.2	32.6	26.5	24.9	26.7	28.3	30.1	26.1	30.4	41.6
Zinc	0.8	221.0	176.0	179.0	153.0	194.0	287.0	96.0	91.7	104.0	88.8	101.0	107.0	102.0	128.0
Total Carbon (%)		3.83	4.01	3.48	3.32	3.52	4.82	11.78	8.16	-	4.77	6.59	7.37	5.23	6.25
Total Inorganic Carbon (%)		1.16	0.89	0.90	0.70	0.89	0.94	1.20	1.40	-	1.78	1.65	1.55	1.64	1.57
Total Organic Carbon (%)		2.67	3.12	2.58	2.62	2.63	3.88	10.58	6.76	-	2.99	4.94	5.82	3.59	4.68
Loss on Ignition (%)	0.1	7.1	8.1	6.4	6.1	6.8	7.5	17.6	14.4	-	7.4	10.9	11.6	7.9	10.9
Moisture Content (%)	0.0	61.6	54.4	51.4	48.0	61.5	60.4	84.8	82.5	81.0	69.2	78.8	76.6	77.2	79.2
Particle Size Distribution															
% Gravel		0.02	1.14	0.46	0.23	0.02	1.49	0.07	0.34	-	0.04	0.00	0.10	0.00	0.16
% Sand		26.38	49.73	49.57	37.19	26.87	25.93	16.60	19.22	-	14.87	20.67	21.26	26.72	23.20
% Silt		68.91	45.94	46.74	59.29	68.03	63.80	57.38	53.34	-	74.04	59.37	62.77	56.86	57.41
% Clay		4.69	3.20	3.22	3.29	5.08	8.77	25.96	27.10	-	11.05	19.96	15.87	16.42	19.23

LOQ = Limit of Quantification
nd = Parameter not detected at LOQ (n.b. for statistics, nd = 1/2 LOQ)
na = Not available/applicable
- = not requested

Table D3-2 Sediment chemistry (mg/kg) from Reference and Exposure Areas; lab values and values normalized for percent fines, Dome Mine Site

Metal (mg/kg)	LOQ	Reference Stations											
		REF 1		REF 2		REF 3		REF 4		REF 5		REF 6	
		LAB	NORMAL.	LAB	NORMAL	LAB	NORMAL	LAB	NORMAL	LAB	NORMAL.	LAB	NORMAL.
Arsenic	2.0	190	256.8	157	320.4	205	410.0	156	247.6	201	275.3	185	253.4
Cadmium	0.1	0.2	0.27	0.1	0.20	0.1	0.20	0.1	0.16	0.1	0.14	0.2	0.27
Chromium	0.5	62.7	84.7	83.8	171.0	44.5	89.0	41.4	65.7	46.5	63.7	53.4	73.2
Cobalt	0.8	19.7	26.6	18.7	38.2	15.8	31.6	13.5	21.4	18.1	24.8	16.3	22.3
Copper	1	274	370.3	168	342.9	269	538.0	203	322.2	228	312.3	287	393.2
Lead	2.5	15.9	21.5	20.1	41.0	10.7	21.4	10.6	16.8	13.6	18.6	16.8	23.0
Mercury	0.01	0.14	0.19	0.06	0.12	0.08	0.16	0.07	0.11	0.09	0.12	0.41	0.56
Molybdenum	1.0	3.9	5.3	2.0	4.1	3.1	6.2	2.3	3.7	3.5	4.8	4.6	6.3
Nickel	1.5	52.6	71.1	55.2	112.7	40.0	80.0	36.1	57.3	44.5	61.0	43.8	60.0
Silver	0.15	0.26	0.35	0.21	0.43	0.19	0.38	0.17	0.27	0.20	0.27	0.46	0.63
Zinc	0.8	221.0	298.6	176.0	359.2	179.0	358.0	153.0	242.9	194.0	265.8	287.0	393.2
FINES (proportion)		**0.74**		**0.49**		**0.50**		**0.63**		**0.73**		**0.73**	

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Table D3-2 Sediment chemistry (mg/kg) from Reference and Exposure Areas; lab values and values normalized for percent fines, Dome Mine Site

Metal (mg/kg)	Exposure Stations											
	EXP 1		EXP 2		EXP 3		EXP 4		EXP 5		EXP 6	
	LAB	NORMAL.	LAB	NORMAL.	LAB	NORMAL.	LAB	NORMAL.	LAB	NORMAL.	LAB	NORMAL.
Arsenic	460	554.2	295	347.1	415	525.3	363	459.5	540	739.7	508	668.4
Cadmium	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	66.9	80.6	76.5	90.0	76.3	96.6	66.6	84.3	79.1	108.4	103.0	135.5
Cobalt	96.4	116.1	47.0	55.3	65.4	82.8	69.3	87.7	66.7	91.4	91.9	120.9
Copper	1190	1433.7	824	969.4	1060	1341.8	1170	1481.0	947	1297.3	1150	1513.2
Lead	8.5	10.2	8.0	9.4	8.0	10.1	8.0	10.1	8.2	11.2	12.4	16.3
Mercury	0.21	0.25	0.14	0.16	0.12	0.15	0.13	0.16	0.13	0.18	0.14	0.18
Molybdenum	7.4	8.9	4.9	5.8	6.7	8.5	7.1	9.0	6.5	8.9	8.9	11.7
Nickel	480	578.3	365	429.4	427	540.5	437	553.2	399	546.6	492	647.4
Silver	4.57	5.51	2.90	3.41	3.90	4.94	4.75	6.01	3.66	5.01	5.03	6.62
Zinc	96.0	115.7	88.8	104.5	101.0	127.8	107.0	135.4	102.0	139.7	128.0	168.4
FINES (proportion)	**0.83**		**0.85**		**0.79**		**0.79**		**0.73**		**0.76**	

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TSL/ASSAYERS Laboratories
1270 FEWSTER DRIVE, UNIT 3 MISSISSAUGA,ONTARIO L4W-1A4
PHONE #: (905)602-8236 FAX #: (905)206-0513

LECO SUITE

MDS ENVIRONMENTAL SERVICES
ATTN: N. BOULTON
PROJ: 966572

Ecological Services for Planning
361 Southgate Drive
Guelph, Ontario N1G 3M5
ATTENTION: Dr. Marilyn Truscott

REPORT No. : M8095
Page No. : 1 of 1
File No. : M8095
Date : SEP-30-1996

RS # 96239

SAMPLE #	TC %	TIC %	TOC %
S03C76499 EXP1-COM R	8.16	1.40	6.76
S03C76500 EXP1-COM	11.78	1.20	10.58
S03C76501 EXP2-COM	4.77	1.78	2.99
S03C76502 EXP3	6.59	1.65	4.94
S03C76503 EXP4	7.37	1.55	5.82
S03C76504 EXP5	5.23	1.64	3.59
S03C76505 EXP6	6.25	1.57	4.68
S03C76506 REF1-COMP	3.83	1.16	2.67
S03C76507 REF2	4.01	0.89	3.12
S03C76508 REF3	3.48	0.90	2.58
S03C76509 REF4	3.32	0.70	2.62
S03C76510 REF5	3.52	0.89	2.63
S03C76511 REF6	4.82	0.94	3.88

TC TOTAL CARBON COMBUSTION METHOD
TIC CARBONATE CARBON ACIDIFICATION METHOD
OC ACID INSOLUBLE CARBON TC-TIC

TSL/96

SIGNED :

Ecological Sercices for Planning
361 Southgate Drive
Guelph, ON N1G 3M5
ATTENTION: Barbara Dowsley

RPC
921 College Hill Road
Fredericton, N.B. E3B 6Z9
Report No: AS/96/4883
Job No: 4000726/7892

MDS Environmental
Services Limited
5595 Fenwick Street
Halifax, N.S. B3H 4M2

October 10, 1996

Grain Size Distribution

	Exp1-Comp Rep	Exp1-Comp	Exp2-Comp	Exp3-Comp	Exp4-Comp
Sample ID	29815	29816	29817	29818	29819
RPC #	7892-14	7892-15	7892-16	7892-17	7892-18
PHI	% Finer				
-2	100.00	100.00	100.00	100.00	100.00
-1	99.66	99.93	99.86	100.00	99.90
0	98.41	99.80	99.73	99.98	99.67
1	97.09	99.32	99.47	99.75	98.85
2	95.56	98.34	99.17	99.25	97.54
3	92.13	95.49	97.44	94.22	92.65
4	80.44	83.33	85.09	79.33	78.64
5	60.71	61.36	54.60	63.88	68.92
6	46.45	44.40	35.84	34.33	43.19
7	30.87	29.83	14.93	29.07	21.21
8	27.10	25.96	11.05	19.96	15.87
9	20.77	20.26	7.18	11.68	9.86
% Gravel	0.34	0.07	0.04	0.00	0.10
% Sand	19.22	16.60	14.87	20.67	21.28
% Silt	53.34	57.38	74.04	59.37	62.77
% Clay	27.10	25.96	11.05	19.96	15.87

RPC
921 College Hill Road
Fredericton, N.B. E3B 6Z9
Report No: AS/96/4883
Job No: 4000726/7892

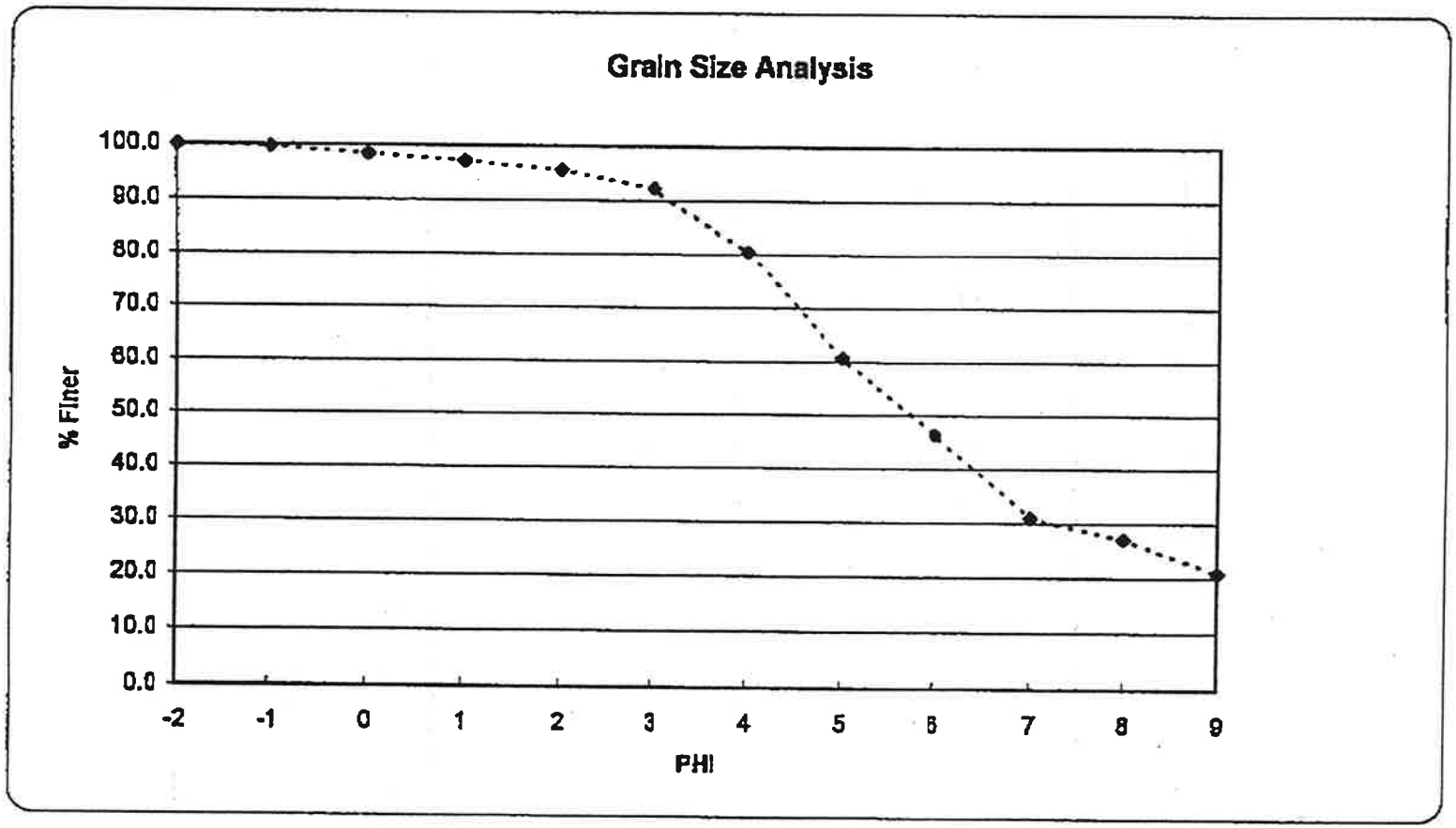
MDS Environmental
Services Limited
5595 Fenwick Street
Halifax, N.S. B3H 4M2

October 10, 1996

Grain Size Distribution

Sample ID	Exp5-Comp	Exp6-Comp	REF1-Comp	REF2-Comp	REF3-Comp	REF4-Comp	REF5-Comp	REF6-Comp
RPC #	29820	29821	29822	29823	29824	29825	29826	29827
PHI	7892-19	7892-20	7892-21	7892-22	7892-23	7892-24	7892-25	7892-26
	% Finer							
-2	100.00	99.84	100.00	99.82	100.00	100.00	100.00	99.10
-1	100.00	99.84	99.98	98.86	99.54	99.77	99.98	98.51
0	99.91	99.45	99.82	96.50	98.10	99.36	99.91	97.74
1	99.54	97.60	99.29	90.92	95.33	98.17	99.64	96.61
2	98.83	94.32	97.65	81.40	88.16	95.11	98.43	94.28
3	90.87	89.50	90.22	66.54	71.09	84.38	92.27	87.33
4	73.28	76.64	73.60	49.13	49.97	62.58	73.11	72.57
5	49.46	52.96	44.23	32.66	28.45	34.49	41.95	43.62
6	34.10	32.67	33.88	15.73	20.70	23.19	26.30	26.16
7	19.18	21.99	6.24	5.29	3.84	3.92	6.21	12.07
8	16.42	19.23	4.69	3.20	3.22	3.29	5.08	8.77
9	11.16	13.26	3.94	2.73	2.31	2.73	4.09	4.96
% Gravel	0.00	0.16	0.02	1.14	0.46	0.23	0.02	1.49
% Sand	26.72	23.20	26.38	49.73	49.57	37.19	26.87	25.93
% Silt	56.86	57.41	68.91	45.94	46.74	59.29	68.03	63.80
% Clay	16.42	19.23	4.69	3.20	3.22	3.29	5.08	8.77

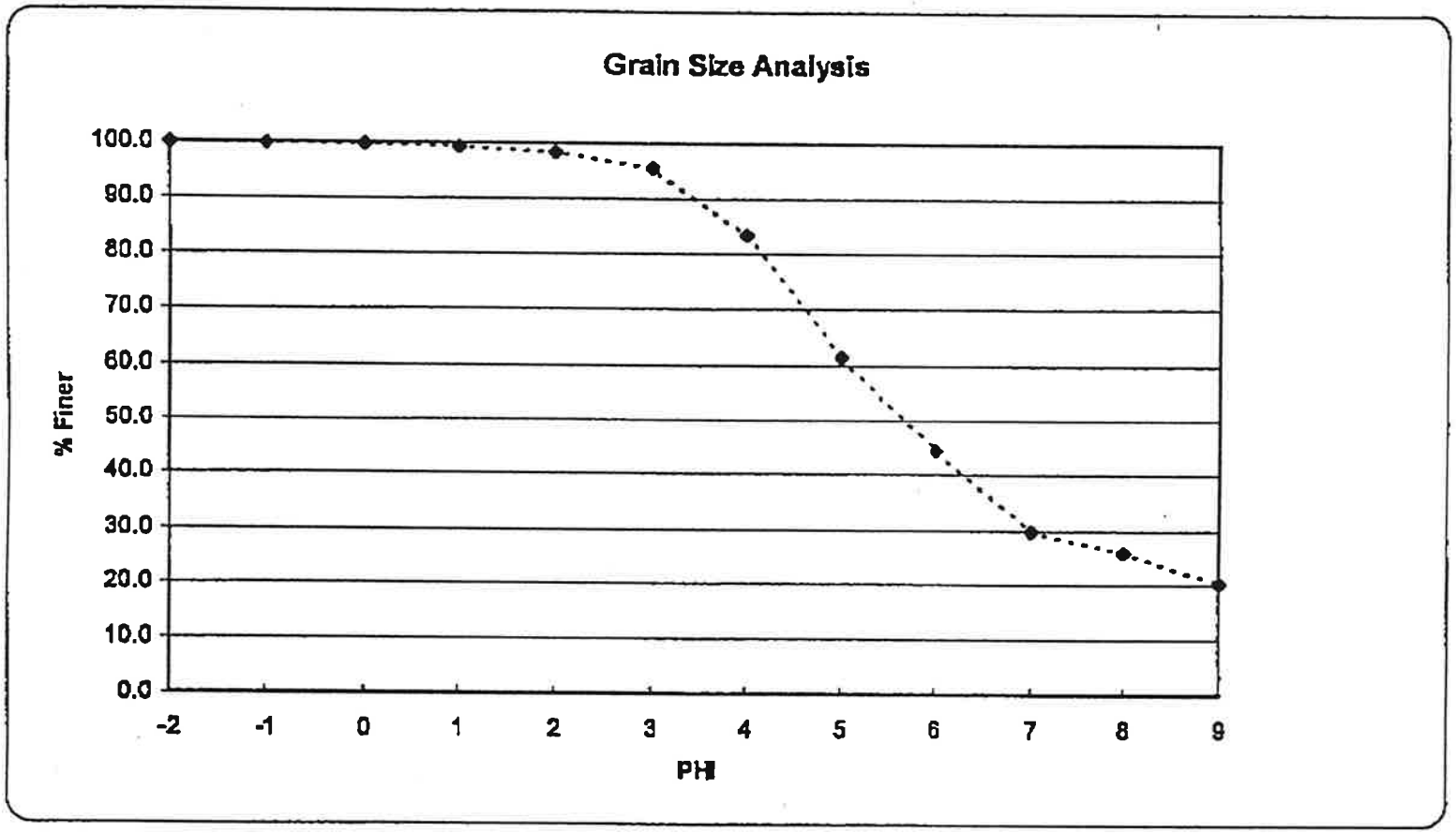
Sample I.D. **29815** Exp1 - CompRep
RPC # **7892-14**



% Gravel	0.34
% Sand	19.22
% Silt	53.34
% Clay	27.10

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

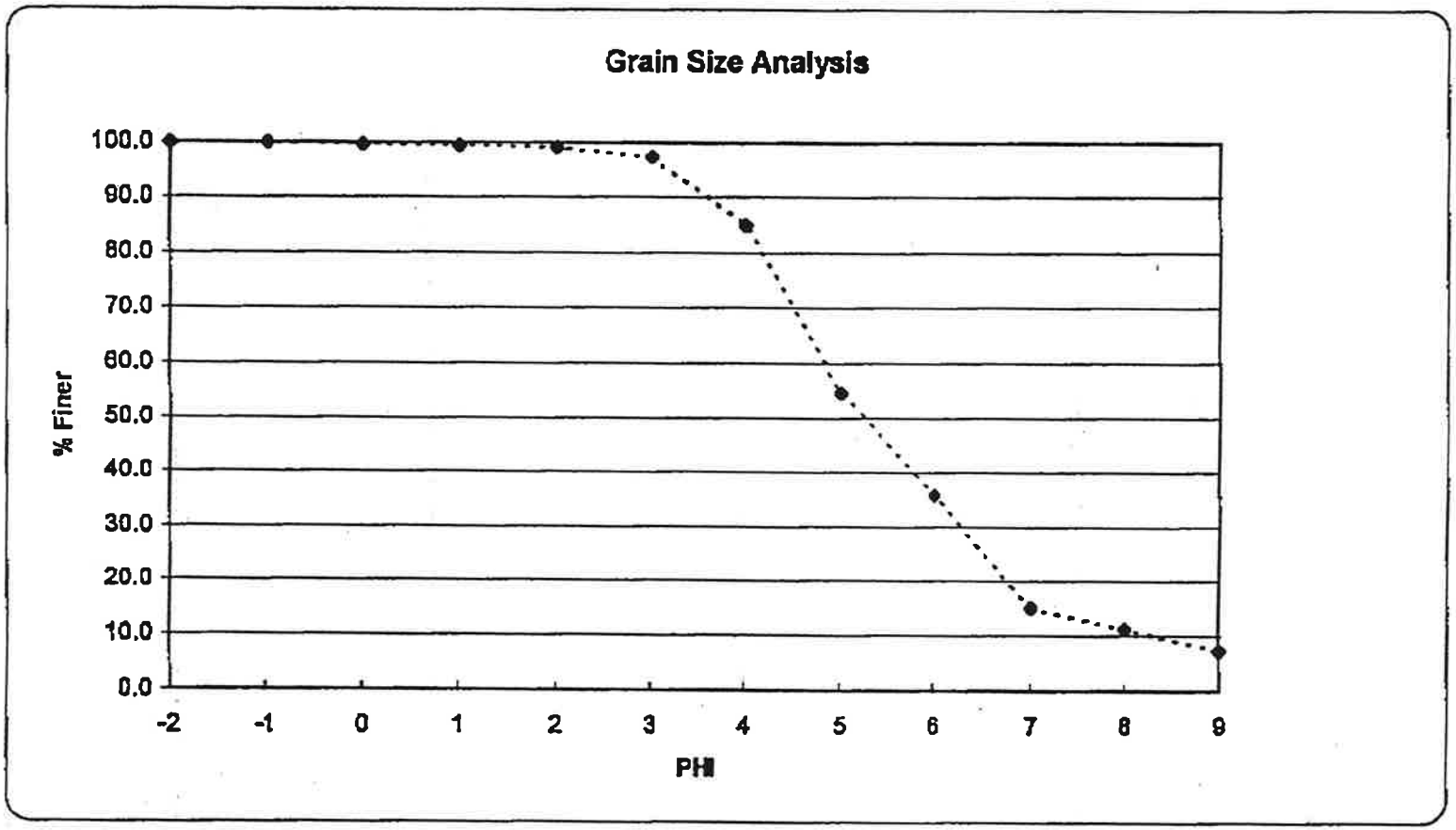
Sample I.D. **29816** EXP1- Comp
RPC # **7892-15**



% Gravel	0.07
% Sand	16.60
% Silt	57.38
% Clay	25.96

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

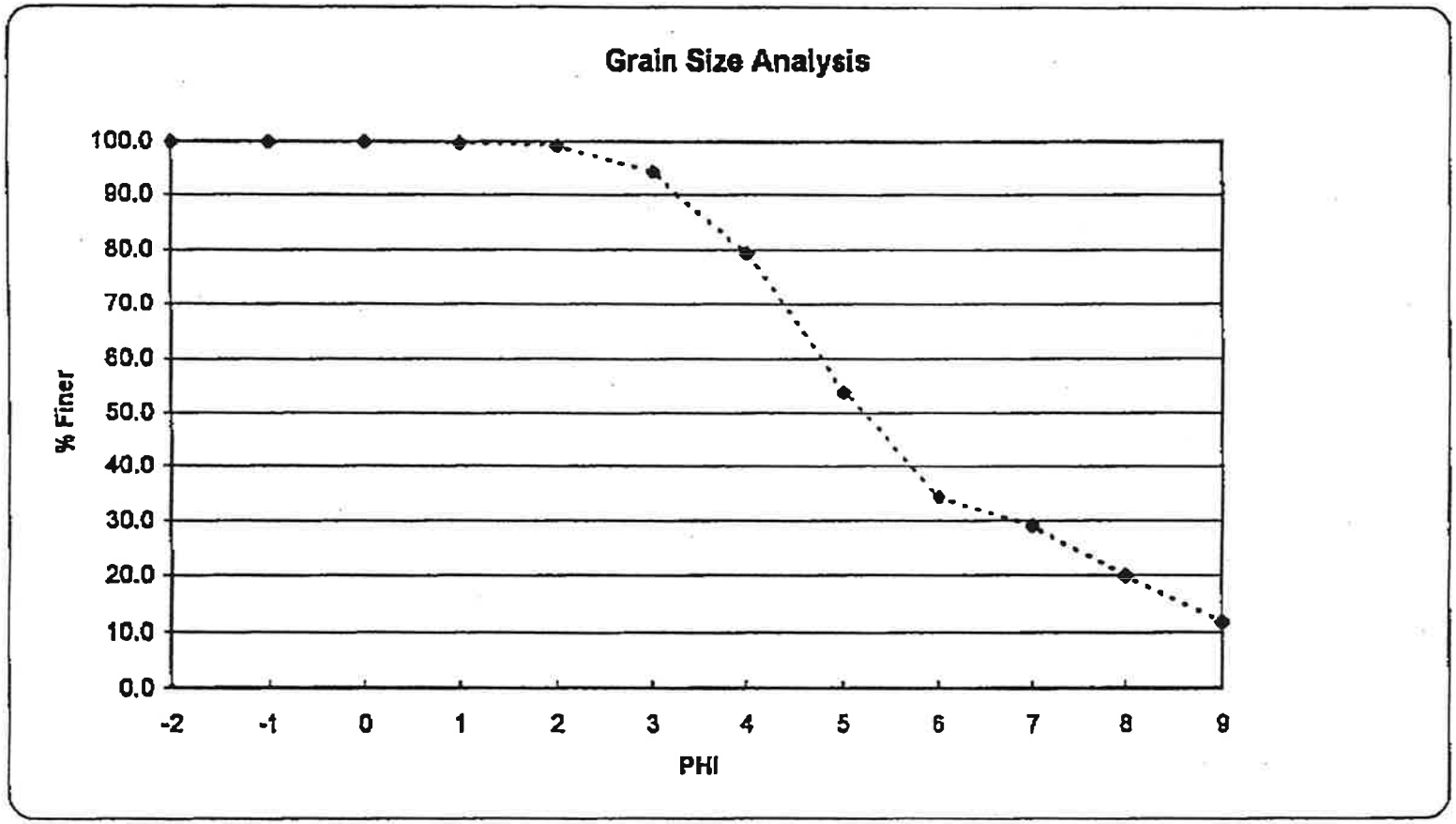
Sample I.D. 29817 EXP2-Comp
RPC # 7892-16



% Gravel	0.04
% Sand	14.87
% Silt	74.04
% Clay	11.05

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

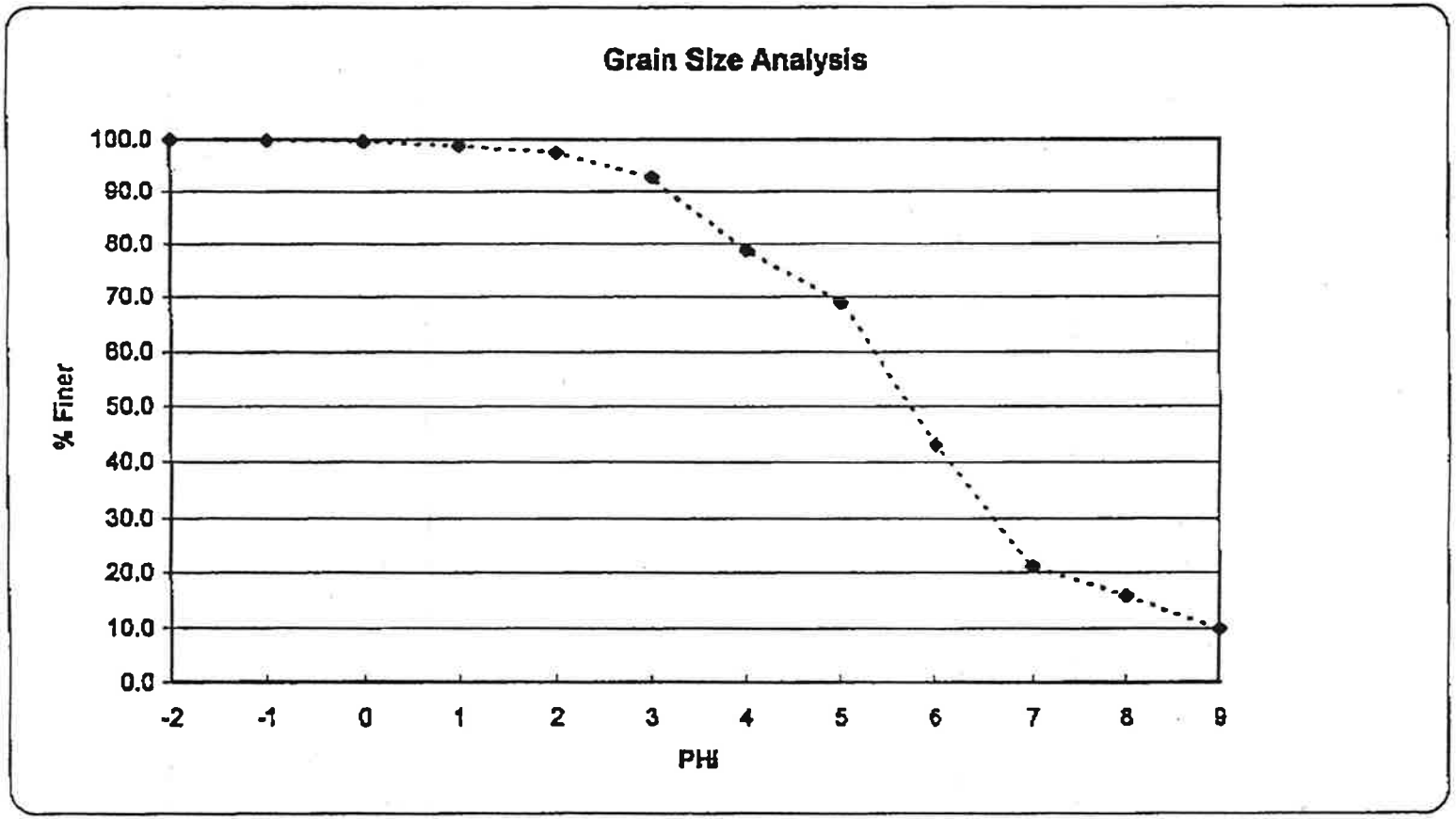
Sample I.D. **29818** EXP3 - Comp.
RPC # **7892-17**



% Gravel	0.00
% Sand	20.67
% Silt	59.37
% Clay	19.96

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

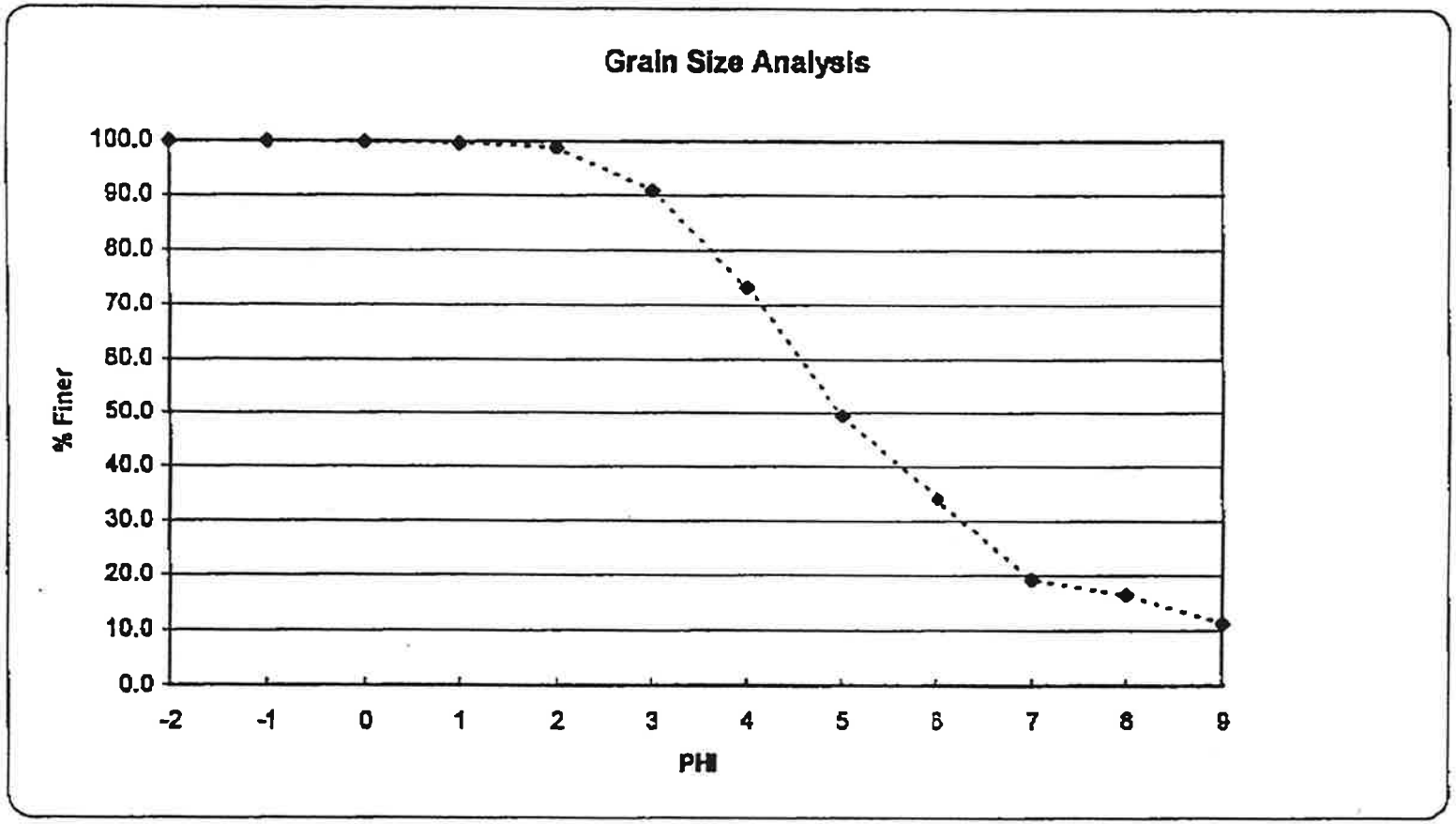
Sample I.D. **29819** EXP 4 - Comp
RPC # **7892-18**



% Gravel	0.10
% Sand	21.28
% Silt	62.77
% Clay	15.87

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

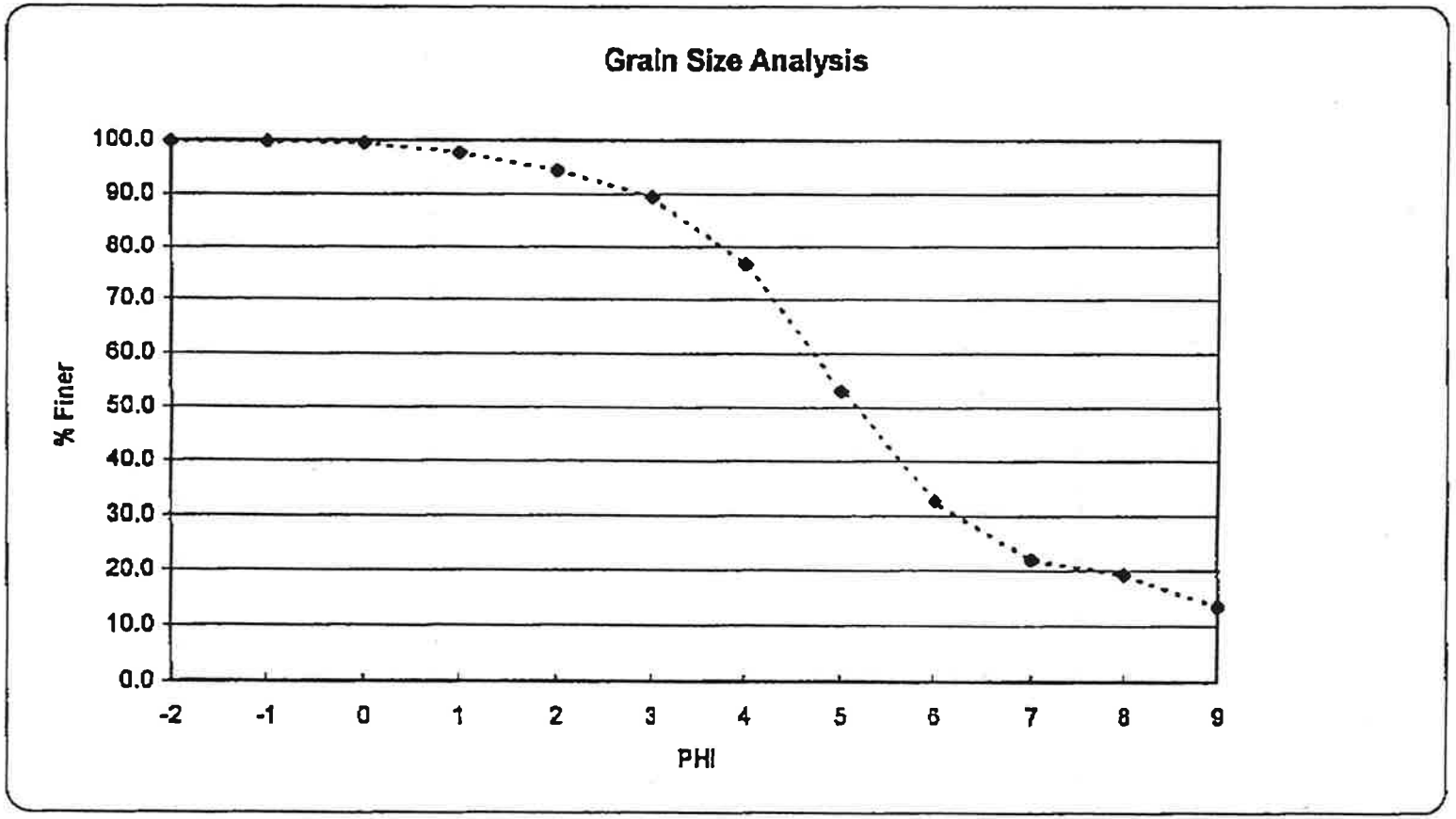
Sample I.D. 29820 Exp 5 - Comp
RPC # 7892-19



% Gravel	0.00
% Sand	26.72
% Silt	56.86
% Clay	16.42

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

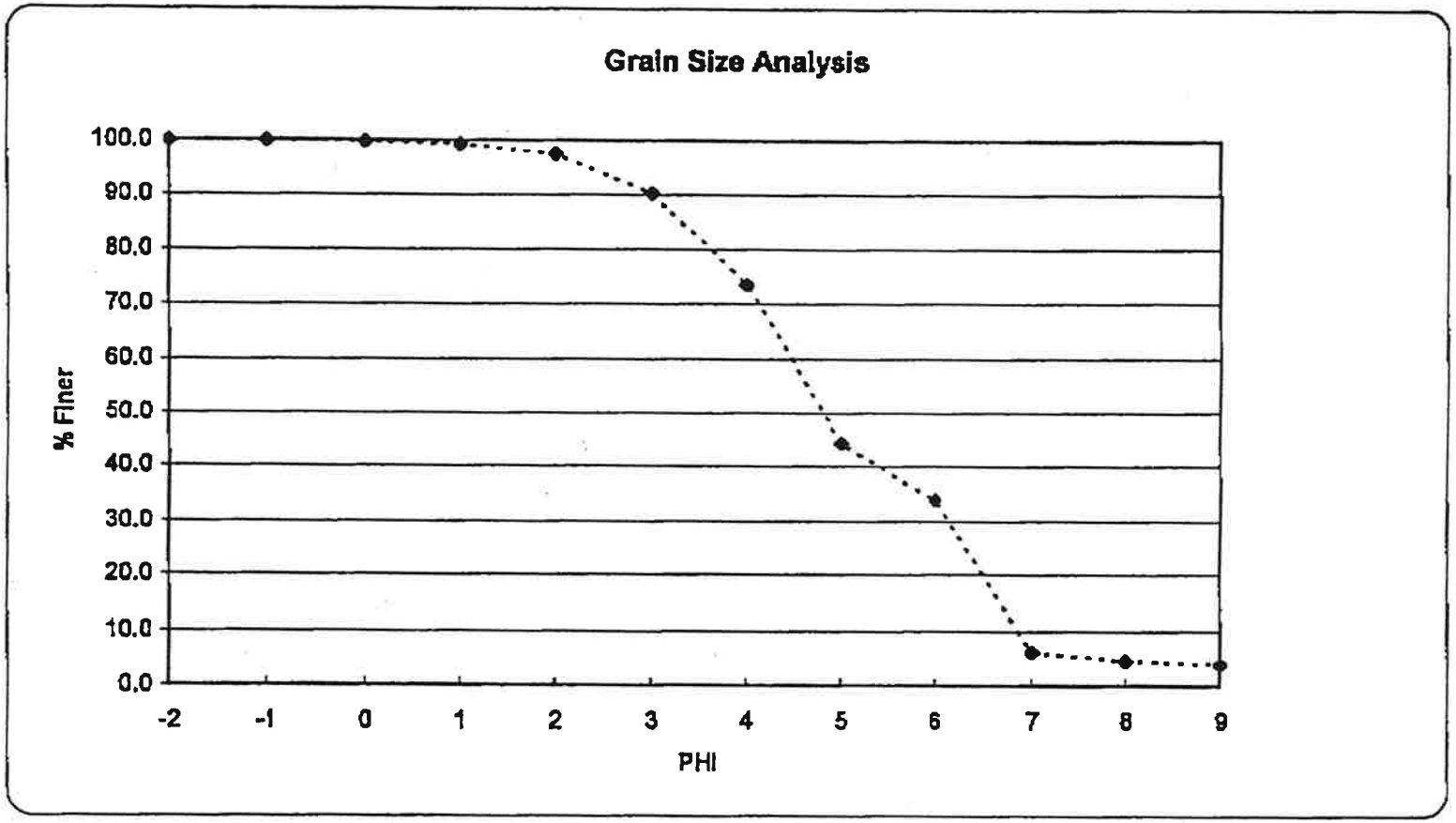
Sample I.D. **29821** EXP6- Comp
RPC # **7892-20**



% Gravel	0.16
% Sand	23.20
% Silt	57.41
% Clay	19.23

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

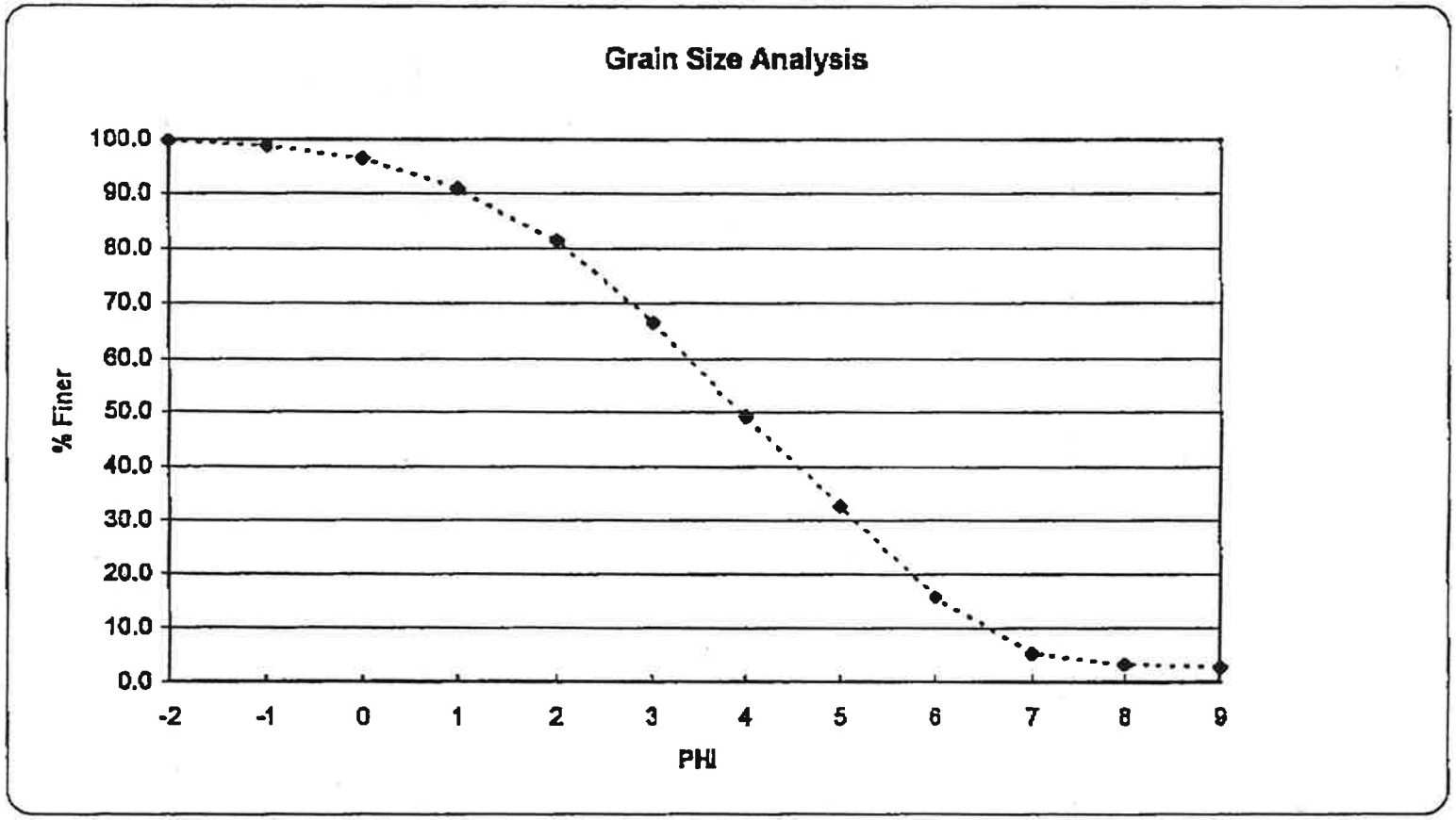
Sample I.D. 29822 REFI-Comp
RPC # 7892-21



% Gravel	0.02
% Sand	26.38
% Silt	68.91
% Clay	4.69

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

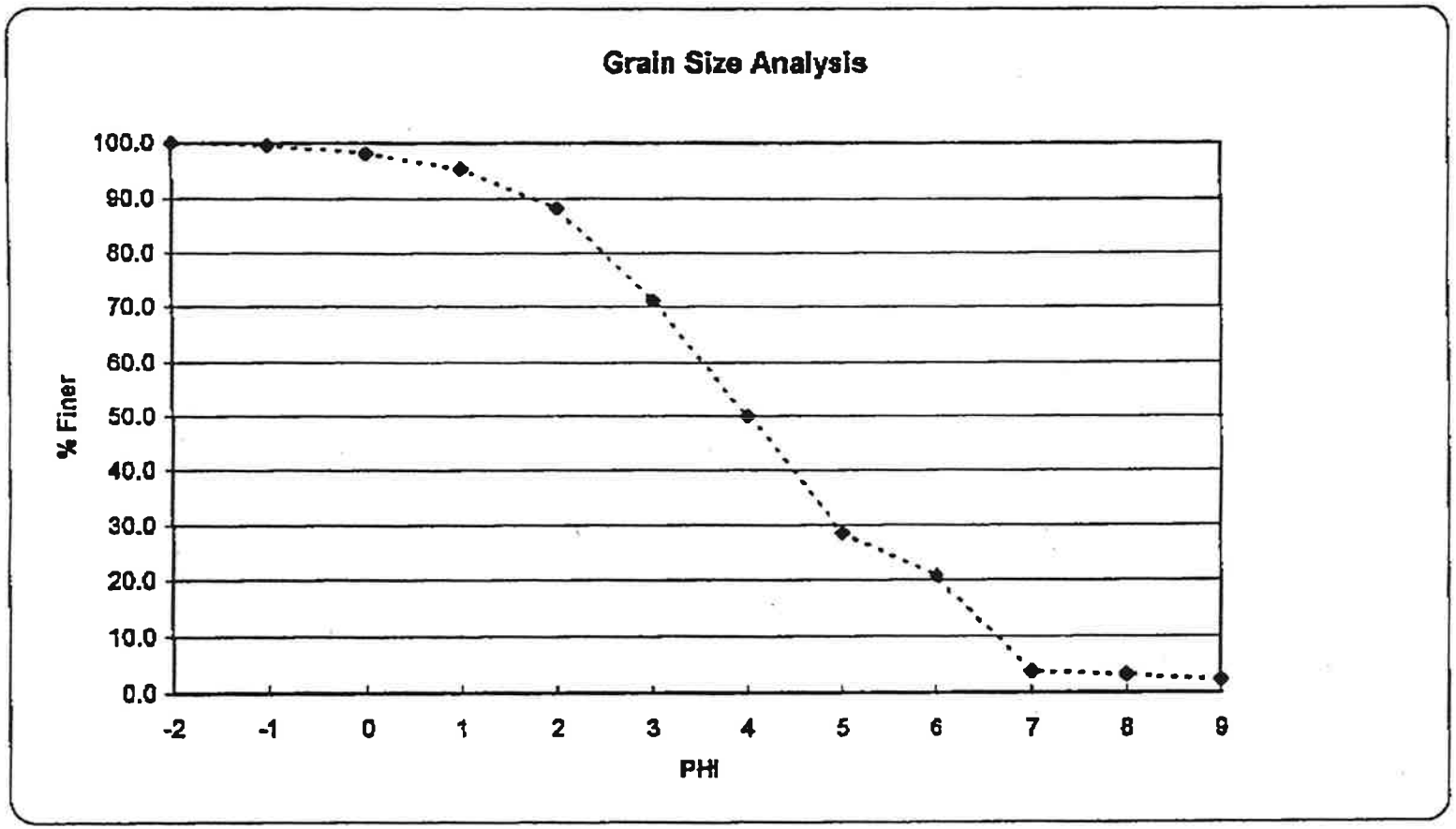
Sample I.D. **29823** REF 2-Comp
RPC # **7892-22**



% Gravel	1.14
% Sand	49.73
% Silt	45.94
% Clay	3.20

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

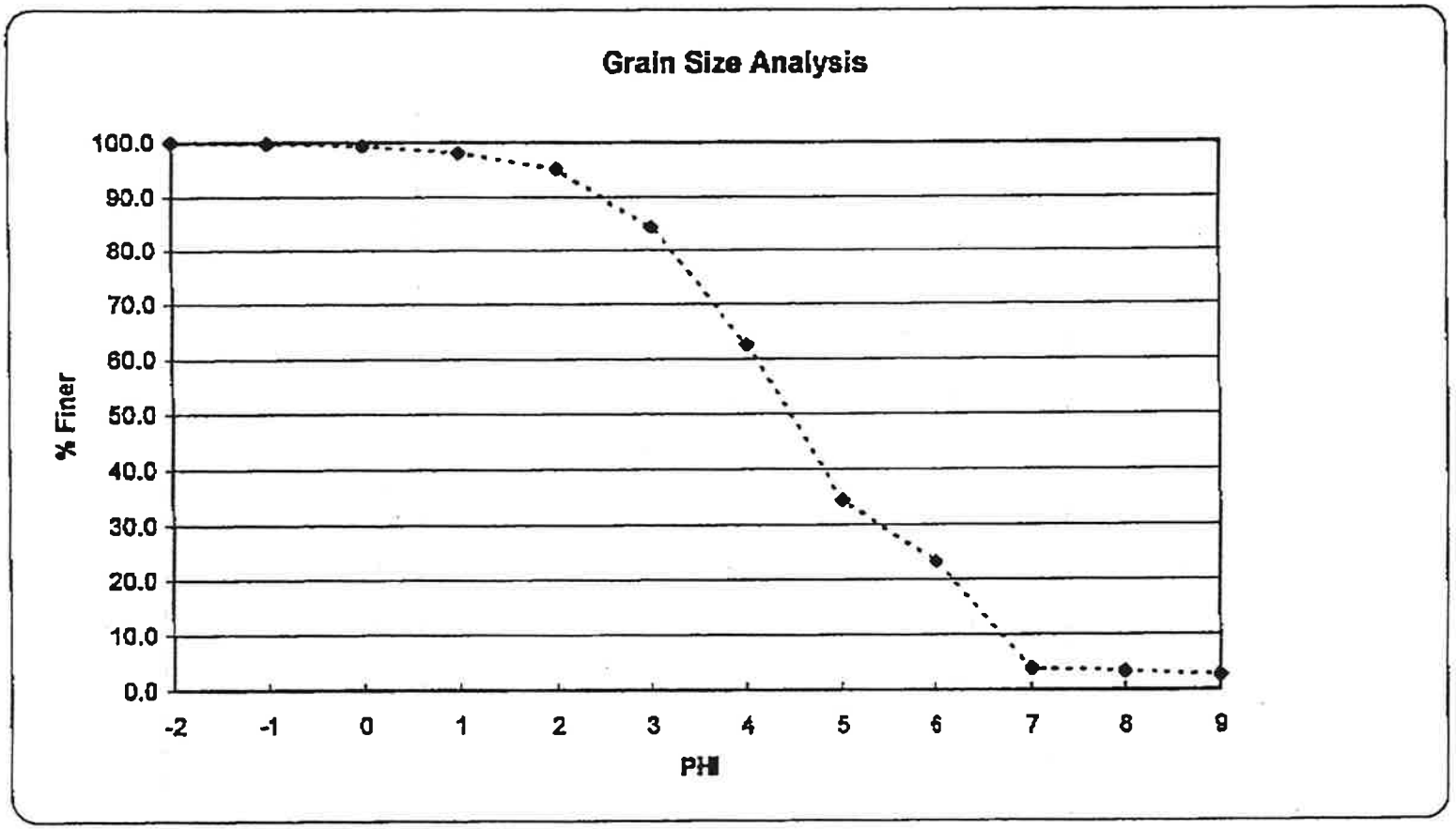
Sample I.D. 29824 REF3 - Comp
RPC # 7892-23



% Gravel	0.46
% Sand	49.57
% Silt	46.74
% Clay	3.22

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

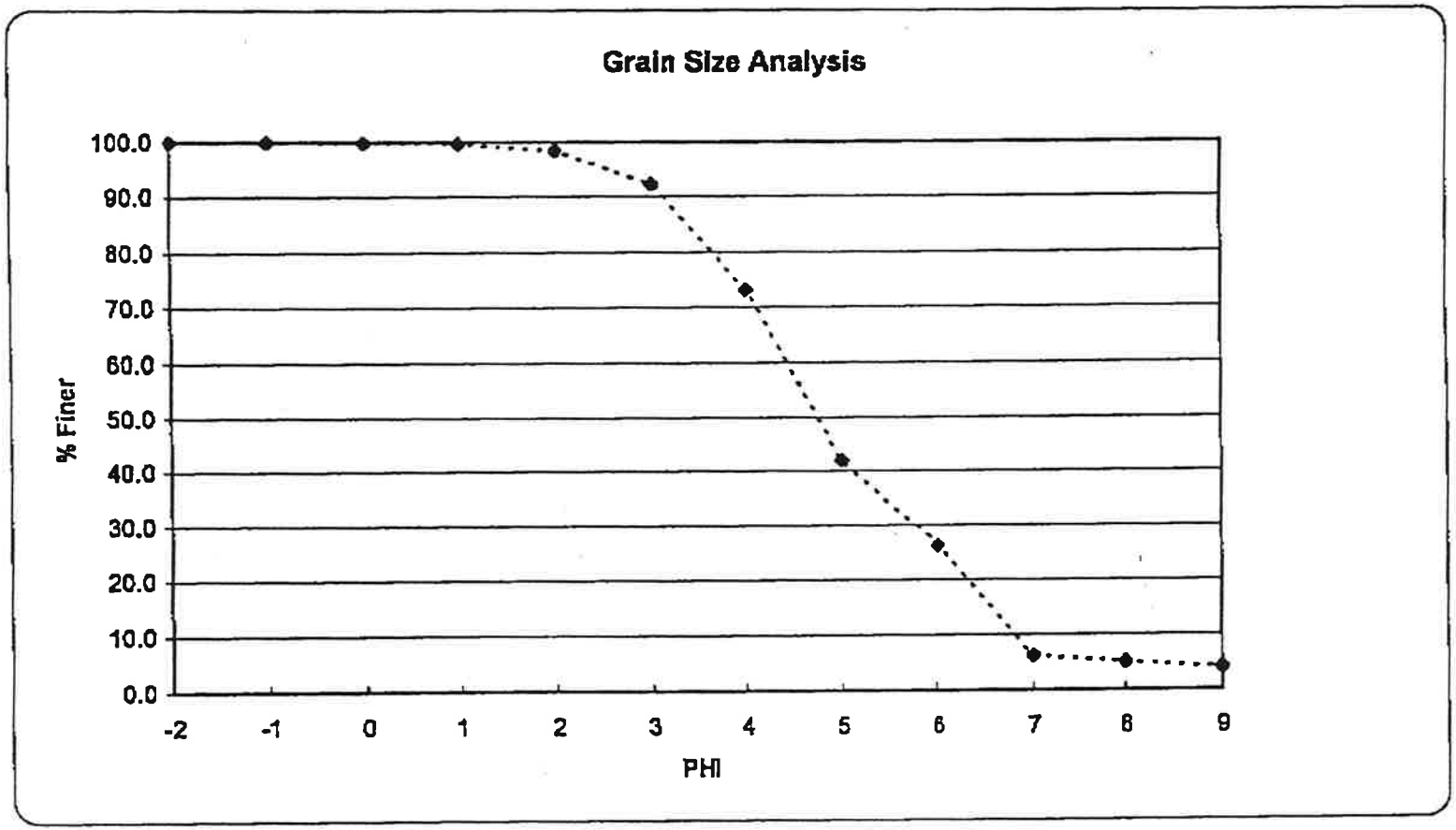
Sample I.D. 29825 REF 4-Comp
RPC # 7892-24



% Gravel	0.23
% Sand	37.19
% Silt	59.29
% Clay	3.29

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

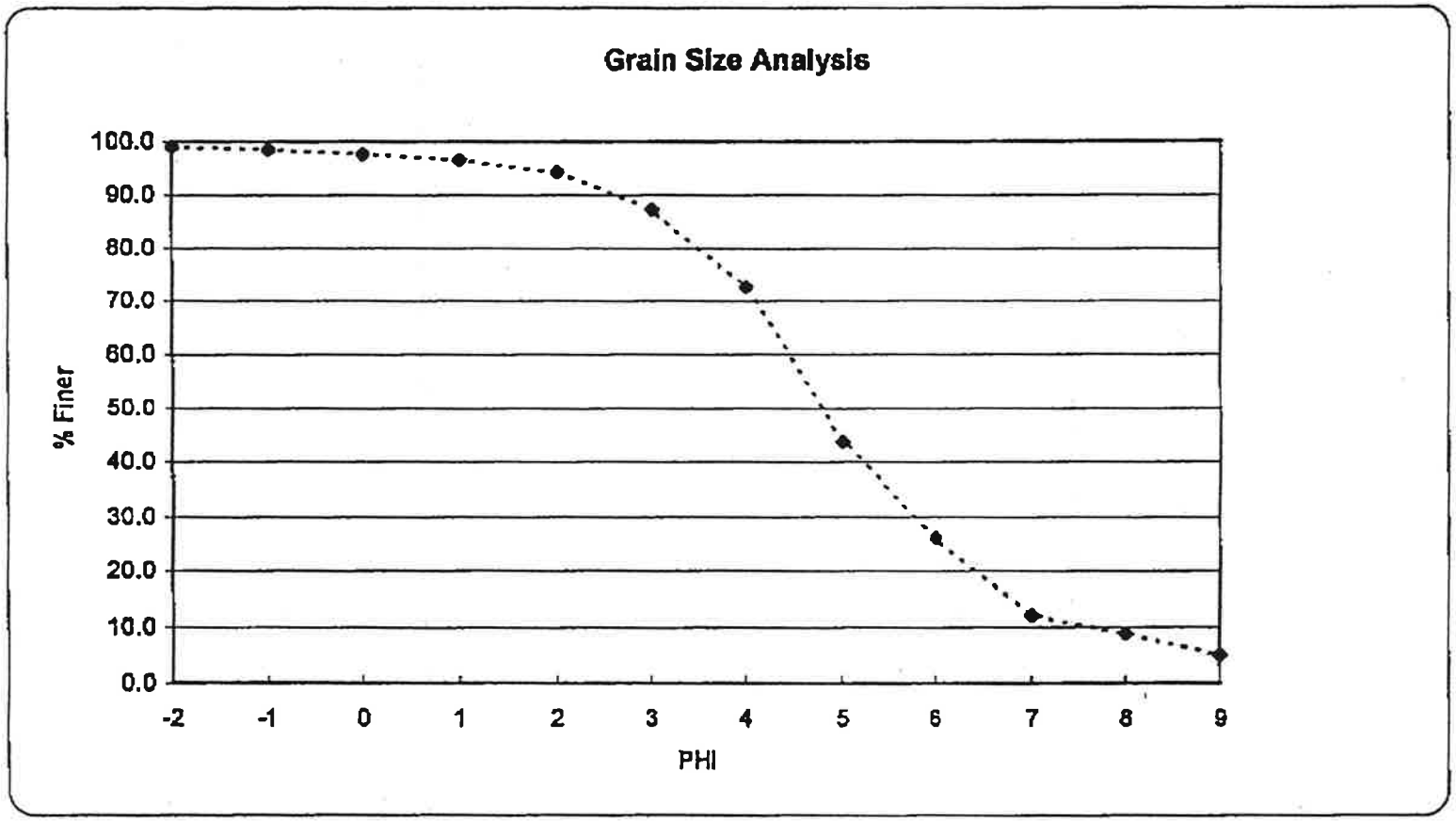
Sample I.D. **29826** REFS- Comp
RPC # **7892-25**



% Gravel	0.02
% Sand	26.87
% Silt	68.03
% Clay	5.08

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

Sample I.D. 29827 REF6-Comp.
RPC # 7892-26



% Gravel	1.49
% Sand	25.93
% Silt	63.80
% Clay	8.77

RPC
921 College Hill Rd.
Fredericton, N.B.
E3B 6Z9

WRKMET ANALYTICAL WORK SHEET - **Metal/Conventional Analysis**

TESTCODE:	COUR-HS-SO
SAMPLE TYPE:	SO

DATE:	96/10/16		
RUN #:	41066		
WC :	CRH	STAT:	COUR

TEST CODE SOP ID:	Courier, Subsample for Halifax

N 966572 Ecological Rev (96/10/11): Ten more samples for MET-30R-WT. MDLs to 1/10th of CCME guidelines where possible. Sn (Tin) to be added to SO 3C samples, a

MDS LAB SAMPLE #	CLIENT SAMPLE ID	Date Received	Process By date	Due Date	Process Date	Analysis Date	Sample Wt/Vol	Final Ext Vol	Add. Dil.	Result		%H2O	Fact.
1-Q1 41066_1													
2-Q2 41066_1													
3-966572 Q3 -76584		1996/09/25											
4-966572 SO 8C 76584	EXP1-Comp Rep	1996/09/25	1996/09/25	96/10/11									
5-966572 Q4 -76584		1996/09/25											
6-966572 SO 8C 76585	EXP1-Comp	1996/09/25	1996/09/25	96/10/11									
7-966572 SO 8C 76586	EXP2-Comp	1996/09/25	1996/09/25	96/10/11									
8-966572 SO 8C 76588	EXP4-Comp	1996/09/25	1996/09/25	96/10/11									
9-966572 SO 8C 76589	EXP5-Comp	1996/09/25	1996/09/25	96/10/11									
10-966572 SO 8C 76590	EXP6-Comp	1996/09/25	1996/09/25	96/10/11									
11-966572 SO 8C 76591	REF1-Comp	1996/09/25	1996/09/25	96/10/11									
12-966572 SO 8C 76592	REF2-Comp	1996/09/25	1996/09/25	96/10/11									
13-966572 SO 8C 76593	REF3-Comp	1996/09/25	1996/09/25	96/10/11									
14-966572 SO 8C 76594	REF4-Comp	1996/09/25	1996/09/25	96/10/11									
15-966572 SO 8C 76595	REF5-Comp	1996/09/25	1996/09/25	96/10/11									
16-966572 SO 8C 76596	REF6-Comp	1996/09/25	1996/09/25	96/10/11									

SURROGATE:	CONC:	UNITS:	VOLUME ADDED:
FORTIFICATION STANDARD:	CONC:	UNITS:	VOLUME ADDED:
INTERNAL STANDARD:	CONC:	UNITS:	VOLUME ADDED:
CALIBRATION STANDARD 1:	CONC:	UNITS:	VOLUME ADDED:
CALIBRATION STANDARD 2:	CONC:	UNITS:	VOLUME ADDED:
CALIBRATION STANDARD 3:	CONC:	UNITS:	VOLUME ADDED:
CALIBRATION STANDARD 4:	CONC:	UNITS:	VOLUME ADDED:
CALIBRATION STANDARD 5:	CONC:	UNITS:	VOLUME ADDED:

SAMPLE CALCULATION:

PROCESSED BY:	DATE:
ANALYZED BY:	DATE:

APPENDIX E

Benthic Invertebrate Community Structure

APPENDIX E1

Detailed Methods

SAMPLE PROCESSING

All benthos samples were processed and analyzed by Zaranko Environmental Assessment Series (ZEAS), Guelph, ON.

Upon arrival, samples were immediately logged and inspected to ensure adequate preservation to a minimum level of 10% buffered formalin and correct labeling. No problems with preservative or labeling were identified. All benthic samples were sorted with the use of a stereomicroscope. A magnification of 10X was used for macrobenthos (invertebrates > 500 µm) and 20X for meiobenthos (invertebrate size from 200 to 500 µm). To expedite sorting, prior to processing, all samples were stained with a protein dye that is absorbed by aquatic organisms but not by organic material such as detritus and algae. The stain has proven to be extremely effective in increasing sorting accuracy and efficiency.

Prior to sorting, samples were washed free of formalin in a 250 µm sieve. Benthic invertebrates and associated debris were elutriated from any sand and gravel in the sample. Elutriation techniques effectively removed almost all organisms. The remaining sand and gravel fraction was closely inspected for the odd heavier organism such as Pelecypoda, Gastropoda, and Trichoptera with stone cases that may not have all been washed from this fraction. After elutriation, the remaining debris and benthic invertebrates were washed through a series of two sieves, 500µm and 250 µm respectively.

SUBSAMPLING

Benthic samples were sorted entirely (both 500 and 250 µm) except in the instance of large amounts of organic matter and high densities of organisms. Benthic samples containing large amount of organic matter or high densities of organisms can often take days to sort entirely. Thus sorting the whole sample may not be cost effective. In addition, with large quantities of organic matter there comes a point when additional sorting does not yield further ecological information. As such, the following subsampling techniques were employed.

Sample material was distributed evenly on the 500 µm and 250 µm sieves. One half of the material was removed and set aside while the remaining half was distributed evenly on each sieve and again divided in two. A minimum subsample volume of 25% was the criteria set for this study. The same fraction was sorted from the 500 µm and the 250 µm sieve. On average, each sample took between five and six hours to sort in which an average of 300 organisms were removed from the associated debris.

Benthic invertebrates were enumerated and sorted into major taxonomic groups, (i.e., order and family), placed in glass vials and represerved in 70% ethanol for more detailed taxonomic analysis by senior staff. Each vial was labeled with the survey name, date, station, and replicate number. For QA/QC evaluation, sorted sediments and debris were represerved and will be retained for up to a

period of six months following the submission of the final report. For those samples that were subsampled, sorted and unsorted fractions were represerved separately.

DETAILED IDENTIFICATION

All invertebrates were identified to the lowest practical level, usually genus, with the exception of bivalves (*Sphaerium*), and oligochaetes which were identified to species. Nematodes were identified to phylum, water mites and harpacticoids to order, and ostracods to class.

Chironomids and oligochaetes were mounted on glass slides in a clearing media prior to identification using a compound microscope. In samples with large numbers of oligochaetes, a random sample of no less than 20% of the picked individuals, up to a maximum of 50, were mounted on slides for identification. Similarly, in samples with a large number of chironomids, individuals that could be identified using a dissecting scope, (e.g., *Cryptochironomus, Chironomus, Monodiamesa, Procladius, Heterotrissocladius*), were enumerated and removed from the sample. The remaining individuals were sorted into sub-families and tribes. A random sample of no less than 20% of the individuals from each group were mounted on slides for identification, up to a maximum of 50 individuals.

VOUCHER COLLECTION

The standard operating procedures for ZEAS's Benthic Ecology Laboratory requires the compilation of a voucher collection for all benthic invertebrate projects. Representative specimens for each taxon are placed in labeled glass vials. Mounted chironomids and oligochaetes remain on the initial slides and representatives of each taxon are circled with a permanent marker. A voucher collection is one way of ensuring continuity in taxonomic identifications if different taxonomists process future samples. The voucher collection is either maintained in our files indefinitely or returned to the client. ZEAS also maintains a master reference collection of all taxa which have been identified by the lab.

QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

ZEAS incorporates the following QA/QC procedures for all benthic studies to ensure reliability of data:

- all samples were stained to facilitate accurate sorting;
- the most updated and widely used taxonomic keys are referenced;
- 10% of all sorted samples were resorted by a second taxonomist to ensure 95% recovery of all invertebrates;
- a voucher collection was compiled and will be kept indefinitely or returned to the client;
- both sorted and unsorted sample fractions were represerved in 10 % formalin and will be maintained for six months after submission of the final report;
- all tabulated benthic data were cross checked against bench sheets by a second person to ensure there have been no data entry errors or incorrect spelling of scientific nomenclature;
- subsampling error was calculated for 10% of the samples requiring subsampling.

REPORTING BENTHIC MACROINVERTEBRATE DATA

Following identification and enumeration, a detailed taxa list was prepared for each station summarizing the total organism density and total number of taxa. The taxa list was prepared using Excel 5.0.

APPENDIX E2

QA/QC

TABLE 1. CALCULATION OF SUBSAMPLING ERROR FOR BENTHIC INVERTEBRATE SAMPLES FROM PLACER DOME, ONTARIO (1996).

Station	Number of Animals in Fraction 1	Number of Animals in Fraction 2	Standard Deviation	Coefficient of Variation
REF 2-1	33	37	2.83	8.1%
REF 5-1	109	97	8.49	8.2%

TABLE 2. PERCENTAGE RECOVERY OF BENTHIC INVERTEBRATES FROM SAMPLES FROM PLACER DOME, ONTARIO (1996).

Station	Number of Animals Recovered	Number of Animals in Re-sort	Percent Recovery
REF 3-1	181	8	95.8%
REF 6-1	167	8	95.4%

TABLE 3. SAMPLE FRACTION SORTED FOR PLACER DOME, ONTARIO (1996).

Station	Fraction Sorted
REF 1-1	1/4
REF 2-1	1/2[a]
REF 3-1	1/4
REF 4-1	1/4
REF 5-1	1/2[a]
REF 6-1	1/4
EXP 1-1	1/4
EXP 2-1	1/4
EXP 3-1	1/4
EXP 4-1	1/4
EXP 5-1	1/4
EXP 6-1	1/4

[a] two quarters sorted for subsampling error calculations

APPENDIX E3

Results

BENTHIC MACROINVERTEBRATES AT DOME MINE SITE (1996).

Station	Reference						Exposed					
Replicate	1	2	3	4	5	6	1	2	3	4	5	6
P. Nematoda	-	8	4	4	-	-	4	8	80	-	-	32
P. Annelida												
Cl. Oligochaeta												
F. Enchytraeidae	-	-	-	-	4	-	-	-	-	-	-	-
F. Naididae												
Chaetogaster diaphanus	-	-	4	-	-	-	-	-	-	-	-	-
Dero nivea	-	-	-	-	4	-	-	-	-	-	-	-
Nais barbata	-	-	-	-	-	-	4	-	-	-	-	-
?Nais communis	-	-	-	-	-	9	-	-	-	-	-	-
Nais simplex	-	-	-	-	-	-	-	-	-	-	-	12
Nais variabilis	-	-	-	-	-	-	4	-	12	8	-	-
F. Tubificidae												
immatures with hair chaetae	12	50	224	60	66	171	-	-	-	-	-	-
P. Arthropoda												
Cl. Arachnida												
O. Hydracarina	-	2	4	-	6	12	20	4	4	12	16	4
Cl. Maxillopoda												
O. Harpacticoida	4	2	-	4	6	4	-	-	-	-	-	-
Cl. Ostracoda	-	2	28	8	8	36	4	-	4	-	-	-
Cl. Entognatha												
O. Collembola	-	14	4	8	24	24	4	4	4	8	28	68
Cl. Insecta												
O. Coleoptera												
F. Haliplidae												
Haliplus	-	-	4	-	-	-	-	-	-	-	-	-
O. Ephemeroptera												
F. Baetidae												
Callibaetis	-	-	-	-	-	-	-	-	4	-	-	-
F. Caenidae												
Caenis	-	-	-	-	-	-	-	-	4	-	-	-
O. Lepidoptera												
F. Pyralidae	-	2	-	-	-	-	-	-	-	-	-	-
O. Odonata												
F. Coenagrionidae												
indeterminate	-	-	-	-	-	4	-	-	-	-	-	-
Enallagma	-	-	-	-	-	-	-	-	-	4	-	-
O. Hemiptera												
F. Corixidae												
Sigara hubbelli	-	-	-	-	2	-	-	-	-	-	-	4
O. Trichoptera												
indeterminate	-	-	4	-	-	-	-	-	-	-	-	-
O. Diptera												
F. Ceratopogonidae	52	10	32	72	12	16	4	-	4	-	-	-
F. Chaoboridae												
Chaoborus flavicans	12	2	-	-	-	-	8	-	-	-	4	-
Chaoborus punctipennis	-	-	-	-	-	-	-	-	-	-	16	16
F. Chironomidae												
S.F. Chironominae												
Chironomus	-	-	44	-	22	4	-	-	-	-	4	-
Cladopelma	8	8	96	16	40	84	-	-	-	-	-	-
Dicrotendipes	4	-	-	-	-	8	-	-	24	-	-	-
Einfeldia	40	24	196	192	186	128	-	-	-	-	-	-
Endochironomus	-	-	-	-	6	32	-	-	32	24	8	24
Parachironomus	-	-	-	-	-	12	4	4	36	32	12	24
Paratanytarsus	-	-	-	-	-	-	-	8	28	-	-	-

BENTHIC MACROINVERTEBRATES AT DOME MINE SITE (1996).

Station	Reference						Exposed					
Replicate	1	2	3	4	5	6	1	2	3	4	5	6
Polypedilum	-	-	-	-	-	4	-	-	8	-	-	-
Tanytarsus	-	2	4	4	-	-	12	-	8	4	-	4
Tribe Chironomini	-	-	-	-	-	-	-	4	12	4	-	-
S.F. Orthocladiinae												
indeterminate	4	-	-	-	-	-	-	-	-	-	-	-
Acricotopus	-	-	-	-	-	-	4	-	-	-	-	-
Corynoneura	-	-	-	-	-	-	-	-	8	-	-	-
Cricotopus	-	2	4	4	8	-	24	4	32	4	-	4
Parakiefferiella	-	-	-	-	-	-	-	4	-	-	-	-
Psectrocladius	-	-	-	-	-	-	8	-	12	-	-	12
Thienemannia	-	2	-	-	-	-	-	-	-	-	-	-
S.F. Tanypodinae												
indeterminate	-	-	-	-	-	4	-	-	-	-	-	-
Ablabesmyia	-	-	-	-	-	-	-	-	8	-	-	-
Procladius	4	2	64	40	20	72	4	-	-	-	-	-
Tanypus	-	2	-	-	-	24	-	-	-	-	-	-
F. Dixidae												
Dixella	-	-	-	-	-	-	-	-	-	-	-	8
P. Mollusca												
Cl. Gastropoda												
F. Planorbidae												
Gyraulus	-	2	-	-	2	-	-	-	-	-	-	-
F. Physidae												
Physella	-	-	4	-	-	-	-	-	-	-	-	-
Cl. Pelecypoda												
F. Sphaeriidae												
Pisidium	-	-	4	4	2	16	-	-	-	-	-	-
Musculium partumeium	-	-	-	-	-	4	-	-	-	-	-	-
TOTAL NUMBER OF ORGANIS	140	136	724	416	418	668	108	40	324	100	88	212
TOTAL NUMBER OF TAXA	9	17	17	12	17	20	14	8	19	9	7	12

TABLE 1. CALCULATION OF SUBSAMPLING ERROR FOR BENTHIC INVERTEBRATE SAMPLES FROM PLACER DOME, ONTARIO (1996).

Station	Number of Animals in Fraction 1	Number of Animals in Fraction 2	Standard Deviation	Coefficient of Variation
REF 2-1	33	37	2.83	8.1%
REF 5-1	109	97	8.49	8.2%

TABLE 2. PERCENTAGE RECOVERY OF BENTHIC INVERTEBRATES FROM SAMPLES FROM PLACER DOME, ONTARIO (1996).

Station	Number of Animals Recovered	Number of Animals in Re-sort	Percent Recovery
REF 3-1	181	8	95.8%
REF 6-1	167	8	95.4%

TABLE 3. SAMPLE FRACTION SORTED FOR PLACER DOME, ONTARIO (1996).

Station	Fraction Sorted
REF 1-1	1/4
REF 2-1	1/2[a]
REF 3-1	1/4
REF 4-1	1/4
REF 5-1	1/2[a]
REF 6-1	1/4
EXP 1-1	1/4
EXP 2-1	1/4
EXP 3-1	1/4
EXP 4-1	1/4
EXP 5-1	1/4
EXP 6-1	1/4

[a] two quarters sorted for subsampling error calculations

APPENDIX F

Fisheries

APPENDIX F1

Detailed Methods

Fish Habitat Assessment Methodology for DNRE/DFO Table

GENERAL INFORMATION
This methodology is to be used for information when completing the DNRE/DFO Table- New Brunswick Stream Survey and Habitat Assessment. The information provided from the survey will help to determine the streams potential for fish production, as well as identify problem areas which may in turn affect the quality of the river/stream.

SIDE 1/PAGE 1

TABLE HEADING	
River:	**- the name of the river or stream being surveyed**
Start Point:	**- 500 m upstream of the proposed crossing**
End Point:	**- 500 m downstream of the proposed crossing**
Drainage Code:	
Stream/River No.:	
Personnel:	**- fill in each surveyors initials**
Date:	**- fill in date on which survey is performed**
GIS Map No.:	**- if known, fill in the Forest Inventory Map number pertaining to area on river/stream being surveyed**
Stream Order No.:	

TABLE	
Rules for filling out the table: • for something assessed, but not observed put (0) • for something not assessed put (--) • specify orientations as: R = right L = left M = middle	
Column 1 **"Reach No."**	• reach number one starts 500 m upstream of the proposed crossing and continues downstream, terminating at the proposed crossing. • reach number two starts at the proposed crossing and continues downstream 500 m.
Column 2 "Unit No."	Each distinctive stream type encountered during the stream survey is denoted as a discrete unit and numbered consecutively, starting with one, from the start point to the end point of each reach surveyed.

Fish Habitat Assessment Methodology (continued)

<table>
<tr><td>Column 3
"Stream Type"</td><td>Identify and record stream type by number from the "Stream Type" table below. Definitions are presented in the attached Glossary.</td></tr>
<tr><td colspan="2">
STREAM TYPE
<table>
<tr><th colspan="2">FASTWATER</th><th colspan="2">POOLS</th></tr>
<tr><td>1. Fall
2. Cascade
3. Riffle (Gr/Rb)
4. Riffle (R/B)
5. Riffle (Sand)</td><td>6. Sheet (ledge)
7. Chute
8. Run
9. Rapid</td><td>10. Midchannel
11. Convergence
12. Lateral
13.Beaver
14.Trench
15. Plunge
16.
17. Bogan</td><td>18. Eddy
19. Gabion
20. Log Structure
21. Road Crossing
22. Wood Debris
23. Man-Made Dam
24. Natural Deadwater</td></tr>
</table>
</td></tr>
<tr><td>Column 4
"Channel Type"</td><td>Two or more stream types may occupy the width of a river/stream. In such cases the location of the stream type must be denoted as R, L or M.

Right and left are with respect to the right and left sides of the surveyor, as the surveyor is moving from upstream to downstream.

Main Channel: used when the stream identified encompasses the entire width of the river.

Side Channel: used when an island divides the river into two or more channels. One channel would be identified as the Main (1) and the other as a Side channel (2).
- specify if the side channel is to the left (L) or the right (R) of the Main Channel.

Split: used when there are two or more stream types encompassing the entire width of the river/stream use R, L to divide right and left sides.

Bogan: used when there is a backdrop of water due to an incoming tributary. Substrate normally consists of sands and fines
- specify if the bogan is on the left (L) or on the right (R).

(e.g., The survey for reach one has just begun. The river or stream has three stream types encompassing the entire width of the river or stream. To the left is a riffle (stream type 3, 4 or 5, depending on substrate composition); In the middle is a pool (stream type 14 to 24, depending on pool characteristics); To the right is a run (stream type 8). The riffle would be unit 1, the pool would be unit 2 and the run would be unit 3. The channel type of unit 1 would be written as 3L. The number designates the riffle as a split, with the unit being on the left side of the stream (L). The channel type for unit 2 would be written as 3M, and that for unit 3 would be 3R.)</td></tr>
<tr><td>Column 5
"Length (m)"</td><td>Length of the stream type being measured (i.e. the length of the unit)</td></tr>
</table>

Fish Habitat Assessment Methodology (continued)

<table>
<tr><td>Column 6
"Average Width (m)"</td><td>Wet Width:
-The width of the river/stream system, in metres, from the edge of the existing water line of one bank to the edge of the existing water line of the opposite bank. Measurement is based on low water. The wet width is measured throughout the unit and the average is calculated.

Bank Channel Width:
-The channel width of river/stream system in, metres, based on the high water mark from one bank to the opposite bank. The channel width is measured throughout the unit and an average is calculated.</td></tr>
<tr><td>Column 7
"Substrate (%)"</td><td>Based on the chart below, use the criteria to identify the percent (%) of each substrate within the stream type.

The total of all substrate types must equal 100%</td></tr>
<tr><td colspan="2">SUBSTRATE AND CRITERIA

1. Bedrock, Ledge
2. Boulder = > 461 mm
3. Rock = 180 - 460 mm
4. Rubble = 54 - 179 mm
5. Gravel = 2.6 - 53 mm
6. Sand = 0.06 - 2.5 mm
7. Fines = 0.0005 - 0.05 mm</td></tr>
<tr><td>Column 8
"Average Depth - Wet Width (m)"</td><td>The wet depth is measured in metres from the stream bed to the water surface.

Measure wet depth throughout each stream type, within the boundaries of the left and right bank waterlines (as determined during the measurement of the average wet width). An average is calculated from the measured wet depths.</td></tr>
<tr><td>Column 9
"0-50% Undercut Bank"</td><td>The bank overhang above the water edge for each stream type, based on low water.

The left and right sides each represent 50% of the total stream type.

Identify the percent of the length of each side (left and right) that is undercut. (i.e., if a stream type is 10 m long and 5 m of the left side has an undercut and 4 m of the right side has an undercut bank then 25% (5m / 10m x 50%) of the left hand bank is undercut and 20% (4m / 10m x 50%) of the right hand bank is undercut.)</td></tr>
</table>

Fish Habitat Assessment Methodology (continued)

Column 10 **"0-50% Overhanging Bank Vegetation"**	Vegetation at or near the water surface. The left and right sides each represent 50% of the total stream type. Identify the percent of the area of both the left side and the right side of the stream type influenced by overhanging vegetation. *(i.e., if a stream type is 10 m long and 5 m of the left side is influenced by overhanging vegetation and 2 m of the right side is influenced by overhanging vegetation then 25 % (5m / 10m x 50%) of the left hand bank has overhanging vegetation and 10% (2m / 10m x 50%) of the right hand bank has overhanging vegetation.)*
Column 11 **"Large Woody Debris in Stream (m)"**	The additive length of in-stream woody debris for each stream type. Only consider woody debris that is 10 cm in diameter or greater.

Fish Habitat Assessment Methodology (continued)

Column 12 **"Flows"**	**Type:** - determined from the "Flow Type " table presented below: **Flow Type:** 1. Survey Stream 2. Spring 3. Tributary 4. Spring Seep **Flow (cms):** to determine flow, first fill out the Water Flow Measurement Table on side 2 of the form: Unit no.- is the unit number for which the flow is being determined (from Side 1). Stream type - is the stream type for which the flow is being determined (from Side 1). Wet width (m) (W) - record corresponding data from Side 1 Depth (m) (D) - the wet depth is taken at ¼, ½ and ¾ of the distance across the wet width, and measured from the stream bed to the water surface - the average of the depth is calculated (depth sum divided by 4) Coefficient (A) - 0.9 (smooth) is used when stream bed is mud, sand, bedrock - 0.8 (rough) is used for all other stream bed types Length (m) (L) - the distance over which an object is floated (not less than 3m), and should be done over an homogenous area Float Time (seconds) (T) - time it takes for a floatable object (*i.e.*, a dry stick, a whiffle ball) to travel the designated length - taken at ¼, ½ and ¾ of the distance across the wet width - the average is calculated (float time sum divided by three) Comments - using the " Checklist of Land use and Attributes" on Side 1, record the number(s) which will best describe the location and/or problems affecting it. If no codes apply then write any observations that can accurately describe the area or location where the flow was measured. Flow is calculated using the equation at the bottom of side 2: W x D x A x L/T. Time: the time at which the flow is measured **Temperature:** the ambient and water temperatures, measured in degrees Celsius, at the time the flow is measured

Fish Habitat Assessment Methodology (continued)

Column 13 **"% Substrate Embeddedness"**	The percent of sands or fine material surrounding larger substrate (gravel through boulder). Record the number, from the chart below, which best represents the embeddedness of the large substrate in the streambed **Embeddedness Criteria** 1. ≤ 20% 2. 20% - 35% 3. 35% - 50% 4. ≥ 50%
Column 14 **"Comments"**	Using the "Checklist of Land Use Attributes", record the number(s) which will best describe the stream type location and/or problems affecting it.
SIDE 2/PAGE 2	
Column 1 **"Reach No."**	As in Side 1
Column 2 **"Site (50 m interval)"**	
Column 3 **"% Site"**	**Riffle/Run** - determine what percentage of each reach is riffle (gravel/rubble or rock/boulder or sand), and what percent of each reach is run. **Pools** - determine what percentage of each reach surveyed was pool habitat
Column 4 "Shade (%)"	Determine the percent of the stream type (from Side 1) which is shaded. This value will be based on the amount of the stream type which would be shaded by the sun between 10 am and 2 pm.
Column 5 **"Stream Banks"**	**Vegetation (%):** - percent of bare ground, grasses, shrubs and trees of both the left and right side from the channel bank and 15 m back (the shrubs category includes alders and willows). The total amount of stream bank vegetation should equal 100%. **Erosion (%):** - the left and right sides each represent 50% of the total stream type. - identify the percent of the length of each side that is stable, bare stable, eroding (bare stable refers to a bank that is stable but that has no vegetation on it). *(e.g., if a stream type is 10 m long and 5 m of the left bank is eroded and the remaining 5 m is stable with vegetation, and 10 m of the right bank is stable with no vegetation then the left bank is 25% (5m / 10m x 50%) stable, 0% bare stable and 25% (5m / 10m x 50%) eroding, and the right bank is 50% (10m / 10m x 50%) bare stable.)*

Fish Habitat Assessment Methodology (continued)

Column 6 **"O_2 (mg/l)"**	- the level of dissolved oxygen (mg/L) for each reach, measured in the field with a calibrated, YSI Dissolved Oxygen Meter (or equivalent)
Column 7 **"ph"**	- the pH for each reach, measured with a calibrated, field pH meter - measured in a laboratory from a grab sample taken at the time of the survey
Calcium and alkalinity are two parameters that need to be tested in the laboratory. There is no space for these criterion, however, these values are necessary in order to complete Table E2, DNRE/DFO - New Brunswick Stream Survey and Habitat Assessment. Only one grab sample is required from each reach to complete the analysis for pH, alkalinity and calcium,	
Column 8 **"Depth"**	**Wet:** the wet depth is taken, for each stream type, at ¼, ½ and ¾ of the distance across the wet width, and measured from the stream bed to the water surface, in metres. **Channel:** the channel depth is taken, for each stream type, at ¼, ½ and ¾ of the distance across the channel width. The depth is measured in metres from the stream bed to the upper limit of the channel width.
Column 9 **"Pool Rating"**	**Number:** assign an appropriate number from the criteria column of the "Pool Rating " table from the bottom of Side 1 to each pool encountered. **Letter:**
Column 10 **"Pool Tail"**	The lower or downstream end of the pool. **Embeddedness:** the percent of sands or fine material surrounding larger substrate (gravel through boulder). - record the number from the column chart, presented below, which best represents the embeddedness of the large substrate in the pool tail <u>Embeddedness Criteria</u> 1 ≤ 20% 2 20% - 35% 3 35% - 50% 4 ≥ 50% **Mean Substrate Size:** - the mean size of the substrate within the pool tail column **% Fine:** - how much of the substrate is fine material (diameter 0.0005 - 0.05 mm, from "Substrate" table, Side 1)
Column 11 "% Turbulence "	

River: South Porcupine River - EXPOSURE

Personnel: M. Zimmer / L. Carnegie

STREAM SURVEY and HABITAT ASSESSMENT

Start Point: EXP6 (17U483575 5367258)

End Point: EXP1 (17U483566 5367161)

Date: September 17/96

GIS Map No.

Drainage Code

Stream/River No.

Stream Order No.

REACH NO.	UNIT NO.*	STREAM TYPE	CHANNEL TYPE	LENGTH (m) *	AVE WIDTH (m) * WET	AVE WIDTH (m) * BANK CHANNEL	SUBSTRATE (%) * BED-ROCK	BOULDER	ROCK	RUBBLE	GRAVEL	SAND	FINES + organics	AVE DEPTH * WET WIDTH (cm) *	0-50% UNDERCUT BANK * L	R	0-50% OVER-HANGING BANK VEGETATION * L	R	LARGE WOODY DEBRIS IN STREAM (m) *	FLOWS * TYPE	FLOW (cms)	TIME	TEMP °C W	TEMP °C A	EMBEDDEDNESS * (CRITERIA) 1: < 20% 2: 20% - 35% 3: 35% - 60% 4: > 60%	COMMENTS	CHECKLIST OF LAND USE ATTRIBUTES (COMMENTS)
EXP	6	13	1	10	6.15		0	0	0	0	0	21	99	1.43	0	0	10	10	0	1	0.096	12:30	14	18	1	1,12,43	
EXP	5	13	1	10	5.75		0	0	0	0	0	21	99	1.72	0	0	10	10	0	1	0.096	12:30	14	18	1	1,12,43	
EXP	4	13	1	10	6.90		0	0	0	0	0	21	99	1.78	0	0	10	10	0	1	0.096	12:30	14	18	1	1,12,43	
EXP	3	13	1	10	5.20		0	0	0	0	0	21	99	1.37	0	0	10	10	0	1	0.096	12:30	14	18	1	1,12,43	
EXP	2	13	1	10	12.4		0	0	0	0	0	21	99	1.77	0	0	10	10	0	1	0.096	12:30	14	18	1	1,12,43	
EXP	1	13	1	10	5.95		0	0	0	0	0	21	99	1.49	0	0	10	10	0	1	0.096	12:30	M	18	1	1,12,43	

* = Sampling site

CHECKLIST OF LAND USE ATTRIBUTES (COMMENTS)

1. ACTIVE BEAVER DAM
2. INACTIVE BEAVER DAM
3. WOODY DEBRIS OBSTRUCTION
4. MAN-MADE DAM OBSTRUCTION
5. ROCK DAM (SWIMMING POOL)
6. BRAIDED STREAM CHANNELS
7. OBSTRUCTION IN STREAM
8. ROAD FORD

POLLUTION CAUSED BY:

9. FOOD PROCESSING INDUSTRY
10. FOREST INDUSTRY
11. CAMPSITES OR RESIDENTIAL
12. MINING
13. LITTER
14. OIL
15. AGRICULTURE WASTE
16. HEALTH HAZARD
17. CLEAR CUT TO STREAM EDGE
18. SELECTIVE CUT
19. BUFFER STRIP PRESENT
20. CATTLE CROSSING
21. EROSION FROM AGRICULTURE
22. SUSPENDED SILT NOTED
23. UNUSUAL STREAM SCOURING
24. LARGE BEDLOAD DEPOSIT
25. BANK EROSION - MODERATE
26. BANK EROSION - EXCESSIVE
27. STREAM DREDGING/BULLDOZING
28. GRAVEL REMOVAL
29. CHANNELIZATION (RIPRAP, ETC.)
30. STREAM DIVERSION
31. WATER WITHDRAWAL
32. REGULATED STREAM FLOW
33. CAMP/COTTAGE PRESENT
34. RESIDENTIAL AREA
35. ACCESS - ATV'S
36. ACCESS - TRAILS
37. ACCESS - TRUCK/CAR
38. ACCESS - BOAT
39. ROAD CROSSING (BRIDGE)
40. ROAD CROSSING (CULVERT)
41. BOAT LANDING
42. ORGANIC LITTER
43. AQUATIC PLANTS ABUNDANT
44. GOOD SPAWNING
45. GOOD NURSERY

STREAM TYPE

FASTWATER
1. Fall
2. Cascade
3. Riffle (GR/RB)
4. Riffle (R/B)
5. Riffle (Sand)
6. Sheet Bedrock
7. Chute
8. Run
9. Rapid

POOLS
10. Midchannel
11. Convergence
12. Lateral
13. Beaver
14. Trench
15. Plunge
16.
17. Bogan
18. Eddy
19. Gabion
20. Log Structure
21. Road Crossing
22. Wood Debris
23. Man-Made Dam
24. Natural Deadwater

CHANNEL TYPE
1. Main (if measurement refers to main area of river)
2. Side Channel (water diverted by islands)
3. Split (if river is split into various different stream types)
4. Bogan

* - Specify Left (L), Right (R) or Middle (M)

SUBSTRATE
1. Bedrock, Ledge
2. Boulder = > 481 mm
3. Rock = 180 - 480 mm
4. Rubble = 64 - 179 mm
5. Gravel = 2.6 - 53 mm
6. Sand = 0.06 - 2.5 mm
7. Fines = 0.0005 - 0.05 mm

FLOW TYPE
1. Survey Stream
2. Spring
3. Brook/River Trib
4. Spring Seep

POOL RATING (reverse side)

CRITERIA (NO.)	% OF POOLS IN SITE (LETTER)
Pool Depth > 1.8 m 1 - Instream Cover > 30% 2 - Instream Cover < 30%	a - > 30% b - > 10% to 30% c - < 10%
Pool Depth .8 to 1.8m 3 - Instream Cover > 30% 4 - Instream Cover > 30%	a - > 50% b - < 50%

Note: Stream surveys should be undertaken only during summer base flow) flow conditions. Also, minimum size of stream type is 4m² for larger streams.

1. Chute: water depth equal to or greater than channel width
2. Riffle: GR/RB - is a riffle flowing over a gravel and/or rubble bottom
   R/B - is a riffle flowing over & through large substrates (eg. rock and /or boulder), some of which protrudes the surface
3. Side channels - treat as a separate stream type

4. Undercut Bank - % of bank overhang (above water edge for stream type. Specify left (L) or right (R)
5. Over-hanging Bank Vegetation - % of vegetation overhang for stream type. Specify L or R
6. Visual Embeddedness - % of sands or fines surrounding the larger substrates, up to 100%
7. Woody Debris - total width should be > 10 cm in diameter

A = 0.8 for rough bottom

REACH NO.	SITE (50m - intervals)	% SITE		SHADE (%)	VEGETATION (%)				EROSION (%)						O₂ (mg/l)	pH	DEPTH						POOL RATING (CRITERIA ON OTHER SIDE)		POOL TAIL			
		RIFFLE/ RUN	POOLS		BARE GROUND	GRASSES	SHRUBS	TREES	LEFT BANK (0-50%)			RIGHT BANK (0-50%)					1/4 (m)		1/2 (m)		3/4 (m)				EMBEDDEDNESS (CRITERIA) 1: ≤ 20% 2: 20% - 35% 3: 35% - 50% 4: > 50%	MEAN SUBSTRATE SIZE (cm or category)	% FINE	TU (C
									STABLE	BARE STABLE	ERODING	STABLE	BARE STABLE	ERODING			WET	CHANNEL	WET	CHANNEL	WET	CHANNEL	NO.	LETTER				
EXP		0	100	0	0	80	20	0	50	0	0	50	0	0	--	--	1.20	--	1.61	--	1.49	--	1		1		100	
EXP		0	100	1	0	60	40	0	50	0	0	50	0	0	--	--	1.77	--	1.78	--	1.61	--	1		1		100	
EXP		0	100	2	0	50	50	0	50	0	0	50	0	0	--	--	1.95	--	2.00	--	1.38	--	1		1		100	
EXP		0	100	0	0	60	40	0	50	0	0	50	0	0	8.0	8.0	1.30	--	1.40	--	1.41	--	3		1		100	
EXP		0	100	0	0	70	30	0	50	0	0	50	0	0	2.0	8.0	1.74	--	1.99	--	1.57	--	1		1		100	
EXP		0	100	2	0	50	50	0	50	0	0	50	0	0	2.4	7.9	1.42	--	1.60	--	1.45	--	1		1		100	

NOTE: * For selected site study, these columns (reverse side) should be done for a habitat assessment

WATER FLOW MEASUREMENT

REACH NO.	CORRESPONDING LOCATION		STREAM TYPE	WET WIDTH (m)	DEPTH (cm)			AVERAGE DEPTH SUM / 4		COEFFICIENT (0.9 - smooth) (0.8 - rough)	LENGTH (3m)	FLOAT TIME (sec)				COMMENTS (LOCATION)
	UNIT NO.	SITE (50 - interval)			1/4 way	1/2 way	3/4 way	CENTIMETERS (cm)	METERS (m)			1/4 way	1/2 way	3/4 way	AVERAGE	

Formula (CMS) = W (m) x D (m) x A x L (m) / T (sec) Where: W = width, D = depth, L = length, A is a coefficient for the stream bottom

CRITERIA:

Personnel M. Zimmer / G. Carnegie — REFERENCE

Start Point: REF6 (17U 480105 5365554) — End Point: REF1 (17U 480108 5365523) — SURVEY and HABITAT ASSESSMENT

Date: Sep 19/96 — GIS Map No. — Drainage Code ☐☐☐☐☐☐

Stream/River No. — Stream Order No.

REACH NO.	UNIT NO.	STREAM TYPE	CHANNEL TYPE	LENGTH (m)	AVE WIDTH (m) WET	AVE WIDTH (m) BANK CHANNEL	SUBSTRATE (%) BED-ROCK	BOULDER	ROCK	RUBBLE	GRAVEL	SAND	FINES	AVE DEPTH - WET WIDTH (cm)	0-50% UNDERCUT BANK L	0-50% UNDERCUT BANK R	0-50% OVER-HANGING BANK VEGETATION L	0-50% OVER-HANGING BANK VEGETATION R	LARGE WOODY DEBRIS IN STREAM (no)	FLOWS TYPE	FLOWS FLOW (cms)	FLOWS TIME	FLOWS TEMP °C W	FLOWS TEMP °C A	EMBEDDEDNESS (CRITERIA)	COMMENTS	CHECKLIST OF LAND USE ATTRIBUTES (COMMENTS)
REF	6	13	1	3	7.65	--	0	0	0	0	0	41	99	94	0	0	25	0	0	1	0.003	17:30	14.0	20.0	1	1,19,43	
REF	5	13	1	3	8.75	--	0	0	0	0	0	41	99	79	0	0	5	0	0	1	0.003	17:45	14.0	14.0	1	1,19,43	
REF	4	13	1	3	6.15	--	0	0	0	0	0	41	99	76	0	0	0	0	0	1	0.003	18:00	14.0	16.0	1	1,19,43	
REF	3	13	1	3	5.36	--	0	0	0	0	0	41	99	82	0	0	15	0	0	1	0.003	18:15	14.0	13.0	1	1,19,43	
REF	2	13	1	3	6.77	--	0	0	0	0	0	41	99	93	0	0	5	0	0	1	0.003	18:30	14.0	13.0	1	1,19,43	
REF	1	13	1	3	8.00	--	0	3	0	0	7	3	87	114	0	0	5	5	0	1	0.003	18:45	14.0	13.0	4	1,40,43	

* = Sampling site

CHECKLIST OF LAND USE ATTRIBUTES (COMMENTS)

1. ACTIVE BEAVER DAM
2. INACTIVE BEAVER DAM
3. WOODY DEBRIS OBSTRUCTION
4. MAN-MADE DAM OBSTRUCTION
5. ROCK DAM (SWIMMING POOL)
6. BRAIDED STREAM CHANNELS
7. OBSTRUCTION IN STREAM
8. ROAD FORD

POLLUTION CAUSED BY:

9. FOOD PROCESSING INDUSTRY
10. FOREST INDUSTRY
11. CAMPSITES OR RESIDENTIAL
12. MINING
13. LITTER
14. OIL
15. AGRICULTURE WASTE
16. HEALTH HAZARD
17. CLEAR CUT TO STREAM EDGE
18. SELECTIVE CUT
19. BUFFER STRIP PRESENT
20. CATTLE CROSSING
21. EROSION FROM AGRICULTURE
22. SUSPENDED SILT NOTED
23. UNUSUAL STREAM SCOURING
24. LARGE BEDLOAD DEPOSIT
25. BANK EROSION - MODERATE
26. BANK EROSION - EXCESSIVE
27. STREAM DREDGING/BULLDOZING
28. GRAVEL REMOVAL
29. CHANNELIZATION (RIPRAP, ETC.)
30. STREAM DIVERSION
31. WATER WITHDRAWAL
32. REGULATED STREAM FLOW
33. CAMP/COTTAGE PRESENT
34. RESIDENTIAL AREA
35. ACCESS - ATV'S
36. ACCESS - TRAILS
37. ACCESS - TRUCK/CAR
38. ACCESS -BOAT
39. ROAD CROSSING (BRIDGE)
40. ROAD CROSSING (CULVERT)
41. BOAT LANDING
42. ORGANIC LITTER
43. AQUATIC PLANTS ABUNDANT
44. GOOD SPAWNING
45. GOOD NURSERY

STREAM TYPE

FASTWATER
1. Fall
2. Cascade
3. Riffle (GR/RB)
4. Riffle (R/B)
5. Riffle (Sand)
6. Sheet Bedrock
7. Chute
8. Run
9. Rapid

POOLS
10. Midchannel
11. Convergence
12. Lateral
13. Beaver
14. Trench
15. Plunge
16.
17. Bogan
18. Eddy
19. Gabion
20. Leg Structure
21. Road Crossing
22. Wood Debris
23. Man-Made Dam
24. Natural Dead-water

CHANNEL TYPE
1. Main (If measurement refers to main area of river)
* 2. Side Channel (water diverted by islands)
* 3. Split (If river is split into various different stream types)
* 4. Bogan
* - Specify Left (L), Right (R) or Middle (M)

SUBSTRATE
1. Bedrock - Ledge
2. Boulder = > 461 mm
3. Rock = 180 - 460 mm
4. Rubble = 54 - 179 mm
5. Gravel = 2.6 - 53 mm
6. Sand = 0.06 - 2.5 mm
7. Fines = 0.0005 - 0.05 mm

FLOW TYPE
1. Survey Stream
2. Spring
3. Brook/River Trib
4. Spring Seep

POOL RATING (reverse side)

CRITERIA (NO.)	% OF POOLS IN SITE (LETTER)
Pool Depth > 1.5 m; 1 - Instream Cover > 30%; 2 - Instream Cover < 30%	a - > 30%; b - > 10% to 30%; c - < 10%
Pool Depth .5 to 1.5m; 3 - Instream Cover 5 - 30%; 4 - Instream Cover > 30%	a - > 50%; b - < 50%

etc: Stream surveys should be undertaken only during summer base flow flow conditions. Also, minimum size of stream type is 4m² for larger streams.

1. Chute: water depth equal to or greater than channel width
2. Riffle: GR/RB - is a riffle flowing over a gravel and/or rubble bottom
   R/B - is a riffle flowing over & through large substrates (eg. rock and /or boulder), some of which protrudes the surface
3. Side channels - treat as a separate stream type

4. Undercut Bank - % of bank overhang (above water edge for stream type. Specify left (L) or right (R)
5. Over-hanging Bank Vegetation - % of vegetation overhang for stream type. Specify L or R
6. Visual Embeddedness - % of sands or fines surrounding the larger substrates, up to 100%
7. Woody Debris - total width should be > 10 cm in diameter

A = 0.8 for rough bottom

REACH NO.	SITE (50m - interval)	% SITE		SHADE (%)	VEGETATION (%)				EROSION (%)						O_2 (mg/l)	pH	1/4 (m)		1/2 (m)		3/4 (m)		SCATTERING OTHER SIDE		EMBEDDEDNESS (CRITERIA) 1: ≤ 20% 2: 20% - 35% 3: 35% - 50% 4: ≥ 50%	MEAN SUBSTRATE SIZE (cm)	% FINE	% TURBIDITY
		RIFFLE/ RUN	POOLS		BARE GROUND	GRASSES	SHRUBS	TREES	LEFT BANK (0-50%)			RIGHT BANK (0-50%)					WET	CHANNEL	WET	CHANNEL	WET	CHANNEL	NO.	LETTER				
									STABLE	BARE STABLE	ERODING	STABLE	BARE STABLE	ERODING														
REF		0	100	10	0	40	15	45	50	0	0	50	0	0	3.2	7.8	0.75	--	0.98	--	1.10	--	3		1	7	50	
REF		0	100	5	0	25	35	40	50	0	0	50	0	0	3.2	7.8	0.93	--	0.96	--	0.49	--	3		1	7	100	
REF		0	100	5	0	20	30	50	50	0	0	50	0	0	2.9	7.9	0.59	--	0.86	--	0.82	--	3		1	7	100	
REF		0	100	5	0	15	20	65	50	0	0	50	0	0	3.1	7.8	0.72	--	0.92	--	0.82	--	3		1	7	100	
REF		0	100	5	0	10	15	75	50	0	0	50	0	0	3.0	7.8	0.92	--	1.05	--	0.82	--	3		1	7	100	
REF		0	100	5	0	10	15	75	47	0	3	47	0	3	3.1	7.9	1.00	--	1.43	--	0.98	--	3		4	7	87	

NOTE: * For selected site study, these columns (reverse side) should be done for a habitat assessment

WATER FLOW MEASUREMENT

REACH NO.	CORRESPONDING LOCATION		STREAM TYPE	WET WIDTH (m)	DEPTH (cm)			AVERAGE DEPTH SUM / 4		COEFFICIENT (0.3 - smooth) (0.8 - rough)	LENGTH (3m)	FLOAT TIME (sec)				COMMENTS (LOCATION)
	UNIT NO.	SITE (50 - interval)			1/4 way	1/2 way	3/4 way	CENTIMETERS (cm)	METERS (m)			1/4 way	1/2 way	3/4 way	AVERAGE	

Formula (CMS) = W ____ (m) x D ____ (m) x A ____ x L ____ (m)
T ____ (sec)

Where: W = width, D = depth, L = length, A is a coefficient for the stream bottom

CRITERIA:

APPENDIX F2

Population Survey

CANMET
Fish Collection Record

Station: EXPOSURE Date: Sept 21, 96 Time: 11:00 Air Temp: 19.0 Water Temp: 13.0

Gear Type: minnow Trap Duration: 22hr Conditions: clear warm – cool (day / night) Crew: M2/GC

Species	Fish #	Fork Length (mm) ± 2mm	Fresh Weight (g)	Gonad Weight (g)	Kidney Weight (g)	Liver Weight (g)	Scale Ray Otolith Operc	Condition/Comments (external/internal)
Yellow perch	1	90	7.4	KEPT WHOLE →			scales L. Pect.	Growth on Rt Pect. fi
	2	100	11.1	KEPT WHOLE →			Scales	yellow grub in muscle tissue
	3	95	8.7	KEPT WHOLE →			scales	lots of yellow grub in muscle tissue
	4	89	7.4	KEPT WHOLE →			Scales	yellow grub in muscle tissue
	5	84	6.5	KEPT WHOLE →			Scales	yellow grub in muscle tissue
	6	84	5.0	KEPT WHOLE →			scales	growth on pelvic and pectoral fins; yellow grub
	7	86	7.1	KEPT WHOLE →			scales	black spot; yellow grub
	8*	88	7.5	KEPT WHOLE →			Scales L pect.	yellow grub
Pearl dace	1A	104	11.8	KEPT WHOLE →			Scales	no noticeable extern abnormalities
	1B	74	3.5	KEPT WHOLE →			scales	part of upper lobe of caudal fin is missing
	2	85	6.1	KEPT WHOLE →			Scales	lession on tongue
	3	78	4.9	KEPT WHOLE →			Scales	no noticable extern abnormalities
	4	75	4.0	KEPT WHOLE →			scales	no noticable extern abnormalities
	5	77	3.7	KEPT WHOLE →			scales	no noticable extern abnormalities
	6	68	2.9	KEPT WHOLE →			scales	gill filaments clump
	7 **	89	6.5	KEPT WHOLE →			scales	no noticable extern abnormalities
	8 **	81	5.3	KEPT WHOLE →			scales	no noticable extern abnormalities

Notes:
- * YP 8 caught in Minnow Trap 4 Sept 22/96
- PD 1B caught in Minnow Trap 3 Sept 21/96
** PD 7 & 8 caught in Minnow Trap 4 Sept 22/96

CANMET
Fish Collection Record

Station: REFERENCE Date: Sept 21 '22 Time: n/a Air Temp: n/a Water Temp: n/a

Gear Type: Gill net (1.5") Minnow traps Duration: MT 1&2 = 27hr each GN1 = 13.75hr GN3 = 2hr Conditions: clear warm - cool (day night) Crew: MZ/GC

Species	Fish #	Fork Length (mm) ±2mm	Fresh Weight (g)	Gonad Weight (g)	Kidney Weight (g)	Liver Weight (g)	Scale Ray Otolith Operc	Condition/Comments (external/internal)	
Pearl Dace	1	85	5.0	KEPT	WHOLE		scales L. Pect	no noticable externa abnormalities	
	2	93	6.9	KEPT	WHOLE		scales L. Pect	no noticable externa abnormalities	
	3	90	7.3	KEPT	WHOLE		Scales L. Pect	no noticable external abnormalities	
	4	93	7.0	KEPT	WHOLE		Scales L. Pect	no noticable externa abnormalities	
	5	96	8.5	KEPT	WHOLE		Scales L. Pect	no noticable extern abnormalities	
	6	61	2.3	KEPT	WHOLE		Scales L. Pect	no noticable external abnormalities	
	7	65	2.6	KEPT	WHOLE		Scales L. Pect	no noticable extern abnormalities	
	8	68	3.1	KEPT	WHOLE		Scales L. Pect	no noticable exter abnormalities	
Yellow Perch	1	157	45.8	♀ 0.3	n/a	0.65	Scales L. Pect Spine (dorsal)	dead in net yellow grub	gill wt = 0.25g
	2	162	36.2	♂ 4.0	n/a	0.3	Scales, spine L. Pect otolith	brown growth along intestinal tract	= 0.9
	3	158	39.1	♂ 2.6	n/a	0.3	Scales, Spine L. Pect otolith	yellow grub	= 1.0
	4	212	88.0	♀ 2.9	n/a	0.9	Scales spine L. Pect, otolith	yellow grub on caudal peduncle	= 2.3
	5	171	43.9	♀ 1.4	n/a	0.5	Scales, spine L. pect otolith	black spot	= 1.0
	6	233	120.5	♀ 4.8	n/a	1.0	Scales, spine L. Pect otolith	black spot yellow grub left operc	= 3.1
	7	150	33.2	♀ 1.0	n/a	0.3	Scales, spine L. Pect otolith	larval leeches on pectoral fin	= 0.9
	8	181	53.1	♀ 1.5	n/a	0.4	Scales, spine L. Pect otolith	black spot yellow grub under chin	= 1.7

Notes: PD caught in minnow traps 1 & 2 - Ref Sites 3 & 6
YP caught in McDonald Lake with 1.5" mesh gill nets
Time, Air & water temp vary
spine = Dorsal fin spines (1st 3)

Dome Exposure - Fisheries

Gear	Set	Checked	Effort (hrs)	Catch	Comments
GL02	Oct 8	Oct 9	24	1 White Sucker	15.6 cm (dissected)
GL02	Oct 9	Oct 10	24	1 Yellow Perch	12.9 cm (released)
GL02	Oct 10	Oct 11	24	1 Yellow Perch	13.7 cm (released)
GL02	Oct 16	Oct 17	17	nil	
MT1	Oct 8	Oct 9	24	2 Northern Red Belly Dace 3 Pearl Dace 2 Brook Sticklebacks	
MT1	Oct 9	Oct 10	24	1 Northern Red Belly Dace 3 Pearl Dace	
MT1	Oct 10	Oct 11	24	3 Northern Red Belly Dace 4 Pearl Dace 2 Brook Sticklebacks	
MT1	Oct 16	Oct 17	17	6 Northern Red Belly Dace 1 Pearl Dace	
MT2	Oct 8	Oct 9	24	nil	
MT3	Oct 9	Oct 10	24	nil	
MT4	Oct 10	Oct 11	24	7 Northern Red Belly Dace 2 Pearl Dace 1 Stickleback	
MT5	Oct 16	Oct 17	17	nil	modified opening of MT - made larger
MT6	Oct 16	Oct 17	17	1 unkn	
MT7	Oct 16	Oct 17	18	1 Pearl Dace	modified opening of MT - made larger
BMT1	Oct 8	Oct 9	24	nil	
	Oct 9	Oct 10	24	nil	
	Oct 10	Oct 11	24	nil	

Total hours fished with:

gillnet - 89 hours
small minnow traps - 213 hours } 246 hrs
big minnow trap - 72 hours

WS	YP	NRD	PD	BSB
1	2	ø	ø	ø
ø	ø	19	14	5
9	6	6	6	6

MacDonald Lake - Reference

Gear	set	checked	effort (hrs)	catch	comments
GL01	Oct 8	Oct 9	28	33 Rock Bass 1 Smallmouth Bass 11 White Sucker	30 were <10mm dissected dissected
MT1	Oct 8	Oct 9	27	nil	
MT2	Oct 8	Oct 9	27	nil	
MT3	Oct 9	Oct 10	24	2 Northern Redbelly Dace 4 Pearl Dace 10 Brook Sticklebacks	
MT4	Oct 9	Oct 10	24	13 Northern Red Belly Dace 8 Pearl Dace 10 ~~Bluntnose~~ Fathead minnows	
BMT1	Oct 8	Oct 9	27	nil	

Total hours fished with:

gillnet - 28 hrs
small minnow traps - 103 hours
big minnow trap - 27 hours

RB	SMB	WS	NRD	PD	BS	FM
33	1	11	ø	ø	ø	ø
ø	ø	ø	15	12	10	10
ø	ø	ø	ø	ø	ø	ø

TO: CHRIS WREN
COMPANY: GESP
FAX #: 519-836-2493
From: MARIANE PICHÉ
RE: EFFORT - CAN-MET FISHERIES

APPENDIX F3

Tissue Processing Methods

Revised Protocol for Metallothionein Analyses
on fish collected during the field trip for the preliminary survey
(Version: August 29, 1996)

Part of the biological monitoring component of AETE program consists of metallothionein analyses of tissues from large fish, e.g., trout, pike, suckers. This protocol presents the on-site sampling requirements. If the contractor is not familiar with conducting preparation of fish, advice in the dissection and handling of tissues should be obtained from the Freshwater Institute.

Sample size and sampling effort

1. Liver, kidney, gill filaments, and skeletal muscle should be dissected from the 8 to 10 (eigth to ten) individual, living fish from each of the two large species from a reference site and an exposed site. The two most abundant large fish species common to the sampling sites are targetted.

2. The largest specimens from each species should be selected.

3. When possible 4 males and 4 females from the same species should be collected. No additionnal sampling effort should be given to meet the above sex requirement for the Phase I of the field study.

4. A minimum number of 8 fish from the same species is required with a reasonable level of effort for sampling. The sampling gear and method should not be destructive: gill nets should be frequently tended to avoid overfishing and sacrifice fewer fish.

5. The tissues from the same fish can be split into two to serve for metallothionein and metal analyses.

6. These tissues should be immediatly placed in marked individual polyethylene ("Whirlpak") bags, frozen on dry ice, and submitted for metallothionein analyses.

7. When fish capture is performed using a seine net, 8 small fish (e.g. young-of-the-year of each species or Forage species) should be collected per site, as well. In this case no dissection is required (abdominal contents will be removed at the laboratory). Whole fish are placed in marked individual polyethylene ("Whirlpak") bags and frozen on dry ice.

Other information required

For the large fish, information should be obtained on fish sex, body length (±1 mm), body weight (±1.0 g), liver and gonadal weights (±0.1 g) and collection should be made of appropriate aging structures (scales, fin rays, operculum, cleithrum or otoliths, depending upon species). All fish should also be checked for external and internal anomalies (a useful guide can be found in Goede and Barton; Amer. Fish. Soc. Sympos. 8:93-108, 1990; other analogous methods can be used). These data should be analysed to provide information on average (with variability) parameters,

growth (size at age), the relationship between body length and weight, and the relationships between body size and liver weight, gonad weight and fecundity. All analyses should be conducted separately for each sex.

On-site sampling requirements

1. For metallothionein analyses, it is essential to obtain tissue samples from fish that are alive after collection and immediately before tissue removal.

2. A sample numbering system must be designed and used to facilitate tracking of all tissue sub-samples taken from the same fish. All tissue samples must be appropriately labelled.

3. After capture, the following measurements should be obtained on each large fish: total body weight (g), gutted carcass weight [g] after removal of viscera), gonad weight (g), liver weight (g), fork length (cm), sex, and appropriate structure(s) for determining fish age should be removed.

4. Sampling of fish tissues should begin immediately after the whole body measurements have been made. Fish should be euthanised via concussion, cervical dislocation or with an overdose of anesthesic.

5. Gill, liver and kidney from the same fish should be divided into a part used for metallothionein analyses and another part used for metal analyses. Work must progress quickly on the euthanised fish with tissue.

6. Dissection and preserving procedures

   a) Gills: Remove the gill arches and attached filaments by severing the dorsal and ventral cartilaginous attachment of the arches to the surrounding oral cavity. Place the gill arches in a polyethylene bag ("Whirlpak"), label and freeze on dry ice. Gill arches are to be removed from the fish and frozen as soon after death as possible.

   b) Open the fish ventrally to expose the abdominal contents by using scissors to cut from the anus to the base of the pectoral fins. Care should be taken not to cut into internal organs when opening the fish.

   c) Liver: Remove the liver using care not to rupture the gall bladder. Remove the gall bladder from liver using care to prevent bile leakage from contacting the liver. Weigh and record weight of liver to the nearest 0.1 g, if possible. Place the part of the liver in a "Whirlpak", label and freeze on dry ice.

   d) Kidney:Remove the kidneys by making lengthwise incisions along each edge of the tissue and then detach using the "spoon" end of a stainless steel weighing spatula by applying firm, but gentle, pressure against the upper abdominal cavity wall (i.e., against the dorsal aorta). In this procedure, the kidney is scraped away

from the dorsal aorta and all associated connective tissue. The kidney is then to be placed in a "Whirlpak", labelled and frozen on dry ice. The kidney is to be removed from the fish and frozen as soon after death as possible.

Samples for metallothionein (on dry ice) should be sent to:

Dr. J.F. Klaverkamp
Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
R3T 2N6
Phone: (204) 983-5003
Fax: (204) 984-6587

(pame)

ESG

Description	Sample ID	Zn µg/g	Cu µg/g	Cd µg/g	MT µg/g	MT µmoles/g	Σ[Mx] µmoles/g
ECOLOGICAL SERVICES GROUP							
SOUTH PORCUPINE RIVER							
VISCERA							
REFERENCE	PDR-A	30	5.6	0.03	69.7	0.0093	0.551
REFERENCE	PDR-B	33	9.8	0.02	55.1	0.0073	0.663
REFERENCE	PDR-3	48	11.6	0.02	41.1	0.0055	0.914
REFERENCE	PDR-4	25	12.2	0.02	182.2	0.0243	0.581
REFERENCE	PDR-5	53	24.3	0.02	61.8	0.0082	1.200
REFERENCE	PDR-6	37	34.9	0.01	181.0	0.0241	1.121
REFERENCE	RDR-A	38	4.3	0.02	51.0	0.0068	0.647
REFERENCE	RDR-B	46	14.4	0.02	169.0	0.0225	0.934
REFERENCE	RDR-2	23	7.2	0.01	98.6	0.0131	0.468
REFERENCE	RDR-6	30	10.8	0.01	377.8	0.0504	0.636
REFERENCE	RDR-7	46	33.2	0.02	339.3	0.0452	1.230
EXP	PDE-A	29	103.0	0.03	70.4	0.0094	2.069
EXP	PDE-3	29	64.8	0.02	199.2	0.0266	1.458
EXP	PDE-4	25	140.2	0.03	66.8	0.0089	2.585
EXP	PDE-5	31	90.4	0.03	102.0	0.0136	1.898
EXP	PDE-6	27	56.5	0.02	72.1	0.0096	1.302
EXP	PDE-7	22	60.5	0.02	161.0	0.0215	1.285
EXP	PDE-8	26	133.5	0.04	116.7	0.0156	2.502
EXP	RDE-A	37	44.1	0.02	282.0	0.0376	1.264
EXP	RDE-B	43	26.1	0.02	250.9	0.0335	1.067
EXP	RDE-C	37	70.0	0.02	188.3	0.0251	1.665
EXP	RDE-6	36	96.6	0.04	123.8	0.0165	2.064
EXP	RDE-7	34	43.6	0.03	245.8	0.0328	1.208
WS REF LIVER	01-RL	14	10.2	1.00	102.5	0.0137	0.390
WS EXP LIVER	01-EL	32	12.7	0.05	207.2	0.0276	0.690
WS EXP LIVER	03-EL	17	20.2	0.08	752.6	0.1003	0.577
WS EXP KIDNEY	EXP-AK	36	4.2	0.74	405.6	0.0541	0.623
WS REF KIDNEY	REF-AK	34	7.4	3.12	114.5	0.0153	0.661
WS EXP GILL	01-EG	17	7.2	0.07	79.4	0.0106	0.377
WS EXP GILL	03-EG	11	9.1	0.07	20.0	0.0027	0.316
WS REF GILL	01-RG	13	0.8	0.11	29.6	0.0039	0.219
WS REF GILL	02-RG	13	3.5	0.18	27.3	0.0036	0.249

Summary

Description	Sample ID	x̄ MT µg/g	S.E.	n	x̄ Σ[Mx] µmol/g	S.E.
Jacque Whitford						
Gaspe site reference	BTR	183.7	37.9	5	1.14	0.14
Gaspe site exposure	BTE	383.1	72.3	8	2.24	0.16
Gaspe site reference	SALR	73.0	13.8	8	3.63	0.35
Gaspe site exposure	SALE	117.7	13.3	8	4.64	0.27
Heath Steele exposure	LCA	81.5	4.59	3	3.95	0.50
Heath Steele reference site 1	LCRA	159.6	16.8	2	3.51	0.55
Heath Steele reference site 2	LCMR	50.3	13.5	3	4.01	0.23
Heath Steele exposure	SALE	64.4	8.77	3	4.47	0.05
Heath Steele reference	SALMR	39.7	2.21	6	5.85	0.99
Heath Steele reference	BTR	128.2	15.7	5	3.75	0.60
ECOLOGICAL SERVICES GROUP						
SOUTH PORCUPINE RIVER						
VISCERA						
Pearl Dace reference site	PDR	98.5	26.6	6	0.84	0.11
Pearl Dace exposure site	PDE	112.6	19.2	7	1.87	0.21
Redbelly Dace reference site	RDR	207.1	64.9	5	0.78	0.13
Redbelly Dace exposure site	RDE	218.2	28.0	5	1.45	0.18
EVS ENVIRONMENT CONSULT.						
SULLIVAN MINE						
Sculpin reference site	SURCC	136.4	13.9	13	2.28	0.40
Sculpin exposure site	SUECC	135.0	13.3	11	2.93	0.40

		Pearl Dace		Redb. Dace	
Type	Rep	flength	weight, g	flength	weight, g
Reference	1	7	3.3	4.8	1.37
Reference	2	6.6	2.83	5.3	2.35
Reference	3	7.8	4.61	4.8	1.03
Reference	4	9.1	7.53	4.9	1.45
Reference	5	5.8	2.9	4.2	1.01
Reference	6	8.8	7.48	6.1	3.89
Reference	7	6.1	2.12	6.8	3.14
Reference	8	5.5	1.72	5.1	1.14
Exposure	1	6.7	2.36	5.2	1.61
Exposure	2	7.4	3.71	5.3	1.63
Exposure	3	9	7.62	5	1.38
Exposure	4	7.9	5	4.6	1.23
Exposure	5	9.7	8.93	5.6	1.72
Exposure	6	8.6	6.46	6.3	2.85
Exposure	7	8.5	6.61	7.1	4.14
Exposure	8	9.8	9.13	5.7	1.83