POLARIS MINE

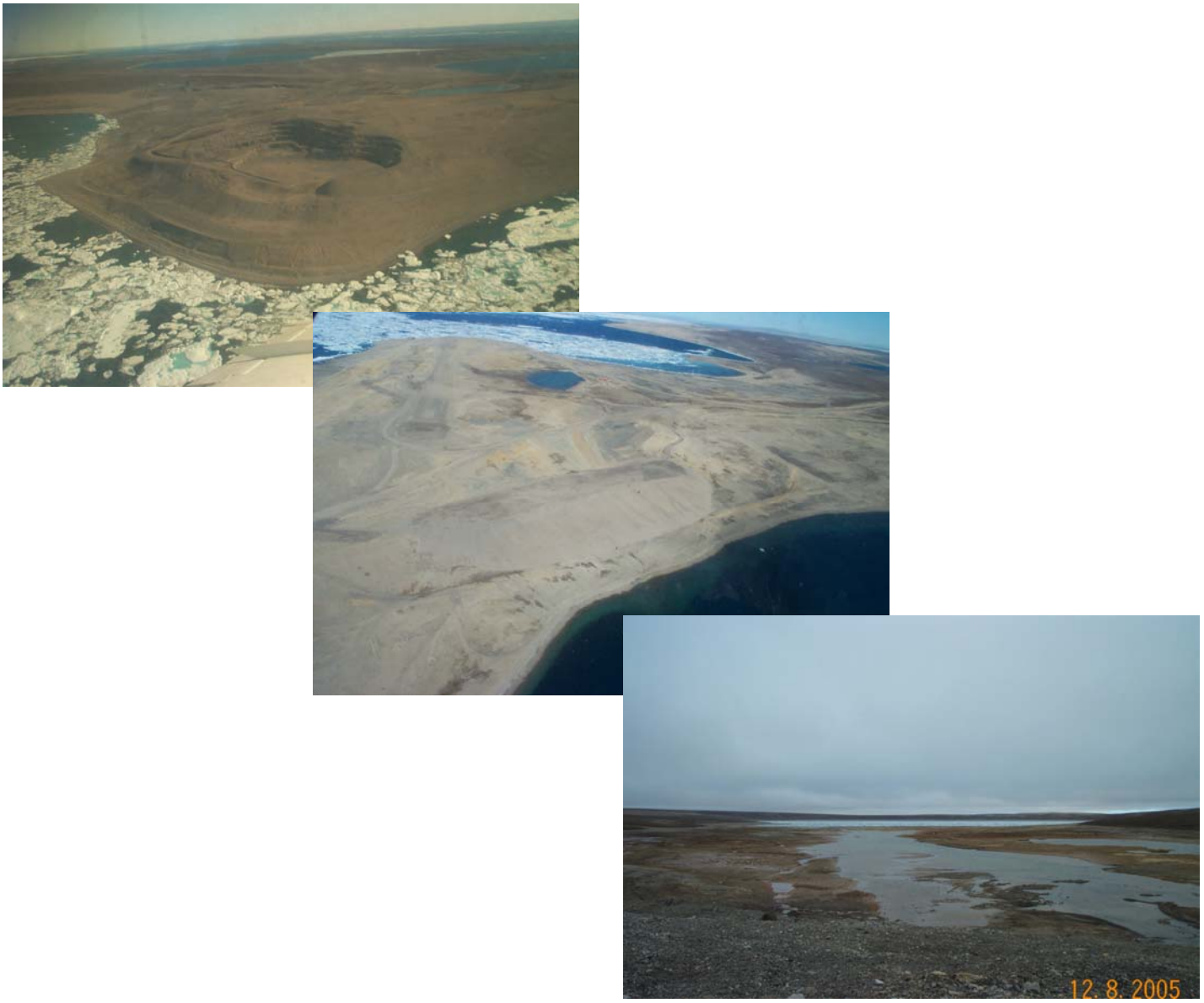
2005 4TH QUARTER & 2005 ANNUAL REPORT

FOR THE

NUNAVUT WATER BOARD

AND

INDIAN AND NORTHERN AFFAIRS CANADA



February 15, 2006

Nunavut Water Board
Box 119
Gjoa Haven, NU
X0B 0J0
Attention: Phyllis Beaulieu, Manager of Licensing

Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit, Nunavut
X0A 0H0
Attention: Spencer Dewar, Manager, Lands Administration

Dear Phyllis and Spencer;

Re: Polaris Mine Water Licence NWB1POL0311 – 2005 4th Quarter and Annual Water Licence and Decommissioning and Reclamation Plan Reports

Please find attached the Polaris Mine 2005 4th Quarter and 2005 Annual Reports as required under Polaris's Water Licence and Decommissioning and Reclamation Plan (DRP). I have attached paper copies of this report to this letter in addition to an electronic copy of the report files.

Section 2.3 of the attached report discusses the application of the Metal Mining Effluent Regulations to the Polaris Mine which are mirrored in the Water Licence requirements. As of the end of 2005, the Polaris Mine is no long subject to the Metal Mining Effluent Regulations. Teck Cominco had requested updating of the sites monitoring requirements in a submission dated June 14th, 2005. In the June 14th submission we indicated that updating of the water quality and biological monitoring programs should be delayed until after submission of the Environmental Effects Monitoring (EEM) Interpretive Report so that all relevant data would be available to make an informed decision. Appendix 3 of the attached report contains a copy of the EEM Interpretive Report. Now that the results of this study have been

submitted, Teck Cominco will be making a submission within the next few months to alter the effluent and water quality monitoring program for the site.

If you have any questions regarding this report, please do not hesitate to contact me.

Yours truly,

Bruce J. Donald
Reclamation Manager
Environment and Corporate Affairs
Teck Cominco Limited

DISTRIBUTION LIST

1. Nunavut Water Board - 2 copies
   Manager of Licensing
   Nunavut Water Board
   P.O. Box 119
   Gjoa Haven, NU X0B 1J0

2. Indian and Northern Affairs Canada – 1 copy
   Manager, Land Administration
   Department of Indian Affairs and Northern Development
   Box 100
   Iqaluit, NU X0A 0H0

3. Teck Cominco Metals Ltd. – 3 copies
   - Vancouver Office – Walter Kuit
   - Kimberley Office – Bruce Donald
   - File Copy

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1. INTRODUCTION

The Polaris Mine ceased operation in September of 2002. Immediately upon mine closure, reclamation activities commenced in accordance with the Decommissioning and Reclamation Plan (DRP) approved by the Nunavut Water Board and Indian and Northern Affairs Canada. The DRP as well as the Water Licence requires reporting of work and monitoring activities on both a quarterly and an annual basis. This document includes both the 2005 4th Quarter and the 2005 Annual Report for the Polaris Mine site.

An executive summary of this report translated into Inuktitut is included as Appendix 1.

2. 2005, 4th QUARTER REPORT

2.1. Reclamation Activities

During the entire 4th Quarter of 2005, the Polaris Mine remained unoccupied by personnel. No reclamation activities were undertaken.

2.2. Site Monitoring

During the entire 4th Quarter of 2005, the Polaris Mine remained unoccupied by personnel and no monitoring events occurred as all surface waters were frozen.

Despite there being no surface water flows to sample, the Metal Mining Effluent Regulations (MMER) requires the submission of a monitoring report. This report is included in Appendix 2.

2.3. Environmental Effects Monitoring

The MMER is applicable to a metal mine while it is operating, and for a three year period after production ceases and after written notification is received by Environment Canada. In the case of the Polaris Mine, notice was received by Environment Canada on December 16, 2002. As required in the MMER, during the three year period, an Environmental Effects Monitoring (EEM) Study must be conducted that includes both the effluent and water quality monitoring studies set out in Part 1 of the MMER as well as the biological monitoring studies set out in Part 2 of the MMER. Polaris has now completed both the water quality monitoring studies as well as the biological monitoring studies. The final EEM study was completed and submitted to Environment Canada in December 2005 and is currently under review by them. Part H of the water licence also requires that the EEM studies be conducted and reported. The results of the EEM study are scientific verification that the effluent from Garrow Lake is not having a significant effect on the receiving environment. Teck Cominco requests that the Water Board review this important study when considering future monitoring requirements at the site. A copy of the Interpretive Report of the Environmental Effects Monitoring Study is included in Appendix 3.

The monitoring requirements under the MMER are rigorous in order to aid in interpreting the results of the EEM studies. The monitoring required under the MMER are designed to be standardized all across Canada so that a statistical analysis of water quality data could be related to the resulting environmental effects (or lack of effects) as documented in all of the EEM studies. Now that Polaris's final EEM study has been completed, the original intent of the rigorous sampling requirements has been satisfied and the necessity of continuing monitoring at this level of rigour is not scientifically justified. Teck Cominco will be submitting a request in the near future for substantial changes to its water quality monitoring program supported by a review of the data and

studies completed to date. The request will be to reduce on-going water quality and biological monitoring requirements to a much more practical level. This would reduce both the current excessive monitoring costs, and reduce the potential risks to that sampling personnel are exposed to due to the frequency of sampling and harsh weather conditions at this remote site.

It is important to note that subsequent to December 16, 2005; now that the Polaris Mine has completed the three year period since closure, it is now deemed to be a "recognized closed mine" and so is no longer regulated under the Metal Mining Effluent Regulations.

3. 2005 ANNUAL REPORT

Part B, Section 6 of the Water Licence requires that an Annual Report be filed that includes the following topics.

3.1. Unauthorized Discharges

The Polaris Mine had no unauthorized discharges to report.

3.2. Progress Report of Studies and Plans

Progress on reports and/or revision of any studies or plans requested by the Board is listed below:

- Teck Cominco submitted a request on June 14th, 2005 for modifications to the monitoring plans that were originally set out in the Decommissioning and Reclamation Plan. This was to recognize that the site had completed the decommissioning phase and that site monitoring should now be updated to reflect current conditions. There were a large number of house keeping changes requested to delete items that were no longer applicable. However, Teck Cominco requested that changes to the Garrow Lake and Garrow Lake effluent water quality monitoring program be delayed until 2006 to allow for the completion of the MMER water quality sampling program and submission of the final EEM study. On July 18, 2005 the Environmental Protection Branch of Environment Canada submitted a response to Teck Cominco's request. The response agreed with most items in the request and disagreed with some other items. Of note was their agreement that review of the water quality program be delayed until after completion of the MMER program.
- Submission of the very comprehensive 2004 Annual Report was made in September 2005 which included the final reporting of the reclamation activities and of the water quality monitoring program results that occurred during 2004. A number of requested studies and as-built drawings remained outstanding when the report was submitted. The submission of the report clearly identified which materials were absent and at the end of 2005, work on completing these deficiencies was in progress. The missing reports are planned to be submitted within the next eight weeks.

3.3. Executive Summary of Report Translated into Inuktitut

Included in Appendix 1 is an executive summary of both the 2005 4th Quarter Report and the 2005 Annual Report translated into Inuktitut.

3.4. Summary of Closure and/or Reclamation Work Undertaken

A summary of any closure and reclamation work undertaken during the year and an outline of work anticipated for the next year is outlined below:

- During June, July and early August; a small crew consisting of 3 to 4 people was stationed on site to conduct maintenance to the temporary site camp and remaining equipment after being used by the reclamation contractor from 2002 to 2004. In addition to carrying out

routine site monitoring activities, crews were assigned to clean up litter around the site. Approximately 50% of the required clean up was completed.

- During 2006 it is planned to undertake the final re-contouring of a slope in the new quarry and the slope by the former tank farm and storage pad areas that were identified in the 2004 fall inspection by INAC and Water Board inspectors. Additionally, the 2005 annual geotechnical inspection identified two areas where runoff from the site is eroding the drainage channels which will be stabilized this coming summer. While personnel are on site, the routine site monitoring will continue as well as the clean up of litter.

3.5. Update of Reclamation and Monitoring Costs

An update of reclamation and monitoring costs is presented in Appendix 4. Costs for 2005 were $407,900 which is higher than the original monitoring forecast. The 2005 costs were high due to:

- During the final weeks of reclamation activities and demobilizing from the site, the reclamation contractor made extensive use of the temporary camp facilities, ATV's, and three pieces of heavy equipment that were left for the post-reclamation site maintenance. During this time period, little or no maintenance was done. To ensure safe, reliable operation of the camp, facilities and equipment, substantial maintenance work was undertaken during the summer.
- All efforts were focused on major demolition of buildings right up until the final stage of site reclamation activities. Less attention was given to the final site cleanup of small pieces of debris and litter. In 2005, crews were assigned to methodically go over the site looking for and collecting the litter. It is estimated that approximately 50% of the clean up was complete at the end of the summer. As a result of this work, additional personnel were on site that otherwise would not have been required.
- Monitoring costs were higher than anticipated due to the requirements of complying with the Water Licence and MMER water quality monitoring program. Environmental scientists had to make several trips to the site from southern Canada, in addition to having technical staff residing on site for 2 ½ months during the summer to comply with the rigorous sampling and quality control requirements of the water monitoring program. Local residents are able to collect simple water samples, but a number of the sampling events required additional sampling skills.

The 2005 cost review in Appendix 4 is not compared against the previously forecast post-reclamation monitoring costs. The original cost estimates were developed at the start of the project and are several years old. Now that there is one year's experience in monitoring the site after completion of reclamation activities, the monitoring and site maintenance cost forecast has been updated and is presented in Appendix 4. The primary purpose of providing the budget is to assist in assessing financial security requirements for the site, and for this reason some internal costs that Teck Cominco incurs but the government wouldn't (if they were managing the site) are excluded from the forecast.

In forecasting costs forward from 2005, there are several items that vary from year to year and some areas where there is still significant uncertainty as to the level of monitoring that will be required. They are as follows:

- Costs for 2006 will continue at a substantial level as there is additional site clean up required and a few outstanding reclamation requirements are yet to be addressed (e.g. re-sloping activities). To be conservative, it is assumed that monitoring requirements will not change in 2006 but now that the MMER requirements are gone, it is anticipated that approval to simplify the water quality program will be obtained this spring.

- Subsequent to 2006 that there should not be any significant site maintenance work required and it is assumed that monitoring requirements will be reduced. If monitoring requirements are made technically simpler, then local Resolute residents can conduct the majority of the monitoring providing local employment and substantially reducing costs.
- Both the Water Licence and Land Leases expire in 2011. In preparation for this, final wrap up studies may be considered in 2010, but at a minimum, comprehensive reviews of the site data will be undertaken in 2011.

3.6. Public Consultation and Participation

- No public consultations were conducted as the site is basically dormant other than for monitoring.
- At least one Inuit resident from Resolute assists with the routine sampling at the site or is part of the team working on reclamation activities on site. In addition to providing local employment, the local knowledge for the safety of workers on site is invaluable. An additional benefit is that this ensures there is someone who lives in the nearest community that is aware of site activity and site conditions.

3.7. Work Conducted in Response to Inspection or Compliance Reports

A brief summary of work done to address concerns or deficiencies listed in inspection/or compliance reports were as follows:

- 2005 site activities included clean up of debris that will continue in subsequent years during summer monitoring events. This was noted in the 2004 fall site inspection report.
- In 2005 a survey of the tank farm pad and adjacent storage pad was undertaken to quantify the amount of recontouring work that is planned for 2006. Overly steep slopes were noted in the 2004 fall inspection report.

3.8. Effluent and water Quality Studies Conducted

3.8.1. Quantities of Fresh Water Pumped From Frustration Lake

The water licence requires the monthly and annual quantities (in cubic metres) of water pumped from Frustration Lake to be reported.

- No water was pumped as the site's freshwater system was demolished and reclaimed in 2004.

3.8.2. Garrow Lake Water Column Monitoring

During 2005, the Water Licence required three monitoring events (at mid-winter, at maximum ice thickness, and at maximum ice melt) in two separate locations of the Garrow Lake water column stratigraphy. The mid-winter monitoring event was not conducted as charter aircraft will not fly to this isolated, abandoned site in the dark. The maximum ice thickness and maximum melt monitoring events took place as required and were reported in the 2nd and 3rd Quarter monitoring reports.

For the past two years, under the requirements of the 2003 Water Licence, data has been collected from two monitoring stations at Garrow Lake. There have been a total of four monitoring events from both of these two monitoring locations. Figures 1 through 4 in Appendix 5, compare the zinc concentrations for each depth below surface of the lake sampled, at both monitoring stations. It should be noted that while zinc is being discussed, confirmation of lake stability would also be indicated by graphing other metals, water density, oxygen content, temperature, or conductivity.

Figure 1 – January 2004 Monitoring Event

Zinc concentrations between the two monitoring stations are almost identical with only minor variations at the 9 and 10 metre depth where a slight difference in

sampling depths can influence the results as the zinc concentrations rise and fall rapidly within this general depth of the lake. Also the 40m depth sample from 262-3 had a bit higher zinc concentration. At this location of the lake, 40m is very near the bottom of the lake and if the person sampling is not very careful, the bottom of the lake is disturbed and results in some zinc containing sediments to be suspended in the water column.

Figure 2 – May 2004 Monitoring Event

The results are very similar to the January 2004 results except that sampling at Station 262-3A was not conducted as deep as the lake is shallower in this area (It is difficult to sample in exactly the same location and lake depths change sharply in this area).

Figure 3 – May 2005 Monitoring Event

The monitoring results were almost identical between the two monitoring stations. At this sampling event, at the 9 and 10 metre depth, results from the 262-3 indicated slightly higher zinc concentrations than at 262-3A. Again, this is believed to be from sampling at a slightly different depth between the two stations.

Figure 4 – August 2005 Monitoring Event

This sampling event is different from the previous three events in that it was done during the ice free period. In August the lake is nearing the end of its annual discharge cycle where fresh melt and surface runoff waters have been added to the top of the lake. This is evident through the lowering of the zinc concentrations in the 0 to 3 metre depths of the lake. While not visible on the graph, Station 262-3 does have a sample result at the 0m depth which has essentially the identical zinc concentration as the 363-2A station 0m depth sample.

Below 3 meters in depth, the results between the two monitoring stations are also almost identical and are very similar to the May 2005 sampling results. Again there are slight variations in zinc concentrations near depths of the lake where zinc concentrations are changing, which is likely the result of sampling at slightly different depths between the two monitoring stations.

Reviewing the data from these four monitoring events, it is apparent that no new data or different understanding of the lake is gained by sampling the lake at two different monitoring stations rather than from just one station. To reduce lab costs and to make is more manageable to complete the sampling event in one day (reduced charter costs and labour costs), we will be requesting that only one monitoring station be sampled in the future.

To obtain trends of changes in zinc concentrations in the water column since active deposition of tailings into the lake ceased at the end of summer in 2004, Figure 5 displays zinc concentrations compared to depth at Station 262-3. The colours of the lines in the graph have been set so that each colour represents a different year. This aids in visualizing the trends for zinc concentration in the water column over time. There are two obvious conclusions resulting from this graph:

a) Each of the four years has two sampling events, and the results within each year are very similar to each other.
b) There is a definite trend to reducing zinc concentrations year by year during this four year period. The trend is especially clear below the 12 metre depth.

3.8.3. Garrow Lake Effluent and Receiving Waters Monitoring

Reports summarizing the effluent monitoring results as required in Part H of the Water Licence and the MMER are included in Appendix 6 as follows:

- The Annual water quality monitoring results from the Final Discharge Point of Garrow Lake are presented. Water quality was compliant throughout the period of the year when effluent was discharging.
- A report summarizing the results of effluent characterization, sub-lethal toxicity testing, and water quality monitoring are presented. There was no acute toxicity in either the Rainbow trout or the Daphnia tests. Two sublethal toxicity tests were conducted during the year. There were no effects observed in the Topsmelt Survival and Growth Test at the highest concentrations tested. Sublethal effects were observed for the echinoid and algal species in both tests. This is explained in Appendix F of the Annual MMER and EEM reports that are included in Appendix 6.

3.9. Details of Water Use or Waste Disposal Requested by the Board

- No details of water use have been requested by the board.
- Waste disposal was restricted to collection of site litter that has been stockpiled for future disposal in LRD Quarry Landfill.

APPENDIX 1

Executive Summary

Translated into Inuktitut

APPENDIX 2

2005 4th Quarter

Final Discharge Point

Water Quality Monitoring Results

Bruce J. Donald
Reclamation Manager

February 1, 2006

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – 2005 4th Quarter Metal Mining Effluent Regulations Report

There was no discharge from the designated final discharge point (i.e., Garrow Lake Siphons) for Polaris Mine during the period October 1st to December 31st of 2005. While there is no data to report other than that there was no effluent discharge, I have completed the monitoring report, as required by the regulations, and have attached it to this letter. 2005 4th quarter MMER regulatory data has also been submitted electronically through the online RISS system, on February 1, 2006.

If you have any questions regarding the quarterly report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me.

Yours truly,

Bruce Donald

Attachments: Quarterly Monitoring Report

cc:
Walter Kuit (Teck Cominco Ltd.)
Randy Baker (Azimuth Consulting Group)

Polaris Mine 2005 4th Quarter MMER Report

Prepared for

Environment Canada, Prairie & Northern Region
Room 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

February 1, 2006

Teck Cominco
Bag 2000
Kimberley, BC, Canada
V1A 3E1

POLARIS MINE – MMER MONITORING REPORT

4th QUARTER 2005

APPENDIX A

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13

APPENDIX B

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14

APPENDIX C

i. Concentration & monthly mean concentrations of each deleterious substance of Schedule 4
ii. pH of the effluents samples as required by subsection 12(1)
iii. Description of sample collection method
iv. Total volume of effluent deposited during each month of the quarter as per section 19
v. Mass loading of the deleterious substances set out in Schedule 4 and as per section 20

APPENDIX D

i. Results of the effluent characterization as per paragraph 15(1)(a)

APPENDIX A

Reporting Requirements for Reference Method EPS 1/RM/13

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as there was no effluent discharge during the quarter.

iii. Type of sample
   - No sampling conducted as there was no effluent discharge during the quarter

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No sampling conducted as there was no effluent discharge during the quarter

vi. Name of person submitting samples
   - No sampling conducted as there was no effluent discharge during the quarter

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted as there was no effluent discharge during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Percent mortality of fish in stock tank(s)
   - None to report. There were no tests conducted during the period

v. Species of test organism
   - None to report as there were no tests conducted during the period

vi. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vii. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

ix. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

x. Indication of aeration of test solutions before introduction of fish
   - None to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Number of fish added to each test vessel
   - No fish added as there were no tests conducted during the period

xiv. Mean and range of fork length of control fish at end of test
   - No data to report as there were no tests conducted during the period

xv. Mean wet weight of individual control fish at end of the test
   - No data to report as there were no tests conducted during the period

xvi. Estimated loading density of fish in test solutions
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPS 1/RM/13 - Continued

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
   - None to report. No tests conducted during the period

ii. Number of control fish showing atypical/stressed behaviour
   - None to report. No tests conducted.

iii. Mean mortality rate in solutions of effluent and control water
   - None to report. No tests conducted

iv. Estimate of 96-h LC50 in multi-concentration tests
   - No data to report. No tests conducted

v. Most recent 96-h LC50 for reference toxicity test(s)
   - No data to report. No tests conducted

APPENDIX B

Reporting Requirements for Reference Method EPS 1/RM/14

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as there was no effluent discharge during the quarter.

iii. Type of sample
   - No sampling conducted as there was no effluent discharge during the quarter

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No sampling conducted as there was no effluent discharge during the quarter

vi. Name of person submitting samples
   - No sampling conducted as there was no effluent discharge during the quarter

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted as there was no effluent discharge during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Species of test organism
   - None to report as there were no tests conducted during the period

v. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vi. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

vii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

viii. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

ix. Indication of any adjustment of hardness of effluent sample
   - No adjustment to report as there were no tests conducted during the period

x. Indication of any aeration of sample
   - No indication to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
   - No data to report as there were no tests conducted during the period

xiv. Number of neonates per test vessel and milliliters of solution per daphnid
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPS 1/RM/14 - Continued

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
   - No data to report. No tests conducted during the period.

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
   - No data to report. No tests conducted during the period.

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
   - No data to report. No tests conducted during the period

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
   - No data to report. No tests conducted during the period.

APPENDIX C

2005 4th QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
2-Oct-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
9-Oct-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
16-Oct-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
23-Oct-05	nd[3]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
30-Oct-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
6-Nov-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
13-Nov-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
20-Nov-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
27-Nov-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
4-Dec-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
11-Dec-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
18-Dec-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
25-Dec-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
October/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
November/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
December/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
2-Oct-05	nd[2]	0	0	0	0	0	0	0	0	0
9-Oct-05	nd[2]	0	0	0	0	0	0	0	0	0
16-Oct-05	nd[2]	0	0	0	0	0	0	0	0	0
23-Oct-05	nd[2]	0	0	0	0	0	0	0	0	0
30-Oct-05	nd[2]	0	0	0	0	0	0	0	0	0
6-Nov-05	nd[2]	0	0	0	0	0	0	0	0	0
13-Nov-05	nd[2]	0	0	0	0	0	0	0	0	0
20-Nov-05	nd[2]	0	0	0	0	0	0	0	0	0
27-Nov-05	nd[2]	0	0	0	0	0	0	0	0	0
4-Dec-05	nd[2]	0	0	0	0	0	0	0	0	0
11-Dec-05	nd[2]	0	0	0	0	0	0	0	0	0
18-Dec-05	nd[2]	0	0	0	0	0	0	0	0	0
25-Dec-05	nd[2]	0	0	0	0	0	0	0	0	0

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note[2] - "nd" refers to no effluent discharge to sample

MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
October/05	-	-	-	-	-	-	-	-	-	-
November/05	-	-	-	-	-	-	-	-	-	-
December/05	-	-	-	-	-	-	-	-	-	-

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the week of June 26, 2005 x 6 days of flow

APPENDIX D

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 15(1)(a)

No effluent samples were collected during the 4th Quarter of 2005 as there was no effluent discharge.
No Acute Lethality Testing conducted during the quarter as there was no effluent being discharged.

APPENDIX 3

Interpretive Report

Environmental Effects Monitoring Program

Interpretative Report

Environmental Effects Monitoring (EEM)
Teck Cominco Polaris Mine, Nunavut

Prepared for

Environment Canada
Prairie and Northern Region
Rm 200 4999 – 49th Ave.
Edmonton Alberta
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December 2005

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Project No. TC-03-03

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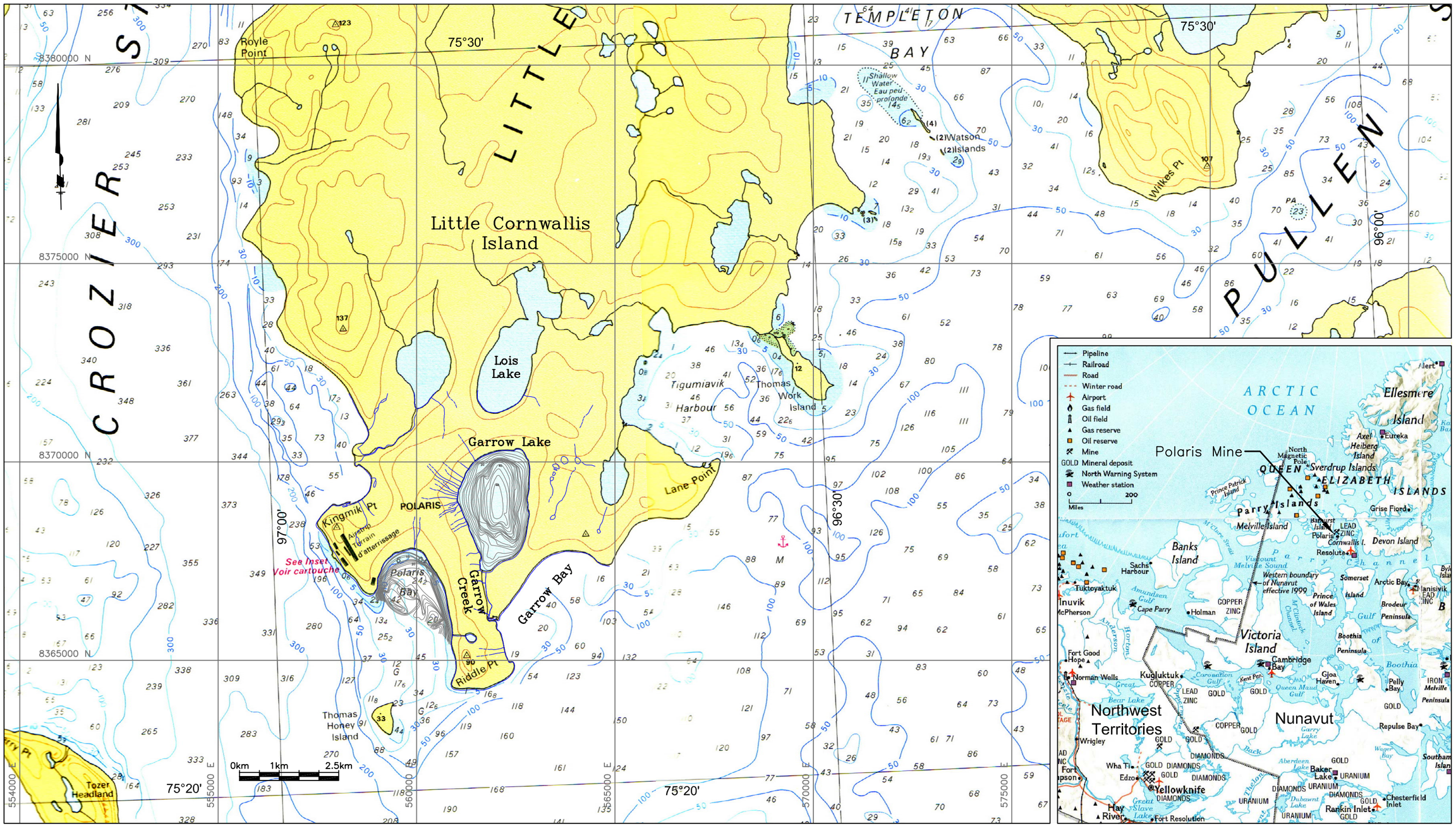

Carrow Lake, Polaris Bay contour data and surrounding creeks digitized from Map 1 Sampling Sites 1980 *prepared by B.C. Research January 1978*

Other data from Crozier Strait And/Et Pullen Strait 7935 *corrected 2003-03-28 published by the Canadian Hydrographic Service*

Insert Location Map from The Modern North: Roads, Radar Stations, and the End of Isolation, *Produced by National Geographic Maps for National Geographic Magazine, Sept. 1997*

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PROJECT: Polaris

TITLE: **Polaris Mine Study Area**

CLIENT: Teck Cominco

Figure 1-1

1 INTRODUCTION

1.1 Background

Teck Cominco Metal Ltd.'s Polaris Mine is located on Little Cornwallis Island in the Canadian high Arctic, Nunavut. Situated at about latitude 75°N and longitude 97°W, Polaris is approximately 100 km northwest of Resolute Bay and is the world's most northerly metal mine (**Figure 1-1**). Underground zinc-lead mining operations, which initially began in the early 1980s, permanently ceased on September 3, 2002 with the final shipment of concentrate, via an ocean going bulk carrier, taking place later that same month. The Polaris Mine concluded a two-year reclamation and decommissioning phase in September 2004.

Tailings from the Polaris Mine have historically been deposited into nearby Garrow Lake, which is recognized under the Metal Mining Regulations (MMER) as a Tailings Impoundment Area. Garrow Lake is permanently thermally and chemically stratified (i.e., meromictic) and, in the nearly 3,000 years since its separation from adjacent marine waters, the annual freeze-thaw cycle at the lake's surface has transferred and concentrated salt in the deeper parts of the lake. The strong density difference between the bottom and surface layers has generally prevented the upward movement of metals associated with the tailings deposited on the bottom. Discharge from Garrow Lake occurs only during summer/fall (i.e., approximately last week of June to early September; 1994 - present) when brackish water from the surface layer of the lake flows into Garrow Creek and, approximately 1.4 km downstream, drains into the marine foreshore of Garrow Bay (**Figure 1-1**). During the remainder of the year, the lake is frozen so no discharge occurs.

Pursuant to Section 32 of the MMER, Teck Cominco provided written notification of closure on December 16, 2002 and undertook to complete a series of environmental investigations over a three-year period. These investigations were aimed at characterizing and monitoring effluent discharge from the Polaris Mine as well as evaluating the spatial extent and magnitude of any effects to fish, fish habitat, and fisheries resources. Under Section 32 of the MMER, the Polaris Mine will become a recognized closed mine after the expiry of the three-year period on December 16, 2005. Any effluents will thereafter be subject to the prohibitions presented in Section 36(3) of the *Fisheries Act*.

Azimuth Consulting Group Inc. (Azimuth) was retained by Teck Cominco to assist in implementation of MMER-related investigations at Polaris. Azimuth also conducted concurrent studies at the site, in Garrow Lake and Garrow Bay, to fulfill obligations under a Fisheries and Oceans Canada (DFO) habitat authorization permit as part of decommissioning activities on-site.

1.2 Objectives

In addition to routine chemical analyses and acute toxicity testing of the mine effluent (i.e., Garrow Lake discharge), a key requirement of the MMER was to undertake an environmental effects monitoring (EEM) program comprised of the following two components:

- Biological monitoring studies, including a fish survey (using indicators of fish population health and fish tissue analysis) and a benthic invertebrate community survey.
- Effluent and water quality monitoring studies during discharge intended to provide background, supporting information for the assessment and interpretation of biological monitoring. These studies included effluent characterization, water quality monitoring, and sublethal effluent testing.

The purpose of the Polaris Mine EEM interpretative report is to document results of the above requirements based on historical information and data collected between 2003 and 2005. Note that, with one exception (see below), most of the information presented in this report was previously submitted and discussed with members of the mine's Technical Advisory Panel (TAP). It is provided as part of this document for ease of reference.

To supplement the interpretative report, we included a discussion of anticipated future trends in effluent characteristics. Its purpose is to provide some context for understanding potential implications for receiving environment water quality in the long-term.

1.3 Approach and Report Organization

The Polaris Mine is located in the high Arctic, where climate is severe, with short cold summers and long (colder…) dark winters. During summer, there is limited opportunity for sampling because of the relative lack of ice-free, open water conditions. Ice movements in Crozier Strait and Garrow Bay are unpredictable and in some years, the bay remains ice-covered. Over the course of the 2003-2005 EEM program, access to Garrow Bay was only possible in 2003 at which time reconnaissance studies in Garrow Bay and comprehensive studies in Garrow Lake were conducted. In 2004, when the main biological monitoring program was planned, Garrow Bay (and Garrow Lake) was completely ice-covered during the entire summer and was inaccessible. Field staff were on site and mobilized to carry out the investigations documented these conditions and communicated regularly with Environment Canada.

Given these harsh field conditions, biological monitoring studies (i.e., the fish and benthic invertebrate community surveys) could not be completed in Garrow Bay as part of the Polaris Mine EEM program. However, access to receiving waters immediately adjacent to the shoreline was possible every year during the summer (i.e., where some ice melt had occurred). Access to Garrow Creek at the discharge location from Garrow Lake

was also possible during each summer. Accordingly, effluent and receiving water quality were monitored as per MMER requirements between 2003 and 2005.

To document our efforts and present available information and data, the interpretative report was organized as follows:

Section 1 – Introduction

Section 2 – Summary of available information and data

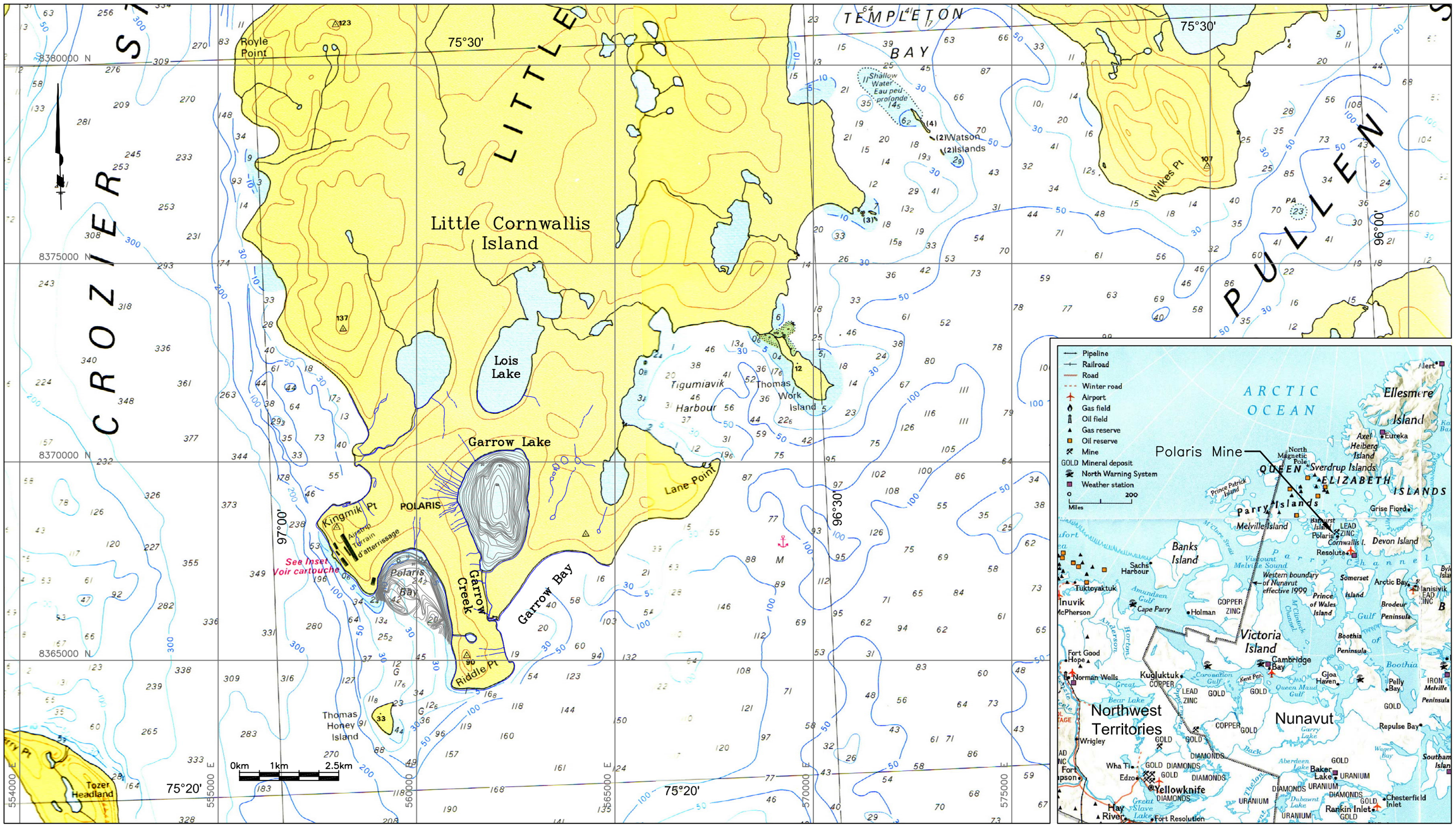
- Study design, including historical synopsis (**Appendix A**)
- Addendum to the study design (**Appendix B**), including
  - Results of 2003 field reconnaissance studies conducted in Garrow Bay documenting field effluent plume delineation, underwater video survey, fish survey, intertidal and subtidal sediment survey.
  - Results of theoretical effluent plume modeling.
- Overview of 2004 EEM field program (**Appendix C**)
- Effluent and water quality data from 2003 to 2005 (**Appendix D**)

Section 3 – Discussion of future trends in effluent characteristics, including:

- Summary of 2003 Garrow Lake limnological and ecological investigations conducted to fulfill obligations under a DFO habitat authorization permit (**Appendix E**)
- Discussion of likely future effluent characteristics and potential effects

Section 4 – References

Note that the "compilation report" format used for the Polaris Mine EEM interpretive report is consistent with discussions and feedback received *a priori* from members of the TAP (J. Ferone, pers. comm.. email to P. Allard, May 9, 2005).



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PROJECT: Polaris

TITLE: **Polaris Mine Study Area**

CLIENT: Teck Cominco

Figure 1-1

2 SUMMARY OF AVAILABLE INFORMATION AND DATA

2.1 Study Design (Appendix A)

A draft study design for the Polaris Mine EEM program was submitted to Environment Canada (S. Blenkinsopp, Edmonton) in June 2003 and approved with minor clarifications. The entire report is appended (**Appendix A**) to facilitate reference to our review of historical data and our proposed design for conducting biological monitoring studies. Specific components of the draft study design were:

- Introduction (**Section 1**)
- Site characterization (**Section 2**)
- Fish survey and tissue analysis (**Section 3**)
- Benthic invertebrate community survey (**Section 4**)
- Supporting environmental variables (**Section 5**)
- General quality assurance/quality control (QA/QC) program (**Section 6**)

Our intent was to finalize the study design following the completion of field reconnaissance work conducted in Garrow Lake and Garrow Bay in summer 2003 (see below).

2.2 Addendum to Study Design (Appendix B)

The purpose of the Addendum report (**Appendix B**) was to finalize the study design for the Polaris Mine EEM program. Specifically, the Addendum supplemented the draft study design report (see **Appendix A**) by outlining final study components and methods that were adopted for biological monitoring to be implemented during summer 2004.

Development of a final EEM strategy for the Polaris Mine incorporated the following information:

- Results of 2003 field reconnaissance studies conducted in Garrow Bay, including:
  - Field effluent plume delineation
  - Underwater video survey
  - Fish survey
  - Sediment survey
- Results of theoretical effluent plume modeling.

- Feedback obtained from members of the TAP during a workshop held in Edmonton in December 2003 as well as written comments received subsequently. Letters received from the TAP are included in **Appendix B**.

The Addendum report followed a letter report format consisting of five sections organized as follows:

- Introduction (**Section 1**)
- Overview and key considerations (**Section 2**)
- Fish survey and tissue analysis (**Section 3**)
- Benthic invertebrate community survey (**Section 4**)
- Supporting environmental variables (**Section 5**)

2.3 Overview of 2004 Field Program (Appendix C)

Implementation of biological monitoring studies in support of the Polaris Mine EEM program was scheduled for August 14 – 28, 2004, when the likelihood of safe access to Garrow Bay for sampling would be optimal. It was agreed *a priori* with members of the TAP that a two-week level of effort would be sufficient for attempting to complete the field studies in the mine's harsh receiving environment (see Minutes of December 2003 Workshop included in **Appendix B**).

As shown in **Appendix C**, highlights of the 2004 field program can be summarized as follows:

- Six field crew members and all equipment arrived at mine site on August 14th.
- Garrow Bay sampling areas were inaccessible from shore or by boat due to large ice floes covering the entire bay and most of offshore Pullen Strait.
- Diving equipment, compressor, two boats, and a beach camp were operational within two days of arrival to ensure readiness in the event that ice conditions changed.
- While Garrow Bay was ice-covered, we conducted a survey of fish habitat near the former dock area using seabed imaging and mapping system (SIMS) on August 16th and 19th. This work fulfilled mine closure requirements by DFO.
- We also conducted an additional underwater survey of the former dock area using divers on August 20th.
- Throughout the duration of the two-week field program, we documented ice conditions on Garrow Bay and provided weekly verbal updates to Sandra Blenkinsopp (Environment Canada).

- Overall, Garrow Bay remained completely inaccessible throughout the summer of 2004 due to ice conditions. Garrow Lake also remained completely ice covered during that summer.

2.4 Effluent and Water Quality: 2003 to 2005 (Appendix D)

As indicated in **Section 2.3**, biological monitoring studies (i.e., fish and benthic invertebrate community surveys) could not be completed in Garrow Bay as part of the Polaris Mine EEM program. However, access to receiving waters immediately adjacent to the shoreline (i.e., corresponding to the exposure and reference stations for water quality monitoring) was possible every year during the summer (i.e., where some ice melt had occurred). Garrow Creek was also accessible at the final discharge point, near Garrow Lake. Accordingly, effluent and water quality were monitored between 2003 and 2005.

Consistent with MMER requirements for annual Effluent and Water Quality Reports, methods and results of the 2003-2005 investigations have been submitted to the Authorization Officer[1]. **Appendix D** provides a compilation of the annual reports and the following sections summarize the findings, particularly for lead and zinc, which are considered the two most relevant metals present in the mine's effluent.

2.4.1 Effluent Characterization

Due to its high Arctic location, Polaris Mine effluent samples could only be collected during the ice-free summer period in 2003 (late July to mid September), 2004 (early July to early September), and 2005 (late June to late August). Effluent samples were analyzed for all MMER water quality parameters. Throughout the remainder of the year there was no discharge from Garrow Lake, as Garrow Creek was frozen.

During the 2003-2005 period, ten EEM effluent characterization events were sampled at the final discharge point in Garrow Creek (about 20 m downstream of the historic dam and siphon location on Garrow Lake) (**Table 2-1**). Over the last three years there was only a single non-compliant concentration for total suspended solids (TSS) on July 7, 2004. Laboratory results indicated a TSS concentration of 117 mg/L compared to the MMER Schedule 4 limit of 30 mg/L for a single grab sample. This was due to entrainment of creek sediment during the "first flush" of the creek during spring break-up. Concurrent with the July 7th, 2004 sample, a set of acute lethality samples were also taken, which were compliant with the MMER and showed no acute toxicity to either rainbow trout or *Daphnia magna* (i.e. LC50s in both cases were >100% effluent). There

[1] Note that for 2005, only the Third Quarter report has been submitted, with the annual report being due by March 31, 2006. Notwithstanding this, the Third Quarter results effectively represent final data given the short discharge period of effluent at the Polaris Mine.

were no other non-compliant results between 2003 and 2005. No holding times were missed for any of the water chemistry or toxicity testing samples with the exception of mercury (June 29, 2005) and nitrate and alkalinity (June 29 and July 6, 2005) due to an oversight by the laboratory. The missed holding times are unlikely to affect results and additional measurements were taken on July 16, 2005, corresponding to acute and sublethal toxicity testing.

2.4.2 Receiving Environment Chemistry

During the same period, water quality characterization was conducted at the exposure (n = 8) and reference[2] (n = 7) stations in Garrow Bay. Fewer samples were collected at these stations than in Garrow Creek due to ice cover in Garrow Bay, preventing sample collection. This occurred on July 7, 2004, July 27, 2004 (reference only), and July 6, 2005.

The exposure station is within the shallow mixing zone where the creek discharges to the intertidal marine environment of Garrow Bay. The reference station is in Garrow Bay approximately 1 km northeast of the exposure station. Both stations were accessed from shore using chest waders, in water no more than 0.8 m depth and 20 m from shore.

Concentrations of all parameters measured at the exposure and reference stations are presented in **Table 2-2**. Polaris was a lead/zinc mine. Concentrations of these metals were plotted during EEM sampling episodes in (1) Garrow Creek, (2) Garrow Bay exposure (i.e., at the creek mouth), and (3) Garrow Bay reference stations for zinc (**Figure 2-1**) and lead (**Figure 2-2**). Concentrations of both metals were consistently well below their respective MMER limits.

Zinc – Concentrations of zinc in Garrow Creek have decreased over time, and, since late July, 2004, are not significantly different from the Canadian Council of Ministers of the Environment (CCME) ambient freshwater guideline of 30 µg/L (0.030 mg/L) (CCME, 2002). As discussed in **Section 3.1** (below), since mining has ceased, dissolved metals concentrations, especially zinc, in the water column of Garrow Lake have diminished. The reduction in zinc concentration in Garrow Creek mirrors what is being observed in surface waters of Garrow Lake.

[2] Initially Tigumiavik Bay was designated as the reference station, and was sampled only on the July 29, 2003 event. However, access to this location via both land and sea was difficult due to terrain, polar bears, shifting ice flows and wind conditions. Therefore, based on the plume delineation study, the reference station was shifted to Garrow Bay, approximately 1km from the mouth of Garrow Creek. See further information provided in the Addendum to the Study Design (**Appendix B**).

Year	Average Zinc Concentration at Final Discharge Point in Garrow Creek[3] (mg/L, range in brackets)	Average Lead Concentration at Final Discharge point in Garrow Creek[2] (mg/L, range in brackets)
2003	0.128 (0.048 – 0.186)	0.0219 (0.00046 – 0.0079)
2004	0.072 (0.035 – 0.198)	0.0167 (0.00032 – 0.0028)
2005	0.039 (0.013 – 0.091)	0.0073 (0.00017 – 0.0023)

Zinc concentrations in the Garrow Bay exposure station show a similar trend of reduction since 2003. It is noteworthy that the receiving environment "exposure" station is very near to the creek mouth where the creek enters the bay. There is no CCME marine guideline for zinc. The BC Approved Water Quality Guideline (BC AWQG) for zinc is 0.010 mg/L (10 µg/L) for the protection of marine life (BC AWQG, 2001). This value is three times lower than the CCME freshwater guideline concentration. Concentrations in the mixing zone were only slightly higher than the guideline concentration for a small zone surrounding the creek mouth. See also results of the plume delineation study presented in **Appendix B**.

Zinc concentrations at the reference station were very low during all events measured (**Figure 2-1**) and well below the BC AWQG marine guideline concentration, as was expected.

Lead – Concentrations of lead in the creek have also decreased over time (**Figure 2-2**; also see above table), and only exceeded the CCME ambient freshwater water quality guideline of 2 µg/L on two occasions. These data again reflect trends in water chemistry observed in Garrow Lake. Lead concentration also declined at the Garrow Bay/Creek exposure station since 2003. Variation in lead concentration in the receiving environment over time may be due to variability in sampling location (e.g., proximity to shore, tide, degree of influence of the creek). Lead exceeded the BC AWQG for marine waters (2 ug/L) only during the July 29, 2003 sampling event at the exposure station, just after mining ceased. Since then, lead concentration at the exposure station has been consistently low.

Lead concentration at the reference station in Garrow Bay was consistently low and well below the BC AWQG concentration (**Figure 2-2**).

2.4.3 Quality Assurance/Quality Control (QA/QC) Data

QA/QC data are presented in **Tables 2-3, 2-4 and 2-5** for 2003, 2004, and 2005, respectively. Relative percent differences (RPDs) were typically less than 50% and showed good reproducibility between co-located field duplicates. The one possible

[3] The average and range includes MMER weekly sampling events in addition to the EEM monitoring events.

exception was the cyanide measurement on July 16, 2005, which was higher than detection limit in the reported sample, but 87% lower in the duplicate. Very small amounts of cyanide were used during processing. Cyanide concentration has always been below detection in all other samples since mining ceased. The reason for higher than detection cyanide is not known, but is probably due to sample contamination. Metal concentrations in blank samples comprised of on-site distilled water were higher than expected for zinc, copper, and lead. Distilled water was prepared on-site and was stored in metal containers. When the mine was operating, distilled water was used frequently and did not sit in the container for long. Since the mine has been closed, this water has not been replaced and we suspect that metal leached from the metal container cans during storage over the 2004-2005 period, resulting in minor contamination of the distilled water source used for QA/QC purposes. Blanks comprised of commercial distilled water shipped with and analysed with field samples indicated low concentrations of all parameters (i.e., typically less than, or slightly higher than detection limits) and confirmed there has been no background contamination issues by the laboratory.

2.4.4 Effluent Toxicity

2.4.4.1 Lethal Toxicity

Eight rainbow trout (*Oncorhynchus mykiss*) and water flea (*Daphnia magna*) acute lethality tests were conducted using effluent collected from the final discharge point (Garrow Creek) during the open water seasons of 2003, 2004, and 2005. Also, toxicity samples were collected during all 10 EEM effluent characterization events. However, due to weather conditions, sample delivery out of the mine site was prevented on August 17, 2004, and July 6, 2005, compromising holding times. Environment Canada was advised during each of these events. There were no adverse effects observed for any of the 96-hr rainbow trout toxicity tests, or the 48-hr *Daphnia magna* toxicity tests. LC50 results were >100% effluent for both species in all testing events (**Table 2-6**). All MMER required reporting information on test conditions, methods, and results have been detailed in the Polaris Mine Effluent and Water Quality annual reports for 2003, 2004, and 2005[4] (**Appendix D**).

2.4.4.2 Semi-annual Sublethal Testing

Sublethal toxicity tests utilized in this EEM program include the estuarine species topsmelt (*Atherinops affinis*) 7-d growth and survival test, the 92-h echinoderm (sandollar *Dendraster excentricus*) fertilization test, and the red algae (*Champia parvula*) 7-d

[4] As mentioned earlier, only the Third Quarter report has been submitted for 2005, with the annual report being due by March 31, 2006. Notwithstanding this, the Third Quarter results effectively represent final data given the short discharge period of effluent at the Polaris Mine.

sublethal toxicity test (**Table 2-7**). Five sublethal toxicity testing events were conducted between 2003 and 2005. A sixth test was conducted on topsmelt only, due to laboratory issues with initiating the Echinoderm and *Champia* tests. There were no effects observed at any concentration for all topsmelt tests for both survival and growth endpoints (the highest concentrations ranged between 67.4 and 72.6% effluent v/v, due to salinity adjustment). IC25s for the Echinoderm test ranged between 3.8 and 17.5 % effluent v/v. IC25s for the *Champia* test ranged between 13.6 and 45.3 % effluent v/v.

Zinc was considered the primary contaminant of potential concern (COPC) in mine effluent. As a result, IC25 and IC50 concentrations (% effluent v/v) were converted to zinc concentrations to assess correlation between zinc in the effluent and reference toxicity tests for zinc performed on *Dendraster* (echinoderm) and *Champia*:

Date	CCME Freshwater Zn Guideline (µg/L)	Calculated Zinc Concentration for Echinoderm Test (µg/L)		Calculated Zinc Concentration for *Champia* Test (µg/L)	
		IC25	IC50	IC25	IC50
19-Aug-03	30	5.5	19.0	19.9	27.4
27-Jul-04	30	3.7	16.0	11.4	18.6
24-Aug-04	30	8.8	25.4	22.6	33.4
16-Jul-05	30	0.93	2.4	4.4	NR
6-Aug-05	30	5.5	19.6	16.1	21.9
Reference	30	8.5-60 (Mean EC50s for *Dendraster* fertilization tests, Dinnel et al. 1983)		27 (16-42) SRC in-house *Champia* IC25 for Zn (95% confidence limits)	

NR = IC50 not reported

Given the similarity between calculated zinc inhibition concentrations (IC) in the effluent samples and the effects concentrations of zinc in reference tests, with the possible exception of the July 16, 2005 sample, it is likely that zinc is responsible for the sublethal effects observed in both the *Dendraster* and *Champia* laboratory tests. Both the echinoderm and *Champia* tests are quite sensitive to zinc, with IC25s and IC50s, and reference test concentrations, being less than the CCME freshwater guideline (30 µg/L), which is unusual. All MMER required reporting information on test conditions, methods, and results have been detailed in the Polaris Mine Effluent and Water Quality annual reports for 2003, 2004, and 2005[5] (**Appendix D**).

[5] As mentioned earlier, only the Third Quarter report has been submitted for 2005, with the annual report being due by March 31, 2006. Notwithstanding this, the Third Quarter results effectively represent final data given the short discharge period of effluent at the Polaris Mine.

Table 2-1. Polaris Mine Effluent Characterization Results, 2003-2005.

Effluent Characterization from Final Discharge Point - Garrow Lake Former Dam / Syphons
Northing: 75°22'32"
Easting: 96°48'37"

Year:				2003				2004					2005
Facility Name:				Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)				Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)					
FDP Name:				Garrow Lake Syphons				Garrow Lake Syphons					
Sample ID:				G-Creek-073003	G-Creek-081903	G-Creek		G Creek	G CREEK	G CREEK	G Creek		G Creek
Sampling Date:				29-Jul-03	19-Aug-03	16-Sep-03		7-Jul-04	27-Jul-04	17-Aug-04	24-Aug-04		29-Jun-05
Sample Method:				Grab	Grab	Grab		Grab	Grab	Grab	Grab		Grab
		MMER Schedule 4 Limits											
Parameter	Units	Column 2 - Monthly mean	Column 4 - Max in grab sample				*Detection Limit*					*Detection Limit*	
Hardness	mg/L			459	1130	1540	*6*	1400	483	973	1380	*2.7*	132
Alkalinity	mg/L			46	103	122	*1*	138	62.4	111	128	*1.0*	30.7
Aluminum	mg/L			<0.1	<0.1	<0.1	*0.1*	0.34	0.021	<0.1	<0.1	*0.1*	<0.1
Cadmium	mg/L			0.00016	0.00037	0.00047	*0.00002*	0.000588	0.00014	0.00023	0.000335	*0.0002*	0.000035
Iron	mg/L			0.02	0.03	0.04	*0.01*	0.487	0.084	0.042	0.014	*0.01*	0.024
Mercury	mg/L			<0.00005	<0.00005	<0.00005	*0.00005*	<0.00001	<0.00001	<0.00001	<0.00001	*0.00001*	<0.00001
Molybdenum	mg/L			<0.002	<0.002	<0.005	*0.002 - 0.005*	<0.005	0.0013	<0.005	<0.005	*0.005*	<0.005
Ammonia	mg/L			0.08	0.03	0.04	*0.02*	0.071	<0.02	0.146	0.133	*0.02*	0.089
Nitrate	mg/L			0.102	0.225	0.217	*0.005*	0.277	0.0644	0.525	0.531	*0.01, 0.02*	0.038
Arsenic	mg/L	0.50	1.00	<0.0004	<0.001	<0.001	*0.0004 - 0.001*	<0.001	<0.001	<0.0002	<0.0002	*0.001, 0.0002*	<0.0002
Copper	mg/L	0.30	0.60	0.00057	0.00097	0.00099	*0.00005*	0.00265	0.000518	0.00121	0.00134	*0.00005*	<0.0005
Cyanide	mg/L	1.00	2.00	<0.005	<0.005	NS	*0.005*	<0.005	<0.005	<0.005	<0.005	*0.005*	<0.005
Lead	mg/L	0.20	0.40	0.00319	0.00046	0.00046	*0.00005*	0.00269	0.00157	0.00177	0.00119	*0.00005*	0.00037
Nickel	mg/L	0.50	1.00	0.00115	0.00265	0.00365	*0.00005*	0.00442	0.00207	0.00644	0.00967	*0.00005*	0.00075
Zinc	mg/L	0.50	1.00	0.0625	0.1460	0.1860	*0.0005*	0.198	0.0429	0.0418	0.0498	*0.0005*	0.0137
TSS	mg/L	15.00	30.00	<3	8	5	*3*	117	<3	5.3	4.4	*3.0*	<3
Radium 226	Bq/L	0.37	1.11	<0.005	<0.005	<0.005	*0.005*	0.02	<0.005	0.01	0.008	*0.005*	<0.005
pH	pH units	<6.0 or >9.5		7.84	8.10	7.96	*0.01*	8.05	7.87	7.95	7.84	*0.01*	7.98

Notes:
NS = no sample
< = Less than the detection limit indicated.
(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.
[1]Original data reports are available upon request
[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).
[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.
[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).
[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

Table 2-1. Polaris Mine Effluent Characterization Results, 2003-2005.

Effluent Characterization from Final Discharge Point - Garrow Lake Former Dam / Syphons
Northing: 75°22'32"
Easting: 96°48'37"

Year:				2005 Cont'd				
Facility Name:				Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)				
FDP Name:				Garrow Lake Syphons				
Sample ID:				G Creek	G-Creek	G-Creek		
Sampling Date:				6-Jul-05	16-Jul-05	6-Aug-05		
Sample Method:				Grab	Grab	Grab		
		MMER Schedule 4 Limits						
Parameter	Units	Column 2 - Monthly mean	Column 4 - Max in grab sample				*Detection Limit*	Methods[1]
Hardness	mg/L			149	184	375	*0.54 - 5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity	mg/L			28.1	29.2	52.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum	mg/L			<0.20	0.0085	<0.20	*0.001 - 0.2*	ICPMS[3]
Cadmium	mg/L			0.000034	0.000044	0.000097	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron	mg/L			0.012	0.043	0.014	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury	mg/L			<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum	mg/L			<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia	mg/L			0.036	0.037	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate	mg/L			0.032	<0.050	0.072	*0.025 - 0.050*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic	mg/L	0.50	1.00	<0.00020	<0.00020	<0.00020	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper	mg/L	0.30	0.60	0.000240	0.000424	0.000516	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide	mg/L	1.00	2.00	<0.0050	0.0444	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using NH_3 selective electrode)
Lead	mg/L	0.20	0.40	0.000166	0.000415	0.000467	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel	mg/L	0.50	1.00	0.000601	0.000807	0.00166	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc	mg/L	0.50	1.00	0.0127	0.0179	0.0356	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
TSS	mg/L	15.00	30.00	4.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium 226	Bq/L	0.37	1.11	0.0050	0.009	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	<6.0 or >9.5		7.49	7.59	7.65	*0.010*	APHA Method 4500-H (pH electrode meter)

Notes:
NS = no sample
< = Less than the detection limit indicated.
(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.
[1]Original data reports are available upon request
[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).
[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.
[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).
[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

Table 2-2. Polaris Mine Water Quality Monitoring Results - Exposure and Reference Stations, 2003 - 2005.

Year:		2003							2004				
Station:		Exposure Area			Reference Area[1]				Exposure Area			Reference Area	
Description:		Garrow Bay at Mouth of Garrow Creek Confluence			Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek)[1].				Garrow Bay at Mouth of Garrow Creek Confluence			Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek).	
Northing:		75°22'15"			75°22'40"				75°22'15"			75°22'40"	
Easting:		96°48'30"			96°47'12"				96°48'30"			96°47'12"	
Facility Name:		Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)			Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)				Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)			Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)	
FDP Name:		Garrow Lake Syphons			Garrow Lake Syphons				Garrow Lake Syphons			Garrow Lake Syphons	
Area Name:		Garrow Bay Exposure			Tigumiavik Bay[1]	Garrow Bay Ref.	Garrow Bay Ref.		Garrow Bay Exposure			Garrow Bay Reference	
Sample ID:		G-Bay-072903	G-Bay-081903	G-Bay	T-Bay-072903	T-Bay-Ref-081903	T-Bay		G BAY	G BAY	G Bay	REF	Ref
Sampling Date:		29-Jul-03	19-Aug-03	16-Sep-03	29-Jul-03	19-Aug-03	16-Sep-03		27-Jul-04	17-Aug-04	24-Aug-04	17-Aug-04	24-Aug-04
Sample Method:		Grab	Grab	Grab	Grab	Grab	Grab		Grab	Grab	Grab	Grab	Grab
Parameters	**Units**							***Detection Limit***					
Hardness	mg/L	456	1120	3620	989	5830	5930	*6*	482	2270	1750	2960	1560
Alkalinity	mg/L	46	104	117	33	115	113	*1*	37.5	45	38.8	46	36.1
Aluminum	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	*0.1*	0.033	<0.1	<0.1	<0.1	<0.1
Cadmium	mg/L	0.00015	0.00038	0.00024	<0.00002	0.00003	0.00003	*0.00002*	0.00007	<0.00002	0.000028	<0.00002	<0.00002
Iron	mg/L	0.03	0.05	0.03	0.01	<0.01	0.02	*0.01*	0.046	<0.01	<0.01	<0.01	<0.01
Mercury	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	*0.00005*	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	mg/L	<0.002	<0.002	0.006	<0.002	0.010	0.011	*0.002 - 0.005*	0.00156	<0.005	<0.005	0.0062	<0.005
Ammonia	mg/L	0.04	0.03	0.03	0.03	<0.02	0.08	*0.02*	<0.02	<0.02	0.02	<0.02	<0.02
Nitrate	mg/L	0.098	0.229	0.159	<0.005	<0.005	<0.005	*0.005*	0.0372	<0.02	<0.02	<0.02	<0.02
Arsenic	mg/L	<0.0004	<0.001	0.001	<0.0004	0.0020	<0.001	*0.0004 - 0.001*	<0.001	<0.0002	0.00027	0.00044	<0.0002
Copper	mg/L	0.00080	0.00106	0.00059	0.00023	0.00044	0.00028	*0.00005*	0.000405	0.000216	0.000209	0.000231	0.000205
Cyanide	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	*0.005*	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	mg/L	0.00435	0.00108	0.00043	0.00032	0.00021	0.00052	*0.00005*	0.00026	<0.00005	0.000267	0.000052	<0.00005
Nickel	mg/L	0.00121	0.00304	0.00169	0.00021	0.00033	0.00026	*0.00005*	0.000979	0.000252	0.000267	0.000217	0.000186
Zinc	mg/L	0.0594	0.1490	0.0881	0.0010	0.0007	0.0011	*0.0005*	0.0242	0.00118	0.00092	0.0005	<0.0005
TSS	mg/L	4	8	10	<3	32	9	*3*	3.7	3.3	8.4	9.3	7
Radium226	Bq/L	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	*0.005*	<0.005	<0.005	0.006	<0.005	<0.005
pH	pH units	7.86	8.13	7.85	7.67	7.87	7.78	*0.01*	7.91	7.79	7.64	7.92	7.62
Water Temp.	°C	0.47	1.08	-0.76	-0.27	0.18	-1.36	-	0.2	0.2	0.9	0.1	1.2
Diss. Oxygen	mg/L	10.29	5.01	5.45	9.27	5.50	3.42	-	13.23	13.78	15.2	14.04	15.13

Notes

The Garrow Bay exposure area (mouth of the creek) was frozen during the July 7, 2004 sampling event.
The Garrow Bay reference area was ice free in 2004 only during August 17 and August 24, 2004 sampling events.
The Garrow Bay exposure area (mouth of the creek), and Garrow Bay reference area were frozen during the July 6, 2005 sampling event.
< = Less than the detection limit indicated.
(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.
(b) n/a for August 6, 2005 sample = not available, the sample was lost during analysis by SRC with no additional sample remaining to repeat the analysis.

[1]Tigumiavik Bay was originally desugnated as the reference station. However, access to Tigumiavik Harbour was very difficult over land (terrain & polar bears) and unsafe over water (shifting ice flows, wind conditions). Therefore, the reference station was relocated to Garrow Bay (~ 1 km from mouth of creek), based on results of field plume delineation.

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique)

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

[6]Temperature and dissolved oxygen data from 2005 are estimated pending verification by Teck Cominco.

Table 2-2. Polaris Mine Water Quality Monitoring Results - Exposure and Reference Stations, 2003 - 2005.

Year:		2004 Cont'd	2005					
Station:			Exposure Area		Reference Area			
Description:			Garrow Bay at Mouth of Garrow Creek Confluence		Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek)			
Northing:			75°22'15"		75°22'40"			
Easting:			96°48'30"		96°47'12"			
Facility Name:			Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)		Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)			
FDP Name:			Garrow Lake Syphons		Garrow Lake Syphons			
Area Name:			Garrow Bay Exposure		Garrow Bay Reference			
Sample ID:			G-BAY	G-Bay (b)	T-BAY REF	Ref		
Sampling Date:			16-Jul-05	6-Aug-05	16-Jul-05	6-Aug-05		
Sample Method:			Grab	Grab	Grab	Grab		
Parameters	**Units**	***Detection Limit***					***Detection Limit***	**Methods**
Hardness	mg/L	*2.7*	215	385	271	840	*0.54-5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity	mg/L	*1.0*	44.2	63.2	23.0	53.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum	mg/L	*0.1*	0.0519	<0.10	0.0619	<0.10	*0.001-0.2*	ICPMS[3]
Cadmium	mg/L	*0.0002*	0.000051	0.000081	<0.000020	<0.000020	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron	mg/L	*0.01*	0.207	0.015	0.217	0.011	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury	mg/L	*0.00001*	<0.000010	<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum	mg/L	*0.005*	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia	mg/L	*0.02*	0.048	<0.020	<0.020	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate	mg/L	*0.02*	<0.050	0.092	<0.050	0.0261	*0.025*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic	mg/L	*0.001, 0.0002*	<0.00020	<0.00020	0.00050	0.00024	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper	mg/L	*0.00005*	0.000748	0.000608	0.000563	0.000305	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide	mg/L	*0.005*	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using NH_3 selective electrode)
Lead	mg/L	*0.00005*	0.00147	0.000517	0.000690	0.000078	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel	mg/L	*0.00005*	0.00126	0.00188	0.000554	0.000412	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc	mg/L	*0.0005*	0.0154	0.0224	0.00323	0.00122	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
TSS	mg/L	*3.0*	16.7	<3.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium226	Bq/L	*0.005*	0.010	n/a	<0.0050	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	*0.01*	7.64	7.96	7.40	7.89	*0.010*	APHA Method 4500-H (pH electrode meter)
Water Temp.	°C	-	0.2	0.6	-0.1	0.2	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85
Diss. Oxygen	mg/L	-	13.2	11.6	15.2	13.9	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85

Notes

The Garrow Bay exposure area (mouth of the creek) was frozen during the July 7, 2004 sampling event.
The Garrow Bay reference area was ice free in 2004 only during August 17 and August 24, 2004 sampling events.
The Garrow Bay exposure area (mouth of the creek), and Garrow Bay reference area were frozen during the July 6, 2005 sampling event.
< = Less than the detection limit indicated.
(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.
(b) n/a for August 6, 2005 sample = not available, the sample was lost during analysis by SRC with no additional sample remaining to repeat the analysis.

[1]Tigumiavik Bay was originally desugnated as the reference station. However, access to Tigumiavik Harbour was very difficult over land (terrain & polar bears) and unsafe over water (shifting ice flows, wind conditions). Therefore, the reference station was relocated to Garrow Bay (~ 1 km from mouth of creek), based on results of field plume delineation.

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

[6]Temperature and dissolved oxygen data from 2005 are estimated pending verification by Teck Cominco.

Table 2-3. 2003 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Original Sample	Field Duplicate		Original Sample	Field Duplicate		Original Sample	Field Duplicate	
Sample ID:		T-Bay-072903	Dup-072903		G-Bay-081903	Dup-081903		G-Creek	DUP	
Location:		Tigumiavik Harbour Reference			Garrow Bay Exposure			Garrow Lake Syphons		
Description:		Final Discharge Point		RPD[2]	Mouth of Garrow Creek Confluence		RPD[2]	Final Discharge Point		RPD[2]
Sampling Date:		29-Jul-03		(%)	19-Aug-03		(%)	16-Sep-03		(%)
Parameters	**Parameter Units**									
Hardness	mg/L	989	1020	3.04	1120	1140	1.75	1540	1470	4.76
Alkalinity	mg/L	33	33	0.00	104	104	0.00	122	119	2.52
Aluminum	mg/L	<0.1	<0.1	n/a	<0.1	<0.1	n/a	<0.1	<0.1	n/a
Cadmium	mg/L	<0.00002	<0.00002	n/a	0.00038	0.00034	11.76	0.00047	0.00047	0.00
Iron	mg/L	0.01	0.01	0.00	0.05	0.05	0.00	0.04	0.03	33.33
Mercury	mg/L	<0.00005	<0.00005	n/a	<0.00005	<0.00005	n/a	<0.00005	<0.00005	n/a
Molybdenum	mg/L	<0.002	<0.002	n/a	<0.002	<0.002	n/a	<0.005	<0.005	n/a
Ammonia	mg/L	0.03	0.04	25.00	0.03	0.03	0.00	0.04	0.02	100.00
Nitrate	mg/L	<0.005	<0.005	n/a	0.229	0.203	12.81	0.217	0.292	25.68
Arsenic	mg/L	<0.0004	<0.0004	n/a	<0.001	<0.001	n/a	<0.001	<0.001	n/a
Copper	mg/L	0.00023	0.0003	23.33	0.00106	0.00103	2.91	0.00099	0.00098	1.02
Cyanide	mg/L	<0.005	<0.005	n/a	<0.005	<0.005	n/a	-	<0.005	n/a
Lead	mg/L	0.00032	0.00102	68.63	0.00108	0.00213	49.30	0.00046	0.00071	35.21
Nickel	mg/L	0.00021	0.00024	12.50	0.00304	0.00266	14.29	0.00365	0.00326	11.96
Zinc	mg/L	0.001	0.001	0.00	0.149	0.138	7.97	0.186	0.187	0.53
TSS	mg/L	<3	5	n/a	8	12	33.33	5	5	n/a
Radium226	Bq/L	<0.005	<0.005	n/a	<0.005	<0.005	n/a	<0.005	0.008	n/a
pH	pH units	7.67	7.63	0.52	8.13	8.02	1.37	7.96	7.94	0.25
Salinity	o/oo	6	6	0.00	6	9	33.33	7	6	16.67
Calcium	mg/L	68.4	71.2	3.93	98	101	2.97	133	127	4.72
Magnesium	mg/L	199	205	2.93	211	216	2.31	294	279	5.38

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 2 blank samples were collected during the 2003 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of lead (July 29, 2003) and ammonia (September 16, 2003). This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 2-3. 2003 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Blank	Field Blank
Sample ID:		F-Blank-081903	F-Blank
Location:		n/a	n/a
Description:		Distilled Water[3]	Distilled Water[3]
Sampling Date:		19-Aug-03	16-Sep-03
Parameters	Parameter Units		
Hardness	mg/L	-	<10
Alkalinity	mg/L	-	-
Aluminum	mg/L	<0.1	<0.1
Cadmium	mg/L	<0.00002	<0.00002
Iron	mg/L	0.01	<0.01
Mercury	mg/L	<0.00005	<0.00005
Molybdenum	mg/L	<0.002	<0.005
Ammonia	mg/L	-	-
Nitrate	mg/L	-	-
Arsenic	mg/L	<0.001	<0.001
Copper	mg/L	0.00033	0.00033
Cyanide	mg/L	-	-
Lead	mg/L	0.00102	0.00018
Nickel	mg/L	<0.00005	0.00008
Zinc	mg/L	0.0014	0.0007
TSS	mg/L	-	-
Radium226	Bq/L	<0.005	<0.005
pH	pH units	-	-
Salinity	o/oo	-	-
Calcium	mg/L	<0.5	<1
Magnesium	mg/L	<1	<2

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 2 blank samples were collected during the 2003 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of lead (July 29, 2003) and ammonia (September 16, 2003). This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 2-4. 2004 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Duplicate	Original Sample		Field Duplicate	Original Sample	
Sample ID:		Dup	G Creek		DUP	G BAY		FIELD DUP	G CREEK	
Location:		Garrow Lake Syphons			Garrow Bay Exposure			Garrow Lake Syphons		
Description:		Final Discharge Point		RPD[2]	Mouth of Garrow Creek Confluence		RPD[2]	Final Discharge Point		RPD[2]
Sampling Date:		7-Jul-04		(%)	27-Jul-04		(%)	17-Aug-04		(%)
Parameters	**Parameter Units**									
Hardness	mg/L	1400	1400	0.00	532	482	10.37	997	973	2.47
Alkalinity	mg/L	132	138	4.35	38.6	37.5	2.93	113	111	1.80
Aluminum	mg/L	0.26	0.34	23.53	0.031	0.033	6.06	<0.10	<0.1	n/a
Cadmium	mg/L	0.000582	0.000588	1.02	0.000062	0.00007	11.43	0.000224	0.00023	2.61
Iron	mg/L	0.441	0.487	9.45	0.035	0.046	23.91	0.039	0.042	7.14
Mercury	mg/L	<0.000010	<0.00001	n/a	<0.000050	<0.00005	n/a	<0.000010	<0.00001	n/a
Molybdenum	mg/L	<0.0050	<0.005	n/a	0.00129	0.00156	17.31	<0.0050	<0.005	n/a
Ammonia	mg/L	0.069	0.071	2.82	<0.020	<0.02	n/a	0.163	0.146	11.64
Nitrate	mg/L	0.284	0.277	2.53	0.0371	0.0372	0.27	0.54	0.525	2.86
Arsenic	mg/L	<0.0010	<0.001	n/a	<0.0010	<0.001	n/a	<0.00020	<0.0002	n/a
Copper	mg/L	0.00252	0.00265	4.91	0.000342	0.000405	15.56	0.00121	0.00121	0.00
Cyanide	mg/L	<0.0050	<0.005	n/a	<0.0050	<0.005	n/a	<0.0050	<0.005	n/a
Lead	mg/L	0.0024	0.00269	10.78	0.000205	0.00026	21.15	0.00187	0.00177	5.65
Nickel	mg/L	0.00438	0.00442	0.90	0.000772	0.000979	21.14	0.00676	0.00644	4.97
Zinc	mg/L	0.196	0.198	1.01	0.019	0.0242	21.49	0.0418	0.0418	0.00
TSS	mg/L	120	117	2.56	7	3.7	89.19	<3.0	5.3	n/a
Radium226	Bq/L	0.02	0.02	0.00	<0.0050	<0.005	n/a	<0.0050	0.01	n/a
pH	pH units	8.06	8.05	0.12	7.76	7.91	1.90	8.02	7.95	0.88

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller.

QAQC Results

A total of 4 duplicate samples and 3 blank samples were collected during the 2004 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of TSS on July 27, 2004. This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 2-4. 2004 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Blank	Transport Blank	Field Blank	Field Blank
Sample ID:		Dup	G Creek		F Blank	T Blank	F BLANK	FIELD BLANK
Location:		Garrow Lake Syphons			n/a	n/a	n/a	n/a
Description:		Final Discharge Point		RPD[2]	Distilled Water[3]	Distilled Water[3]	Distilled Water[3]	Distilled Water[3]
Sampling Date:		24-Aug-04		(%)	7-Jul-04	7-Jul-04	27-Jul-04	17-Aug-04
Parameters	Parameter Units							
Hardness	mg/L	1380	1380	0.00	<0.54	<0.54	-	<0.54
Alkalinity	mg/L	128	128	0.00	-	-	-	<1.0
Aluminum	mg/L	<0.10	<0.1	n/a	<0.10	<0.10	<0.0010	<0.0010
Cadmium	mg/L	0.000342	0.000335	2.09	<0.000020	<0.000020	<0.000050	<0.00020
Iron	mg/L	0.015	0.014	7.14	<0.010	<0.010	<0.030	<0.030
Mercury	mg/L	<0.000010	<0.00001	n/a	<0.000010	<0.000010	<0.000050	<0.000010
Molybdenum	mg/L	<0.0050	<0.005	n/a	<0.0050	<0.0050	<0.000050	<0.0010
Ammonia	mg/L	0.114	0.133	14.29	-	-	-	0.028
Nitrate	mg/L	0.529	0.531	0.38	-	-	-	<0.0050
Arsenic	mg/L	<0.00020	<0.0002	n/a	<0.0010	<0.0010	<0.0010	<0.00020
Copper	mg/L	0.00140	0.00134	4.48	0.00012	0.00012	0.00023	<0.0010
Cyanide	mg/L	<0.0050	<0.005	n/a	-	-	-	<0.0050
Lead	mg/L	0.00116	0.00119	2.52	0.00017	0.00021	0.000209	<0.0010
Nickel	mg/L	0.00971	0.00967	0.41	<0.00050	<0.00050	<0.00050	<0.0010
Zinc	mg/L	0.0514	0.0498	3.21	0.0012	<0.0010	0.0025	<0.0050
TSS	mg/L	3.7	4.4	15.91	-	-	-	<3.0
Radium226	Bq/L	<0.0050	0.008	n/a	<0.0050	0.006	-	<0.0050
pH	pH units	7.93	7.84	1.15	-	-	-	5.51

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller.

QAQC Results

A total of 4 duplicate samples and 3 blank samples were collected during the 2004 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of TSS on July 27, 2004. This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 2-5. 2005 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Duplicate	Original Sample		Field Duplicate	Original Sample	
Sample ID:		Dup	G Creek		Dup	G Creek		DUP	G-Creek	
Location:		Garrow Lake Syphons			Garrow Lake Syphons			Garrow Lake Syphons		
Description:		Final Discharge Point		RPD[2]	Final Discharge Point		RPD[2]	Final Discharge Point		RPD[2]
Sampling Date:		29-Jun-05		(%)	6-Jul-05		(%)	16-Jul-05		(%)
Parameters	Parameter Units									
Hardness	mg/L	124	132	6.1	140	149	6.0	187	184	1.6
Alkalinity, Total	mg/L	-	30.7	n/a	28.0	28.1	0.4	29.0	29.2	0.7
Aluminum, Total	mg/L	<0.10	<0.1	n/a	<0.10	<0.20	n/a	0.0087	0.0085	2.4
Cadmium, Total	mg/L	0.000042	0.000035	20.0	0.000040	0.000034	17.6	0.000049	0.000044	11.4
Iron, Total	mg/L	0.026	0.024	8.3	0.013	0.012	8.3	0.043	0.043	0.0
Mercury, Total	mg/L	<0.000010	<0.00001	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum, Total	mg/L	<0.0050	<0.005	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Ammonia Nitrogen	mg/L	-	0.089	n/a	0.032	0.036	11.1	0.044	0.037	18.9
Nitrate Nitrogen	mg/L	-	0.038	n/a	0.028	0.032	12.5	<0.050	<0.050	n/a
Arsenic, Total	mg/L	<0.00020	<0.0002	n/a	0.00021	<0.00020	n/a	<0.00020	<0.00020	n/a
Copper, Total	mg/L	0.000444	<0.0005	n/a	0.000295	0.000240	22.9	0.000376	0.000424	11.3
Cyanide, Total	mg/L	-	<0.005	n/a	<0.0050	<0.0050	n/a	0.0058	0.0444	86.9
Lead, Total	mg/L	0.000414	0.00037	12.5	0.000241	0.000166	45.2	0.000409	0.000415	1.4
Nickel, Total	mg/L	0.000799	0.00075	6.0	0.000673	0.000601	12.0	0.000819	0.000807	1.5
Zinc, Total	mg/L	0.0143	0.0137	4.4	0.0136	0.0127	7.1	0.0185	0.0179	3.4
Total Suspended Solids	mg/L	-	<3	n/a	<3.0	4.0	n/a	<3.0	<3.0	n/a
Radium-226 (a,b)	Bq/L	-	<0.005	n/a	<0.0050	0.0050	n/a	<0.0050	0.009	n/a
pH	pH units	-	7.98	n/a	7.62	7.49	1.7	7.58	7.59	0.1
Salinity	o/oo	-	-		<1.0	<1.0	n/a	<1.0	<1.0	n/a
Calcium, Total	mg/L	-	-		16.5	19.1	13.6	21.4	21.1	1.4
Magnesium, Total	mg/L	-	-		24.0	24.6	2.4	32.3	31.9	1.3

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller, stored for 1 year in jerry cans onsite.

[4]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 5 blank samples were collected during the 2005 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of cyanide on July 16, 2005. Cyanide is not used in the process and is typically measured at less than the detection limit. With the exception of the aforementioned cyanide measurement, which is questionable, the data generally indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples from the on-site distilled water that had been stored indicated relatively high levels of zinc, copper, and lead. This contamination was considered to be a result of the storage procedure and metal leaching from the metal jerry cans that the water was stored in for the year. The transport blanks using commmercial distilled water indicated low concentrations of all paramters (i.e., typically less than, or slightly higher than detection limits), which indicate no background contamination issues with the analysis.

Table 2-5. 2005 Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Blank	Field Blank	Field Blank	Field Blank	ALS Travel Blank	ALS Travel Blank
Sample ID:		Dup	Ref							
Location:		Garrow Bay Reference			n/a	n/a	n/a	n/a	n/a	n/a
Description:		~1km NE of confluence with Garrow Creek		RPD[2]	Distilled Water[3]	Distilled Water[3]	Distilled Water[3]	Distilled Water[3]	Distilled Water[4]	Distilled Water[5]
Sampling Date:		6-Aug-05		(%)	29-Jun-05	6-Jul-05	16-Jul-05	6-Aug-05	24-Aug-05	24-Aug-05
Parameters	Parameter Units									
Hardness	mg/L	852	840	1.4	0.61	3.07	<0.54	0.85	<0.50	<0.50
Alkalinity, Total	mg/L	53.8	53.5	0.6	-	3.2	<2.0	<2.0	<2.0	<2.0
Aluminum, Total	mg/L	<0.10	<0.10	n/a	<0.0010	<0.0010	<0.0050	<0.10	<0.0010	<0.0010
Cadmium, Total	mg/L	<0.000020	<0.000020	n/a	<0.000050	<0.000050	<0.000020	<0.000050	<0.000020	<0.000050
Iron, Total	mg/L	0.011	0.011	0.0	<0.030	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury, Total	mg/L	<0.000010	<0.000010	n/a	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum, Total	mg/L	<0.0050	<0.0050	n/a	<0.000050	<0.000050	<0.0050	<0.0050	<0.000050	<0.000050
Ammonia Nitrogen	mg/L	<0.020	<0.020	n/a	-	<0.020	<0.020	<0.020	-	-
Nitrate Nitrogen	mg/L	0.0348	0.0261	33.3	-	<0.0050	<0.0050	<0.0050	-	-
Arsenic, Total	mg/L	<0.00020	0.00024	n/a	0.00033	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Copper, Total	mg/L	0.000321	0.000305	5.2	0.0151	0.00484	0.00167	0.0244	<0.000050	<0.00010
Cyanide, Total	mg/L	<0.0050	<0.0050	n/a	-	<0.0050	<0.0050	<0.0050	-	-
Lead, Total	mg/L	0.000062	0.000078	20.5	0.0143	0.00212	0.00607	0.0445	<0.000050	<0.000050
Nickel, Total	mg/L	0.000460	0.000412	11.7	<0.00010	<0.00010	<0.000050	<0.00050	<0.000050	<0.00010
Zinc, Total	mg/L	0.00165	0.00122	35.2	0.0084	0.0080	0.00440	0.0040	<0.00050	<0.0010
Total Suspended Solids	mg/L	<3.0	<3.0	n/a	-	<3.0	<3.0	<3.0	<3.0	<3.0
Radium-226 (a,b)	Bq/L	0.0060	<0.0050	n/a	<0.0050	<0.0050	<0.0050	<0.0050	-	-
pH	pH units	7.80	7.89	1.1	-	6.27	5.59	6.17	5.51	5.53
Salinity	o/oo	4.6	4.6	0.0	-	<1.0	<1.0	<1.0	<1.0	<1.0
Calcium, Total	mg/L	58.1	57.6	0.9	-	1.23	0.084	0.341	<0.050	<0.050
Magnesium, Total	mg/L	172	169	1.8	-	<0.10	<0.10	<0.10	<0.050	<0.050

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller, stored for 1 year in jerry cans onsite.

[4]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 5 blank samples were collected during the 2005 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of cyanide on July 16, 2005. Cyanide is not used in the process and is typically measured at less than the detection limit. With the exception of the aforementioned cyanide measurement, which is questionable, the data generally indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples from the on-site distilled water that had been stored indicated relatively high levels of zinc, copper, and lead. This contamination was considered to be a result of the storage procedure and metal leaching from the metal jerry cans that the water was stored in for the year. The transport blanks using commmercial distilled water indicated low concentrations of all paramters (i.e., typically less than, or slightly higher than detection limits), which indicate no background contamination issues with the analysis.

Table 2-6. Summary of Polaris Mine acute toxicity tests, 2003 - 2005.

Facility Name: Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)
Final Discharge Point Name: Garrow Lake Syphons
Northing: 75°22'32"
Easting: 96°48'37"

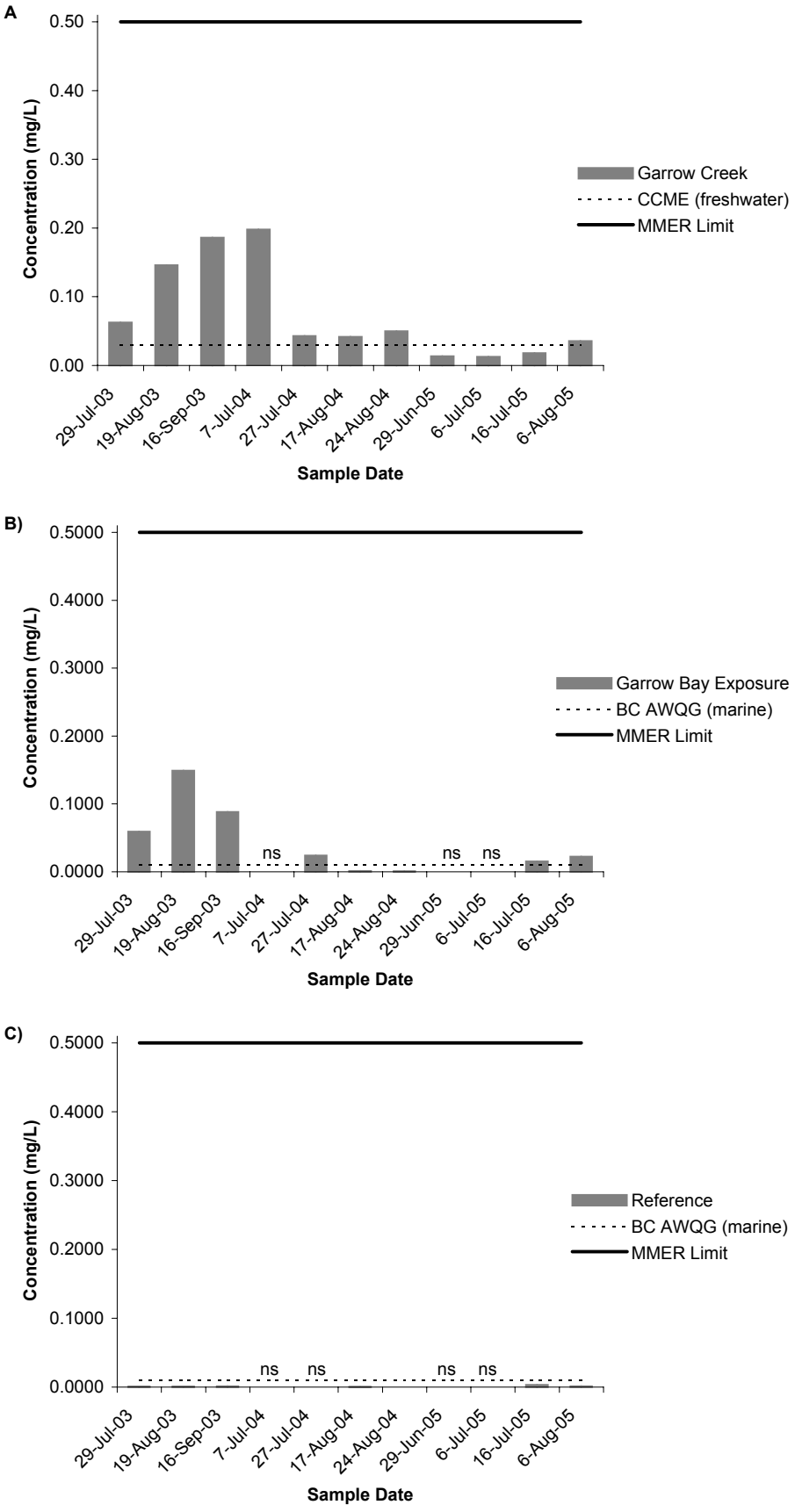
Test Date	Species Tested	Test Type	Sample Method	Consultant Laboratory	LC50 (% effluent)	LC50 Lower Confidence Limit (% effluent)	LC50 Upper Confidence Limit (% effluent)
Rainbow Trout 96-hr LC50							
29-Jul-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
19-Aug-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
16-Sep-03	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
7-Jul-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
27-Jul-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
24-Aug-04	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Jul-05	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
6-Aug-05	*Oncorhynchus mykiss*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
***Daphnia magna* 48-hr LC50**							
29-Jul-03	*Daphnia magna*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
19-Aug-03	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Sep-03	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
7-Jul-04	*Daphnia magna*	Survival	Grab	EVS Consultants, North Vancouver, BC	> 100	-	-
27-Jul-04	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
24-Aug-04	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
16-Jul-05	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
6-Aug-05	*Daphnia magna*	Survival	Grab	EVS Consultants North Vancouver, BC	> 100	-	-
						-	-

Table 2-7. Summary of Polaris Mine sublethal toxicity tests 2003 - 2005.

Facility Name: Teck Cominco Metals - Polaris Mine (Little Cornwallis Island)
Final Discharge Point Name: Garrow Lake Syphons
Northing: 75°22'32"
Easting: 96°48'37"

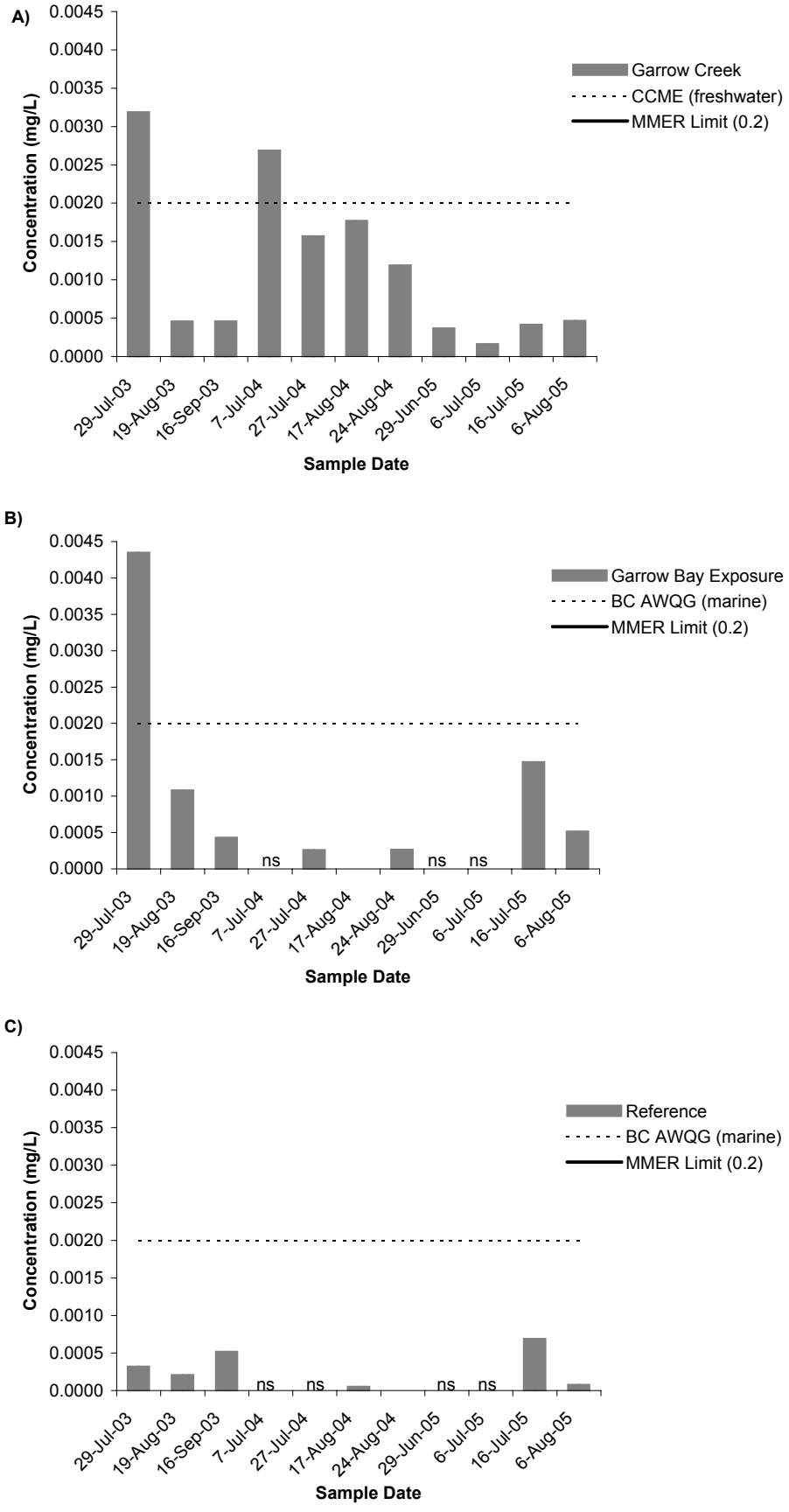
Test Date	Species Tested	Test Type	Sample Method	Consultant Laboratory	EC25 or IC25 (% effluent)	EC25 or IC25 Lower Confidence Limit (% effluent)	EC25 or IC25 Upper Confidence Limit (% effluent)
Topsmelt (*Atherinops affinis*) 7-d Growth and Survival Toxicity Test - Growth Endpoint							
19-Aug-03	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 72.3	-	-
7-Jul-04	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 72.6	-	-
27-Jul-04	*Atherinops affinis*	Growth	Grab	EVS Consultants, North Vancouver, BC	> 69.0	-	-
24-Aug-04	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 71.0	-	-
16-Jul-05	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 71.4	-	-
6-Aug-05	*Atherinops affinis*	Growth	Grab	EVS Consultants North Vancouver, BC	> 67.4	-	-
Topsmelt (*Atherinops affinis*) 7-d Growth and Survival Toxicity Test - Survival Endpoint					**LC50 (% effluent) for survival endpoint only**		
19-Aug-03	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 72.3	-	-
7-Jul-04	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 72.6	-	-
27-Jul-04	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 69.0	-	-
24-Aug-04	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 71.0	-	-
16-Jul-05	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 71.4	-	-
6-Aug-05	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC	> 67.4	-	-
Sandollar Echinoderm (*Dendraster excentricus*) 92-h Echinoderm Fertilization Test							
19-Aug-03	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	3.8	1.1	7.2
27-Jul-04	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	8.7	7.6	9.9
24-Aug-04	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	17.5	11.6	22.6
16-Jul-05	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	5.2	4.4	6
6-Aug-05	*Dendraster excentricus*	Reproduction	Grab	EVS Consultants North Vancouver, BC	15.6	13.6	18.3
Red Algae (*Champia parvula*) 7-d Sublethal Algal Toxicity Test							
19-Aug-03	*Champia parvula*	Reproduction	Grab	Saskatchewan Research Council (SRC), Saskatoon, SK	13.6	9.0	16.0
27-Jul-04	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	26.6	20.8	31.5
24-Aug-04	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	45.3	36.3	58.1
16-Jul-05	*Champia parvula*	Reproduction	Grab	Stantec Inc, Guelph,ON	24.6	22.2	27.2
6-Aug-05	*Champia parvula*	Reproduction	Grab	SRC, Saskatoon, SK	45.3	27.5	52.4

Figure 2-1. Zinc concentrations at (A) Garrow Creek final discharge point (Garrow Lake Syphons), (B) Garrow Bay exposure station, and (C) Garrow Bay reference station, 2003 - 2005.



Note: ns = no sample due to ice covered conditions in Garrow Bay.
MMER criterion is monthly mean (Schedule 4, column 2)
The BC AWQG for zinc is a recommended guideline for marine waters

Figure 2-2. Lead concentrations at (A) Garrow Creek final discharge point (Garrow Lake Syphons), (B) Garrow Bay exposure station, and (C) Garrow Bay reference station, 2003 - 2005.



Note: ns = no sample due to ice covered conditions in Garrow Bay.
MMER criterion is monthly mean (Schedule 4, column 2)
The BC AWQG for lead is the 30-day chronic guideline for marine and estuarine waters

3 FUTURE TRENDS IN EFFLUENT CHARACTERISTICS

This section provides a discussion of anticipated future trends in effluent characteristics and was included in the interpretative report to provide some context for understanding potential implications for receiving environment quality in the long-term.

3.1 Summary of Garrow Lake Investigations (Appendix E)

As part of a 2002 DFO habitat authorization (02-HCAA-000-000063) during the decommissioning and dam removal process from the mouth of Garrow Lake, Teck Cominco was specifically required to measure the following:

- "TSS and turbidity in different strata of Garrow Lake to confirm the absence of contaminants in surface waters;
- metals concentration in sediment in the littoral zone of Garrow Lake; and
- whole-body metal concentration in fourhorn sculpin".

Garrow Lake was the recipient of all metals contaminated mine tailings during the 20 year operation of the mine and water discharge from the lake to Garrow Creek effectively represent the mine's effluent. Therefore, understanding the limnology and surface water chemistry of the lake is very relevant to understanding chemical features of the creek that is measured for chemistry and toxicity on a regular basis throughout the summer open water season.

Garrow Lake is small, ultra-oligotrophic and permanently chemically and thermally stratified (i.e., meromictic). Between 1981 and 2002, approximately 15 million tonnes of tailings solids were deposited into the lake within the monimnolimnion (i.e., unmixed deep layer). Prior to tailings deposition, the biologically active mixolimnion (i.e., well-mixed surface layer) ranged between zero and 12 m – 14 m in depth and was well oxygenated, cold and brackish (3 – 7 ppt salinity). The deep monimolimnion extended from about 18 m to the bottom and was unusually warm (8^{o}C), completely anoxic, sulphide rich and hypersaline, with a salinity of nearly 90 ppt. These layers were separated by a 6 m thick pycnocline (i.e., density barrier) where temperature increased, oxygen concentration fell and salinity increased rapidly with increasing depth.

Over time, tailings disposal caused upward displacement of the mixolimnion, thinning of the pycnocline and reduced total water depth of the lake from 46 m to 42 m. Discharge of tailings also caused vertical mixing within the monimolimnion and reduced mean salinity, from 90 ppt to 70 ppt. Although mixolimnion thickness was reduced by four or five meters vertical temperature, oxygen and salinity profiles do not appear to have changed since prior to mining.

As mentioned above, surface waters of Garrow Lake constitute the "effluent" or outflow from Garrow Creek. Early in spring (late June) when the creek channel thaws and discharge begins, the creek consists of melt water from the creek channel and surrounding terrestrial area that thaws before the lake does. One or two weeks after the creek channel begins to flow, ice on Garrow Lake melts and the discharge is comprised of melt-water from ice and snow from the lake and surrounding basin. During mid- to late summer (August), discharge to the creek consists primarily of surface water from Garrow Lake itself, as water chemistry of the creek more closely mirrors mixolimnion water chemistry from the lake.

To determine the possible effects of more than 20 years of tailings disposal, a comprehensive investigation of the limnology and ecology of Garrow Lake was conducted in August 2003 (see complete report in **Appendix E**). Prior to mining, the lake supported a depauperate biological community including a small, dwarf population of landlocked fourhorn sculpin (*Myoxocephalus quadricornis*). Despite routine monitoring of lake water quality and stratification during mine life, there was no evaluation of changes in sediment quality or biological community structure during tailings disposal to the lake bottom between 1980 and September 1992.

Tailings deposition has not changed limnological conditions of the mixolimnion (0 – 9 m). Winter and summer water temperatures remain cold, ranging from –0.5 ^{o}C to 4 ^{o}C with little difference between seasons. Salinity ranged from 3.8 ppt at the surface to 7.1 ppt at the pycnocline (9 m) with slight inverse stratification. Oxygen concentration was stratified and high in winter (13 – 20 mg/L) and supersaturated, a condition also noted during pre-mine conditions, presumably from algae and photosynthetic bacteria. During mid-summer, oxygen concentration was high but was not supersaturated because absence of ice cover and mixing by wind, allowing oxygen to escape to the atmosphere.
In 1984/85, a pipeline break caused tailings to spill into the littoral zone, resulting in widespread contamination of zinc in littoral zone sediment. This caused an increase in lead and zinc concentration of nearly two orders of magnitude in surface waters of Garrow Lake and the outflow creek. Pre-mine zinc concentration in surface waters was 0.003 mg/L. Shortly after the spill, zinc concentration was 0.23 mg/L and remained steady until the end of mining in 2002. Since 2001 (0.22 mg/L), zinc concentration in the mixolimnion has been gradually declining, from 0.18 mg/L in 2003 to 0.13 mg/L in summer 2005.

Vertical distribution of zinc concentration from the center and south end of Garrow Lake between 2003 and 2005 is depicted in **Figure 3-1**. Late-winter zinc concentration in the mixolimnion (to 9 m) averages 0.21 mg/L and is nearly double open-water (summer) zinc concentration because of dilution by ice and snow melt. Zinc concentration at the top of the pycnocline is highest at more than 1.0 mg/L because of accumulation within bacterial tissue that have settled at the top of the density barrier. Note that since tailings deposition to the monimolimnion has ceased, zinc concentration in deep water (>15 m) has declined

considerably, from 0.28 mg/L in 2003, to 0.04 mg/L in 2005. Thus, zinc concentration in surface and deep waters have declined by 50% and 80% respectively in the three years since cessation of tailings deposition. This suggests that water quality will continue to improve.

Nineteen sculpins were captured in 2003 and all appeared to be healthy with no external or internal tumors, scars or other abnormalities. Mean length (149 mm), weight (25 g) and condition (0.70) of sculpins from 2003 did not differ from sculpins collected in 1976 (155 mm, 26 g, 0.72), several years before mining.

Whole body concentration of manganese, lead (0.81 mg/kg ww) and zinc (72 mg/kg) in sculpins was higher in 2003 than prior to mining. Other metals including arsenic, cadmium, copper, mercury, and nickel were lower or did not differ among years. Elevated lead and zinc concentrations in sediment and the water column as a result of the spill appear responsible for elevated tissue concentration, however, the magnitude of increase in tissue was small, only 2 – 3 times higher than pre-mining concentration, despite a two-order of magnitude increase in lead and zinc concentration in sediment.

The size, distribution, growth rate and reproductive status of the sculpin community has not changed markedly since pre-mining studies, although sculpins were more difficult to capture and did not appear to be as abundant as pre-mine surveys. This may be related to reduced benthic habitat available to sculpins and their food sources because of gradual upward displacement of the mixolimnion. Nevertheless, sculpins have survived in Garrow Lake throughout the history of mining and tailings deposition to the lake, which is still designated as a tailings disposal facility. Presence and health of sculpins in Garrow Lake is circumstantially relevant because these fish have survived in what is in effect "100% effluent" during mine life and have not appeared to have suffered any ill effects.

3.2 Future Effluent Characteristics and Effects

Despite considerable planning and efforts spent in conducting biological monitoring studies in Garrow Bay, a formal EEM program could not be implemented due to the harsh field conditions encountered on Little Cornwallis Island. Notwithstanding this, historical information as well as more recent data, especially those collected in the field during the 2003 reconnaissance studies, were considered relevant for understanding the likelihood of adverse biological effects occurring in the Garrow Bay receiving environment.

Specifically, the following paragraphs summarize the findings of multiple lines of evidence compiled in this report (**Appendices A to E**). Together, they represent a weight-of-evidence assessment providing some context for evaluating long-term conditions:

- Water chemistry in Garrow Creek changes over the course of the summer. Local channel and terrestrial snow melt that is low in metals dominates early creek flow

and is gradually replaced by outflow from Garrow Lake that is higher in metals. All metals concentrations are well below MMER limits. The only metal to consistently exceed the CCME freshwater guideline for the protection of aquatic life (0.03 mg/L or 30 µg/L) was zinc. The mean zinc concentration in Garrow Creek during mining was consistently about 0.20 mg/L or about seven times the CCME guideline. Surface water zinc concentrations in Garrow Lake and Garrow Creek have diminished since mining ended in 2002. Total zinc concentrations (mg/L) in effluent from monthly samples between 2003 and 2005 illustrate this trend.

Total zinc concentration (mg/L) in monthly effluent samples

	2003	2004	2005
Late June	0.062	0.198	0.0127
July	0.146	0.043	0.0179
August	0.186	0.042	0.0356

Total zinc concentration in 2005 was consistently lower in concentration (3 – 6 times) than in 2003. This is a reflection of the reduced zinc concentration in mixolimnion of Garrow Lake (**Figure 3-1**). Thus, zinc concentration appears to be diminishing over time and is expected to continue to diminish. In 2005, zinc only slightly exceeded the CCME guideline of 0.03 mg/L on one occasion in August.

- Surface (mixolimnion) and deep (monimolimnion) zinc concentrations in Garrow Lake have diminished throughout the water column as can be seen from vertical zinc profiles during winter/summer since 2003 (**Figure 3-1**). It is expected that concentrations will continue to decline in the absence of mining.
- Despite 20 years of mining and discharge of creek water with elevated zinc concentrations, there has been no biologically significant accumulation of zinc in sediments of Garrow Bay (2003 reconnaissance sampling program; **Appendix B**). Zinc concentrations in intertidal sediments at the creek mouth ranged from 72 to 103 mg/kg in 2003, which is approximately twice background concentrations, but is lower than the conservative CCME interim sediment quality guideline (ISQG) of 124 mg/kg for marine sediments. Zinc concentrations in subtidal sediment ranged from 29 – 39 mg/kg, which is similar to reference area sediment and similar to pre-mining sediment concentrations. Pre-mine (1978) sediment zinc concentrations (Fallis, 1984) ranged from 29 – 38 mg/kg. These data

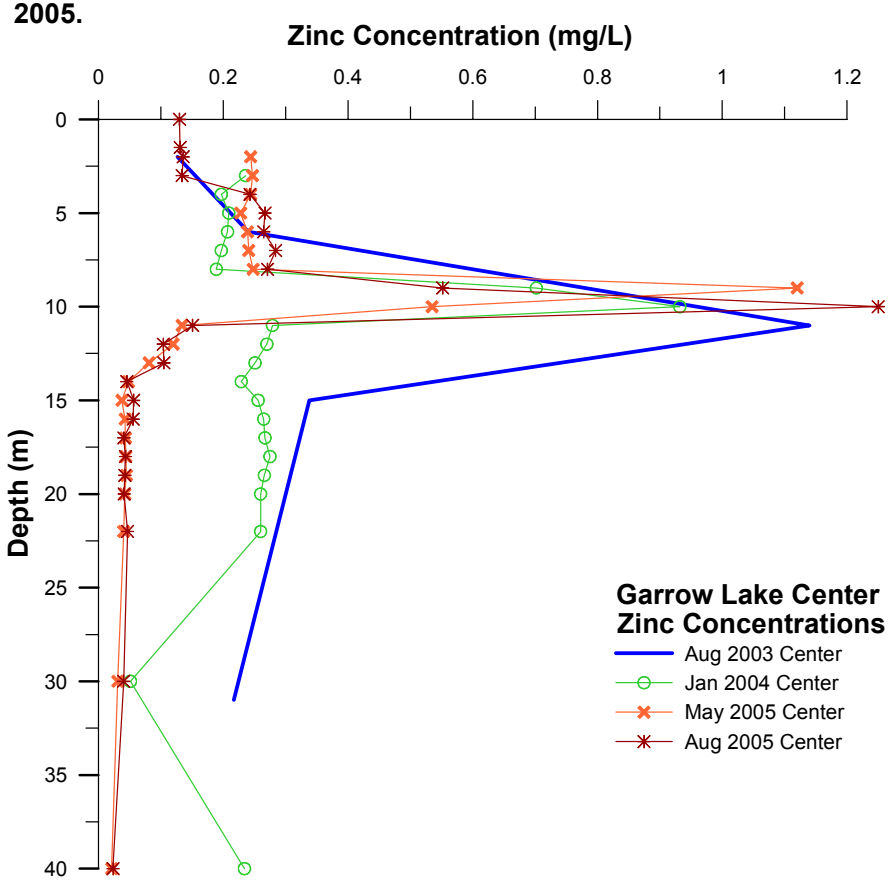
indicate that there has been no biologically significant accumulation of zinc in intertidal and subtidal sediments during 20 years of effluent discharge.

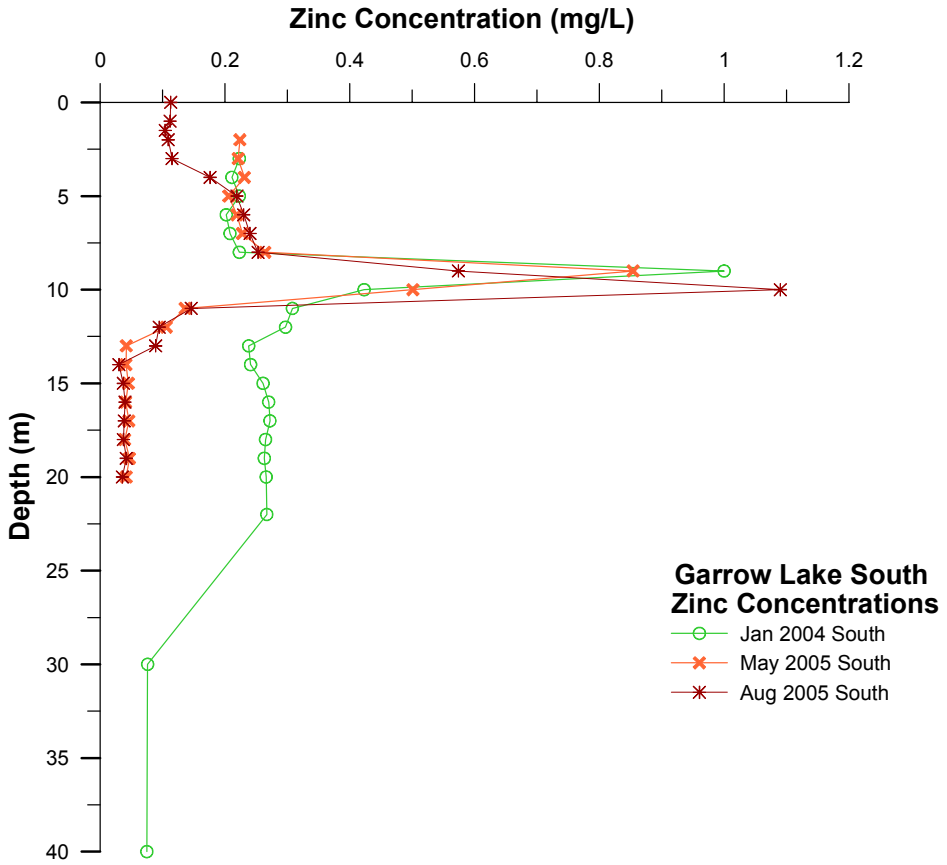
- Empirical data and theoretical modeling of brackish Garrow Creek water entering the marine environment of Garrow Bay confirmed that the plume is small, confined to a thin surface layer and is rapidly broken down and mixed by currents, wind-driven mixing and by ice. The low salinity creek water enters Garrow Bay as a thin (< 20 cm), narrow plume that likely becomes laterally and vertically dispersed well within the intertidal, ice-scour zone of Garrow Bay. Concentrations of zinc in marine water immediately below the plume are similar to background. There does not appear to be any exposure pathway of zinc or any other metal to marine sediments. This assumption is supported by the sediment data.
- No acute toxicity to rainbow trout or *Daphnia magna* was measured during three years of toxicity testing. No mortality or sublethal effects (growth) were observed for topsmelt (*Atherinops affinis*) during three years of testing. Sublethal toxicity was detected in Echinoderm sand dollar (*Dendraster excentricus*; 5 – 15% effluent concentration) and algae (*Champia parvula*; 25 – 45 % effluent concentration) in 2005. Based on comparisons between toxicity test results and calculated lead and zinc concentrations in matching effluent samples, it is likely that zinc was responsible for the sublethal effects observed in both the *Dendraster* and *Champia* laboratory tests. However, toxicity threshold levels appeared to be lower than the CCME freshwater guideline, which indicates that these species may have been unusually sensitive. Other lines of evidence presented in this section address potential implications of these results for marine organisms residing in the Garrow Bay receiving environment.
- During the 2003 reconnaissance studies (see **Appendix B**), marine clams (*Mya truncata*) were collected by divers from three exposure stations surrounding the mouth of Garrow Creek. These stations were located in the subtidal zone between 7 m and 10 m depth and were about 200 m offshore (i.e., the most near-field location where clams could be found). In addition, clams were also collected at a reference station located 1 km south of the creek. Zinc concentrations in tissue composites ranged from 15 – 39 mg/kg, 15 – 31 mg/kg, and 26 – 33 mg/kg for the three exposure stations. Zinc concentrations in reference clams ranged from 18 – 32 mg/kg, which is consistent with exposure stations. These tissue concentrations are also similar to clam data collected in Garrow Bay prior to mining (29 – 38 mg/kg; Fallis, 1984). Consequently, clams do not show any evidence of metals accumulation as a result of effluent exposure.
- Divers conducted an underwater video survey during the 2003 reconnaissance study (see **Appendix B**). The survey focused on the exposure area located near the mouth of Garrow Creek. Overall, growth and abundance of marine kelp and

other marine organisms did not appear to be impaired relative to observations made during clam tissue sampling at the reference location. Rather, distribution and abundance of marine organisms appeared strongly dictated by depth of ice within the ice-scour zone that extended for at least 100 m offshore.

Based on the above lines of evidence, the likelihood of potential effects to marine life in Garrow Bay under current conditions appears negligible to low. Furthermore, since concentrations of zinc in surface waters of Garrow Lake and Garrow Creek appear to have decreased considerably since mining ceased in 2002, the likelihood of future long-term effects is also considered negligible. Note that the latter prediction assumes that metals exposure will remain the same as present or continue to show improvements. This is predicated on the assumption that Garrow Lake will remain permanently chemically stratified. In 2000, Teck Cominco commissioned AXYS (2001) to determine whether lowering mixolimnion depth to 7 m risked turnover and mixing of the mixolimnion and metals-rich monimolimnion. If this occurred, this might result in contamination of the lake and therefore, Garrow Creek. AXYS (2001) concluded that the density barrier of the pycnocline was strong enough that it cannot be broken down or compromised by wind and wave action. Thus, no mixing of the mixolimnion and monimolimnion appears possible. There is on-going, twice annual monitoring of the water column to monitor this situation and verify this assumption.

Figure 3-1. Summary of zinc concentrations (mg/L) as a function of depth (m) at Garrow Lake center (left) and south (right) stations, 2003-2005.





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APPENDIX B

ADDENDUM
ENVIRONMENTAL EFFECTS MONITORING (EEM) STUDY DESIGN –
TECK COMINCO POLARIS MINE, NUNAVUT (AZIMUTH, 2004a)

Addendum

Environmental Effects Monitoring (EEM) Study Design – Teck Cominco Polaris Mine, Nunavut

Prepared for

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Appendix B – Physical Assessment of Garrow Creek Effluent Plume (Sea Science Inc.).

Appendix C – Minutes of December 2003 Workshop.

Appendix D – Review of Polaris Mine EEM Study Design Outline.

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Table 1: Polaris Mine EEM – outline of study design for biological monitoring studies.

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Figure 1: Polaris Mine EEM – study design for biological monitoring studies.

1. INTRODUCTION

The purpose of this Addendum is to finalize the study design for the environmental effects monitoring (EEM) program at Teck Cominco's Polaris Mine, Nunavut. Specifically, the Addendum supplements the draft study design report (Azimuth, 2003) by outlining final study components and methods that will be adopted for biological monitoring. Note that while the accompanying table documents the complete study design, emphasis in the text has been placed on identifying deviations and refinements made to the initial program[1].

Development of a final EEM strategy for the Polaris Mine incorporated the following information:

- Results of 2003 field reconnaissance studies conducted in Garrow Bay (**Appendix A**), including:
  - Field effluent plume delineation
  - Underwater video survey
  - Fish survey
  - Sediment survey
- Results of theoretical effluent plume modeling (**Appendix B**).
- Feedback obtained from members of the Technical Advisory Panel (TAP) during the December 2003 workshop held in Edmonton (**Appendix C**) and on the draft study design outline submitted to the TAP in March 2004 (**Appendix D**).

The Addendum, which follows a letter report format, consists of five sections organized as follows:

- Introduction (Section 1)
- Overview and key considerations (Section 2)
- Fish survey and tissue analysis (Section 3)
- Benthic invertebrate community survey (Section 4)
- Supporting environmental variables (Section 5)

Note that the field program for biological monitoring studies is currently scheduled for August 14 – 28, 2004, when the likelihood of safe access to Garrow Bay for sampling is

[1] Sampling analysis procedures generally follow those described in Azimuth (2003) and Environment Canada (2002).

optimal. An interpretative report incorporating results of all EEM study components will be prepared and submitted to the Authorization Officer by June 6, 2005.

2. OVERVIEW AND KEY CONSIDERATIONS

The receiving environment for EEM at the Polaris Mine poses a number of logistical challenges that have been documented as part of reconnaissance studies completed in 2003 (**Appendix A**). These challenges have led to some refinements of the draft study design (Azimuth, 2003) as well as to the prioritization of study components in the event that field conditions and/or other safety issues limit access to Garrow Bay. **Table 1** present the main components of the final study design developed for the Polaris Mine (see **Figure 1** for sampling locations). Implementation of the program will take into account the following key considerations:

- The overall sampling strategy consists of a control/impact design focusing on one high exposure area (i.e., aquatic receiving environment that is nearest to the mouth of Garrow Creek and that contains an appropriate habitat type with sufficient geographic area to accommodate the necessary number of replicate stations; Environment Canada, 2002) and one reference area. Both areas are located in Garrow Bay, approximately 1 km apart (**Figure 1**).
- Our rationale for targeting one high exposure area, rather than multiple near-field and far-field exposure areas, follows guidance from Environment Canada (2002) and reflects findings of the 2003 reconnaissance studies (**Appendix A**) and theoretical effluent plume modeling (**Appendix B**). These clearly indicated the lack of an exposure gradient between the mouth of Garrow Creek and the reference area.
- Standard and accepted quality assurance/quality control (QA/QC) procedures (Environment Canada, 2002) will be used throughout the program. Only those pertaining to novel or site-specific techniques (e.g., clam gonadosomatic index, diver-assisted benthic sampling) will be briefly discussed in this Addendum.
- The final study design is optimistic. While every attempt will be made to achieve the goals of the program, field conditions and safety issues may require us to focus on a few priority study components. As discussed with members of the TAP, all clam, benthos, and sediment collections will be diver-assisted, so local weather and ice conditions will dictate level of effort. Based on feedback received from the TAP (**Appendices C and D**), field work will be prioritized as follows:
    1. Fish survey and tissue analyses
    2. Supporting environmental variables (water and sediment quality surveys)
    3. Benthic invertebrate community survey

4. Seabed imaging and mapping system (SIMS) survey

3. FISH SURVEY AND TISSUE ANALYSES

A detailed outline of the final study design for the fish survey and tissue analyses is presented in **Table 1** (see also Azimuth, 2003). Additional relevant information includes:

- Softshell clams (*Mya truncata*) were selected as the only candidate species for EEM at Polaris.
- Clams will be collected with the assistance of divers during ice-free conditions; only intact clams will be retained for analysis.
- Sample size and replication used for the fish survey and tissue analyses are presented in **Table 1**.
- Following collection, every effort will be made to keep the clams alive until shipping (on ice, not frozen) to the laboratories for analysis; clams will be maintained in seawater (changed daily) and air pumps will be used to keep water well oxygenated. Special 3M ice packs used in the health industry for the transport of live organs will be used to preserve the clams during transport.
- With the exception of tissue chemistry, all measurement endpoints will be determined by Integrated Resource Consultants (IRC) under the general supervision and QA/QC oversight of Dr. Sylvie St-Jean, National Water Research Institute. Of particular interest is the determination of a gonadosomatic index. The latter is used to determine reproductive investment by assessing gametes production and storage in the mantle lobes. A brief summary of the steps to determine the gonadosomatic index[2] of bivalves includes:
  - Measurement of animal length, width, height and the whole animal wet weight to be used in determination of animal condition factor.
  - Dissection of each animal.
  - Determination of sex.
  - Removal and weighing of each mantle lobe and determination of the body mass for each individual.
  - If female: one mantle lobe is used for dry weight and calculation of gonadosomatic index ratio (ratio between body weight [minus gonads] and the

[2] If possible, the gonadosomatic index should be determined when 90% of the mantle lobe consists of gonads, generally slightly prior to spawning. Due to the limited field sampling season at Polaris, it is not possible to determine *a priori* whether the timing of clam collection will be optimal.

gonad). If male, both lobes are used, female calculation should be extrapolated for both lobes.

- The second lobe in females should be used to assess reproductive effort[3], through egg measurement and count.
- A minimum of 20 eggs per animal are measured at the outer layer axis, representing yolk and other material and from the nucleus. These measurements will allow the stage of oocyte development to be determined.
- Eggs present in the subsamples are counted and an estimation of each female reproductive effort determined.

- As required under EEM, the latitude and longitude of each sampling area will be documented.

4. BENTHIC INVERTEBRATE COMMUNITY SURVEY

A detailed outline of the final study design for the benthic invertebrate community survey is presented in **Table 1** (see also Azimuth, 2003). Additional relevant information includes:

- Sediment samples for benthic analysis will be collected using divers rather than standard grab samplers due to the coarse nature of the substrate in Garrow Bay. Five subsamples will be collected within each station and pooled prior to processing.
- Each subsample will be collected consistently using a 1 L plastic container with a 10 cm wide opening. The container will be inserted horizontally into the sediment (to a 10 cm depth) and filled by moving the container laterally. This method ensures that penetration and sediment volume is the same for all subsamples.
- Processing will be performed using a stacked set of 1 and 0.5 mm mesh size (the 0.5 mm screen will be archived and only analyzed if appropriate).
- Identifications will be performed to the lowest practicable taxonomic level.
- As required under EEM, the latitude and longitude of each sampling station will be documented.

A SIMS survey will also be conducted in the high exposure and references areas (**Table 1**) to assess potential gross impacts to macrobenthic epifauna. Methods will follow those described in Azimuth (2003).

[3] This endpoint will only be determined if the clams are in the appropriate reproductive stage.

5. SUPPORTING ENVIRONMENTAL VARIABLES

A detailed outline of the final study design for supporting environmental variables is presented in **Table 1** (see also Azimuth, 2003). Additional relevant information includes:

- With the exception of benthic supporting variables (see below), water quality monitoring will be conducted at one representative station within each of the two sampling areas.
- At each representative station, field measurements made at 1 m depth intervals, except for the first meter (0.1, 0.5, and 1 m) and water samples for chemical analysis will be collected subsurface (0.1 m) and near the bottom (0.25 m from substrate). Further details are provided in **Table 1**.
- Consistent with Table 5-7 of Environment Canada (2002), total organic carbon, grain size, sediment Eh, total sulphides, substrate characteristics, and a suite of metals will be measured at each benthic station. In addition, physical-chemical measurements will be taken in the water column at 0.25 m from the substrate. These will include depth, dissolved oxygen, transparency, and salinity.

6. REFERENCES

Azimuth (Azimuth Consulting Group Inc.). 2003. Environmental effects monitoring (EEM) study design, Teck Cominco Polaris Mine, Nunavut. Draft (June 2003) prepared for Environment Canada on behalf of Teck Cominco.

Environment Canada. 2002. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Document available at: www.ec.gc.ca/eem

Table 1: Polaris Mine EEM - outline of study design for biological monitoring studies.

Study Component	Sampling Areas	Sample Size and Replication		Mesurement Endpoints	Sampling Method
Fish Survey and Tissue Analyses - Species selected: softshell clam (*Mya truncata*)	**Garrow Bay high exposure area**: located in the area closest to the mouth of Garrow Creek where sufficient clams can be collected (approx. 6 - 8 m depth)	- Target of 40 clams[1]	- Individual clams (subset of 35)	- Length, width and height[2] - Whole animal wet weight[2] - Shell weight[2] - Soft tissue fresh and dry weight[2] - Gonad fresh and dry weight[2] - Sex[2] - Condition index - Gonadosomatic index[2] - Reproductive effort[2,3]	- Diver-assisted sampling; collection of individuals by hand, only intact clams will be retained - Following collection, every effort will be made to keep the clams alive until shipping (on ice, not frozen) to the laboratories for analysis; clams will be maintained in seawater (changed daily) and air pumps will be used to keep water well oxygenated
			- Individual clams (subset of 5)[4]	- Tissue chemistry: moisture and lipid content, suite of metals	
	Garrow Bay reference area: located approximately 1 km to the northeast, upstream of the predominant current direction (approx. 6 - 8 m depth)	- Target of 40 clams[1]	- Individual clams (subset of 35)	Same as high exposure area	Same as high exposure area
			- Individual clams (subset of 5)[4]	Same as high exposure area	
Benthic Invertebrate Community Survey	**Garrow Bay high exposure area**: located in the area closest to the mouth of Garrow Creek where benthic communities can be sampled (approx. 6 - 8 m depth)	- 5 replicate stations (approx. 10 m x 10 m each and separated by approx. 50 m)	- 5 x 1L subsamples per station	- Total invertebrate density - Taxon richness - Simpson's diversity index - Bray-Curtis index - Evenness - Taxon density - Taxon proportions - Taxon presence/absence	- Diver-assisted sampling; upper 10 cm of sediment will be collected for each subsample using a 1L plastic container - All 5 x 1L subsamples for a given station will be physically pooled prior to processing - Processing will be performed using a stacked set of 1 and 0.5 mm mesh size (the 0.5 mm screen will be archived and only analyzed if appropriate) - Identifications will be performed to the lowest practicable taxonomic level
	Garrow Bay reference area: located approximately 1 km to the northeast, upstream of the predominant current direction (approx. 6 - 8 m depth)	- 5 replicate stations (approx. 10 m x 10 m each and separated by approx. 50 m)	- 5 x 1L subsamples per station	Same as high exposure area	Same as high exposure area

Table 1: (Continued)

Study Component	Sampling Areas	Sample Size and Replication		Mesurement Endpoints	Sampling Method
Supporting Environmental Variables					
- Water quality monitoring	**Garrow Bay high exposure area**: location matching fish and benthic survey sampling area	- 1 representative station located at the center of the sampling area[5]	- Measurements made at 1 m depth intervals, except for the first meter (0.1, 0.5, and 1 m)	- Field measurements: DO, pH, temperature, salinity, conductivity, transparency and water depth	- Calibrated YSI meter, pH probe, and depthmeter will be used for all field measurements - Surface water samples will be collected directly into sample containers - Subsurface sampling will be conducted using divers; care will be taken not to disturb sediments during sampling - Timing of sampling will match routine MMER effluent characterization as well as EEM effluent and water quality monitoring
		- 1 representative station located at the center of the sampling area	- Sample collected subsurface (0.1 m) and near the bottom (0.25 m from substrate)	- Laboratory analyses: pH, temperature, DO, hardness, alkalinity, Al, As, Cd, Cu, cyanide, Fe, Hg, Pb, Mo, Ni, Zn, TSS, ammonia, nitrate, radium 226	
	Garrow Bay reference area: location matching fish and benthic survey sampling area	- 1 representative station located at the center of the sampling area[5]	- Measurements made at 1 m depth intervals, except for the first meter (0.1, 0.5, and 1 m)	Same as high exposure area	Same as high exposure area
		- 1 representative station located at the center of the sampling area	- Sample collected subsurface (0.1 m) and near the bottom (0.25 m from substrate)	Same as high exposure area	
- Sediment quality monitoring	**Garrow Bay high exposure area**: location matching fish and benthic survey sampling area	- 5 replicate stations (matching benthic replicate stations)	- 5 subsamples (matching benthic subsamples) per station	- Sediment chemistry: TOC, grain size, sediment Eh, total sulphides, substrate characteristics, suite of metals	- Diver-assisted sampling; upper 10 cm of sediment will be collected for each subsample using a 1L plastic container - All 5 x 1 L subsamples for a given station will be composited prior to analysis
	Garrow Bay reference area: location matching fish and benthic survey sampling area	- 5 replicate stations (matching benthic replicate stations)	- 5 subsamples (matching benthic subsamples) per station	Same as high exposure area	Same as high exposure area
Additional Studies - Seabed Imaging and Mapping System (SIMS)	**Garrow Bay high exposure area** and **Garrow Bay reference area**	- Numerous georeferenced tracklines within each area	- Continuous imagery	- Seabed classification maps including: substrate type, vegetation type and cover, distribution and relative abundance of macrofauna	- Towed underwater camera (SIMS) providing semi-quantitative survey of physical and biological features of the seabed

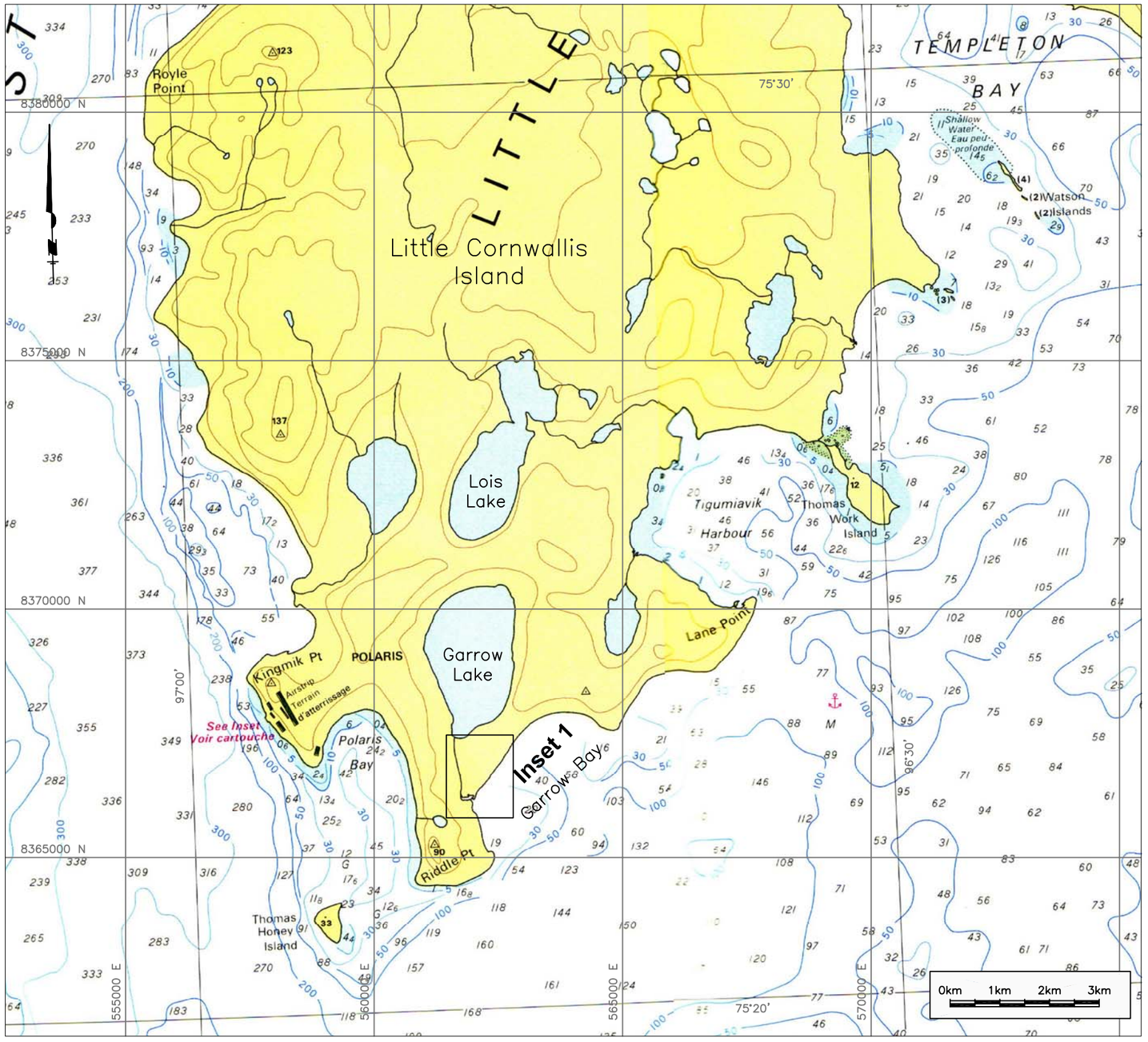
[1] During the 2003 reconnaissance studies, a total of 29 clams were collected by divers; access to Garrow Bay for diving was limited to 3 out of 14 field days due to harsh weather conditions (e.g., presence of ice flows, strong winds, blizzard). Every effort will be made during the 2004 field program to meet the mininum EEM requirement of 40 individuals per sampling area; however, the total sample size may be limited by field conditions. In addition, the inherent difficulty in identifying clam sexes in the field may result in a departure from the requirement for 20 males and 20 females.

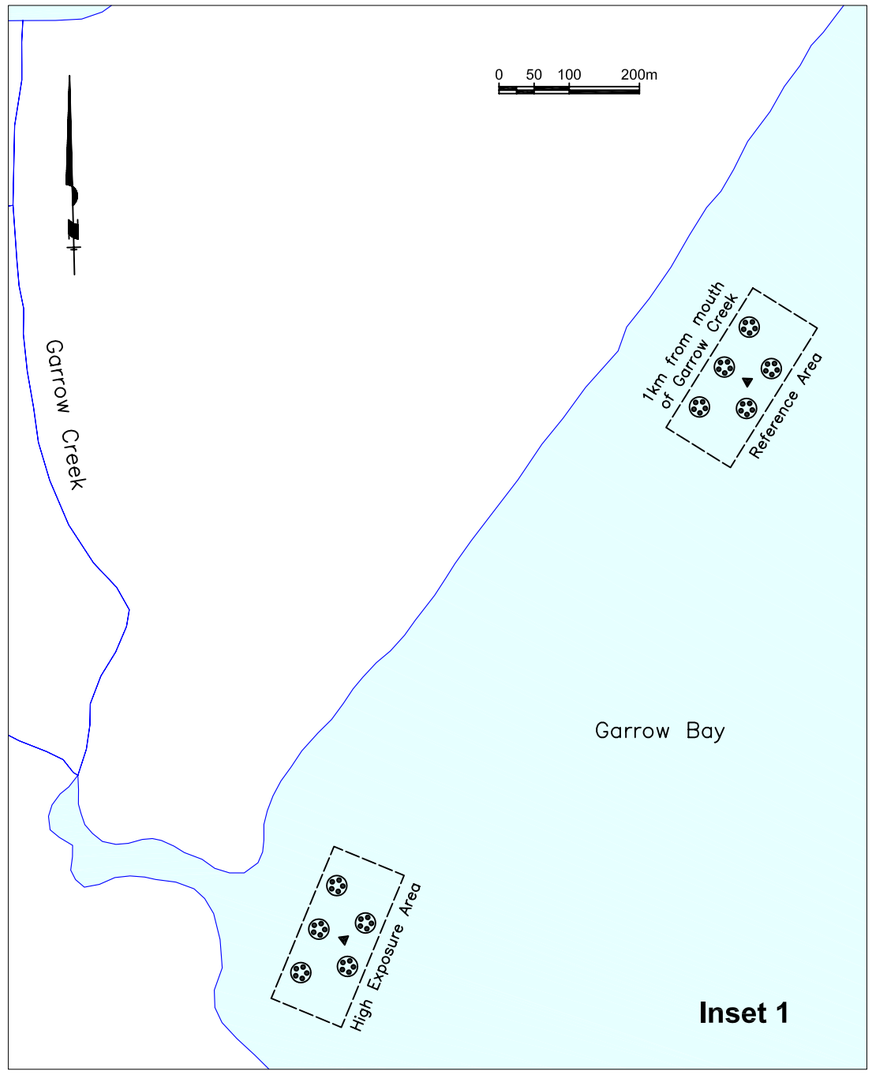
[2] These endpoints will be determined by Integrated Resource Consultants (IRC) under the general supervision and QA/QC oversight of Dr. Sylvie St-Jean, National Water Research Institute. The sample size will be assessed once field work is completed.

[3] Reproductive effort (i.e., number and size of eggs) will only be determined if clams are in the appropriate reproductive stage.

[4] A subset of 5 clams will be analyzed individually for tissue chemistry. They will be selected among the 40 clams to represent various size classes. Other measurements on these individuals will include length, width, height, whole animal wet weight, and condition index.

[5] Note that to support the benthic community survey (Table 5-7 of the Metal Mining Technical Guidance Document), water depth, DO, transparency and salinity will be measured in the field at each of the benthic stations; all measurements will be made 0.25 m from the bottom.





Sampling area for fish survey and benthic invertebrate community survey

Replicate station - benthos, sediment, water (benthic supporting environmental variables only; see below for general water quality monitoring)

Subsample - benthos, sediment

Representative station - water (field measurements and laboratory analyses); note that field measurement will be made at 1m depth intervals (except for the first meter: 0.1, 0.5 and 1m) whereas water samples will be collected subsurface (0.1m) and near the bottom (0.25m from substrate)

Inset data and surrounding creeks digitized from Map 1 Sampling Sites 1980 *prepared by B.C. Research January 1978*

Other data from Crozier Strait And/Et Pullen Strait 7935 *corrected 2003-03-28 published by the Canadian Hydrographic Service*

AZIMUTH

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DRAWN BY:	CHK. BY:	PROJECT No:
BT	PA	TC-03-03
	DATE: 6/15/2004 9:39 AM	

PROJECT: Polaris

TITLE:

Polairs Mine EEM
Study Design for Biological Studies

CLIENT: Teck Cominco

Figure 1

APPENDICES

APPENDIX A

TECHNICAL PRESENTATION AT DECEMBER 2003 WORKSHOP

Polaris Mine EEM: Finalization of Study Design

Teck Cominco Metals Ltd. &
Azimuth Consulting Group Inc.

December 16, 2003

Meeting Overview

Goal

- Finalize the EEM study design (implementation scheduled for August 2004)

Approach

- Review results of 2003 effluent characterization and field reconnaissance studies in Garrow Bay

Meeting Overview (cont'd)

Context

- To guide finalization of 2004 study design, 2003 results need to be reviewed in light of MMER requirements and EEM guiding principles:

1. Scientific defensibility
2. Cost effectiveness
3. Provide flexibility for site-specific requirements, without subjecting field crews to unsafe sampling conditions

Outline of Presentation

- Effluent characterization (chemistry and toxicity)
- Reconnaissance studies in Garrow Bay
  - Field conditions and safety issues
  - Plume delineation (field and modeling)
  - 2003 reconnaissance design
  - Video survey
  - Fish survey
  - Sediment survey
- Weight-of-evidence assessment
- Options for EEM Study Design

Effluent Characterization

Effluent Chemistry (weekly):

- 9 weeks of discharge into Garrow Creek (July 22 to September 16, 2003)
- Flow rates varied between 0.4 to 1.3 m^3/s (expected to be considerably lower in future)
- As expected, the effluent is brackish (2-7 ppt)
- No exceedances of MMER limits
- Lead and zinc exceed BC AWQG
- Mercury concentration in Garrow Lake surface water < 1.1 ng/L (much lower than MMER trigger for fish tissue analysis which is 100 ng/L)

N.B. All analyses completed within appropriate holding times

2003 Effluent Chemistry Data

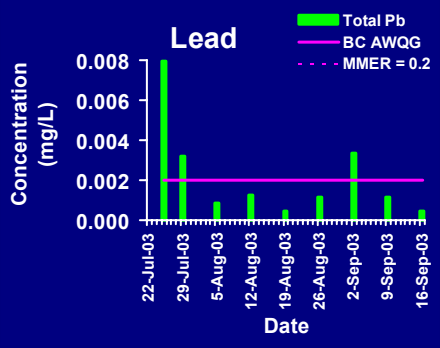
	Water Quality Guidelines		Garrow Creek Concentrations		
	MMER	BC AWQG	Mean ± SD	Min	Max
Physical Tests & Cyanide (mg/L)					
pH	NG	6.5 - 9.0	7.94 ± 0.10	7.77	8.10
Salinity o/oo	NG	NG	5 ± 2	2	7
TSS	15	25	5 ± 3	3	11
Total Cyanide	1	NG	<0.005	<0.005	<0.005
Total Metals (µg/L)					
Aluminum	NG	100	90 ± 0.03	<10	100
Arsenic	500	12	<1	<2	<20
Cadmium	NG	1	0.33 ± 0.13	0.12	0.47
Copper	300	2	0.91 ± 0.19	0.57	1.22
Iron	NG	50	33 ± 45	10	150
Lead	200	2	**2.2** ± 2.4	0.5	**7.9**
Mercury	NG	0.020	<0.05	<0.05	<0.05
Molybdenum	NG	1000	2.9 ± 1.4	<2	5.0
Nickel	500	8.3	2.3 ± 0.9	1.2	3.7
Zinc	500	10	**128** ± 49	**48**	**186**
Radium-226 (Bq/L)	0.37	NG	0.006 ± 0.002	<0.005	0.01

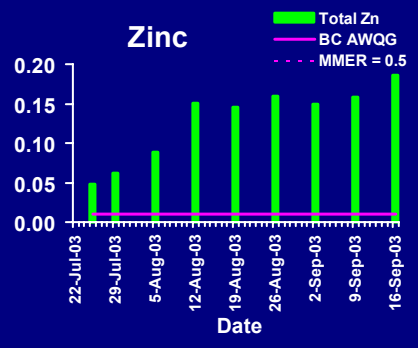
Note: BOLD concentrations exceed BC AWQG

Note: Boxed concentrations exceed MMER limits

[1]BC Approved Water Quality Guidelines for the protection of marine life
[2]BC AWQG 30-day average for freshwater (no guideline for marine water)
[3]BC AWQG interim marine water guideline
[4]BC AWQG 30-day average for marine water
[5]BC AWQG recommended marine water guideline
[6]No guideline for total (strong acid dissociable cyanide), or Radium-226

Contaminants of Potential Concern





Effluent Characterization (cont'd)

Effluent Toxicity – Acute toxicity testing (freshwater):

- 3 tests conducted in 2003
- Tests included a salinity control due to brackish effluent
- No toxicity to rainbow trout (96 hr LC_{50} >100% effluent v/v)
- No toxicity to *Daphnia magna* (48 hr LC_{50} >100% effluent v/v)

Effluent Characterization (cont'd)

Effluent Toxicity – Sublethal toxicity testing (marine):

- Tests required salinity (brine) adjustment – 72% effluent v/v is highest concentration tested
- No toxicity to Topsmelt (survival and growth endpoints) (NOAEL = 72% effluent v/v)
- For echinoderm fertilization test, the IC_{25} was 3.8% v/v
- For algae reproduction test, the IC_{25} was 13.6% v/v

N.B. All tests completed within appropriate holding times

Effluent Characterization (cont'd)

Implications of sublethal toxicity test results:

- Zinc concentration in effluent at time of testing (Aug 19) was 146µg/L; lead concentrations were below BC AWQG
- Echinoderm IC_{25} corresponds to 5.5µg/L zinc
  - Result suggests either high sensitivity of test organism to zinc (< BC AWQG) or other cause(s) of toxicity
- Algae IC_{25} corresponds to 19.9µg/L zinc
  - Result consistent with 1) zinc reference toxicant for *Champia* and 2) available toxicological literature used to derive zinc BC AWQG

Effluent Characterization (cont'd)

Relevance of sublethal toxicity test results:

- Temperature known to affect toxicity: echinoderm tested at 15°C; algae tested at 23°C; Garrow Bay ~ 0°C
- Studies conducted at Polaris by Chapman (1992) using arctic amphipods showed no acute toxicity at [Zn] > 11.8 mg/L
- Field observations confirm presence of millions of marine amphipods at mouth of Garrow Creek
- Healthy populations of fourhorn sculpins were documented in Garrow Lake during 2003 study

Reconnaissance Studies in Garrow Bay

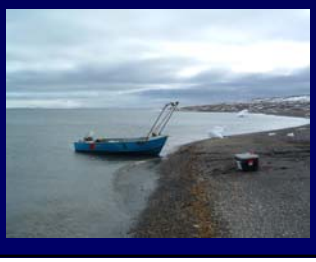
Overview:

- Field conditions and safety issues
- Plume delineation (field and modeling)
- 2003 reconnaissance design
- Video survey
- Fish survey
- Sediment survey

Field Conditions & Safety Issues

- Timing: first 2 weeks of August (summer)
- Garrow Bay covered with ice for 7 out of 14 days
- Small craft warning (winds > 20 knots) for 4 days out of the remaining 7 days, including 2 days with blizzard conditions
- 3 polar bear sightings (mine safety officers advised against field work)

Field Conditions & Safety Issues (cont'd)



Field Conditions & Safety Issues (cont'd)

Plume Delineation

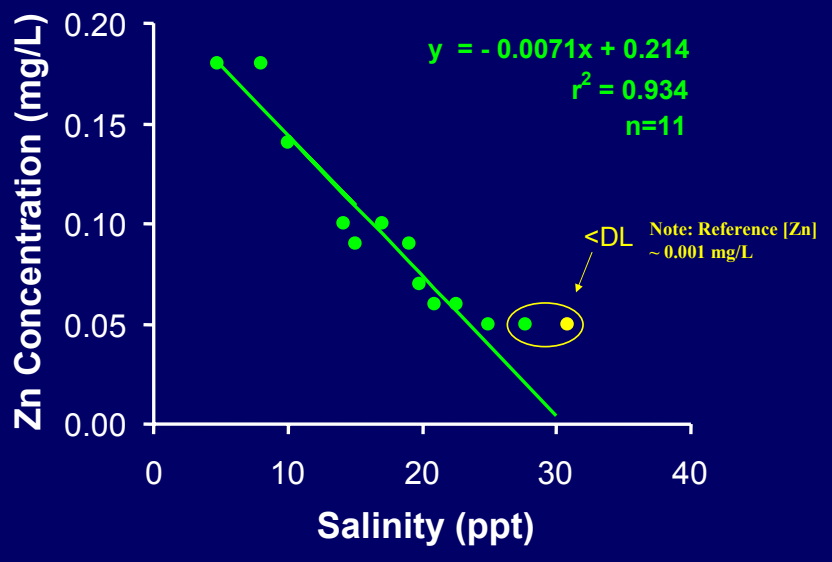
Two components:

1. Field measurements (temperature, salinity, [Zn])
2. Modeling (EPA's Visual Plumes software; Frick et al., 2003)

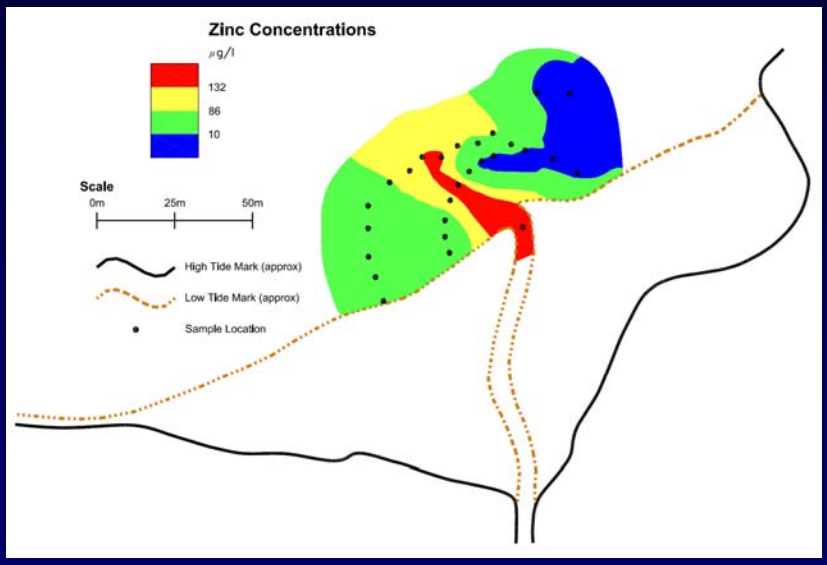
Plume Delineation – Field

- Creek discharge ~ 1.0 m^3/s; 6 ppt salinity
- Vertical temperature/salinity profiles during high and low tide
- Water samples acquired from boat moving from offshore to onshore within plume
- Samples acquired at surface (top 30 cm) and below surface plume (10 cm off bottom)

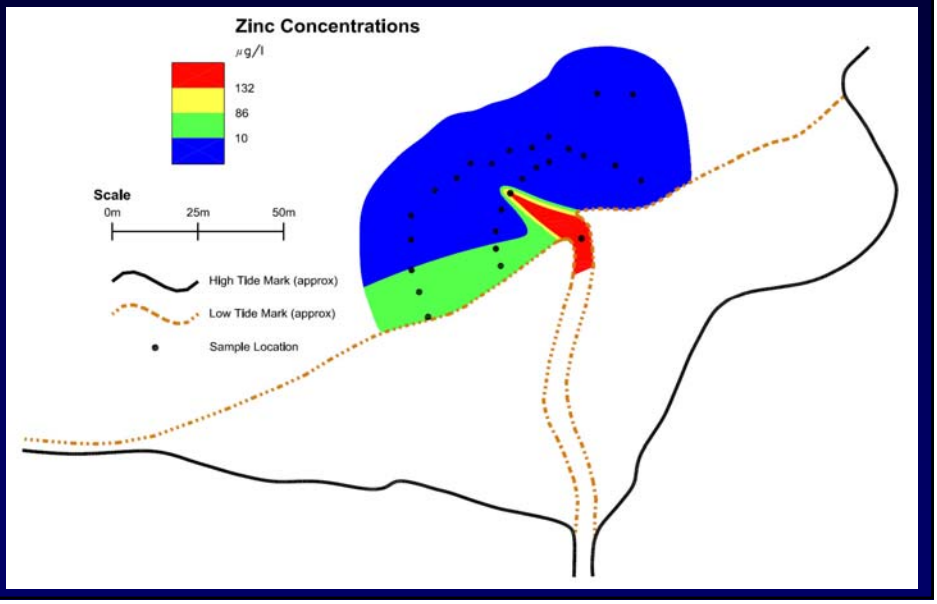
Relationship Between Zn and Salinity



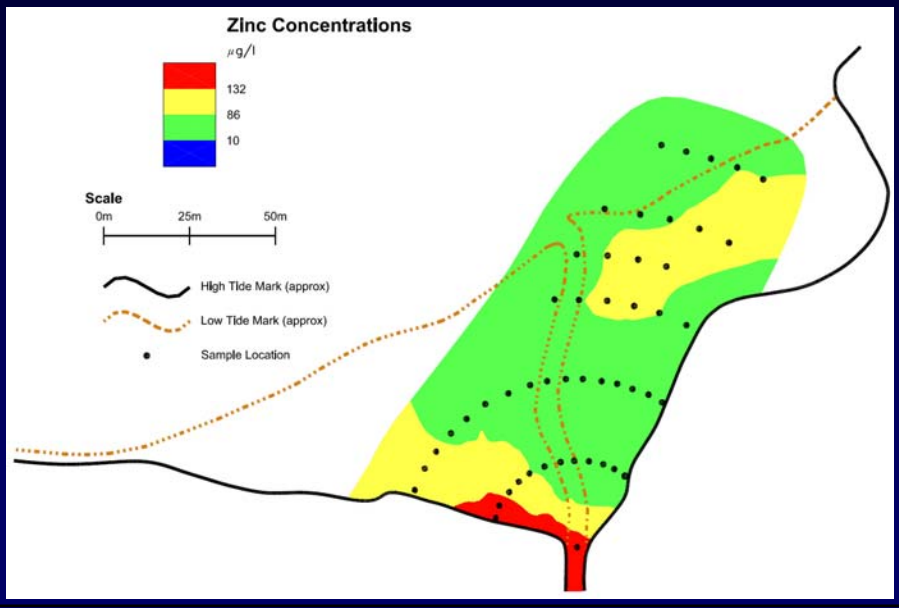
Plume Delineation – Trends in Surface [Zn] During Low Tide



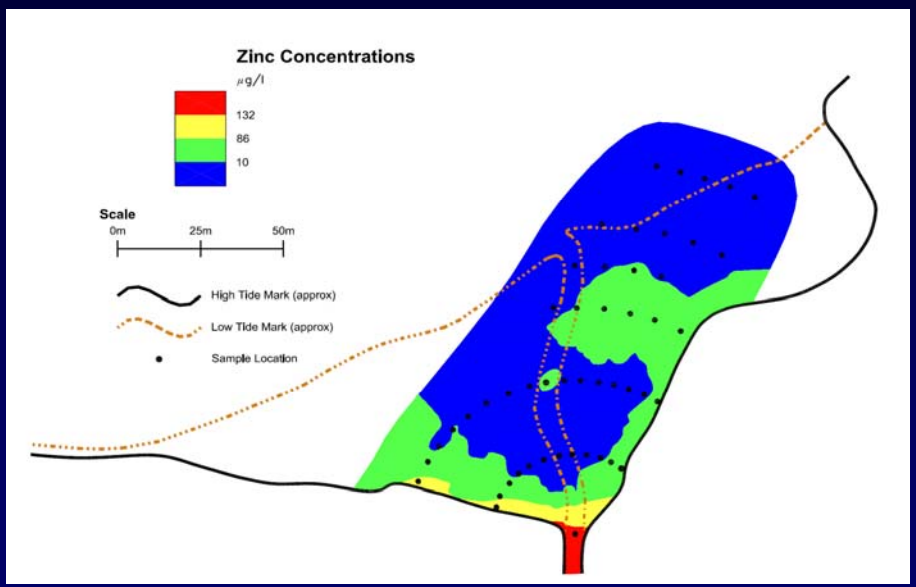
Plume Delineation – Trends in Subsurface [Zn] During Low Tide



Plume Delineation – Trends in Surface [Zn] During High Tide



Plume Delineation – Trends in Subsurface [Zn] During High Tide

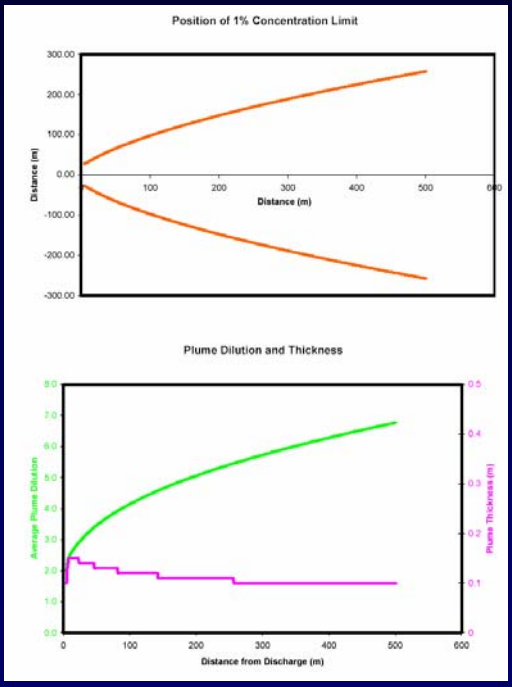


Plume Delineation – Modeling

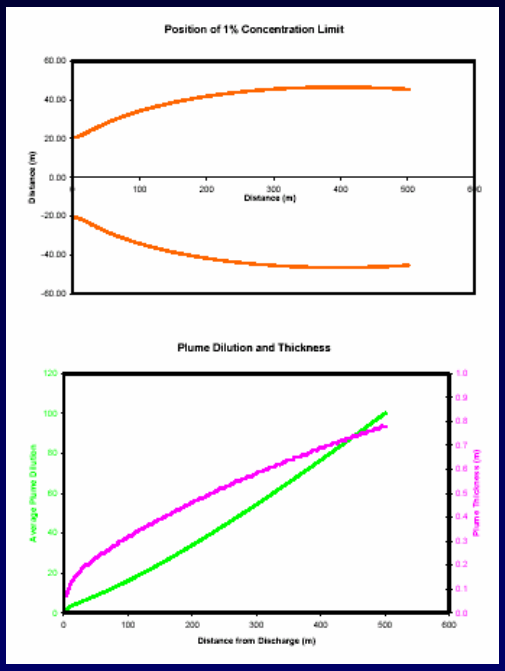
Main conditions of model runs:

- Typical discharge of 0.2 m^3/s vs. maximum discharge of 2.5 m^3/s
- No wind or current mixing vs. wind/current mixing to create 0.3 m/s current

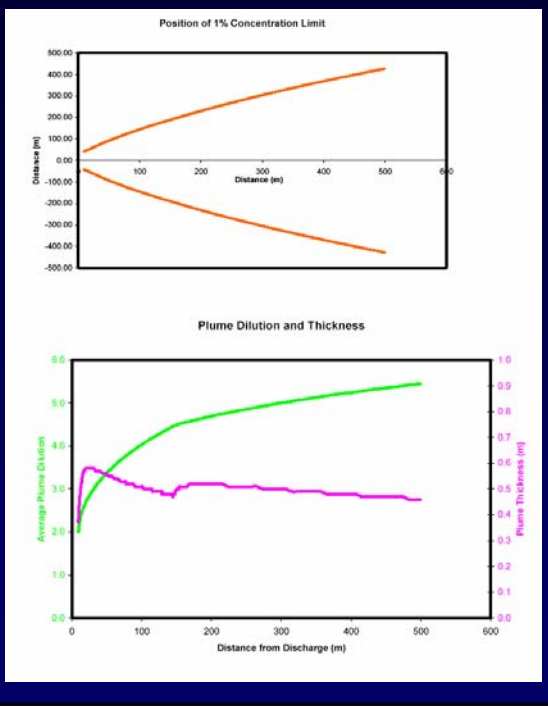
Plume Modeling: 0.2 m^3/s with no wind/current



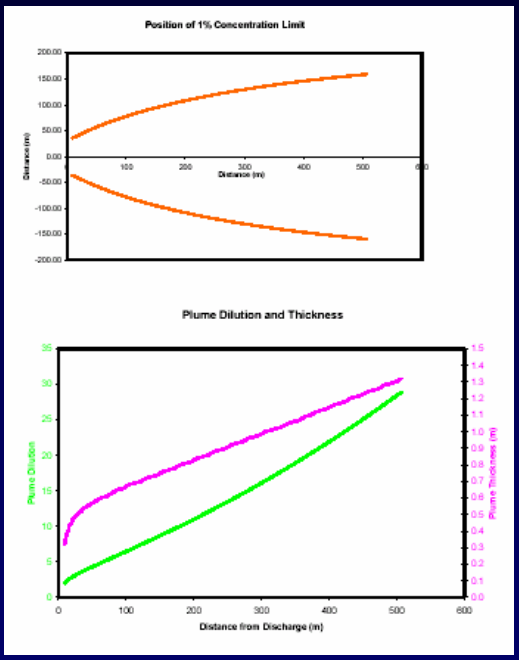
Plume Modeling: 0.2 m^3/s with typical wind & current



Plume Modeling: 2.5 m^3/s with no wind/current



Plume Modeling: 2.5 m^3/s with typical wind & current



Plume Delineation Summary

Strong density differences between effluent and receiving marine waters drive plume characteristics:

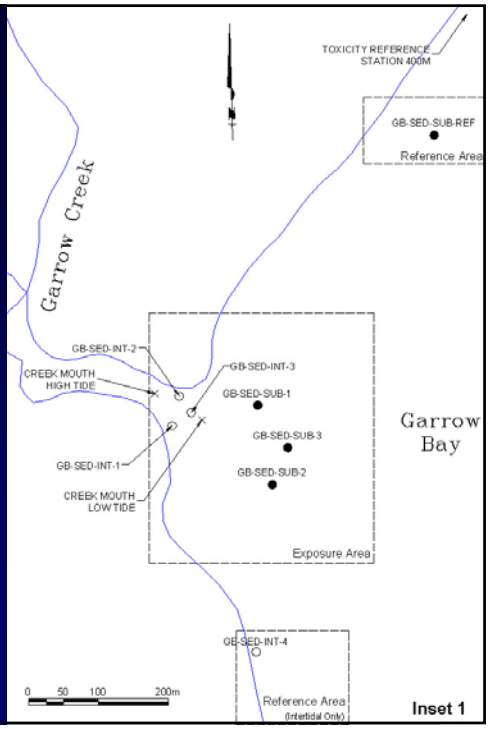
- Plume limited to surface water (< 0.5 m under extreme worst-case conditions)
- Plume consists of relatively narrow band that stretches offshore

Mixing strongly influenced by wind and current conditions

2003 Reconnaissance Design - Reference Area

- Access to Tigumiavik Harbour very difficult over land (terrain & polar bears) and unsafe over water (shifting ice flows, wind conditions)
- Reference was relocated to Garrow Bay (~ 550 m from mouth of creek) based on results of field plume delineation
- Monthly water quality monitoring confirmed background conditions (also supported by sediment and clam tissue data)

2003 Reconnaissance Design



Diver Video Survey

Fish Survey

- Few fish (e.g., sculpins) observed during video survey and during diver-assisted sampling of sediment and clams
- Fish trap deployed in exposure area – destroyed overnight by drifting ice

- Focus on diver-assisted clam sampling:
  - 29 soft-shell clams (*Mya sp.*) collected over 4 dives
  - Tissue composited according to 4 discrete size classes
  - Exposure area (3 stations collected as close to creek mouth as possible
  - Reference area (1 station)

Average Metals Concentrations in Clam Tissue - 2003

	Site 1 (n=3)	Site 2 (n=4)	Site 3 (n=4)	Ref (n=3)
Physical Tests				
Moisture (%)	82.1	82.9	84.1	83.0
Total Metals (mg/kg ww)				
Aluminum	37	19	31	8
Arsenic	1.85	2.03	1.41	1.43
Cadmium	0.612	0.781	0.926	0.769
Chromium	0.6	0.3	0.4	<0.1
Cobalt	0.13	0.10	0.07	0.05
Copper	1.98	1.72	1.91	1.71
Lead	0.12	0.11	0.25	0.08
Mercury	0.013	0.019	0.012	0.010
Nickel	0.8	1.4	0.6	0.3
Zinc	26.5	24.8	29.2	25.0

Note: There was no significant relationship between metals concentrations and size of clams

Historical Metals Concentrations in Clam Tissue

	Pre - Mine Development				Post - Mine Development				
	Fallis 1984[a]	BC Research 1978[b,c]	AXYS 1991[b,c]		Gartner Lee 1999[b,c]	Azimuth 2003[b,c]			
Metal (mg/kg ww)	n=8	n=33	n=2	Ref (n=1)	n=2	Site 1 n=3	Site 2 n=4	Site 3 n=4	Ref n=3
Lead	0.14	0.19	0.05	0.14	<0.1	0.12	0.11	0.25	0.08
Zinc	9	16.6	14.8	24.2	21	26.5	24.8	29.2	25.0

[a] 1981 Data; converted to wet wt using 85% moisture; depurated clams

[b] Non-depurated clams

[c] Reflects composite from larger number of clams (typically > 5 individuals)

Sediment Survey

Objectives:

1. Determine feasibility of benthic community survey using grab sampler

2. Evaluate sediment chemistry
   - Intertidal sediment adjacent to creek mouth – worst-case exposure
   - Subtidal sediment paired with clam tissue samples – exposure area (3 stations) and reference area (1 station)

Sediment Survey (cont'd)

Grab sampling efforts & results:

- > 40 attempts with std. Ponar grab over both exposure and reference areas (~ 10 m depth)
- Some sediment recovered in 3 grabs; however all grabs were unacceptable for benthos:
  - Incomplete closure (kelp, gravel)
  - Inadequate and inconsistent penetration

Sediment Survey (cont'd)

Intertidal Sediment – Near-field Area

Metals Concentrations in Sediment - 2003

	Sediment Guidelines		Garrow Bay - Intertidal				Garrow Bay - Subtidal			
	ISQG	PEL	1	2	3	REF	1	2	3	REF
Total Metals (mg/kg dw)										
Aluminum	NG	NG	5890	5830	6660	5960	4110	4210	3920	4320
Arsenic	5.9	17	**11**	**11**	**15**	**13**	**8**	5	**6**	**6**
Cadmium	0.7	4.2	<0.5	<0.5	<0.5	**<1**	<0.5	<0.5	<0.5	<0.5
Chromium	37.3	90	14	14	16	15	12	11	10	12
Cobalt	NG	NG	4	4	4	<4	2	<2	<2	<2
Copper	18.7	108	18	16	18	18	9	9	8	9
Lead	30.2	112	19	21	21	11	11	11	10	7
Mercury	0.17	0.49	0.07	0.09	0.09	0.08	<0.05	<0.05	<0.05	<0.05
Nickel	18	36	**22**	**20**	**25**	**25**	12	11	9	10
Zinc	124	271	103	72	86	73	34	39	29	29
Organic Parameters										
Total Organic Carbon (%)	NG	NG	5.6	<0.6	<0.6	2.4	<1	<0.8	<1	1.2
Particle Size (%)										
Gravel (>2.00mm)	NG	NG	42.4	35.4	40.2	39.8	24.6	10.7	56.3	60
Sand (2.00mm - 0.063mm)	NG	NG	52.3	59.7	57	59.4	42.2	30.7	10.5	13.4
Silt (0.063mm - 4um)	NG	NG	4	4.2	2	0.4	28.1	49.1	28.3	21.4
Clay (<4um)	NG	NG	1.3	0.7	0.8	0.4	5.1	9.5	4.9	5.2

BOLD concentrations exceed ISQG
Boxed concentrations exceed PEL

[1]Canadian Council of the Ministers for the Environment Interim Sediment Quality Guideline
[2]Canadian Council of the Ministers for the Environment Probable Effects Level Guideline
[3]NG = no guideline

Historical Metals Concentrations in Sediment

	CCME Sediment Quality Guidelines[1,2]		Pre - Mine Development	Post - Mine Development				
			Fallis 1984 Thomas & Erickson 1983 BC Research 1978,1981	BC Research 1988	AXYS 1991	Gartner Lee 1999	Azimuth 2003	
			Subtidal	Subtidal	Subtidal	Subtidal	Intertidal	Subtidal
Metals (ug/g)	**ISQG**	**PEL**						
Lead	30.2	112	6.0 - 11.6	4.6 - 7.6	3.8 - 4.5	7.5	11 - 21	7 - 11
Zinc	124	271	21 - 45	32 - 41	30 - 37	38	72 - 103	29 - 39

[1]Canadian Council of the Ministers for the Environment Interim Sediment Quality Guideline
[2]Canadian Council of the Ministers for the Environment Probable Effects Level Guideline

Overall Weight-of-Evidence Assessment

Study Component	Finding
Discharge Conditions	Limited to 9 weeks of flow in 2003
Effluent Chemistry	Pb and Zn > BC AWQG
Effluent Sublethal Toxicity	
- Topsmelt Survival and Growth	No toxicity
- Echinoderm Fertilization	IC_{25} = 3.8% effluent v/v (related to high Zn sensitivity and/or other causes)
- Algae Reproduction	IC_{25} = 13.6% effluent v/v (likely Zn-related)
Plume Delineation	1% plume relatively narrow and thin (exceeds 1% beyond 250 m) Wind, currents and ice are key drivers of dilution
Tissue Chemistry	No Exposure (based on clams)
Sediment Chemistry	
- Intertidal	Negligible Exposure (lower than CCME guidelines)
- Subtidal	No Exposure
Resident Benthic Communities	No apparent signs of gross impacts based on field observations and diver video survey; substrate does not support quantitative benthic survey
Fish	None captured (trap destroyed); one observed by divers
Overall Assessment for Garrow Bay	**Exposure to contaminants negligible and limited to surface water only**

Effects to biota unlikely

Options for EEM Study Design

Current design intended to meet MMER requirements, but also consider EEM guiding principles:

1. Scientific defensibility
   - **Negligible exposure (in time and space)**
   - **Effects to fish and benthos unlikely**
2. Cost effectiveness
   - **Polaris one of most remote and expensive mines to study (~ 2003 costs $140,000 to date)**
3. Provide flexibility for site-specific requirements, without subjecting field crews to unsafe sampling conditions
   - **Field conditions are severe and there is high concern regarding safety issues (polar bears, ice flows, strong winds)**

Design Options (cont'd)

Four options:

1. Attempt to conduct EEM "compliant" study despite prevailing information collected in 2003
2. Conduct limited field studies using alternative tools:
   - Diver-assisted sampling of sediment and clams
   - Towed underwater video survey (SIMS) to further document status of subtidal benthic communities
3. No further biological monitoring studies; continue ongoing effluent (chemistry and toxicity) and water quality monitoring
4. Other?

Design Options (cont'd)

Notes:

- Consider consequences of Option 1 (no data)
- Both Options 2 and 3 require some departure from MMER requirements but not from EEM guiding principles

APPENDIX B

PHYSICAL ASSESSMENT OF GARROW CREEK EFFLUENT PLUME (SEA SCIENCE INC)

SEA SCIENCE Inc.

Physical Assessment of the Garrow Creek Effluent Plume Polaris Mine Little Cornwallis Island Nunavut

prepared for

Azimuth Consulting Group Inc.
218 – 2902 West Broadway
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15 December 2003

Sea Science Inc.
200 - 1311 Howe Street
Vancouver, B.C., Canada
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1 INTRODUCTION

The Polaris Mine site is located on Little Cornwallis Island in the territory of Nunavut in the Canadian Arctic (Figure 1). The lead-zinc mine, owned and operated by Teck Cominco Ltd., began production in 1981 and ceased operation in September 2002. During the period of mine operation, thickened tailings were discharged into the bottom waters of Garrow Lake, a meromictic lake adjacent to the mine itself. Tailings disposal to the lake ended as concentrate production ceased in 2002. Garrow Lake is designated as a Tailings Impoundment Area in the Metal Mining Effluent Regulations issued by the Government of Canada in June 2002.

Garrow Lake is ice-free for two to three months in the late summer and early fall of each year. During the short ice-free period, discharge from the lake flows through a small creek to the marine waters of Garrow Bay, roughly 1500 m from the lake outlet (Figure 2). No discharge occurs during the remainder of the year.

The Metal Mining Effluent Regulations (MMER) apply to mines where effluent discharges exceed a flow rate of 50 m^3 per day, and the effluent contains a deleterious substance as defined by the MMER and the Fisheries Act. Both of these conditions are met, on a limited seasonal basis, by the effluent discharging through Garrow Creek to Garrow Bay. The MMER apply to mines in commercial operation on the date of registration of the Regulations, 6 June 2002.

The MMER require environmental effects monitoring studies to be conducted for qualifying effluent discharges. The required studies consist of effluent, water quality and biological monitoring studies as set out in the Regulations. The study design for the first biological monitoring studies must contain a site characterization, including:

(a) a description of the manner in which the effluent mixes within the exposure area, including an estimate of the concentration of effluent in water at 250 m from each final discharge point;

(b) a description of the reference and exposure areas where the biological monitoring studies will be conducted that includes information on the geological, hydrological, oceanographical, limnological, chemical and biological features of those areas.

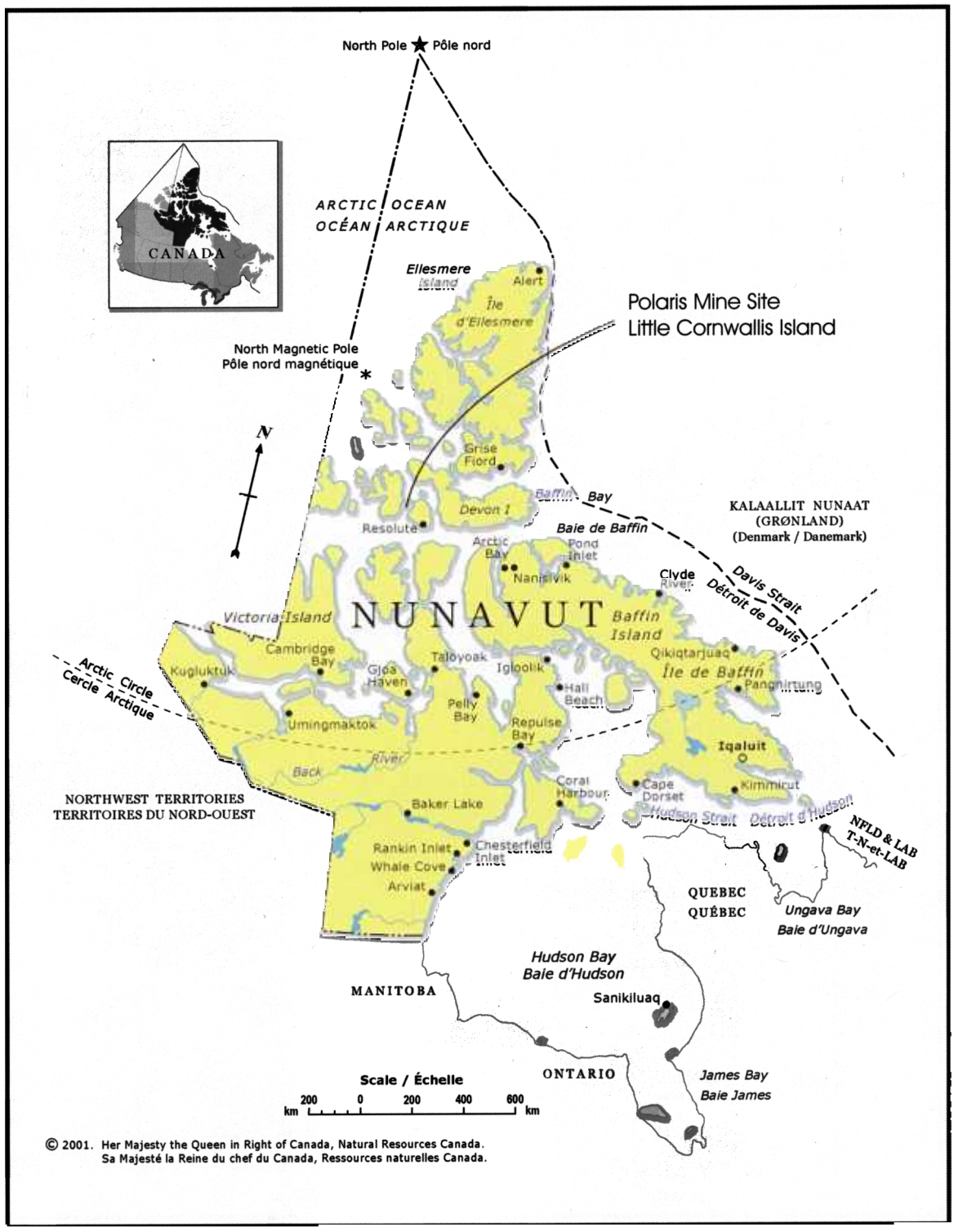


Figure 1. Location of Polaris Mine on Little Cornwallis Island, Nunavit.

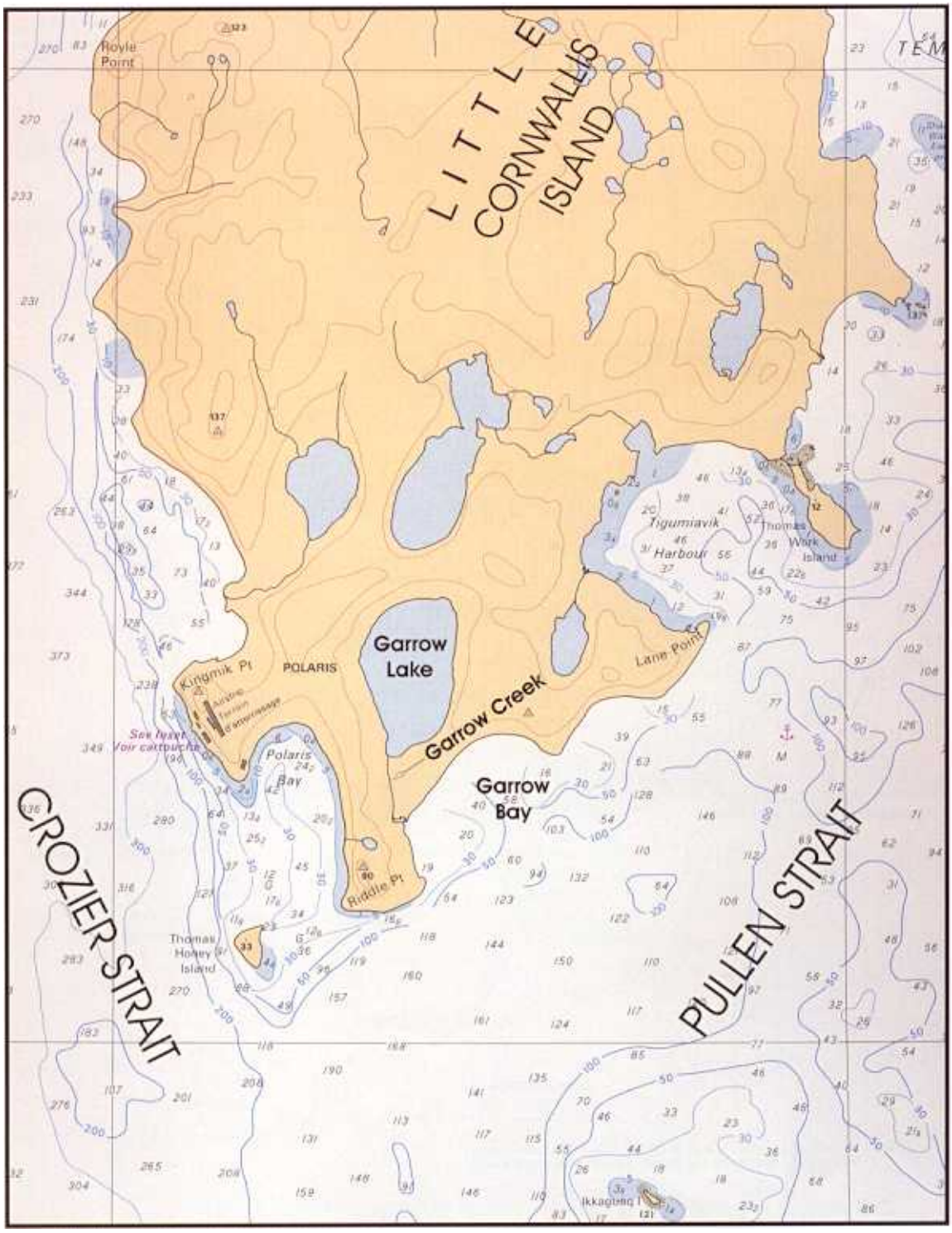


Figure 2. Location of Garrow Lake and Garrow Bay on Little Corwallis Island.

> When the effluent characterization work indicates that the concentration of effluent in the exposure area is greater than 1% at a distance of 250 m from a final discharge point, the biological monitoring studies must include a fish population survey and fish tissue analysis.

Under the MMR, the final discharge point for the effluent flowing out of the tailings impoundment in Garrow Lake has been designated as the point where Garrow Creek enters Garrow Bay (Figure 2). Using this interpretation, the Regulations require the dispersion and dilution of effluent to be determined in the marine waters of Garrow Bay.

The effluent flowing into Garrow Bay forms a surface plume, where it is transported away from the final discharge point by the effects of ocean currents. These currents result primarily from the effects of tides, winds, and density differences in the water column. As the plume is transported away from the discharge point, the effluent mixes with the ambient marine water and is diluted as it is dispersed.

This report describes the work completed by Sea Science Inc. to provide preliminary estimates of the dilution and dispersion of the effluent plume in Garrow Bay. These estimates have been based on the available data as described in Section 2, and have been conducted using the numerical modelling techniques described in Section 3. A discussion of the project results is presented in Section 4.

2 SITE CHARACTERISTICS

The seasonal discharge of effluent from Garrow Lake enters the marine waters of Garrow Bay as a surface plume, where it mixes with the ambient ocean water as it travels away from the mouth of Garrow Creek. The rate of mixing, or dilution, of the effluent plume depends upon a number of factors:

- The physical characteristics of the effluent discharge system;

  The effluent density and flow rate;

- The density structure of the marine waters; and

  The ocean currents and circulation patterns.

This section summarizes the available information and data used to assess the dilution of the effluent plume in Garrow Bay. The characteristics of the effluent discharge will first be discussed, followed by the characteristics of the receiving environment as they pertain to effluent dilution.

2.1 Discharge System and Effluent Characteristics

Tailings from the Polaris Mine were discharged to the bottom waters of Garrow Lake over the period of mine operation from 1981 through to the summer of 2002. The physical and chemical characteristics of Garrow Lake have been studied prior to development of the mine (e.g. B.C. Research 1975, 1978), throughout mine operation as part of the environmental monitoring program (e.g. Fallis et al. 1987, McElroy 1988) and as part of recent studies related to mine closure (e.g. Erickson and Bennett 2001).

Garrow Lake is shown in Figure 3. The lake is meromictic, permanently stratified into three well-defined layers:

1 A well-mixed, aerobic surface layer with slightly brackish water;

2. A deep, anaerobic bottom layer with salinities almost three times that of ocean water and high concentrations of dissolved sulphide; and

3. An intermediate halocline, or zone of rapidly increasing salinity, providing a transition between the surface and bottom waters of the lake.

Figure 3. Garrow Lake, showing the dam across the outlet and Garrow Bay in the background.

The lake is frozen throughout much of the year, with periods of unstable ice or open water typically extending from July through September each year. The natural inflow to the lake occurs as a combination of early-summer snowmelt and summer rainfall events. Using the mean total yearly precipitation of 13.6 cm as measured at Resolute (B.C. Research 1975) and the watershed area of 14.7 km^2 (B.C. Research 1978) yields an estimated average annual inflow volume to Garrow Lake of 2 million m^3 of water each year. This natural inflow volume can be equated to an average annual fluctuation in water level in Garrow Lake of roughly 0.5 m.

1.1.1 Discharge System

The discharge from Garrow Lake flows through Garrow Creek (Figure 4) to the ocean at Garrow Bay. Prior to mine development, the creek outflow was described as "diffuse, with no clearly-defined creek channel" (B.C. Research 1978). A single measurement of natural discharge through Garrow Creek was obtained in August 1974; at this time, the discharge rate was 0.21 m^3s^{-1}, with an average flow depth of 10 cm. In August 1977, the flow in Garrow Creek was described as primarily sub-surface, with minimal observable surface

flow. No other observations of the natural discharge in Garrow Creek (prior to the addition of mine tailings to Garrow Lake) were available for use in this project.

Figure 4. Garrow Creek as seen from the vicinity of the Garrow Lake outlet.

The disposal of thickened tailings to the bottom waters of Garrow Lake added a volume of approximately 1 million m^3 per year to the lake, increasing the annual fluctuation in lake levels and consequently increasing the annual discharge to Garrow Bay. Monitored discharges through Garrow Creek are shown in Figure 5 for the period 1984 through 1989. These flows include both the natural outflows from the lake and the additional flows related to tailings disposal. Assuming that the level of the lake outlet did not change over the measurement period, the consequence of tailings disposal would be to increase the volume of surface water discharged from the lake by an amount equivalent to the volume of tailings added each year.

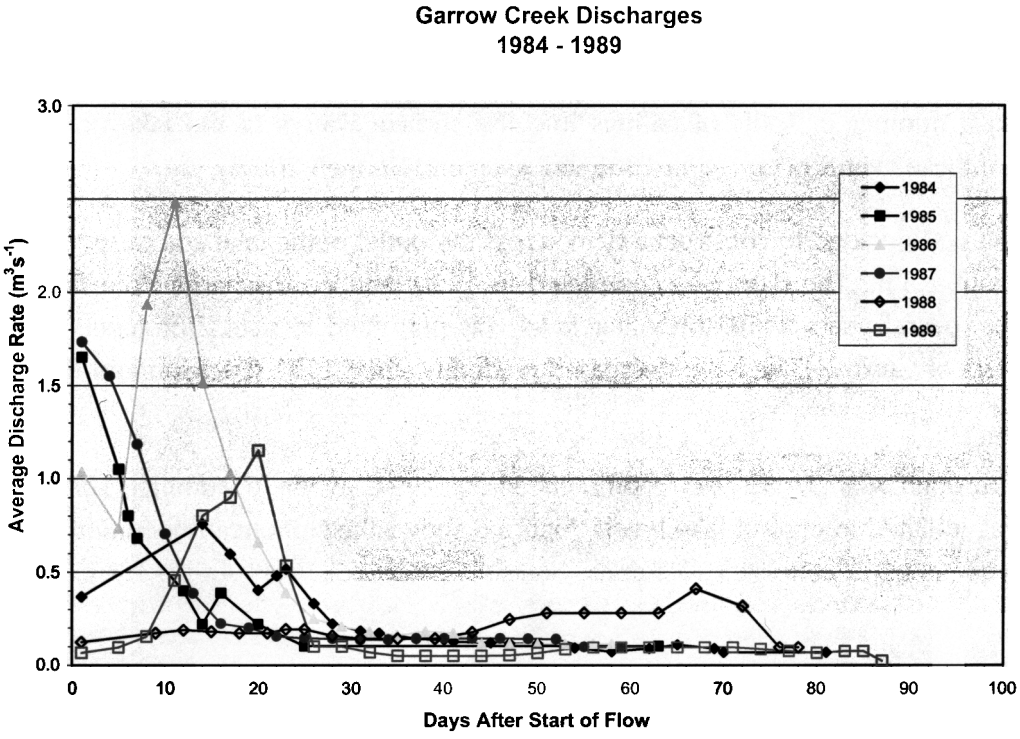


Figure 5. Monitored discharge rates for Garrow Creek, covering a time period when Garrow Lake was utilized for tailings disposal.

In a typical year, the highest measured flow rates were on the order of 1.7 m^3s^{-1} and occurred near the beginning of the discharge period. The high initial discharges are thought to be associated with snowmelt and/or rainfall events while the lake is still ice-covered (McElroy 1988). The highest recorded flow rate of 2.5 m^3s^{-1} was measured in 1986. The discharge rate typically drops rapidly over the first month of flow, reaching a relatively stead flow of about 0.2 m^3s^{-1} for the remaining ice-free period. The maximum time period over which flow occurred in Garrow Creek was 90 days, in 1989.

No information was available regarding the methods used to measure the discharge rates shown in Figure 5. However, it appears that the total volume discharged from the lake was measured or estimated at periodic intervals ranging from daily to monthly, with average flow rates then calculated for the period between measurements. Thus, shorter-term flows in Garrow Creek may have varied significantly from those shown in Figure 5. It is not known if peak discharges in the creek are adequately represented by these measurements.

Over a several year period in the mid-1980's, monitoring of the chemical properties of Garrow Lake indicated both increasing zinc levels in the surface waters of the lake and a slow, upward displacement of the halocline layer. These changes have been attributed primarily to a number of spills of tailings into the surface waters of the lake; the most significant of these events occurred in 1985 (Erickson and Bennett 2001).

As a result, it was decided to construct a dam across the outlet of the lake and raise the lake level by about 2.5 m. The dam was completed in 1990, and no discharge from the lake occurred for several years while the water level was permitted to rise. Zinc levels in the surface waters of Garrow Lake have decreased gradually since 1991 (Erickson and Bennett 2001).

Discharge through Garrow Creek recommenced in 1994, when a summer siphoning program was initiated to control lake levels. Figure 6 shows the siphons in operation on 23 July 2003.

Figure 6. Siphoning of Garrow Lake surface water across the outlet dam into Garrow Creek (looking downstream).

In the mine closure planning process, the decision was made to remove the Garrow Lake dam, return the lake to its previous level and allow natural drainage to occur. Drawdown was commenced in 2000, with plans to remove the dam in the spring of 2004 and allow natural drainage patterns to resume. Effluent discharge volumes and average discharge rates over the season are given in Table 1 for the years from 1994 through 2003 (Randy Baker, Azimuth Consulting Group, per. comm., 2003).

Table 1
Effluent Discharge Volumes and Rates
Garrow Lake, 1994 – 2003

Year	Discharge Duration	Number of Days	Total Annual Discharge (m^3)	Mean Discharge Rate (m^3s^{-1})
1994	July 12 - Sept 13	63	1,034,136	0.19
1995	July 12 - Sept 12	60	2,862,470	0.55
1996	July 22 - Oct 7	78	2,652,081	0.39
1997	July 21 - Oct 7	79	3,256,677	0.48
1998	July 2 - Aug 25	55	2,165,671	0.46
1999	July 13 - Sept 30	80	2,446,242	0.35
2000	July 20 - Sept 30	72	4,262,427	0.68
2001	July 24 - Sept 25	63	2,955,954	0.54
2002	July 26 - Oct 3	69	5,048,667	0.85
2003*	late July - late Sept	60	6,500,000	1.25

*Projected flow based on planned drawdown of lake; actual data not available for this project.

At moderate flow rates, Garrow Creek discharges through a distinct channel as can be seen in Figure 4. The creek drops roughly 7 m in elevation over a distance of 1450 m between the lake outlet and the creek mouth at Garrow Bay. On entering the bay, Garrow Creek crosses a coarse sand and gravel beach approximately 100 m in width. Figure 7 shows the channel mouth in August 2003, with a discharge rate of roughly 1.0 m^3s^{-1}. Under this flow rate, the channel was about 0.3 m deep and 6 m wide at the mouth.

Figure 7. Garrow Creek at the entrance to Garrow Bay.

2.1.1 Effluent Characteristics

The difference in density between the effluent leaving Garrow Creek and the receiving waters in Garrow Bay is a significant factor affecting effluent dilution. For both the effluent and the receiving waters, the primary factors influencing density are temperature and salinity. The salinity and temperature characteristics of the marine waters in Garrow Bay are discussed in more detail in Section 2.2.2 of this report.

Although there are few salinity and temperature measurements available for the creek itself, there is an extensive database of historical data for the surface waters of Garrow Lake, the source of Garrow Creek waters. The long-term trends in salinity of the surface waters of Garrow Lake are shown in Figure 8, which compares field observations with the predictions of a numerical model for the physical and chemical characteristics of Garrow Lake (Erickson and Bennett 2001). This figure illustrates both the long-term variability in

surface salinities in Garrow Lake and the expected future trend once tailings discharge had ceased. It can be seen that both historical and predicted mean salinities in the surface waters of Garrow Lake vary over the range between about 5‰ and 8‰.

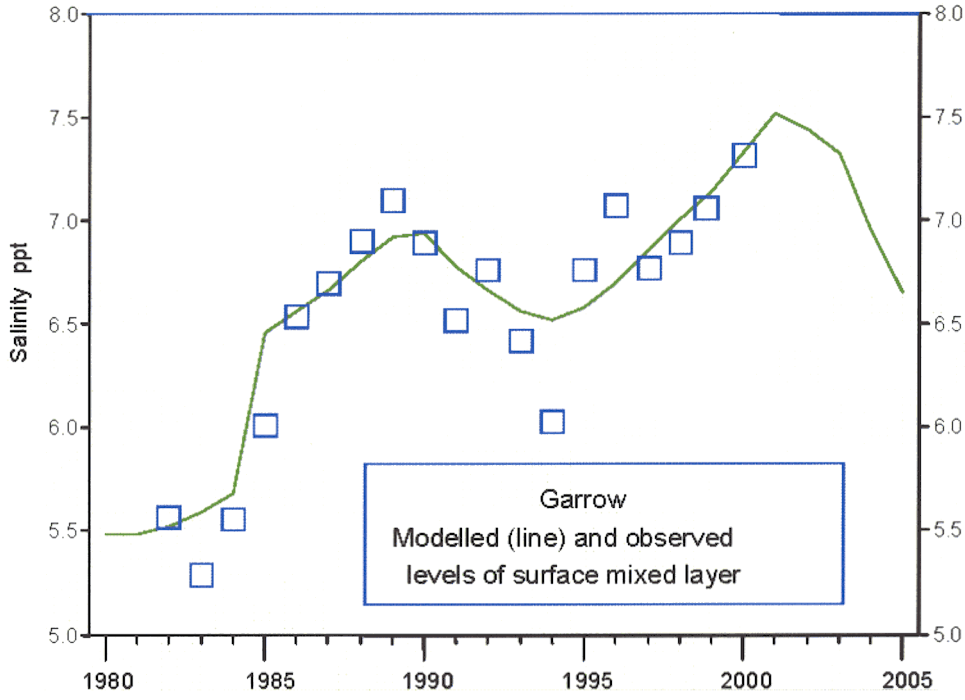


Figure 8. Long-term trends in the mean salinity of the surface layer of Garrow Lake, comparing actual measurements (blue boxes) with model predictions (Erickson and Bennett 2001).

The limited measurements of salinity in Garrow Creek show some variability over the course of a single summer discharge season. Early in the season, while Garrow Lake is still essentially ice-covered, the discharge through Garrow Creek consists of a high percentage of snowmelt water and a relatively low percentage of surface water from the lake. At this time, the salinity in Garrow Creek is lower than that in the lake, and can be assumed to be near 0‰. As the discharge season progresses and the surface of Garrow Lake becomes free of ice, this ratio changes until the salinity of the discharge in Garrow Creek is essentially the same as that of the surface waters in the lake.

Historical data for temperatures of the surface waters of Garrow Lake suggest a range between about 0°C and 4°C. Measurements of the effluent temperature collected from late

July through the end of September 2001 are shown in Figure 9. The range of observed effluent temperatures through this single discharge season is similar to the historical range for the surface waters of Garrow Lake. A trend towards decreasing water temperatures as the discharge season progresses is evident in Figure 9, albeit with large scatter. This trend may reflect the changing composition of the effluent over time from essentially freshwater runoff to primarily brackish lake water, combined with decreasing ambient air temperatures through August and September.

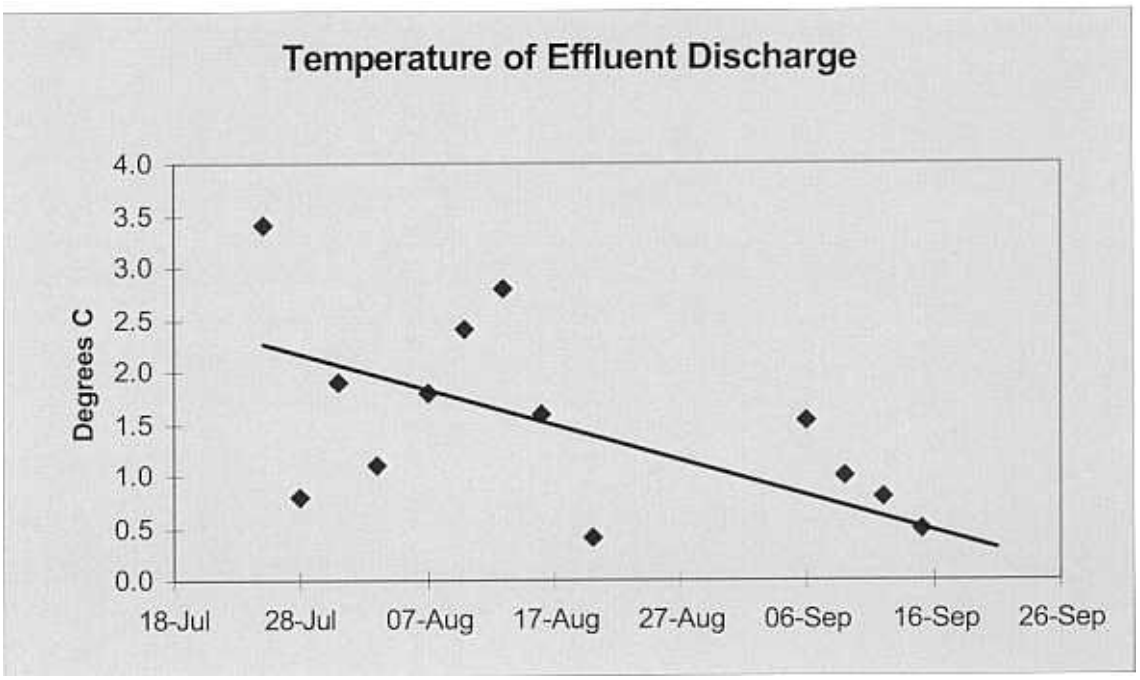


Figure 9. Temperature of Garrow Creek flows measured during the 2001 discharge season.

2.2 Receiving Environment

The discharge from Garrow Lake flows through Garrow Creek to the ocean at Garrow Bay (Figure 2 and Figure 7), where it enters the marine waters as a surface discharge. The factors impacting effluent dilution in the marine environment include the geometry of the discharge area, the density structure of the water column, and the ocean currents and circulation patterns.

2.2.1 *Bathymetry and Water Levels*

Garrow Bay is located on the eastern side of Riddle Point, at the southern end of Little Cornwallis Island (Figure 2). At Riddle Point, the waters of McDougall Sound to the south of Little Cornwallis Island split into Crozier Strait to the west and Pullen Strait to the east.

Garrow Bay forms a relatively open embayment, facing southeast onto the waters of Pullen Strait. The bay extends roughly 3.5 km in the shore-parallel direction, and 1.0 km from the shore to the comparatively open waters of Pullen Strait. Garrow Creek enters the bay towards the southern end, but well within the embayed area (Figure 2).

The available bathymetric information in Garrow Bay is limited, with the published chart information based on selected spot measurements obtained through the ice during the Polar Continental Shelf Project in 1979. Shoal areas were not identified and charted. These data suggest a gradually sloping seabed from the shoreline out to water depths of about 50 m at the mouth of the bay. Diver observations indicate the near-shore areas of the seabed to be highly disturbed by ice-scouring.

Water levels have been measured at the mine site in Cominco Bay by the Canadian Hydrographic Service. Tides in the area are mixed semi-diurnal, with a range of 1.4 m on a large tide and 0.9 m on a mean tide. Mean water level is 0.9 m above chart datum. Water level information is summarized in Table 2.

Table 2
Tidal Fluctuations in Water Level, Elevations Above Chart Datum
Little Cornwallis Island

	Higher High Water	Lower Low Water
Large Tide	1.3	-0.1
Mean Tide	1.1	0.2

2.2.2 *Water Column Density Structure*

The density structure of the water column is determined by the variations in temperature and salinity with water depth. Local measurements of salinity and temperature are limited, and, for the purposes of this project, have been supplemented with regional data. The available data include both through-ice measurements and measurements during the open

water season. The focus of this project is on conditions during the open water season, primarily the months of July, August and September.

A series of six CTD (conductivity-temperature-depth) profiles through the water column were collected in a transect across McDougall Sound on 3 September 1997. Surface ice was not present in the sound at the time. The measurements typically show temperature and salinity increasing with depth at least in the surface layer, with the top of the halocline or thermocline often found only a few metres below the water surface. Surface salinities ranged from 30.9‰ to 31.6‰, and from 32.3‰ to 32.5‰ in deeper waters. Surface water temperatures varied between -1.7°C and -1.3°C, with maximum values in deeper waters ranging from -1.3°C to -1.1°C.

The results of CTD casts in Garrow Bay were reported by Axys Environmental Consulting (1991). In September, they found the water column to be stratified, with salinities varying between 30.4‰ at the water surface, 31.5‰ at 17 m water depth and 32.0‰ at 36 m depth. Temperatures increased from -1.6°C at the surface to -0.7°C at depth.

Selected spot measurements of salinity and temperature were obtained at two stations in Garrow Bay by B.C. Research (1978) on 28 August 1977. The data from Station 2, away from the mouth of Garrow Creek, indicate salinity readings of 31.7‰ at the water surface and 33.0‰ at both 10 and 20 m water depths. Recorded temperatures were 3.7°C at the water surface and 4.1°C at 5 m water depth.

Both the local and regional under-ice measurements indicate a uniform water column, with salinities very near to 33.0‰ and temperatures of approximately -1.7°C.

2.2.3 Ocean Currents and Circulation Patterns

Ocean currents arise primarily through the actions of tides, the effects of density differences in the water column, atmospheric forcing and storm events. In the case of surface waters, local winds can play a major role in determining water movements.

No local measurements of ocean currents in Garrow Bay were available for use in this project. Regional-scale measurements of ocean currents in Crozier and Pullen Straits were made in 1977 from late spring through summer; these measurements show the strong dominance of under-ice flows by tidal currents. The Pullen Strait records show mid-depth currents speeds ranging up to 0.40 ms^{-1}, with mean speeds on the order of 0.20 ms^{-1}. Surface currents were weaker due to the proximity of the instrument to the ice boundary.

These measurements were made in the narrow section of Pullen Strait between Wilkes Point on Little Cornwallis Island and Marshall Peninsula on Cornwallis Island. Garrow Bay fronts onto a wider and deeper portion of Pullen Strait, where currents are expected to be significantly weaker than those measured in 1977. Garrow Bay itself is somewhat shielded from the open channel currents by the headlands to the northeast and southwest (Riddle Point).

The tidal currents in the Arctic Archipelago have been modelled by Dupont et al. (2002). The model grid is not sufficiently detailed to resolve Garrow Bay itself, but the model predictions indicate very low current speeds adjacent to Little Cornwallis Island, typically less than a few centimetres per second. It is not known if a backeddy forms within Garrow Bay on certain tidal conditions.

Qualitative observations of currents within Garrow Bay have been made on several occasions. B.C. Research (1978) reported a pronounced along-shore current in Garrow Bay during both the flood and ebb tides, with current speeds estimated from roughly 0 to 0.3 ms^{-1}. The current was observed to flow along the shore in a southwards direction at all tidal stages. Azimuth Consulting Group (2003) describes very weak currents during their summer fieldwork program.

When tidal currents are very weak as appears to be the case in Garrow Bay, wind can play an important role in water movement, particularly for surface waters. For the purposes of this project, wind records from the airport at Resolute have been examined in order to estimate the effects of wind. Although there is an airport on Little Cornwallis Island, wind records were not available in a useable format.

Wind records for Resolute Airport were available for the period from 1967 through 2003. Monthly statistics for frequency of occurrence by direction and speed class were obtained. Wind conditions for the typical discharge months of July, August and September were compared. These records show that the strongest winds blow from the east, northeast and north, with mean wind speeds of 31, 28 and 25 $km \cdot hr^{-1}$, respectively. Wind speeds greater than 40 $km \cdot hr^{-1}$ occur less than 7.5% of the time in July and August, and roughly 13% of the time in September. Wind directions are variable, but blow less frequently from the south and southwest.

Using a "rule-of-thumb" for wind-driven currents of 3% of the wind speed in surface waters gives mean wind-driven current speeds on the order of 0.20 to 0.25 ms^{-1}. Although this is a simple, order of magnitude estimate and does not consider the effects of topography or

bathymetry, it strongly indicates the dominance of wind-forcing over tides in determining the magnitude and direction of ocean currents in the surface waters of Garrow Bay.

3 PLUME DILUTION AND DISPERSION MODELLING

The dilution and dispersion of the effluent plume in the marine environment have been examined using the Visual Plumes software developed and distributed by the United States Environmental Protection Agency (Frick et al. 2003). The Visual Plumes software provides a graphical user interface and software management system for several plume dispersion models and represents the most recent version of a series of software systems developed by the USEPA for this purpose. These models are accepted as industry-standard for effluent plume analyses.

Of the various sub-models imbedded in the Visual Plumes system, the PDS (Prych-Davis-Shirazi) submodel has been selected for use in this project. The PDS model has been designed to simulate the discharge of a buoyant fluid into the surface layer of a moving ambient body of water. The model includes the effects of buoyant spreading and surface heat transfer. The model is a Eulerian integral flux model originally coded in Fortran but embedded in Visual Plumes as executable routines.

As the plume moves away from the discharge point (in this case, the mouth of Garrow Creek), it is subject to buoyancy, drag and interfacial shear forces. These forces act to keep the plume at the water surface, and cause it to spread as it moves away from the point of discharge. At the same time, ambient ocean water is entrained into the plume through the actions of both jet entrainment and ambient turbulent mixing. These mixing processes act to reduce the differences in composition between the plume waters and the ambient receiving environment.

The PDS model provides predictions of the plume width and depth as a function of distance away from the discharge location. In addition, the minimum and average plume dilutions are provided. The minimum plume dilution is assumed to occur along the plume centre-line, while the average dilution represents the mean value over the plume cross-section. Again, the mean and average dilutions are given as a function of distance away from the point of discharge.

The PDS model assumes a Gaussian distribution in the horizontal direction. For the purposes of this project, the position of the 1% concentration limit has been calculated using the available model outputs and the theoretical assumptions embedded in the model formulation.

A sensitivity analysis has been performed by varying the model input parameters over the range of effluent and receiving water conditions described in Section 2 of this report. This

analysis has shown that the model predictions for effluent dilution are relatively insensitive to the temperature and salinity of both the Garrow Creek and Garrow Bay waters. Over the range of observed values, the density differences between the effluent and the receiving waters are sufficient to maintain a stable, buoyant plume at the water surface, at least within the near-field region.

The two factors which have the greatest impact on the dilution of the plume as it moves away from the point of discharge are the initial discharge velocity (Garrow Creek) and the currents in the ambient receiving waters (Garrow Bay). These factors impact both the initial jet entrainment and the rate of turbulent mixing between the effluent and receiving waters. The initial discharge velocity varies with both the effluent discharge rate and the cross-sectional area of the creek channel; available information is summarized in Section 2 of this report. In general, the dilution of the effluent plume increases with both increasing discharge velocity and increasing current speed in Garrow Bay.

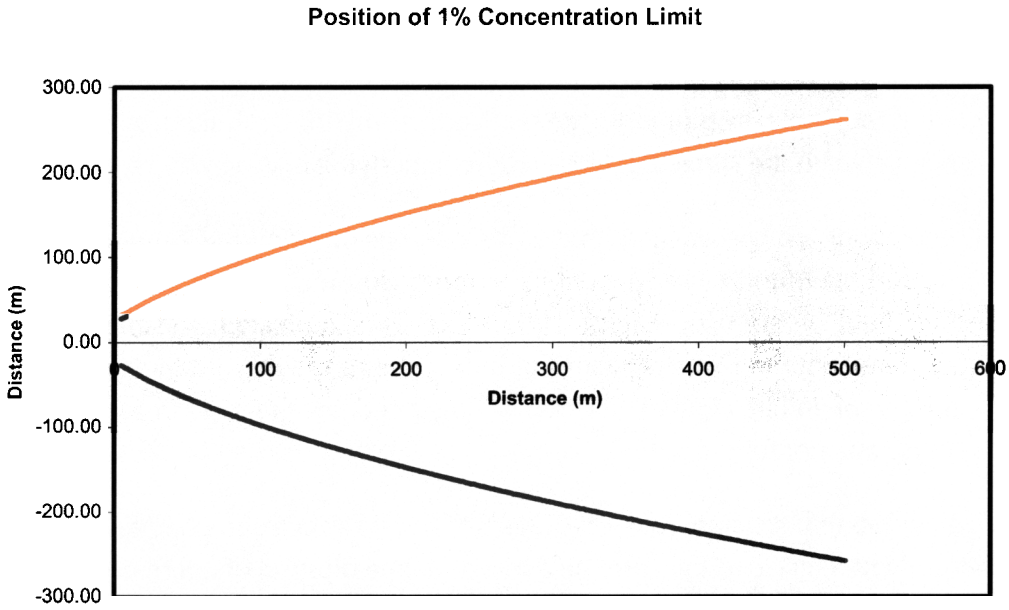
The main goal of this study has been to assess the near-field plume dilution and dispersion under both typical and extreme conditions at the Polaris site. For this study, a typical effluent discharge rate has been taken as 0.2 m^3s^{-1}, and a "worst-case" discharge of 2.5 m^3s^{-1} (see Figure 5). It should be remembered that these values are likely to be conservative, in that they include the volume of water displaced by mine tailings discharged to the bottom waters of Garrow Lake during the period from 1984 through 1989.

Model predictions have been given over a distance of 500 m from the point of discharge at the mouth of Garrow Creek. Beyond this region, it is felt that the model assumptions lose validity and a far-field approach should be used. The 500 m distance was selected on the basis of a qualitative analysis and has not been based on detailed computations.

3.1 Typical Discharge Conditions

Figure 10 shows the behaviour of the effluent plume for the typical effluent discharge rate of 0.2 m^3s^{-1} with minimal currents in the receiving environment (0.03 ms^{-1}). The top portion of the figure shows the position of the 1% effluent concentration line relative to the point of discharge at the mouth of Garrow Creek (located at the graph origin). The bottom portion of the figure shows the average plume dilution and plume thickness as a function of distance away from the point of discharge.

As the plume moves away from the discharge point at Garrow Creek, it gradually widens and spreads horizontally. The initial increase in plume thickness and relatively rapid entrainment of ambient water are driven by the jet entrainment process; however, this



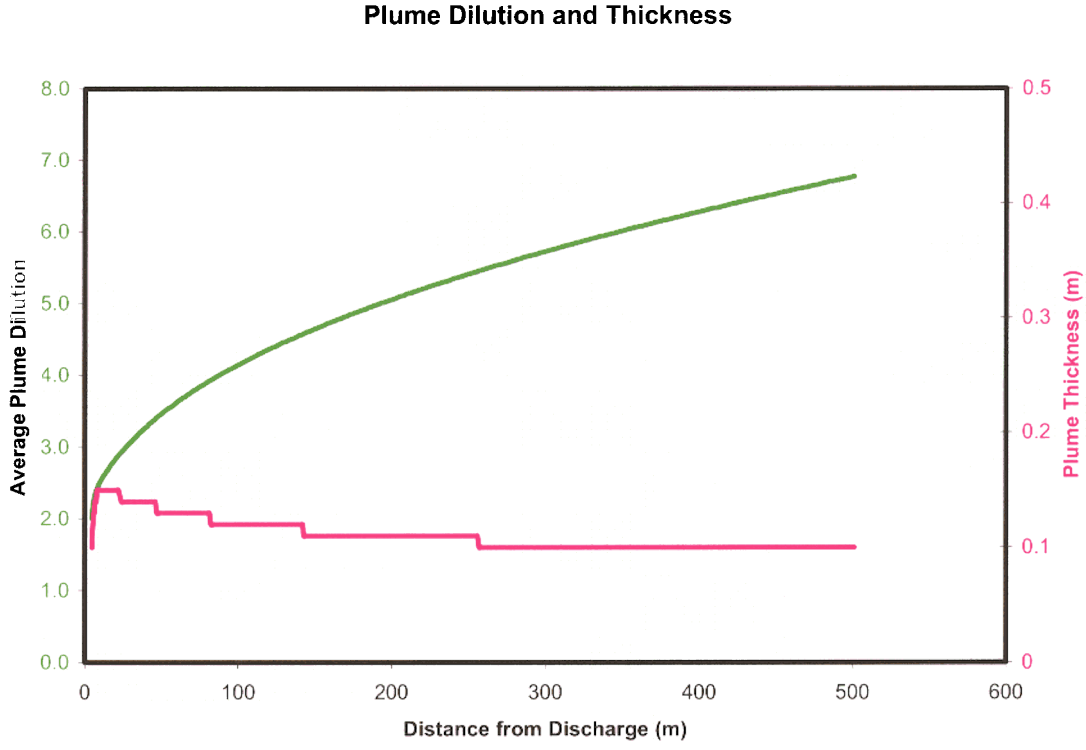


Figure 10. PDS model predictions for a discharge rate of 0.2 m^3s^{-1} and an ambient current speed of 0.03 ms^{-1}.

process is only important within a short distance of the discharge point. The much slower mixing driven by the ambient levels of turbulence is dominant over much of the plume. The ambient turbulent process is relatively slow, as can be seen by the low dilution levels and corresponding reduction in plume thickness. Vertical mixing is limited by the strong density difference between the surface plume and the underlying marine waters.

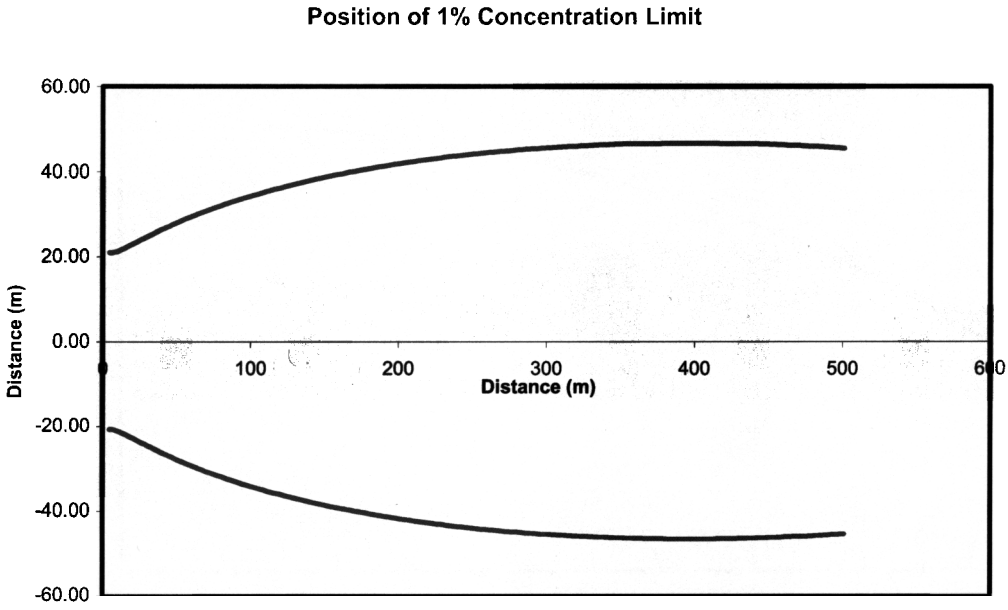
These model predictions are consistent with the observations of Azimuth Consulting Group (2003), who mapped the effluent concentrations in the region immediately adjacent to the discharge in their field program of August 2003. This work indicated a stable, buoyant plume overlying denser marine waters, with the plume thinning with distance away from shore. Some degree of initial effluent dilution is suggested by the field measurements, although the plume was not fully mapped.

For the typical effluent discharge rate of 0.2 m^3s^{-1} and low current conditions in the receiving environment, Figure 10 indicates an average plume dilution of approximately 5 at a distance of 250 m from the mouth of Garrow Creek. This corresponds to a mixture of effluent and ambient ocean water consisting of 20% effluent and 80% ocean water. At a distance of 250 m from the mouth of Garrow Creek, the width of the plume as defined by the 1% concentration line is about 340 m, and the plume thickness is approximately 0.1 m.

As discussed in Section 2, the effects of winds on surface currents are likely to be significant in Garrow Bay. Winds are persistent in the region, with mean wind speeds on the order of 30 $km \cdot hr^{-1}$. Using an order-of-magnitude approximation of 3% of the wind speed for surface currents leads to a wind-driven current speed of about 0.25 ms^{-1}.

Model predictions for a current speed of 0.30 ms^{-1} (wind plus tide) are given in Figure 11. A comparison of Figure 11 with Figure 10 clearly shows the enhanced ambient entrainment associated with the higher current speeds. This enhanced entrainment results in significantly higher average plume dilution and increasing plume thickness with distance away from the point of discharge. At a distance of 250 m, the average plume dilution is about 44 (corresponding to 2% effluent in the plume), the plume width is roughly 90 m between the 1% concentration lines, and the plume thickness is 0.5 m.

Figure 11 shows the plume behaviour for a variable current direction, up to the point where the plume attaches to the shoreline. Shoreline attachment is the expected behaviour for a plume exposed to relatively strong currents running in a shore-parallel direction. Once attached to the shoreline, ambient entrainment is reduced. Figure 12 shows the plume behaviour under a shore-parallel current with a speed of 0.30 ms^{-1}. In Figure 12, the shoreline is represented by the horizontal axis of the upper plot. At a distance of 250 m



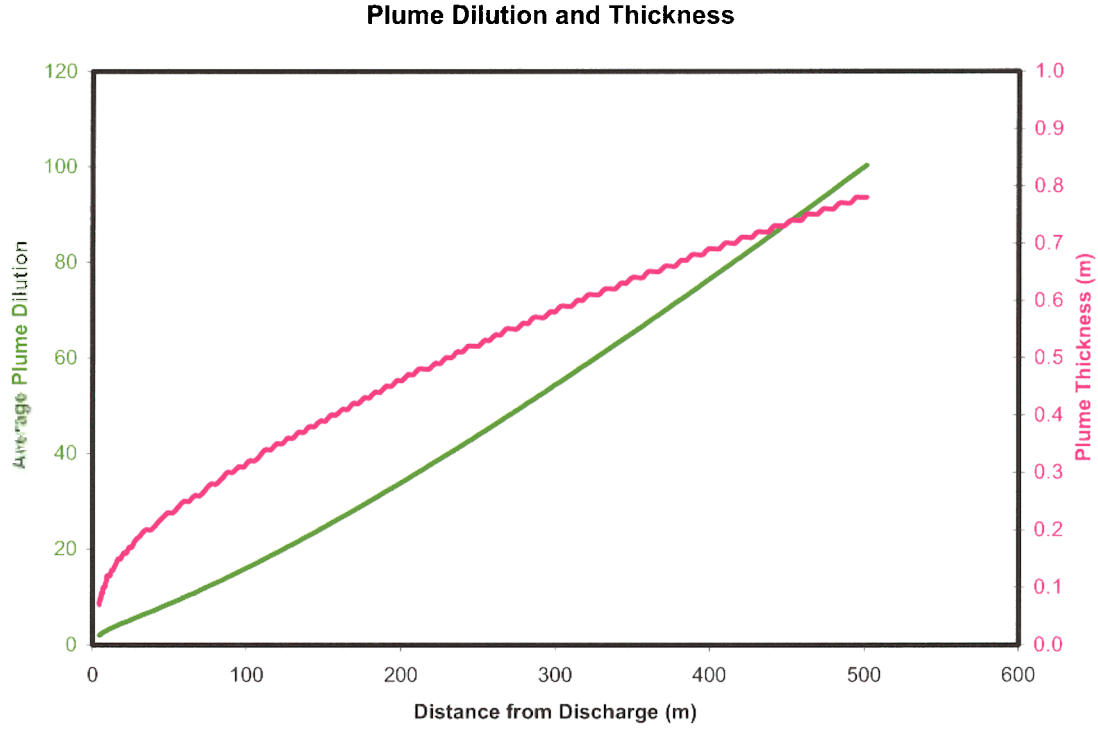
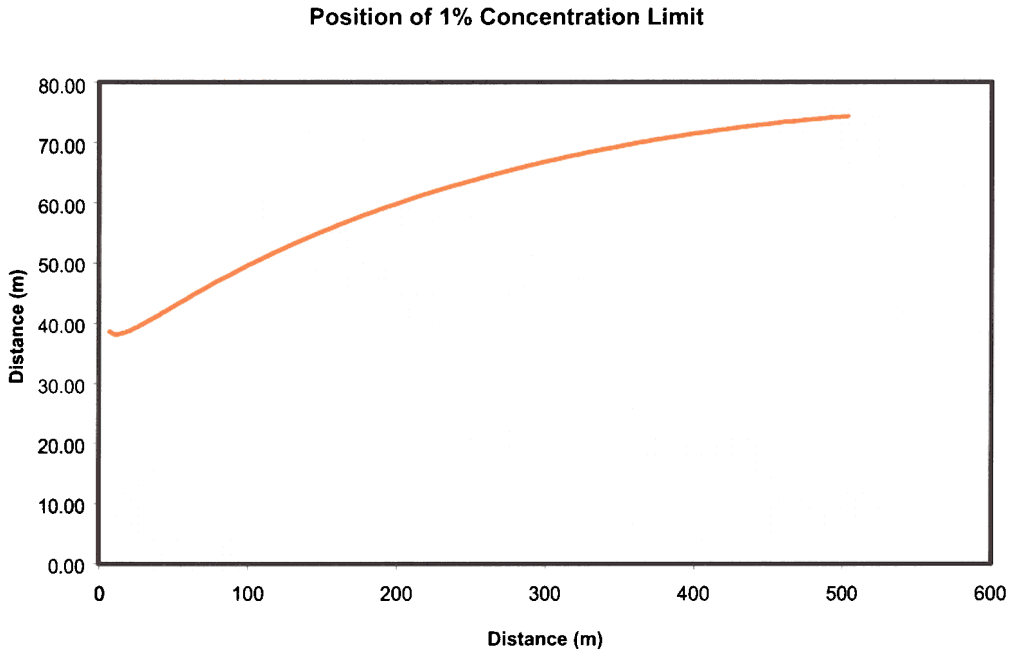


Figure 11. PDS model predictions for a discharge rate of 0.2 m^3s^{-1} and an ambient current speed of 0.30 ms^{-1}.



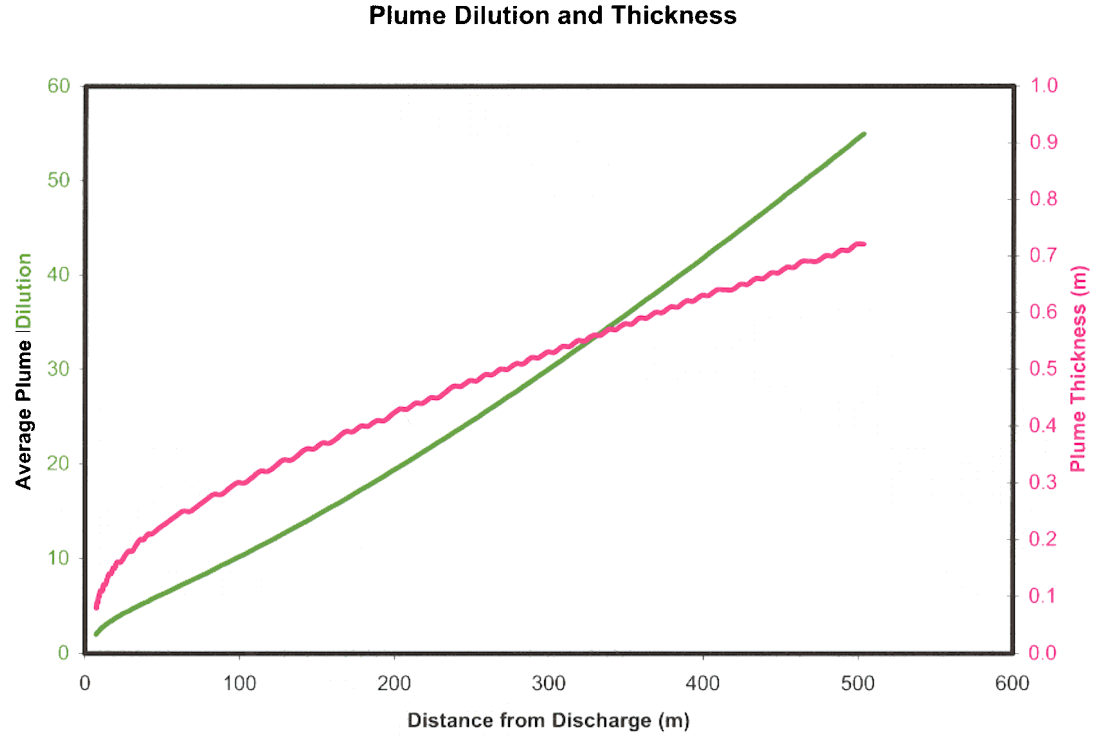


Figure 12. PDS model predictions for a discharge rate of 0.2 m^3s^{-1}, an ambient current speed of 0.30 ms^{-1} and a shore-attached plume.

from the point of discharge, the average plume dilution is estimated to be 24 (4% effluent), the plume extends 65 m from the shoreline to the 1% concentration line and the plume is predicted to be 0.5 m thick.

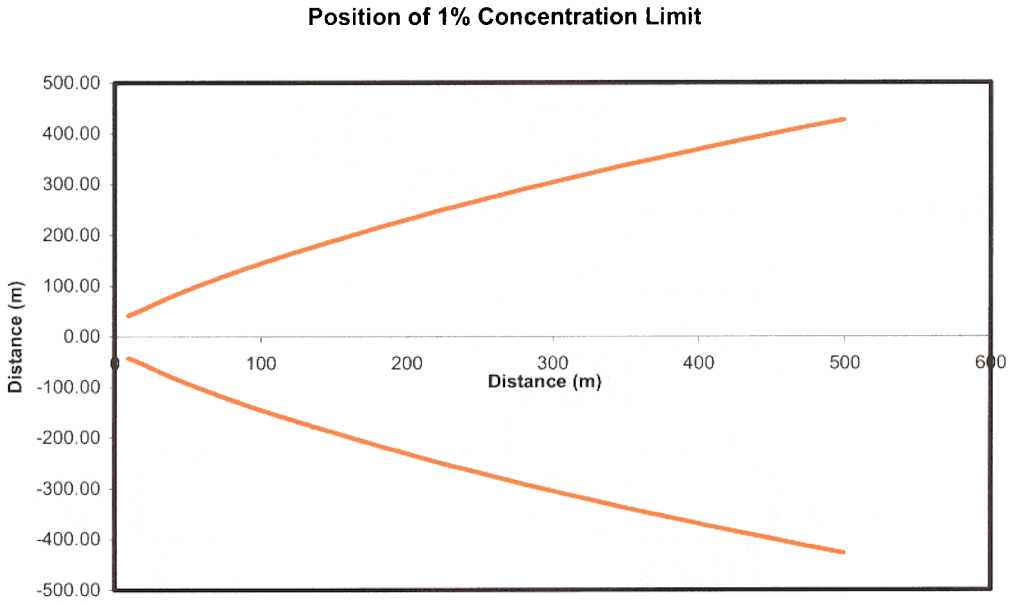
3.2 Extreme Discharge Conditions

A similar analysis has been performed using the estimated "worst-case" discharge value of 2.5 ms^{-1}. Figures 13 and 14 present the model predictions for cases with low (0.03 m^3s^{-1}) and moderate (0.30 m^3s^{-1}) current speeds, respectively. For the extreme discharge rate and low current speed in the receiving waters, Figure 13 indicates an average plume dilution of about 5 (20% effluent) at a distance of 250 m from the mouth of Garrow Creek. At this location, the width of the plume is roughly 535 m, with an estimated plume thickness of about 0.5 m.

Model predictions for a discharge rate of 2.5 m^3s^{-1} and an ambient current speed of 0.30 ms^{-1} are shown in Figure 14. Under these conditions, the PDS model predicts an average plume dilution of 13 (8% effluent), a plume width of 240 m and a plume thickness of 0.9 m at a distance of 250 m from the point of discharge. As for the lower discharge case described in Section 3.1, higher current speeds act to enhance ambient entrainment and increase plume dilution in comparison with the case where current speeds in the receiving waters are relatively slow.

A comparison with the model predictions for the typical discharge rate of 0.20 m^3s^{-1} (Section 3.1) indicates that the plume dimensions (width and thickness) are significantly larger for the higher discharge, as would be expected. For the low current case, plume dilutions are similar. However, there are significant differences between the plume dilutions at the different discharge rates for the moderate ambient current conditions. A comparison of Figure 14 with Figure 11 shows that plume dilutions are three to four times higher at the lower effluent discharge rate. This difference is likely a consequence of the proportionately lower surface area available for horizontal entrainment of ambient water into the larger plume at the higher discharge rate.

The case where the plume attaches to the shoreline is shown in Figure 15. Again, the shoreline is represented by the horizontal axis of the upper plot. At a distance of 250 m from the point of discharge, the average plume dilution is about 8 (13% effluent), the plume extends 155 m from the shoreline to the 1% concentration line and the plume is 0.8 m thick. If the plume attaches to the seabed as well as to the shoreline, the dilution will be reduced from the values given here.



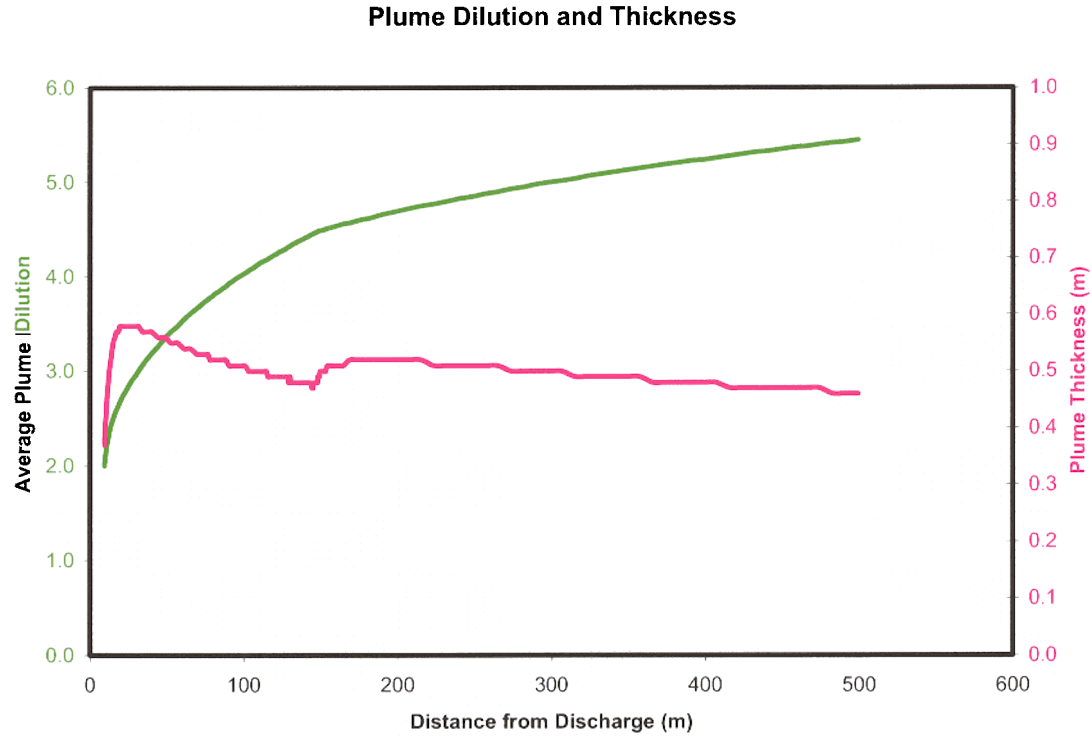
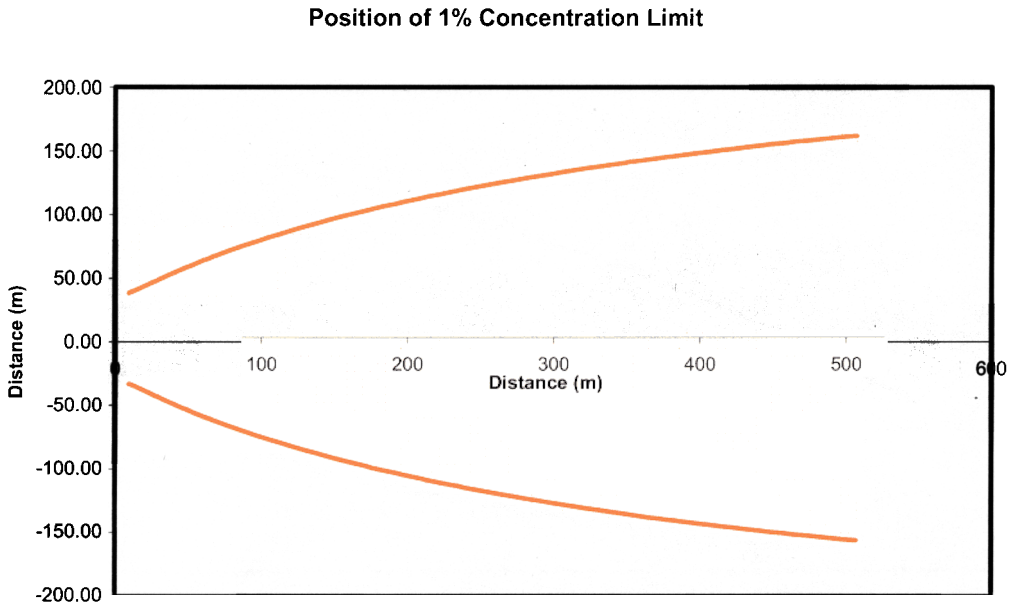


Figure 13. PDS model predictions for a discharge rate of 2.5 m^3s^{-1} and an ambient current speed of 0.03 ms^{-1}.



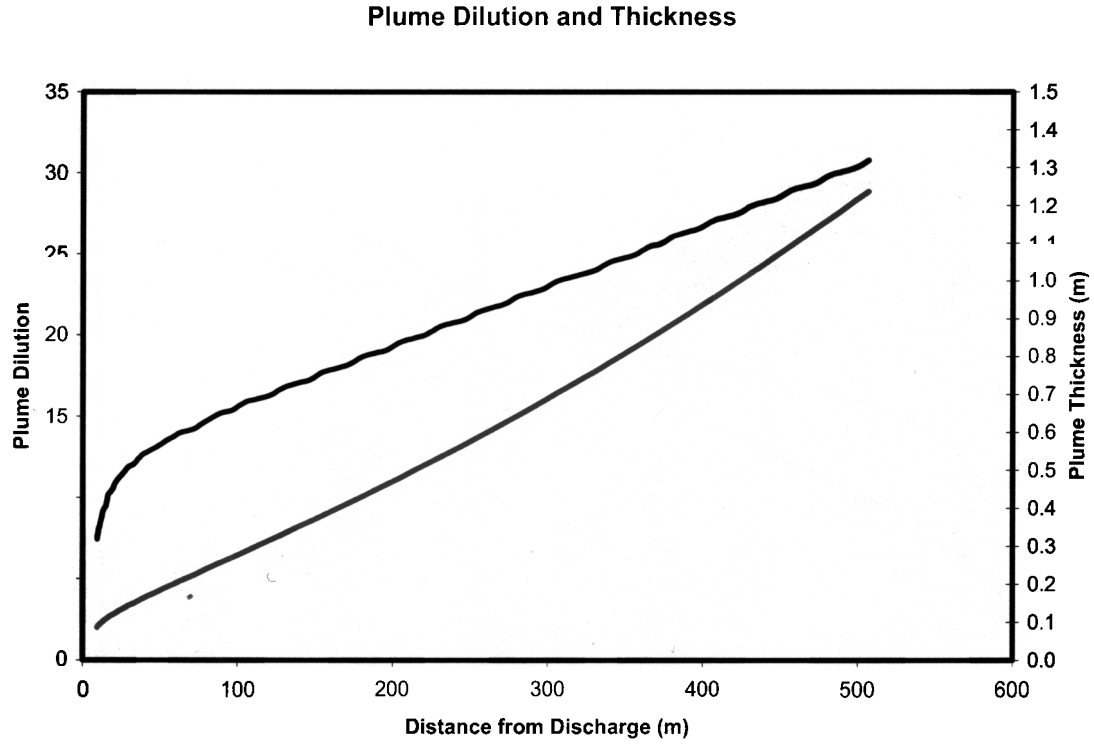
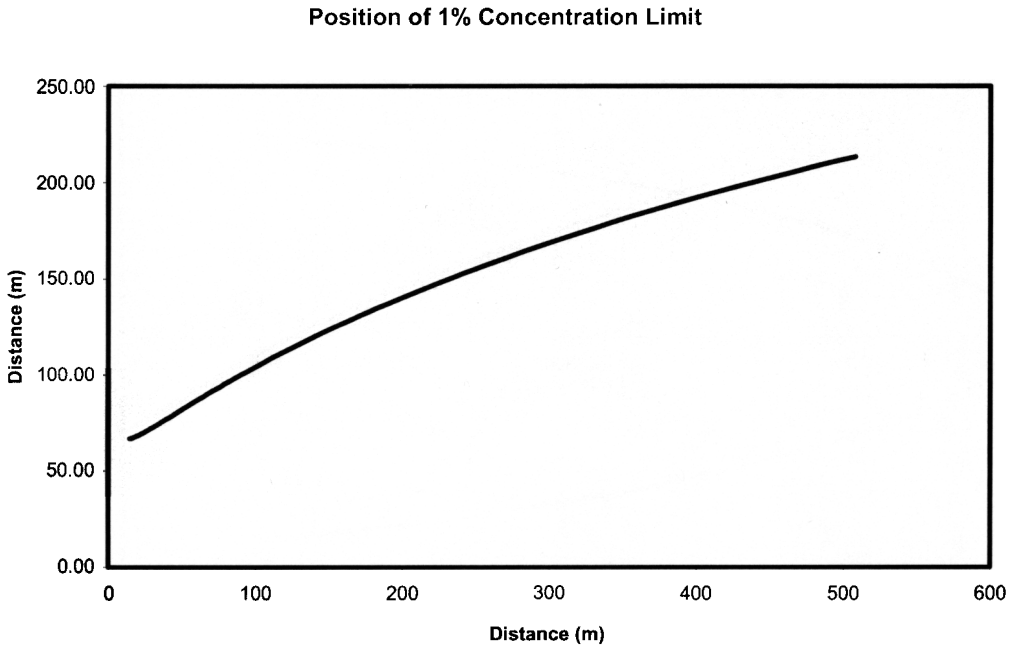


Figure 14. PDS model predictions for a discharge rate of 2.5 m^3s^{-1} and an ambient current speed of 0.30 ms^{-1}.



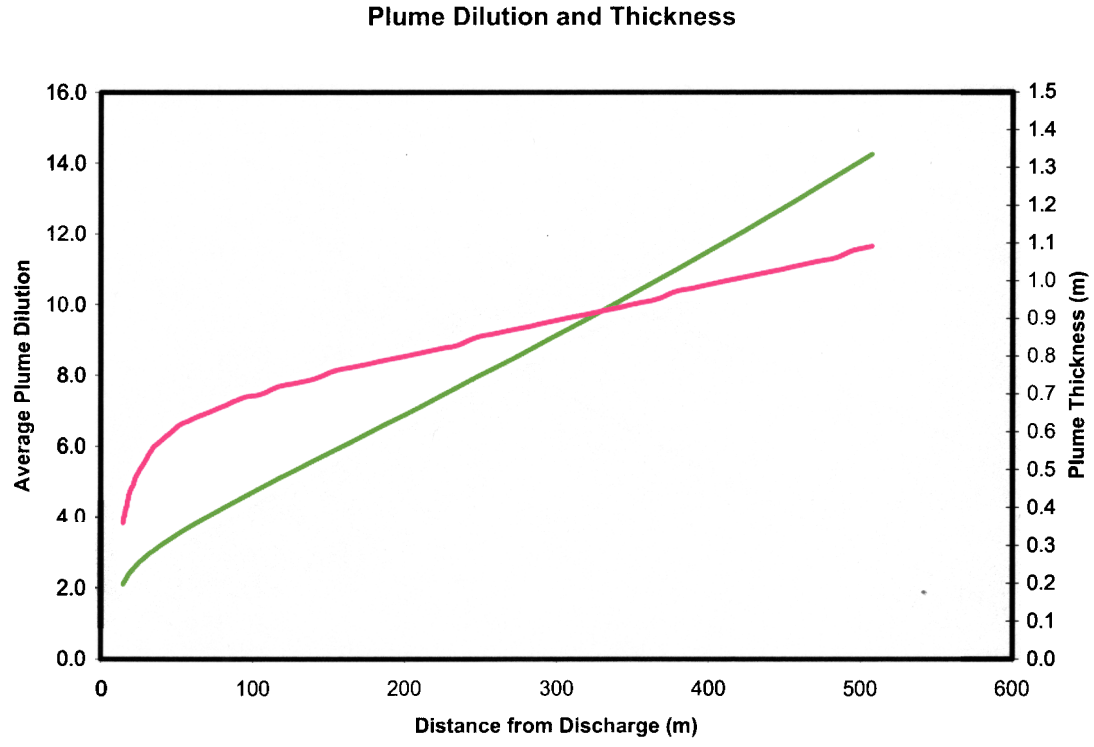


Figure 15. PDS model predictions for a discharge rate of 2.5 m^3s^{-1}, an ambient current speed of 0.30 ms^{-1} and a shore-attached plume.

3.3 Uncertainty in Model Predictions

There are two main sources of uncertainty inherent in this plume modelling exercise. These are uncertainties in our current state of knowledge regarding the dynamics of plume dilution and dispersion, and uncertainties in the appropriate model input parameters to use in this project.

With respect to uncertainties in the current state of knowledge regarding the dynamics of plume dilution and dispersion, one of the largest uncertainties is associated with the distribution of effluent across the plume cross-section. Most models include assumptions about the shape of this distribution; the PDS model used in this project uses a Gaussian formulation. Different assumptions about the shape of this distribution can lead to significant differences in the calculation of peak-to-mean dilution ratios and plume dimensions. This is a topic of current research (Frick et al. 2003).

Secondly, the analyses presented in this report include the effects of winds through the generation of surface currents. There is no differentiation in the model formulation between entrainment by wind-generated currents and entrainment by currents generated by other processes. This is a common factor of all of the plume models supported by the USEPA. As a result, the models may underestimate the plume dilution under certain conditions by under-estimating the vertical component of mixing induced by wind shear.

The sensitivity analyses conducted in this project have shown that variations in the effluent discharge velocity for a fixed discharge rate can impact the average plume dilution by at least a factor of two. Extremely limited information was available for this project on the relevant discharge characteristics at different discharge rates. The return period associated with the extreme discharge value of 2.5 m^3s^{-1} used in this project is unknown.

This project has shown the plume dilutions to also be sensitive to the ambient currents in the receiving waters. No measurements of currents were available for this project, hence the uncertainty associated with the current velocity estimates is not known.

During the period of high flows at the beginning of the discharge period, there typically are large numbers of ice floes in Garrow Bay. The floes may be floating in the bay or grounded near the shoreline or in the mouth of Garrow Creek. The impacts of ice on plume dilution are not well known. Care must be taken when using salinity data to map the presence of the effluent plume to differentiate between Garrow Creek water and water from melting ice floes in the bay.

4 SUMMARY AND DISCUSSION

The primary goal of this project has been to assess the initial dilution and dispersion of the effluent plume entering Garrow Bay from Garrow Creek, focusing on the 1% concentration limit under typical and extreme conditions. In achieving this goal, the relevant site data have been reviewed and assessed, and a specialized numerical modelling tool applied.

The review of the available site data has shown that information is limited for both the characteristics of the effluent and of the receiving waters. In terms of the effluent discharging from Garrow Creek, limited information is available with respect to the variability in discharge rates to be expected once the dam has been removed from Garrow Lake and the natural hydrological regime restored. The discharge rates used in this study may be conservative, in that they are based on measurements made during the period when tailings disposal to Garrow Lake was ongoing. However, a hydrologic assessment of the lake and creek would be required in order to determine the reduction in the high initial flows to be expected under natural flow conditions.

Of equal importance is the discharge velocity, which is a function of the discharge rate and the cross-sectional area of the discharge channel at the point of discharge. For natural channels, the cross-sectional area varies with discharge rate and can change over time in response to channel erosion and sedimentation. The available information consists of two observations of channel configuration at different times and different discharge rates.

Similarly, the current velocities in the receiving waters of Garrow Bay are the major factor impacting the plume behaviour in the turbulent entrainment phase. Currents in Garrow Bay have been estimated based on anecdotal observations and using order-of-magnitude estimation techniques applied to wind data from the town of Resolute. No actual measurements of currents within the bay were found for use in this project.

The PDS numerical model and the Visual Plumes model interface developed and distributed by the USEPA have been used to assess the near-field plume behaviour in Garrow Bay. The model has been run for three different current conditions in Garrow Bay, using estimated typical and extreme discharge rates from Garrow Creek. The results of this modelling exercise are summarized in Table 3, giving values for plume dilution and dimensions at a distance of 250 m from the mouth of Garrow Creek. The plume dilutions are given as a dilution ratio with percent effluent in brackets.

Table 3
Plume Characteristics at 250 m from the Point of Discharge

Discharge Rate (m^3s^{-1})	Ambient Currents	Plume Characteristics		
		Average Dilution	Width (m)	Thickness (m)
0.2	low	5 (20%)	340	0.1
0.2	moderate	44 (2%)	90	0.5
0.2	moderate, shore-parallel	24 (4%)	65	0.5
2.5	low	5 (20%)	535	0.5
2.5	moderate	13 (8%)	240	0.9
2.5	moderate, shore-parallel	8 (13%)	155	0.8

In all of the cases considered in this study, the concentration of effluent in the receiving waters is estimated to exceed 1% at a distance of 250 m from the final discharge point. However, the relative level of uncertainty associated with these predictions is high.

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APPENDIX C

MINUTES OF DECEMBER 2003 WORKSHOP

FINAL MEETING MINUTES

ENVIRONMENTAL EFFECTS MONITORING
STUDY DESIGN MEETING
POLARIS MINE (TECK COMINCO) & TECHNICAL ADVISORY PANEL
Tuesday, December 16, 2003
1:00 p.m to 5:00 pm.

Bev Burns Boardroom, Environment Canada, Edmonton

Attendees:

Bruce Donald	Teck Cominco, Cranbrook
John Knapp	Teck Cominco
Randy Baker	Azimuth Consulting Group Inc., Vancouver
Patrick Allard	Azimuth Consulting Group, Inc., Vancouver
Dionne Filiatrault	Nunavut Water Board, Gjoa Haven
Chris Baron	F&O Canada, Winnipeg
Meighan Wilson	Indian and Northern Affairs, Yellowknife
Stephen Harbicht	Environment Canada, Yellowknife
Sandra Blenkinsopp	Environment Canada, Edmonton
Jenny Ferone	Environment Canada, Edmonton
Paula Siwik	Environment Canada, Edmonton

1. Attendees introduced themselves.

2. No additional items were added to the agenda.

3. Review of the objective: To discuss the findings of the August 2003 reconnaissance studies, and to incorporate these findings into a revised EEM study, scheduled for August 2004.

4. Results of the August 2003 field reconnaissance studies on water chemistry, toxicity testing, plume delineation & modeling, sediment chemistry, benthos, and fish were presented by Randy Baker and Patrick Allard. Their presentation is appended (a hard copy will be sent with the final version of the minutes). An underwater video clip was also viewed. Information from the video presentation and slide presentation is appended at the end of the minutes.

5. General Discussion on Study Design Key Components

Adult Fish Survey

- Given that fin fish were found to be very rare in Garrow Bay, clams will be used in lieu of fin fish.
- The sampling design for collecting clams was discussed, given the limitations on the divers (2 dives per day, approximately 30 -35 minutes per dive). If discrete sampling stations are used similar to a benthic invertebrate sampling design with 5 stations, the divers will only be able to collect about 5 clams per station. Further discussion is needed to confirm if 20 - 25 clams, for example, are sufficient given the variability in a natural population. Another option is to collect clams on a per area basis.
- The range of EEM endpoints found in the MMER EEM Technical Guidance for caged bivalves should be measured on the wild clams, e.g. length, width, etc. (Note: The information is found in the Alternative Monitoring Chapter - Chapter 12).
- The exposure area clams should be collected along the first depth contour where clams are exposed to the effluent from Garrow Creek. This would probably be at the 5 to 6 m depth. Note: Steve Harbicht wants to see solid baseline data from this area in the event that Garrow Lake has a release in the future.
- The reference area will be in the subtidal area to the north of the mouth of Garrow Creek. The reference area clams will be collected along the same depth contour as the exposure area clams to remove the effect of depth. Note that results from the reconnaissance work indicated that metal levels in clams and sediment in this area as well as in the exposure area were similar to background concentrations measured in Tigumiavik Harbour.
- Exposure will be assessed by conducting soft tissue analyses for a suite of metals.

Action Item: Sandra Blenkinsopp to collect information on wild clam sample size. Done - Sandra spoke with Dr. Sylvie St.-Jean en route to the EEM Science Symposium. Dr. St.-Jean suggested a minimum of 40 clams of each sex per area, which usually requires a field collection of about 120 clams.

Action Item: Sandra Blenkinsopp will send Sylvie St.-Jean's contact information to Patrick so that he can get the current information on reproductive endpoints, which are under development. Done. Patrick and Sylvie have discussed the study. Patrick indicated that it was agreed that while 40 clams of each sex per study area would be ideal, it is unlikely that such a large sample size can be achieved due to sampling limitations in Garrow Bay (e.g., diver-assisted, ice flows, weather conditions, etc). Rather, it was agreed that 40 clams total per study area will be targeted. While 20 males and 20 females are recommended for the fish survey, it was acknowledged that difficulties in sexing clams in the field may result in departures from this target ratio.

Benthic Invertebrate Community Survey

- Grabs from the surface will not work because the sediments are too hard.
- Could use diver-assisted cores or quadrats
  - Cores – subsurface too hard
  - Quadrats – difficult because of kelp beds
- Could do a combination – SIMS and diver assisted cores or through-ice cores.
- Benthic stations (5 per area) will be located along a depth contour (approx. 6 m) to remove effect of depth, using same areas as clam survey.
- Patrick suggested divers could use a 1L wide-mouth jar, and drag it at a consistent depth and in a consistent manner until full. Used this method at Burrard Inlet.
- TAP suggested increasing subsamples per station and using a smaller volume. Could possibly do 2 to 3 subsamples per 500 mL jar.
- Use of amphipods briefly discussed (& subsequently discarded).
- Unlikely to have enough time to collect samples from a far-field site. (Note to TAP: a far-field benthic site is not required for an initial MMER EEM survey.)
- SIMS will be back-up, used in same area.

Sediment Collection

- Grabs will not work because the sediments are too hard (see benthic above).
- Steve Harbicht asked about the sediment chemistry with respect to the digest, etc.

Action Item: Sandra Blenkinsopp to confirm if sediment is to be collected per station. Done - Sediment sampling is to be done at each benthic station.

Action Item: Sandra Blenkinsopp to check sediment chemistry guidance for marine environments to determine recommended digestion process for EEM. Status: In Progress.

Effluent and Water Quality Monitoring

- The effluent and water quality monitoring, which includes effluent sublethal toxicity testing, must continue for the full 3 year period until the mine receives recognized closed mine status
- Two effluent samples must be collected for sublethal toxicity testing per year. The mine indicated that it had only collected one in 2003 in 9 weeks of discharge.

Action Item: Sandra Blenkinsopp to follow up with Patrick Allard. Done. The 2004 and 2005 monitoring events will include two samples for sublethal toxicity testing.

Timing of Survey

- Survey will be conducted approximately Aug 10 – 25th, 2004.

- Based on experience during the field reconnaissance survey last year, ½ of days up there might be working days.
- Field support for divers was discussed. A lot of the infrastructure will be gone and the medical facility will be decommissioned by August. Sandra Blenkinsopp suggested that it may be better to sample in May through an ice platform when more infrastructure was present at the site. Bruce Donald indicated that effluent wouldn't be flowing in May. Sandra Blenkinsopp has discussed this site with the National EEM Office, and the National EEM Office indicated that the effluent would not have to be flowing during sampling at this site. The consultants decided to work in August. They want to concentrate on open water sampling.
- If due to inclement weather or other difficulties the survey can't be completed, Patrick asked what happens, and the following summarizes the discussion:
    - Sandra Blenkinsopp indicated that the consultants should keep in touch with her or the Authorization Officer (AO) during the field work so that the TAP can be informed if weather is causing a problem, etc., Weather problems, communications with EC, etc., should be documented by the consultants for use in writing up the interpretive report. **Human safety is of primary importance.**
    - Sandra indicated that two weeks is an acceptable level of effort to attempt to achieve the objectives of the field survey.
    - Fall-back position – Combine 2 years of data.
    - Jenny Ferone suggested prioritizing elements of study, e.g. collect clam biological endpoints first.
    - Seabed Imaging and Mapping System (SIMS – see below) will be a backup, since it will be done in the same area. There is value in having both – cores and visual.
- First weekend of September in 2004 – sea-lift. Everybody and everything goes.

Seabed Imaging and Mapping System (SIMS) – The consultants indicated that there is a F&O requirement for SIMS to be done at the dock site now that the dock structure has been removed. Ten to 15 m intervals parallel to shore will be done, followed by tows perpendicular to shore, and then oblique tows. Abundance, and presence / absence will be noted, as well as depth. Drop camera, magnify and do quadrat survey. This is a semi-quantitative method.

6. Steps Forward
    - Sandra Blenkinsopp to distribute minutes
    - Azimuth to finalize study design. Anticipate a 2 to 3 month turn-around time.
    - Randy will make a copy of the video for EC (Received by Edm Office January 7, 2004).

Video and Slide Presentation

Notes from video presentation:

- Video taken first weeks of August 2003
- Thin layer of sand/silt over cobble and gravel
- One fish; Clouds of amphipods (mysids)
- Starting at mouth of creek and moving out
- Ice scour area – rocky, no kelp
- Lot of cobble and gravel and attached kelp typical of 5 to 8 metres depth, 150 – 200 m offshore
- Stark difference in kelp/benthic community abundance between scoured intertidal and subtidal area
- Maximum depth sampled approximately 8 m. Floats were set for the collection of clams at approximately 8 m.
- Clams in softer sediments as well as between larger substrates
- Looking for clams as near to shore as possible, looking for siphons that stick out of the sand. Suspended material hung in water column
- Collected paired sediment and clam tissue samples
- Sediments collected by hand into jar prior to clam collection
- Clams (*Mya truncata*), 17 - 50 g wet body weight, approx. 4 size classes (17-19, 32, 40, & 50 g)
- Dragged a zooplankton net in shallows and collected specimens. Made a representative zooplankton collection.
- Water temperature was -0.5 to -1 ^{o}C water temp, 0 ^{o}C at surface
- 30 to 35 minutes per dive

Slide 4 - Garrow Lake Effluent Characterization

- Collected water samples weekly
- Early in the year the freshwater ice melt causes a drop in salinity
- Garrow Lake is siphoned over the dam then flows by gravity.
- Garrow Creek typical discharge was 0.1 to 0.2 m^3/s. Spring flow generally 1.5 to 2 m^3/s.
- Flow rates are higher this year because more siphons were on line.
- Approximately 20 cm remains to get lake down to level. The dam will be opened for this.
- Garrow Lake sampling performed for Fisheries & Oceans Canada in August 2003: Captured 19 sculpins, sacrificed 11; Zooplankton
- Garrow Lake top 9 or 10 m was brackish water; 2 ppt down to 7 or 8 ppt. Transition zone at 10 or 11m when salinity went from 10 to 60 ppt. Pretty well uniform at 60 ppt to bottom. Temperature inversion – about 8^{o}C at bottom.

Slide 6 – 2003 Effluent Chemistry Data

- BC Aquatic Water Quality Guidelines are marine limits based on toxicity to algae with a 2 fold safety factor

Slide 7 – Contaminants of Potential Concern

- Concentration of Zinc – low initially at ice melt and then increases
- Bruce Donald indicated that in the future Zinc concentrations should be lower, since only meltwater should be drawing down.
- High Pb, reason not known. Could have been due to new siphons.

Slide 8 – Effluent Characterization - Sublethal Toxicity Testing
- Didn't miss any holding times for getting samples to the toxicity lab in Vancouver.
- Acute Lethality Tests – included salinity controls
- SLTT – 72% v/v highest effluent concentration tested; used sea salts
- Randy Baker asked if other mines are doing the salinity adjustment. Sandra B indicated that for marine tests the standard protocol is to adjust salinity.
- Note: Only one effluent collection for SLTT was done. The mine discharged for approximately 9 weeks.

Slides 10 & 11 – Effluent Characterization - Sublethal Toxicity Testing
- Think Zinc was the cause of the toxicity. Paired samples - one for toxicity and one for chemistry.
- Arctic amphipods used by Peter Chapman were collected from discharge environment. Temperature known to affect toxicity. The higher the temperature, the higher the toxicity.

Slide 12 to 13 - Reconnaissance Studies in Garrow Bay
- 16' boat, rifle, communications – radio to mine
- Plume Delineation was done using a boat and chest-waders

Slide 14 to 20 – Plume Delineation
- Chest waders and boat survey, working from outside in
- Field measurements taken of temperature, salinity and zinc concentration
- Samples collected at surface (top 30 cm) and subsurface (10 cm off bottom)
- Effluent was 40 cm 'thick' at mouth of Garrow Creek and decreased to 10 to 20 cm 'thick' 200 m offshore
- At about 25 to 26 ppt salinity, Zinc was down to 0.05 mg/L (detection limit)
- Negative regression between zinc concentration and salinity
- Ice present in bay really accelerates mixing process as plume moves around and under ice blocks.

Slide 21 Modeling - Frick *et al.* 2003 EPA visual plumes software
- Wind and current influences mixing.
- No ice involved in model
- In the future, discharge will be approximately 1/5 to 1/10 of what it was in 2003

Slide 27 – 2003 Reconnaissance Design

- Had planned to use Tigumiavik Harbour as a reference area, but access was too difficult.
- Reference was moved to approximately 500 m north of Garrow Creek mouth, based on results of plume delineation.
- Water Quality Monitoring as well as sediment and clam tissue data indicate background conditions.

Slide 28
- Previous surveys, clams collected under ice but tried to get clams from closer to the creek mouth this time using divers. Intertidal area devoid of life except for amphipods.
- 2 reference areas, one for intertidal and one for sub-tidal, access limited.
- Plume moved both ways, went far enough away north/south to be out of the plume. Also suspected a back eddy but wind a bigger issue.
- Three exposure stations sampled & 1 reference– were limited by divers and clams.

Slide 30
- Prawn trap was baited with cat food. Worked very well in Garrow Lake when baited with cat food. Tried in marine environment – amphipods ate cat food. Was crushed by ice on second night.
- Clams – composited 3 to 4 clams per size category and analyzed composite.

Slide 31
- N=3 means 3 composite samples each comprised of 3 to 4 clams
- Metal suite on body tissue
  - Intended to depurate but not enough clams
  - Pulled them out, put them in bags, scrubbed them in lab, pulled siphon and cleaned as best as could
  - Results include everything: siphon, sediment, gut contents, etc.
- No relationship between size and metal concentration

Slide 32 – Historical Metals Concentrations in Clam Tissue
- Fallis' historical clam data was on depurated clams. Sample size is number of composites in all cases except for BC research who analyzed individual clams.

Slide 34 – Sediment Survey
- Unable to collect sediment with standard Ponar grab
- Recovered kelp on gravel most times in spaces allowed for water movement
- Rate of failure consistent between near-field, far-field and ref area

Slide 35 – Metal Concentrations in Sediment 2003
- Intertidal concentrations higher than sub-tidal concentrations.

- Did analysis on 2mm (sand) fraction and down. In both subtidal and tidal targeted fine sediments.
- Note: likely the first metals data for intertidal sediment collected at this site.

Four options raised for discussion:

- conduct an EEM compliant study design
  - consultants don't think this can be done
- conduct a limited field study using alternative tools
  - diver assisted clams and sediment
    - underwater imagery (SIMS)
    - F&O Canada requires SIMS for intertidal areas by barge
- No further biological monitoring
  - Continue effluent and water quality monitoring
- Other?

APPENDIX D

REVIEW OF POLARIS MINE EEM STUDY DESIGN OUTLINE

Review of Polaris Mine EEM
Study Design Outline for Biological Monitoring Studies

Highlights Section
The benthic survey component should be given the 3rd priority rather than the 4th priority. The benthic survey is a main EEM component. If time becomes an issue, the TAP recommends that sediment and water quality sample collection be reduced as indicated in the comments below.

Fish Survey and Tissue Analysis
Gonad dry weight and animal height should be added to the list of measured endpoints.

Benthic Invertebrate Community Survey
The MMER TGD recommends that in marine systems, a stacked set of 1.0 and 0.5 mm screens be used in the field with the 0.5 mm samples being archived and processed only if appropriate.

Benthic Supporting Environmental Variables (Chapter 5 of TGD)
Please see Table 5-7 of the MM TGD for the recommended supporting explanatory variables to be measured at each station in marine/estuarine benthic invertebrate habitats. In addition to the parameters listed in your outline, this table also recommends that dissolved oxygen near the bottom, sediment Eh (redox) and sediment total sulfides, as well as substratum characteristics be measured at each benthic station.

If time is limiting, the TAP recommends that **one sediment sample be collected per station** at the same time as the benthic invertebrate sampling.

Water Quality Monitoring during biological field work (Chapter 6 of MM TGD)
If time is limiting, the TAP recommends that the water quality sample collection work be done within each fish and benthic invertebrate sampling **area at one representative station** (pg 6-5, MM TGD).

Field Measurement of Water Quality Parameters - Please note that when water depth is greater than 4m, the standard water quality parameters measurable in the field should be taken throughout the water column at one to five metre intervals depending on total depth (pg. 6-9 MM TGD). The TAP recommends that the interval at which measurements are taken be less than every meter in the upper portion of the water column, in order to pick up where the freshwater lens is, etc. It is also recommended that conductivity be added to the list of standard field measurements.

Collection of Water Samples for Laboratory Analyses - The water collected for laboratory analyses of water quality should be collected at 2 depth intervals: the subsurface and near bottom (pg. 6-10 MM TGD), as described in your outline.

APPENDIX C

PHOTOGRAPHIC OVERVIEW OF POLARIS EEM
2004 FIELD PROGRAM (AZIMUTH, 2004b)

Photographic Overview of Polaris EEM 2004 Field Program

August 14 – 28th, 2004

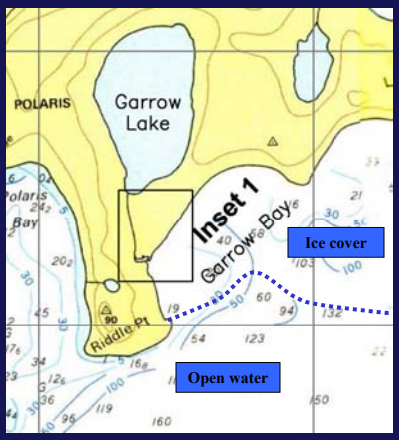
Prepared by Azimuth Consulting Group Inc.

Polaris EEM – 2004 Field Program Highlights

- Six field crew and all equipment arrived at mine site on August 14th.
- Garrow Bay sampling areas inaccessible from shore or by boat due to large ice floes covering entire bay and most of offshore Pullen Strait.
- Diving equipment, compressor, two boats, and beach camp operational within two days of arrival to ensure readiness in the event that ice conditions changed.
- Conducted survey of fish habitat near former dock area using seabed imaging and mapping system (SIMS) on August 16th and 19th. This work fulfilled mine closure requirements by Fisheries and Oceans Canada.
- Conducted additional underwater survey of former dock area using divers on August 20th.
- Documented ice conditions on Garrow Bay throughout duration of the two-week field program – overall the bay remained completely inaccessible due to ice conditions.
- Weekly verbal updates were provided to Sandra Blenkinsopp (Environment Canada).

Polaris EEM – Overview of Study Design for Biological Monitoring Studies (including overlay of ice conditions during field program)

Study Area



Inset 1

Polaris EEM Field 2004 Photos – Panorama (Aug 16)

Polaris EEM Field 2004 Photos

Garrow Bay		Offshore Pullen Strait
	Aug 14	
	Aug 15	

Polaris EEM Field 2004 Photos (cont'd)

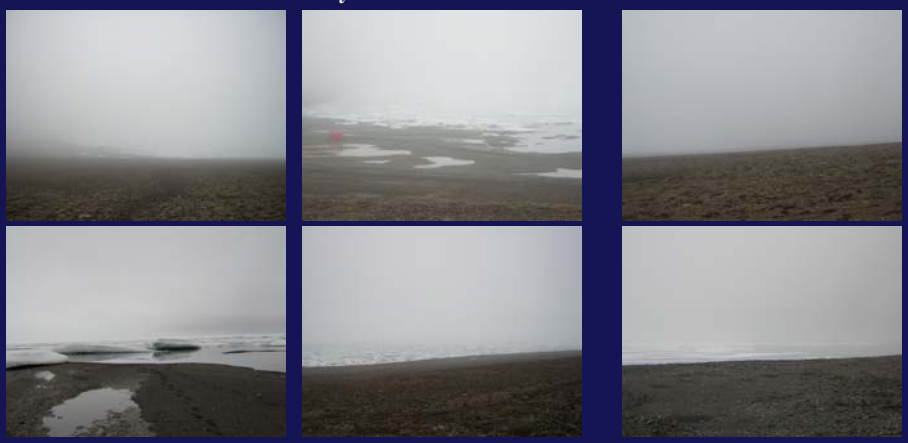
Garrow Bay		Offshore Pullen Strait
	Aug 16	
	Aug 17	

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay (Reference Area) Aug 17

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay **Offshore Pullen Strait**



Aug 18

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 19

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 20

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 21

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 22

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 22 (late afternoon)

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 23

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 23

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay (Reference Area) Aug 24

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 25

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 25

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Aug 26

Offshore Pullen Strait

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 26

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay

Offshore Pullen Strait

Aug 27

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 27

Polaris EEM Field 2004 Photos – Panorama (Aug 27)

Polaris EEM Field 2004 Photos (cont'd)

Garrow Bay and Offshore Pullen Strait – Aug 28

APPENDIX D

EFFLUENT AND WATER QUALITY DATA: 2003 to 2005

2003 POLARIS MINE MMER 3RD QUARTER REPORT

Bruce J. Donald
Reclamation Manager

November 14, 2003

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – 2003 3rd Quarter Metal Mining Effluent Regulations Report

Please find attached the Metal Mining Effluent Report for the Polaris Mine for the 3rd Quarter of 2003. Discharge from Garrow Lake was initiated the week of July 21, 2003 and ceased the week of September 15, 2003. The associated water quality sampling and environmental effects monitoring were conducted as required. The results of the effluent characterization are discussed in Appendix G.

For your information, the field work associated with the first stage of the environmental effects monitoring study proposed for this summer was been completed as planned. Data is currently being reviewed and the results will be presented to the Technical Advisory Panel at a meeting scheduled in Edmonton for review and discussion on December 16, 2003

I am also forwarding you a paper copy of this report. Please contact me if there are any questions related to enclosed information.

Yours truly,
Original signed by B Donald

Bruce Donald

Attachments: 3rd Quarterly Monitoring Report

cc:
Walter Kuit (Teck Cominco Limited)
John Knapp (Teck Cominco Limited)
Randy Baker (Azimuth Consulting Group)

POLARIS MINE – MMER MONITORING REPORT

3rd QUARTER 2003

APPENDIX A

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test

APPENDIX B

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test

APPENDIX C

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPAW 95-EPA West Coast: 7-day Topsmelt Survival and Growth Test.

APPENDIX D

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPS 1/Rm/27-EC: 92 hr Echinoderm (sand dollar) Fertilization Test (Annual)

APPENDIX E

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPA/600/4-91-003, Method 1009.0: Algae (*Champia parvula*) 7-day Sublethal Growth Test (Annual).

APPENDIX F (Mass Loadings)

i. Concentration & monthly mean concentrations of each deleterious substance of Schedule 4
ii. pH of the effluents samples as required by subsection 12(1)
iii. Description of sample collection method
iv. Total volume of effluent deposited during each month of the quarter as per section 19
v. Mass loading of the deleterious substances set out in Schedule 4 and as per section 20

APPENDIX G

i. Results of the effluent characterization as per paragraph 15(1)(a)

APPENDIX A

96-h Acute Rainbow Trout Toxicity Test

Reporting Requirements for Reference Method EPS 1/RM/13

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Wednesday July 30, 2003 - 1:00 PM
   - Test 2: Wednesday August 20, 2003 - 12:30 AM
   - Test 3: Tuesday September 16, 2003 - 5:00 PM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - 96-hour Rainbow Trout LC_{50}

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements
   - Salinity controls were run
   - Sample water salinity was 2ppt (Test 1); 4ppt (Test 2), and 6ppt (Test 3)

iii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iv. Percent mortality of fish in stock tank(s)
   - Test 1: 0.1%
   - Test 2: 0.1%
   - Test 3: 1%

v. Species of test organism
   - Rainbow Trout (*Oncorhynchus mykiss*)

vi. Date and time for start of definitive test
   - Test 1: Saturday August 2, 2003 - 2:00 PM
   - Test 2: Friday August 22, 2003 - 12:30 PM
   - Test 3: Friday September 19, 2003 - 5:00 PM

vii. Person(s) performing the test and verifying the results
   - Andy Diewald, Devika Jayaweera, May Lee

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - Test 1: pH - 7.8, T - 15.0°C, DO - 10.0mg/L, C - 4100µmhos/cm
   - Test 2: pH - 7.8, T - 15.0°C, DO - 10.1mg/L, C - 6000µmhos/cm
   - Test 3: pH - 8.1, T - 16.0°C, DO - 10.0mg/L, C - 8000µmhos/cm

Reporting Requirements for Reference Method EPS 1/RM/13

ix. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment
- Test 3: No pH adjustment

x. Indication of aeration of test solutions before introduction of fish
- Test 1: 6.5 ± 1 mL/min/L for 60mins
- Test 2: 6.5 ± 1 mL/min/L for 90mins
- Test 3: 6.5 ± 1 mL/min/L for 120mins

xi. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 12 L (test 1&2), 15 L (test 3)
- 6.25% - 12 L (test 1&2), 15 L (test 3)
- 12.5% - 12 L (test 1&2), 15 L (test 3)
- 25% - 12 L (test 1&2), 15 L (test 3)
- 50% - 12 L (test 1&2), 15 L (test 3)
- 100% - 12 L (test 1&2), 15 L (test 3)
- Salinity Control - 12 L (test 1&2), 15 L (test 3)

xii. Measurements of dissolved oxygen, pH and temperature
- Test 1: DO: 8.2 - 10.1 mg/L, pH: 7.0 - 7.8, T: 15.0 °C
- Test 2: DO: 8.2 - 10.1 mg/L, pH: 7.1 - 7.8, T: 15.0 °C
- Test 3: DO: 8.2 - 10.0 mg/L, pH: 6.6 - 8.1, T: 15.0 - 16.0 °C

xiii. Number of fish added to each test vessel
- 10 fish/ vessel

xiv. Mean and range of fork length of control fish at end of test
- Test 1: 42mm (40-44)
- Test 2: 38mm (35-42)
- Test 3: 36mm (32-40)

xv. Mean wet weight of individual control fish at end of the test
- Test 1: 0.57g (0.43-0.68)
- Test 2: 0.59g (0.43-0.72)
- Test 3: 0.50g (0.35-0.61)

xvi. Estimated loading density of fish in test solutions
- Test 1: 0.48g/L
- Test 2: 0.49g/L
- Test 3: 0.33g/L

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
- Results were the same for Test 1, Test 2, and Test 3, except where noted
- Control (0%) - 0
- 6.25% - 0
- 12.5% - 0
- 25% - 0
- 50% - 0 (test 1&2), 1 (test 3)
- 100% - 0
- Salinity Control - 0

Reporting Requirements for Reference Method EPS 1/RM/13

ii. Number of control fish showing atypical/stressed behaviour
- None in Test 1, Test 2, or Test 3

iii. Mean mortality rate in solutions of effluent and control water
- Results were the same for Test 1, Test 2, and Test 3, except where noted
- Control (0%) - 0%
- 6.25% - 0%
- 12.5% - 0%
- 25% - 0%
- 50% - 0% (test 1&2), 10% (test 3)
- 100% - 0%
- Salinity Control - 0%

iv. Estimate of 96-h LC50 in multi-concentration tests
- Results were the same for Test 1, Test 2, and Test 3
- 96hr LC_{50} concentration > 100% effluent

v. Most recent 96-h LC50 for reference toxicity test(s)
- Reference toxicity tests for Toxicant: SDS
- Test 1: (Jul-10-03) 96-h LC_{50} = 36mg/L SDS, 95% CL = 30-42mg/L
- Test 2: (Aug-5-03) 96-h LC_{50} = 24mg/L SDS, 95% CL = 18-32mg/L
- Test 3: (Sep-3-03) 96-h LC_{50} = 24mg/L SDS, 95% CL = 22-26mg/L

APPENDIX B

72-h Acute *Daphnia magna* Toxicity Test

Reporting Requirements for Reference Method EPS 1/RM/14

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75^{o} 22' 32" N, 97^{o} 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Wednesday July 30, 2003 - 1:00 PM
   - Test 2: Wednesday August 20, 2003 - 12:30 AM
   - Test 3: Tuesday September 16, 2003 - 5:00 PM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - 48-hour *Daphnia magna* LC_{50}

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements
   - Salinity controls were run
   - Sample water salinity was 2ppt (Test 1); 4ppt (Test 2), and 6ppt (Test 3)

iii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iv. Species of test organism
   - *Daphnia magna*

v. Date and time for start of definitive test
   - Test 1: Saturday August 2, 2003 - 2:00 PM
   - Test 2: Friday August 22, 2003 - 3:30 PM
   - Test 3: Friday September 19, 2003 - 3:15 PM

vi. Person(s) performing the test and verifying the results
   - Andy Diewald and May Lee

vii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - Test 1: pH - 7.5, T - 21.0°C, DO - 8.7mg/L, C - 4100µmhos/cm
   - Test 2: pH - 7.8, T - 20.0°C, DO - 8.9mg/L, C - 9280µmhos/cm
   - Test 3: pH - 8.0, T - 19.5°C, DO - 8.7mg/L, C - 11330µmhos/cm

viii. Confirmation that no adjustment of sample or solution pH occurred
   - Test 1: No pH adjustment
   - Test 2: No pH adjustment
   - Test 3: No pH adjustment

Reporting Requirements for Reference Method EPS 1/RM/14

ix. Indication of any adjustment of hardness of effluent sample
- Test 1: No hardness adjustment
- Test 2: No hardness adjustment
- Test 3: No hardness adjustment

x. Indication of any aeration of sample
- Test 1: No pre-aeration adjustment
- Test 2: No pre-aeration adjustment
- Test 3: 25-50 mL/min/L for 10mins

xi. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 200 mL
- 6.25% - 200 mL
- 12.5% - 200 mL
- 25% - 200 mL
- 50% - 200 mL
- 100% - 200 mL
- Salinity Control - 200 mL

xii. Measurements of dissolved oxygen, pH and temperature
- Test 1: DO: 8.3 - 8.7 mg/L, pH: 7.5 - 7.9, T: 20.0 - 21.0 °C
- Test 2: DO: 8.4 - 9.0 mg/L, pH: 7.6 - 8.1, T: 20.0 - 20.5 °C
- Test 3: DO: 8.3 - 9.1 mg/L, pH: 7.6 - 8.1, T: 19.5 - 21.0 °C

xiii. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
- Test 1: 9 days to brood, >15 neonates/brood, 4.6% mortality in 7d prior to test
- Test 2: 9 days to brood, >19.9 neonates/brood, 10.0% mortality in 7d prior to test
- Test 3: 8 days to brood, >26.3 neonates/brood, 5.5% mortality in 7d prior to test

xiv. Number of neonates per test vessel and milliliters of solution per daphnid
- Methods for all tests and dilution series were the same:
- 10 neonates per vessel
- 200 mL of solution per daphnid

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
- Results were the same for Test 1, Test 2, and Test 3, except where noted
- Control (0%) - 0 dead / immobile (test 1&2), 1 dead (test 3)
- 6.25% - 0 dead / immobile
- 12.5% - 0 dead / immobile
- 25% - 0 dead / immobile
- 50% - 0 dead / immobile
- 100% - 0 dead / immobile (test 1&2), 1 dead (test 3)
- Salinity Control - 0 dead / immobile

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
- Single concentration test was not conducted, dilution series tests were conducted

Reporting Requirements for Reference Method EPS 1/RM/14

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
- Test 1: 48-h LC_{50} = > 100% effluent
- Test 2: 48-h LC_{50} = > 100% effluent
- Test 3: 48-h LC_{50} = > 100% effluent

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
- Reference toxicity tests for Toxicant: Zinc
- Test 1: (Aug-7-03) 96-h LC_{50} = 453µg/L Zinc, 95% CL = 377-544µg/L
- Test 2: (Aug-7-03) 96-h LC_{50} = 453µg/L Zinc, 95% CL = 377-544µg/L
- Test 3: (Sep-23-03) 96-h LC_{50} = 429µg/L Zinc, 95% CL = 355-518µg/L

APPENDIX C

7-d Topsmelt Growth and Survival Toxicity Test

Reporting Requirements for Reference Method EPA/600/R-95/136

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Test Organisms Imported from External Supplier

i. Species of test organism
   - Topsmelt (*Atherinops affinis*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Aquatic Bio Systems (ABS), Fort Collins, Colorado

iv. Date test species acquired on
   - August 21, 2003

v. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vi. Percent mortality of fish in 24-hour period preceding the test
   - <10% mortality

vii. Age at start of test
   - 10 days post-hatch

viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
   - Nothing unusual, no excessive crowding of larvae, larvae appear healthy, disease-free, stress free,

ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
   - Larvae actively feeding and swimbladders not inflated

x. Confirmation that temperature change was <3°C and dissolved oxygen was maintained at >6mg/L during transport
   - Temperature change was <2°C and dissolved oxygen supersaturated mg/L during transport

xi. Test organism acclimation rate at the testing laboratory
   - Holding water conditions upon arrival were DO=supersaturated, pH=7.3, T=22°C
   - Organisms were acclimated slowly overnight
   - Addition of EVS lab seawater at intervals of 30 – 60min to reach acceptable conditions
   - Organisms were acclimated to DO=8mg/L, salinity=28ppt,T=20°C

Reporting Requirements for Reference Method EPA/600/R-95/136

Test Facilities and Conditions

i. Test type & method
   - 7-day Topsmelt (*Atherinops affinis*) Survival and Growth Toxicity Test
   - Static renewal
   - Sample water was renewed daily
   - Reference Method - EPA/600/R-95/136 (EPAW 95-EPA West Coast)

ii. Indications of deviations from requirements in Sections 11 of Method EPA/600/R-95/136 (EPAW 95-EPA West Coast)
   - No deviations from requirements
   - Salinity controls were run
   - Sample water salinity was 5.3ppt

iii. Date and time for start of definitive test
   - Friday August 22, 2003 - 5:00 PM

iv. Test vessel description
   - 600mL beaker

v. Person(s) performing the test and verifying the results
   - Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang

vi. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - pH - 7.9, T - 20.0°C, DO - 11.0mg/L, C - 9570µmhos/cm, (salinity - 5.3 ppt)

vii. Confirmation that no adjustment of sample or solution pH occurred
   - No pH adjustment

viii. Indication of aeration of test solutions before introduction of fish
   - Pre-aeration at 6.5mL/min/L for 30mins due to supersaturation of sample with O_2 when sample was heated to 20°C
   - DO was reduced from 11.0mg/L to 7.8 mg/L

ix. Indication that EC guidance document for salinity adjustment was followed
   - No deviations from EC guidance document on preparation of hypersaline brine
   - HSB prepared from natural seawater concentrated to 90ppt (by freezing/refreezing to remove frozen layer and concentrate salts)
   - No deviations from EC guidance document for salinity adjustment of sample
   - HSB was added to samples to salinity adjust them from 5.3ppt to 30ppt

x. Type and source of control/dilution water
   - UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xi. Concentrations and volumes tested
   - Concentrations (% effluent volume / total volume) tested and total volumes used were:
   - Control (0%) - 200 mL
   - Salinity Control (0%) - 200 mL
   - 4.5% - 200mL
   - 9.0% - 200mL
   - 18.1% - 200mL
   - 36.2% - 200mL
   - 72.3% - 200mL

xii. Number of replicated per concentration
   - 5 replicates per concentration

xiii. Number of organisms added to each test vessel
   - 5 fish per vessel

xiv. Manner and rate of exchange of test solutions
   - Daily renewal

Reporting Requirements for Reference Method EPA/600/R-95/136

xv. Measurements of dissolved oxygen, pH and temperature
- DO: 6.6 - 7.8 mg/L, pH: 7.7 - 8.2, T: 19.0 - 20.0 °C, salinity: 29 - 31 ppt

Results

i. Number and % of mortalities of fish in each test solution
- Totals from all 5 replicates are presented:
- Control (0%) - 1/25 = 4%
- Salinity Control - 0/25 = 0%
- 4.5% - 0/25 = 0%
- 9.0% - 0/25 = 0%
- 18.1% - 0/25 = 0%
- 36.2% - 0/25 = 0%
- 72.3% - 1/25 = 4%

ii. Average dry weight per original fish in test vessel
- Means from all 5 replicates are presented:
- Control (0%) - 1.18 mg
- Salinity Control - 1.14 mg
- 4.5% - 1.13 mg
- 9.0% - 1.32 mg
- 18.1% - 1.09 mg
- 36.2% - 1.11 mg
- 72.3% - 1.14 mg

iii. Estimate of 7-d LC_{50} (95% CL)
- 7-d LC_{50} concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

iv. Estimate of 7-d IC_{25} (95% CL) for growth
- 7-d IC_{25} concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

v. Current reference toxicity tests (95% CL) for 7-d LC_{50} for survival and 7-d IC_{50} for growth
- Reference toxicity tests for Toxicant: Copper
- Test conducted on August 22, 2003, same day as effluent test
- Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
- 7-d LC_{50} survival = 122mg/L Cu, 95% CL = 111-135mg/L
- 7-d IC_{50} growth = 122mg/L Cu, 95% CL = 106-132mg/L

vi. Reference toxicity warning limits (+/- SD) for 7-d LC_{50} for survival and 7-d IC_{50} for growth
- Reference toxicity tests for Toxicant: Copper
- 7-d LC_{50} survival = 139 ± 63mg/L Cu,
- 7-d IC_{50} growth = 136 ± 52mg/L Cu

APPENDIX D

92-h Echinoderm Fertilization Test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Test Organisms

i. Species of test organism
   - Sandollar Echinoid (*Dendraster excentricus*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - M-REP, Escondido, California
   - All adults providing gametes are from the same population and source
   - Gametes are spawned in-house at EVS

iv. Date test species acquired on
   - August 22, 2003

v. Holding time and conditions for adults
   - Adults received at the testing laboratory the day of the test, shipped overnight

vi. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vii. Weekly percent mortality of adults being held over 7d preceding test
   - <2% per day over the 7 days preceding the test

viii. Age of test organisms
   - < 4 hours after spawning

ix. Unusual appearance, behaviour, or treatment of adults or gametes before test start
   - Organisms appear healthy

Test Facilities and Conditions

i. Test type & method
   - Echinoderm (*Dendraster excentricus*) Fertilization Toxicity Test
   - Static
   - Reference Method – EPS/1/RM/27 with 1997 amendments

ii. Test duration
   - 10:10 min (10min sperm + 10min sperm & egg)

iii. Date and time for start of definitive test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Friday August 22, 2003 - 5:00 PM

iv. Test vessel description
- 16 x 125mm test tubes

v. Person(s) performing the test and verifying the results
- Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang

vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
- No pre-aeration

vii. Confirmation that no adjustment of sample or solution pH occurred
- No pH adjustment

viii. Procedure for sample filtration
- No sample filtration

ix. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment

x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment
- Salinity adjusted from 5ppt to 29ppt

xi. Type and source of control/dilution water
- UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 10mL
- Salinity Control (0%) - 10mL
- 4.6% - 10mL
- 9.1% - 10mL
- 18.2% - 10mL
- 36.5% - 10mL
- 73.0% - 10mL

xiii. Number of replicated per concentration
- 4 replicates per treatment concentration

xiv. Number of organisms per container
- 2000 eggs per 10mL vessel

xv. Measurements of pH and dissolved oxygen in sample water before use
- pH - 8.3, DO - 8.4mg/L

xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
- pH - 7.9-8.4, T - 15.0-15.5°C, DO - 8.1-8.4mg/L, salinity - 29ppt

Results

i. Number and % of fertilized eggs in each test concentration
- (Number is equal to percent since totals were 100)
- Control (0%): #F = 51, 50, 52, 54 #UF = 49, 50, 49, 46
- Salinity Control: #F = 51, 52, 50, 51 #UF = 49, 48, 50, 49
- 4.6%: #F = 35, 40, 29, 45 #UF = 65, 60, 71, 55
- 9.1%: #F = 36, 28, 33, 25 #UF = 64, 72, 67, 75
- 18.2%: #F = 22, 24, 18, 20 #UF = 78, 78, 82, 80
- 36.5%: #F = 12, 8, 7, 10 #UF = 88, 92, 93, 90
- 73.0%: #F = 1, 0, 2, 0 #UF = 99, 100, 98, 100

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

ii. Estimate of IC_{25} (95% CL) for fertilization success
- IC_{25} concentration = 3.8 (1.1 - 7.2)% v/v effluent
- Quantal statistic method = log linear interpolation

iii. Current reference toxicity tests (95% CL) for IC_{50} for fertilization
- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test conducted on August 22, 2003, same day as effluent test
- Reference test conducted under same conditions
- IC_{50} for fertilization = 1.3mg/L SDS, 95% CL = 1.1-1.5mg/L

APPENDIX E

7-d Sublethal *Champia* (Algae) Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 1 x 4L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

vii. Temperature of water upon receipt at lab
   - 13°C

Test Organisms

i. Species of test organism
   - Algae (*Champia parvula*)

ii. Name and city of testing laboratory
   - Saskatchewan Research Council [SRC], Saskatoon, SK

iii. Source of test species
   - Sexually mature male and female branches
   - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
   - Appear in good health
   - Females have trichogynes, males have sori with spermatia

Test Facilities and Conditions

i. Test type & method
   - *Champia parvula* sexual reproduction test
   - Static, non-renewal
   - 2-day exposure, followed by 5-7 day recovery period for cystocarp development
   - Reference Method - EPA/600/4-91/003, Method 1009.0

ii. Date and time for start of definitive test
   - Friday August 22, 2003 – 10:00 AM

iii. Test vessel description
   - 270mL transparent polystyrene cups with polystyrene lids

iv. Person(s) performing the test and verifying the results
   - Mary Moody

v. Indication of pre-aeration of test solutions
   - No pre-aeration

vi. Confirmation that no pH adjustment of sample or solution occurred
   - No pH adjustment

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

vii. Indication that EC guidance document for salinity adjustment was followed
- No deviations from EC guidance document on preparation of hypersaline brine
- HSB prepared from natural seawater at 90ppt
- No deviations from EC guidance document for salinity adjustment of sample
- Salinity adjustment: 642mL effluent + 258mL HSB + 9mL test nutrient solution
- Salinity of samples adjusted from 5ppt to 30ppt

viii. Type and source of control/dilution water
- Natural seawater collected at the Pacific Environmental Center, Environment Canada, North Vancouver, BC
- Filtered to 0.2µm and autoclaved prior to use
- Salinity adjusted as per EC guidance document to 30ppt with HSB from the same source

ix. Concentrations and volumes of test solutions
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
- Salinity Control Brine (0%) - 100mL, 4.5cm depth
- 4.5% - 100mL, 4.5cm depth
- 8.9% - 100mL, 4.5cm depth
- 17.8% - 100mL, 4.5cm depth
- 35.6% - 100mL, 4.5cm depth
- 71.3% - 100mL, 4.5cm depth

x. Number of replicated per concentration
- 3 replicates per concentration

xi. Number of organisms per test chamber
- 5 female branches + 2 male branches per chamber

xii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use
- pH - 7.93, T - 23.5°C, DO - 9.4mg/L, salinity - 5ppt

xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample during test
- DO: 7.8 - 8.0 mg/L, pH: 7.74 - 8.98, T: 23°C, salinity: 30ppt

Results

i. Number and % mortality of female plants after recovery in each test solution
- Totals from all 3 replicates are presented:
- Control (0%): 0 (0%) mortality
- Salinity Control (0%): 0 (0%) mortality
- 4.5%: 0 (0%) mortality
- 8.9%: 0 (0%) mortality
- 17.8%: 0 (0%) mortality
- 35.6%: 0 (0%) mortality
- 71.3%: 0 (0%) mortality

ii. Mean number of cystocarps per plant in each test concentration
- Control (0%): 57.4; 49.6; 44.2
- Salinity Control (0%): 66.4; 44.0; 45.2
- 4.5%: 52.2; 51.4; 57.4
- 8.9%: 61.2; 63.6; 41.2
- 17.8%: 30.4; 34.4; 18.6
- 35.6%: 6.6; 6.0; 7.6
- 71.3%: 0.0; 2.4; 1.4

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

iii. Estimate of IC_{25} (95% CL) for cystocarp development
- IC_{25} concentration = 13.6 (9.0-16.0)% effluent v/v
- Quantal statistic method was linear interpolation

iv. Current reference toxicity tests (95% CL) for IC_{50} for cystocarp development
- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test conducted on July 29, 2003, within 30 days of effluent test
- Reference toxicant test was conducted under the same experimental conditions as the effluent test
- IC_{50} cystocarp development = 1.19mg/L SDS, 95% CL = 1.14-1.23mg/L

v. Reference toxicity warning limits (+/- 2SD) for IC_{50} for cystocarp development
- Reference toxicity tests for Toxicant: SDS
- 7-d IC_{50} growth = 1.47 (1.17-1.84) mg/L SDS

APPENDIX F

Effluent Metals Concentrations and Loadings

2003 3rd QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1]								pH[1]	Collection Method
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]		
07-Jul-03	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]
14-Jul-03	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]
21-Jul-03	25-Jul-03	*0.000*	0.001	*0.005*	0.008	0.001	0.048	*3.0*	*0.005*	7.77	Water Pump
28-Jul-03	30-Jul-03	*0.000*	0.001	*0.005*	0.003	0.001	0.063	*3.0*	*0.005*	7.84	Water Pump
04-Aug-03	05-Aug-03	*0.001*	0.001	*0.005*	0.001	0.001	0.089	*3.0*	*0.005*	7.85	Water Pump
11-Aug-03	12-Aug-03	*0.001*	0.001	*0.005*	0.001	0.003	0.151	*3.0*	*0.005*	7.94	Water Pump
18-Aug-03	19-Aug-03	*0.001*	0.001	*0.005*	0.000	0.003	0.146	8.0	*0.005*	8.1	Water Pump
25-Aug-03	26-Aug-03	*0.001*	0.001	*0.005*	0.001	0.003	0.160	*3.0*	*0.005*	7.96	Water Pump
01-Sep-03	02-Sep-03	*0.000*	0.001	*0.005*	0.003	0.003	0.150	10.0	*0.005*	8.06	Water Pump
08-Sep-03	09-Sep-03	*0.002*	0.001	*0.005*	0.001	0.003	0.158	11.0	0.010	7.94	Water Pump
15-Sep-03	16-Sep-03	*0.001*	0.001	-	0.000	0.004	0.186	5.0	*0.005*	7.96	Water Pump
22-Sep-03	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]
29-Sep-03	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]	na[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "na" refers to no effluent discharge to sample

Concentrations in red italics were set to the detection limit

MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[2]							
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
July/03	0.000	0.001	0.005	0.006	0.001	0.055	3.00	0.005
August/03	0.001	0.001	0.005	0.001	0.002	0.137	4.25	0.005
September/03	0.001	0.001	0.005	0.002	0.003	0.165	8.67	0.007

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note[2] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
07-Jul-03	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]
14-Jul-03	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]
21-Jul-03	25-Jul-03	0.004	0.044	0.181	0.286	0.046	1.730	108.4	180,615	36,123
28-Jul-03	30-Jul-03	0.026	0.037	0.321	0.205	0.074	4.015	192.7	321,225	64,245
04-Aug-03	05-Aug-03	0.038	0.052	0.384	0.064	0.110	6.843	230.2	383,590	76,718
11-Aug-03	12-Aug-03	0.089	0.081	0.443	0.110	0.227	13.388	266.0	443,310	88,662
18-Aug-03	19-Aug-03	0.097	0.094	0.484	0.045	0.257	14.141	774.9	484,295	96,859
25-Aug-03	26-Aug-03	0.113	0.102	0.566	0.129	0.295	18.100	339.4	565,610	113,122
01-Sep-03	02-Sep-03	0.021	0.094	0.525	0.350	0.288	15.762	1050.8	525,415	105,083
08-Sep-03	09-Sep-03	0.195	0.105	0.489	0.114	0.285	15.441	1075.0	977,270	97,727
15-Sep-03	16-Sep-03	0.080	0.079	-	0.037	0.291	14.817	398.3	398,305	79,661
22-Sep-03	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]
29-Sep-03	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]	na[3]

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note[2] - Flow Rate must be taken at the same time as samples are effluent qualtity samples are taken

Note [3] - "na" refers to no effluent discharge to sample

MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
July/03	0.45	1.25	7.78	7.62	1.85	89	4,667	7,778,520	351,288	1,555,704
August/03	2.61	2.55	14.55	2.69	6.89	407	12,480	14,545,239	656,882	2,909,048
September/03	2.96	2.77	15.21	5.01	8.64	460	25,241	19,009,900	659,099	2,824,710

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the month x days in month

APPENDIX G

Results of Effluent Characterization

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 15(1)(a)

Nine effluent samples were collected on a weekly basis during the 3rd Quarter of 2003 beginning on July 25, 2003 and ceasing on September 16, 2003. Three of the nine samples were "monthly" samples and analysed for a wider suite of elements, as per the guidance document. Monthly loadings of metals to Garrow Bay were calculated based on average weekly discharge volumes from Garrow Lake to Garrow Bay via the creek outflow.

No holding times were missed for any of the water chemistry of toxicity testing samples.

Water samples for acute and sublethal toxicity testing were collected using a pump system from about 20 m downstream of the dam on Garrow Lake, within the main flow of the creek. Acute Lethality Testing was conducted during three months (July, August, and September) during the quarter. There were no adverse effects observed for either the 96-hr Rainbow Trout toxicity test, or the 48-hr *Daphnia magna* toxicity test. LC_{50} values were >100% effluent for both species in all testing events.

Sublethal Toxicity Testing was conducted once during August 2003. As this is considered a marine discharge, marine species were used for sublethal testing following brine adjustment of the brackish effluent (as per test protocols). Testing for fish (7-d Topsmelt growth and survival) and invertebrates (Sand dollar) was conducted at EVS Environment Consultants, Vancouver, while algae (48-h *Champia*) testing was undertaken by the Saskatchewan Research Council, Saskatoon.

There were no effects observed in the Topsmelt Survival and Growth Test at 100% effluent v/v.

Sublethal effects were observed for the echinoid and algal tests and concentrations less than 100% effluent v/v. In the echinoid *(Dendraster excentricus)* fertilization test (EVS Consultants), the LOAEL was 4.6% v/v effluent, the IC_{25} was 3.8% v/v, and the IC_{50} was 13.0% v/v. In the *Champia parvula* sexual reproduction test (Saskatchewan Research Council) the LOAEL was 17.8% v/v effluent, the IC_{25} 13.6% v/v, and the IC_{50} was 18.8% v/v.

Zinc was the primary contaminant of potential concern (COPC) identified in mine effluent and is the only metal to consistently exceed BC Ambient Water Quality Guidelines (BC AWQG) in effluent. During the 9 week discharge period, effluent zinc concentration averaged 128 ± 49µg/L (range 48 – 186µg/L), which is well below the MMER effluent limit of 500µg/L. The BC AWQG is 10µg/L. On August 19, 2003, when the sublethal samples were collected, the concentration of Zn in the effluent was 146µg/L. Converting the echinoid test endpoints into Zn concentrations results in a Lowest Observed Adverse Effect Level (LOAEL) of 6.7µg/L Zinc, an IC_{25} of 5.5µg/L, and an IC_{50} of 19.0µg/L. Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC_{50} concentrations of 8.5-60µg/L (Dinnel et al. 1983). The concentration of zinc in the effluent that corresponds to the IC_{50} (i.e., 19.0µg/L) is within the effects range reported in reference *Dendraster* fertilization tests. Thus the echinoid test is quite sensitive to zinc, with the LOAEL being less than the BC AWQG concentration.

Endpoints for the *Champia* test in terms of zinc concentrations were 26.0µg/L Zn (LOAEL), 19.9µg/L (IC_{25}), and 27.4µg/L (IC_{50}). The reference IC_{25} endpoint for zinc in the *Champia* test performed in-house at SRC was 27µg/L (95% confidence limits 16-42µg/L). This reference concentration is very similar to zinc concentrations in the mine effluent at the toxicity endpoints observed in the *Champia* test. *Champia* also appears to be sensitive to zinc concentrations at or below the BC AWQG.

Given the similarity between zinc concentrations in the effluent samples and the effects concentrations of zinc in reference tests, it is likely that zinc is responsible for the sublethal effects observed in both the *Dendraster* and *Champia* tests.

Reference: Dinnel, P.A., Q.J. Stober, J.M. Link, M.W. Letourneau, W.E. Roberts, S.P. Felton, and R.E. Nakatan. 1983. Methodology and Validation of a Sperm Cell Toxicity Test for Testing Toxic Substances in Marine Waters. Final Report, FRI-UW-8306, Fisheries Research Inst., School of Fisheries, University of Washington, Seattle, WA :208. Source: EPA EcoTox database.

2003 POLARIS MINE MMER/EEM ANNUAL REPORT

Bruce J. Donald
Reclamation Manager

March 31, 2004

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – 2003 ANNUAL Metal Mining Effluent Regulations Summary Report

Please find attached a **revised** Polaris Mine annual MMER summary report as the original report submitted January 27, 2004 was not complete and contained errors. There were no non-compliant concentrations related to Schedule 4 limits and no non-compliant results of the acute lethality tests during the year.

The following is included in our revised 2003 Annual Submission:

1. Requirements under Schedule 6
   - Identification of Site, Owner, Location, etc.
   - Non-Compliance information
   - Table 1 – Monthly Mean Concentrations, pH Range and Volume of Effluent
   - Table 2 – Results of Acute Lethality Tests and Daphnia Magna Monitoring Tests

2. Requirements under Part 1 Section 8
   - Results of studies conducted under Part 1, Section 4 (Effluent Characterization)
   - Results of studies conducted under Part 1, Section 5 (Sublethal Toxicity Testing)
   - Part 1, Section 6 Required Frequency of Effluent Characterization
   - Results of studies conducted under Part 1, Section 7 (Water Quality Monitoring)

During 2003, Teck Cominco conducted only one series of sublethal effluent testing in error contrary to the requirements of Part 1, Section 6 of the MMER. The report contains a letter from our consultants explaining the error. Teck Cominco intends to comply with section of the regulations as part of our monitoring program planned for 2004 and 2005.

The monitoring data required to be reported in electronic format has been emailed to you along with an electronic copy of this report (emailed March 31, 2004).

Please note that the location of the final discharge point previously submitted had a typographical error which has been corrected in this report.

If you have any questions regarding the annual report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me at any time.

Yours truly,

Original signed by B. Donald
Bruce Donald

Attachments: Revised 2003 MMER Annual Report
cc: Walter Kuit (Teck Cominco Limited)
Joe Dahoy (Cascade Management)
Patrick Allard (Azimuth Consulting Group)

SCHEDULE 6

(Section 22)

SCHEDULE 6

(Section 22)

Mine Name : Polaris Mine

Mine Operator: Cominco Mining Partnership and Teck Cominco Ltd.

Mine Address: Box 188, Resolute, NU X0A 0B0

Telephone: (867) 253-2201 (Site Manager, Joe Dahoy)

E-mail: joe.dahoy@teckcominco.com

Location of Final Discharge Point:
Garrow Lake Siphons at 75^0 22' 32" N, 96^0 48' 37" W.

Reporting Period: January 1, 2003 to December 31, 2003

Date of Report: **Revised** March 31, 2003

Non-Compliance Information:

There were no non-compliant effluent discharges during 2003. All effluent sample results were within Schedule 4 limits.

There were no non-compliant acute lethality tests during 2003.

SCHEDULE 6

TABLE 1

MONTHLY MEAN CONCENTRATIONS, pH RANGE AND VOLUME OF EFFLUENT (1)(2)

MONTH	As (mg/L)	Cu (mg/L)	CN (mg/L)	Pb (mg/L)	Ni (mg/L)	Zn (mg/L)	TSS (mg/L)	Ra (Bq/L)	pH	Effluent Volume (m^3)
January	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
February	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
March	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
April	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
May	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
June	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
July	0.000	0.001	0.005	0.006	0.001	0.055	3.00	0.005	7.77 - 7.84	1,555,704
August	0.001	0.001	0.005	0.001	0.002	0.137	4.25	0.005	7.85 - 8.10	2,909,048
September	0.001	0.001	0.005	0.002	0.003	0.165	8.67	0.007	7.94 - 8.06	2,824,710
October	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
November	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]
December	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]	ND[1]

Note [1] - "ND" refers to any measurement not taken because there was no deposit from the final discharge point.

Note [2] - "NMR" refers to any measurement not taken because no measurement was required in accordance with the conditions set out in Section 13 of the regulations.

SCHEDULE 6
TABLE 2

RESULTS OF ACUTE LETHALITY TESTS AND DAPHNIA MAGNA MONITORING TESTS

DATE SAMPLE COLLECTED	EFFLUENT ACUTELY LETHAL TO RAINBOW TROUT (Yes or No)	EFFLUENT ACUTELY LETHAL TO DAPHNIA MAGNA (Yes or No)
30-Jul-03	No	No
20-Aug-03	No	No
16-Sep-03	No	No

REQUIREMENTS UNDER SECTION 4 OF PART 1

EFFLUENT CHARACTERIZATION

Monthly Sampling of Effluent in Garrow Creek for EEM

(Lat 75°22'32", Long 96°48'37")

	Conventional Water Chemistry and Water Quality Parameters									
Sample Date	Lab pH	Field pH	Field Temperature	Dissolved Oxygen	Hardness	Alkalinity	Ammonia	Cyanide	Nitrate	TSS
2003-07-29	7.84	7.69	0.30	10.53	459	46	0.08	*0.005*	0.102	*3*
2003-08-19	8.10	8.70	1.22	4.94	1130	103	0.03	*0.005*	0.225	8
2003-09-16	7.96	8.75	0.19	3.95	1540	122	0.04	NA	0.217	5

	Dissolved Metal Concentrations										
Sample Date	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Arsenic	Copper	Lead	Nickel	Zinc	Radium ^{226}
2003-07-29	*0.1*	0.00016	0.02	*0.00005*	*0.002*	*0.0004*	0.00057	0.00319	0.00115	0.0625	*0.005*
2003-08-19	*0.1*	0.00037	0.03	*0.00005*	*0.002*	*0.0010*	0.00097	0.00046	0.00265	0.1460	*0.005*
2003-09-16	*0.1*	0.00047	0.04	*0.00005*	*0.005*	*0.0010*	0.00099	0.00046	0.00365	0.1860	*0.005*

NA - Not Available (no sample).

Note[1] - All concentrations are in mg/L, except pH which is in pH units and temperature which is in °C

Concentrations in *red italics* were set to the detection limit.

POLARIS MINE ANNUAL MMER REPORT

REQUIREMENTS UNDER SECTION 5, PART 1

APPENDIX A

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPAW 95-EPA West Coast: 7-day Topsmelt Survival and Growth Test.

APPENDIX B

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPS 1/Rm/27-EC: 92 hr Echinoderm (sand dollar) Fertilization Test (Annual)

APPENDIX C

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPA/600/4-91-003, Method 1009.0: Algae (*Champia parvula*) 7-day Sublethal Growth Test (Annual).

APPENDIX A

7-d Topsmelt Growth and Survival Toxicity Test

Reporting Requirements for Reference Method EPA/600/R-95/136

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Test Organisms Imported from External Supplier

i. Species of test organism
   - Topsmelt (*Atherinops affinis*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Aquatic Bio Systems (ABS), Fort Collins, Colorado

iv. Date test species acquired on
   - August 21, 2003

v. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vi. Percent mortality of fish in 24-hour period preceding the test
   - <10% mortality

vii. Age at start of test
   - 10 days post-hatch

viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
   - Nothing unusual, no excessive crowding of larvae, larvae appear healthy, disease-free, stress free,

ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
   - Larvae actively feeding and swimbladders not inflated

x. Confirmation that temperature change was <3°C and dissolved oxygen was maintained at >6mg/L during transport
   - Temperature change was <2°C and dissolved oxygen supersaturated mg/L during transport

xi. Test organism acclimation rate at the testing laboratory
   - Holding water conditions upon arrival were DO=supersaturated, pH=7.3, T=22°C
   - Organisms were acclimated slowly overnight
   - Addition of EVS lab seawater at intervals of 30 – 60min to reach acceptable conditions
   - Organisms were acclimated to DO=8mg/L, salinity=28ppt,T=20°C

Reporting Requirements for Reference Method EPA/600/R-95/136

Test Facilities and Conditions

i. Test type & method
   - 7-day Topsmelt (*Atherinops affinis*) Survival and Growth Toxicity Test
   - Static renewal
   - Sample water was renewed daily
   - Reference Method - EPA/600/R-95/136 (EPAW 95-EPA West Coast)

ii. Indications of deviations from requirements in Sections 11 of Method EPA/600/R-95/136 (EPAW 95-EPA West Coast)
   - No deviations from requirements
   - Salinity controls were run
   - Sample water salinity was 5.3ppt

iii. Date and time for start of definitive test
   - Friday August 22, 2003 - 5:00 PM

iv. Test vessel description
   - 600mL beaker

v. Person(s) performing the test and verifying the results
   - Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang

vi. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - pH - 7.9, T - 20.0°C, DO - 11.0mg/L, C - 9570µmhos/cm, (salinity - 5.3 ppt)

vii. Confirmation that no adjustment of sample or solution pH occurred
   - No pH adjustment

viii. Indication of aeration of test solutions before introduction of fish
   - Pre-aeration at 6.5mL/min/L for 30mins due to supersaturation of sample with O_2 when sample was heated to 20°C
   - DO was reduced from 11.0mg/L to 7.8 mg/L

ix. Indication that EC guidance document for salinity adjustment was followed
   - No deviations from EC guidance document on preparation of hypersaline brine
   - HSB prepared from natural seawater concentrated to 90ppt (by freezing/refreezing to remove frozen layer and concentrate salts)
   - No deviations from EC guidance document for salinity adjustment of sample
   - HSB was added to samples to salinity adjust them from 5.3ppt to 30ppt

x. Type and source of control/dilution water
   - UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xi. Concentrations and volumes tested
   - Concentrations (% effluent volume / total volume) tested and total volumes used were:
   - Control (0%) - 200 mL
   - Salinity Control (0%) - 200 mL
   - 4.5% - 200mL
   - 9.0% - 200mL
   - 18.1% - 200mL
   - 36.2% - 200mL
   - 72.3% - 200mL

xii. Number of replicated per concentration
   - 5 replicates per concentration

xiii. Number of organisms added to each test vessel
   - 5 fish per vessel

xiv. Manner and rate of exchange of test solutions
   - Daily renewal

Reporting Requirements for Reference Method EPA/600/R-95/136

xv. Measurements of dissolved oxygen, pH and temperature
- DO: 6.6 - 7.8 mg/L, pH: 7.7 - 8.2, T: 19.0 - 20.0 °C, salinity: 29 - 31 ppt

Results

i. Number and % of mortalities of fish in each test solution
- Totals from all 5 replicates are presented:
- Control (0%) - 1/25 = 4%
- Salinity Control - 0/25 = 0%
- 4.5% - 0/25 = 0%
- 9.0% - 0/25 = 0%
- 18.1% - 0/25 = 0%
- 36.2% - 0/25 = 0%
- 72.3% - 1/25 = 4%

ii. Average dry weight per original fish in test vessel
- Means from all 5 replicates are presented:
- Control (0%) - 1.18 mg
- Salinity Control - 1.14 mg
- 4.5% - 1.13 mg
- 9.0% - 1.32 mg
- 18.1% - 1.09 mg
- 36.2% - 1.11 mg
- 72.3% - 1.14 mg

iii. Estimate of 7-d LC_{50} (95% CL)
- 7-d LC_{50} concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

iv. Estimate of 7-d IC_{25} (95% CL) for growth
- 7-d IC_{25} concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

v. Current reference toxicity tests (95% CL) for 7-d LC_{50} for survival and 7-d IC_{50} for growth
- Reference toxicity tests for Toxicant: Copper
- Test conducted on August 22, 2003, same day as effluent test
- Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
- 7-d LC_{50} survival = 122mg/L Cu, 95% CL = 111-135mg/L
- 7-d IC_{50} growth = 122mg/L Cu, 95% CL = 106-132mg/L

vi. Reference toxicity warning limits (+/- SD) for 7-d LC_{50} for survival and 7-d IC_{50} for growth
- Reference toxicity tests for Toxicant: Copper
- 7-d LC_{50} survival = 139 ± 63mg/L Cu,
- 7-d IC_{50} growth = 136 ± 52mg/L Cu

APPENDIX B

92-h Echinoderm Fertilization Test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

Test Organisms

i. Species of test organism
   - Sandollar Echinoid (*Dendraster excentricus*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - M-REP, Escondido, California
   - All adults providing gametes are from the same population and source
   - Gametes are spawned in-house at EVS

iv. Date test species acquired on
   - August 22, 2003

v. Holding time and conditions for adults
   - Adults received at the testing laboratory the day of the test, shipped overnight

vi. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vii. Weekly percent mortality of adults being held over 7d preceding test
   - <2% per day over the 7 days preceding the test

viii. Age of test organisms
   - < 4 hours after spawning

ix. Unusual appearance, behaviour, or treatment of adults or gametes before test start
   - Organisms appear healthy

Test Facilities and Conditions

i. Test type & method
   - Echinoderm (*Dendraster excentricus*) Fertilization Toxicity Test
   - Static
   - Reference Method – EPS/1/RM/27 with 1997 amendments

ii. Test duration
   - 10:10 min (10min sperm + 10min sperm & egg)

iii. Date and time for start of definitive test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Friday August 22, 2003 - 5:00 PM

iv. Test vessel description
- 16 x 125mm test tubes

v. Person(s) performing the test and verifying the results
- Kevin Goodearle, Julianna Kalocai, Sioe Lie Kwee, Rachel DeWynter, Edmund Canaria, and Armando Tang

vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
- No pre-aeration

vii. Confirmation that no adjustment of sample or solution pH occurred
- No pH adjustment

viii. Procedure for sample filtration
- No sample filtration

ix. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment

x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment
- Salinity adjusted from 5ppt to 29ppt

xi. Type and source of control/dilution water
- UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 10mL
- Salinity Control (0%) - 10mL
- 4.6% - 10mL
- 9.1% - 10mL
- 18.2% - 10mL
- 36.5% - 10mL
- 73.0% - 10mL

xiii. Number of replicated per concentration
- 4 replicates per treatment concentration

xiv. Number of organisms per container
- 2000 eggs per 10mL vessel

xv. Measurements of pH and dissolved oxygen in sample water before use
- pH - 8.3, DO - 8.4mg/L

xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
- pH - 7.9-8.4, T - 15.0-15.5°C, DO - 8.1-8.4mg/L, salinity - 29ppt

Results

i. Number and % of fertilized eggs in each test concentration
- (Number is equal to percent since totals were 100)
- Control (0%): #F = 51, 50, 52, 54 #UF = 49, 50, 49, 46
- Salinity Control: #F = 51, 52, 50, 51 #UF = 49, 48, 50, 49
- 4.6%: #F = 35, 40, 29, 45 #UF = 65, 60, 71, 55
- 9.1%: #F = 36, 28, 33, 25 #UF = 64, 72, 67, 75
- 18.2%: #F = 22, 24, 18, 20 #UF = 78, 78, 82, 80
- 36.5%: #F = 12, 8, 7, 10 #UF = 88, 92, 93, 90
- 73.0%: #F = 1, 0, 2, 0 #UF = 99, 100, 98, 100

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

ii. Estimate of IC_{25} (95% CL) for fertilization success
- IC_{25} concentration = 3.8 (1.1 - 7.2)% v/v effluent
- Quantal statistic method = log linear interpolation

iii. Current reference toxicity tests (95% CL) for IC_{50} for fertilization
- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test conducted on August 22, 2003, same day as effluent test
- Reference test conducted under same conditions
- IC_{50} for fertilization = 1.3mg/L SDS, 95% CL = 1.1-1.5mg/L

APPENDIX C

7-d Sublethal *Champia* (Algae) Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Wednesday August 20, 2003 - 12:30 AM

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 1 x 4L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee)

vii. Temperature of water upon receipt at lab
   - 13°C

Test Organisms

i. Species of test organism
   - Algae (*Champia parvula*)

ii. Name and city of testing laboratory
   - Saskatchewan Research Council [SRC], Saskatoon, SK

iii. Source of test species
   - Sexually mature male and female branches
   - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
   - Appear in good health
   - Females have trichogynes, males have sori with spermatia

Test Facilities and Conditions

i. Test type & method
   - *Champia parvula* sexual reproduction test
   - Static, non-renewal
   - 2-day exposure, followed by 5-7 day recovery period for cystocarp development
   - Reference Method - EPA/600/4-91/003, Method 1009.0

ii. Date and time for start of definitive test
   - Friday August 22, 2003 – 10:00 AM

iii. Test vessel description
   - 270mL transparent polystyrene cups with polystyrene lids

iv. Person(s) performing the test and verifying the results
   - Mary Moody

v. Indication of pre-aeration of test solutions
   - No pre-aeration

vi. Confirmation that no pH adjustment of sample or solution occurred
   - No pH adjustment

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

vii. Indication that EC guidance document for salinity adjustment was followed
- No deviations from EC guidance document on preparation of hypersaline brine
- HSB prepared from natural seawater at 90ppt
- No deviations from EC guidance document for salinity adjustment of sample
- Salinity adjustment: 642mL effluent + 258mL HSB + 9mL test nutrient solution
- Salinity of samples adjusted from 5ppt to 30ppt

viii. Type and source of control/dilution water
- Natural seawater collected at the Pacific Environmental Center, Environment Canada, North Vancouver, BC
- Filtered to 0.2µm and autoclaved prior to use
- Salinity adjusted as per EC guidance document to 30ppt with HSB from the same source

ix. Concentrations and volumes of test solutions
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
- Salinity Control Brine (0%) - 100mL, 4.5cm depth
- 4.5% - 100mL, 4.5cm depth
- 8.9% - 100mL, 4.5cm depth
- 17.8% - 100mL, 4.5cm depth
- 35.6% - 100mL, 4.5cm depth
- 71.3% - 100mL, 4.5cm depth

x. Number of replicated per concentration
- 3 replicates per concentration

xi. Number of organisms per test chamber
- 5 female branches + 2 male branches per chamber

xii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use
- pH - 7.93, T - 23.5°C, DO - 9.4mg/L, salinity - 5ppt

xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample during test
- DO: 7.8 - 8.0 mg/L, pH: 7.74 - 8.98, T: 23°C, salinity: 30ppt

Results

i. Number and % mortality of female plants after recovery in each test solution
- Totals from all 3 replicates are presented:
- Control (0%): 0 (0%) mortality
- Salinity Control (0%): 0 (0%) mortality
- 4.5%: 0 (0%) mortality
- 8.9%: 0 (0%) mortality
- 17.8%: 0 (0%) mortality
- 35.6%: 0 (0%) mortality
- 71.3%: 0 (0%) mortality

ii. Mean number of cystocarps per plant in each test concentration
- Control (0%): 57.4; 49.6; 44.2
- Salinity Control (0%): 66.4; 44.0; 45.2
- 4.5%: 52.2; 51.4; 57.4
- 8.9%: 61.2; 63.6; 41.2
- 17.8%: 30.4; 34.4; 18.6
- 35.6%: 6.6; 6.0; 7.6
- 71.3%: 0.0; 2.4; 1.4

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

iii. Estimate of IC_{25} (95% CL) for cystocarp development
- IC_{25} concentration = 13.6 (9.0-16.0)% effluent v/v
- Quantal statistic method was linear interpolation

iv. Current reference toxicity tests (95% CL) for IC_{50} for cystocarp development
- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test conducted on July 29, 2003, within 30 days of effluent test
- Reference toxicant test was conducted under the same experimental conditions as the effluent test
- IC_{50} cystocarp development = 1.19mg/L SDS, 95% CL = 1.14-1.23mg/L

v. Reference toxicity warning limits (+/- 2SD) for IC_{50} for cystocarp development
- Reference toxicity tests for Toxicant: SDS
- 7-d IC_{50} growth = 1.47 (1.17-1.84) mg/L SDS

REQUIREMENTS UNDER SECTION 6 OF PART 1

SUBLETHAL TOXICITY TESTING FREQUENCY

Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC V6K 2G8

Phone: 604-730-1220
Fax: 604-739-8511

Our File #: TC-03-03

March 18, 2004

Sidney F. Bruinsma
Enforcement/Emergencies Officer, Nunavut
Northern Division, Environmental Protection Branch
Environment Canada
Box 1870, Iqaluit
Nunavut X0A 0H0

Dear Mr. Bruinsma:

Re: Polaris Mine EEM – Missed Sublethal Toxicity Test Sampling Event

Further to our recent discussion, we are pleased to document the issues and circumstances surrounding the missed 2003 sampling event for sublethal toxicity testing (SLTT) of effluent at Teck Cominco's Polaris Mine.

First, Azimuth Consulting Group (Azimuth) takes full responsibility for the missed sampling event, which resulted from an oversight on our part. Our staff have considerable experience conducting environmental effects monitoring (EEM) programs under the Pulp and Paper Effluent Regulations (PPER), which have been in place for some years. We understand the importance of the SLTT as an EEM investigative tool and would not knowingly miss a sampling event. The oversight comes from our interpretation of the new Metal Mining Effluent Regulations (MMER) and how they apply to the Polaris Mine, which has a unique discharge situation (i.e., limited to approximately 60 days per calendar year). Under both the PPER and MMER, two sampling events are required for the SLTT. However, if the discharge period is less than 120 days, the PPER require only one sampling event. We mistakenly assumed that these terms would also apply to the MMER, which provide less detail pertaining to the requirements of this test than the PPER. This issue was compounded by the unique discharge characteristics and receiving environment of the Polaris Mine, which make the MMER more difficult to interpret and apply compared to mines discharging under more usual conditions.

We became aware of the missed SLTT event during a December 2003 workshop intended to present results of 2003 reconnaissance studies carried out at the mine and to seek feedback from the Technical Advisory Committee (TAP) on our proposed study design for the Polaris Mine. Following our presentation, Ms. Sandra Blenkinsopp pointed out that two sampling events were indeed required under MMER. She then indicated that Environment Canada would contact us to further discuss the implications of this matter.

We agree that the missed SLTT event is unfortunate and will ensure that this test is carried out twice during the 2004 and 2005 discharge periods.

Please do not hesitate to contact us if you have any questions or require further clarification.

Sincerely,

Azimuth Consulting Group Inc.

Patrick Allard, M.Sc., R.P.Bio.

cc: Randy Baker (Azimuth)
Bruce Donald (Teck Cominco)

REQUIREMENTS UNDER SECTION 7 OF PART 1

WATER QUALITY MONITORING

Monthly Sampling of Exposure Station in Garrow Bay at mouth of Garrow Creek

(Lat 75°22'15", Long 96°48'30")

	Conventional Water Chemistry and Water Quality Parameters									
Sample Date	Lab pH	Field pH	Field Temperature	Dissolved Oxygen	Hardness	Alkalinity	Ammonia	Cyanide	Nitrate	TSS
2003-07-29	7.86	7.75	0.47	10.29	456	46	0.04	*0.005*	0.098	4
2003-08-19	8.13	8.36	1.08	5.01	1120	104	0.03	*0.005*	0.229	8
2003-09-16	7.85	8.38	-0.76	5.45	3620	117	0.03	*0.005*	0.159	10

	Dissolved Metal Concentrations										
Sample Date	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Arsenic	Copper	Lead	Nickel	Zinc	Radium ^{226}
2003-07-29	*0.1*	0.00015	0.03	*0.00005*	*0.002*	*0.0004*	0.00080	0.00435	0.00121	0.0594	*0.005*
2003-08-19	*0.1*	0.00038	0.05	*0.00005*	*0.002*	*0.001*	0.00106	0.00108	0.00304	0.1490	*0.005*
2003-09-16	*0.1*	0.00024	0.03	*0.00005*	0.006	0.001	0.00059	0.00043	0.00169	0.0881	0.005

Note[1] - All concentrations are in mg/L, except pH which is in pH units, Radium ^{226} which is in Bq/L and temperature which is in °C

Concentrations in *red italics* were set to the detection limit.

Monthly Sampling of Reference Station in Garrow Bay (1 km NE of Exposure Station)

(Lat 75°22'40", Long 96°47'12")

	Conventional Water Chemistry and Water Quality Parameters									
Sample Date	Lab pH	Field pH	Field Temperature	Dissolved Oxygen	Hardness	Alkalinity	Ammonia	Cyanide	Nitrate	TSS
2003-07-29	7.67	7.13	-0.27	9.27	989	33	0.03	*0.005*	*0.005*	*3*
2003-08-19	7.87	8.32	0.18	5.50	5830	115	*0.02*	*0.005*	*0.005*	32
2003-09-16	7.78	8.35	-1.36	3.42	5930	113	0.08	*0.005*	*0.005*	9

	Dissolved Metal Concentrations										
Sample Date	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Arsenic	Copper	Lead	Nickel	Zinc	Radium ^{226}
2003-07-29	*0.1*	*0.00002*	0.01	*0.00005*	*0.002*	*0.0004*	0.00023	0.00032	0.00021	0.0010	*0.005*
2003-08-19	*0.1*	0.00003	*0.01*	*0.00005*	0.010	0.0020	0.00044	0.00021	0.00033	0.0007	*0.005*
2003-09-16	*0.1*	0.00003	0.02	*0.00005*	0.011	*0.0010*	0.00028	0.00052	0.00026	0.0011	*0.005*

Note[1] - All concentrations are in mg/L, except pH which is in pH units, Radium ^{226} which is in Bq/L and temperature which is in ^{o}C

Concentrations in *red italics* were set to the detection limit.

Insert 2003 Acute Toxicity Test Reports Here

October 2003

LABORATORY REPORT

Polaris Mine

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

September 2003

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

September 2003

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
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EVS Environment Consultants
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EVS Project No.

09-0302-54

September 2003

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GLOSSARY

Concentration-Response	The relationship between the test concentration and the response being measured.
CL	95% confidence limits around estimated value such as an LC50.
EC50	The concentration of a substance (toxicant, stimulant, etc.) that causes a specified effect, lethal or non-lethal, in 50% of the organisms tested in a laboratory bioassay of specified duration. The effect as well as the exposure-time must be specified (e.g., 96-h EC50 for loss of equilibrium).
Endpoint(s)	The variable(s) (i.e., time, reaction of the organisms, etc.) which indicate the termination of a test; also, the measurement(s) or value(s) derived, that characterize the results of the test (NOEC, LC50, IC*p*, etc.).
Ic*p*	A point estimate of the concentration of test material that causes a specified percentage impairment in a quantitative biological function. This measurement is used for any toxicological test which measures a change in rate, such as reproduction, growth, or respiration. (The term EC50 or median effective concentration is limited to quantal measurements, i.e., number of individuals which show a particular effect.)
LC50	The median lethal concentration; the concentration of material in water to which test organisms are exposed that is estimated to be lethal to 50% of the test organisms. The LC50 is usually expressed as a time-dependent value (e.g., 24-h or 96-h LC50; the concentration estimated to be lethal to 50% of the test organisms after 24 or 96 h of exposure).
Lowest Observed Effect Concentration (LOEC)	The lowest concentration of a material used in a toxicity test that has a statistically significant adverse effect on the exposed population of test organisms as compared with the controls.

Negative Control	Material (e.g., water) that is essentially free of contaminants and of any other characteristics that could adversely affect the test organism. It is used to assess the "background response" of the test organism to determine the acceptability of the test using predefined criteria.
No Observed Effect Concentration (NOEC)	The highest concentration of a material in a toxicity test that has no statistically significant adverse effect on the exposed population of test organisms as compared with the controls.
Reference Toxicant	A chemical of quantified toxicity to test organisms, used to gauge the fitness, health and sensitivity of a batch of test organisms, as well as to validate the test procedure.
v/v	Concentration, usually a percentage, of volume of effluent per volume of dilution water.

ACKNOWLEDGEMENTS

Toxicity testing was conducted by Keven Goodearle, Julianna Kalocai, Sioe Lie Kwee and Rachel DeWynter. Statistical analyses were perfomed by Sioe Lie Kwee and Julianna Kalocai. The report was written by Rachel DeWynter and reviewed by Edmund Canaria. Quality Assurance/Quality Control (QA/QC) review was conducted by Armando Tang.

EXECUTIVE SUMMARY

A mining effluent sample, identified as G-Creek, was received from Azimuth Consulting Group, Vancouver, BC for sublethal toxicity testing under the Environmental Effects Monitoring (EEM) program for Polaris Mine. The topsmelt (*Atherinops affinis*) growth and survival and the echinoid (*Dendraster excentricus*) fertilization toxicity tests were conducted by EVS Environment Consultants. The algal (*Champia parvula*) reproduction toxicity test was conducted by Saskatchewan Research Council, Saskatoon, SK. Results of the toxicity tests are summarized in Tables ES-1, ES-2 and ES-3.

Table ES-1 Summary of statistical endpoints measured in the 7-d Topsmelt (Atherinops affinis) survival and growth toxicity test

TEST ENDPOINT	SURVIVAL (% v/v)	GROWTH (% v/v)
NOEC	72.3	72.3
LOEC	>72.3	>72.3
LC50	>72.3	na
IC50	na	>72.3
IC25	na	>72.3

na – not applicable.

Table ES-2 Summary of statistical endpoints measured in the Echinoid (*Dendraster excentricus)* fertilization test

TEST ENDPOINT	PROPORTION FERTILIZED (% v/v)
NOEC	<4.6
LOEC	4.6
IC50 (95% CL)	13.0 (7.1 – 16.2)
IC25 (95% CL)	3.8 (1.1 – 7.2)

CL – Confidence Limits.

Table ES-3 Summary of statistical endpoints measured in the 48-h Algal (*Champia parvula)* reproduction toxicity test

TEST ENDPOINT	PROPORTION FERTILIEZED (% v/v)
NOEC	8.9
LOEC	17.8
IC50 (95% CL)	18.8 (13.8 – 25.3)
IC25 (95% CL)	13.6 (9.0 – 16.0)

CL – Confidence Limits.

1. INTRODUCTION

EVS Environment Consultants conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine. A sample, identified as G Creek, was collected from the Polaris Mine Site on August 20, 2003 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on August 22, 2003 and was stored in the dark at 4°C prior to test initiation. Testing was performed using the following toxicity tests:

- **7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test**
- **Echinoderm (*Dendraster excentricus*) fertilization toxicity test**
- **48-h Algal (*Champia parvula*) reproduction toxicity test**

This report describes the methods and results of the toxicity tests. The raw data and statistical analyses are provided in Appendices A – C and the chain-of-custody forms are provided in Appendix D.

2. METHODS

The data were analyzed for statistical endpoints using pooled negative and brine controls. Statistical analyses for all tests were conducted using the computer software program TOXCALC version 5.0.23 (Tidepool Scientific Software, 1994).

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The 7-d topsmelt (*Atherinops affinis)* survival and growth toxicity test was conducted in accordance with the US EPA (1995). The methods for this test are summarized in Table 1.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was performed according to the procedures described in Environment Canada (1992 with 1997 amendments). Methods for this test are summarized in Table 2.

2.3 48-H ALGAL (*CHAMPIA PARVULA*) REPRODUCTION TOXICITY TEST

The 48-h algal reproduction toxicity test with the marine red algae (*Champia parvula)* was conducted by Saskatchewan Research Council (SRC), Saskatoon, SK. The test was performed according to the procedures described in US EPA (1994). Methods for this test are summarized in Table 3.

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study was conducted following appropriate QA/QC methodology to ensure that valid and scientifically defensible data were generated. General QA/QC procedures include following standard operating procedures (SOPs) for handling samples and performing toxicity tests, use of appropriate control treatments, evaluation of organism sensitivity using reference toxicant tests, calibration and maintenance of equipment, and review of data by a member of the EVS QA/QC Committee.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.45µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 9.0, 18.1, 36.2, 72.3% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity adjusted
Control/dilution water	UV-sterilized and 0.45µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.6, 9.1, 18.2, 36.5, 73% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and conductivity daily; hardness and alkalinity at test initiation
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

Table 2. 48-h Algal (*Champia parvula*) reproduction toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	2-d exposure to test material followed by 5-7-d recovery for cystocarp development
Test chamber	250-mL Erlenmeyer flask
Test solution volume	100 mL
Number of replicate chambers per treatment	4
Number of organisms per test chamber	5 female branch tips and 2 male plants
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity adjustment
Control/dilution water	Autoclaved 0.2µm filtered natural sea water (with nutrient supplement), collected from PESC, North Vancouver, BC
Dilutions	4.5, 8.9, 17.8, 35.6, 71.3% (v/v)
Renewal of dilutions	None
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	23 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HBS]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Reduction in cystocarp production compared to controls
Test validity	≥ 80% mean control; ≥ 10 cystocarps per control plants
Reference protocol	US EPA (1994), EPA/600/4-91/003

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The highest concentration tested was 72% due to salinity adjustment. The test results are summarized in Table 4 and the raw statistical analyses are provided in Appendix A.

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). The mean survival in the negative control was 96%.

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The highest concentration tested was 73% due to salinity adjustment. The test results are summarized in Table 5 and the raw statistical analyses are provided in Appendix B.

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all the test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was <4.6 and LOEC was 4.6 %(v/v). The IC50 and IC25 (95% confidence limits) values were 13.0 (7.1 – 16.2) and 3.8 (1.1 – 7.2) %(v/v), respectively. Mean fertilization in the controls was 51.4%.

3.3 48-H ALGAL (*CHAMPIA PARVULA*) REPRODUCTION TOXICITY TEST

The highest concentration tested was 71% due to salinity adjustment. The test results are summarized in Table 6 and the raw statistical analyses are provided in Appendix C.

The *C. parvula* reproduction toxicity test showed adverse effects in the three highest sample concentrations (17.8, 35.6, 71.3% [v/v]) tested relative to the pooled controls ($p \leq 0.05$). The NOEC was 8.9 and LOEC was 17.8 %(v/v). The IC50 and IC25 (95% confidence limits) values were 18.8 (13.8 – 25.3) and 13.6 (9.0 – 16.0) %(v/v), respectively. Mean cystocarp reproduction in the controls was 51.3.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 4. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% v/v)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	96.0 ± 8.9	1.18 ± 0.19
Brine Control	100 ± 0.0	1.14 ± 0.20
Pooled	98.0 ± 6.3	1.16 ± 0.18
4.5	100 ± 0.0	1.13 ± 0.26
9	100 ± 0.0	1.32 ± 0.21
18.1	100 ± 0.0	1.09 ± 0.12
36.2	100 ± 0.0	1.11 ± 0.23
72.3	96.0 ± 8.9	1.14 ± 0.20
TEST ENDPOINT	**SURVIVAL (% v/v)**	**GROWTH (% v/v)**
NOEC	72.3	72.3
LOEC	>72.3	>72.3
LC50 (95% CL)	>72.3	na
IC50 (95% CL)	na	>72.3
IC25 (95% CL)	na	>72.3

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits; na – not applicable.

Table 5. Summary of results for the Echinoderm (*Dendraster excentricus*) fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	51.6 ± 1.7
Brine Control	51.0 ± 0.8
Pooled Control	51.3 ± 1.3
4.6	37.3 ± 6.8*
9.1	30.5 ± 4.9*
18.2	21.0 ± 2.6*
36.5	9.3 ± 2.2*
73.0	0.8 ± 1.0*

TEST ENDPOINT	PROPORTION FERTILIZED %(v/v)
NOEC	<4.6
LOEC	4.6
IC50 (95% CL)	13.0 (7.1 - 16.2)
IC25 (95% CL)	3.8 (1.1 - 7.2)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls based on statistical analysis or data observation.
SD – Standard Deviation; CL – Confidence Limits.

Table 6. Summay of results for the 48-h Algal (*Champia parvula)* reproduction toxicity test

TEST CONCENTRATION (% v/v)	NUMBER OF CYSTOCARPS (MEAN ± SD)
Negative Control	50.4 ± 8.4
Brine Control	51.9 ± 14.4
Pooled	51.1 ± 11.6
4.5	53.7 ± 8.6
8.9	55.3 ± 13.9
17.8	27.8 ± 12.6*
35.6	6.7 ± 2.7*
71.3	1.3 ± 2.2*
TEST ENDPOINT	**NUMBER OF CYSTOCARPS %(v/v)**
NOEC	8.9
LOEC	17.8
IC50 (95% CL)	18.8 (13.8 – 25.3)
IC25 (95% CL)	13.6 (9.0 – 16.0)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

US EPA. 1994. Short term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 2nd edition. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, OH. EPA/600/4-91/003/003. 400 pp.

US EPA. 1995. Short term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 2nd edition. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Office of Research and Development, Washington, DC. EPA/600/R-95/136. 563 pp.

Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX A

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client: Azimuth (Polaris Mine)
EVS Analysts: KMG, SLK.
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0300439
Test Initiation Date: 22-Aug-03

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-Creek →	→	→
Amount Received	1 x 20L	1x20L	2 x 20L
Date Collected	20 Aug 03 →	→	→
Date Received	22-Aug-03 →	→	→
Temperature (°C)	20.0	21.0	21.0
pH	7.9	7.9	7.8
DO (mg/L)	11.0 *① → ~~8.7~~ 7.8	11.0* ① → ~~8.8~~ 7.8	10.8 ① → 7.8
Conductivity (µmhos/cm)	9570	9580	9580
Salinity (ppt)	5.3	5.3	5.3
Ammonia (mg/L N)	–	–	–
Chlorine (mg/L Cl)	–	–	–
Other	–	–	–

DILUTION/CONTROL WATER (initial water quality)
Water Type: Sea H2O (Filtered & UV Ster.)
Temperature (°C): 20.0
pH: 7.8
Dissolved Oxygen (mg/L): 7.6
Salinity: 29

TEST SPECIES INFORMATION
Source: Aquatic Bio Systems (ABS)
Date Received: 21-Aug-03
Age (on Day 0): 10-d
Reference Toxicant: Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date: 22 Aug 03
7-d survival LC50: 122 (111 - 135) µg/L Cu
7-d growth IC50: 122 (106 - 132) µg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50: 139 ± 63 µg/L Cu; CV = 23%.
7-d growth IC50: ~~195 ± 53 µg/L Cu; CV = 19.1~~
136 ± 52/2 µg/L Cu CV = ~~20%~~ 19%.

TEST CONDITIONS
Temperature Range (°C): 19.0 - 20.0
pH Range: 7.7 - 8.2
Dissolved Oxygen Range (mg/L): 6.6 - 7.8
Salinity (ppt): 29 - 31
Photoperiod (L:D h): 16:8
Aeration Provided?: no
Other: –

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	72.3	>72.3	72.3		
Growth		72.3	>72.3		>72.3	>72.3

Other: * SUPERSATURATED DUE TO HEATING SAMPLE TO 20°C.
① AERATED @ 30 mins. & SAL. ADJUSTED.
Data Verified By: [signature] Date Verified: September 24, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0800439

Sample ID: G-Creek
Test Species/Batch: Topsmelt / 210803
Test Initiation Date/Time: 22-Aug-03 / 1700h
No. of Organisms/Volume: 5 / 200mL

Concentration (% v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
NEG. CTL	A	S1	5	5	5	5	5	5	5	
	B	S2	5	5	5	5	5	5	5	
	C	S3	4	4	4	4	4	4	4	
	D	S4	5	5	5	5	5	5	5	
	E	S5	5	5	5	5	5	5	5	
BRINE CTL.	A	S6	5	5	5	5	5	5	5	
	B	S7	5	5	5	5	5	5	5	
	C	S8	5	5	5	5	5	5	5	
	D	S9	5	5	5	5	5	5	5	
	E	S10	5	5	5	5	5	5	5	
4.5	A	S11	5	5	5	5	5	5	5	
	B	S12	5	5	5	5	5	5	5	
	C	S13	5	5	5	5	5	5	5	
	D	S14	5	5	5	5	5	5	5	
	E	S15	5	5	5	5	5	5	5	
9.0	A	S16	5	5	5	5	5	5	5	
	B	S17	5	5	5	5	5	5	5	
	C	S18	5	5	5	5	5	5	5	
	D	S19	5	5	5	5	5	5	5	
	E	S20	5	5	5	5	5	5	5	
Technician Initials		KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	

Sample Description: CLEAR / COLORLESS
Data Verified By: Lorraine Terry
Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Clarks M. Inc)
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0300439
Sample ID: G-CREEK
Test Species/Batch: Topsmelt / 210803
Test Initiation Date/Time: 22-Aug-03 / 1700h
No. of Organisms/Volume: 5 / 200mL

Concentration (%v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
18.1	A	S21	5	5	5	5	5	5	5	
	B	S22	5	5	5	5	5	5	5	
	C	S23	5	5	5	5	5	5	5	
	D	S24	5	5	5	5	5	5	5	
	E	S25	5	5	5	5	5	5	5	
36.2	A	S26	5	5	5	5	5	5	5	
	B	S27	5	5	5	5	5	5	5	
	C	S28	5	5	5	5	5	5	5	
	D	S29	5	5	5	5	5	5	5	
	E	S30	5	5	5	5	5	5	5	
72.3	A	S31	5	5	4	4	4	4	4	
	B	S32	5	5	5	5	5	5	5	
	C	S33	5	5	5	5	5	5	5	
	D	S34	5	5	5	5	5	5	5	
	E	S35	5	5	5	5	5	5	5	
	A									
	B									
	C									
	D									
	E									
Technician Initials		KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	

Sample Description: CLEAR/ODOURLESS
Data Verified By: Armando Tang
Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: AZIMUTH (RARIS MINE) | Sample ID: G-CREEK
EVS Project No.: 09-0302-54.01 | Test Initiation Date/Time: 22-AUG-03 / 1700h
EVS Work Order No.: 03C0439 | Source/Date Received: ABS / 21-AUG-03

Concentration (% v/v)	Temperature (°C)													
	0	1		2		3		4		5		6		7
NEG. CTL	20.0	20.0	19.0	20.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
BRINE CTL	19.0	20.0	19.0	20.0	19.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
4.5	20.0	20.0	19.0	19.5	19.0	19.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
9.0	20.0	19.5	19.0	19.5	19.0	19.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
18.1	19.5	19.5	19.0	19.5	19.0	19.5	20.0	19.5	20.0	19.5	20.0	20.0	20.0	20.0
36.2	19.0	19.5	19.0	19.0	19.0	19.0	20.0	19.5	20.0	19.5	20.0	19.5	20.0	20.0
72.3	19.0	19.0	19.0	19.0	19.0	19.0	20.0	19.0	20.0	19.0	20.0	19.0	20.0	20.0
Tech. Initials	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

Concentration (% v/v)	pH													
	0	1		2		3		4		5		6		7
NEG CTL.	7.8	7.9	7.7	8.0	7.8	8.0	7.8	7.8	7.7	8.0	7.8	7.9	7.8	7.8
BRINE CTL.	8.1	8.0	7.8	8.1	7.8	8.1	7.8	8.0	7.7	8.1	7.9	8.1	7.8	7.8
4.5	7.8	7.9	7.8	8.0	7.9	8.0	7.9	7.9	7.8	8.0	7.9	8.0	7.8	7.9
9.0	7.8	8.0	7.8	8.0	7.9	8.0	7.9	7.9	7.8	8.0	7.9	8.0	7.9	7.9
18.1	7.9	8.0	7.9	8.1	7.9	8.0	7.9	7.9	7.8	8.0	7.9	8.0	7.9	8.0
36.2	7.9	8.0	7.9	8.1	8.0	8.1	8.0	7.9	7.8	8.0	8.0	8.0	7.9	8.0
72.3	7.9	8.0	8.0	8.2	8.1	8.1	8.0	7.9	7.9	8.0	8.0	8.0	8.0	8.0
Tech. Initials	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

WQ Instruments Used: Temp. CALIB. Hg THERM. pH II-A-51
Comments

Test Set Up By: KMB | Data Verified By: Armando Tay | Date Verified: Sept 22/03

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: G-CEGEV
EVS Project No.: 09-0502-54.01 | Test Initiation Date/Time: 22-AUG-03/1700h
EVS Work Order No.: 03004139 | Source/Date Received: ABS / 21-AUG-03

Concentration (% v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
NEG. CTL	29	29	30	30	30	30	30	30
BRINE CTL	31	31	31	31	31	31	31	31
4.5	30	29	30	30	30	30	30	30
9.0	30	30	30	30	30	30	30	30
18.1	30	30	30	30	30	30	30	30
36.2	30	30	30	30	30	30	30	31
72.3	30	30	31	31	31	31	31	31
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

Concentration (% v/v)	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
NEG. CTL	7.6	7.6	6.7	7.7	7.0	7.6	7.0	7.5	7.0	7.6	7.0	7.6	6.8	7.0
BRINE CTL	7.8	7.6	6.6	7.6	6.9	7.6	7.0	7.6	7.0	7.6	6.9	7.5	6.9	6.9
4.5	7.6	7.6	6.8	7.7	6.8	7.7	7.0	7.6	6.8	7.6	6.8	7.5	6.8	6.8
9.0	7.6	7.7	6.9	7.7	6.9	7.7	7.0	7.6	6.8	7.6	6.9	7.6	6.9	6.8
18.1	7.7	7.7	7.0	7.7	7.0	7.7	7.0	7.7	6.8	7.7	6.9	7.6	6.8	7.0
36.2	7.8	7.7	7.0	7.8	6.8	7.8	6.9	7.7	6.9	7.7	6.8	7.6	6.8	7.0
72.3	7.8	7.8	6.9	7.8	6.8	7.8	6.8	7.8	6.9	7.8	6.7	7.8	6.7	6.9
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

WQ Instruments Used: Salinity II-A-030303 DO II-A-011202
Comments

Test Set Up By: KMG | Data Verified By: Armando Tan | Date Verified: Sept 22/03

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris Mine) | Start Date (Day 0): 22-AUG-03

EVS Project No.: 09-0302-54.01 | Sample ID: G-CREEK

EVS Work Order No.: 0300439 | Balance Type/Serial Number: SARTORIUS BP211D

Sample ID (% v/v)	Rep.	Pan No.	Pan Weight (mg)[1]	Final Weight (mg) (pan + biomass)[1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
NEG. CTL	A	S1	971.99	978.96	5	5		SLK
↓	B	S2	973.23	978.89	5	5		↓
	C	S3	969.63	~~975~~. 976.02	4	4		
	D	S4	974.21	980.08	5	5		
↓	E	S5	965.11	969.60	5	5		
BRINE CTL	A	S6	965.69	971.90	5	5	(971.64) - final wt	
↓	B	S7	964.96	969.08	5	5		
	C	S8	964.48	969.90	5	5		
	D	S9	967.55	971.06	5	3①	①technician error - two fish lost in transfer	
↓	E	S10	965.51	972.34	5	5	(965.46)	
4.5	A	S11	962.39	968.59	5	5		
↓	B	S12	965.47	970.37	5	5		
	C	S13	967.44	974.82	5	5		
	D	S14	965.60	971.51	5	5		
↓	E	S15	965.24	969.17	5	5		↓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Armando Tang | Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0300439
Start Date (Day 0): 02-Aug-03
Sample ID: G-Creek
Balance Type/Serial Number: Sartorius BP211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
9.0	A	S16	964.90	972.59	5	5	(972.22) - final wt	SK
↓	B	S17	977.31	984.55	5	5		↓
	C	S18	963.53	969.75	5	5		
	D	S19	962.80	969.65	5	5		
↓	E	S20	958.75	963.80	5	5	(958.77)	
18.1	A	S21	956.37	~~961~~. 962.12	5	5		
↓	B	S22	955.95	961.89	5	5		
	C	S23	959.07	963.46	5	5		
	D	S24	962.81	968.26	5	5		
↓	E	S25	955.07	960.68	5	5		
36.2	A	S26	954.05	960.80	5	5		
↓	B	S27	952.14	955.96	5	5		
	C	S28	950.65	955.84	5	5		
	D	S29	947.14	952.73	5	5	(952.48) - final wt	
↓	E	S30	953.75	960.04	5	5	(953.83)	↓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Armando Tang
Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Rogers Mine)
EVS Project No.: 69-0302-54/101
EVS Work Order No.: 0300439

Start Date (Day 0): 22-Aug-03
Sample ID: G-Creek
Balance Type/Serial Number: Sartorius BP211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
72.3	A	S31	952.19	957.14	*84	*84		SLH
↓	B	S32	955.93	962.33	5	5		↓
	C	S33	956.81	963.28	5	5		
	D	S34	958.93	963.29	5	5		
↓	E	S35	955.48	961.91	5	5	(955.51)	↓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: LT Armando Terry

Date Verified: September 22, 2003

Test: LF-Larval Fish Growth and Survival Test | Test ID: 0300439
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: G-Creek | Sample Type: EFF2-Industrial
Start Date: 8/22/2003 End Date: 8/29/2003 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	978.96	971.99
	2	2	D-Control	5							5	5	978.89	973.23
	3	3	D-Control	5							4	4	976.02	969.63
	4	4	D-Control	5							5	5	980.08	974.21
	5	5	D-Control	5							5	5	969.6	965.11
	6	1	Brine Control	5							5	5	971.9	965.69
	7	2	Brine Control	5							5	5	969.08	964.96
	8	3	Brine Control	5							5	5	969.9	964.48
	9	4	Brine Control	5							5	3	971.06	967.55
	10	5	Brine Control	5							5	5	972.34	965.51
	11	1	4.500	5							5	5	968.59	962.39
	12	2	4.500	5							5	5	970.37	965.47
	13	3	4.500	5							5	5	974.82	967.44
	14	4	4.500	5							5	5	971.51	965.6
	15	5	4.500	5							5	5	969.17	965.24
	16	1	9.000	5							5	5	972.59	964.9
	17	2	9.000	5							5	5	984.55	977.31
	18	3	9.000	5							5	5	969.75	963.53
	19	4	9.000	5							5	5	969.65	962.8
	20	5	9.000	5							5	5	963.8	958.75
	21	1	18.100	5							5	5	962.12	956.37
	22	2	18.100	5							5	5	961.89	955.95
	23	3	18.100	5							5	5	963.46	959.07
	24	4	18.100	5							5	5	968.26	962.81
	25	5	18.100	5							5	5	960.68	955.07
	26	1	36.200	5							5	5	960.8	954.05
	27	2	36.200	5							5	5	955.96	952.14
	28	3	36.200	5							5	5	955.84	950.65
	29	4	36.200	5							5	5	952.73	947.14
	30	5	36.200	5							5	5	960.04	953.75
	31	1	72.300	5							4	4	957.14	952.19
	32	2	72.300	5							5	5	962.33	955.93
	33	3	72.300	5							5	5	963.28	956.81
	34	4	72.300	5							5	5	963.29	958.93
	35	5	72.300	5							5	5	961.91	955.48

Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

Reviewed by: Sept 24/03

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/22/2003	Test ID:	300439	Sample ID:	G-CREEK-082003
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/20/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis

Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

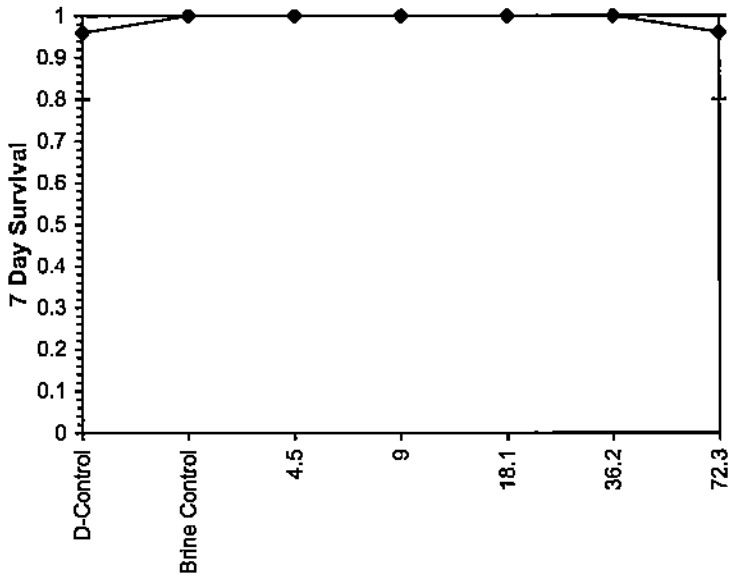
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	0.8000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
18.1	1.0000	1.0000	1.0000	1.0000	1.0000
36.2	1.0000	1.0000	1.0000	1.0000	1.0000
72.3	0.8000	1.0000	1.0000	1.0000	1.0000

			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5		
Brine Control	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5		
4.5	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	30.00	16.00
9	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	30.00	16.00
18.1	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	30.00	16.00
36.2	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	30.00	16.00
72.3	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	27.50	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.5466	0.9	-2.7369	8.25694
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 0.35)	1	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	72.3	>72.3		1.38313

Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: Sept 22/03

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/22/2003	Test ID: 300439	Sample ID: G-Creek
End Date:	8/29/2003	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	8/20/2003	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments:	Azimuth - Polaris Mine; 09-0302-54.01; 0300439		

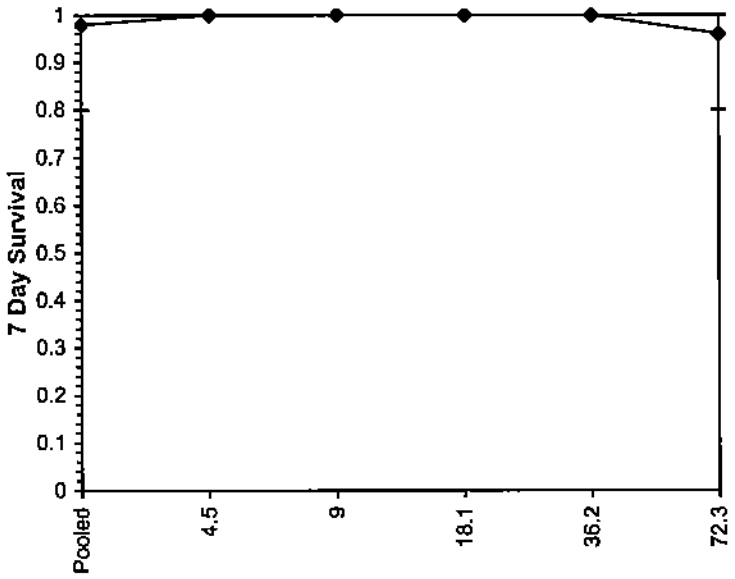
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	0.8000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
18.1	1.0000	1.0000	1.0000	1.0000	1.0000
36.2	1.0000	1.0000	1.0000	1.0000	1.0000
72.3	0.8000	1.0000	1.0000	1.0000	1.0000

			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	0.9800	0.0632	0.9800	0.8000	1.0000	6.454	10		
4.5	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	42.50	21.00
9	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	42.50	21.00
18.1	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	42.50	21.00
36.2	1.0000	0.0000	1.0000	1.0000	1.0000	0.000	5	42.50	21.00
72.3	0.9600	0.0894	0.9600	0.8000	1.0000	9.317	5	37.50	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.5116	0.91	-3.3481	11.7781
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 0.35)	1	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	72.3	>72.3		1.38313

Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: APT Sept 22/03

Larval Fish Growth and Survival Test-7 Day Growth (U.S.)

Start Date:	8/22/2003	Test ID:	300439	Sample ID:	G_Creek
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Ce	Sample Type:	EFF2-Industrial
Sample Date:	8/20/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris Mine; 09-0302-54.01; 0300439				

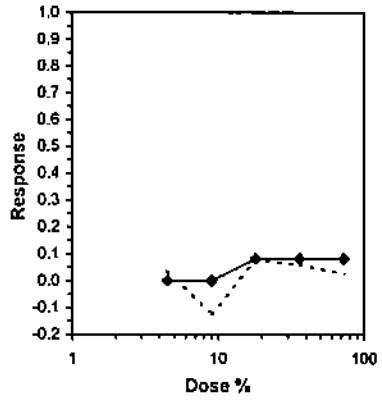
Conc-%	1	2	3	4	5
D-Control	1.3940	1.1320	1.2780	1.1740	0.8980
Brine Control	1.2420	0.8240	1.0840	1.1700	1.3660
4.5	1.2400	0.9800	1.4760	1.1820	0.7860
9	1.5380	1.4480	1.2440	1.3700	1.0100
18.1	1.1500	1.1880	0.8780	1.0900	1.1220
36.2	1.3500	0.7640	1.0380	1.1180	1.2580
72.3	0.9900	1.2600	1.2940	0.8720	1.2860

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	1.1752	0.1852	1.1752	0.8980	1.3940	15.756	5				1.2100	1.0000
Brine Control	1.1372	0.2033	1.1372	0.8240	1.3660	17.878	5					
4.5	1.1328	0.2624	1.1328	0.7860	1.4760	23.160	5	0.328	2.360	0.3051	1.2100	1.0000
9	1.3220	0.2051	1.3220	1.0100	1.5380	15.514	5	-1.135	2.360	0.3051	1.2100	1.0000
18.1	1.0856	0.1215	1.0856	0.8780	1.1880	11.194	5	0.693	2.360	0.3051	1.1119	0.9189
36.2	1.1056	0.2260	1.1056	0.7640	1.3500	20.445	5	0.538	2.360	0.3051	1.1119	0.9189
72.3	1.1444	0.1993	1.1444	0.8720	1.2940	17.414	5	0.238	2.360	0.3051	1.1119	0.9189

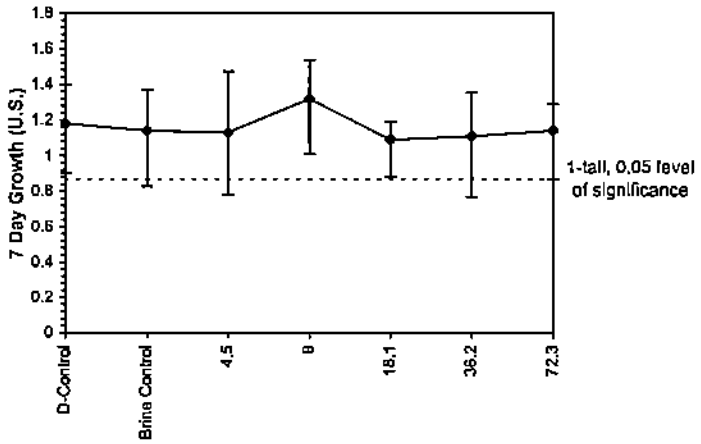
Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.94551		0.9		-0.441	-0.6308
Bartlett's Test indicates equal variances (p = 0.83)					2.12489		15.0863			
The control means are not significantly different (p = 0.77)					0.30899		2.30601			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	72.3	>72.3		1.38313	0.30514	0.25965	0.03595	0.04179	0.52181	5, 24

Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	13.903			
IC10	>72.3			
IC15	>72.3			
IC20	>72.3			
IC25	>72.3			
IC40	>72.3			
IC50	>72.3			



Dose-Response Plot



Reviewed by: Sept 24/03

Larval Fish Growth and Survival Test-7 Day Growth (U.S.)

Start Date:	8/22/2003	Test ID:	300439	Sample ID:	G_Creek
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Ce	Sample Type:	EFF2-Industrial
Sample Date:	8/20/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis

Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

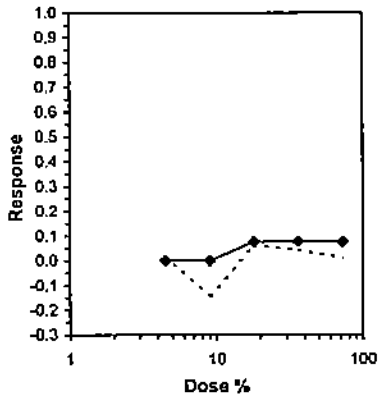
Conc-%	1	2	3	4	5
D-Control	1.3940	1.1320	1.2780	1.1740	0.8980
Brine Control	1.2420	0.8240	1.0840	1.1700	1.3660
4.5	1.2400	0.9800	1.4760	1.1820	0.7860
9	1.5380	1.4480	1.2440	1.3700	1.0100
18.1	1.1500	1.1880	0.8780	1.0900	1.1220
36.2	1.3500	0.7640	1.0380	1.1180	1.2580
72.3	0.9900	1.2800	1.2940	0.8720	1.2860

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	1.1562	0.1844	1.1562	0.8240	1.3940	15.950	10				1.2037	1.0000
4.5	1.1328	0.2624	1.1328	0.7860	1.4760	23.160	5	0.213	2.462	0.2711	1.2037	1.0000
9	1.3220	0.2051	1.3220	1.0100	1.5380	15.514	5	-1.506	2.462	0.2711	1.2037	1.0000
18.1	1.0856	0.1215	1.0856	0.8780	1.1880	11.194	5	0.641	2.462	0.2711	1.1119	0.9237
36.2	1.1056	0.2260	1.1056	0.7640	1.3500	20.445	5	0.460	2.462	0.2711	1.1119	0.9237
72.3	1.1444	0.1993	1.1444	0.8720	1.2940	17.414	5	0.107	2.462	0.2711	1.1119	0.9237

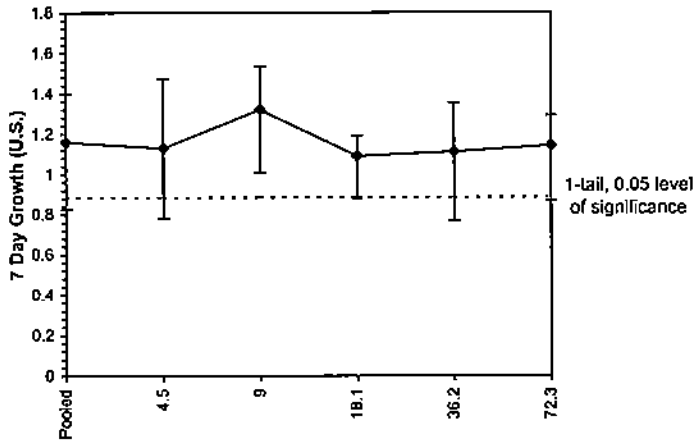
Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.94009		0.91		-0.4684	-0.6237
Bartlett's Test indicates equal variances (p = 0.82)					2.22379		15.0863			
The control means are not significantly different (p = 0.77)					0.30899		2.30601			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Bonferroni t Test	72.3	>72.3		1.38313	0.27109	0.23447	0.03571	0.04041	0.50456	5, 29

Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	14.284			
IC10	>72.3			
IC15	>72.3			
IC20	>72.3			
IC25	>72.3			
IC40	>72.3			
IC50	>72.3			



Dose-Response Plot



Reviewed by: KBT Sept 24/03

Randomization Chart

Client: Azimuth (Polaris Mine)
Project Number: 09-0302-54
Work Order Number:
Sample ID: Polaris Mine Sample

Date Generated: Aug 21/03

Test Vessel ID	Position
Neg. Control A	20
Neg. Control B	8
Neg. Control C	34
Neg. Control D	33
Neg. Control E	35
Brine Control A	30
Brine Control B	15
Brine Control C	10
Brine Control D	7
Brine Control E	25
Conc 1A	1
Conc 1B	12
Conc 1C	4
Conc 1D	11
Conc 1E	14
Conc 2A	29
Conc 2B	26
Conc 2C	24
Conc 2D	23
Conc 2E	19
Conc 3A	21
Conc 3B	27
Conc 3C	16
Conc 3D	32
Conc 3E	13
Conc 4A	22
Conc 4B	18
Conc 4C	28
Conc 4D	31
Conc 4E	3
Conc 5A	6
Conc 5B	2
Conc 5C	9
Conc 5D	17
Conc 5E	5

4.5%

9.0%

18.1%

36.2%

72.3%

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth (Polaris Mine) EVS Analysts KMG, SLK
EVS Project No. 09-0302-54
EVS Work Order No. 0300349 Test Initiation Date 22 Aug 03

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	Cu Reftox (03-Cu-001 100mg/L Cu)		
Amount ~~Received~~ Prepared (ASG)	1 X 1L		
Date ~~Collected~~ (ASG) Prepared	18-Apr-03		
Date Received	n/a		
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			

DILUTION/CONTROL WATER (initial water quality)
Water Type filtered, UV sterilized SW
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.6
Salinity 29

TEST CONDITIONS
Temperature Range (°C) 19.0-20.0
pH Range 7.7-8.0
Dissolved Oxygen Range (mg/L) 6.8-7.7
Salinity (ppt) 29-30
Photoperiod (L:D h) 16:8
Aeration Provided? no
Other -

TEST SPECIES INFORMATION
Source Aquatic Bio Systems
Date Received 21-Aug-03
Age (on Day 0) 10 days
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 22-Aug-03
7-d survival LC50 122 (110-135) ug/L Cu
7-d growth IC50 121 (106-134) ug/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 139 ± 63 ug/L Cu CV: 23%
7-d growth IC50 ~~135 ± 53 ug/L Cu CV: 19%~~ (ASG)
136 ± 54 (ASG) ug/L Cu CV: 20% (ASG)
19

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	ug/L Cu	100	320	122 (110-135)		
Growth		56	100		~~122~~ 121 (106-134)	96 (31-115)

Other

Data Verified By Leonard G Tong Date Verified September 24, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth -(Polaris Hire)
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0300439

Sample ID: Cw Reftox
Test Species/Batch: Topsmelt / 210803
Test Initiation Date/Time: 28-Aug-03 / 1730
No. of Organisms/Volume: 5 / 200mL

Concentration (µg/L)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
Neg Con	A	1	5	5	5	5	5	5	5	
	B	2	5	5	5	5	5	5	5	
	C	3	5	5	5	5	5	5	5	
	D	4	5	5	5	5	5	5	5	
	E	5	5	5	5	5	5	5	5	
32	A	6	5	5	5	5	5	5	5	
	B	7	5	5	5	5	5	5	5	
	C	8	5	5	5	5	5	5	5	
	D	9	5	5	5	5	5	5	5	
	E	10	5	5	5	5	5	5	5	
56	A	11	5	5	5	5	5	5	5	
	B	12	5	5	5	5	5	5	5	
	C	13	5	5	4	4	4	4	4	
	D	14	5	5	5	5	5	5	5	
	E	15	5	5	5	5	5	5	5	
100	A	16	5	4	3	3	3	3	3	
	B	17	5	5	5	5	5	5	5	
	C	18	4	4	4	4	4	4	4	
	D	19	5	5	5	5	5	5	5	
	E	20	5	4	4	4	4	4	4	
Technician Initials			KWB	KWB	KWB	KWB	KWB	KWB	KWB	

Sample Description: Reftox
Data Verified By: Armando Tong
Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth - (Polaris Mine)
EVS Project No.: DA-0302-SA.01
EVS Work Order No.: D300439

Sample ID: Cu REFTOX
Test Species/Batch: TOPSMELT / 210803
Test Initiation Date/Time: 22 AUG 03 / 1730
No. of Organisms/Volume: 5 / 200 mL

Concentration (ug/L)	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
180	A	21	4	0	1	0	—	—	—	
	B	22	2	0	—	—	—	—	—	
	C	23	3	3	2	2	2	1	0	
	D	24	4	2	1	1	1	0	—	
	E	25	4	1	0	—	—	—	—	
320	A	26	4	2	2	0	—	—	—	
	B	27	2	0	—	—	—	—	—	
	C	28	2	2	1	1	1	1	1	
	D	29	2	2	1	0	—	—	—	
	E	30	2	0	—	—	—	—	—	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials			KMB	KMB	KMB	KMB	KMB	KMB	KMB	

Sample Description: REFTOX
Data Verified By: Amanda Tang
Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: Cu Reftox

EVS Project No.: 09-0302-5A.01 | Test Initiation Date/Time: 22 Aug 03 / 1730

EVS Work Order No.: 0300439 | Source/Date Received: ABS / 21-Aug-03

Concentration (mg/L)	Temperature (°C)													
	0	1		2		3		4		5		6		7
Neg. Ctl	20.0	20.0	19.0	20.0	20 19.0	20.0	20.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0
32	20.0	20.0	19.0	20.0	19.0	20.0	20.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0
56	20.0	20.0	19.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
100	20.0	20.0	19.0	20.0	19.0	20.0	20.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0
180	20.0	20.0	19.0	20.0	19.0	20.0	20.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0
320	20.0	20.0	19.0	20.0	19.5	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

Concentration (mg/L)	pH													
	0	1		2		3		4		5		6		7
Neg. Ctl	7.9	7.9	7.8	8.0	7.8	8.0	7.8	7.8	7.7	8.0	7.9	7.9	7.8	7.9
32	7.8	7.9	7.8	8.0	7.9	8.0	7.9	7.8	7.8	8.0	7.9	7.9	7.8	7.9
56	7.8	7.9	7.8	8.0	7.9	8.0	7.9	7.8	7.7	8.0	7.9	7.9	7.8	7.9
100	7.8	7.9	7.8	8.0	7.9	8.0	7.9	7.8	7.8	8.0	7.9	7.9	7.8	7.9
180	7.8	7.9	7.8	8.0	7.9	8.0	7.9	7.8	7.8	8.0	7.9	7.9	7.9	8.0
320	7.7	7.9	7.8	8.0	7.9	8.0	7.9	7.8	7.8	7.9	8.0	7.9	7.9	7.9
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

WQ Instruments Used: Temp. CALIB. Hg THERM. pH IF-A-51

Comments

Test Set Up By: KMG | Data Verified By: Amanda Tse | Date Verified: Sept 22/03

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: Cu Reftox
EVS Project No.: 09-0302-54.01 | Test Initiation Date/Time: 22 Aug 03 / 1730
EVS Work Order No.: 0300439 | Source/Date Received: ABS / 21-AUG-03

Concentration (ug/L)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
NEG CTL	29	29	30	30	30	30	30	30
32	29	29	30	30	30	30	30	30
56	29	29	30	30	30	30	30	30
100	29	29	30	30	30	30	30	30
180	29	29	30	30	30	30	30	30
320	29	29	30	30	30	30	30	30
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

Concentration (ug/L)	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
NEG. CTL	7.6	7.6	7.0	7.7	6.9	7.6	7.1	7.5	6.9	7.6	7.1	7.6	7.0	7.0
32	7.6	7.6	7.1	7.7	7.0	7.6	7.2	7.5	7.1	7.6	7.1	7.6	6.9	7.1
56	7.6	7.6	6.9	7.7	6.9	7.6	7.0	7.5	6.9	7.6	6.9	7.6	6.8	6.9
100	7.6	7.6	6.9	7.7	6.8	7.6	7.1	7.5	6.8	7.6	7.0	7.6	6.9	7.0
180	7.6	7.6	6.9	7.7	7.0	7.6	7.1	7.5	7.0	7.6	7.0	7.6	7.0	7.2
320	7.6	7.6	7.0	7.7	7.1	7.6	7.3	7.5	7.2	7.6	7.1	7.6	7.1	7.4
Tech. Initials	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG	KMG

WQ Instruments Used: Salinity II-A-030303 DO II-A-011202
Comments

Test Set Up By: KMG | Data Verified By: [signature] | Date Verified: Sept 22/03

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris Mine) | Start Date (Day 0): 22-Sep-03

EVS Project No.: 09-0302-54.01 | Sample ID: Cu REFTOX

EVS Work Order No.: 0302439 | Balance Type/Serial Number: SARTORIUS BP211D

Sample ID (µg/L)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
NEG. CTL	A	Cu 1	966.95	973.10	5	5	(967.04)	SLH
↓	B	Cu 2	968.37	973.88	5	5		↓
↓	C	Cu 3	968.02	973.93	5	5		↓
↓	D	Cu 4	969.18	974.21	5	5		↓
↓	E	Cu 5	967.02	973.95	5	5	(973.38) - final wt	↓
32	A	Cu 6	966.49	972.69	5	5		↓
↓	B	Cu 7	966.70	973.20	5	5		↓
↓	C	Cu 8	961.94	967.28	5	5		↓
↓	D	Cu 9	964.95	968.65	5	5		↓
↓	E	Cu 10	958.75	965.33	5	5		↓
56	A	Cu 11	965.12	968.99	5	5		↓
↓	B	Cu 12	962.95	965.46	5	20	① technician error - 3 fish lost in transfer	↓
↓	C	Cu 13	963.87	968.41	4	4	(968.08) - final wt	↓
↓	D	Cu 14	962.59	~~966.~~ 967.09	5	5		↓
↓	E	Cu 15	963.64	970.28	5	5	(963.57)	↓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Rosemarie Tang | Date Verified: September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris Mine) | Start Date (Day 0): 22-AUG-03
EVS Project No.: 09-0302-54.01 | Sample ID: Cu REFTOX
EVS Work Order No.: 0300439 | Balance Type/Serial Number: SARTORIUS BP211D

Sample ID (ug/L)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
100	A	Cu16	964.86	968.51	3	3		SM
	B	Cu17	968.35	972.79	5	5		
	C	Cu18	968.22	974.29	4	4		
	D	Cu19	963.74	967.99	5	5		
	E	Cu20	962.19	965.62	4	4		
180	A	Cu21	964.45	–	0	0		
	B	Cu22	949.29	–	0	0		
	C	Cu23	951.08	–	0	0		
	D	Cu24	949.84	–	0	0		
	E	Cu25	953.15	–	0	0	(953.15)	
320	A	Cu26	952.02	–	0	0		
	B	Cu27	952.76	–	0	0		
	C	Cu28	950.55	951.43	1	1		
	D	Cu29	951.44	–	0	0		
	E	Cu30	958.97	–	0	0		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Armando Tay | Date Verified: September 22, 2003

Test: LF-Larval Fish Growth and Survival Test | Test ID: RTAACu26
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: REF-Ref Toxicant | Sample Type: CU-Copper
Start Date: 8/22/2003 End Date: 8/29/2003 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	973.10	966.95
	2	2	D-Control	5							5	5	973.88	968.37
	3	3	D-Control	5							5	5	973.93	968.02
	4	4	D-Control	5							5	5	974.21	969.18
	5	5	D-Control	5							5	5	973.95	967.02
	6	1	32	5							5	5	972.69	966.49
	7	2	32	5							5	5	973.20	966.70
	8	3	32	5							5	5	967.28	961.94
	9	4	32	5							5	5	968.65	964.95
	10	5	32	5							5	5	965.33	958.75
	11	1	56	5							5	5	968.99	965.12
	12	2	56	5							5	2	965.46	962.95
	13	3	56	5							4	4	968.41	963.87
	14	4	56	5							5	5	967.09	962.59
	15	5	56	5							5	5	970.28	963.64
	16	1	100	5							3	3	968.51	964.86
	17	2	100	5							5	5	972.79	968.35
	18	3	100	5							4	4	974.29	968.22
	19	4	100	5							5	5	967.99	963.74
	20	5	100	5							4	4	965.62	962.19
	21	1	180	5							0	0	0	0
	22	2	180	5							0	0	0	0
	23	3	180	5							0	0	0	0
	24	4	180	5							0	0	0	0
	25	5	180	5							0	0	0	0
	26	1	320	5							0	0	0	0
	27	2	320	5							0	0	0	0
	28	3	320	5							1	1	951.43	950.55
	29	4	320	5							0	0	0	0
	30	5	320	5							0	0	0	0

Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

Reviewed by: LFT Sept 22/03

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/22/2003	Test ID:	RTAACu28	Sample ID:	REF-Ref Toxicant
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Ct	Sample Type:	CU-Copper
Sample Date:	4/18/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis

Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

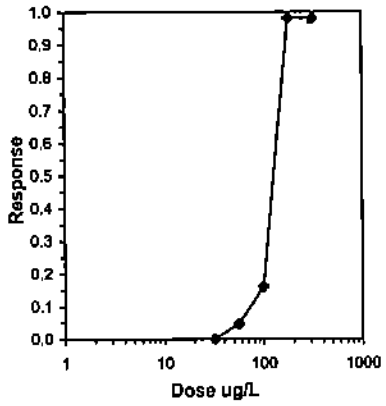
Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
32	1.0000	1.0000	1.0000	1.0000	1.0000
56	1.0000	1.0000	0.8000	1.0000	1.0000
100	0.6000	1.0000	0.8000	1.0000	0.8000
180	0.0000	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.2000	0.0000	0.0000

			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	17.00	0	25
56	0.9600	0.0894	1.2705	1.1071	1.3453	8.549	5	22.50	17.00	1	22
100	0.8400	0.1673	1.1582	0.8861	1.3453	16.679	5	20.00	17.00	4	25
180	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25
*320	0.0400	0.0894	0.2731	0.2255	0.4636	38.990	5	15.00	17.00	24	25

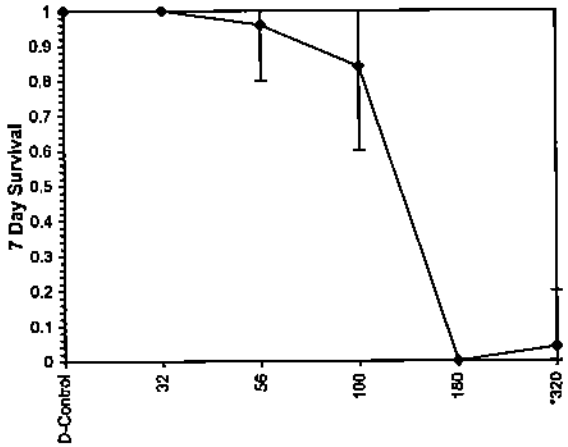
Auxiliary Tests				Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)				0.87628	0.888	-0.1865	1.91202
Equality of variance cannot be confirmed							
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**			
Steel's Many-One Rank Test	100	320	178.885				

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%			
5.0%	123.93	112.11	136.98
10.0%	126.36	112.06	142.47
20.0%	127.60	119.72	136.00
Auto-2.0%	121.76	109.89	134.92



Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: Sept 22/03

Larval Fish Growth and Survival Test-7 Day Growth (U.S.)

Start Date:	8/22/2003	Test ID:	RTAACu26	Sample ID:	REF-Ref Toxicant
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Ca	Sample Type:	CU-Copper
Sample Date:	4/18/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris Mine; 09-0302-54.01; 0300439				

Conc-ug/L	1	2	3	4	5
D-Control	1.2300	1.1020	1.1820	1.0060	1.3860
32	1.2400	1.3000	1.0680	0.7400	1.3160
56	0.7740	1.2550	0.9080	0.9000	1.3280
100	0.7300	0.8880	1.2140	0.8500	0.6860
180	0.0000	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.1760	0.0000	0.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	1.1812	0.1428	1.1812	1.0060	1.3860	12.089	5				1.1812	1.0000
32	1.1328	0.2408	1.1328	0.7400	1.3160	21.237	5	0.360	2.230	0.2998	1.1328	0.9590
56	1.0330	0.2433	1.0330	0.7740	1.3280	23.549	5	1.103	2.230	0.2998	1.0330	0.8745
*100	0.8736	0.2078	0.8736	0.6860	1.2140	23.788	5	2.290	2.230	0.2998	0.8736	0.7396
180	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0176	0.0149
320	0.0352	0.0787	0.0352	0.0000	0.1760	223.607	5				0.0176	0.0149

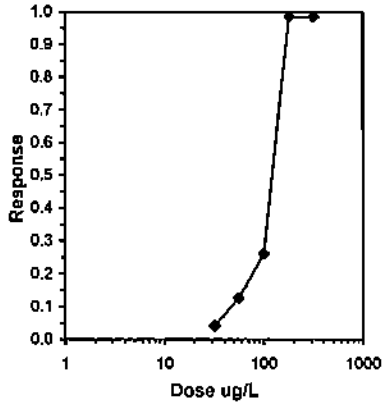
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97905	0.868	-0.0094	-0.5992
Bartlett's Test indicates equal variances (p = 0.76)	1.17038	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	56	100	74.8331		0.29959	0.25383	0.09228	0.04512	0.14806	3, 16

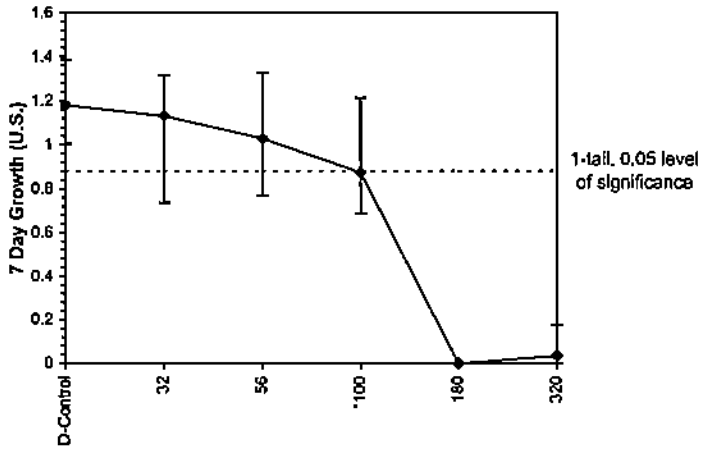
Log-Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew
IC05	33.98	19.83	0.00	77.24	0.0739
IC10	47.34	20.32	0.00	91.83	-0.0862
IC15	62.25	20.53	0.00	120.66	-0.0019
IC20	77.18	19.25	11.64	116.54	-0.0791
IC25	95.64	16.91	31.35	115.05	-0.4907
IC40	112.01	6.06	94.87	125.46	-0.5098
IC50	121.49	5.14	106.38	134.11	-0.0192

ug/L Cu



Dose-Response Plot



Reviewed by: KRT 9/23/03

Randomization Chart

Client: Azimuth (Polaris Mine)
Project Number: 09-0302-54
Work Order Number:
Sample ID: Cu Reftox

Date Generated: Aug 21/03

Test Vessel ID	Position
Control A	28
Control B	16
Control C	10
Control D	27
Control E	8
32 A	6
32 B	11
32 C	1
32 D	26
32 E	9
56 A	22
56 B	13
56 C	25
56 D	23
56 E	14
100 A	3
100 B	24
100 C	5
100 D	18
100 E	29
180 A	4
180 B	30
180 C	19
180 D	12
180 E	7
320 A	20
320 B	15
320 C	21
320 D	17
320 E	2

APPENDIX B

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group (Polaris) | EVS Analysts: JGk, RSD
EVS Project No.: 09-0302-54 | Test Initiation Date: August 22, 2003
EVS Work Order No.: 0300440

SAMPLE

Identification: G-Creek 082003
Amount Received: 5 x 20 L
Date Collected: August 20, 2003
Date Received: August 22, 2003
Temperature (°C): 15.0
pH: 8.2 ① → 8.3
Dissolved Oxygen (mg/L): 10.4 ① → 8.4
Conductivity (µmhos/cm): 9570
Salinity (ppt): 5 ① → 29
Ammonia (mg/L N): n/a
Chlorine (mg/L Cl): n/a
Other: ① After brine adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: M-REP
Date Received: August 22, 2003
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: August 22, 2003
IC50 (and 95% CL): 1.3 (1.1 - 1.5) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
Lab. mean cannot be generated yet due to insufficient data points.

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Sterilized, 0.45µ Filtered SW
Temperature (°C): 16.0
pH: 7.9
Dissolved Oxygen (mg/L): 8.1
Salinity (ppt): 29
Other: –

TEST CONDITIONS

Temperature Range (°C): 15.0 - 15.5
pH Range: 7.9 - 8.4
Dissolved Oxygen Range (mg/L): 8.1 - 8.4
Salinity Range (ppt): 29
Sperm:Egg Ratio: 1200 : 1
Test Duration: 10 : 10
Other: –

TEST RESULTS
IC 50: 13.0 (7.1 - 16.2) % (v/v)
IC 25: ~~< 4.6 % (v/v)~~ 3.8 (1.1 - 7.2) %(v/v)
NOEC: < 4.6 % (v/v)
LOEC: 4.6 % (v/v)

Data Verified By: Amedeo Tee | Date Verified: September 23, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: Azimuth Consulting Group (Polaris) Test Initiation Date/Time: Aug 22, 2003 / 1639h
EVS Project No.: 09-0302-54 Test Species: Dendraster excentricus
EVS Work Order No.: 0300440 Source/Date Received: M-REP / Aug 22, 2003
Logbook: #13 Pages: 43-48 Test Duration: 10:10

Sample ID G Creek	Conc/Rep v. v/v	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
	SW Ctl	15.5	7.9	29	8.1	
	Brine Ctl	15.0	8.4	29	8.3	
	4.6	15.5	8.0	29	8.2	
	9.1	15.5	8.0	29	8.2	
	18.2	15.5	8.1	29	8.2	
	36.5	15.0	8.1	29	8.2	
	73.0	15.0	8.3	29	8.4	
Tech. Init.		RSD	RSD	RSD	RSD	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II A 51 Salinity II A 030304 DO II A 011202
Data Verified By: Rennata Tang Date Verified: September 23, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimuth Consulting Group (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0300440
Logbook #13 Pages 43-48

Test Initiation Date/Time August 22, 2003 / 1639h
Test Species Dendraster excentricus
Source/Date Received M-REP / August 22, 2003
Test Duration 10:10
Sperm:Egg Ratio 1200:1

Sample ID	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
SW CONTROL	A	51	49		JGL
	B	50	50		↓
	C	52	49		↓
	D	54	46		↓
BRINE CONTROL	A	51	49		JGL
	B	52	48		↓
	C	50	50		↓
	D	51	49		↓
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Data Verified By Amanda Tang Date Verified September 18, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimuth Consulting Group (Polaris)
EVS Project No. 09-03020-54
EVS Work Order No. 0300440
Logbook # 13 Pages 43-48

Test Initiation Date/Time August 22, 2003/1639 h
Test Species Dendraster excentricus
Source/Date Received M-REP / August 22, 2003
Test Duration 10:10
Sperm:Egg Ratio 1200:1

G-Creek-082003

Sample ID % (v/v)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
4.6	A	35	65		JGL
	B	40	60		↓
	C	29	71		↓
	D	45	55		↓
9.1	A	36	64		JGL
	B	28	72		↓
	C	33	67		↓
	D	25	75		↓
18.2	A	22	78		JGL
	B	24	76		↓
	C	18	82		↓
	D	20	80		↓
36.5	A	12	88		JGL
	B	8	92		↓
	C	7	93		↓
	D	10	90		↓
73	A	1	99		JGL
	B	0	100		↓
	C	2	98		↓
	D	0	100		↓
	A				
	B				
	C				
	D				

Data Verified By Armando Tay Date Verified September 18, 2003

Test: SC-Sperm Cell Fertilization test						Test ID: 0300440	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: G CREEK 082003						Sample Type: EFF2-Industrial	
Start Date: 8/22/2003 16:39			End Date: 8/22/2003			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	51	49	
	2	2	D-Control	100	50	50	
	3	3	D-Control	101	52	49	
	4	4	D-Control	100	54	46	
	5	1	B-Control	100	51	49	
	6	2	B-Control	100	52	48	
	7	3	B-Control	100	50	50	
	8	4	B-Control	100	51	49	
	9	1	4.6	100	35	65	
	10	2	4.6	100	40	60	
	11	3	4.6	100	29	71	
	12	4	4.6	100	45	55	
	13	1	9.1	100	36	64	
	14	2	9.1	100	28	72	
	15	3	9.1	100	33	67	
	16	4	9.1	100	25	75	
	17	1	18.2	100	22	78	
	18	2	18.2	100	24	76	
	19	3	18.2	100	18	82	
	20	4	18.2	100	20	80	
	21	1	36.5	100	12	88	
	22	2	36.5	100	8	92	
	23	3	36.5	100	7	93	
	24	4	36.5	100	10	90	
	25	1	73.0	100	1	99	
	26	2	73.0	100	0	100	
	27	3	73.0	100	2	98	
	28	4	73.0	100	0	100	

Comments: Azimuth Consulting Group (Polaris), 09-0302-54 (0300440)

Reviewed by: 23/03

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/22/2003 16:39	Test ID:	300440
End Date:	8/22/2003	Lab ID:	BCEVS-EVS Environment Cc
Sample Date:	8/20/2003	Protocol:	EPS1/RM/27-EC 92 (Sperm (
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0300440)		

Sample ID:	G CREEK 082003			
Sample Type:	EFF2-Industrial			
Test Species:	DE-Dendraster excentricus			

Conc-%	1	2	3	4
D-Control	0.5100	0.5000	0.5149	0.5400
B-Control	0.5100	0.5200	0.5000	0.5100
4.6	0.3500	0.4000	0.2900	0.4500
9.1	0.3600	0.2800	0.3300	0.2500
18.2	0.2200	0.2400	0.1800	0.2000
36.5	0.1200	0.0800	0.0700	0.1000
73	0.0100	0.0000	0.0200	0.0000

			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.5162	0.0170	0.8016	0.7854	0.8254	2.126	4				0.5162	1.0000
B-Control	0.5100	0.0082	0.7854	0.7854	0.8054	1.027	4					
*4.6	0.3725	0.0685	0.6554	0.5687	0.7353	10.884	4	4.494	2.410	0.0784	0.3725	0.7216
*9.1	0.3050	0.0493	0.5842	0.5236	0.6435	9.201	4	6.685	2.410	0.0784	0.3050	0.5908
*18.2	0.2100	0.0258	0.4755	0.4381	0.5120	6.681	4	10.025	2.410	0.0784	0.2100	0.4068
*36.5	0.0925	0.0222	0.3075	0.2678	0.3537	12.384	4	15.190	2.410	0.0784	0.0925	0.1792
*73	0.0075	0.0096	0.0855	0.0500	0.1419	51.910	4	22.013	2.410	0.0784	0.0075	0.0145

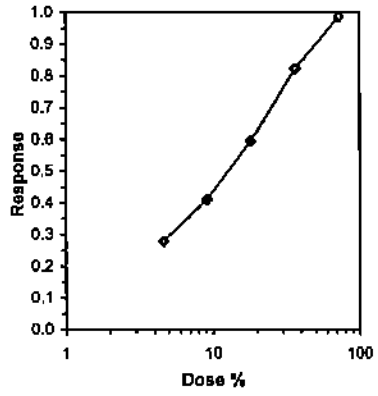
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98646	0.884	-0.0081	-0.3462
Bartlett's Test indicates equal variances (p = 0.38)	5.27856	15.0863		
The control means are not significantly different (p = 0.53)	0.65859	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<4.6	4.6			0.07823	0.15155	0.26425	0.00212	2.5E-13	5, 18

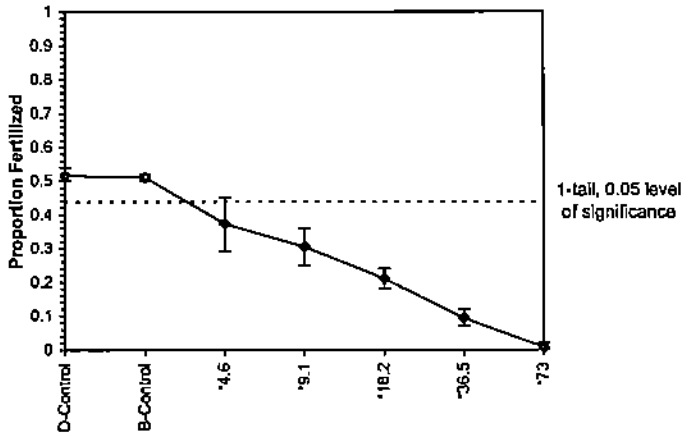
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.363	0.131	0.183	0.997	1.5175	
IC10*	0.857	0.397	0.388	2.838	1.8896	
IC15*	1.530	0.827	0.610	6.194	1.6379	
IC20*	2.447	1.132	0.844	6.914	0.6945	
IC25*	3.698	1.253	1.073	7.653	0.1137	
IC40	8.691	1.404	4.592	12.591	-0.5045	
IC50	12.869	1.264	7.929	16.074	-0.6649	%(v/v)

* Indicates IC estimate less than the lowest concentration



Dose-Response Plot



Statistical comparisons were against the D-Control only

Reviewed by: Sept 23/03

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/22/2003 16:39	Test ID:	300440	Sample ID:	G CREEK 082003
End Date:	8/22/2003	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/20/2003	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0300440)				

Conc-%	1	2	3	4
D-Control	0.5100	0.5000	0.5149	0.5400
B-Control	0.5100	0.5200	0.5000	0.5100
4.6	0.3500	0.4000	0.2800	0.4500
9.1	0.3600	0.2800	0.3300	0.2500
18.2	0.2200	0.2400	0.1800	0.2000
36.5	0.1200	0.0800	0.0700	0.1000
73	0.0100	0.0000	0.0200	0.0000

			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.5131	0.0128	0.7985	0.7854	0.8254	1.604	8				0.5131	1.0000
*4.6	0.3725	0.0685	0.6554	0.5687	0.7353	10.884	4	5.594	2.508	0.0642	0.3725	0.7260
*9.1	0.3050	0.0493	0.5842	0.5236	0.6435	9.201	4	8.381	2.508	0.0642	0.3050	0.5944
*18.2	0.2100	0.0258	0.4755	0.4381	0.5120	6.681	4	12.630	2.508	0.0642	0.2100	0.4093
*36.5	0.0925	0.0222	0.3075	0.2678	0.3537	12.384	4	19.199	2.508	0.0642	0.0925	0.1803
*73	0.0075	0.0096	0.0855	0.0500	0.1419	51.910	4	27.878	2.508	0.0642	0.0075	0.0146

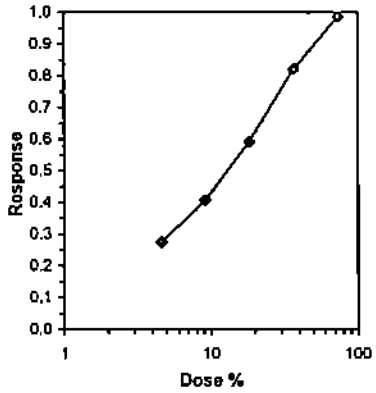
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.99124	0.896	-0.0039	0.07756
Bartlett's Test indicates equal variances (p = 0.03)	12.2117	15.0863		
The control means are not significantly different (p = 0.53)	0.65859	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	<4.6	4.6			0.06406	0.12485	0.33032	0.00174	2.6E-17	5, 22

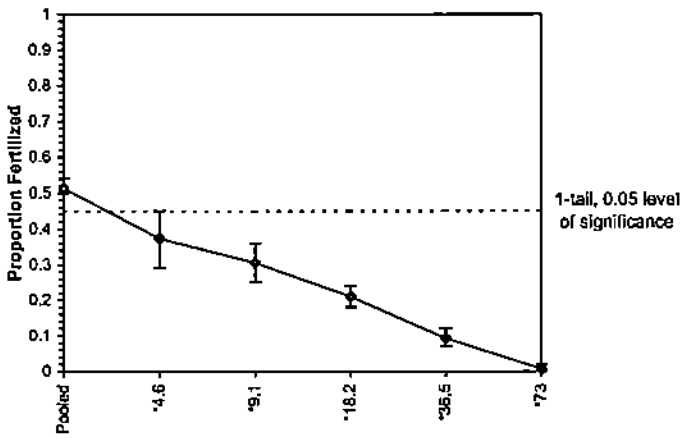
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.369	0.109	0.185	0.854	2.2609	
IC10*	0.675	0.329	0.392	2.349	2.8131	
IC15*	1.568	0.667	0.617	4.942	2.4566	
IC20*	2.516	0.939	0.851	6.599	1.1126	
IC25*	3.815	1.093	1.078	7.156	0.2793	
IC40	8.850	1.324	5.055	12.587	-0.2193	
IC50	13.015	1.334	7.060	16.168	-0.8087	%(v/v)

* Indicates IC estimate less than the lowest concentration



Dose-Response Plot



Pooled Controls were used for statistical comparisons

Reviewed by KF Sept 23/03

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Project No.: 09-0302-5&4
EVS Work Order No.: 0300440

EVS Analysts: JGL, RSD
Test Initiation Date: August 22, 2003

SAMPLE

Identification: SDS RefTox Stock Lot #03-5009
Amount ~~Received~~ Prepared: 1 x 1 L
Date ~~Collected~~ Prepared for: May 16, 2003
Date Received: n/a
Temperature (°C):
pH:
Dissolved Oxygen (mg/L):
Conductivity (µmhos/cm):
Salinity (ppt):
Ammonia (mg/L N):
Chlorine (mg/L Cl):
Other:

TEST SPECIES

Organism: Dendraster excentricus
Source: M-REP
Date Received: August 22, 2003
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: August 22, 2003
IC50 (and 95% CL): 1.3 (1.1-1.5) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
Lab. mean can not be generated yet due to insufficient data points

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Sterilized, 0.45µ Filtered SW
Temperature (°C): 16.0
pH: 7.9
Dissolved Oxygen (mg/L): 8.1
Salinity (ppt): 29
Other: –

TEST CONDITIONS

Temperature Range (°C): 15.5
pH Range: 7.9
Dissolved Oxygen Range (mg/L): 8.1
Salinity Range (ppt): 29
Sperm:Egg Ratio: 1200:1
Test Duration: 10:10
Other: –

TEST RESULTS

IC 50: 1.3 (1.1-1.5) mg/L SDS
IC 25: < 1 mg/L SDS
NOEC: < 1 mg/L SDS
LOEC: 1 mg/L SDS

Data Verified By: Rosemarie Tang
Date Verified: September 23, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0300440
Logbook # 13 Pages 43-48

Test Initiation Date/Time August 22, 2003/1639h
Test Species Dendraster excentricus
Source/Date Received M-REP / August 22, 2003
Test Duration 10:10

Sample ID SDS (mg/L)	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
	SW CONTROL	15.5	7.9	29	8.1	
	1.0	15.5	7.9	29	8.1	
	1.8	15.5	7.9	29	8.1	
	3.2	15.5	7.9	29	8.1	
	5.6	15.5	7.9	29	8.1	
	10	15.5	7.9	29	8.1	
Tech. Init.		RSD	RSD	RSD	RSD	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II A 51 Salinity II A 030304 DO II A 011202
Data Verified By Fernando Tovar Date Verified September 23, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client Azimuth Consulting Group
EVS Project No. 09-0302.54
EVS Work Order No. 0300440
Logbook # 13 Pages 43-48

Test Initiation Date/Time August 22, 2003 / 1639 G
Test Species Dendraster excentricus
Test Duration 10:10
Sperm:Egg Ratio 1200:1

Concentration (mg/L)	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant SDS					
1.0	A	38	62		JGL
	B	34	66		↓
	C	37	63		↓
	D	32	68		↓
1.8	A	20	80		JGL
	B	18	82		↓
	C	12	~~88~~ 88		↓
	D	21	79		↓
3.2	A	4	96		JGL
	B	5	95		↓
	C	5	95		↓
	D	6	94		↓
5.6	A	2	98		JGL
	B	1	99		↓
	C	2	98		↓
	D	0	100		↓
10	A	1	99		JGL
	B	0	100		↓
	C	0	100		↓
	D	1	99		↓
Control Seawater					
	A	51	49		JGL
	B	53	47		↓
	C	61	39		↓
	D	63	37		↓

Data Verified By Armando Tang Date Verified September 18, 2003

Test: SC-Sperm Cell Fertilization test						Test ID: rtscsds7	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: REF-Ref Toxicant						Sample Type: SDS-Sodium dodecyl sulfate	
Start Date: 8/22/2003 10:10			End Date: 8/22/2003			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	51	49	
	2	2	D-Control	100	53	47	
	3	3	D-Control	100	61	39	
	4	4	D-Control	100	63	37	
	5	1	1.000	100	38	62	
	6	2	1.000	100	34	66	
	7	3	1.000	100	37	63	
	8	4	1.000	100	32	68	
	9	1	1.800	100	20	80	
	10	2	1.800	100	18	82	
	11	3	1.800	100	12	88	
	12	4	1.800	100	21	79	
	13	1	3.200	100	4	96	
	14	2	3.200	100	5	95	
	15	3	3.200	100	5	95	
	16	4	3.200	100	6	94	
	17	1	5.600	100	2	98	
	18	2	5.600	100	1	99	
	19	3	5.600	100	2	98	
	20	4	5.600	100	0	100	
	21	1	10.000	100	1	99	
	22	2	10.000	100	0	100	
	23	3	10.000	100	0	100	
	24	4	10.000	100	1	99	

Comments: Azimuth Consulting Group 09-0302-54 (0300440)

Reviewed by: 18/03

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/22/2003 10:10	Test ID:	rlscsds7	Sample ID:	REF-Ref Toxicant
End Date:	8/22/2003	Lab ID:	BCEVS-EVS Environment Ce	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm t	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 09-0302-54 (0300440)				

Conc-mg/L	1	2	3	4
D-Control	0.5100	0.5300	0.6100	0.6300
1	0.3800	0.3400	0.3700	0.3200
1.8	0.2000	0.1800	0.1200	0.2100
3.2	0.0400	0.0500	0.0500	0.0600
5.6	0.0200	0.0100	0.0200	0.0000
10	0.0100	0.0000	0.0000	0.0100

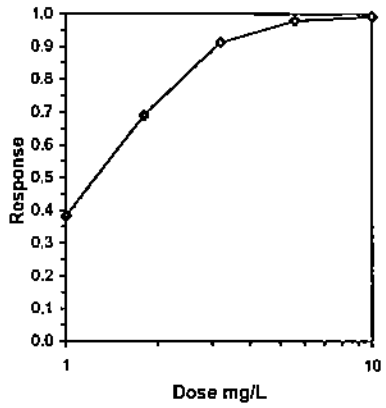
			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.5700	0.0589	0.8560	0.7954	0.9169	6.962	4				0.5700	1.0000
*1	0.3525	0.0275	0.6355	0.6013	0.6642	4.545	4	7.449	2.410	0.0714	0.3525	0.6184
*1.8	0.1775	0.0403	0.4329	0.3537	0.4760	12.722	4	14.291	2.410	0.0714	0.1775	0.3114
*3.2	0.0500	0.0082	0.2250	0.2014	0.2475	6.372	4	21.314	2.410	0.0714	0.0500	0.0877
*5.6	0.0125	0.0096	0.1085	0.0500	0.1419	40.246	4	25.248	2.410	0.0714	0.0125	0.0219
*10	0.0050	0.0058	0.0751	0.0500	0.1002	38.554	4	26.377	2.410	0.0714	0.0050	0.0088

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95469		0.884		-0.4898	-0.5931
Bartlett's Test indicates equal variances (p = 0.46)					4.62079		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	<1	1			0.07112	0.12468	0.38792	0.00175	1.7E-15	5, 18

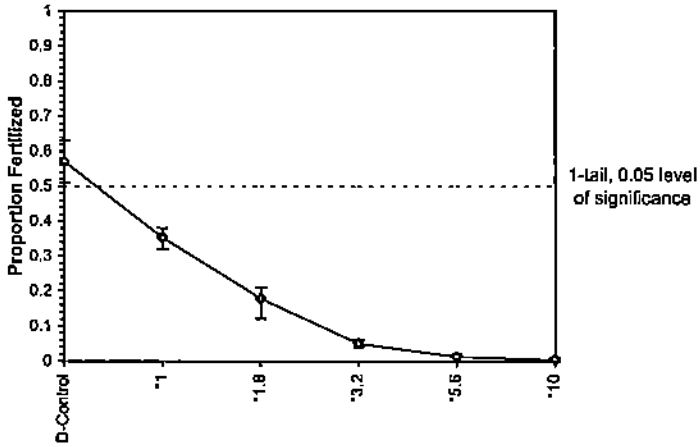
Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew	
IC05*	0.0951	0.0093	0.0737	0.1278	0.8048	
IC10*	0.1992	0.0205	0.1526	0.2715	0.8412	
IC15*	0.3132	0.0338	0.2372	0.4330	0.8781	
IC20*	0.4381	0.0496	0.3277	0.6147	0.9156	
IC25*	0.5748	0.0683	0.4247	0.8188	0.9537	
IC40	1.0408	0.0789	0.7747	1.2480	-0.3942	
IC50	1.2772	0.0706	1.0817	1.4972	-0.0664	mg/L SDS

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by: ART Sept 18/03

APPENDIX C

Raw Data and Statistical Analyses:

Champia parvula

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Champia parvula Sexual Reproduction Test Quality Assurance Summary

Client	EVS	SRC Sample #	P359
File #	MM478	Test Initiation Date	Aug 22/03
Analyst	M. Moody	Test Completion Date	Aug 29/03
Sample Identity/Name	Teck Cominco/Azimuth Consulting Group, Polaris effluent water		

This report is based on the Report Assessment Checklist for EEM Cycle Two: Test of Sexual Reproduction using the Red Macroalga *Champia parvula*. (May 1999)

Test Organisms, Method and Conditions - Species: *Champia parvula*, sexually mature male and female branches, in good health, males having sori with spermatia, females having trichogynes. Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day effluent exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Exposure/Dilution Medium: natural seawater collected at Pacific Environmental Science Centre, Environment Canada, North Vancouver, B.C., filtered to 0.2μm and autoclaved before use, adjusted as necessary to salinity 30 ppt. with hypersaline brine made from the same source water. Test medium is natural seawater enriched with 10 ml/L Test Nutrient Solution. Recovery Medium is natural seawater as above, enriched with 10 ml/L Culture Nutrient Solution (method section 16.10.1.3).

Reference Toxicant Test - Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day toxicant exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Test conditions: performed under same experimental conditions as effluent sample. Compound: sodium dodecyl sulphate mg/L

Date of test: July 29/03	Historic value, warning limits ±2SD
IC_{50} (95 % CL) mg/L 1.19 (1.14 - 1.23)	1.47 (1.17 - 1.84)

Quality Control Data - There was no unusual appearance or treatment of test organisms before their use in the test. There was nothing unusual about the test, no deviation from the test method or problems encountered. No control mortality was observed in any control solution during observation periods. Sample was tested within 72 hours of collection. The mean number of cystocarps per plant counted in this test must be >10 to be acceptable. Data for this test is as follows.

natural seawater controls	50.4
brine controls	51.9
pooled control cystocarp count*	51.1

* this number used in calculation of IC values as required in EC guidance document on salinity adjustment, July 1997

Toxicity Test Results

IC_{25} (95 % CL) %v/v	13.6 (9.04 - 16.0)
Signature	M Moody
Date	Sep 2/03

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Test Data Summary

SAMPLE SRC# P359

Identification/Name: Teck Cominco/Azimuth Consulting Group, Polaris effluent water | Analyst: Mary Moody

Date/Time Received: Aug 22/03@10 am | Date Collected: Aug 19/03 | Temperature Upon Receipt (°C): 13

Test Initiation Date: Aug 22/03 | Test Completion Date: Aug 29/03

ORGANISM INFORMATION

Species: *Champia parvula* | Appearance/Health of *Champia*: excellent

Source: sexually mature male and female branches, obtained from USEPA, Hatfield Marine Science Center, Newport, Oregon, 1995

Females, Presence of Trichogynes: yes | Males, Presence of Sori with Spermatia: yes

TEST CONDITIONS

Test Method: USEPA/600/4-91/003, Method 1009.0 | Dilution water: Natural seawater from Pacific Environmental Science Centre, North Vancouver B.C.

Test Type: static, non-renewal; 2 day effluent exposure followed by 5-7 day recovery period in control medium for cystocarp development

Test Vessels (Exposure & Recovery): 270 ml transparent polystyrene cups, transparent polystyrene lids

Exposure Volume / Depth: 100 ml / 4.5 cm | Recovery Volume / Depth: 200 ml / 7.3 cm

Replicates/Conc.: 3 | No. of organisms (female/male): 5/2

Number and Concentrations of Test Solutions (%v/v): Controls: (two) natural sea water, brine
Tests: 71.3, 35.65, 17.83. 8.91, 4.46, 2.23, 1.11%

Chemicals added to control/dilution water: Test Nutrients as described in method cited at 10 ml/L, analytical grade

Sample Treatment

D.O. on unadjusted sample salinity adjustment (mg/L): 9.4 | D.O. after salinity adjustment (mg/L): 8.0

Aeration (duration/rate): none | Filtration: none | pH Adjustment: none

Salinity Adjustment*: 642 mL effluent + 258 mL hypersaline brine + 9 mL test nutrient solution

Hypersaline Brine for Salinity Adjustment*: Prepared from natural seawater, at 90 ppt salinity

** as per EC guidance document on salinity adjustment, May 2001*

Exposure Period (48 h) and Recovery Period (5-7 days)

Temperature, pH, D.O. and Salinity of test solutions and controls on following page

Photoperiod (L:D h): 16:8 | Agitation of tests and controls during exposure: gentle rotary shaking

Recovery Medium: natural sea water containing 10 ml/L Culture Nutrients (section 16.10.1.3 of cited method) | Aeration during recovery: gentle aeration supplied

TOXICITY TEST RESULTS

IC_{25} (%v/v) (95% CL): 13.56 (9.04 - 16.0) | IC_{50} (%v/v), (95% CL): 18.8 (13.8 - 25.3)

Mean control cystocarps/female (pooled natural sea water and brine controls): 51.1

Submitted By: M Moody | **Date:** Sep 2/03

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Water Quality Data

Sample Identification/Name: Teck Cominco/Azimuth Consulting Group, Polaris effluent water — SRC# P359

INITIAL WATER QUALITY	UNADJUSTED SAMPLE at test start, without salinity adjustment	TEST MEDIUM	RECOVERY MEDIUM
Temperature (°C)	23.5	23	23
Dissolved Oxygen (mg/L)	9.4	8.0	7.9
pH	7.93	8.41	8.39
Salinity (ppt):	5	30	30

Sample Description: clear colourless liquid — Length of Recovery Period (days): 5

Water Quality Data during Exposure Period (0, 48 hr) and Recovery Period (0 and end)

Concentration % (v/v)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Salinity (ppt)			
	exposure		recovery		exposure		recovery		exposure		recovery		exposure		recovery	
	0	48	0	end	0	48	0	end	0	48	0	end	0	48	0	end
Control-NSW*	23	23	23	23	8.0	7.9	8.0	7.9	8.41	8.25	8.39	8.90	30	30	30	30
Control-brine	23	23	23	23	7.8	7.9	8.0	7.9	7.74	8.79	8.39	8.73	30	30	30	30
A 71.3	23	23	23	23	8.0	7.9	8.0	7.9	7.81	8.79	8.39	8.81	30	30	30	30
C 17.8	23	23	23	23	8.0	7.9	8.0	7.9	8.27	8.32	8.39	8.75	30	30	30	30
G 1.11	23	23	23	23	8.0	7.9	8.0	7.9	8.41	8.98	8.39	8.75	30	30	30	30

RECOVERY PERIOD - TEMPERATURE MONITORING (initial daily entries)

Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
23	23	23	23	23	23		

Comments

*NSW natural sea water

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Test Data

Sample Identification: Teck Cominco/Azimuth Consulting Group, Polaris effluent water — P359

Concentration % (v/v) #		Rep	Mortality #	Mortality %	Individual Plant Cystocarp Counts 1	2	3	4	5	mean	SD*	Comments
Control, Natural Sea Water		A	0	0	60	62	69	45	51	57.4	9.4	Mean and SD 50.4, 8.4 Healthy red colour, normal growth
		B	0	0	55	48	50	43	52	49.6	4.5	
		C	0	0	42	37	49	50	43	44.2	5.4	
Control, brine		A	0	0	62	63	70	80	57	66.4	8.9	Mean and SD 51.9, 11.6 Healthy red colour, normal growth
		B	0	0	57	38	47	34	44	44.0	8.9	
		C	0	0	31	59	32	48	56	45.2	13.1	
G	1.11		0	0	not counted							
F	2.23		0	0	not counted							
E	6.25	A	0	0	38	48	58	66	51	52.2	10.5	Mean and SD 53.7, 8.6 Healthy red colour, normal growth
		B	0	0	48	50	53	46	60	51.4	5.5	
		C	0	0	66	44	52	67	58	57.4	9.7	
D	12.5	A	0	0	77	73	43	63	50	61.2	14.6	Mean and SD 55.3, 13.9 Healthy red colour, normal growth
		B	0	0	63	71	67	54	63	63.6	6.3	
		C	0	0	32	38	41	49	46	41.2	6.7	
C	25	A	0	0	22	49	36	24	21	30.4	12.0	Mean and SD 27.8, 12.6 Healthy red colour, normal growth
		B	0	0	28	59	31	23	31	34.4	14.1	
		C	0	0	18	8	19	25	23	18.6	6.6	
B	50	A	0	0	7	2	12	6	6	6.6	3.6	Mean and SD 6.7, 2.7 Healthy red colour, normal growth
		B	0	0	11	7	3	4	5	6.0	3.2	
		C	0	0	7	8	9	6	8	7.6	1.1	
A	100	A	0	0	0	0	0	0	0	0.0	0.0	Mean and SD 1.3, 2.2 Healthy red colour, normal growth
		B	0	0	7	0	0	5	0	2.4	3.4	
		C	0	0	0	2	1	3	1	1.4	1.1	

* Standard Deviation

Submitted by: M Mody Date: Sept/03

Algal Reproduction Test-Reproduction

Start Date:	8/22/2003	Test ID:	CP478FJ	Sample ID:	P359
End Date:	8/29/2003	Lab ID:	SRC-Saskatchewan Researc	Sample Type:	MIN-Mining Effluent
Sample Date:	8/19/2003	Protocol:	-EPA MARINE	Test Species:	CP-Champia parvula
Comments:	Teck Cominco/Azimuth Consulting Group, Polaris effluent water				

Conc-%	1	2	3	4	5	6
NSW Control	57.4	49.6	44.2			
Brine Control	66.4	44.0	45.2			
4.46	52.2	51.4	57.4			
8.91	61.2	63.6	41.2			
17.83	30.4	34.4	18.6			
35.65	6.6	6.0	7.6			
71.3	0.0	2.4	1.4			

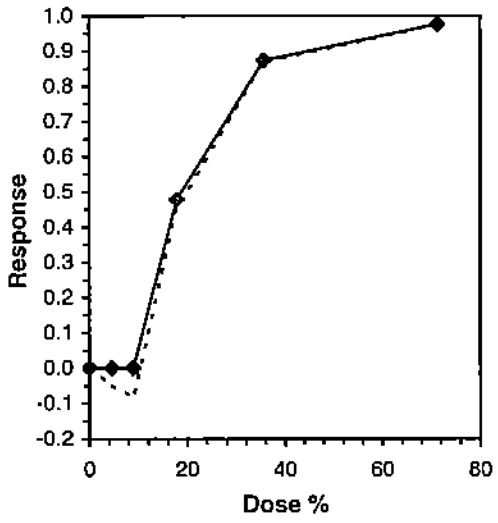
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Controls	51.133	1.0000	51.133	44.000	66.400	17.685	6				53.378	1.0000
4.46	53.667	1.0495	53.667	51.400	57.400	6.070	3	-0.470	2.602	14.029	53.378	1.0000
8.91	55.333	1.0821	55.333	41.200	63.600	22.226	3	-0.779	2.602	14.029	53.378	1.0000
*17.83	27.800	0.5437	27.800	18.600	34.400	29.549	3	4.329	2.602	14.029	27.800	0.5208
*35.65	6.733	0.1317	6.733	6.000	7.600	12.004	3	8.237	2.602	14.029	6.733	0.1261
*71.3	1.267	0.0248	1.267	0.000	2.400	95.174	3	9.251	2.602	14.029	1.267	0.0237

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98043	0.873	0.07731	0.65432
Bartlett's Test indicates equal variances (p = 0.02)	13.4704	15.0863		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test Treatments vs Controls	8.91	17.83	12.6042	11.2233	14.029	0.27436	1962.38	58.1173	1.2E-07	5, 15

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	9.841	1.772	0.203	10.332	-1.8660
IC10	10.771	1.255	4.031	11.755	-1.9311
IC15	11.702	1.089	5.692	13.177	-1.5175
IC20	12.633	1.062	7.509	14.600	-1.0509
IC25	13.564	1.061	9.040	16.022	-0.5321
IC40	16.356	1.364	12.837	21.148	0.5910
IC50	18.770	2.099	13.842	25.262	0.4212



Reviewed by:

APPENDIX D

Chain-of-Custody Forms

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-988-4331
Fax: 604-662-8548
www.evsenvironment.com

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

Client Name: Azimuth Client Contact Name: Randy Baker Ship to: EVS

Address: Phone:

Fax: Shipping Date: 20 Aug 03

Sampled By: Attn: Meg Hughes

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: 96h RBT LC50	48h Daphnia LC50	7d Topsmelt	Echinoderm SCP			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)
For composite sample record date & time starting and ending														
20Aug03	0030	G-Creek-082003	E	-	G	5x20L	CC	✓	✓	✓	✓			

PO/Reference No.: Comments/Instructions:

Project Title:

Results Needed By:

A) Released By: Date:
Company: Time:
Courier name:
Shipping containers secured by: Tape Straps Lock Other (circle one)
Custody seals used? Yes No

B) Received by: RJW Date: 22Aug03
Company: EVS Time: 0930
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

C) Released By: Date:
Company: Time:
Courier name:
Shipping containers secured by: Tape Straps Lock Other (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies:
White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

2004 POLARIS MINE MMER 3RD QUARTER REPORT

2004 POLARIS MINE MMER/EEM ANNUAL REPORT

Bruce J. Donald
Reclamation Manager

September 28, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Jenny Ferone, Regional EEM Coordinator
Peter Blackall, Regional Director of Environmental Protection

Dear Jenny Ferone and Peter Blackall;

Re: REVISED Polaris Mine 2004 Annual MMER and EEM Report

This revised report is being submitted in response to the August 9, 2005 letter from Jenny Ferone (Environment Canada) to Bruce Donald (Teck Cominco Metals Ltd.), regarding purported reporting deficiencies for the Polaris Mine 2004 Annual Report (provided in Appendix F). Azimuth staff prepared the initial 2004 Annual Report and have addressed the issues identified in the August 9th letter within this Revised 2004 Annual Report. In addition, Azimuth responded to each specific reporting issue in a letter sent to Environment Canada on behalf of Teck Cominco, dated September 14, 2005 (provided in Appendix G). Within this letter, Azimuth identified sections of the original report where some of the deficient data were presented and requested further guidance and clarification from Environment Canada on some of the reviewers' comments. Azimuth has not heard back to date, and has prepared this Revised 2004 Annual Report according to the assumptions and interpretations stated in the September 14th letter. Teck Cominco and Azimuth will ensure that all required information will be included in future reports.

Please find attached the REVISED 2004 Polaris Mine Annual Report. There was one non-compliant concentration related to Schedule 4 limits (TSS) as previously reported. There were no non-compliant results of the acute lethality tests during the year.

The following is included in our Revised 2004 Annual Report:

1. Requirements under Schedule 6
   - Identification of Site, Owner, Location, etc.
   - Non-Compliance information
   - Table 1 – Monthly Mean Concentrations, pH Range and Volume of Effluent
   - Table 2 – Results of Acute Lethality Tests and Daphnia Magna Monitoring Tests

2. Requirements under Part 1 Section 8
   - Results of studies conducted under Part 1, Section 4 (Effluent Characterization) (Table 3, Table 5)
   - Results of studies conducted under Part 1, Section 5 (Sublethal Toxicity Testing) (Table 6, Table 7, Appendix A, B, C and E) (Note that within Appendices A, B, and C, ** denotes the sections where reporting issues from the August 9th letter have been addressed)
   - Results of studies conducted under Part 1, Section 7 (Water Quality Monitoring) (Table 4, Table 5)

3. Additional Appendices
   - Appendix D – acute toxicity testing reports
   - Appendix F – Letter from Environment Canada to Teck Cominco Metals Ltd., dated August 9, 2005
   - Appendix G – Letter from Azimuth Consulting Group to Environment Canada, dated September 14, 2005.
   - Appendix H – Polaris Mine – Revised 2004 3rd Quarter Metal Mining Effluent Regulations Report (dated March 22, 2005)

As in the initial 2004 Annual Report, the revised 3rd Quarter regulatory data set is included in this submission in Appendix H. This data was revised to ensure consistency between the hardcopy and online RISS system reports.

The MMER and EEM data required to be reported in electronic format were submitted electronically through the RISS online system in March 2005, and no additional information was requested for this report format. In addition to this hardcopy report, an electronic pdf version of this report is being emailed to you (e-mailed September 28, 2005).

If you have any questions regarding the annual report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me.

Yours truly,

Original signed by B. Donald

Bruce Donald

Attachments: 2004 MMER Annual Report; Revised 2004 3rd Quarter Regulatory Data Tables

cc: Randy Baker (Azimuth Consulting Group)

Ken Russell (Environment Canada)

INFORMATION TO BE INCLUDED IN ANNUAL REPORT SUMMARY

The following information is to be submitted for each final discharge point.

Mine Name :	Polaris Mine
Mine Operator :	Cominco Mining Partnership and Teck Cominco Metals Lt
Address :	Bag 2000
	Kimberley, BC
	V1A 3E1
Telephone :	(250) 427-8405 Bruce Donald
E-mail :	bruce.donald@teckcominco.com
Location of Final Discharge point :	Garrow Lake Former Dam at 75o22'32"N, 96o48'37"W.
Reporting Period :	January 1, 2004 to December 31, 2004.
Date of Report :	March 21, 2005.

Non-Compliance Information

There was one non-compliant effluent discharge during 2004 (I.e., TSS of 117 mg/L, July 7, 2004), with respect to Schedule 4 limits. Upon receiving the results from the lab, this exceedance was reported to Environment Canada regulatory authorites in a letter dated August 12, 2004. The exceedance was due to the initial ice melt unplugging Garrow Lake, resulting in a flushing of sediment. There were no other non-compliant concentrations of substances during this initial flow, and TSS dropped to values of approximately 3-15 mg/L in all subsequent sampling events. Upon review of the information, Environment Canada recommended no further action in a letter date January 11, 2005 from Sidney Bruinsma. There were no non-compliant acute lethality tests during 2004, including tests performed on the July 7, 2004 sample.

TABLE 1

MONTHLY MEAN CONCENTRATIONS, pH RANGE AND VOLUME OF EFFLUENT (1)(2)

Month	As (mg/L)	Cu (mg/L)	CN (mg/L)	Pb (mg/L)	Ni (mg/L)	Zn (mg/L)	TSS (mg/L)	Ra (Bq/L)	pH range	Effluent Volume (m3)
Jan.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Feb.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Mar.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Apr.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
May	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
June	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
July	0.0015	0.0011	0.0050	0.0014	0.0024	0.0980	32.0000	0.0090	7.90 - 8.05	4066913.00
Aug.	0.0004	0.0012	0.0051	0.0019	0.0081	0.0508	6.1000	0.0074	7.84 - 8.04	324551.00
Sept.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Oct.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Nov.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
Dec.	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

(1) Any measurement not taken because there was no deposit from the final discharge point shall be identified by the letters "ND" - (No Deposit)

(2) Any measurement not taken because no measurement was required in accordance with the conditions set out in section 13 of the Regulations shall be identified by the letters "NMR" - (No Measurement Required).

TABLE 2

RESULTS OF ACUTE LETHALITY TESTS AND
DAPHNIA MAGNA MONITORING TESTS

Date Sample Collected	Effluent Acutely Lethal to Rainbow Trout (yes or no)	Effluent Acutely Lethal to *Daphnia magna* (yes or no)
7/7/2004	No	No
7/27/2004	No	No
8/24/2004	No	No

REVISED Table 3. Effluent Characterization Results (Part 1, Section 4)

Effluent Characterization from Final Discharge Point - Garrow Lake Former Dam / Syphons
Northing: 75°22'32"
Easting: 96°48'37"

Facility Name:		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)					
FDP Name:		Garrow Lake Syphons					
Sampling Date:		7/7/2004	7/27/2004	8/17/2004	8/24/2004		
Sample Method:		Grab	Grab	Grab	Grab		
Parameter	**Units**					***Detection Limit***	**Methods[1]**
Hardness	mg/L	1400	483	973	1380	*2.7*	EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity	mg/L	138	62.4	111	128	*1.0*	APHA Method 2320 (potentiometric titration)
Aluminum	mg/L	0.34	0.021	<0.1	<0.1	*0.1*	SPR-IDA[2], Graphite Furnace Atomic Absorption Spectrophotometry
Cadmium	mg/L	0.000588	0.00014	0.00023	0.000335	*0.0002*	SPR-IDA[2], ICPMS[3]
Iron	mg/L	0.487	0.084	0.042	0.014	*0.01*	SPR-IDA[2], Flame Atomic Absorption Spectrophotometry
Mercury	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	*0.00001*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum	mg/L	<0.005	0.0013	<0.005	<0.005	*0.005*	ICPMS[3]
Ammonia	mg/L	0.071	<0.02	0.146	0.133	*0.02*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate	mg/L	0.277	0.0644	0.525	0.531	*0.01, 0.02*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic	mg/L	<0.001	<0.001	<0.0002	<0.0002	*0.001, 0.0002*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper	mg/L	0.00265	0.000518	0.00121	0.00134	*0.00005*	SPR-IDA[2], ICPMS[3]
Cyanide	mg/L	<0.005	<0.005	<0.005	<0.005	*0.005*	APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode)
Lead	mg/L	0.00269	0.00157	0.00177	0.00119	*0.00005*	SPR-IDA[2], ICPMS[3]
Nickel	mg/L	0.00442	0.00207	0.00644	0.00967	*0.00005*	SPR-IDA[2], ICPMS[3]
Zinc	mg/L	0.198	0.0429	0.0418	0.0498	*0.0005*	SPR-IDA[2], ICPMS[3]
TSS	mg/L	117	<3	5.3	4.4	*3.0*	APHA Method 2540 (filtration through glass fibre filter)
Radium 226	Bq/L	0.02	<0.005	0.01	0.008	*0.005*	Radio Chemistry[5]
pH	pH units	8.05	7.87	7.95	7.84	*0.01*	APHA Method 4500-H (pH electrode)

Notes:

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

REVISED Table 4. Water Quality Monitoring Results (Part 1, Section 7)

Station:		Exposure Area			Reference Area			
Description:		Garrow Bay at Mouth of Garrow Creek Confluence			Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek).			
Northing:		75°22'15"			75°22'40"			
Easting:		96°48'30"			96°47'12"			
Facility Name:		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)			Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)			
FDP Name:		Garrow Lake Syphons			Garrow Lake Syphons			
Area Name:		Garrow Bay Exposure			Garrow Bay Reference			
Sampling Date:		7/27/2004	8/17/2004	8/24/2004	8/17/2004	8/24/2004		
Sample Method:		Grab	Grab	Grab	Grab	Grab		
Parameters	**Units**						***Detection Limit***	**Methods[1]**
Hardness	mg/L	482	2270	1750	2960	1560	*2.7*	EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity	mg/L	37.5	45	38.8	46	36.1	*1.0*	APHA Method 2320 (potentiometric titration)
Aluminum	mg/L	0.033	<0.1	<0.1	<0.1	<0.1	*0.1*	SPR-IDA[2], Graphite Furnace Atomic Absorption Spectrophotometry
Cadmium	mg/L	0.00007	<0.00002	0.000028	<0.00002	<0.00002	*0.0002*	SPR-IDA[2], ICPMS[3]
Iron	mg/L	0.046	<0.01	<0.01	<0.01	<0.01	*0.01*	SPR-IDA[2], Flame Atomic Absorption Spectrophotometry
Mercury	mg/L	<0.00005	<0.00001	<0.00001	<0.00001	<0.00001	*0.00001*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum	mg/L	0.00156	<0.005	<0.005	0.0062	<0.005	*0.005*	ICPMS[3]
Ammonia	mg/L	<0.02	<0.02	0.02	<0.02	<0.02	*0.02*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate	mg/L	0.0372	<0.02	<0.02	<0.02	<0.02	*0.02*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic	mg/L	<0.001	<0.0002	0.00027	0.00044	<0.0002	*0.001, 0.0002*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper	mg/L	0.000405	0.000216	0.000209	0.000231	0.000205	*0.00005*	SPR-IDA[2], ICPMS[3]
Cyanide	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	*0.005*	APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode)
Lead	mg/L	0.00026	<0.00005	0.000267	0.000052	<0.00005	*0.00005*	SPR-IDA[2], ICPMS[3]
Nickel	mg/L	0.000979	0.000252	0.000267	0.000217	0.000186	*0.00005*	SPR-IDA[2], ICPMS[3]
Zinc	mg/L	0.0242	0.00118	0.00092	0.0005	<0.0005	*0.0005*	SPR-IDA[2], ICPMS[3]
TSS	mg/L	3.7	3.3	8.4	9.3	7	*3.0*	APHA Method 2540 (filtration through glass fibre filter)
Radium226	Bq/L	<0.005	<0.005	0.006	<0.005	<0.005	*0.005*	Radio Chemistry[5]
pH	pH units	7.91	7.79	7.64	7.92	7.62	*0.01*	APHA Method 4500-H (pH electrode)
Water Temperature	°C	0.2	0.2	0.9	0.1	1.2	-	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85
Dissolved Oxygen	mg/L	13.23	13.78	15.2	14.04	15.13	-	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85

Notes

The Garrow Bay exposure area (mouth of the creek) was frozen during the July 7, 2004 sampling event.

Note that the reference area was ice free only during August 17 and August 24, 2004 sampling events.

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

Table 5. QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Duplicate	Original Sample		Field Duplicate	Original Sample	
Location:		Garrow Lake Syphons			Garrow Bay Exposure			Garrow Lake Syphons		
Description:		Final Discharge Point		RPD[2]	Mouth of Garrow Creek Confluence		RPD[2]	Final Discharge Point		RPD[2]
Sampling Date:		7/7/2004		(%)	7/27/2004		(%)	8/17/2004		(%)
Parameters	Parameter Units									
Hardness	mg/L	1400	1400	0.00	532	482	10.37	997	973	2.47
Alkalinity	mg/L	132	138	4.35	38.6	37.5	2.93	113	111	1.80
Aluminum	mg/L	0.26	0.34	23.53	0.031	0.033	6.06	<0.10	<0.1	n/a
Cadmium	mg/L	0.000582	0.000588	1.02	0.000062	0.00007	11.43	0.000224	0.00023	2.61
Iron	mg/L	0.441	0.487	9.45	0.035	0.046	23.91	0.039	0.042	7.14
Mercury	mg/L	<0.000010	<0.00001	n/a	<0.000050	<0.00005	n/a	<0.000010	<0.00001	n/a
Molybdenum	mg/L	<0.0050	<0.005	n/a	0.00129	0.00156	17.31	<0.0050	<0.005	n/a
Ammonia	mg/L	0.069	0.071	2.82	<0.020	<0.02	n/a	0.163	0.146	11.64
Nitrate	mg/L	0.284	0.277	2.53	0.0371	0.0372	0.27	0.54	0.525	2.86
Arsenic	mg/L	<0.0010	<0.001	n/a	<0.0010	<0.001	n/a	<0.00020	<0.0002	n/a
Copper	mg/L	0.00252	0.00265	4.91	0.000342	0.000405	15.56	0.00121	0.00121	0.00
Cyanide	mg/L	<0.0050	<0.005	n/a	<0.0050	<0.005	n/a	<0.0050	<0.005	n/a
Lead	mg/L	0.0024	0.00269	10.78	0.000205	0.00026	21.15	0.00187	0.00177	5.65
Nickel	mg/L	0.00438	0.00442	0.90	0.000772	0.000979	21.14	0.00676	0.00644	4.97
Zinc	mg/L	0.196	0.198	1.01	0.019	0.0242	21.49	0.0418	0.0418	0.00
TSS	mg/L	120	117	2.56	7	3.7	89.19	<3.0	5.3	n/a
Radium226	Bq/L	0.02	0.02	0.00	<0.0050	<0.005	n/a	<0.0050	0.01	n/a
pH	pH units	8.06	8.05	0.12	7.76	7.91	1.90	8.02	7.95	0.88

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller.

QAQC Results

A total of 4 duplicate samples and 3 blank samples were collected during the 2004 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of TSS on July 27, 2004. This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 5. QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Blank	Transport Blank	Field Blank
Location:		Garrow Lake Syphons			n/a	n/a	n/a
Description:		Final Discharge Point		RPD[2]	Distilled Water[3]	Distilled Water[3]	Distilled Water[3]
Sampling Date:		8/24/2004		(%)	7/7/2004	7/7/2004	8/17/2004
Parameters	Parameter Units						
Hardness	mg/L	1380	1380	0.00	<0.54	<0.54	<0.54
Alkalinity	mg/L	128	128	0.00	-	-	<1.0
Aluminum	mg/L	<0.10	<0.1	n/a	<0.10	<0.10	<0.0010
Cadmium	mg/L	0.000342	0.000335	2.09	<0.000020	<0.000020	<0.00020
Iron	mg/L	0.015	0.014	7.14	<0.010	<0.010	<0.030
Mercury	mg/L	<0.000010	<0.00001	n/a	<0.000010	<0.000010	<0.000010
Molybdenum	mg/L	<0.0050	<0.005	n/a	<0.0050	<0.0050	<0.0010
Ammonia	mg/L	0.114	0.133	14.29	-	-	0.028
Nitrate	mg/L	0.529	0.531	0.38	-	-	<0.0050
Arsenic	mg/L	<0.00020	<0.0002	n/a	<0.0010	<0.0010	<0.00020
Copper	mg/L	0.00140	0.00134	4.48	0.00012	0.00012	<0.0010
Cyanide	mg/L	<0.0050	<0.005	n/a	-	-	<0.0050
Lead	mg/L	0.00116	0.00119	2.52	0.00017	0.00021	<0.0010
Nickel	mg/L	0.00971	0.00967	0.41	<0.00050	<0.00050	<0.0010
Zinc	mg/L	0.0514	0.0498	3.21	0.0012	<0.0010	<0.0050
TSS	mg/L	3.7	4.4	15.91	-	-	<3.0
Radium226	Bq/L	<0.0050	0.008	n/a	<0.0050	0.006	<0.0050
pH	pH units	7.93	7.84	1.15	-	-	5.51

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller.

QAQC Results

A total of 4 duplicate samples and 3 blank samples were collected during the 2004 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of TSS on July 27, 2004. This data indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples were typically less than, or slightly higher than detection limits, revealing no background contamination issues.

Table 6. Sublethal Toxicity Testing Results EC50 (Part 1, Section 5)

Facility Name	FDP Name	EC25 Test Date	Species Test	Sublethal Test Type	Sample Method	Consultant Laboratory
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/7/2004	Atherinops affinis	Growth	Grab	EVS Consultants, North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/27/2004	Atherinops affinis	Growth	Grab	EVS Consultants, North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/27/2004	Dendraster excentricus	Reproduction	Grab	EVS Consultants North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/27/2004	Champia parvula	Reproduction	Grab	Saskatchewan Research Council (SRC)
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	8/24/2004	Champia parvula	Reproduction	Grab	Saskatchewan Research Council (SRC)
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	8/24/2004	Dendraster excentricus	Reproduction	Grab	EVS Consultants North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	8/24/2004	Atherinops affinis	Growth	Grab	EVS Consultants North Vancouver, BC

Table 6. Sublethal Toxicity Testing Results EC50 (Part 1, Section 5)

EC25 Test Date	Species Test	EC25 or IC25	EC25 or IC25 Lower Confidence Limit	EC25 or IC25 Upper Confidence Limit	Notes
7/7/2004	Atherinops affinis	> 72.6	72.6	72.6	IC25 (95%CL) was > 72.6%, the highest exposure concentration due to salinity adjustment.
7/27/2004	Atherinops affinis	> 69	69	69	IC25 (95% CL) was > 69%, the highest concentration tested due to salinity adjustment.
7/27/2004	Dendraster excentricus	8.7	7.6	9.9	July 7 sandollar test not initiated because sandollars did not spawn.
7/27/2004	Champia parvula	26.6	20.8	31.5	
8/24/2004	Champia parvula	45.3	36.3	58.1	
8/24/2004	Dendraster excentricus	17.5	11.6	22.6	
8/24/2004	Atherinops affinis	> 71	71	71	IC25 (95% CL) was > 71%, the highest concentration tested due to salinity adjustment.

Table 7. Sublethal Toxicity Testing Results LC50 (Part 1, Section 5)

Facility Name	FDP Name	LC50 Test Date	Species Tested	Sublethal Test Type	Sample Method	Consultant Laboratory
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/7/2004	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	7/27/2004	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	8/24/2004	Atherinops affinis	Survival	Grab	EVS Consultants, North Vancouver, BC

Table 7. Sublethal Toxicity Testing Results LC50 (Part 1, Section 5)

LC50 Test Date	Species Tested	LC50	LC50 Lower Limit	LC50 Upper limit	Notes
7/7/2004	Atherinops affinis	> 72.6	72.6	72.6	LC50 (95% CL) was > 72.6%, the highest exposure concentration tested, due to salinity adjustment.
7/27/2004	Atherinops affinis	> 69	69	69	LC50 (95% CL) was > 69%, the highest concentration tested due to salinity adjustment.
8/24/2004	Atherinops affinis	> 71	71	71	LC50 (95% CL) was > 71%, the highest concentration tested due to salinity adjustment.

POLARIS MINE – MMER ANNUAL SUMMARY REPORT 2004

APPENDIX A

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPAW 95-EPA West Coast: 7-day Topsmelt Survival and Growth Tests.

APPENDIX B

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPS 1/Rm/27-EC: 92 hr Echinoderm (sand dollar) Fertilization Test

APPENDIX C

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPA/600/4-91-003, Method 1009.0: Algae (*Champia parvula*) 7-day Sublethal Growth Tests

APPENDIX D

i. Acute toxicity testing laboratory reports

APPENDIX E

i. Sublethal toxicity testing laboratory reports

APPENDIX F

i. Letter from Environment Canada to Teck Cominco Metals, Ltd. re: Polaris 2004 Annual Report (dated August 9, 2005)

APPENDIX G

i. Letter from Azimuth Consulting Group, Inc. to Environment Canada re: Clarification of reporting issues outlined in August 9, 2005 letter (dated September 14, 2005)

APPENDIX H

i. Polaris Mine – Revised 2004 3rd Quarter Metal Mining Effluent Regulations Report (dated March 22, 2005)

APPENDIX A

7-d Topsmelt Growth and Survival Toxicity Test

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 - Wednesday July 7, 2004 – 1100h
     Test 2 - Tuesday July 27, 2004 – 2130h
     Test 3 – Tuesday Aug 24, 2004 – 1500h

iii. Type of sample
   - Final effluent water from final discharge point

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 3 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee) Tests 1 & 2
   - Patrick Allard (Azimuth) Test 3

vii. **Labeling/coding of sample (Sample IDs)
   - Test 1 - G-Creek_sub_070704
   - Test 2 - G-Creek_Sublethal_270704
   - Test 3 – G-Creek_081704

viii. **Date & time of sample receipt
   - Samples for sublethal toxicity testing were collected:
     Test 1 - Saturday July 10, 2004 – 1425h
     Test 2 - Friday July 30, 2004 – 1200h
     Test 3 – Friday Aug 27, 2004 – 0945h

ix. **Temperature upon sample receipt at laboratory
   - Test 1 – 11.6 °C
   - Test 2 – 13.0 °C
   - Test 3 – 15.4 °C

Test Organisms Imported from External Supplier

i. Species of test organism
   - Topsmelt (*Atherinops affinis*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Aquatic Bio Systems (ABS), Fort Collins, Colorado

iv. Date test species acquired on
   - Test 1 – July 8, 2004
   - Test 2 – July 29, 2004
   - Test 3 – August 26, 2004

v. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

vi. Percent mortality of fish in 24-hour period preceding the test
- Test 1 - <10% mortality
- Test 2 - <10% mortality
- Test 3 - <10% mortality

vii. Age at start of test
- Test 1 - 11 days post-hatch
- Test 2 – 10 days post-hatch
- Test 3 – 10 days post-hatch

viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
- None noted for any test.

ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
- All tests - Larvae actively feeding and swimbladders not inflated

x. Confirmation that temperature change was <3°C and dissolved oxygen was maintained at >6mg/L during transport
- Temperature change was <2°C and dissolved oxygen supersaturated mg/L during transport

xi. Test organism acclimation rate at the testing laboratory
- Holding water conditions upon arrival were DO=supersaturated, pH = 7.9, T = 20°C
- Organisms were acclimated slowly overnight
- Addition of EVS lab seawater at intervals of 30 – 60min to reach acceptable conditions
- Organisms were acclimated to DO = 7.4mg/L, salinity = 28ppt, T=20°C

Test Facilities and Conditions

i. Test type & method
- 7-day Topsmelt (*Atherinops affinis*) Survival and Growth Toxicity Test
- Static renewal
- Sample water was renewed daily
- Reference Method - EPA/600/R-95/136 (EPAW 95-EPA West Coast)

ii. **Dates or test days during test when subsamples or multiple samples were renewed
- Samples were renewed daily for all tests (Test Day 1,2,3,4,5,6)
- Three subsamples were used on days i) 0-1; ii) 2-3; and iii) 4-5-6-7

iii. Indications of deviations from requirements in Sections 11 of Method EPA/600/R-95/136 (EPAW 95-EPA West Coast)
- No deviations from requirements
- Salinity controls were run
- Sample water salinity for
    - Test 1 was 7ppt
    - Test 2 was 2.6 ppt
    - Test 3 was 5.2ppt

iv. Date and time for start of definitive test
- Test 1 Saturday July 10, 2004 – 1730h (within 3 days)
- Test 2 Friday July 30, 2004 – 1500h (within 3 days)
- Test 3 Tuesday August 27, 2004 – 1230h (within 3 days)

v. **Date for test completion
- Test 1 July 17, 2004
- Test 2 August 6, 2004
- Test 3 September 3, 2004

vi. Test vessel description
- For all tests was a 600mL beaker

vii. Person(s) performing the test and verifying the results

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

- Test 1: Testing by: Andy Diewald, Anja Fouche, Keven Goodearle, Ann-Marie Norris and Jenny Shao; Statistical analyses by Jenny Shao and QA/QC by Julianna Kalokai
- Test 2: Testing by: Andy Diewald, Ann-Marie Norris and Jenny Shao; Statistical analysis by Jenny Shao and Kathryn Sentance; QA/QC by Armando Tang
- Test 3: Testing by Andy Diewald, Anja Fouche and Jenny Shao; Statistics by Jenny Shao and Kathryn Sentance; QA/QC by Julianna Kalokai

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent

- Test 1: pH 8.1, T 19.5 °C, DO 9.3 mg/L, C 11660 µmhos/cm
- Test 2: pH 7.8, T 20.0 °C, DO 10.7 mg/L, C 4880 µmhos/cm
- Test 3: pH 7.6, T 20.0 °C, DO 10.1 mg/L, C 9230 µmhos/cm

ix. Confirmation that no adjustment of sample or solution pH occurred

- No pH adjustment

x. Indication of aeration of test solutions before introduction of fish

- Pre-aeration at 6.5mL/min/L for 30mins due to supersaturation of sample with O_2 when sample was heated to 19°C

xi. **Indication that EC guidance document for salinity adjustment was followed

- The following was done for all 3 tests:
    - No deviations from EC guidance document on preparation of hypersaline brine (HSB)
    - HSB prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 µm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
    - No deviations from EC guidance document for salinity adjustment of sample
    - HSB was added to samples to salinity adjust them to 30ppt
    - For a 200mL volume the concentrations were prepared by adding:
        - Test 1: 145mL of effluent + 55mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).
        - Test 2: 138mL of effluent + 62mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).
        - Test 3: 142mL of effluent + 58mL of HSB for the highest concentration. This solution was then diluted using natural seawater to make the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).

xii. Type and source of control/dilution water

- For all 3 tests, control/dilution water was UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xiii. Concentrations and volumes tested:

- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- For Test 1:
    - Control (0%) - 200 mL
    - Salinity Control (0%) - 200 mL
    - 4.5% - 200mL
    - 9.1% - 200mL
    - 18.2% - 200mL

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

- 36.3% - 200mL
- 72.6% - 200mL

- For Test 2:
  - Control (0%) - 200 mL
  - Salinity Control (0%) - 200 mL
  - 4.3% - 200mL
  - 8.6% - 200mL
  - 17.3% - 200mL
  - 34.5% - 200mL
  - 69.0% - 200mL
- For Test 3:
  - Control (0%) - 200 mL
  - Salinity Control (0%) - 200 mL
  - 4.4% - 200mL
  - 9.0% - 200mL
  - 18.0% - 200mL
  - 36.0% - 200mL
  - 71.0% - 200mL

xiv. Number of replicated per concentration
- For all 3 tests: 5 replicates per concentration

xv. Number of organisms added to each test vessel
- For all 3 tests: 5 fish per vessel

xvi. Manner and rate of exchange of test solutions
- For all 3 test: Daily renewal

xvii. **Measurements of dissolved oxygen, pH and temperature, and salinity for each 24 hr period
- Test 1: See attached photocopied pages 1.1 and 1.2 of original laboratory report
- Test 2: See attached photocopied pages 2.1 and 2.2 of original laboratory report
- Test 3: See attached photocopied pages 3.1 and 3.2 of original laboratory report

Results

i. **Number and % of mortalities of fish in each test solution. Note that this data is presented in units of number of SURVIVORS and % MORTLITY. (Data is entered from original handwritten tables in lab reports)
- Test 1: Totals from all 5 replicates are presented (see attached pages 1.3-1.4 for original lab data):

Concentration		Number of Survivors - Day of Test							% Mortality on the Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	4	4	4	0	0	0	0	20	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Brine Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
4.5%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

Concentration		Number of Survivors - Day of Test							% Mortality on the Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
9.1%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
18.2%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
36.3%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	4	4	4	4	4	4	4	20	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
72.6%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20

- Test 2: Totals from all 5 replicates are presented (see attached pages 2.3-2.4 for original lab data):

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Brine Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
4.3%	A	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
8.6%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
17.3%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
34.5%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
69.0%	A	5	5	5	5	4	4	4	0	0	0	0	20	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0

- Test 3: Totals from all 5 replicates are presented (see attached pages 3.3-3.4 for original lab data):

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Brine Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
4.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
9.0%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
18.0%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
36.0%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	4	0	0	0	0	0	0	20

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
71.0%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0

ii. **Average dry weight (mg) per original fish in test vessel. No preservation of fish was used. Fish were dried and then weighed.

- Test 1: Mean dry weight (mg) of each replicate and overall means are presented:

Concentration	Replicate					Overall Mean	Standard Deviation
(% effluent v/v)	1	2	3	4	5		
Neg Control (0%)	1.2120	1.0040	0.7980	0.7880	0.8460	0.9296	0.1800
Salinity Control	1.1300	0.8540	1.3000	1.1120	0.9940	1.0780	0.1661
4.5%	0.9500	0.9440	0.9500	1.1360	1.0260	1.0012	0.0826
9.1%	1.0520	1.0060	0.9040	1.0820	1.1360	1.0360	0.0876
18.2%	1.1100	0.9080	0.9340	0.9140	0.9160	0.9564	0.0864
36.3%	1.0560	1.2980	0.9260	1.0120	1.2220	1.1028	0.1533
72.6%	0.9560	1.3320	0.8120	0.8060	1.0460	0.9904	0.2161

- Test 2: Mean dry weight (mg) of each replicate are presented:

Concentration	Replicate						
(% effluent v/v)	1	2	3	4	5	Overall Mean	Standard Deviation
Neg Control (0%)	1.000	1.122	0.952	0.962	0.866	0.9804	0.0931
Salinity Control	1.170	0.812	1.042	0.880	1.030	0.9868	0.1418
4.3%	0.754	1.078	1.064	0.814	0.840	0.9100	0.1503
8.6%	1.098	0.866	0.884	0.726	0.778	0.8704	0.1426
17.3%	0.710	0.794	0.944	0.596	0.872	0.7832	0.1363
34.5%	0.912	0.874	0.918	0.854	0.924	0.8964	0.0307
69.0%	0.486	0.818	0.756	0.808	1.000	0.7736	0.1854

- Test 3: Mean dry weight (mg) of each replicate are presented:

Concentration	Replicate						
(% effluent v/v)	1	2	3	4	5	Overall Mean	Standard Deviation
Neg Control (0%)	0.9680	0.9700	0.9780	0.8460	0.8940	0.9312	0.0585
Salinity Control	0.9040	0.8600	1.2680	0.9720	0.8080	0.9624	0.1811
4.4%	0.9380	1.5180	1.0220	0.8620	0.9420	1.0564	0.2642
9.0%	0.8960	0.8600	0.9480	0.7900	0.8320	0.8652	0.0604
18.0%	0.9240	0.6960	1.1280	1.0860	0.9940	0.9656	0.1704
36.0%	1.0900	0.8140	0.7880	1.0300	0.8900	0.9224	0.1328
71.0%	0.6680	0.7620	1.0920	0.9280	0.9060	0.8712	0.1631

iii. Estimate of 7-d LC_{50} (95% CL)

- Test 1: 7-d LC_{50} concentration > 72.6% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d LC_{50} concentration > 69.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 3: : 7-d LC_{50} concentration > 71.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

iv. Estimate of 7-d IC_{25} (95% CL) for growth

Reporting Requirements for Reference Method EPAW 95-EPA West Coast (Topsmelt)

- Test 1: 7-d IC_{25} concentration > 72.6% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d IC_{25} concentration > 69.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 3: 7-d IC_{25} concentration > 71.0% effluent (highest concentration tested due to dilution for salinity adjustment)

v. Current reference toxicity tests (95% CL) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1 :Reference toxicity tests for Toxicant: Copper
  - Test conducted on July 10, 2004, same day as effluent test
  - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
  - 7-d LC_{50} survival = 161mg/L Cu, 95% CL = 139-188mg/L
  - 7-d IC_{50} growth = 147mg/L Cu, 95% CL = 119-169mg/L
- Test 2 :Reference toxicity tests for Toxicant: Copper
  - Test conducted on July 30, 2004, same day as effluent test
  - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
  - 7-d LC_{50} survival = 130mg/L Cu, 95% CL = 115-147mg/L
  - 7-d IC_{50} growth = 124mg/L Cu, 95% CL = 87-144mg/L
- Test 3 :Reference toxicity tests for Toxicant: Copper
  - Test conducted on August 27, 2004, same day as effluent test
  - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
  - 7-d LC_{50} survival = 121mg/L Cu, 95% CL = 107-137mg/L
  - 7-d IC_{50} growth = 128mg/L Cu, 95% CL = 85-150mg/L

vi. Reference toxicity warning limits (+/- SD) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1: Reference toxicity tests for Toxicant: Copper
  - 7-d LC_{50} survival = 137 ± 56mg/L Cu
  - 7-d IC_{50} growth = 135 ± 51mg/L Cu
- Test 2: Reference toxicity tests for Toxicant: Copper
  - 7-d LC_{50} survival = 129 ± 48mg/L Cu,
  - 7-d IC_{50} growth = 130 ± 52mg/L Cu
- Test 3: Reference toxicity tests for Toxicant: Copper
  - 7-d LC_{50} survival = 132 ± 48mg/L Cu,
  - 7-d IC_{50} growth = 131 ± 51mg/L Cu

APPENDIX B

92-h Echinoderm Fertilization Test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75^{o} 22' 32" N, 97^{o} 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 - Wednesday July 7, 2004 – 1100h
     Test 2 - Tuesday July 27, 2004 – 2130h
     Test 3 – Tuesday Aug 24, 2004 – 1500h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee) Tests 1 & 2
   - Patrick Allard (Azimuth) Test 3

x. **Labeling/coding of sample (Sample IDs)
   - Test 1 - G-Creek_sub_070704
   - Test 2 - G-Creek_Sublethal_270704
   - Test 3 – G-Creek_081704

xi. **Date & time of sample receipt
   - Samples for sublethal toxicity testing were collected:
     Test 1 - Saturday July 10, 2004 – 1425h
     Test 2 - Friday July 30, 2004 – 1200h
     Test 3 – Friday Aug 27, 2004 – 0945h

xii. **Temperature upon sample receipt at laboratory
   - Test 1 – n/a no test
   - Test 2 – 13.0 °C
   - Test 3 – 15.4 °C

Test Organisms

i. Species of test organism
   - Sandollar Echinoid (*Dendraster excentricus*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - M-REP, Escondido, California
   - All adults providing gametes are from the same population and source
   - Gametes are spawned in-house at EVS

iv. Date test species acquired on
   - Test 1: Test was not initiated due to inability of the Sandollars to spawn.
   - Test 2: July 30, 2004
   - Test 3: August 27, 2004

v. Holding time and conditions for adults
   - Test 1: N.A.

- Test 2: Adults received at the testing laboratory the day of the test.
- Test 3: Adults received at the testing laboratory the day of the test.

vi. Indications of deviations from EC guidance on the importation of test organisms
- Test 1: na
- Test 2: No deviations from EC requirements
- Test 3: No deviations from EC requirements

vii. Weekly percent mortality of adults being held over 7d preceding test
- Test 1: na
- Test 2: <2% per day over the 7 days preceding the test
- Test 3: <2% per day over the 7 days preceding the test

viii. Age of test organisms
- Test 1: n.a.
- Test 2: < 4 hours after spawning
- Test 3: < 4 hours after spawning

ix. **Unusual appearance, behaviour, or treatment of adults or gametes before test start, or anything unusual about the test
- Test 1: Test was not initiated due to inability of the Sandollars to spawn
- Test 2 Organisms appear healthy, in good condition, nothing unusual about test organisms or test
- Test 3: Organisms appear healthy, in good condition, nothing unusual about test organisms or test

Test Facilities and Conditions

i. Test type & method
- Echinoderm (*Dendraster excentricus*) Fertilization Toxicity Test
- Static
- Reference Method – EPS/1/RM/27 with 1997 amendments

ii. Test duration
- Test 1: na
- Test 2: 10:10 min (10min sperm + 10min sperm & egg)
- Test 3: 10:10 min (10min sperm + 10min sperm & egg)

iii. Date and time for start of definitive test
- Test 1: na
- Test 2: Friday July 30, 2004 – 1620h
- Test 3: Friday August 27, 2004 – 1334h

iv. Test vessel description
- Test 1: na
- Test 2: 16 x 125mm test tubes
- Test 3: 16 x 125mm test tubes

v. Person(s) performing the test and verifying the results
- Test 1: na
- Test 2: Testing by Kathryn Sentance and Ann-Marie Norris. Statistical analyses by Jenny Shao and Kathryn Sentance. QA/QC reviewed by Julianna Kalokai.
- Test 3: Testing by Kathryn Sentance and Ann-Marie Norris. Statistical analyses by Jenny Shao and Kathryn Sentance. QA/QC reviewed by Julianna Kalokai.

vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
- Test 1: na
- Test 2: No pre-aeration noted.
- Test 3: No pre-aeration noted.

vii. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: na

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Test 2: No pH adjustment
- Test 3: No pH adjustment

viii. Procedure for sample filtration
- Test 1: na
- Test 2: No sample filtration
- Test 2: No sample filtration

ix. **Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997
- Test 1: na
- Test 2: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.31mL of effluent + 2.69mL of HSB for the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.
- Test 2: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.51mL of effluent + 2.49mL of HSB for the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.

x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment
- Test 1: na
- Test 2: salinity adjusted from 2.8 to 28 ppt
- Test 3: salinity adjusted from 5 to 28 ppt

xi. Type and source of control/dilution water
- Test 1: na
- Test 2: UV-sterilized, 0.45μm-filtered natural seawater from the Vancouver Aquarium
- Test 3: UV-sterilized, 0.45μm-filtered natural seawater from the Vancouver Aquarium

xii. Concentrations and volumes tested
- Test 1: na
- Test 2: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.6% - 10mL
    - 9.1% - 10mL
    - 18.3% - 10mL
    - 36.6% - 10mL
    - 73.1% - 10mL
- Test 3: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.7% - 10mL
    - 9.4% - 10mL

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- 18.8% - 10mL
- 37.5% - 10mL
- 75.1% - 10mL

xiii. Number of replicated per concentration
- Test 1: na
- Test 2: 4 replicates per treatment concentration
- Test 3: 4 replicates per treatment concentration

xiv. **Number of organisms per container
- Test 1: na
- Test 2: 2000 eggs per vessel (100 counted)
- Test 3: 2000 eggs per vessel (100 counted)

xv. Measurements of pH and dissolved oxygen in sample water before use
- Test 1: na
- Test 2: pH 8.1, DO 8.5
- Test 3: pH 8.0, DO 8.5

xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
- Test 1: na
- Test 2: pH – 8.0 – 8.1, T - 15.0-16.0°C, DO - 8.2-8.5mg/L, salinity - 28ppt
- Test 3: pH – 8.2 – 8.5, T - 15.0-16.0°C, DO - 8.2-8.5mg/L, salinity - 28ppt

Results

i. Number and % of fertilized eggs in each test concentration
- Test 1: na
- Test 2: (Number is equal to percent since totals were 100)
  - Control (0%): #F = 59, 62, 56, 65 #UF = 41, 38, 44, 35
  - Salinity Control: #F = 60, 57, 59, 62 #UF = 40, 43, 41, 38
  - 4.6%: #F = 60, 66, 56, 58 #UF = 40, 34, 44, 42
  - 9.1%: #F = 46, 42, 45, 42 #UF = 54, 58, 55, 58
  - 18.3%: #F = 39, 39, 37, 36 #UF = 61, 64, 63, 64
  - 36.6%: #F = 31, 34, 25, 31 #UF = 69, 66, 75, 69
  - 73.1%: #F = 19, 20, 21, 20 #UF = 81, 80, 79, 80
- Test 3: (Number is equal to percent since totals were 100)
  - Control (0%): #F = 77, 80, 74, 77 #UF = 23, 20, 26, 23
  - Salinity Control: #F = 76, 73, 79, 77 #UF = 24, 27, 21, 23
  - 4.7%: #F = 78, 74, 76, 72 #UF = 22, 26, 24, 28
  - 9.4%: #F = 61, 62, 62, 60 #UF = 39, 38, 38, 40
  - 18.8%: #F = 56, 58, 59, 55 #UF = 44, 42, 41, 45
  - 37.5%: #F = 49, 50, 50, 48 #UF = 51, 50, 50, 52
  - 75.1%: #F = 25, 27, 24, 27 #UF = 75, 73, 76, 73

ii. **Estimate of IC_{25} (95% CL) for fertilization success
- Test 1: na
- Test 2: IC_{25} concentration = 8.7 (7.6 – 9.9)% v/v effluent
- Test 3: IC_{25} concentration = 17.5 (11.6 – 22.6)% v/v effluent
- Quantitative statistic used to generate IC_{25} values was log-linear interpolation (200 resamples) calculated in ToxCalc v5.0.23 (Test 2) and log-logit interpolation (200 resamples) calculated in ToxCalc v5.0.23 (Test 3)

iii. Current reference toxicity tests (95% CL) for IC_{50} for fertilization
- Test 1: na
- Test 2: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Test conducted on July 30, 2004, same day as effluent test
- Reference test conducted under same conditions
- IC_{50} for fertilization = 2.1mg/L SDS, 95% CL = (1.9 – 2.4)mg/L

- Test 3: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on August 27, 2004, same day as effluent test
  - Reference test conducted under same conditions
  - IC_{50} for fertilization = 2.3mg/L SDS, 95% CL = (2.1 – 2.4)mg/L

iv. Reference toxicant warning limits (+/- 2SD) for IC_{50} for fertilization

- Test 1: na
- Test 2: 4.2 +/- 4.8 mg/L SDS
- Test 3: 3.9 +/- 4.6 mg/L SDS

APPENDIX C

7-d Sublethal *Champia* (Algae) Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Test 1 - Wednesday July 7, 2004 – 1100h
     Test 2 - Tuesday July 27, 2004 – 2130h
     Test 3 – Tuesday Aug 24, 2004 – 1500h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 1 x 4L sample bottles were filled

vi. Name of person submitting samples
   - Dennis Lu (Gartner Lee) Tests 1 & 2
   - Patrick Allard (Azimuth) Test 3

vii. Temperature of water upon receipt at lab
   - Test 1: Test was not conducted as sample was delayed by weather and person qualified to conduct the work at the lab left for vacation. This was discussed with Sandra Blenkinsopp at the time to provide direction.
   - Test 2: 8°C
   - Test 3: 17°C

xiii. **Labeling/coding of sample (Sample IDs)
   - Test 1 - G-Creek_sub_070704
   - Test 2 - G-Creek_Sublethal_270704
   - Test 3 – G-Creek_081704

xiv. **Date & time of sample receipt
   - Samples for sublethal toxicity testing were collected:
     Test 1 – n/a test not conducted
     Test 2 - Friday July 30, 2004 – 0900h
     Test 3 – Friday Aug 27, 2004 – 0900h

Test Organisms

i. Species of test organism
   - Algae (*Champia parvula*)

ii. Name and city of testing laboratory
   - Saskatchewan Research Council [SRC], Saskatoon, SK

iii. Source of test species and health of organisms
   - Test 1: na
   - Test 2 and Test 3
     - Sexually mature male and female branches
     - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
     - Appear in excellent health, healthy red color
     - Females have trichogynes, males have sori with spermatia

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

iv. **Any unusual appearance, behaviour, or treatment of test organisms, before their use in test
- Test 1: na
- Test 2 and Test 3
    - Nothing unusual about the appearance, behaviour, or treatment of test organisms, before their use in test; everything is normal
    - Nothing unusual about the tests

Test Facilities and Conditions

i. Test type & method
- *Champia parvula* sexual reproduction test
- Static, non-renewal
- 2-day exposure, followed by 5-7 day recovery period for cystocarp development
- Reference Method - EPA/600/4-91/003, Method 1009.0

ii. Date and time for start of definitive test
- Test 1: na
- Test 2: Friday July 30, 2004 – time not noted but lab notes state tests started within 72 hrs of collection
- Test 3: Friday August 27, 2004 – time not noted but lab notes state tests started within 72 hrs of collection

xviii. **Date for test completion
- Test 1 – n/a
- Test 2 – August 6, 2004
- Test 3 – September 3, 2004

iii. Test vessel description
- Test 1: na
- Test 2: 270mL transparent polystyrene cups with polystyrene lids
- Test 2: 270mL transparent polystyrene cups with polystyrene lids

iv. Person(s) performing the test and verifying the results
- Test 1: na
- Tests 2 & 3 - Mary Moody

v. Indication of pre-aeration of test solutions
- Test 1: na
- Tests 2 & 3 - No pre-aeration

vi. Confirmation that no pH adjustment of sample or solution occurred
- Test 1: na
- Tests 2 & 3: - No pH adjustment

vii. **Indication that EC guidance document for salinity adjustment was followed
- Test 1: na
- Test 2:
    - No deviations from EC guidance document on preparation of hypersaline brine (May 2001)
    - HSB prepared from natural seawater at 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
    - No deviations from EC guidance document for salinity adjustment of sample
    - Salinity adjustment: 600mL effluent + 250mL HSB + 8.5mL test nutrient solution
    - Salinity of samples adjusted from 4ppt to 30ppt
- Test 3:

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

- No deviations from EC guidance document on preparation of hypersaline brine (May 2001)
- HSB prepared from natural seawater at 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
- No deviations from EC guidance document for salinity adjustment of sample
- Salinity adjustment: 600mL effluent + 230mL HSB + 10 ml test nutrient solution
- Salinity of samples adjusted from 5ppt to 30ppt

viii. Type and source of control/dilution water

- Test 1: na
- Tests 2 & 3
  - Natural seawater collected at the Pacific Environmental Center, Environment Canada, North Vancouver, BC
  - Filtered to 0.2μm and autoclaved prior to use
  - Salinity adjusted as per EC guidance document to 30ppt with HSB from the same source

ix. **Type and quantity of any chemicals added to the control dilution water

- Test 1: na
- Test 2: Test nutrients as described in Test Method USEPA/600/4-91/003, Method 1009.0 were added at concentration of 10mL/L, analytical grade, 8.5mL added
- Test 3: Test nutrients as described in Test Method USEPA/600/4-91/003, Method 1009.0 were added at concentration of 10mL/L, analytical grade, 10mL added

x. Concentrations and volumes of test solutions

- Concentrations (% effluent volume / total volume) tested and total volumes used were:
  - Test 1: na
  - Tests 2:
    - Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
    - Salinity Control Brine (0%) - 100mL, 4.5cm depth
    - 4.38% - 100mL, 4.5cm depth
    - 8.75% - 100mL, 4.5cm depth
    - 17.5% - 100mL, 4.5cm depth
    - 35.0% - 100mL, 4.5cm depth
    - 70.0% - 100mL, 4.5cm depth
  - Tests 3:
    - Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
    - Salinity Control Brine (0%) - 100mL, 4.5cm depth
    - 4.5% - 100mL, 4.5cm depth
    - 9.0% - 100mL, 4.5cm depth
    - 18.0% - 100mL, 4.5cm depth
    - 36.0% - 100mL, 4.5cm depth
    - 72.0% - 100mL, 4.5cm depth

xi. Number of replicated per concentration

- Test 1: na
- Tests 2 & 3: 3 replicates per concentration

xii. Number of organisms per test chamber

- Test 1: na
- Tests 2 & 3: 5 female branches + 2 male branches per chamber

xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

- Test 1: na
- Test 2: pH - 7.78, T – 22.0 °C, DO – 7.9mg/L, salinity - 4ppt
- Test 3: pH - 7.58, T – 23.0 °C, DO – 8.0mg/L, salinity - 5ppt

xiv. **Measurements of pH, temperature, dissolved oxygen, and salinity of test solution and controls at 0hr, 48hr, and the beginning and end of recovery period

- Test 1: na
- Test 2:

Concentration (% v/v)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH (pH units)				Salinity (ppt)			
	Exposure		Recovery		Exposure		Recovery		Exposure		Recovery		Exposure		Recovery	
	0	48	0	end	0	48	0	end	0	48	0	end	0	48	0	end
Control-NSW[1]	22	23	22	23	7.9	7.9	8.0	7.9	8.20	8.35	8.33	8.22	30	30	30	30
Control-brine	22	23	22	23	7.9	7.9	8.0	7.9	7.93	8.20	8.34	8.21	30	30	30	30
A 70	22	23	22	23	7.9	7.9	8.0	7.9	7.80	8.40	8.34	8.26	30	30	30	30
C 17.5	22	23	22	23	7.9	7.9	8.0	7.9	8.15	8.31	8.34	8.36	30	30	30	30
E 4.38	22	23	22	23	7.9	7.9	8.0	7.9	8.19	8.36	8.34	8.21	30	30	30	30

[1]NSW = natural seawater

- Test 3:

Concentration (% v/v)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH (pH units)				Salinity (ppt)			
	Exposure		Recovery		Exposure		Recovery		Exposure		Recovery		Exposure		Recovery	
	0	48	0	end	0	48	0	end	0	48	0	end	0	48	0	end
Control-NSW[1]	23	23	23	23	7.9	7.9	8.0	7.9	8.34	8.61	8.22	8.37	30	30	30	30
Control-brine	23	23	23	23	7.9	7.9	8.0	7.9	7.92	8.52	8.22	8.42	30	30	30	30
A 70	23	23	23	23	8.0	7.9	8.0	7.9	7.83	8.52	8.22	8.44	30	30	30	30
C 17.5	23	23	23	23	7.9	7.9	8.0	7.9	8.21	8.29	8.21	8.41	30	30	30	30
E 4.38	23	23	23	23	7.9	7.9	8.0	7.9	8.32	8.42	8.22	8.39	30	30	30	30

[1]NSW = natural seawater

Results

i. Number and % mortality of female plants after recovery in each test solution

- Totals from all 3 replicates are presented:
- Test 1: na
- Test 2:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 4.38%: 0 (0%) mortality
  - 8.75%: 0 (0%) mortality
  - 17.5%: 0 (0%) mortality
  - 35.0%: 0 (0%) mortality
  - 70.0%: 0 (0%) mortality
- Test 3:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 4.5%: 0 (0%) mortality
  - 9.0%: 0 (0%) mortality
  - 18.0%: 0 (0%) mortality
  - 36.0%: 0 (0%) mortality
  - 72.0%: 0 (0%) mortality

ii. **Mean number of cystocarps per plant in each replicate of each test concentration

- Test 1: na
- Test 2: (Replicates are A, B, and C)
  - Control (0%): A) 89.6, B) 89.8, C) 96.8
  - Salinity Control (0%): A) 86.2, B) 93.4, C) 98.0

- 4.38%: A) 114.8, B) 101.0, C) 99.6
- 8.75%: A) 108.4, B) 105.8, C) 101.0
- 17.5%: A) 81.6, B) 90.2, C) 100.2
- 35.0%: A) 54.4, B) 64.2, C) 67.0
- 70.0%: A) 9.6, B) 9.0, C) 21.4

- Test 3: (Replicates are A, B, and C)
  - Control (0%): A) 55.2, B) 62.0, C) 57.6
  - Salinity Control (0%): A) 50.8, B) 70.4, C) 55.6
  - 4.5%: A) 61.4, B) 50.8, C) 67.0
  - 9.0%: A) 63.0, B) 56.0, C) 61.0
  - 18.0%: A) 68.6, B) 53.2, C) 61.0
  - 36.0%: A) 53.8, B) 48.6, C) 51.6
  - 72.0%: A) 31.2, B) 36.4, C) 11.2

iii. **Estimate of IC_{25} (95% CL) for cystocarp development

- Test 1: na
- Test 2: IC_{25} concentration = 26.6 (20.8 – 31.5)% effluent v/v
- Test 3: IC_{25} concentration = 45.3 (36.3 – 58.1)% effluent v/v
  - Quantal statistic method was linear interpolation (200 resamples) determined using ToxCalc v5.0.23

iv. Current reference toxicity tests (95% CL) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test 1: na
- Test 2: Test conducted on July 27, 2004, within 30 days of effluent test
  - Reference toxicant test was conducted under the same experimental conditions as the effluent test
  - IC_{50} cystocarp development = 1.48mg/L SDS, 95% CL = (1.38 - 1.62) mg/L
  - Reference toxicity warning limits 1.40 (+/- 2SD) for IC_{50} for cystocarp development
- Test 3: Test conducted on July 27, 2004, within 30 days of effluent test
  - Reference toxicant test was conducted under the same experimental conditions as the effluent test
  - IC_{50} cystocarp development = 1.48mg/L SDS, 95% CL = (1.38 - 1.62) mg/L
  - Reference toxicity warning limits 1.40 (+/- 2SD) for IC_{50} for cystocarp development

v. Reference toxicant warning limits (+/- 2SD) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test 1: na
- Test 2: 1.40 (1.6-1.70) mg/L SDS
- Test 3: 1.40 (1.6-1.70) mg/L SDS

Note that Pages 1.1-1.4, 2.1-2.4, 3.1-3.4 are included in the hardcopy paper report only. This data can also be found in Appendix E. Note that the champia test lab reports are only included in the hardcopy paper report, not in this pdf.

APPENDIX D

Acute Toxicity Testing Laboratory Reports

EVS environment consultants

July 21, 2004

Our File: 09-0302-54.00
Work Order: 0400304/307

Cheryl Mackintosh
Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Dear Ms. Mackintosh:

RE: Acute Toxicity Test Results for a sample collected July 7, 2004

We are pleased to provide you with the results of the toxicity tests performed on the sample identified as G-Creek acute 070704 (received July 10, 2004). The sample was tested with the 96-h rainbow trout LC50 test and the 48-h *Daphnia magna* LC50 test. Testing was performed according to the Environment Canada protocols for conducting acute toxicity tests using rainbow trout (EPS 1/RM/13, Second Edition, 2000) and *D. magna* (EPS 1/RM/14, Second Edition, 2000). An independent EVS QA/QC review confirmed that all acceptability criteria specified by the protocols were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Table 1. Toxicity Test Results.

Sample ID	Sample Date (Time h)	96-h Rainbow Trout LC50 (95% CL) (% v/v)	48-h *Daphnia magna* LC50 (95% CL) (% v/v)
G-Creek acute 070704	7-July-04 (2200h)	>100	>100

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Sincerely,

Robert Harrison, B.Sc. Hons.
Assistant Bioassay Test Supervisor– Fish Team
rharrison@evsenvironment.com

Verified By:

QA/QC Committee:
Armando Tang, B.Sc.
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.
John Wilcockson, M.Sc.

195 Pemberton Ave.
North Vancouver, BC
Canada V7P 2R4

Tel: 604.986.4331
Fax: 604.662.8548
www.evsenvironment.com
info@evsenvironment.com

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: (Polaris) Azimuth
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400304
EVS Analysts: RGH, AWD
Test Type: 96h LC50
Test Initiation Date: July 12/04 @ 1445

SAMPLE
Identification: G-Creek acute 070704
Amount Received: 2 x 20L
Date Collected: July 7 /04
Date Received: July 10 /04
Other:

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15.0
pH: 7.4
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 37
Hardness (mg/L as $CaCO_3$): 12
Alkalinity (mg/L as $CaCO_3$): 12
Other:

TEST SPECIES INFORMATION
Source: Fraser Valley
Collection Date/Batch: 052604
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: July 16 /04
Fork Length (mm): 34±2 (29-37)
Wet Weight (g): 0.39±0.09 (0.22-0.54)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: June 21 /04
Duration of Acclimation (days): 26
96-h LC50 (and 95% CL): 23 (20 and 25) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29±12 mg/L SDS CV: 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.3 - 10.1
Temperature Range (°C): 14.0 - 15.0
pH Range: 7.0 - 8.3
Conductivity Range (µS/cm): 37 - 11843
Aeration Provided? (give rate): 6.5±1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/10L
Loading Density (g/L): 0.39
Acclimation Before Testing (days): 47
Mortality In Previous Week of Acclimation (%): 0
Other:

TEST RESULTS The 96h LC50 is estimated at > 100% (v/v)

Data Verified By: Amanda Terry
Date Verified: August 5, 2004

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	14		14
pH	8.1		8.1
DO (mg/L)	10.0		10.1
Cond. (µS/cm)	11730		11730

1. Document pH adjustment procedure (if used) under "Comments".

Total Pre-Aeration Time 30 min

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400304
Trout Batch No. and 7-d Acclimation Mortality 052604/0%
No. Fish/Volume 10/10L
Sample ID CT-Creek acute 070704
Date/Time Collected July 7/04
Test Initiation Date/Time July 12/04 @ 1445

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	10.1	9.5	9.8	9.8	10.0	15.0	15.0	15.0	15	15	7.4	7.3	7.0	7.2	7.1	37	43
6.25				10	10	10	10	10.1	9.5	9.6	9.7	9.8	15.0	15.0	15.0	15	15	7.6	7.3	7.1	7.1	7.2	1520	1543
12.5				10	10	10	10	10.1	9.6	9.3	9.7	9.9	14.5	15.0	15.0	15	15	7.8	7.5	7.3	7.4	7.4	2270	2300
25				10	10	10	10	10.1	9.7	9.8	9.6	9.9	14.5	15.0	15.0	15	15	7.9	7.6	7.5	7.6	7.7	3660	3700
50				10	10	10	10	10.1	9.6	9.7	9.7	9.9	14.5	15.0	15.0	15	15	8.0	7.8	7.7	7.8	7.9	6070	6120
100				10	10	10	10	10.1	9.8	9.8	9.7	9.9	14.0	15.0	15.0	15	15	8.1	8.3	8.2	7.9	8.1	11730	11843
Technician Initials				RLH	RLH	~	~	RLH	RLH	RLH	~	~	RLH	RLH	RLH	~	~	RLH	RLH	RLH	~	~	RLH	~

WQ Instruments Used: Temperature Calibrated Hg Thermometer pH II-A-030302 DO II-A-3 Conductivity II-A-030306
Sample Description cloudy white/grey
Comments

Test Set Up By RLH Data Verified By Amanda Tang Date Verified July 30, 2004

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth (Polaris) | EVS Analysts: AKN JRY
EVS Project No.: 09-0302-54 | Test Type: 48hr - LC50
EVS Work Order No.: 0400307 | Test Initiation Date: July 11, 2004

SAMPLE INFORMATION

Identification: G-Creek. 070704
Amount Received: 1 x 2L subsampled from 2x20L @ EVS
Date Collected: July 7, 2004
Date Received: 10 July 2004
Temperature (°C): 22.0 → 20.0
pH: 7.9 → 7.8
pH adjustment details: None.
Dissolved Oxygen (mg/L): 11.4 → 9.1
Pre-aeration rate and duration: @ aerated 8 min
Conductivity (µmhos/cm): 11850
Hardness (mg/L as $CaCO_3$): 1440
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

DILUTION/CONTROL WATER (initial water quality)

Water Type: Moderately Hard H_2O (July 7B)
Temperature (°C): 20.0
pH: 8.0
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 357
Hardness (mg/L as $CaCO_3$): 98
Alkalinity (mg/L as $CaCO_3$): 66
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): June 15A+B
Age (on Day 0): <24h
Days to First Brood: 8
Avg. Young/Brood (after 1st brood): 27.5
% Mortality in 7 d Before Test: ~~11.8%~~ 9.5%
Reference Toxicant: Zinc
Current Reference Toxicant Result
Reference Toxicant Test Date: July 6, 2004
48-h LC50 and 95% CL: 483 (403 - 578) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
462 ± 315 mg/L Zn % CV = 34

TEST CONDITIONS

Temperature Range (°C): 20.0 - 21.5
pH Range: RBA 7.7-8 - 8.2
Dissolved Oxygen Range (mg/L): 8.6 - 9.1
Conductivity Range (µS/cm): 357 - 11850
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200mL
Other: —

TEST RESULTS The 48h LC50 for G-Creek 070704 is > 100% (v/v).

Data Verified By: Amanda Tang | Date Verified: August 5, 2004

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth – Polaris
Sample ID: G-Creek. 070704
EVS Project No.: 09-0302-54
Date Collected: July 7, 2004
EVS Work Order No.: 0400309
Test Initiation Date/Time: July 11th/04 @ 1400
Daphnid Broodstock Batch: June 15A
No. Organisms/Volume: 10/200mL.

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
CONTROL				10	10	9.1	8.8	8.6	20.0	21.0	21.5	8.0	7.7	7.7	357	~~357~~ 358
6.25				10	10	9.1	8.8	8.7	20.0	21.0	21.0	8.0	7.8	7.8	1231	1206
12.5				10	10	9.1	8.8	8.8	20.0	21.0	21.0	8.0	7.9	7.9	2020	2000
25				10	10	9.1	8.8	8.8	20.0	21.0	21.0	7.9	7.9	8.0	3630	3600
50				10	10	9.1	8.8	8.8	20.0	21.0	21.0	7.9	8.0	8.1	6370	6270
100				10	7	9.1	8.8	8.8	20.0	21.0	21.0	7.8	8.0	8.2	11850	11640
Technician Initials				AM	AM	AW	AM	AM	AW	AM	AM	AW	AM	AM	AW	AM

Sample Description: Clear colourless
WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-020502 DO II-A-011201 Cond. II-A-990501
Comments:

Test Set Up By: AKN Data Verified By: Armando Tang Date Verified: August 5, 2004

AZIMUTH (POLARIS)

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

Tel: (604) 986-4331
Fax: (604) 662-8548
www.evsenvironment.com

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:

Address: Bag 2000
Kimberley, BC
V1A 3E9
Phone: 250 427-8405
Fax: 250 427.8451
Sampled by: Dennis Lu
Attn:
Shipping Date:

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (√)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	3 Sample Container Type by Code	Test(s) Requested: 96hr LC50 Rainbow Trout	Test(s) Requested: Tajima / Ceriodaphnia	Test(s) Requested: D. magna 48h LC50	Test(s) Requested	Test(s) Requested	4 Sample Notes (e.g. preserved, saltwater, freshwater, may contain sewage)
~~07/Jul/2004~~	~~22:00~~	~~G-Creek_070704~~											
07/Jul/2004	22:00	G-Creek_acute_070704	E		G	2x70L		X		X			
07/Jul/2004	22:00	G-Creek_sub_070704	E		G	3x70L			X				

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by:	Date:	2) Released by:	Date:
Company:	Time:	Company:	Time:
Courier name:		Courier name:	
1) Received: JGK	Date: 10 JUL 04	2) Received by:	Date:
Company: EVS	Time: 1425	Company:	Time:

Shaded area to be completed by EVS Laboratory upon sample receipt.

EVS Project No. 04-0302-54
EVS Work Order (WO) No. 0400302/303/304/307
EOH TOSM. RBT DAPH.
Condition Upon Receipt GOOD
Receipt Sample Temp. (C) 11.6°

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, yellow - accompany the shipment
Pink - kept by consignor (e.g., shipper)
Yellow - kept by consignee (e.g., receiver)
White - returned to consignor by consignee

Please see instructions for completion on back of form.

Revision Date: March 6, 2004

EVS environment consultants

August 9, 2004

Our File: 09-0302-54.00
Work Order: 0400342,348

Cheryl Mackintosh
Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Dear Ms. Mackintosh:

RE: Acute Toxicity Test Results for a sample collected July 27, 2004

We are pleased to provide you with the results of the toxicity tests performed on the sample identified as G-Creek acute 270704 (received July 27, 2004). The sample was tested with the 96-h rainbow trout LC50 test and the 48-h *Daphnia magna* LC50 test. Testing was performed according to the Environment Canada protocols for conducting acute toxicity tests using rainbow trout (EPS 1/RM/13, Second Edition, 2000) and *D. magna* (EPS 1/RM/14, Second Edition, 2000). An independent EVS QA/QC review confirmed that all acceptability criteria specified by the protocols were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Table 1. Toxicity Test Results.

Sample ID	Sample Date (Time h)	96-h Rainbow Trout LC50 (95% CL) (% v/v)	48-h *Daphnia magna* LC50 (95% CL) (% v/v)
G-Creek acute 270704	27-July-04 (2130h)	>100	>100

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Sincerely,

Rachel DeWynter, B.Sc.
Algal Bioassay Supervisor
rdewynter@evsenvironment.com

Verified By:

QA/QC Committee:
Armando Tang, B.Sc.
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.
John Wilcockson, M.Sc.

195 Pemberton Ave.
North Vancouver, BC
Canada V7P 2R4

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Fax: 604.662.8548
www.evsenvironment.com
info@evsenvironment.com

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth - (Polaris)
EVS Project No.: 09-0302-54.01
EVS Work Order No.: 0400348
EVS Analysts: JRY, AWD
Test Type: 48h LC50
Test Initiation Date: July 30, 2004

SAMPLE INFORMATION

Identification: G-Creek 270704
Amount Received: 3 x 20L
Date Collected: July 27, 2004
Date Received: July 30, 2004
Temperature (°C): 22.0 @ 21.5
pH: 7.8 @ 8.0
Dissolved Oxygen (mg/L): 12.1 @ 8.8
Conductivity (µmhos/cm): 5020
Hardness (mg/L as $CaCO_3$): 590
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

pH adjustment details: none
①Pre-aeration rate and duration: 10 minutes gentle aeration

DILUTION/CONTROL WATER (initial water quality)

Water Type: Moderately Hard Water (July 29)
Temperature (°C): 20.0
pH: 7.8
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 363
Hardness (mg/L as $CaCO_3$): 96
Alkalinity (mg/L as $CaCO_3$): 56
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): July 2B
Age (on Day 0): <24hrs.
Days to First Brood: 7
Avg. Young/Brood (after 1st brood): 24
% Mortality in 7 d Before Test: 6%
Reference Toxicant: ZnC
Current Reference Toxicant Result
Reference Toxicant Test Date: 27-Jul-04
48-h LC50 and 95% CL: 683 (578-807) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
463 ± 315 mg/L Zn %CV=34

TEST CONDITIONS

Temperature Range (°C): 20.0 - 21.5
pH Range: 7.7 - 8.0
Dissolved Oxygen Range (mg/L): 8.6 - 9.1
Conductivity Range (µS/cm): 363 - 5020
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48h LC50 of G-Creek 270704 is >100% (v/v)

Data Verified By: [signature]
Date Verified: Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth (Polaris) | Sample ID: G-Creek 270704
EVS Project No.: 04-0302-5401 | Date Collected: July 27, 2004
EVS Work Order No.: 0400348 | Test Initiation Date/Time: July 30, 2004 @ 14:00
Daphnid Broodstock Batch: July 2B | No. Organisms/Volume: 10/200ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.1	8.9	8.7	20.0	21.0	21.0	7.8	8.1	7.9	363	374
6.25				10	10	9.0	8.9	8.6	20.5	21.0	21.0	7.8	8.1	7.8	688	680
12.5				10	10	8.9	8.8	8.7	21.0	21.0	21.0	7.9	7.7	7.7	990	984
25				10	10	8.9	8.8	8.7	21.0	21.0	21.0	7.9	7.7	7.7	1592	1586
50				10	10	8.9	8.6	8.7	21.0	21.0	21.0	7.9	7.6	7.8	2750	2690
100				10	10	8.8	8.7	8.6	21.5	21.0	21.0	8.0	7.7	7.7	5020	4940
Technician Initials				~	~	JM	~	~	JM	~	~	JM	~	~	JM	~

Sample Description: Clear, colourless
WQ Instruments Used: Temp. Calibrated Hg Thermometers pH II-A-020502 DO II-A-011201 Cond. II-A-990901
Comments:

Test Set Up By: JRY | Data Verified By: [illegible] | Date Verified: Sept 8/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340 342 RSD
EVS Analysts: AWD
Test Type: 96h LC50
Test Initiation Date: Aug 1/04

SAMPLE
Identification: G-Creek acute 270704
Amount Received: 3x20L
Date Collected: July 27/04
Date Received: July 30/04
Other:

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 14
pH: 6.8
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 30
Hardness (mg/L as $CaCO_3$): 16
Alkalinity (mg/L as $CaCO_3$): 10
Other:

TEST SPECIES INFORMATION
Source: Fraser Valley
Collection Date/Batch: 070504
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: Aug 5/04
Fork Length (mm): 33 ± 2 (31-35)
Wet Weight (g): 0.34 ± 0.04 (0.29-0.42)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: July 23/04
Duration of Acclimation (days): 18
96-h LC50 (and 95% CL): 21 (17 and 26)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV = 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.6 - 10.1
Temperature Range (°C): 14
pH Range: 6.8 - 8.3
Conductivity Range (µS/cm): 30 - ~~4860~~ RSD 4870
Aeration Provided? (give rate): 6.5 ± 1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/10L
Loading Density (g/L): 0.34
Acclimation Before Testing (days): 27
Mortality In Previous Week of Acclimation (%): 0.25
Other:

TEST RESULTS The 96-h LC50 was estimated to be > 100% (v/v)

Data Verified By: [signature]
Date Verified: Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	14		14
pH	7.6		7.7
DO (mg/L)	10.1		10.1
Cond. (µS/cm)	4810		4870

1. Document pH adjustment procedure (if used) under "Comments".

Total Pre-Aeration Time 30 min

Client Polaris Azimuth
EVS Project No. 09-0302-54
EVS Work Order No. 0400~~346~~342
Trout Batch No. and 7-d Acclimation Mortality 070504/0.25%
No. Fish/Volume 10/10L
Sample ID G-Creek
Date/Time Collected July 27/04 @ ~~2230~~ 2130
Test Initiation Date/Time Aug 1-04 @ 1030

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control			10	10	10	10	10	10.1	9.8	9.6	9.7	9.9	14	14	14	14	14	68	71	74	72	73	38	41
6.25			10	10	10	10	10	10.1	9.8	9.6	9.7	9.7	14	14	14	14	14	71	74	75	74	72	~~360~~ 350	540
12.5			10	10	10	10	10	10.1	9.6	9.6	9.7	9.8	14	14	14	14	14	74	78	77	75	72	900	940
25			10	10	10	10	10	10.1	9.7	9.7	9.6	9.6	14	14	14	14	14	75	79	80	76	74	1670	1760
50			10	10	10	10	10	10.1	9.7	9.8	9.7	9.7	14	14	14	14	14	76	80	79	78	79	~~4840~~ 2020	2110
100			10	10	10	10	10	10.1	9.7	9.7	9.7	9.7	14	14	14	14	14	77	81	82	83	81	4870	4860
Technician Initials			~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temperature Calibrated Hg Thermometer pH II-A-030302 DO II-A-3 Conductivity II-A-030306
Sample Description Clear
Comments

Test Set Up By ~ Data Verified By [illegible] Date Verified Sept. 10/04

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Teck Cominco (Polaris) Client Contact Name: Cheryl. MacKintosh Ship to:

Address: Azimuth Consulting Group Phone: 604 730 9220

218-2902 West Broadway Fax: 604 739 8511

Vancouver B.C. Sampled By: Karlette Tinsley Attn: Shipping Date:

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	Type of Each Sample [1]	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab, C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	Sample Container Type by Code [2]	Tests Requested: 7D TOXMELT	RBT LC50 96H	48H ECHINODERM	48H DAPHNIA			Notes? (e.g. preserved, saltwater, freshwater, may contain sewage) [3]
For composite sample record date & time starting and ending														
27/07/04	9:30PM	G-Creek_Sublethal_270704	E			2x20L	HDPE	✓		✓				POLARIS PROJ
		G-Creek-Acute_270704	E			3x20L	HDPE		✓		✓			POLARIS PROJ

PO/Reference No.:

Project Title:

Results Needed By:

Comments/Instructions:

A) Released By: Date:
Company: Time:
Courier name:
Shipping containers secured by: Tape Straps Lock Other (circle one)
Custody seals used? Yes No

B) Received by: AWD Date: 30 JUL 04
Company: EVS Time: 12:00
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

C) Released By: Date:
Company: Time:
Courier name:
Shipping containers secured by: Tape Straps Lock Other (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify) HDPE Plastic
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

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Photocopy of original because 3 Cooler

EVS environment consultants

A member of the Golder group of companies

Golder Associates

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia
Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

Our File: 09-0302-54.00
Work Order: 0400382,383

September 2, 2004

Cheryl Mackintosh
Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Dear Ms. Mackintosh:

RE: Acute Toxicity Test Results for a sample collected August 24, 2004

We are pleased to provide you with the results of the toxicity tests performed on the sample identified as G-Creek acute 081704 (received August 24, 2004). The sample was tested with the 96-h rainbow trout LC50 test and the 48-h *Daphnia magna* LC50 test. Testing was performed according to the Environment Canada protocols for conducting acute toxicity tests using rainbow trout (EPS 1/RM/13, Second Edition, 2000) and *D. magna* (EPS 1/RM/14, Second Edition, 2000). An independent EVS QA/QC review confirmed that all acceptability criteria specified by the protocols were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Table 1. Toxicity Test Results.

Sample ID	Sample Date (Time h)	96-h Rainbow Trout LC50 (95% CL) (% v/v)	48-h *Daphnia magna* LC50 (95% CL) (% v/v)
G-Creek acute 081704	24-Aug-04 (1500h)	>100	>100

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Sincerely,

Robert Harrison, B.Sc. Hons.
Assistant Bioassay Test Supervisor– Fish Team
rharrison@evsenvironment.com

Verified By:

QA/QC Committee:
Armando Tang, B.Sc.
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.
John Wilcockson, M.Sc.

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth (Polaris)
EVS Project No.: 09-1108-01.01
EVS Work Order No.: 0400383
EVS Analysts: JRY, ~~BLR~~ AWP
Test Type: 48hr LC50
Test Initiation Date: August 27, 2004

SAMPLE INFORMATION
Identification: G-Creek 081704
Amount Received: 1x2L subsampled @ EVS from 1x20L
Date Collected: August 24, 2004
Date Received: August 27, 2004
Temperature (°C): 23.0 ① 22.0
pH: 7.8 ① 8.1
Dissolved Oxygen (mg/L): 10.2 ① 8.7
Conductivity (µmhos/cm): 9320
Hardness (mg/L as $CaCO_3$): 1220
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

pH adjustment details: none
Pre-aeration rate and duration: 20 minutes

DILUTION/CONTROL WATER (initial water quality)
Water Type: Moderately Hard water (Aug 23)
Temperature (°C): 20.5
pH: 8.0
Dissolved Oxygen (mg/L): 9.0
Conductivity (µS/cm): 319
Hardness (mg/L as $CaCO_3$): 84 80
Alkalinity (mg/L as $CaCO_3$): 50
Other: —

TEST SPECIES INFORMATION
Broodstock Culture ID (in-house culture): Aug 6A
Age (on Day 0): <24hrs
Days to First Brood: 7
Avg. Young/Brood (after 1st brood): 21
% Mortality in 7 d Before Test: 0
Reference Toxicant: Zinc
Current Reference Toxicant Result
Reference Toxicant Test Date: August 24, 2004
48-h LC50 and 95% CL: 536 (438 - 656) µS/cm Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
481 ± 322 µS/cm Zn ; CV = 33

TEST CONDITIONS
Temperature Range (°C): 20.5 - 22.0
pH Range: 7.6 - 8.1
Dissolved Oxygen Range (mg/L): 8.5 - 9.0
Conductivity Range (µS/cm): 303 - 9320
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48hr LC50 of G-Creek 081704 is > 100 % (v/v).

Data Verified By: [signature]
Date Verified: Nov. 16/04

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimuth (Pobris)
EVS Project No. 04-1108-01.01
EVS Work Order No. 0400383
Daphnid Broodstock Batch Aug 6A

Sample ID G-Creek 081704
Date Collected August 24, 2004
Test Initiation Date/Time August 27/04 @ 11:00
No. Organisms/Volume 10/200ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.0	8.8	8.7	20.5	21.0	21.5	8.0	7.6	7.7	319	305
6.25				10	10	9.0	8.7	8.7	20.5	21.5	21.5	8.0	7.6	7.7	919	924
12.5				10	10	9.0	8.7	8.6	20.5	21.5	21.5	8.0	7.7	7.8	1514	1551
25				10	10	9.0	8.7	8.6	20.5	21.5	21.5	8.0	7.6	7.8	2720	2810
50				10	10	8.9	8.6	8.5	21.0	21.5	21.5	8.0	7.7	7.8	4960	4920
100				10	10	8.7	8.7	8.5	22.0	21.5	21.5	8.1	7.7	7.8	9320	9120
Technician Initials				~	~	JM	~	~	JM	~	~	JM	~	~	JM	~

Sample Description Clear, colourless
WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-080501 DO II-A-011201 Cond. II-A-990501
Comments

Test Set Up By JRY Data Verified By [signature] Date Verified Nov. 16/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth (Polaris) | EVS Analysts: AMD, RETH
EVS Project No.: 09-0302-54 | Test Type: 96-h LC50
EVS Work Order No.: 0900382 | Test Initiation Date: August 27/04 @ 1145

SAMPLE
Identification: G-Creek
Amount Received: 5 x 20L
Date Collected: Aug 24/04
Date Received: Aug 27/04
Other: —

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15
pH: 7.4
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 46
Hardness (mg/L as $CaCO_3$): 16
Alkalinity (mg/L as $CaCO_3$): 10
Other: —

TEST SPECIES INFORMATION
Source: Sun Valley
Collection Date/Batch: 072804
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: Aug 31/04
Fork Length (mm): 0.40 ± 0.02 (0.38–0.44)
Wet Weight (g): 0.45 ± 0.10 (0.31–0.61)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: Aug 27/04
Duration of Acclimation (days): 30
96-h LC50 (and 95% CL): 38 (33 and 44) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 13 mg/L SDS CV: 22%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.1 – 10.1
Temperature Range (°C): 15 each
pH Range: 7.2 – 7.89
Conductivity Range (µS/cm): 46 – 7533
Aeration Provided? (give rate): 6.5 ± 1 mL/min
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10 / 12L
Loading Density (g/L): 0.38
Acclimation Before Testing (days): 30
Mortality In Previous Week of Acclimation (%): 0
Other: —

TEST RESULTS The 96-h LC50 was estimated to be >100% (v/v)

Data Verified By: Original | Date Verified: Nov 16/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	15		15
pH	7.7		7.7
DO (mg/L)	9.9		10.1
Cond. (µS/cm)	7416		7416

1. Document pH adjustment procedure (if used) under "Comments".

Total Pre-Aeration Time 30 minutes

Client Azimuth (Polaris)
EVS Project No. 09-0302-S4
EVS Work Order No. 0400382
Trout Batch No. and 7-d Acclimation Mortality 072804 / 0%
No. Fish/Volume 10/12L
Sample ID G-Creek
Date/Time Collected August 24/04 @ 1500
Test Initiation Date/Time August 27/04 @ 1145

Concentration % (V/V)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	10.1	9.9	9.8	10.0	9.8	15	15	15	15	15	7.4	7.4	7.5	7.2	7.4	46	58
6.25				10	10	10	10	10.1	9.7	9.8	10.0	9.9	15	15	15	15	15	7.5	7.5	7.9	7.4	7.9	556	601
12.5				10	10	10	10	10.1	9.9	9.8	9.3	9.6	15	15	16	15	15	7.6	7.5	7.8	7.5	7.6	1030	1054
25				10	10	10	10	10.1	9.8	9.9	9.1	9.5	15	15	16	15	15	7.6	7.7	7.8	7.6	7.6	1825	1881
50				10	10	10	10	10.1	9.8	9.9	9.5	9.3	15	16	16	15	15	7.7	7.8	7.7	7.6	7.7	3950	3983
100				10	10	10	10	10.1	9.8	9.9	9.6	9.5	15	15	16	15	15	7.7	7.8	7.9	7.8	7.8	7416	7533
Technician Initials						RKH	RKH	RKH			RKH	RKH	RKH			RKH	RKH	RKH			RKH	RKH	RKH	RKH

WQ Instruments Used: Temperature Calibrated Hg Thermo pH II-A-020601 DO II-A-3 Conductivity II-A-030306
Sample Description Test is clear with slight cloudy
Comments

Test Set Up By RKH Data Verified By [signature] Date Verified Nov. 16/04

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

Client Name: Atlantic Consulting Ltd / Teck Cominco
Client Contact Name: Cheryl Mackenzie / Bruce Deed
Ship to: EVS Environmental Consultants
Address: 208-2002 West Broadway, Vancouver BC, V6K 2G8
Phone: (604) 730-1220
Fax: (604) 739-9070
195 Pemberton Ave., North Vancouver, BC, V7P 2R4
Shipping Date: Aug. 31, 2004
Sampled By: Brandy Hooker / Mackenzie
Attn: Edmund Chavis

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested						3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (°C)	4 Condition/Integrity
For composite sample record date & time starting and ending								Rainbow trout 96hr LC50	Daphnia magna 48hr LC50	7-day Ceriodaphnia	Echinoderm 48hr fertilization					
31/Aug/04	15:00	G-Creek-mouth	C		G	5x20L	C	✓	✓	✓	✓			Preserved 4°C pot		

EVS Receipt Check List

EVS Project #: 04-1108-01
EVS Workorder #: 0408532 / 3855 / 3856 / 3857
Sample Storage Location: 4°C ☒ Chemical ☐ Other: RET / MMER / Geotech
Supporting documentation/other information attached if applicable:

1. Signatures & dates correct? Y N
2. Chain-of-custody fully completed? Y N
3. Containers arrived in good condition (unbroken)? Y N
4. Container labels completed (i.e. dates, ID's)? Y N
5. Container labels agreed with custody papers? Y N
6. Sample receipt temperature within acceptable range? Y N
7a. Sediment testing going to be initiated within 14 days? Y N
7b. If no, are samples under Nitrogen? If not, why? Y N
8. Chain-of-custody generated upon receipt? ☐
9. Sample containers originate from EVS? ☐

PO/Reference No.: 11-05-03
Project Title: Blais Miner
Results Needed By:

Comments/Instructions:

A) Released By: [illegible] Date: Aug 31/04
Company: Atlantic Time: 4:00pm
Courier name: Bus via Prince
Shipping containers secured by: (Tape) Straps Lock Other _____ (circle one)
Custody seals used? Yes No METAL STRIPS

B) Received by: DXF Date: 7 SEP 04
Company: EVS Time: 0945
Shipping containers received secure? (Yes) No
Custody seals intact? (Yes) No N/A

C) Released By: Date:
Company: Time:
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

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White - returned to consignor by consignee

Revision Date: Sept. 25, 2000

APPENDIX E

Sublethal Toxicity Testing Laboratory Reports

Azimuth Consulting Group

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 10, 2004

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 10, 2004

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

09-0302-54

September 2004

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3.1 7-d Topsmelt (*Atherinops affinis)* Survival and Growth Toxicity Test 4
3.2 Quality Assurance/Quality Control (QA/QC) 4

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APPENDIX A Raw Data and Statistical Analyses: *Atherinops affinis*

APPENDIX B Chain-of-Custody Form

LIST OF TABLES

Table 1: 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods **3**

Table 2: Summary of results for the 7-d Topsmelt (*Atherinops affinis)* surival and growth toxicity test. **5**

ACKNOWLEDGEMENTS

Toxicity testing was conducted by Andy Diewald, Anja Fouche, Keven Goodearle, Ann-Marie Norris and Jenny Shao. Statistical analyses were perfomed by Jenny Shao The report was written by Kathryn Sentance and reviewed by Edmund Canaria. Quality Assurance/Quality Control (QA/QC) review was conducted by Julianna Kalokai.

1. INTRODUCTION

EVS Environment Consultants conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as G Creek, was collected from the Polaris Mine Site on July 07, 2004 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on July 10, 2004 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test. The 7-d topsmelt toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test. The raw data and statistical analyses are provided in Appendix A and the chain-of-custody form is provided in Appendix B.

The sample was also intended for toxicity evaluation using the echinoderm (*Dendraster excentricus*) fertilization toxicity test as part of the EEM program requirements. The test was not initiated successfully due to inability of the sand dollars to spawn.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d toxicity test and reference toxicant test using topsmelt (A. *affinis*) was conducted in accordance with EVS Environment Consultants Standard Operating Procedures (SOP) 1100-4 (EVS, 2002) with modifications based on U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994). The Power Standards were calculated as outlined by the Washington Department of Ecology (WDOE, 2001).

2.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and record-keeping, and use of standard operating procedures (SOPs). To ensure the highest quality of data and reporting, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	11d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.45µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 9.1, 18.2, 36.3, 72.6% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The highest concentration tested was 72.6% due to salinity adjustment. The test results are summarized in Table 2 and the raw statistical analyses are provided in Appendix A.

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). The mean survival in both the negative and brine controls was 96%.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

An attempt was made to initiate the echinoderm (*Dendraster excentricus*) fertilization toxicity test as part of the sample evaluation requirements. The sand dollars purchased from Westwind Sealab Supplies, did not spawn, and consequently, the test was not initiated. The inability of the sand dollars to spawn may have resulted from various reasons such as handling of organisms during transport, seasonal conditions, holding and culturing conditions and poor quality of organisms.

Table 2. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% v/v)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	96.0 ± 8.9	0.93 ± 0.18
Brine Control	96.0 ± 8.9	1.08 ± 0.17
Pooled Controls	96.0 ± 8.4	1.00 ± 0.18
4.5	100 ± 0.0	1.00 ± 0.08
9.1	100 ± 0.0	1.04 ± 0.09
18.2	100 ± 0.0	0.96 ± 0.09
36.3	96.0 ± 8.9	1.10 ± 0.15
72.6	92.0 ± 11.0	0.99 ± 0.22
TEST ENDPOINT	**SURVIVAL (% v/v)**	**GROWTH (% v/v)**
NOEC	72.6	72.6
LOEC	>72.6	>72.6
LC50	>72.6	na
IC50	na	>72.6
IC25	na	>72.6

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; na – not applicable.

4. REFERENCES

EVS (EVS Environment Consultants). 2002. Topsmelt (*Atherinops affinis*) 7-d larval survival and growth test. EVS SOP 1100-4. In: EVS Consultants Laboratory Standard Operating Procedures (SOP) Manual. Volume II: Water Toxicity Tests. EVS Environment Consultants, North Vancouver, BC.

US EPA (U.S. Environmental Protection Agency). 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 3rd edition. US Environmental Protection Agency, Office of Water (4303T). US Environmental Protection Agency, Washington, DC. EPA/821/R-02/014. 464 pp.

US EPA. 1995. Short term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 2nd edition. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Office of Research and Development, Washington, DC. EPA/600/R-95/136. 563 pp.

Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX A

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client ** Azimuth (Polaris Mine)
EVS Project No. 09-0302-54
EVS Work Order No. 0400303

EVS Analysts KMG. AKN AWD. AXF, JXS
Test Initiation Date 10-Jul-04

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-CREEK -070704	-	-
Amount Received		-	-
Date Collected		-	-
Date Received	10-Jul-04	-	-
Temperature (°C)	19.5 ① → 19.0	-	-
pH	8.1 ① → 8.0	-	-
DO (mg/L)	9.3 ① → 7.9	-	-
Conductivity (µmhos/cm)	11600	-	-
Salinity (ppt)	7 ① → 29	-	-
Ammonia (mg/L N)	-	-	-
Chlorine (mg/L Cl)	-	-	-
Other	-	-	-

DILUTION/CONTROL WATER (initial water quality)
Water Type UV STERILIZED, FILTERED SEA H2O
Temperature (°C) 20.0
pH 8.0
Dissolved Oxygen (mg/L) 7.6
Salinity 28

TEST SPECIES INFORMATION
Source AQUATIC BIO SYSTEMS (ABS)
Date Received 08-Jul-04
Age (on Day 0) 11d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 10-Jul-04
7-d survival LC50 ~~143~~ 161 ~~148-203~~ 203 mg/L Cu (139-188)
7-d growth IC50 147 mg/L Cu (119-169)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 134 mg/L Cu ± ~~28.5~~ 28.6 CV = 21%
7-d growth IC50 135 mg/L Cu ± ~~24~~ 25 CV = 19%

① SAL. ADJ. TO 30 ± 2 ppt.

TEST CONDITIONS
Temperature Range (°C) 19.0 - 21.0
pH Range 7.8 - 8.3
Dissolved Oxygen Range (mg/L) 6.1 - 7.9
Salinity (ppt) 28 - 31
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other —

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	72.6	> 72.6	> 72.6		
Growth		72.6	> 72.6		> 72.6	> 72.6

Other -

Data Verified By Galyn A
Date Verified August 18/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Pebble Mines) | Sample ID: G-Creek [illegible] 7 of 7

EVS Project No.: 09-0302-84 | Test Initiation Date/Time: 10-Jul-04 / 1730h

EVS Work Order No.: 04CC303 | Source/Date Received: ABS / 08-Jul-04

Concentration (% v/v)	Temperature (°C)													
	0	1		new 2	old	3		new 4	old	new 5	old	new 6	old	7
Neg. Ctl	20.0	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
Brine Ctl	20.0	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
4.5	20.0	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
9.1	20.0	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
18.2	20.0	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
36.3	19.5	20.0	19.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
72.6	19.0	20.0	19.5	20.0	20.5	20.5	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
Tech. Initials	KWL	AF	AF				JAS	JAS	JAS			JAS	JAS	

Concentration (% v/v)	pH													
	0	1		2		3		New 4		5		6		7
Neg. Ctl	8.0	8.0	7.9	7.9	7.8	7.9	7.8	8.0	7.8	8.0	7.9	8.0	7.9	7.9
Brine Ctl	8.1	8.0	7.9	7.9	7.8	7.9	7.8	8.0	7.8	8.0	7.9	8.0	7.9	7.9
4.5	8.0	8.0	7.9	7.9	7.8	7.9	7.8	8.0	7.9	~~7.6~~ 8.1	7.9	8.0	7.9	7.9
9.1	8.0	8.0	7.9	7.9	7.8	7.9	7.8	8.0	7.9	8.1	8.0	8.0	8.0	7.9
18.2	8.0	8.0	7.9	7.9	7.8	7.9	7.9	8.1	8.0	8.2	8.1	8.1	8.0	7.9
36.3	8.0	8.0	7.9	7.9	7.9	7.9	7.9	8.1	8.0	8.3	8.1	8.1	8.1	8.0
72.6	8.0	8.0	7.9	8.0	7.9	8.1	8.0	8.2	8.1	8.3	8.2	8.2	8.1	8.1
Tech. Initials	KWL	AF	AF		AXF		JAS	JAS	JAS			JAS	JAS	

WQ Instruments Used: Temp. Cal. Hg Therm. pH II-A-030301

Comments

Test Set Up By KWL Data Verified By [signature] Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: G-Creek - 070704

EVS Project No.: 04-0302.54 | Test Initiation Date/Time: 10-Jul-04 / 1730h

EVS Work Order No.: 0406303 | Source/Date Received: ABS / 08-Jul-04

Concentration (% v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Neg. Ctl	28	30	28	28	28	28	28	29
Brine Ctl	29	30	30	29	29	30	30	30
4.5	28	30	28	28	28	28	28	29
9.1	28	31	28	28	28	28	28	29
18.2	28	30	28	28	28	28	28	29
36.3	28	31	28	28	28	28	28	29
72.6	29	30	28	28	28	28	28	29
Tech. Initials	KMB	AL	~	~	JLJ	~	JLJ	~

Concentration (% v/v)	Dissolved Oxygen (mg/L)													
	0	1		2		3		New 4		5		6		7
Neg. Ctl	7.6	7.6	7.4	7.5	6.1	7.4	6.2	7.6	6.6	7.5	6.9	7.6	6.6	6.7
Brine Ctl	7.6	7.6	7.5	7.5	6.2	7.5	6.2	7.5	6.6	7.5	6.8	7.5	6.6	6.6
4.5	7.4	7.6	7.3	7.4	6.1	7.4	6.2	7.6	6.4	7.4	6.8	7.6	6.7	6.8
9.1	7.4	7.6	7.3	7.4	6.1	7.4	6.2	7.6	6.5	7.4	6.8	7.6	6.6	6.7
18.2	7.6	7.4	7.3	7.5	6.3	7.4	6.2	7.6	6.6	7.4	6.7	7.6	6.6	6.7
36.3	7.6	7.6	7.4	7.5	6.3	7.5	6.2	7.6	6.6	7.4	6.8	7.6	6.5	6.7
72.6	7.9	7.6	7.2	7.6	6.4	7.6	6.2	7.6	6.5	7.4	6.8	7.6	6.6	6.7
Tech. Initials	KMB	~	~	AK	AXF	~	JLJ	JLJ	JLJ	~	~	JLJ	JLJ	~

WQ Instruments Used: Salinity II-A-030306 DO II-A-3 / II-A-011202

Comments

Test Set Up By: KMB Data Verified By: [signature] Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54
EVS Work Order No.: 04 08303

Sample ID: ~~EE~~ G-Creek-070704
Test Species/Batch: A. affinis / 6-29-04
Test Initiation Date/Time: 10-Jul-04 / 1730h
No. of Organisms/Volume: 5 / 200 mL

Concentration (% v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
Neg Ctl	A	T1	5	5	5	5	5	5	5	
	B	T2	5	5	5	5	5	5	5	
	C	T3	5	5	5	5	4	4	4	
	D	T4	5	5	5	5	5	5	5	
	E	T5	5	5	5	5	5	5	5	
Reinf Ctl.	A	T6	5	5	5	5	5	5	5	
	B	T7	5	5	5	5	5	5	~~5~~ 4	
	C	T8	5	5	5	5	5	5	5	
	D	T9	5	5	5	5	5	5	5	
	E	T10	5	5	5	5	5	5	5	
4.5	A	T11	5	5	5	5	5	5	5	
	B	T12	5	5	5	5	5	5	5	
	C	T13	5	5	5	5	5	5	5	
	D	T14	5	5	5	5	5	5	5	
	E	T15	5	5	5	5	5	5	5	
9.1	A	T16	5	5	5	5	5	5	5	
	B	T17	5	5	5	5	5	5	5	
	C	T18	5	5	5	5	5	5	5	
	D	T19	5	5	5	5	5	5	5	
	E	T20	5	5	5	5	5	5	5	
Technician Initials		JW	AH	AH	JW	JW	JW	JW	JW	

Sample Description: LIGHT GREY TRANSPARENT, NO ODOUR.
Data Verified By: [signature]
Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-0302-54
EVS Work Order No.: 0400303

Sample ID: G. CREEK - 070704
Test Species/Batch: A. AFFINIS / 6.09.04
Test Initiation Date/Time: 10-JUL-04 / 1730h
No. of Organisms/Volume: 5 / 200mL

Concentration (% v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
18.2	A	T21	5	5	5	5	5	5	5	
	B	T22	5	5	5	5	5	5	5	
	C	T23	5	5	5	5	5	5	5	
	D	T24	5	5	5	5	5	5	5	
	E	T25	5	5	5	5	5	5	5	
36.3	A	T26	5	5	5	5	5	5	5	
	B	T27	5	5	5	5	5	5	5	
	C	T28	4	4	4	4	4	4	4	
	D	T29	5	5	5	5	5	5	5	
	E	T30	5	5	5	5	5	5	5	
72.6	A	T31	5	5	5	5	5	5	5	
	B	T32	5	5	5	5	5	5	5	
	C	T33	5	5	5	5	5	5	4	
	D	T34	5	5	5	5	5	5	5	
	E	T35	5	5	5	5	5	5	4	
	A									
	B									
	C									
	D									
	E									
Technician Initials		Tay		AH/m	JJ	JD	JM	JLS		

Sample Description: LIGHT GREY, TRANSPARENT, NO ODOUR.
Data Verified By: Quality
Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111

Test Type: 7 d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: G & L Creek - 070704

Sample ID 0% (S/U)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
Ctl	A	1	1265.92	1271.98	5	5		TM
	B	2	1267.67	1272.69	5	5		
	C	3	1264.20	1269.67	4	4		
	D	4	1265.68	1268.14	5	5		
	E	5	1265.14	1269.37	5	5		
Brine Ctl	A	6	1275.52	1281.17	5	5		TM
	B	7	1262.43	1266.70	4	4		
	C	8	1261.98	1268.48	5	5		
	D	9	1264.82	1270.38	5	5	confirmed: 1270.27 mg ✓	
	E	10	1262.05	1267.02	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]
Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111

Test Type: 7 d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: G L Creek - 070704

Sample ID % (J/J)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
4.5	A	T 11	1266.53	1271.28	5	5		JJ
	B	12	1271.92	1276.64	5	5		
	C	13	1270.40	1275.21	5	5		
	D	14	1276.78	1282.46	5	5		
	E	15	1248.70	1253.83	5	5		
9.1	A	T 16	1273.13	1278.39	5	5		JJ
	B	17	1259.26	1264.29	5	5		
	C	18	1270.13	1274.65	5	5		
	D	19	1258.37	1263.78	5	5		
	E	20	1256.17	1261.85	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Gal Jick

Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111

Test Type: 7 d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: G-L Creek - 070704

Sample ID % (S/J)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
18.2	A	21	1257.35	1262.90	5	5		JCS
	B	22	1273.94	1278.48	5	5	confirmed: 1278.26 ✓	
	C	23	1277.53	1282.20	5	5		
	D	24	1274.93	1279.50	5	5		
	E	25	1268.36	1272.94	5	5		
36.3	A	26	1269.83	1275.11	5	5	confirmed 1274.99 mg ✓	JCS
	B	27	1269.98	1276.47	5	5		
	C	28	1276.05	1280.68	4	4		
	D	29	1249.27	1254.33	5	5		
	E	30	1265.89	1271.96	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Gaigh

Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP211

Test Type: 7 d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: 6 Creek - 070704

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
72.6 (5/5)	A	T 31	1251.66	1256.44	5	5	confirmed: 1256.42 mg ✓	JG
↓	B	32	1263.20	1269.86	5	5		↓
	C	33	1278.57	1282.63	4	4		
	D	34	1281.29	1285.32	5	5		
	E	√ 35	1253.46	1258.69	4	4		↓
	A	T 6						
	B	7						
	C	8						
	D	9						
	E	√ 10						

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Galyk

Date Verified: August 17/04

Test: LF-Larval Fish Growth and Survival Test
Test ID: 0400303
Species: AA-Atherinops affinis
Protocol: EPAW 95-EPA West Coast
Sample ID: G-Creek-070704
Sample Type: EFF2-Industrial
Start Date: 7/10/2004 End Date: 7/17/2004
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	Neg Control	5							5	5	1271.98	1265.92
	2	2	Neg Control	5							5	5	1272.69	1267.67
	3	3	Neg Control	5							4	4	1269.67	1265.68
	4	4	Neg Control	5							5	5	1268.14	1264.2
	5	5	Neg Control	5							5	5	1269.37	1265.14
	6	1	Brine Control	5							5	5	1281.17	1275.52
	7	2	Brine Control	5							4	4	1266.7	1262.43
	8	3	Brine Control	5							5	5	1268.48	1261.98
	9	4	Brine Control	5							5	5	1270.38	1264.82
	10	5	Brine Control	5							5	5	1267.02	1262.05
	11	1	4.500	5							5	5	1271.28	1266.53
	12	2	4.500	5							5	5	1276.64	1271.92
	13	3	4.500	5							5	5	1275.21	1270.46
	14	4	4.500	5							5	5	1282.46	1276.78
	15	5	4.500	5							5	5	1253.83	1248.7
	16	1	9.100	5							5	5	1278.39	1273.13
	17	2	9.100	5							5	5	1264.29	1259.26
	18	3	9.100	5							5	5	1274.65	1270.13
	19	4	9.100	5							5	5	1263.78	1258.37
	20	5	9.100	5							5	5	1261.85	1256.17
	21	1	18.200	5							5	5	1262.9	1257.35
	22	2	18.200	5							5	5	1278.48	1273.94
	23	3	18.200	5							5	5	1282.2	1277.53
	24	4	18.200	5							5	5	1279.5	1274.93
	25	5	18.200	5							5	5	1272.94	1268.36
	26	1	36.300	5							5	5	1275.11	1269.83
	27	2	36.300	5							5	5	1276.47	1269.98
	28	3	36.300	5							4	4	1280.68	1276.05
	29	4	36.300	5							5	5	1254.33	1249.27
	30	5	36.300	5							5	5	1271.98	1265.87
	31	1	72.600	5							5	5	1256.44	1251.66
	32	2	72.600	5							5	5	1269.86	1263.2
	33	3	72.600	5							4	4	1282.63	1278.57
	34	4	72.600	5							5	5	1285.32	1281.29
	35	5	72.600	5							4	4	1258.69	1253.46

Comments: Azimuth(Polaris Mine)09-0302-54; 0400303

Reviewed by: August 18/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/10/2004	Test ID: 400303	Sample ID: G-Creek-070704
End Date:	7/17/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:		Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54; 0400303		

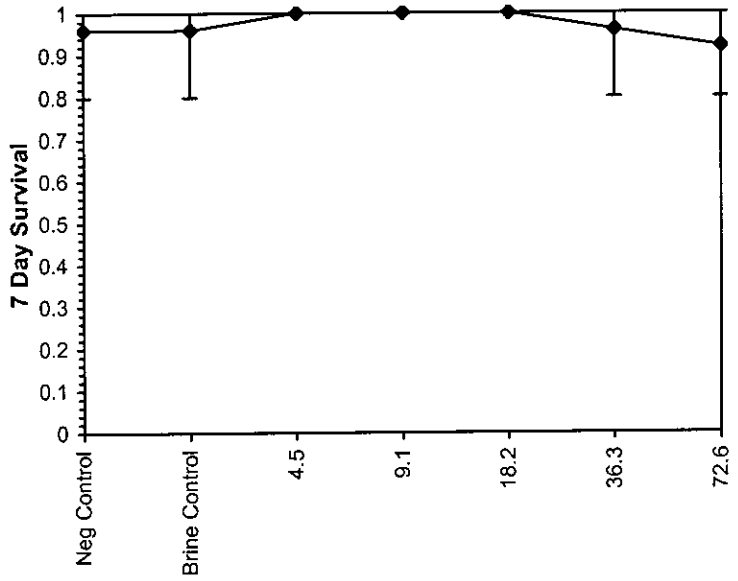
Conc-%	1	2	3	4	5
Neg Control	1.0000	1.0000	0.8000	1.0000	1.0000
Brine Control	1.0000	0.8000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	1.0000	1.0000
9.1	1.0000	1.0000	1.0000	1.0000	1.0000
18.2	1.0000	1.0000	1.0000	1.0000	1.0000
36.3	1.0000	1.0000	0.8000	1.0000	1.0000
72.6	1.0000	1.0000	0.8000	1.0000	0.8000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Neg Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5		
Brine Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5		
4.5	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	16.00
9.1	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	16.00
18.2	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	16.00
36.3	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	27.50	16.00
72.6	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	25.00	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.76012	0.9	-1.4778	1.97749
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	72.6	>72.6		1.37741

Dose-Response Plot



Statistical comparisons were aginst the Neg Control only

Reviewed by: August 18/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/10/2004	Test ID:	400303	Sample ID:	G-Creek-070704
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54; 0400303				

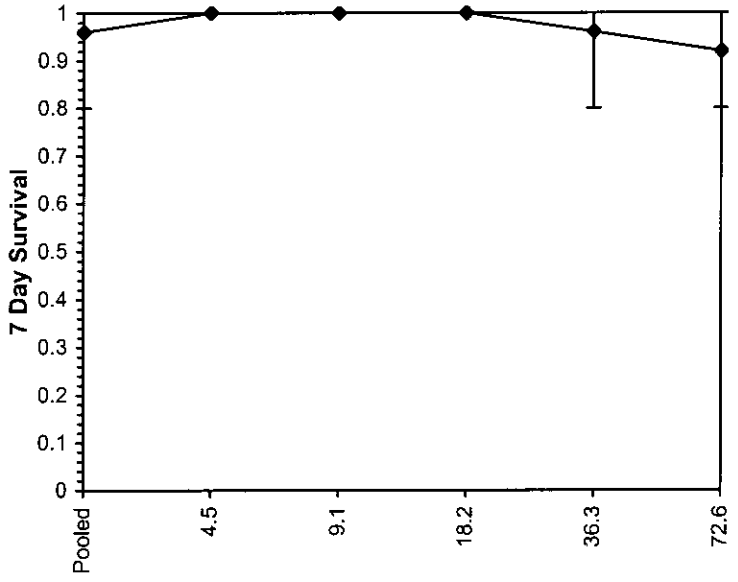
Conc-%	1	2	3	4	5
Neg Control	1.0000	1.0000	0.8000	1.0000	1.0000
Brine Control	1.0000	0.8000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	1.0000	1.0000
9.1	1.0000	1.0000	1.0000	1.0000	1.0000
18.2	1.0000	1.0000	1.0000	1.0000	1.0000
36.3	1.0000	1.0000	0.8000	1.0000	1.0000
72.6	1.0000	1.0000	0.8000	1.0000	0.8000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	0.9600	0.0843	1.2977	1.1071	1.3453	7.738	10		
4.5	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	45.00	21.00
9.1	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	45.00	21.00
18.2	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	45.00	21.00
36.3	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	40.00	21.00
72.6	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	35.00	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.74527	0.91	-1.5211	1.67424
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	72.6	>72.6		1.37741

Dose-Response Plot



Statistical comparisons were against the Pooled Controls

Reviewed by: August 18/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/10/2004	Test ID:	400303	Sample ID:	G-Creek-070704
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54; 0400303				

Conc-%	1	2	3	4	5
Neg Control	1.2120	1.0040	0.7980	0.7880	0.8460
Brine Control	1.1300	0.8540	1.3000	1.1120	0.9940
4.5	0.9500	0.9440	0.9500	1.1360	1.0260
9.1	1.0520	1.0060	0.9040	1.0820	1.1360
18.2	1.1100	0.9080	0.9340	0.9140	0.9160
36.3	1.0560	1.2980	0.9260	1.0120	1.2220
72.6	0.9560	1.3320	0.8120	0.8060	1.0460

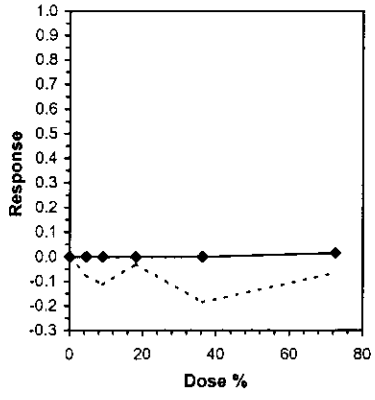
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Neg Control	0.9296	0.1800	0.9296	0.7880	1.2120	19.366	5				1.0052	1.0000
Brine Control	1.0780	0.1661	1.0780	0.8540	1.3000	15.410	5					
4.5	1.0012	0.0826	1.0012	0.9440	1.1360	8.252	5	-0.786	2.360	0.2151	1.0052	1.0000
9.1	1.0360	0.0876	1.0360	0.9040	1.1360	8.456	5	-1.168	2.360	0.2151	1.0052	1.0000
18.2	0.9564	0.0864	0.9564	0.9080	1.1100	9.035	5	-0.294	2.360	0.2151	1.0052	1.0000
36.3	1.1028	0.1533	1.1028	0.9260	1.2980	13.901	5	-1.901	2.360	0.2151	1.0052	1.0000
72.6	0.9904	0.2161	0.9904	0.8060	1.3320	21.819	5	-0.667	2.360	0.2151	0.9904	0.9853

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93465	0.9	0.85573	0.53805
Bartlett's Test indicates equal variances (p = 0.27)	6.38263	15.0863		
The control means are not significantly different (p = 0.21)	1.35465	2.30601		

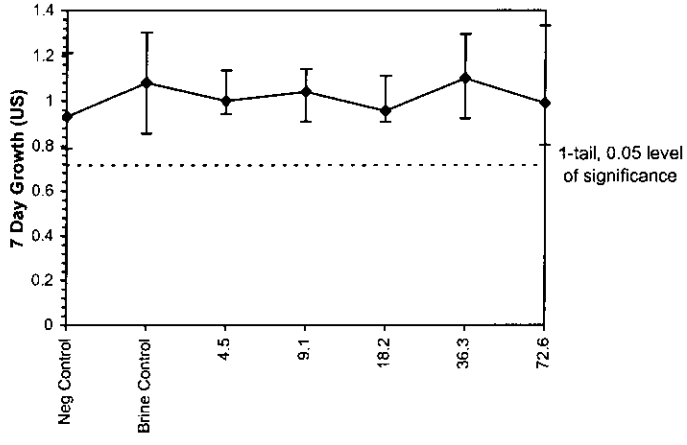
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	72.6	>72.6		1.37741	0.21507	0.23136	0.01877	0.02076	0.49467	5, 24

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	>72.6			
IC10	>72.6			
IC15	>72.6			
IC20	>72.6			
IC25	>72.6			
IC40	>72.6			
IC50	>72.6		%(v/v)	



Dose-Response Plot



Statistical comparisons were against the Neg Control only

Reviewed by: August 18/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/10/2004	Test ID:	400303	Sample ID:	G-Creek-070704
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54; 0400303				

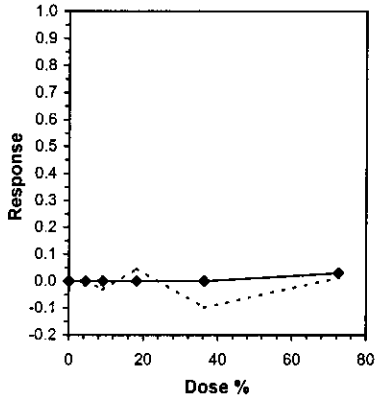
Conc-%	1	2	3	4	5
Neg Control	1.2120	1.0040	0.7980	0.7880	0.8460
Brine Control	1.1300	0.8540	1.3000	1.1120	0.9940
4.5	0.9500	0.9440	0.9500	1.1360	1.0260
9.1	1.0520	1.0060	0.9040	1.0820	1.1360
18.2	1.1100	0.9080	0.9340	0.9140	0.9160
36.3	1.0560	1.2980	0.9260	1.0120	1.2220
72.6	0.9560	1.3320	0.8120	0.8060	1.0460

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	1.0038	0.1811	1.0038	0.7880	1.3000	18.038	10				1.0200	1.0000
4.5	1.0012	0.0826	1.0012	0.9440	1.1360	8.252	5	0.031	2.462	0.2040	1.0200	1.0000
9.1	1.0360	0.0876	1.0360	0.9040	1.1360	8.456	5	-0.389	2.462	0.2040	1.0200	1.0000
18.2	0.9564	0.0864	0.9564	0.9080	1.1100	9.035	5	0.572	2.462	0.2040	1.0200	1.0000
36.3	1.1028	0.1533	1.1028	0.9260	1.2980	13.901	5	-1.195	2.462	0.2040	1.0200	1.0000
72.6	0.9904	0.2161	0.9904	0.8060	1.3320	21.819	5	0.162	2.462	0.2040	0.9904	0.9709

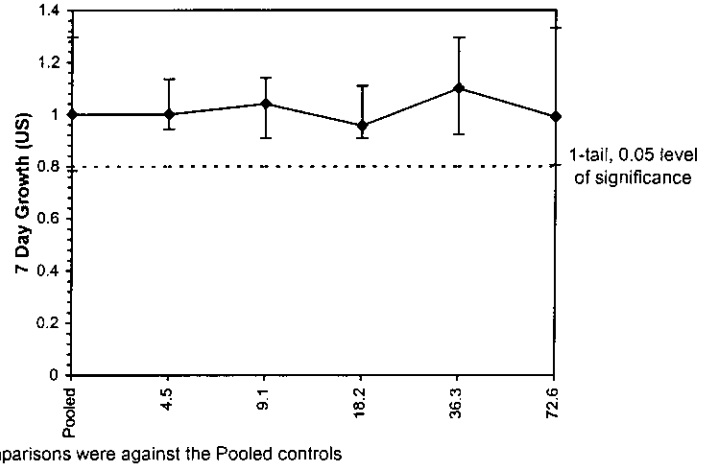
Auxiliary Tests				Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)				0.95473		0.91		0.53946	-0.0716
Bartlett's Test indicates equal variances (p = 0.23)				6.8891		15.0863			
The control means are not significantly different (p = 0.21)				1.35465		2.30601			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Bonferroni t Test	72.6	>72.6		1.37741	0.20401	0.20324	0.01261	0.02289	0.73615	5, 29

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	>72.6			
IC10	>72.6			
IC15	>72.6			
IC20	>72.6			
IC25	>72.6			
IC40	>72.6			
IC50	>72.6		%(v/v)	



Dose-Response Plot



Statistical comparisons were against the Pooled controls

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-0302-54
EVS Work Order No.: 0400303

EVS Analysts: KMG, AKN, AWD, AVF, JXS
Test Initiation Date: 10-Jun-04

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	Cu Reftox (04-Cu-001)	–	–
Amount ~~Received~~ Refreshed	1 x 1L	–	–
Date ~~Collected~~ Prepared	15-MAR-04	–	–
Date Received	–	–	–
Temperature (°C)	–	–	–
pH	–	–	–
DO (mg/L)	–	–	–
Conductivity (µmhos/cm)	–	–	–
Salinity (ppt)	–	–	–
Ammonia (mg/L N)	–	–	–
Chlorine (mg/L Cl)	–	–	–
Other	–	–	–

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Sterilized, Filtered Sea H2O
Temperature (°C): 20.0
pH: 8.0
Dissolved Oxygen (mg/L): 7.6
Salinity: 28

TEST SPECIES INFORMATION

Source: Aquatic BioSystems (ABS)
Date Received: 08-Jun-04
Age (on Day 0): 11d
Reference Toxicant: Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date: 15-Jul-04
7-d survival LC50: 161 mg/L Cu ~~(145-203)~~ (139-188)
7-d growth IC50: 147 mg/L Cu (119-169)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50: 137 mg/L Cu ± 23.50 CV = 21%
7-d growth IC50: 135 mg/L Cu ± 26.51 CV = 19%

TEST CONDITIONS

Temperature Range (°C): 19.5 - 20.5
pH Range: 7.8 - 8.0
Dissolved Oxygen Range (mg/L): 6.4 - 7.6
Salinity (ppt): 23-33
Photoperiod (L:D h): 16:8
Aeration Provided?: No
Other: –

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L Cu	100	180	161 (139-188)		
Growth		100	180		147 (119-169)	101 (63-133)

Other: –

Data Verified By: Qualified
Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: Cu Reftox
EVS Project No.: 09-0302-54 | Test Initiation Date/Time: 10-Jul-04 / 1715h
EVS Work Order No.: 0400303 | Source/Date Received: ABS / 08-Jul-04

Concentration (µg/L Cu)	Temperature (°C)													
	0	1		New 2 old		New 3 old		New 4 old		5		6		7
CTL	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
32	20.0	20.0	19.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
56	20.0	20.0	19.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
100	20.0	20.0	19.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
180	20.0	20.0	19.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
320	20.0	20.0	19.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0
Tech. Initials	KMB	AKW	AF	~	JKJ	~	~	JKJ	JKJ	~	~	JKJ	JKJ	~

Concentration (µg/L Cu)	pH													
	0	1		New 2 old		New 3 old		New 4		5		6		7
CTL	8.0	8.0	7.9	7.9	7.8	7.9	7.8	7.9	7.9	8.0	7.9	8.0	7.9	7.9
32	8.0	8.0	7.9	7.9	7.8	7.9	7.8	7.9	7.9	8.0	7.9	8.0	7.9	7.9
56	8.0	8.0	7.8	7.9	7.8	7.9	7.9	7.9	7.9	8.0	7.9	8.0	7.9	7.9
100	8.0	8.0	7.8	7.9	7.8	7.9	7.9	7.9	7.9	8.0	7.9	8.0	7.9	7.9
180	8.0	8.0	7.8	7.9	7.8	7.9	7.9	7.9	7.9	8.0	7.9	8.0	7.9	7.9
320	8.0	8.0	7.8	7.9	7.8	7.9	7.9	7.9	7.9	8.0	8.0	8.0	7.9	7.9
Tech. Initials	KMB	AKW	AF	~	AXF/~	~	~	JKJ	JKJ	~	~	JKJ	JKJ	~

WQ Instruments Used: Temp. Cal. Hg Therm. pH I-A-0303c1
Comments

Test Set Up By: KMB | Data Verified By: QAC | Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris Mine) | Sample ID: Cu Reftox
EVS Project No.: 09-0302-54 | Test Initiation Date/Time: 10-Jul-04 / 1715h
EVS Work Order No.: 0400303 | Source/Date Received: ABS / 08-Jul-04

Concentration (µg/L Cu)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
CTL	28	30	28	28	28	28	28	29
32	28	30	28	28	28	28	28	29
56	28	30	28	28	28	28	28	29
100	28	30	28	28	28	28	28	29
180	28	30	28	28	28	28	28	29
320	28	30	28	28	28	28	28	29
Tech. Initials	KMC	AW	AW	AW	JCS	AW	JCS	AW

Concentration (µg/L Cu)	Dissolved Oxygen (mg/L)													
	0	1		2		3		New 4		5		6		7
CTL	7.6	7.6	7.5	7.5	5.4 AXE	7.4	6.4	7.6	6.6	7.5	7.0	7.6	6.6	7.0
32	7.6	7.6	7.5	7.5	6.4	7.4	6.6	7.6	6.6	7.5	7.0	7.6	6.8	6.9
56	7.6	7.6	7.4	7.5	6.7	7.4	6.5	7.6	6.4	7.5	7.0	7.6	6.6	6.9
100	7.6	7.6	7.4	7.5	6.6	7.4	6.6	7.6	6.6	7.5	7.0	7.6	6.7	6.9
180	7.6	7.6	7.4	7.5	6.8	7.4	6.4	7.6	6.6	7.5	7.0	7.6	6.7	6.7
320	7.6	7.6	7.0	7.5	6.9	7.4	6.7	7.6	6.6	7.5	6.9	7.6	6.7	6.6
Tech. Initials	KMC	AW	AW	AW	AXE/AW	AW	JCS	JCS	JCS	AW	AW	JCS	JCS	AW

WQ Instruments Used: Salinity II-A-030306 DO II-A-3 / II-A-011202

Comments

Test Set Up By: KMC Data Verified By: [signature] Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Nine)
EVS Project No.: 09-0302-54
EVS Work Order No.: 04CC303

Sample ID: Cu Reftox
Test Species/Batch: A. affinis / 6.29.04
Test Initiation Date/Time: 10-Jul-04 / 1715h
No. of Organisms/Volume: 5 / 200mL

Concentration (mg/L Cu)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
CTL	A	T36	5	5	5	5	5	5	5	
	B	T37	5	5	5	5	5	5	5	
	C	T38	5	5	5	5	5	5	5	
	D	T39	5	5	5	5	5	5	5	
	E	T40	5	5	5	5	5	4	4	
32	A	T41	5	5	5	5	5	5	5	
	B	T42	5	5	5	5	5	5	5	
	C	T43	5	5	5	5	5	5	5	
	D	T44	5	5	5	5	5	5	5	
	E	T45	5	5	5	5	5	5	5	
56	A	T46	5	5	5	5	5	5	5	
	B	T47	5	5	5	5	5	5	5	
	C	T48	5	5	5	5	5	5	5	
	D	T49	5	5	5	5	5	5	5	
	E	T50	5	5	5	5	5	5	5	
100	A	T51	5	5	5	4	4	~~3~~	~~3~~	
	B	T52	5	5	5	5	5	5	5	
	C	T53	5	5	5	5	5	5	5	
	D	T54	5	5	4	4	4	4	~~4~~	
	E	T55	5	5	5	5	5	5	5	
Technician Initials		TW	AW	AW		TW	TW	TW		

Sample Description: CLEAR, COLORLESS, ODORLESS.
Data Verified By: Qualified
Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine) | Sample ID: Cu Reflex
EVS Project No.: C9-0302-54 | Test Species/Batch: A. affinis / 6.29.04
EVS Work Order No.: 04CC303 | Test Initiation Date/Time: 10-Jul-04 / 1715h
No. of Organisms/Volume: 5 / 200mL

Concentration (µg/L Cu)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
180	A	T56	5	5	4	4	3	3	3	
	B	T57	5	3	1	1	1	1	1	
	C	T58	5	4	2	2	2	2	2	
	D	T59	5	3	2	1	1	1	1	
	E	T60	4	3	3	2	2	2	2	
320	A	T61	1	0	—	—	—	—	—	
	B	T62	3	3	3	2	2	2	2	
	C	T63	2	2	1	0	—	—	—	
	D	T64	1	1	0	—	—	—	—	
	E	T65	3	3	1	0	—	—	—	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials		JZS	AHW	AHW	N	JZS	JZS	JZS	N	

Sample Description: CLEAR, COLOURLESS, ODOURLESS.
Data Verified By: Qualified | Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111

Test Type: 7 d Survival and Growth
Test Species: Arctinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: Cu Reftox

Sample ID 49/L Cu	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
320	A	T61	1255.61	—	0	0		TM
↓	B	62	1256.09	1257.79	2	2		↓
	C	63	1268.85	—	0	0		
	D	64	1252.87	—	0	0		
↓	E	↓65	1270.02	—	0	0		↓
180	A	T56	1252.98	1255.06	3	3		TM
↓	B	57	1247.43	1248.02	1	1		↓
	C	58	1270.37	1272.49	2	2	confirmed 1272.50 mg ✓	
	D	59	1280.94	1281.59	1	1		
↓	E	↓60	1280.02	1282.095	2	2		↓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qualified

Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Mines)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111)

Test Type: 7 d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: Cu Reftox

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
49/L Cu								
100	A	T51	1272.54	1275.53	3	3		JZS
	B	52	1242.48	1247.54	5	5		
	C	53	1265.30	1269.62	5	5		
	D	54	1240.38	1243.48	4	4		
	E	55	1264.67	1269.25	5	5		
56	A	T46	1286.39	1291.02	5	5	confirm 1291.05 mg ✓	JZS
	B	47	1271.46	1276.05	5	5		
	C	48	1238.91	1243.78	5	5		
	D	49	1262.66	1267.58	5	5		
	E	50	1256.18	1261.80	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qualified

Date Verified: August 17/04

EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA

Client: Azimuth (Polaris Minerals)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400303
Balance Type/Serial Number: Sartorius BP2111)

Test Type: 7-d Survival and Growth
Test Species: Atherinops affinis (Topsmelt)
Start Date (Day 0): July 10-04
Sample ID: Cu Reftox

Sample ID 49/L Cu	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
32	A	T41	1280.70	1283.71	5	5		JCS
	B	42	1256.85	1261.03	5	5		
	C	43	1272.55	1276.95	5	5		
	D	44	1278.22	1284.04	5	5		
	E	45	1273.94	1280.06	5	5		
Ctl	A	T36	1272.84	1277.49	5	5		JCS
	B	37	1275.33	1280.65	5	5	confirmed: 1280.57 mg ✓	
	C	38	1269.27	1274.85	5	5		
	D	39	1236.88	1241.99	5	5		
	E	40	1264.45	1269.15	4	4		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Rachel

Date Verified: August 17/04

Test: LF-Larval Fish Growth and Survival Test
Species: AA-Atherinops affinis
Sample ID: REF-Ref Toxicant
Start Date: 7/10/2004 End Date: 7/17/2004

Test ID: RTAACu36
Protocol: EPAW 95-EPA West Coast
Sample Type: CU-Copper
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1277.49	1272.84
	2	2	D-Control	5							5	5	1280.65	1275.33
	3	3	D-Control	5							5	5	1274.85	1269.27
	4	4	D-Control	5							5	5	1241.99	1236.88
	5	5	D-Control	5							4	4	1269.15	1264.45
	6	1	32.000	5							5	5	1283.71	1280.7
	7	2	32.000	5							5	5	1261.03	1256.85
	8	3	32.000	5							5	5	1276.95	1272.95
	9	4	32.000	5							5	5	1284.04	1278.22
	10	5	32.000	5							5	5	1280.06	1273.94
	11	1	56.000	5							5	5	1291.02	1286.39
	12	2	56.000	5							5	5	1276.05	1271.46
	13	3	56.000	5							5	5	1243.78	1238.91
	14	4	56.000	5							5	5	1267.58	1262.66
	15	5	56.000	5							5	5	1261.8	1256.18
	16	1	100.000	5							3	3	1275.53	1272.54
	17	2	100.000	5							5	5	1247.54	1242.48
	18	3	100.000	5							5	5	1269.68	1265.3
	19	4	100.000	5							4	4	1243.48	1240.38
	20	5	100.000	5							5	5	1269.25	1264.67
	21	1	180.000	5							3	3	1255.06	1252.98
	22	2	180.000	5							1	1	1248.02	1247.43
	23	3	180.000	5							2	2	1272.49	1270.37
	24	4	180.000	5							1	1	1281.59	1280.94
	25	5	180.000	5							2	2	1282.05	1280.02
	26	1	320.000	5							0	0	0	1255.61
	27	2	320.000	5							2	2	1257.79	1256.09
	28	3	320.000	5							0	0	0	1268.85
	29	4	320.000	5							0	0	0	1252.87
	30	5	320.000	5							0	0	0	1270.02

Comments: 09-0302-54, 0400303

Reviewed by: August 17/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/10/2004	Test ID:	RTAACu36	Sample ID:	REF-Ref Toxicant
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400303				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	0.8000
32	1.0000	1.0000	1.0000	1.0000	1.0000
56	1.0000	1.0000	1.0000	1.0000	1.0000
100	0.6000	1.0000	1.0000	0.8000	1.0000
180	0.6000	0.2000	0.4000	0.2000	0.4000
320	0.0000	0.4000	0.0000	0.0000	0.0000

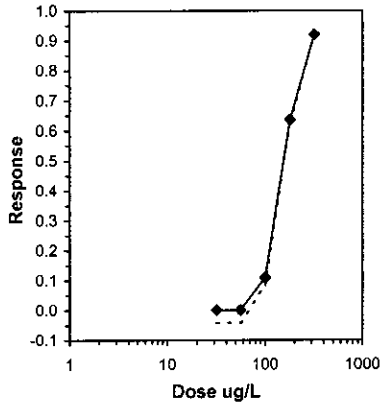
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5			1	25
32	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	16.00	0	25
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	16.00	0	25
100	0.8800	0.1789	1.2058	0.8861	1.3453	17.113	5	24.50	16.00	3	25
*180	0.3600	0.1673	0.6366	0.4636	0.8861	27.958	5	15.00	16.00	16	25
*320	0.0800	0.1789	0.3174	0.2255	0.6847	64.711	5	15.00	16.00	23	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93876	0.9	0.31435	1.7423
Equality of variance cannot be confirmed				

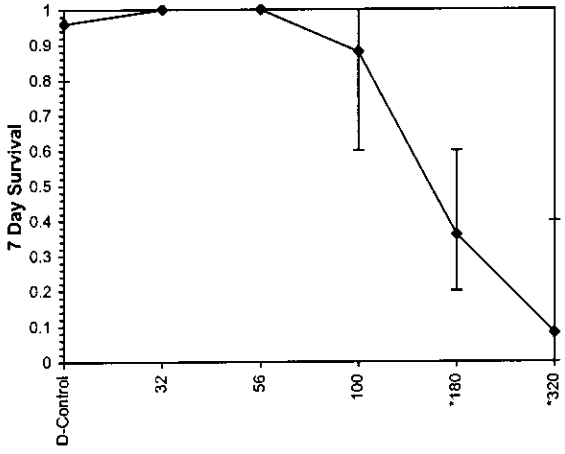
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	180	134.164	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%				
10.0%	161.11	138.26	187.73	
20.0%	158.05	132.14	189.04	
Auto-8.1%	161.46	138.66	188.00	ug/L Cu



Dose-Response Plot



Reviewed by Qalijk August 17/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/10/2004	Test ID:	RTAACu36	Sample ID:	REF-Ref Toxicant
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400303				

Conc-ug/L	1	2	3	4	5
D-Control	0.9300	1.0640	1.1160	1.0220	0.9400
32	0.6020	0.8360	0.8000	1.1640	1.2240
56	0.9260	0.9180	0.9740	0.9840	1.1240
100	0.5980	1.0120	0.8760	0.6200	0.9160
180	0.4160	0.1180	0.4240	0.1300	0.4060
320	0.0000	0.3400	0.0000	0.0000	0.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	1.0144	0.0798	1.0144	0.9300	1.1160	7.871	5				1.0144	1.0000
32	0.9252	0.2619	0.9252	0.6020	1.2240	28.309	5	0.851	2.360	0.2474	0.9552	0.9416
56	0.9852	0.0828	0.9852	0.9180	1.1240	8.403	5	0.279	2.360	0.2474	0.9552	0.9416
100	0.8044	0.1853	0.8044	0.5980	1.0120	23.031	5	2.004	2.360	0.2474	0.8044	0.7930
*180	0.2988	0.1598	0.2988	0.1180	0.4240	53.465	5	6.827	2.360	0.2474	0.2988	0.2946
*320	0.0680	0.1521	0.0680	0.0000	0.3400	223.607	5	9.029	2.360	0.2474	0.0680	0.0670

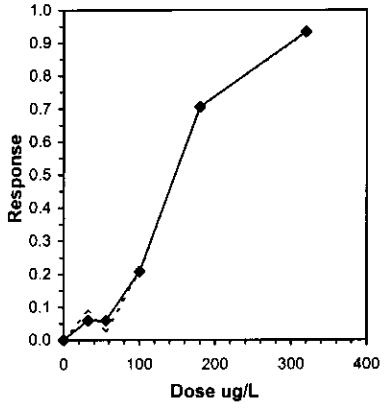
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97039	0.9	0.15928	-0.3767
Bartlett's Test indicates equal variances (p = 0.21)	7.13123	15.0863		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	180	134.164		0.24736	0.24385	0.80038	0.02746	1.9E-09	5, 24

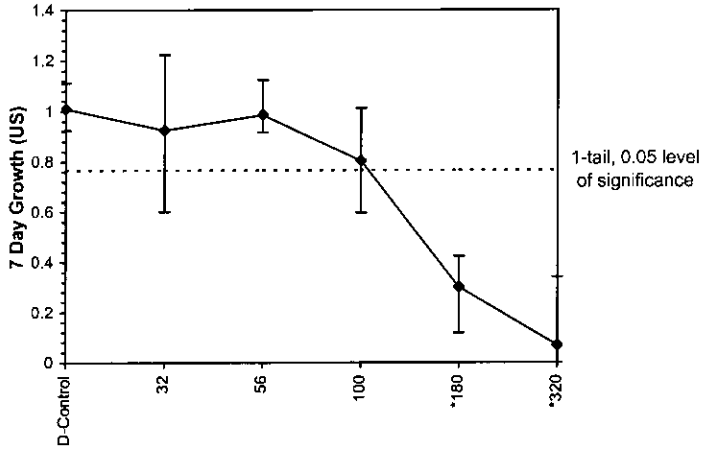
Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew
IC05*	27.42	22.74	0.00	93.30	0.4541
IC10	68.32	24.38	0.00	122.43	-0.2058
IC15	83.12	21.17	0.00	125.48	-0.8306
IC20	97.92	15.93	48.64	127.61	-0.9650
IC25	106.90	12.35	63.02	133.27	-0.3411
IC40	130.97	9.49	95.73	153.51	-0.4555
IC50	147.03	8.36	119.23	169.15	-0.1133

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



ToxCalc v5.0.23

Reviewed by: August 17/04

APPENDIX B

Chain-of-Custody Form

AZIMUTH (POLARIS)

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

Tel: (604) 986-4331
Fax: (604) 662-8548
www.evsenvironment.com

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:

Address: Bag 2000
Kimberley, BC
V1A 3E1
Phone: 250 427-8405
Fax: 250 427-8451
Sampled by: Dennis Lu
Attn:
Shipping Date:

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	3 Sample Container Type by Code	Test(s) Requested: 96h LC50 Rainbow Trout	Test(s) Requested: Topsmelt / Echinoderm	Test(s) Requested: D. magna 48h LC50	Test(s) Requested	Test(s) Requested	4 Sample Notes (e.g. preserved, saltwater, freshwater, may contain sewage)
~~07/Jul/2004~~	~~22:00~~	~~G-Creek_070704~~											
07/Jul/2004	22:00	G-Creek_comte_070704	E		G	2x20L		X		X			
07/Jul/2004	22:00	G-Creek_sed_070704	E		G	3x20L			X				

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by:	Date:	2) Released by:	Date:
Company:	Time:	Company:	Time:
Courier name:		Courier name:	
1) Received: JGK	Date: 10 Jul 04	2) Received by:	Date:
Company: EVS	Time: 1425	Company:	Time:

Shaded area to be completed by EVS Laboratory upon sample receipt.

EVS Project No. 04-0302-54
EVS Work Order (WO) No. 0400302/303/304/307
EOH TOBM. RBT DAPH.
Condition Upon Receipt GOOD
Receipt Sample Temp. (C) 11-6°

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, yellow - accompany the shipment
Pink - kept by consignor (e.g., shipper)
Yellow - kept by consignee (e.g., receiver)
White - returned to consignor by consignee

Please see instructions for completion on back of form.

Revision Date: March 6, 2004

September 2004

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 30, 2004

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 30, 2004

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants - A Member of the Golder Group of Companies
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

09-0302-54

September 2004

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ACKNOWLEDGEMENTS

The *A. affinis* toxicity test was conducted by Andy Diewald, Ann-Marie Norris and Jenny Shao. Kathryn Sentance and Armando Tang performed the *D. excentricus* fertilization toxicity test. Statistical analyses were performed by Jenny Shao and Kathryn Sentance. The report was written by Kathryn Sentance and reviewed by Edmund Canaria. Quality Assurance/Quality Control (QA/QC) review on the *D. excentricus* test was conducted by Julianna Kalokai and Armando Tang reviewed the *A. affinis* toxicity test.

1. INTRODUCTION

EVS Environment Consultants conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as G Creek, was collected from the Polaris Mine Site on July 27, 2004 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on July 30, 2004 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendix A and B respectively, and the chain-of-custody form is provided in Appendix C.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d toxicity test and reference toxicant test using topsmelt (A. *affinis*) was conducted in accordance with EVS Environment Consultants Standard Operating Procedures (SOP) 1100-4 (EVS, 2002) with modifications based on U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general

QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and record-keeping, and use of standard operating procedures (SOPs). To ensure the highest quality of data and reporting, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.3, 8.6, 17.3, 34.5, 69.0% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity adjusted
Control/dilution water	UV-sterilized and 0.5µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.6, 9.1, 18.3, 36.6, 73.1% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and conductivity daily; hardness and alkalinity at test initiation
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 1 and the raw statistical analyses are provided in Appendix A.

The highest concentration tested was 69.0% due to salinity adjustment. The mean survival in both the negative and brine controls was 100%. The negative and brine controls were not significantly different for the growth and survival endpoints (p =1.00 and p =0.93, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival in all tested concentrations relative to the pooled controls ($p \leq 0.05$). Adverse effects for growth were observed in the 17.3 and 69.0% (v/v) concentrations. For the survival and growth endpoints the NOEC was 69.0 and 8.6, and the LOEC was >69.0 and 17.3% (v/v), respectively. The LC50 for survival was >69.0% (v/v). The IC50 and IC25 for growth were both >69.0% (v/v)

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 2 and the raw statistical analyses are provided in Appendix B.

The highest concentration tested was 73.1% due to salinity adjustment. Mean fertilization in the pooled controls was 59.9%. The negative and brine controls were not significantly different (p =0.72).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all except the lowest (4.6%(v/v)) test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was 4.6 and LOEC was 9.1 %(v/v). The IC50 and IC25 (95% confidence limits) values were 37.3 (24.4 – 46.0) and 8.7 (7.6 – 9.9) %(v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point

estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% v/v)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	100.0 ± 0.0	0.98 ± 0.09
Brine Control	100.0 ± 0.0	0.99 ± 0.14
Pooled Controls	100.0 ± 0.0	0.98 ± 0.11
4.3	96.0 ± 8.9	0.91 ± 0.15
8.6	96.0 ± 8.9	0.87 ± 0.14
17.3	100.0 ± 0.0	0.78 ± 0.14*
34.5	100.0 ± 0.0	0.90 ± 0.03
69.0	96.0 ± 8.9	0.77 ± 0.19*
TEST ENDPOINT	**SURVIVAL (% v/v)**	**GROWTH (% v/v)**
NOEC	69.0	8.6
LOEC	>69.0	17.3
LC50	>69.0	na
IC50	na	>69.0
IC25	na	>69.0

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus*) fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	60.0 ± 4.1
Brine Control	60.0 ± 2.1
Pooled Control	60.0 ± 3.0
4.6	60.0 ± 4.3
9.1	43.8 ± 2.1*
18.3	37.0 ± 1.4*
36.6	30.2 ± 3.8*
73.1	20.0 ± 0.8*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	4.6
LOEC	9.1
IC50 (95% CL)	37.3 (24.4 – 46.0)
IC25 (95% CL)	8.7 (7.6 – 9.9)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

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Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX A

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth (Polaris) | EVS Analysts AWD. JES. AKN

EVS Project No. 09-0302-54

EVS Work Order No. 0400339 | Test Initiation Date July 30, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-Creek - sublethal - 27704		
Amount Received	20 L		
Date Collected	July 27, 2004		
Date Received	July 30, 2004		
Temperature (°C)	20.0 D→ 20.0		
pH	7.8 D→ 8.3		
DO (mg/L)	10.7 D→ 7.4		
Conductivity (µmhos/cm)	4880		
Salinity (ppt)	2.6 D→ 28		
Ammonia (mg/L N)	—		
Chlorine (mg/L Cl)	—		
Other	0 Brine adjusted to 30±2 ppt with 90 ppt HSB		

DILUTION/CONTROL WATER (initial water quality)

Water Type Filtered, UV sterilized seaH2O

Temperature (°C) 20.0

pH 8.1

Dissolved Oxygen (mg/L) 7.4

Salinity 28 ppt

TEST SPECIES INFORMATION

Source Aquatic Biosystems (ABS)

Date Received July 29, 2004

Age (on Day 0) 10-d

Reference Toxicant Cu

Current Reference Toxicant Result (incl. 95% CL)

Reference Toxicant Test Date July 30, 2004

7-d survival LC50 130 (115-147) mg/L Cu

7-d growth IC50 124 (87-144) mg/L Cu

Reference Toxicant Warning Limits (mean ± 2SD) and CV

7-d survival LC50 129 ± 48 mg/L Cu. CV=19%

7-d growth IC50 130 ± 52 mg/L Cu. CV=20%

TEST CONDITIONS

Temperature Range (°C) 20.0-20.5

pH Range 7.8-8.1

Dissolved Oxygen Range (mg/L) 6.4-7.7

Salinity (ppt) 28

Photoperiod (L:D h) 16:8

Aeration Provided? NA

Other —

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	69	>69	>69		
Growth		8.6 ~~34.5~~	17.3 ~~69~~		>69	>69

Other

Data Verified By [signature] | Date Verified Sept. 16/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Polaris) Sample ID G-Creek - Acute - 270704

EVS Project No. 09-0302-54 Test Initiation Date/Time July 30/1500 h

EVS Work Order No. 0400339 Source/Date Received ABS / July 29/04

Concentration (%)	Temperature (°C)													
	0	1 old	1 new	2		3		4		5		6		7
Neg. CTL	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
B-CTL	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
4.3	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
8.6	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
17.3	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
34.5	20.0	20.5	20.0	20.5	20.0	20.6	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
69	20.0	20.5	20.0	20.5	20.0	20.6	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
Tech. Initials	JES													

Concentration (%)	pH													
	0	1		2		3		4		5		6		7
Neg. CTL	8.1	8.1	7.9	7.9	8.0	8.0	7.9	8.0	7.8	8.0	7.8	7.9	8.0	7.9
B-CTL	8.1	8.1	7.9	7.9	8.0	7.9	7.9	8.0	7.8	8.0	7.8	7.9	8.0	7.9
4.3	8.2	8.0	8.1	8.1	8.1	7.9	8.1	7.9	8.1	7.9	8.1	8.0	8.1	8.0
8.6	8.2	8.1	8.2	8.2	8.1	8.1	8.2	8.1	8.1	8.0	8.2	8.1	8.1	8.1
17.3	8.2	8.1	8.2	8.2	8.2	8.1	8.2	8.2	8.2	8.1	8.2	8.2	8.2	8.1
34.5	8.2	8.1	8.3	8.3	8.2	8.2	8.2	8.2	8.3	8.2	8.2	8.2	8.3	8.2
69	8.3	8.2	8.4	8.4	8.4	8.3	8.3	8.3	8.4	8.3	8.7	8.4	8.3	8.2
Tech. Initials	JES													

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51

Comments

Test Set Up By AWD. JES. AKN Data Verified By [signature] Date Verified Sept. 13/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Polaris) Sample ID G - Creek - Anuke - 270704

EVS Project No. 09-0302-54 Test Initiation Date/Time July 30 / 15:00 h

EVS Work Order No. 0400339 Source/Date Received ABS / July 29/04

Concentration % (v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Neg-CTL	28	28	28	28	28	28	28	28
B-CTL	28	28	28	28	28	28	28	28
4.3	28	28	28	28	28	28	28	28
8.6	28	28	28	28	28	28	28	28
17.3	28	28	28	28	28	28	28	28
34.5	28	28	28	28	28	28	28	28
69	28	28	28	28	28	28	28	28
Tech. Initials	JES	~	~	~	~	~	~	~

Concentration % (v/v)	Dissolved Oxygen (mg/L)													
	0	1		new 2 old		3		4		5		6		7
Neg. CTL	7.4	6.6	7.4	7.5	6.8	7.4	7.0	7.5	7.0	7.6	6.8	6.7	7.6	6.8
B-CTL	7.4	6.8	7.4	7.5	6.7	7.4	6.9	7.5	6.9	7.6	6.7	6.6	7.6	6.9
4.3	7.4	6.7	7.4	7.5	6.8	7.4	6.8	7.5	6.8	7.6	6.7	6.6	7.6	6.9
8.6	7.4	6.8	7.0	7.5	6.9	7.4	6.8	7.5	6.8	7.6	6.7	6.5	7.7	6.8
17.3	7.4	6.9	7.4	7.5	6.8	7.4	6.6	7.5	6.5	7.6	6.8	6.6	7.7	6.7
34.5	7.4	6.7	7.4	7.5	6.7	7.4	6.7	7.5	6.4	7.6	6.8	6.7	7.7	6.7
69	7.4	6.7	7.4	7.4	6.7	7.4	6.7	7.5	6.4	7.6	6.8	6.7	7.7	6.7
Tech. Initials	JES	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Salinity II-A-030304 DO II-A-011202

Comments

Test Set Up By AWD, JES, AKN Data Verified By Qualified Date Verified Sept 13/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400339

Start Date (Day 0) July 30/04
Sample ID G-Creek - Acute - 270704
Balance Type/Serial Number Sartorius BP211D

Sample ID % v/v	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
Neg. CTL	A	A 1	1239.31	1244.31	5	5		JBA JWS/AD
	B	A 2	1249.28	1254.89	5	5		
	C	A 3	1245.80	1250.56	5	5		
	D	A 4	1249.65	1254.46	5	5		
	E	A 5	1272.31	1276.64	5	5		
Brine CTL	A	A 6	1247.06	1252.91	5	5		
	B	A 7	1253.79	1257.85	5	5	confirmed 1257.82 ✓	
	C	A 8	1281.77	1286.98	5	5		
	D	A 9	1251.58	1255.98	5	5		
	E	A 10	1259.93	1265.08	5	5		
4.3	A	A 11	1257.42	1261.19	4	4		
	B	A 12	1236.86	~~1242.25~~	5	5	confirmed 1242.19 ✓	
	C	A 13	1239.81	1244.13	5	5		
	D	A 14	1242.95	1246.92	5	5		
	E	A 15	1235.71	1239.91	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Ralph

Date Verified Sept. 13/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400339

Start Date (Day 0) July 30, 2004
Sample ID G-Creek - Acute - 270704
Balance Type/Serial Number Sartorius BP 211D

Sample ID % %N	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
8.6	A	A16	1227.02	1232.51	5	5		
	B	A17	1239.24	1243.57	5	5		
	C	A18	1229.02	1233.44	4	4		
	D	A19	1233.84	1237.47	5	5		
	E	A20	1228.86	1232.75	5	5	confirmed 1232.80 ✓	
17.3	A	A21	1231.20	1234.75	5	5		
	B	A22	1233.22	1237.19	5	5		
	C	A23	1222.38	1227.10	5	5		
	D	A24	1222.20	1225.18	5	5		
	E	A25	1226.00	1230.36	5	5		
34.5	A	A26	1225.11	1229.67	5	5		
	B	A27	1233.99	1238.36	5	5		
	C	A28	1237.10	1241.69	5	5	confirmed 1241.64 ✓	
	D	A29	1222.42	1226.65	5	5		
	E	A30	1233.63	1238.25	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Ralph K

Date Verified Sept. 13/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339

Start Date (Day 0): July 30/04
Sample ID: G-Creek - Acute - 270704
Balance Type/Serial Number: Sartorius BP211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
69	A	A31	1239.64	1242.07	4	4		~~JJ~~
	B	A32	1237.11	1241.20	5	5		
	C	A33	1231.11	1234.89	5	5		
	D	A34	1239.84	1243.88	5	5		
	E	A35	1233.50	1238.50	5	5	confirmed 1238.46 ✓	

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]
Date Verified: Sept. 13/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339

Sample ID: G-Creek - Grab - 270704
Test Species/Batch: A. affinis
Test Initiation Date/Time: July 30 / 15:00 2004
No. of Organisms/Volume: 5 / 200 ml

Concentration % v/v	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
Neg. CTL	A		5	5	5	5	5	5	5	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
B-CTL	A		5	5	5	5	5	5	5	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
4.3	A		5	5	5	5	5	5	4	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
8.6	A		5	5	5	5	5	5	5	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	4	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
Technician Initials										

Sample Description: clear, colorless
Data Verified By: [signature]
Date Verified: Sept. 15/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339

Sample ID: G-Creek - Acute - 270704
Test Species/Batch: A. affinis / July 29, 04
Test Initiation Date/Time: July 30 / 15:00
No. of Organisms/Volume: 5/200ml

Concentration %	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
17.3	A		5	5	5	5	5	5	5	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
34.5	A		5	5	5	5	5	5	5	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
69	A		5	5	5	5	4	4	4	
	B		5	5	5	5	5	5	5	
	C		5	5	5	5	5	5	5	
	D		5	5	5	5	5	5	5	
	E		5	5	5	5	5	5	5	
	A									
	B									
	C									
	D									
	E									
Technician Initials										

Sample Description: clear colorless
Data Verified By: Qualified
Date Verified: Sept 15/04

Test: LF-Larval Fish Growth and Survival Test | Test ID: 0400339
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: G-Creek-sublethal-270704 | Sample Type: EFF2-Industrial
Start Date: 7/30/2004 End Date: 8/6/2004 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	Neg Control	5							5	5	1244.31	1239.31
	2	2	Neg Control	5							5	5	1254.89	1249.28
	3	3	Neg Control	5							5	5	1250.56	1245.8
	4	4	Neg Control	5							5	5	1254.46	1249.65
	5	5	Neg Control	5							5	5	1276.64	1272.31
	6	1	Brine Control	5							5	5	1252.91	1247.06
	7	2	Brine Control	5							5	5	1257.85	1253.79
	8	3	Brine Control	5							5	5	1286.98	1281.77
	9	4	Brine Control	5							5	5	1255.98	1251.58
	10	5	Brine Control	5							5	5	1265.08	1259.93
	11	1	4.300	5							4	4	1261.19	1257.42
	12	2	4.300	5							5	5	1242.25	1236.86
	13	3	4.300	5							5	5	1245.13	1239.81
	14	4	4.300	5							5	5	1246.92	1242.85
	15	5	4.300	5							5	5	1239.91	1235.71
	16	1	8.600	5							5	5	1232.51	1227.02
	17	2	8.600	5							5	5	1243.57	1239.24
	18	3	8.600	5							4	4	1233.44	1229.02
	19	4	8.600	5							5	5	1237.47	1233.84
	20	5	8.600	5							5	5	1232.75	1228.86
	21	1	17.300	5							5	5	1234.75	1231.2
	22	2	17.300	5							5	5	1237.19	1233.22
	23	3	17.300	5							5	5	1227.1	1222.38
	24	4	17.300	5							5	5	1225.18	1222.2
	25	5	17.300	5							5	5	1230.36	1226
	26	1	34.500	5							5	5	1229.67	1225.11
	27	2	34.500	5							5	5	1238.36	1233.99
	28	3	34.500	5							5	5	1241.69	1237.1
	29	4	34.500	5							5	5	1226.65	1222.38
	30	5	34.500	5							5	5	1238.25	1233.63
	31	1	69.000	5							4	4	1242.07	1239.64
	32	2	69.000	5							5	5	1241.2	1237.11
	33	3	69.000	5							5	5	1234.89	1231.11
	34	4	69.000	5							5	5	1243.88	1239.84
	35	5	69.000	5							5	5	1238.5	1233.5

Comments: Azimuth(Polaris Mine)09-0302-54

Reviewed by: 8/17/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/30/2004	Test ID:	400339	Sample ID:	G-Creek-sublethal-270704
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54				

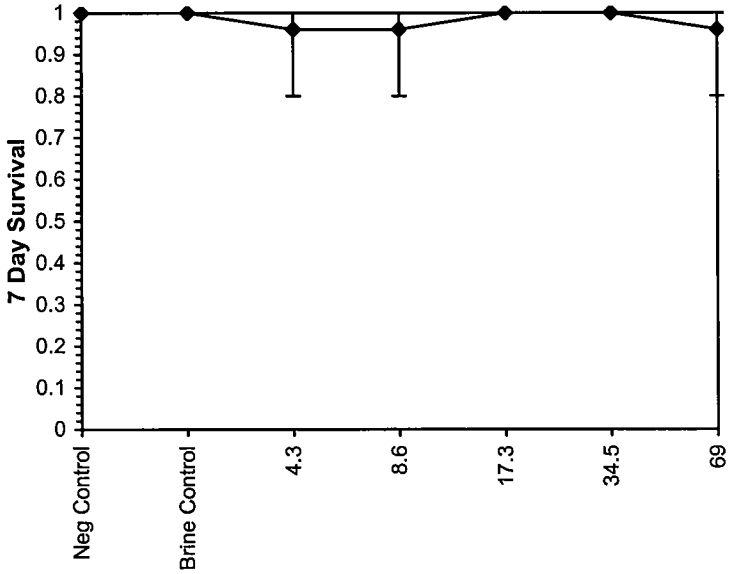
Conc-%	1	2	3	4	5
Neg Control	1.0000	1.0000	1.0000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.3	0.8000	1.0000	1.0000	1.0000	1.0000
8.6	1.0000	1.0000	0.8000	1.0000	1.0000
17.3	1.0000	1.0000	1.0000	1.0000	1.0000
34.5	1.0000	1.0000	1.0000	1.0000	1.0000
69	0.8000	1.0000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Neg Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
Brine Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
4.3	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
8.6	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
17.3	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
34.5	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
69	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.59678	0.9	-2.2346	4.3922
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	69	>69		1.44928

Dose-Response Plot



Statistical comparisons were against the D-Control only

Reviewed by: Galfi 4
Sent · 15/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/30/2004	Test ID:	400339	Sample ID:	G-Creek-sublethal-270704
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54				

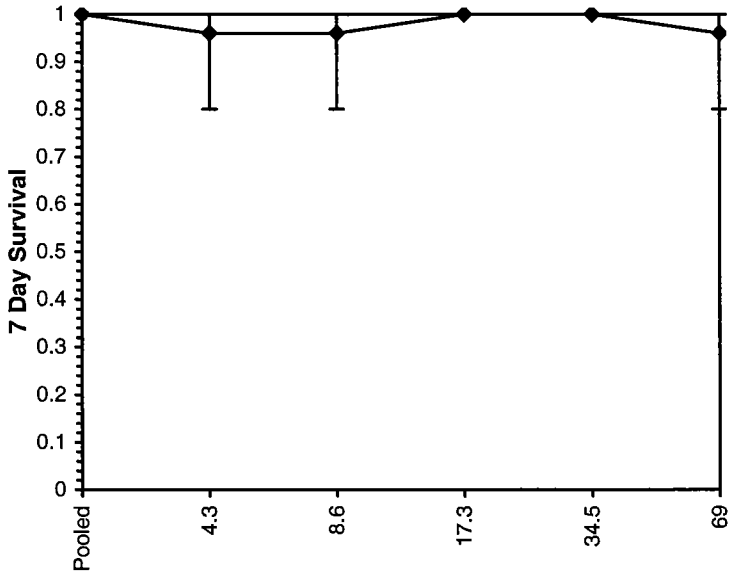
Conc-%	1	2	3	4	5
Neg Control	1.0000	1.0000	1.0000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.3	0.8000	1.0000	1.0000	1.0000	1.0000
8.6	1.0000	1.0000	0.8000	1.0000	1.0000
17.3	1.0000	1.0000	1.0000	1.0000	1.0000
34.5	1.0000	1.0000	1.0000	1.0000	1.0000
69	0.8000	1.0000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	10		
4.3	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
8.6	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
17.3	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
34.5	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
69	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.58129	0.91	-2.3952	5.50568
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	69	>69		1.44928

Dose-Response Plot



Statistical comparisons were against the Pooled control.

Reviewed by: Galfi
Sent. 16/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/30/2004	Test ID:	400339	Sample ID:	G-Creek-sublethal-270704
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54				

Conc-%	1	2	3	4	5
Neg Control	1.0000	1.1220	0.9520	0.9620	0.8660
Brine Control	1.1700	0.8120	1.0420	0.8800	1.0300
4.3	0.7540	1.0780	1.0640	0.8140	0.8400
8.6	1.0980	0.8660	0.8840	0.7260	0.7780
17.3	0.7100	0.7940	0.9440	0.5960	0.8720
34.5	0.9120	0.8740	0.9180	0.8540	0.9240
69	0.4860	0.8180	0.7560	0.8080	1.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Neg Control	0.9804	0.0931	0.9804	0.8660	1.1220	9.496	5				0.9804	1.0000
Brine Control	0.9868	0.1418	0.9868	0.8120	1.1700	14.370	5					
4.3	0.9100	0.1503	0.9100	0.7540	1.0780	16.519	5	0.840	2.360	0.1979	0.9100	0.9282
8.6	0.8704	0.1426	0.8704	0.7260	1.0980	16.389	5	1.312	2.360	0.1979	0.8704	0.8878
17.3	0.7832	0.1363	0.7832	0.5960	0.9440	17.397	5	2.352	2.360	0.1979	0.8398	0.8566
34.5	0.8964	0.0307	0.8964	0.8540	0.9240	3.425	5	1.002	2.360	0.1979	0.8398	0.8566
*69	0.7736	0.1854	0.7736	0.4860	1.0000	23.961	5	2.466	2.360	0.1979	0.7736	0.7891

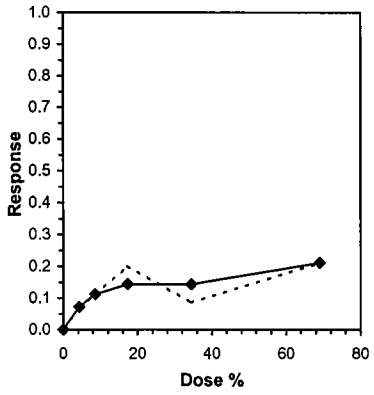
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97283	0.9	-0.0321	0.12793
Bartlett's Test indicates equal variances (p = 0.10)	9.1539	15.0863		
The control means are not significantly different (p = 0.93)	0.08436	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	34.5	69	48.7904	2.89855	0.1979	0.20186	0.03131	0.01758	0.15497	5, 24

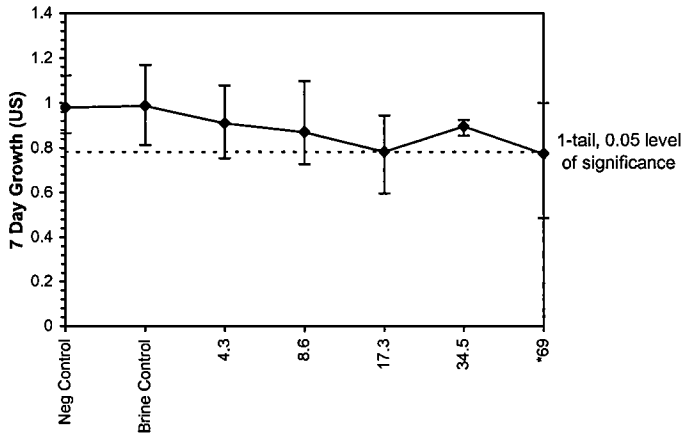
Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.994	3.701	0.790	14.903	3.3103
IC10	7.301				
IC15	37.867				
IC20	63.413				
IC25	>69				
IC40	>69				
IC50	>69				

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Statistical comparisons were against the D-Control only

Reviewed by Sept. 15-'04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/30/2004	Test ID:	400339	Sample ID:	G-Creek-sublethal-270704
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris Mine)09-0302-54				

Conc-%	1	2	3	4	5
Neg Control	1.0000	1.1220	0.9520	0.9620	0.8660
Brine Control	1.1700	0.8120	1.0420	0.8800	1.0300
4.3	0.7540	1.0780	1.0640	0.8140	0.8400
8.6	1.0980	0.8660	0.8840	0.7260	0.7780
17.3	0.7100	0.7940	0.9440	0.5960	0.8720
34.5	0.9120	0.8740	0.9180	0.8540	0.9240
69	0.4860	0.8180	0.7560	0.8080	1.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.9836	0.1131	0.9836	0.8120	1.1700	11.503	10				0.9836	1.0000
4.3	0.9100	0.1503	0.9100	0.7540	1.0780	16.519	5	1.021	2.462	0.1775	0.9100	0.9252
8.6	0.8704	0.1426	0.8704	0.7260	1.0980	16.389	5	1.570	2.462	0.1775	0.8704	0.8849
*17.3	0.7832	0.1363	0.7832	0.5960	0.9440	17.397	5	2.780	2.462	0.1775	0.8398	0.8538
34.5	0.8964	0.0307	0.8964	0.8540	0.9240	3.425	5	1.209	2.462	0.1775	0.8398	0.8538
*69	0.7736	0.1854	0.7736	0.4860	1.0000	23.961	5	2.913	2.462	0.1775	0.7736	0.7865

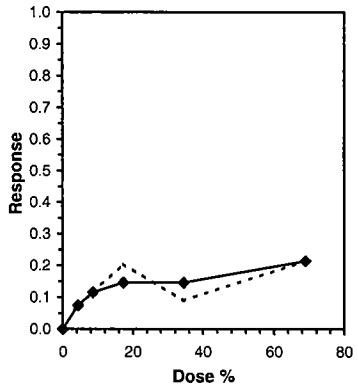
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97705	0.91	-0.0216	-0.1535
Bartlett's Test indicates equal variances (p = 0.11)	8.86442	15.0863		
The control means are not significantly different (p = 0.93)	0.08436	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	8.6	17.3	12.1975	11.6279	0.1775	0.18046	0.04318	0.01733	0.05389	5, 29

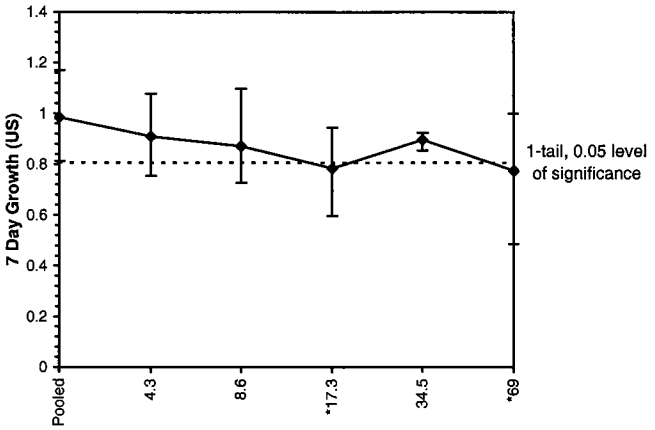
Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.873	2.982	0.771	15.235	1.2072
IC10	6.989				
IC15	36.449				
IC20	62.079				
IC25	>69				
IC40	>69				
IC50	>69				

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Statistic comparisons were against the pooled control.

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth (Polaris) EVS Analysts JLS, AWD
EVS Project No. 09-0302-54
EVS Work Order No. 0400339 Test Initiation Date July 30, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	04-Cu-001		
Amount ~~Received~~	1 L		
Date ~~Collected~~ Prepared	March-15, 04		
Date Received			
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			

DILUTION/CONTROL WATER (initial water quality)
Water Type UV sterilized, filtered SW
Temperature (°C) 20.0
pH 8.1
Dissolved Oxygen (mg/L) 7.4
Salinity 28 ppt

TEST SPECIES INFORMATION
Source Aquatic Biosystems (ABS)
Date Received July 29, 2004
Age (on Day 0) 10-d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date July 30, 04
7-d survival LC50 130 (115-147) mg/L Cu
7-d growth IC50 ~~119 (89-138)~~ 124 (87-144) mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 129 ± 48 mg/L Cu. CV = 19%
7-d growth IC50 130 ± 52 mg/L Cu. CV = 20%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 20.5
pH Range 7.8 - 8.1
Dissolved Oxygen Range (mg/L) 6.4 - 7.6
Salinity (ppt) 28
Photoperiod (L:D h) 16:8
Aeration Provided? NA
Other —

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L Cu	100	180	130 (115-147)		
Growth		56	100		~~119 (89-138)~~ 124 (87-144)	~~82 (0.4-124)~~ 85 (~~127~~ 73.6-127)

Other

Data Verified By [signature] Date Verified Sept. 13/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris) | Sample ID: Cu reftox

EVS Project No.: 09-0302-54 | Test Initiation Date/Time: July 30/04 / 1430 h

EVS Work Order No.: 0400339 | Source/Date Received: ABS / July 29, 2004

Concentration Cu mg/L	Temperature (°C)													
	0	old 1	new	2		3		4		5		6		7
Neg. CTL.	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
32	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
56	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
100	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
180	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
320	20.0	20.5	20.0	20.5	20.0									
Tech. Initials	JW	~	~	~	~	~	~	~	~	~	~	~	~	~

Concentration Cu mg/L	pH													
	0	1		2		3		4		5		6		7
Neg. CTL	8.1	8.0	7.9	7.9	8.0	7.9	8.0	7.8	8.0	7.8	8.0	8.0	7.9	7.8
32	8.1	8.0	7.9	7.9	8.0	7.9	8.1	7.8	8.0	7.8	8.1	8.0	7.9	7.8
56	8.1	7.9	7.9	7.9	8.0	7.9	8.1	7.8	8.0	7.8	8.1	8.0	7.9	7.9
100	8.1	7.9	7.9	7.9	8.0	7.9	8.1	7.8	7.9	7.8	8.0	8.0	7.8	7.9
180	8.1	7.9	7.9	7.9	8.0	7.9	8.1	7.8	7.9	7.8	8.1	8.0	7.9	7.9
320	8.1	7.9	7.9	7.9	8.0									
Tech. Initials	JW	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51

Comments

Test Set Up By: JW/AS Data Verified By: [signature] Date Verified: Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth | Sample ID Cu · reftox

EVS Project No. 09-0302-54 | Test Initiation Date/Time July 30, 2004 / 1430 h

EVS Work Order No. 0400339 | Source/Date Received ABS / July 29, 04

Concentration Cu mg/L	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Neg. CTL	28	28	28	28	28	28	28	28
32	28	28	28	28	28	28	28	28
56	28	28	28	28	28	28	28	28
100	28	28	28	28	28	28	28	28
180	28	28	28	28	28	28	28	28
320	28	28	28	—	—	—	—	—
Tech. Initials	JKS	~	~	~	~	~	~	

Concentration Cu mg/L	Dissolved Oxygen (mg/L)													
	0	1		2 new old		3		4		5		6		7
Neg. CTL	7.4	7.0	7.4	7.5	6.7	7.0	7.4	7.0	7.5	6.8	7.6	6.4	7.~~6~~	6.7
32	7.4	6.9	7.4	7.5	6.7	6.8	7.4	6.9	7.5	6.9	7.6	6.6	7.6	6.8
56	7.4	6.9	7.4	7.5	6.8	6.8	7.4	6.7	7.5	7.0	7.6	6.7	7.6	6.7
100	7.4	6.8	7.4	7.5	6.8	6.7	7.4	6.5	7.5	6.9	7.6	6.4	7.6	6.8
180	7.4	6.8	7.4	7.5	6.7	6.7	7.4	6.4	7.5	6.8	7.6	6.6	7.6	6.8
320	7.4	6.8	7.4	7.5	6.7	~~6.8~~	~~7.4~~	—	—	—	—	—	—	—
Tech. Initials	JKS	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Salinity II-A030304 | DO II-A-011202

Comments

Test Set Up By JKS/AWD | Data Verified By Qualich | Date Verified Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris Mine)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339

Sample ID: Cu (Reflox)
Test Species/Batch: A. affinis / July 29, 2004
Test Initiation Date/Time: July 30, 2004 / 1430 h
No. of Organisms/Volume: 5/200ml

Cu ug/L Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
Neg. CTL	A	A 36	5	5	5	5	5	5	5	
	B	37	5	5	5	5	5	5	5	
	C	38	5	5	5	5	5	5	5	
	D	39	5	5	5	5	5	5	5	
	E	40	5	5	5	5	5	5	5	
32	A	41	5	5	5	5	5	5	5	
	B	42	5	5	5	5	5	5	5	
	C	43	5	5	5	4	4	4	4	
	D	44	5	5	5	5	5	5	M/5	
	E	45	5	5	5	5	5	5	5	
56	A	46	5	5	5	5	5	5	5	
	B	47	5	5	5	5	5	4	4	
	C	49	5	5	5	5	5	5	5	
	D	50	5	5	5	5	5	5	5	
	E	51	5	5	5	5	5	5	5	
100	A	52	4	3	3	3	3	3	3	
	B	53	4	4	4	4	4	4	4	
	C	54	5	5	5	5	5	5	5	
	D	55	5	5	5	5	5	5	5	
	E	56	5	5	5	4	4	4	4	
Technician Initials										

Sample Description: clear, colorless
Data Verified By: [signature]
Date Verified: Sept. 13/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth (Polaris Mine)
EVS Project No. 09-0302-54
EVS Work Order No. 0400339

Sample ID Cu reflux
Test Species/Batch A. affinis / July 29, 2004
Test Initiation Date/Time July 30, 04/1430 h
No. of Organisms/Volume 5/200ml

Cu µg/L Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
180	A	~~A5~~	2	1	0	—	—	—	—	
	B	—	2	2	1	1	0	—	—	
	C	A58	4	4	2	2	2	2	2	
	D	A59	2	1	1	1	1	1	1	
	E	—	2	2	2	1	0	—	—	
320	A	—	1	0	—	—	—	—	—	
	B	—	0	—	—	—	—	—	—	
	C	—	0	—	—	—	—	—	—	
	D	—	0	—	—	—	—	—	—	
	E	—	0	—	—	—	—	—	—	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials										

Sample Description
Data Verified By Ralph H Date Verified Sept 13/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339

Start Date (Day 0): July 30, 2004
Sample ID: Cu - reftox
Balance Type/Serial Number: Sartorius BP211D

Sample ID (Cu µg/L)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
Neg. CTL	A	A36	1225.46	1231.37	5	5		JDS/AD
	B	A37	1223.00	1227.74	5	5		
	C	A38	1227.28	1232.01	5	5		
	D	A39	1225.60	1232.35	5	5		
	E	A40	1231.361	1238.39	5	5	confirmed 1238.42 ✓	
32	A	A41	1223.15	1228.32	5	5		
	B	A42	1232.24	1238.17	5	5		
	C	A43	1228.15 (1228.29 TKD)	1232.39	4	4		
	D	A44	1228.67	1233.67	5	5		
	E	A45	1223.92	1228.14	5	5	Confirmed 1228.16 ✓	
56	A	A46	1224.29	1229.51	5	5		
	B	A47	1219.34	1223.14	4	4		
	C	A48	1223.19	12			RD	
	~~C~~ D	~~A49~~ A51	1224.29	1229.03	5	5		"
	~~ED~~	~~A50~~	1228.49	1234.94	5	5		"

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]
Date Verified: Sept. 13/04

Forms\Lab\Datasheets\Larvalfish\Topsmelt\7D-DRYWEIGHT.DOC August 26, 2002

concentration	Pan #	pan wt	Final pan wt	# Survival	# Weighed
56 µg/L E	A51	1228.55	1233.48	5	5

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400339
Start Date (Day 0): July 30-04
Sample ID: Cu Effluent
Balance Type/Serial Number: Sartorius BP 211D

Sample ID Cu µg/L	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
100	A	A52	1229.80	1231.98	3	3		JAS µ
	B	A53	1230.92	1234.72	4	4		
	C	A54	1226.04	1230.33	5	5		
	D	A55	1228.91	1234.05	5	5	confirmed 1234.07 ✓	
	E	A56	1226.61	1231.21	4	4		
180	C	~~A58~~ A63 ^	~~1230.23~~ 1214.44 ^	1215.67	2	2		
	D	~~A59~~ A64 ^	~~1225.91~~ 1229.90 ^	1230.26	1	1		✓

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]
Date Verified: Sept - 13/04

Test: LF-Larval Fish Growth and Survival Test | Test ID: RTAACu37
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: REF-Ref Toxicant | Sample Type: CU-Copper
Start Date: 7/30/2004 End Date: 8/6/2004 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1231.37	1225.46
	2	2	D-Control	5							5	5	1227.74	1223
	3	3	D-Control	5							5	5	1232.01	1227.28
	4	4	D-Control	5							5	5	1232.35	1225.6
	5	5	D-Control	5							5	5	1238.39	1231.61
	6	1	32.000	5							5	5	1228.32	1223.15
	7	2	32.000	5							5	5	1238.17	1232.24
	8	3	32.000	5							4	4	1232.39	1228.15
	9	4	32.000	5							5	5	1233.67	1228.67
	10	5	32.000	5							5	5	1228.14	1223.92
	11	1	56.000	5							5	5	1229.51	1224.29
	12	2	56.000	5							4	4	1223.14	1219.34
	13	3	56.000	5							5	5	1229.03	1224.29
	14	4	56.000	5							5	5	1234.94	1228.49
	15	5	56.000	5							5	5	1233.48	1228.55
	16	1	100.000	5							3	3	1231.98	1229.8
	17	2	100.000	5							4	4	1234.72	1230.92
	18	3	100.000	5							5	5	1230.33	1226.04
	19	4	100.000	5							5	5	1234.05	1228.91
	20	5	100.000	5							4	4	1231.21	1226.61
	21	1	180.000	5							0	0	0	0
	22	2	180.000	5							0	0	0	0
	23	3	180.000	5							2	2	1215.67	1214.44
	24	4	180.000	5							1	1	1230.26	1229.9
	25	5	180.000	5							0	0	0	0
	26	1	320.000	5							0	0	0	0
	27	2	320.000	5							0	0	0	0
	28	3	320.000	5							0	0	0	0
	29	4	320.000	5							0	0	0	0
	30	5	320.000	5							0	0	0	0

Comments: 09-0302-54, 0400339

Reviewed by: 8/12/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	7/30/2004	Test ID:	RTAACu37	Sample ID:	REF-Ref Toxicant
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400339				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
32	1.0000	1.0000	0.8000	1.0000	1.0000
56	1.0000	0.8000	1.0000	1.0000	1.0000
100	0.6000	0.8000	1.0000	1.0000	0.8000
180	0.0000	0.0000	0.4000	0.2000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

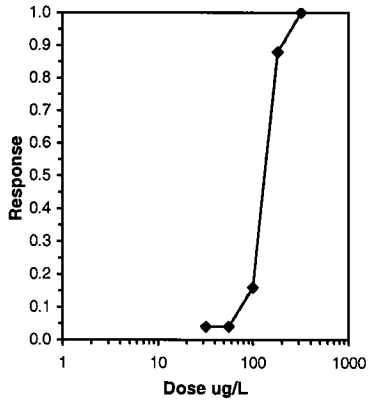
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
100	0.8400	0.1673	1.1582	0.8861	1.3453	16.679	5	20.00	17.00	4	25
*180	0.1200	0.1789	0.3650	0.2255	0.6847	56.537	5	15.00	17.00	22	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94287	0.888	0.10595	0.6692
Equality of variance cannot be confirmed				

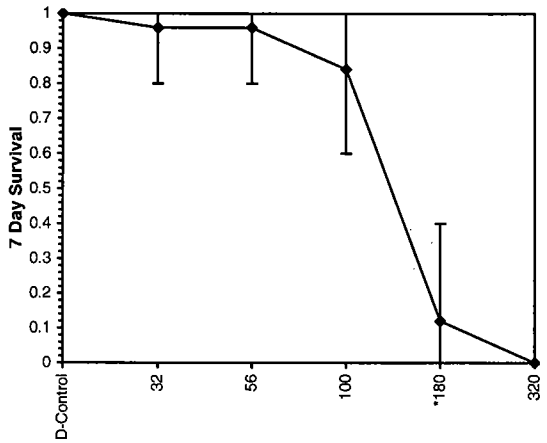
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	180	134.164	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	129.88	114.75	146.99	
10.0%	130.93	116.99	146.54	
20.0%	131.99	121.77	143.08	
Auto-4.0%	129.69	114.60	146.77	ug/L Cu



Dose-Response Plot



Reviewed by: Galfit
Sept. 13/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/30/2004	Test ID:	RTAACu37	Sample ID:	REF-Ref Toxicant
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400339				

Conc-ug/L	1	2	3	4	5
D-Control	1.1820	0.9480	0.9460	1.3500	1.3560
32	1.0340	1.1860	0.8480	1.0000	0.8440
56	1.0440	0.7600	0.9480	1.2900	0.9860
100	0.4360	0.7600	0.8580	1.0280	0.9200
180	0.0000	0.0000	0.2460	0.0720	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	1.1564	0.2035	1.1564	0.9460	1.3560	17.599	5				1.1564	1.0000
32	0.9824	0.1429	0.9824	0.8440	1.1860	14.543	5	1.534	2.300	0.2608	0.9940	0.8596
56	1.0056	0.1913	1.0056	0.7600	1.2900	19.023	5	1.330	2.300	0.2608	0.9940	0.8596
*100	0.8004	0.2257	0.8004	0.4360	1.0280	28.204	5	3.139	2.300	0.2608	0.8004	0.6921
*180	0.0636	0.1066	0.0636	0.0000	0.2460	167.649	5	9.636	2.300	0.2608	0.0636	0.0550
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97311	0.888	-0.2174	-0.3474
Bartlett's Test indicates equal variances (p = 0.67)	2.36564	13.2767		

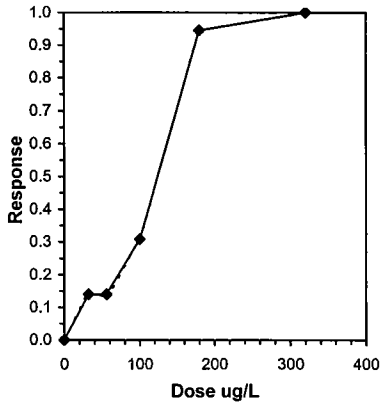
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	56	100	74.8331		0.26083	0.22555	0.93104	0.03215	4.6E-08	4, 20

Linear Interpolation (200 Resamples)

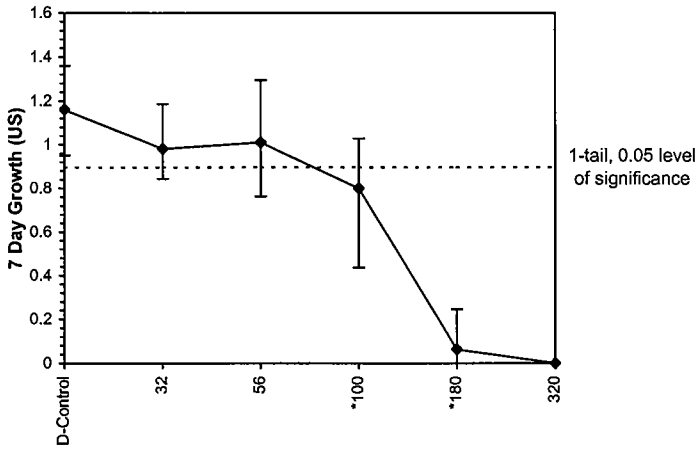
Point	ug/L	SD	95% CL(Exp)		Skew
IC05*	11.39	19.61	3.51	97.01	1.6113
IC10*	22.79	23.89	7.01	129.04	1.0634
IC15	58.51	26.81	0.00	126.48	0.4512
IC20	71.65	25.04	0.99	127.04	-0.1836
IC25	84.80	21.56	3.62	127.36	-0.5667
IC40	111.57	11.06	71.01	135.64	-0.6491
IC50	124.13	9.44	86.97	143.83	-0.7596

ug/L Cu

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by Gail H 4 Sept. 13/04

APPENDIX B

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340

EVS Analysts: KES ART
Test Initiation Date: 30 July 2004

SAMPLE

Identification: G-Creek Sublethal-270704
Amount Received: 5 x 20L
Date Collected: 27 July 2004
Date Received: 30 July 2004
Temperature (°C): 16.0 ① → 15.0
pH: 7.7 ① → 8.1
Dissolved Oxygen (mg/L): 9.6 ① → 8.5
Conductivity (µmhos/cm): 4940
Salinity (ppt): 2.6 ① → 28
Ammonia (mg/L N): –
Chlorine (mg/L Cl): –
Other: –

① Brine adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab Supplies
Date Received: 30 July 2004
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 30 July 2004
IC50 (and 95% CL): ~~2.2~~ 2.1 (1.9-2.4) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
4.2 ± 4.8 mg/L SDS, CV% = 57

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Steralized, 0.45µm filtered SW
Temperature (°C): 16.0
pH: 8.0
Dissolved Oxygen (mg/L): 8.2
Salinity (ppt): 28
Other: –

TEST CONDITIONS

Temperature Range (°C): 15.0 – 16.0
pH Range: 8.0 – 8.1
Dissolved Oxygen Range (mg/L): 8.2 – 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 1600:1
Test Duration: 10:10
Other: –

TEST RESULTS

IC 50: 37.3 (24.4 – 46.0) % v/v
IC 25: 8.7 (7.6 – 9.9) % v/v
NOEC: 4.6 % v/v
LOEC: 9.1 % v/v

Data Verified By: [signature]
Date Verified: Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client ~~09-0302-54~~ #kf AZIMUTH CONSULTING GROUP Test Initiation Date/Time 30 JULY 2004

EVS Project No. 09-0302-54 Test Species Dendraster excentricus

EVS Work Order No. 0400340 Source/Date Received #kf 30 JULY 2004 / Westwind Sealab Supplies

Logbook #13 Pages 50 – 53 Test Duration 10:10

Sample ID	Conc/Rep %. v/v	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
CONTROL		16.0	8.0	28	8.2	
BRINE CONTROL		15.0	8.1	28	8.4	
G. CREEK #kf	4.6	15.5	8.0	28	8.2	
↓	9.1	15.5	8.0	28	8.3	
	18.3	15.0	8.0	28	8.3	
	36.6	15.0	8.1	28	8.4	
	73.1	15.0	8.1	28	8.5	
Tech. Init.	kf	kf	kf	kf	kf	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-030303 DO II-A-011202

Data Verified By Qualified Date Verified Sept. 8, 2004

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340
Logbook: Echinoid #13 Pages: 50-53

Test Initiation Date/Time: 30 JULY 2004 @ 16:20
Test Species: Dendraster excentricus
Source/Date Received: Westwind Sealab Supplies/30 July 2004
Test Duration: 10:10
Sperm:Egg Ratio: 1600:1

Sample ID % (v/v)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
CONTROL	A	59	41		KEF
	B	62	38		
	C	56	44		
	D	65	35		
4.6	A	60	40		KEF
	B	66	34		
	C	56	44		
	D	58	42		
9.1	A	46	54		KEF
	B	42	58		
	C	45	55		
	D	42	58		
18.3	A	39	61		KEF
	B	36	64		
	C	37	63		
	D	36	64		
36.6	A	31	69		KEF
	B	34	66		
	C	25	75		
	D	31	69		
73.1	A	19	81		KEF
	B	20	80		
	C	21	79		
	D	20	80		

Data Verified By: [signature]
Date Verified: 2/11-8/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340
Logbook: Echinoid #13 Pages: 50-53

Test Initiation Date/Time: 30 JULY 2004 @ 16:20
Test Species: Dendraster excentricus
Source/Date Received: Westwind Sealab Supplies / 30 July 2004
Test Duration: 10:10
Sperm:Egg Ratio: 1600:1

Sample ID	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
BRINE CONTROL	A	60	40		KG
	B	57	43		↓
	C	59	41		
	D	62	38		↓
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Data Verified By: [signature]
Date Verified: Sept. 8/04

Test: SC-Sperm Cell Fertilization test						Test ID: 0400340	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: G CREEK 270704E						Sample Type: EFF2-Industrial	
Start Date: 7/30/2004 16:20 (10:16)				End Date: 7/30/2004		Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	59	41	
	2	2	D-Control	100	62	38	
	3	3	D-Control	101	56	44	
	4	4	D-Control	100	65	35	
	5	1	B-Control	100	60	40	
	6	2	B-Control	100	57	43	
	7	3	B-Control	100	59	41	
	8	4	B-Control	100	62	38	
	9	1	4.6	100	60	40	
	10	2	4.6	100	66	34	
	11	3	4.6	100	56	44	
	12	4	4.6	100	58	42	
	13	1	9.1	100	46	54	
	14	2	9.1	100	42	58	
	15	3	9.1	100	45	55	
	16	4	9.1	100	42	58	
	17	1	18.3	100	39	61	
	18	2	18.3	100	36	64	
	19	3	18.3	100	37	63	
	20	4	18.3	100	36	64	
	21	1	36.6	100	31	69	
	22	2	36.6	100	34	66	
	23	3	36.6	100	25	75	
	24	4	36.6	100	31	69	
	25	1	73.1	100	19	81	
	26	2	73.1	100	20	80	
	27	3	73.1	100	21	79	
	28	4	73.1	100	20	80	

Comments: Azimuth Consulting Group (Polaris), 09-0302-54 (0400340)

Reviewed by: Qual 8/10/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/30/2004 10:10	Test ID:	400340	Sample ID:	G CREEK 270704E
End Date:	7/30/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus

Comments: Azimuth Consulting Group (Polaris), 09-0302-54 (0400340)

Conc-%	1	2	3	4
D-Control	0.5900	0.6200	0.5545	0.6500
B-Control	0.6000	0.5700	0.5900	0.6200
4.6	0.6000	0.6600	0.5600	0.5800
9.1	0.4600	0.4200	0.4500	0.4200
18.3	0.3900	0.3600	0.3700	0.3600
36.6	0.3100	0.3400	0.2500	0.3100
73.1	0.1900	0.2000	0.2100	0.2000

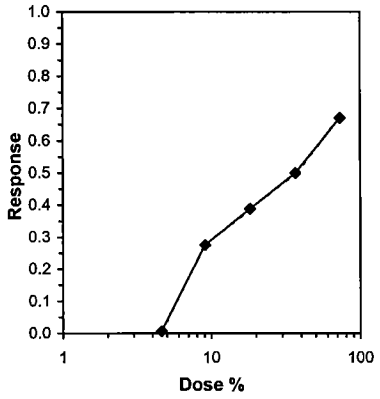
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6036	0.0409	0.6036	0.5545	0.6500	6.778	4				0.6035	1.0000
B-Control	0.5950	0.0208	0.5950	0.5700	0.6200	3.499	4					
4.6	0.6000	0.0432	0.6000	0.5600	0.6600	7.201	4	0.166	2.410	0.0523	0.6000	0.9942
*9.1	0.4375	0.0206	0.4375	0.4200	0.4600	4.712	4	7.650	2.410	0.0523	0.4375	0.7249
*18.3	0.3700	0.0141	0.3700	0.3600	0.3900	3.822	4	10.759	2.410	0.0523	0.3700	0.6131
*36.6	0.3025	0.0377	0.3025	0.2500	0.3400	12.479	4	13.868	2.410	0.0523	0.3025	0.5013
*73.1	0.2000	0.0082	0.2000	0.1900	0.2100	4.082	4	18.589	2.410	0.0523	0.2000	0.3314

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97262	0.884	0.10504	0.3504
Bartlett's Test indicates equal variances (p = 0.12)	8.83506	15.0863		
The control means are not significantly different (p = 0.72)	0.37528	2.44691		

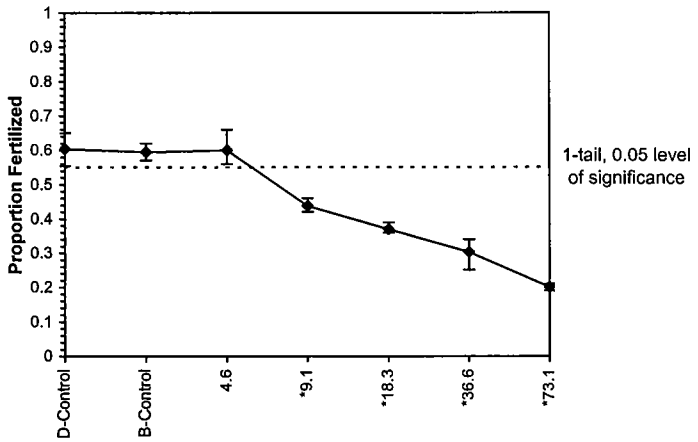
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	4.6	9.1	6.46993	21.7391	0.05233	0.08669	0.1049	0.00094	6.9E-13	5, 18

Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	5.169	1.017	0.000	5.397	-2.0092
IC10	5.883	0.366	4.155	6.252	-1.2685
IC15	6.680	0.367	5.002	7.221	-0.7933
IC20	7.569	0.396	5.813	8.353	-0.2936
IC25	8.561	0.492	6.881	9.883	0.8154
IC40	19.868	2.019	13.185	25.832	0.4117
IC50	36.788	4.538	22.468	46.940	-0.2718



Dose-Response Plot



Statistical comparisons were against the D-control

Reviewed by [signature] 10/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/30/2004 10:10	Test ID:	400340	Sample ID:	G CREEK 270704E
End Date:	7/30/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0400340)				

Conc-%	1	2	3	4
D-Control	0.5900	0.6200	0.5545	0.6500
B-Control	0.6000	0.5700	0.5900	0.6200
4.6	0.6000	0.6600	0.5600	0.5800
9.1	0.4600	0.4200	0.4500	0.4200
18.3	0.3900	0.3600	0.3700	0.3600
36.6	0.3100	0.3400	0.2500	0.3100
73.1	0.1900	0.2000	0.2100	0.2000

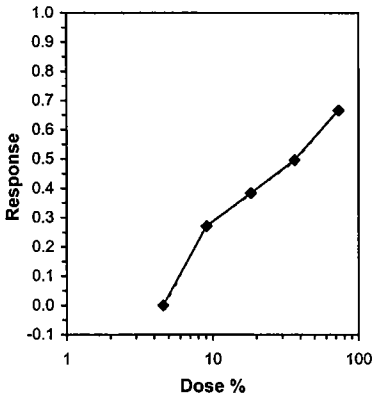
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.5993	0.0304	0.5993	0.5545	0.6500	5.073	8				0.5996	1.0000
4.6	0.6000	0.0432	0.6000	0.5600	0.6600	7.201	4	-0.039	2.508	0.0444	0.5996	1.0000
*9.1	0.4375	0.0206	0.4375	0.4200	0.4600	4.712	4	9.132	2.508	0.0444	0.4375	0.7296
*18.3	0.3700	0.0141	0.3700	0.3600	0.3900	3.822	4	12.941	2.508	0.0444	0.3700	0.6171
*36.6	0.3025	0.0377	0.3025	0.2500	0.3400	12.479	4	16.750	2.508	0.0444	0.3025	0.5045
*73.1	0.2000	0.0082	0.2000	0.1900	0.2100	4.082	4	22.535	2.508	0.0444	0.2000	0.3335

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97514	0.896	0.207	0.38283
Bartlett's Test indicates equal variances (p = 0.14)	8.25726	15.0863		
The control means are not significantly different (p = 0.72)	0.37528	2.44691		

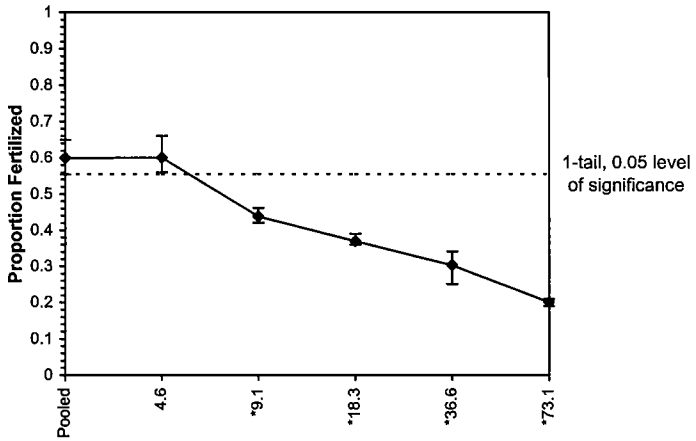
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	4.6	9.1	6.46993	21.7391	0.04445	0.07416	0.12612	0.00084	3.0E-16	5, 22

Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05	5.245	0.437	3.010	5.322	-4.5891	
IC10	5.965	0.211	4.856	6.144	-1.3490	
IC15	6.768	0.218	5.712	7.144	-0.5439	
IC20	7.663	0.265	6.670	8.281	0.2881	
IC25	8.661	0.385	7.566	9.896	1.1053	
IC40	20.352	1.691	14.803	25.784	0.6254	
IC50	37.275	3.916	24.371	46.032	-0.2591	%v/v



Dose-Response Plot



Statistical comparisons were against the pooled controls

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340

EVS Analysts: KES, ART
Test Initiation Date: 30 July 2004

SAMPLE

Identification: SDS RefTox Stock Sol^n #04-5-005
Amount ~~Received~~ Prep'd: 1 x 1L
Date ~~Collected~~ Prep'd: 26 April 2004
Date Received: n/a
Temperature (°C):
pH:
Dissolved Oxygen (mg/L):
Conductivity (µmhos/cm):
Salinity (ppt):
Ammonia (mg/L N):
Chlorine (mg/L Cl):
Other:

TEST SPECIES

Organism: Dendraster excentricus
Source: Westcoast Sealab Supplies
Date Received: 30 July 2004
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 30 July 2004
IC50 (and 95% CL): 2.1 (1.9-2.4) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
4.2 ± 4.8 mg/L SDS, CV% = 57

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Steralized, 0.45µm filtered SW
Temperature (°C): 16.0
pH: 8.0
Dissolved Oxygen (mg/L): 8.2
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 16.0
pH Range: 8.0
Dissolved Oxygen Range (mg/L): 8.2
Salinity Range (ppt): 28
Sperm:Egg Ratio: 1600:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: ~~1/2~~ 2.1 (1.9-2.4) mg/L SDS
IC 25: ~~1/3~~ 1.7 (0.9-1.5) mg/L SDS
NOEC: <1 mg/L SDS
LOEC: 1 mg/L SDS

Data Verified By: [signature]
Date Verified: Sept-10/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400340
Logbook: ECHINOID #13 Pages: 50-53

Test Initiation Date/Time: 30 JULY 2004 @16:20
Test Species: Dendraster excentricus
Source/Date Received: 30 JULY
Test Duration: 10:10

Sample ID	Conc/Rep mg/L	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
SDS	CONTROL	16.0	8.0	28	8.2	
	1.0	16.0	8.0	28	~~8.4~~ 8.2	
	1.8	16.0	8.0	28	8.2	
	3.2	16.0	8.0	28	8.2	
	5.6	16.0	8.0	28	8.2	
↓	10.0	16.0	8.0	28	8.2	
Tech. Init.	KEJ	KEJ	KEJ	KEJ	KEJ	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-03-03 DO II-A-011202

Data Verified By: [signature] Date Verified: Sept 8/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09 0302-54
EVS Work Order No.: 0400340
Logbook: ECHINOID #13 Pages: 50 – 53

Test Initiation Date/Time: 30 JULY 2004 @ 16:20
Test Species: Dendraster excentricus
Test Duration: 10:10
Sperm:Egg Ratio: ~~1:1600~~ KEF 1600:1

Concentration SDS mg/L	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	47	53		KEF
	B	55	45		↓
	C	50	50		↓
	D	48	52		↓
1.8	A	33	67		KEF
	B	36	64		↓
	C	39	61		↓
	D	35	65		↓
3.2	A	14	86		KEF
	B	11	89		↓
	C	~~KEF 15~~ 15	85		↓
	D	18	82		↓
5.6	A	5	~~KEF 95~~ 95		KEF
	B	8	92		↓
	C	7	93		↓
	D	5	~~482~~ 95		↓
10.0	A	2	98		KEF
	B	3	97		↓
	C	2	98		↓
	D	2	98		↓
Control Seawater					
	A	59	41		KEF
	B	62	38		↓
	C	56	44		↓
	D	65	35		↓

Data Verified By: [signature]
Date Verified: Sept. 10/04

Test: SC-Sperm Cell Fertilization test						Test ID: rtscsds8	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: REF-Ref Toxicant						Sample Type: SDS-Sodium dodecyl sulfate	
Start Date: 7/30/2003 10:10			End Date: 7/30/2003			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	59	41	
	2	2	D-Control	100	62	38	
	3	3	D-Control	100	56	44	
	4	4	D-Control	100	65	35	
	5	1	1.0	100	47	53	
	6	2	1.0	100	55	45	
	7	3	1.0	100	50	50	
	8	4	1.0	100	48	52	
	9	1	1.8	100	33	67	
	10	2	1.8	100	36	64	
	11	3	1.8	100	39	61	
	12	4	1.8	100	35	65	
	13	1	3.2	100	14	86	
	14	2	3.2	100	11	89	
	15	3	3.2	100	15	85	
	16	4	3.2	100	18	82	
	17	1	5.6	100	5	95	
	18	2	5.6	100	8	92	
	19	3	5.6	100	7	93	
	20	4	5.6	100	5	95	
	21	1	10.0	100	2	98	
	22	2	10.0	100	3	97	
	23	3	10.0	100	2	98	
	24	4	10.0	100	2	98	

Comments: Azimuth Consulting Group 09-0302-54 (0400340)

Reviewed by: Qualified

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/30/2003 10:10	Test ID:	rtscsds8	Sample ID:	REF-Ref Toxicant
End Date:	7/30/2003	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 09-0302-54 (0400340)				

Conc-mg/L	1	2	3	4
D-Control	0.5900	0.6200	0.5600	0.6500
1	0.4700	0.5500	0.5000	0.4800
1.8	0.3300	0.3600	0.3900	0.3500
3.2	0.1400	0.1100	0.1300	0.1800
5.6	0.0500	0.0800	0.0700	0.0500
10	0.0200	0.0300	0.0200	0.0200

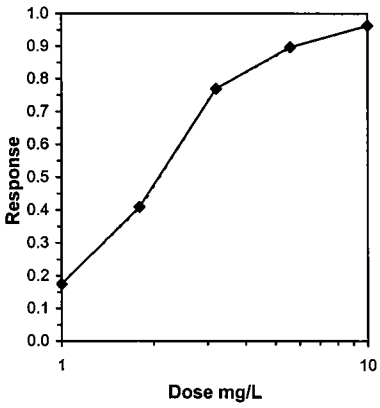
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6050	0.0387	0.6050	0.5600	0.6500	6.402	4				0.6050	1.0000
*1	0.5000	0.0356	0.5000	0.4700	0.5500	7.118	4	5.417	2.410	0.0467	0.5000	0.8264
*1.8	0.3575	0.0250	0.3575	0.3300	0.3900	6.993	4	12.769	2.410	0.0467	0.3575	0.5909
*3.2	0.1400	0.0294	0.1400	0.1100	0.1800	21.028	4	23.990	2.410	0.0467	0.1400	0.2314
*5.6	0.0625	0.0150	0.0625	0.0500	0.0800	24.000	4	27.989	2.410	0.0467	0.0625	0.1033
*10	0.0225	0.0050	0.0225	0.0200	0.0300	22.222	4	30.052	2.410	0.0467	0.0225	0.0372

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95924		0.884		0.47024	-0.048
Bartlett's Test indicates equal variances (p = 0.10)					9.12722		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	<1	1			0.04671	0.07721	0.23459	0.00075	7.9E-17	5, 18

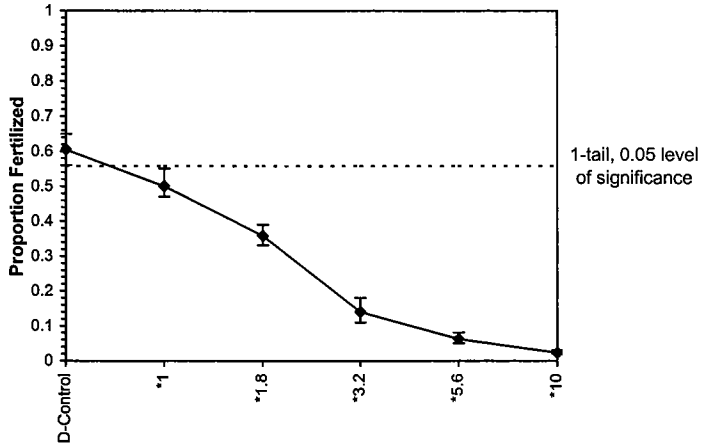
Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew
IC05*	0.2210	0.0598	0.1215	0.4427	1.9998
IC10*	0.4909	0.1376	0.2541	1.0631	1.4199
IC15*	0.8204	0.1664	0.3977	1.2636	0.1322
IC20	1.0770	0.1112	0.6393	1.3408	-0.5478
IC25	1.2308	0.0881	0.9462	1.4744	0.0167
IC40	1.7639	0.0892	1.4812	2.0222	0.0823
IC50	2.1023	0.0768	1.8738	2.3581	0.1963 mg/L SDS

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by: Sent. 15/06

APPENDIX C

Chain-of-Custody Form

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Teck Cominco (Polaris) Client Contact Name: Cheryl. MacKintosh Ship to: _____

Address: Azimuth Consulting Group Phone: 604 730 1220

218-2902 West Broadway Fax: 604 739 8511

Vancouver B.C. Sampled By: Karlette Tinaley Attn: _____ Shipping Date: _____

Topsoil

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested					3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)
For composite sample record date & time starting and ending								Fed Topsoil					
27/07/04	9:30AM	G-Creek_Sublethal_270704	E			2x20L	HDPE						POLARIS Proj
		G-Creek_Acute_270704	E			3x20L	HDPE						POLARIS Proj

PO/Reference No.:

Project Title:

Results Needed By:

Comments/Instructions:

A) Released By: Date:
Company: Time:
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

B) Received by: Ano Date: July 30-04
Company: EVS Time: 1200
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

C) Released By: Date:
Company: Time:
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify) HDPE Plastic
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies:
White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

Photocopy of original because 3 coolers.

-54

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Teck Cominco (Polaris) Client Contact Name: Cheryl. MacKintosh Ship to: _____

Address: ~~Azimuth Consulting Group~~ Phone: 604 730 7220

218-2902 West Broadway Fax: 604 739 8511

Vancouver B.C. Sampled By: Karlette Tinsley Attn: _____

Shipping Date: _____ Kathyrn

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested						3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)
For composite sample record date & time starting and ending														
27/07/04	9:30PM	G-Creek_Sublethal_270704	E			2x20L	HDPE							POLARIS PROJ
		G-Creek_Acute_270704	E			3x20L	HDPE							POLARIS PROJ

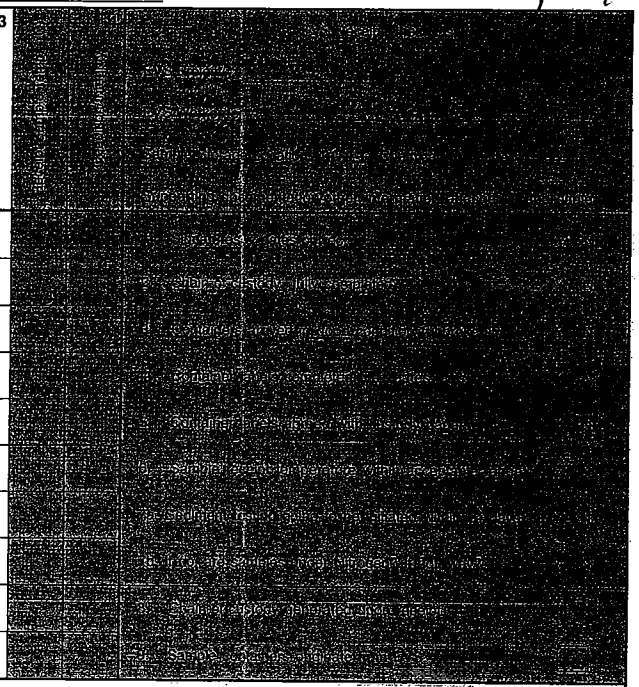


Photo copy of orginal because 3 coolers

PO/Reference No.:

Project Title:

Results Needed By:

Comments/Instructions:

A) Released By: Date:
Company: Time:
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

B) Received by: AWD Date: 30 JULY 2004
Company: EVS Time: 12:00
Shipping containers received secure? (Yes) No
Custody seals intact? (Yes) No ~~N/A~~

C) Released By: Date:
Company: Time:
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify) HDPE Plastic
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies:
White, yellow, pink - accompany the shipment
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October 2004

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

August 24, 2004

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

August 24, 2004

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants - A Member of the Golder Group of Companies
195 Pemberton Avenue
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EVS Project No.

09-0302-54

October 2004

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ACKNOWLEDGEMENTS

The *A. affinis* toxicity test was conducted by Andy Diewald, Anja Fouche and Jenny Shao. Kathryn Sentance and Ann-Marie Norris performed the *D. excentricus* fertilization toxicity test. Statistical analyses were performed by Jenny Shao and Kathryn Sentance. The report was written by Kathryn Sentance and reviewed by Edmund Canaria. Quality Assurance/Quality Control (QA/QC) review was conducted by Julianna Kalokai.

1. INTRODUCTION

EVS Environment Consultants conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as G Creek-082404, was collected from the Polaris Mine Site on August 24, 2004 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on August 27, 2004 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendix A and B respectively, and the chain-of-custody form is provided in Appendix C.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d toxicity test and reference toxicant test using topsmelt (A. *affinis*) was conducted in accordance with EVS Environment Consultants Standard Operating Procedures (SOP) 1100-5 (EVS, 2004) with modifications based on U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general

QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and record-keeping, and use of standard operating procedures (SOPs). To ensure the highest quality of data and reporting, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.4, 9.0, 18.0, 36.0, 71.0% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity adjusted
Control/dilution water	UV-sterilized and 0.5µm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.7, 9.4, 18.8, 37.5, 75.1% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 1 and the raw statistical analyses are provided in Appendix A.

The highest concentration tested was approximately 71.0% due to salinity adjustment. The mean survival in both the negative and brine controls was 100%.Mean dry weight in the pooled controls was 0.95mg. The negative and brine controls were not significantly different for the growth and survival endpoints (p =1.00 and p =0.72, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). For the survival and growth endpoints the NOEC was 71.0, and the LOEC was >71.0% (v/v). The LC50 for survival was >71.0% (v/v). The IC50 and IC25 for growth were both >71.0% (v/v)

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 2 and the raw statistical analyses are provided in Appendix B.

The highest concentration tested was 75.1% due to salinity adjustment. Mean fertilization in the pooled controls was 76.6%. The negative and brine controls were not significantly different (p =0.68).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all except the lowest [4.7%(v/v)] test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was 4.7 and LOEC was 9.4 %(v/v). The IC50 and IC25 (95% confidence limits) values were 50.7 (48.1 – 53.6) and 17.5 (11.6 – 22.6) %(v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% v/v)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	100.0 ± 0.0	0.93 ± 0.06
Brine Control	100.0 ± 0.0	0.96 ± 0.18
Pooled Controls	100.0 ± 0.0	0.95 ± 0.13
4.4	100.0 ± 0.0	1.06 ± 0.26
9.0	100.0 ± 0.0	0.87 ± 0.06
18.0	100.0 ± 0.0	0.97 ± 0.17
36.0	96.0 ± 8.9	0.92 ± 0.13
71.0	100.0 ± 0.0	0.87 ± 0.16
TEST ENDPOINT	**SURVIVAL (% v/v)**	**GROWTH (% v/v)**
NOEC	71.0	71.0
LOEC	>71.0	>71.0
LC50	>71.0	na
IC50	na	>71.0
IC25	na	>71.0

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus*) fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	77.0 ± 2.4
Brine Control	76.2 ± 2.5
Pooled Control	76.6 ± 2.3
4.7	75.0 ± 2.6
9.4	61.2 ± 1.0*
18.8	57.0 ± 1.8*
37.5	49.2 ± 1.0*
75.1	25.8 ± 1.5*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	4.7
LOEC	9.4
IC50 (95% CL)	50.7 (48.1 – 53.6)
IC25 (95% CL)	17.5 (11.6 – 22.6)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

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Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

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APPENDIX A

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client: Azimuth (Polaris) | EVS Analysts: AWD, JKS
EVS Project No.: 09-5302-54
EVS Work Order No.: 0400384 | Test Initiation Date: Aug 25, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-Creek 082404	→	→
Amount Received	1 x 20L	→	→
Date Collected	24-Aug-04	→	→
Date Received	27-Aug-04	→	→
Temperature (°C)	20.0 B 20.0	20.0 D 20.0	20.0 D 20.0
pH	7.6 D 8.1	7.6 D 8.2	7.5 D 8.3
DO (mg/L)	10.1 D 7.4	10.0 D 7.5	11.0 D 7.5
Conductivity (µmhos/cm)	9230	—	—
Salinity (ppt)	5.2 D 28	5.1 D 28	5.2 D 28
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other	D Salinity adj. to 30±2 ppt w/ 90ppt HSB		

DILUTION/CONTROL WATER (initial water quality)
Water Type: UV Sterilized S.W.
Temperature (°C): 20.0
pH: 7.8
Dissolved Oxygen (mg/L): 7.4
Salinity: 28

TEST SPECIES INFORMATION
Source: ABS (Aquatic Bio Systems)
Date Received: Aug 26 2004
Age (on Day 0): 10-d
Reference Toxicant: Copper
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date: Aug 25, 2004
7-d survival LC50: 121 (107-137) ug/L
7-d growth IC50: 128 (85-152) (41-153) ug/L
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50: 132 ± 48 ug/L CV: 18%
7-d growth IC50: 138 ± 51 ug/L CV: 20%

TEST CONDITIONS
Temperature Range (°C): 20.0 - 21.0
pH Range: 7.8 - 8.3
Dissolved Oxygen Range (mg/L): 6.4 - 7.6
Salinity (ppt): 28
Photoperiod (L:D h): 16:8
Aeration Provided?: No
Other: —

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	71	>71	>71		
Growth		71	>71		>71	>71

Other:

Data Verified By: [signature] | Date Verified: Oct-27/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris) | Sample ID: G-Creek @ 082404

EVS Project No.: 09-0302-54 | Test Initiation Date/Time: Aug 25, 2004 @ 1230 L

EVS Work Order No.: 0400384 | Source/Date Received: ABS / Aug 26, 2004

Concentration % (v/v)	Temperature (°C)													
	0	1 old	1 new	2		3		4		5		6		7
Control	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.0	20.5
Brine Control	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.5	20.0
4.4	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.5	20.5
9.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.5	20.5
18	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.5	20.5
36	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.5	20.0	20.5	20.5
71	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	21.0	20.0	20.6	20.0	20.0	20.5
Tech. Initials	~	~	~	~	~	~	~	JW	JW	~	~	JW	JW	JW

Concentration % (v/v)	pH													
	0	1		2		3		4		5		6		7
Control	7.8	8.0	8.0	8.1	7.9	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.9	7.9
Brine Control	7.8	8.0	8.0	8.1	7.9	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.9	7.9
4.4	7.7	8.1	8.1	8.1	8.1	8.0	8.1	8.0	8.1	8.0	8.1	7.9	7.9	8.0
9.0	7.8	8.3	8.1	8.2	8.1	8.0	8.2	8.0	8.1	8.1	8.1	8.0	7.9	8.0
18	7.8	8.2	8.1	8.2	8.2	8.0	8.2	8.0	8.1	8.1	8.1	8.0	8.0	8.1
36	7.9	8.3	8.2	8.2	8.2	8.0	8.2	8.1	8.2	8.1	8.1	8.1	8.0	8.1
71	8.1	8.3	8.3	8.3	8.2	8.0	8.3	8.2	8.3	8.2	8.2	8.2	8.1	8.1
Tech. Initials	~	~	~		~	~	~	JW	JW	A	~	JW	JW	JW

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH H-A-52

Comments

Test Set Up By: AWN | Data Verified By: [signature] | Date Verified: Oct 20/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris) | Sample ID: G-Creek 082404

EVS Project No.: 09-0302-54 | Test Initiation Date/Time: Aug 25th 2004 @ 1230h

EVS Work Order No.: 0400384 | Source/Date Received: ABS / Aug 26th 2004

Concentration %o (v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Control	28	28	28	28	28	28	28	28
Brine Control	28	28	28	28	28	28	28	28
4.4	28	28	28	28	28	28	28	28
9.0	28	28	28	28	28	28	28	28
18	28	28	28	28	28	28	28	28
36	28	28	28	28	28	28	28	28
71	28	28	28	28	28	28	28	28
Tech. Initials	~	~	~	~	AWS	JWS	JWS	AS

Concentration %o (v/v)	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
Control	7.4	6.5	7.5	6.9	7.5	7.0	7.5	7.0	7.5	6.4	7.4	7.6	6.5	6.6
Brine Control	7.4	6.6	7.5	6.8	7.5	6.9	7.5	6.9	7.5	6.6	7.4	7.5	6.4	6.4
4.4	7.4	6.7	7.5	6.7	7.5	6.9	7.5	6.9	7.5	6.7	7.5	7.6	6.6	6.5
9.0	7.4	6.6	7.5	6.8	7.5	6.9	7.5	7.0	7.5	6.8	7.5	7.6	6.6	6.5
18	7.4	6.4	7.5	6.8	7.5	6.9	7.5	6.9	7.5	6.8	7.6	7.5	6.7	6.5
36	7.4	6.5	7.6	6.9	7.5	6.9	7.5	6.9	7.5	6.8	7.5	7.5	6.8	6.4
71	7.4	6.5	7.6	6.8	7.5	6.9	7.5	6.9	7.5	6.7	7.4	7.5	6.7	6.5
Tech. Initials	~	~	~	~	~	~	AWS	JWS	AWS	~	~	JWS	JWS	~

WQ Instruments Used: Salinity II-A-030304 DO II-A-3

Comments

Test Set Up By: AWS | Data Verified By: [signature] | Date Verified: Oct-20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris) | Sample ID: G-Creek 082404
EVS Project No.: 09-0302-54 | Test Species/Batch: A. affinis / Aug 17-04
EVS Work Order No.: 0400384 | Test Initiation Date/Time: Aug 25, 2004 @ 1230h
No. of Organisms/Volume: 5/200mL

% (v/v) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
Control	A	A 31	5	5	5	5	5	5	5	
	B	32	5	5	5	5	5	5	5	
	C	33	5	5	5	5	5	5	5	
	D	34	5	5	5	5	5	5	5	
	E	35	5	5	5	5	5	5	5	
Brine	A	36	5	5	5	5	5	5	5	
	B	37	5	5	5	5	5	5	5	
	C	38	5	5	5	5	5	5	5	
	D	39	5	5	5	5	5	5	5	
	E	40	5	5	5	5	5	5	5	
4.4	A	41	5	5	5	5	5	5	5	
	B	42	5	5	5	5	5	5	5	
	C	43	5	5	5	5	5	5	5	
	D	44	5	5	5	5	5	5	5	
	E	45	5	5	5	5	5	5	5	
9.0	A	546	5	5	5	5	5	5	5	
	B	547	5	5	5	5	5	5	5	
	C	548	5	5	5	5	5	5	5	
	D	549	5	5	5	5	5	5	5	
	E	680	5	5	5	5	5	5	5	
Technician Initials		JvS	~	~	JvS	~	~	JvS	JvS	

Sample Description: clear, colorless
Data Verified By: Galphy | Date Verified: Oct 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Sample ID: G. Creek 082404
Test Species/Batch: A. affinis / Aug 9-04
Test Initiation Date/Time: Aug 25, 2004 @ 1230h
No. of Organisms/Volume: 5/200mL

% (v/v) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
18	A	46	5	5	5	5	5	5	5	
	B	47	5	5	5	5	5	5	5	
	C	48	5	5	5	5	5	5	5	
	D	49	5	5	5	5	5	5	5	
	E	50	5	5	5	5	5	5	5	
36	A	51	5	5	5	5	5	5	5	
	B	52	5	5	5	5	5	5	5	
	C	53	5	5	5	5	5	5	4	
	D	54	5	5	5	5	5	5	5	
	E	55	5	5	5	5	5	5	5	
71	A	61	5	5	5	5	5	5	5	
	B	62	5	5	5	5	5	5	5	
	C	63	5	5	5	5	5	5	5	
	D	64	5	5	5	5	5	5	5	
	E	65	5	5	5	5	5	5	5	
	A	6								
	B	7								
	C	8								
	D	9								
	E	10								
Technician Initials		JCS	M	—	JCS	C	~	JCS	JCS	

Sample Description: clear, colorless
Data Verified By: Ralph K
Date Verified: Oct 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Start Date (Day 0): August 25, 2004
Sample ID: G-Creek 082404
Balance Type/Serial Number: Sartorius BP211D

Sample ID % (v/v)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
Control	A	A31	1228.40	1233.24	5	5	pre-WT: 1228.42 mg	
	B	32	1229.96	1234.81	5	5		
	C	33	1231.09	1235.98	5	5		
	D	34	1226.23	1230.46	5	5	reweighed 1230.49 mg ✓	
	E	35	1218.59	1223.06	5	5		
Brine control	A	36	1226.59	1231.11	5	5		
	B	37	1234.73	1239.03	5	5		
	C	38	1220.42	1226.76	5	5		
	D	39	1232.69	1237.55	5	5		
	E	40	1236.53	1240.57	5	5		
4.4%	A	41	1227.94	1232.63	5	5		
	B	42	1224.25	1231.84	5	5		
	C	43	1235.61	1240.72	5	5	reweighed 1240.68 mg ✓	
	D	44	1219.66	1223.97	5	5		
	E	45	1225.29	1230.00	5	5	pre-WT: 1225.29 mg	

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]
Date Verified: Oct. 20/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Start Date (Day 0): August 25, 2004
Sample ID: G-Creek 082404
Balance Type/Serial Number: Sartorius BP 211D

Sample ID % (J/J)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
18	A	A 46	12.17.86	1222.46	5	5		
	B	47	1225.29	1228.77	5	5		
	C	48	1236.54	1242.18	5	5		
	D	49	1239.09	1244.52	5	5		
	E	50	1241.45	1246.42	5	5	reweighed: 1246.43 mg ✓	
36	A	51	1227.42	1230.87	5	5		
	B	52	1224.43	1228.50	5	5		
	C	53	1239.89	1243.83	4	4		
	D	54	1231.71	1236.86	5	5		
	E	55	1236.12	1240.57	5	5		
8.8	A	56	1233.41	1237.89	5	5		
	B	57	1232.69	1236.99	5	5		
	C	58	1218.75	1223.49	5	5		
	D	59	1238.08	1237.03	5	5		
	E	60	1222.96	1227.12	5	5	prewt: 1222.96 mg	

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph K

Date Verified: Oct 20/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
Start Date (Day 0): August 25, 2004
EVS Project No.: 09-0302-54
Sample ID: G-Creek 082404
EVS Work Order No.: 0400384
Balance Type/Serial Number: Sartorius BP211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
0% (4/5)								
72 71	A	A 61	1236.40	1239.74	5	5		~~TD~~
	B	62	1236.44	1240.25	5	5		
	C	63	1219.08 ~~1223.84~~	1224.54	5	5	reweighed 1224.57 mg	
	D	64	1228.47	1233.11	5	5		
	E	65	1243.42	1247.95	5	5	pre-wt: 1243.44 mg	
	A	6						
	B	7						
	C	8						
	D	9						
	E	0						
	A	1						
	B	2						
	C	3						
	D	4						
	E	5						

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph Ty
Date Verified: Oct 20/04

Test: LF-Larval Fish Growth and Survival Test
Test ID: 0400384
Species: AA-Atherinops affinis
Protocol: EPAW 95-EPA West Coast
Sample ID: G_CREEK
Sample Type: EFF2-Industrial
Start Date: 8/27/2004 End Date: 9/3/2004
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1233.24	1228.4
	2	2	D-Control	5							5	5	1234.81	1229.96
	3	3	D-Control	5							5	5	1235.98	1231.09
	4	4	D-Control	5							5	5	1230.46	1226.23
	5	5	D-Control	5							5	5	1223.06	1218.59
	6	1	Brine Control	5							5	5	1231.11	1226.59
	7	2	Brine Control	5							5	5	1239.03	1234.73
	8	3	Brine Control	5							5	5	1226.76	1220.42
	9	4	Brine Control	5							5	5	1237.55	1232.69
	10	5	Brine Control	5							5	5	1240.57	1236.53
	11	1	4.400	5							5	5	1232.63	1227.94
	12	2	4.400	5							5	5	1231.84	1224.25
	13	3	4.400	5							5	5	1240.72	1235.61
	14	4	4.400	5							5	5	1223.97	1219.66
	15	5	4.400	5							5	5	1230	1225.29
	16	1	9.000	5							5	5	1237.89	1233.41
	17	2	9.000	5							5	5	1236.99	1232.69
	18	3	9.000	5							5	5	1223.49	1218.75
	19	4	9.000	5							5	5	1237.03	1233.08
	20	5	9.000	5							5	5	1227.12	1222.96
	21	1	18.000	5							5	5	1222.48	1217.86
	22	2	18.000	5							5	5	1228.77	1225.29
	23	3	18.000	5							5	5	1242.18	1236.54
	24	4	18.000	5							5	5	1244.52	1239.09
	25	5	18.000	5							5	5	1246.42	1241.45
	26	1	36.000	5							5	5	1230.87	1225.42
	27	2	36.000	5							5	5	1228.5	1224.43
	28	3	36.000	5							4	4	1243.83	1239.89
	29	4	36.000	5							5	5	1236.86	1231.71
	30	5	36.000	5							5	5	1240.57	1236.12
	31	1	71.000	5							5	5	1239.74	1236.4
	32	2	71.000	5							5	5	1240.25	1236.44
	33	3	71.000	5							5	5	1224.54	1219.08
	34	4	71.000	5							5	5	1233.11	1228.47
	35	5	71.000	5							5	5	1247.95	1243.42

Comments: Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384

Reviewed by: Oct 17/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/27/2004	Test ID: 400384	Sample ID: G_CREEK-082404
End Date:	9/3/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	8/24/2004	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments:	Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384		

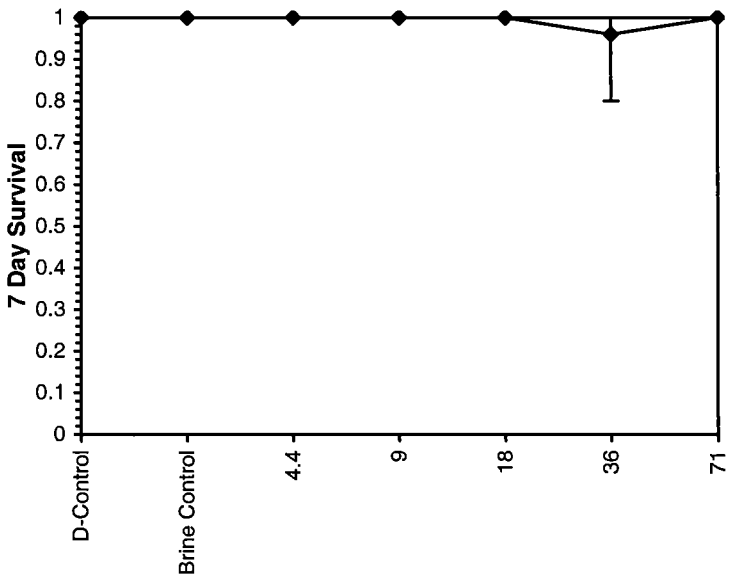
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.4	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000
36	1.0000	1.0000	0.8000	1.0000	1.0000
71	1.0000	1.0000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
Brine Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
4.4	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
18	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
36	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
71	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.41613	0.9	-3.8705	19.8512
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	71	>71		1.40845

Dose-Response Plot



Statistical comparison were against the D-control.

Reviewed by: Oct-20/04

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/27/2004	Test ID:	400384	Sample ID:	G_CREEK-082404
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/24/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384				

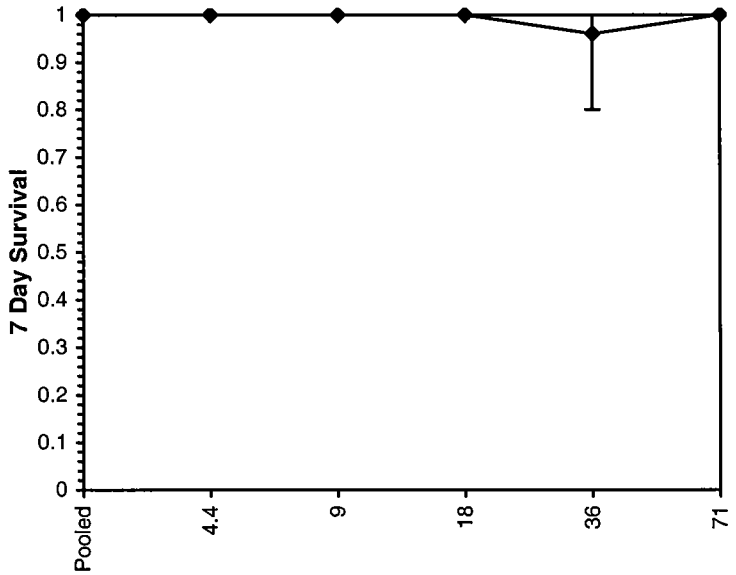
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
Brine Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.4	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000
36	1.0000	1.0000	0.8000	1.0000	1.0000
71	1.0000	1.0000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	10		
4.4	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
18	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
36	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
71	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.38831	0.91	-4.1486	23.0852
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	71	>71		1.40845

Dose-Response Plot



Statistical comparison were against the pooled control.

Reviewed by: Oct 20/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/27/2004	Test ID:	400384	Sample ID:	G_CREEK-082404
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	EFF2-Industrial
Sample Date:	8/24/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis

Comments: Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384

Conc-%	1	2	3	4	5
D-Control	0.9680	0.9700	0.9780	0.8460	0.8940
Brine Control	0.9040	0.8600	1.2680	0.9720	0.8080
4.4	0.9380	1.5180	1.0220	0.8620	0.9420
9	0.8960	0.8600	0.9480	0.7900	0.8320
18	0.9240	0.6960	1.1280	1.0860	0.9940
36	1.0900	0.8140	0.7880	1.0300	0.8900
71	0.6680	0.7620	1.0920	0.9280	0.9060

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.9312	0.0585	0.9312	0.8460	0.9780	6.283	5				0.9938	1.0000
Brine Control	0.9624	0.1811	0.9624	0.8080	1.2680	18.820	5					
4.4	1.0564	0.2642	1.0564	0.8620	1.5180	25.007	5	-1.252	2.360	0.2361	0.9938	1.0000
9	0.8652	0.0604	0.8652	0.7900	0.9480	6.980	5	0.660	2.360	0.2361	0.9177	0.9235
18	0.9656	0.1704	0.9656	0.6960	1.1280	17.643	5	-0.344	2.360	0.2361	0.9177	0.9235
36	0.9224	0.1328	0.9224	0.7880	1.0900	14.396	5	0.088	2.360	0.2361	0.9177	0.9235
71	0.8712	0.1631	0.8712	0.6680	1.0920	18.721	5	0.600	2.360	0.2361	0.8712	0.8766

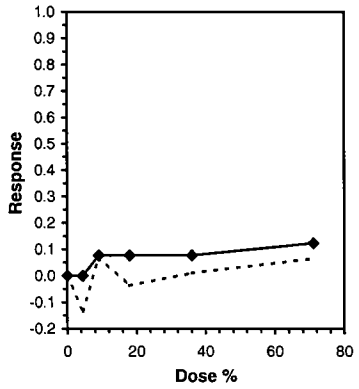
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94863	0.9	0.95961	2.51611
Bartlett's Test indicates equal variances (p = 0.05)	11.0427	15.0863		
The control means are not significantly different (p = 0.72)	0.36654	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	71	>71		1.40845	0.23609	0.25353	0.02479	0.02502	0.44403	5, 24

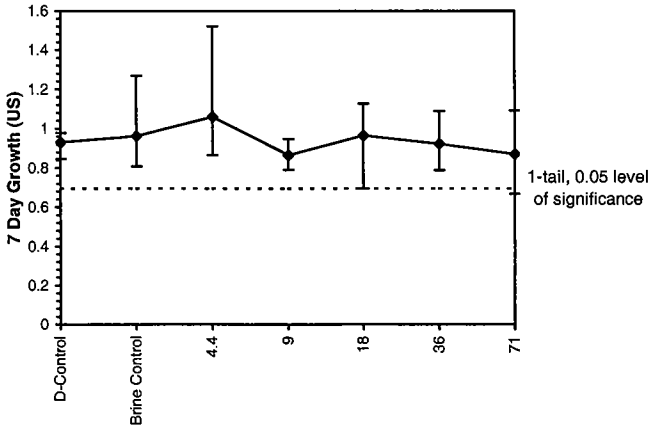
Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	7.405			
IC10	53.535			
IC15	>71			
IC20	>71			
IC25	>71			
IC40	>71			
IC50	>71			

% (v/v)



Dose-Response Plot



Statistical comparison were against the D-control.

Reviewed by: Oct-20/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/27/2004	Test ID:	400384	Sample ID:	G_CREEK-082404
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/24/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis

Comments: Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384

Conc-%	1	2	3	4	5
D-Control	0.9680	0.9700	0.9780	0.8460	0.8940
Brine Control	0.9040	0.8600	1.2680	0.9720	0.8080
4.4	0.9380	1.5180	1.0220	0.8620	0.9420
9	0.8960	0.8600	0.9480	0.7900	0.8320
18	0.9240	0.6960	1.1280	1.0860	0.9940
36	1.0900	0.8140	0.7880	1.0300	0.8900
71	0.6680	0.7620	1.0920	0.9280	0.9060

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.9468	0.1280	0.9468	0.8080	1.2680	13.514	10				1.0016	1.0000
4.4	1.0564	0.2642	1.0564	0.8620	1.5180	25.007	5	-1.258	2.462	0.2146	1.0016	1.0000
9	0.8652	0.0604	0.8652	0.7900	0.9480	6.980	5	0.936	2.462	0.2146	0.9177	0.9163
18	0.9656	0.1704	0.9656	0.6960	1.1280	17.643	5	-0.216	2.462	0.2146	0.9177	0.9163
36	0.9224	0.1328	0.9224	0.7880	1.0900	14.396	5	0.280	2.462	0.2146	0.9177	0.9163
71	0.8712	0.1631	0.8712	0.6680	1.0920	18.721	5	0.868	2.462	0.2146	0.8712	0.8698

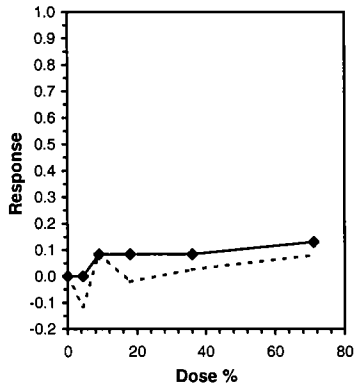
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94174	0.91	1.04686	2.00659
Bartlett's Test indicates equal variances (p = 0.18)	7.64107	15.0863		
The control means are not significantly different (p = 0.72)	0.36654	2.30601		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	71	>71		1.40845	0.21455	0.22661	0.02493	0.02531	0.44385	5, 29

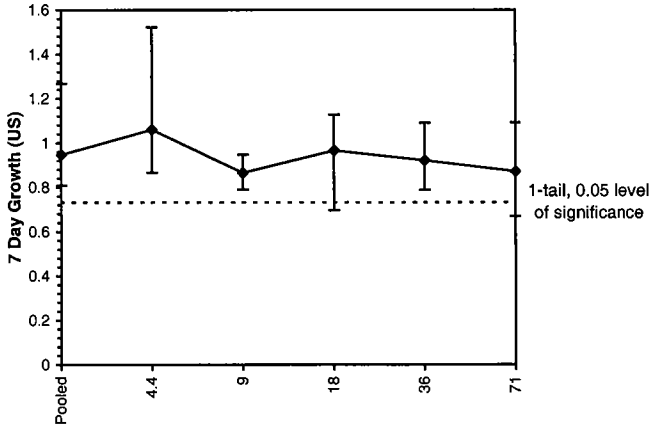
Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	7.147			
IC10	48.255			
IC15	>71			
IC20	>71			
IC25	>71			
IC40	>71			
IC50	>71			

% (v/v)



Dose-Response Plot



Statistical comparison were against the pooled control.

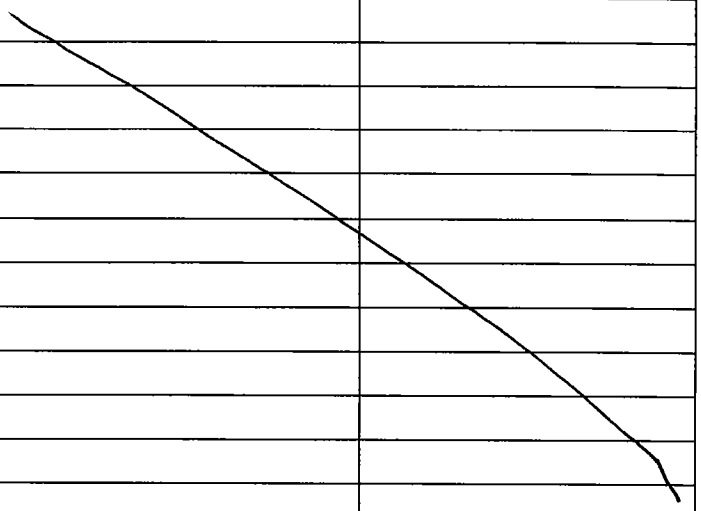
Reviewed by Oct 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400384

EVS Analysts AWD. JxS. AxF
Test Initiation Date Aug 27, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	04-Cu-001		
Amount Received	1 x 1 L		
Date Collected	15-March-04		
Date Received			
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			



DILUTION/CONTROL WATER (initial water quality)
Water Type Filtered, UV sterilized S.W.
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.4
Salinity 28

TEST SPECIES INFORMATION
Source ABS (Aquatic Biosystems)
Date Received Aug 26, 2004
Age (on Day 0) 10-d
Reference Toxicant Copper
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date Aug 27, 2004
7-d survival LC50 121 (107-137) mg/L Cu
7-d growth IC50 128 (85-150) mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 132 ± 48 mg/L CV: 18%
7-d growth IC50 131 ± 52 mg/L CV: 20%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.8 - 8.2
Dissolved Oxygen Range (mg/L) 6.4 - 7.7
Salinity (ppt) 28
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L	100	180	121 (107-137)		
Growth		56	100		128 (85-150)	93 (53-124)

Other

Data Verified By [signature] Date Verified Oct. 27/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris) | Sample ID: Cu Ref/tox
EVS Project No.: 09-0302-54 | Test Initiation Date/Time: Aug 25, 2004 / 1245 (26th)
EVS Work Order No.: 0400384 | Source/Date Received: ABS / Aug 18, 2004

Concentration µg/L	Temperature (°C)													
	0	1		2		3		4		5		6		7
Control	20.0	20.5	20.0	20.5	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0	20.5
32.0	20.0	20.5	20.0	20.5	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0	20.5
56.0	20.0	20.5	20.0	20.5	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0	20.5
100.0	20.0	20.5	20.0	20.5	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0	20.5
180.0	20.0	20.5	20.0	20.5	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0	20.5
320.0	20.0	20.5	20.0	20.5	20.0	20.0	20.5	—						
Tech. Initials														

Concentration µg/L	pH													
	0	1		2		3		4		5		6		7
Control	7.8	8.0	8.0	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
32.0	7.8	8.0	8.0	8.0	7.9	8.0	7.9	8.0	7.9	7.9	7.8	7.9	7.8	7.8
56.0	7.8	8.1	8.0	7.9	7.9	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.8	7.8
100.0	7.8	8.1	8.0	8.1	7.9	8.0	7.9	8.0	7.9	8.0	7.9	7.9	7.8	7.9
180.0	7.8	8.1	8.0	8.0	7.9	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.9	7.9
320.0	7.8	8.0	8.0	8.0	7.9	8.0	7.9	—						
Tech. Initials														

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-52
Comments

Test Set Up By: AWD | Data Verified By: [signature] | Date Verified: Oct. 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client: Azimuth (Polaris) | Sample ID: Cu Ref Tox

EVS Project No.: 09-0302-54 | Test Initiation Date/Time: Aug 27, 2004 @ 1245

EVS Work Order No.: 0400384 | Source/Date Received: ABS / Aug 26, 2004

Concentration µg/L	Salinity (ppt)							
	0	1	2	3	4	5	6	7
control	28	28	28	28	28	28	28	28
32.0	28	28	28	28	28	28	28	28
56.0	28	28	28	28	28	28	28	28
100.0	28	28	28	28	28	28	28	28
180.0	28	28	28	28	28	28	28	28
320.0	28	28	28	28	28	~~28~~	—	—
Tech. Initials	^	^	^	JAS	^	^	JAS	JAS

Concentration µg/L	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
control	7.4	6.7	7.5	6.6	7.5	6.9	7.5	7.0	7.7	6.7	7.4	7.6	6.7	6.6
32.0	7.4	6.4	7.5	6.7	7.5	6.9	7.5	6.9	7.5	6.6	7.4	7.6	6.8	6.7
56.0	7.4	6.5	7.5	6.6	7.5	6.9	7.5	7.0	7.5	6.6	7.4	7.6	6.9	6.8
100.0	7.4	6.5	7.5	6.7	7.5	7.0	7.5	7.1	7.5	6.7	7.4	7.6	6.7	6.7
180.0	7.4	6.6	7.5	6.7	7.5	7.0	7.5	7.0	7.5	6.4	7.4	7.7	6.7	6.7
320.0	7.4	6.6	7.5	6.7	7.5	7.1	7.5	7.0	7.5	—				
Tech. Initials	^	^	^	^	^	JAS	^	^	^	^	^	JAS	JAS	JAS

WQ Instruments Used: Salinity II-A-030304 DO II-A-3

Comments

Test Set Up By: AWD | Data Verified By: Qualified | Date Verified: Oct-20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Sample ID: Cu Reftox
Test Species/Batch: A. affinis / Aug 17-04
Test Initiation Date/Time: Aug 25, 2004 @ 1245 L
No. of Organisms/Volume: 5/200mL

Concentration 49/L	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
Control	A	A 1	5	5	5	5	5	5	5	
	B	2	5	5	5	5	5	5	5	
	C	3	5	5	5	5	5	5	5	
	D	4	5	5	5	5	5	5	5	
	E	5	5	5	5	5	5	5	5	
320	A	6	5	5	5	5	5	4	4	
	B	7	5	5	5	5	5	5	5	
	C	8	5	5	5	5	5	5	5	
	D	9	5	5	5	5	5	5	5	
	E	0	5	5	5	5	5	5	5	
560	A	11	5	5	5	5	5	5	5	
	B	12	5	5	5	5	5	5	5	
	C	13	5	5	5	5	5	5	5	
	D	14	5	5	5	5	5	5	5	
	E	15	5	5	5	5	5	5	5	
1000	A	16	4	4	4	4	4	4	4	
	B	17	5	5	5	5	5	5	5	
	C	18	5	5	5	5	5	5	5	
	D	19	4	2	2	2	2	2	2	
	E	20	4	4	4	4	4	3	3	
Technician Initials		JWS	~	~	JWS	~	~	AXF/JWS	JWS	

Sample Description: clear, colorless
Data Verified By: Ralph K
Date Verified: Oct-27/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Sample ID: Cu reftox
Test Species/Batch: A. affinis / Aug 24-04
Test Initiation Date/Time: Aug 25, 2004 @ 1245
No. of Organisms/Volume: 5/200mL

Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
49/L	A	A21	2	2	2	2	2	2	2	
	B	22	2	0	0	~				
1800	C	23	5	3	3	3	3	2	0	
	D	24	1	1	1	1	1	0		
	E	25	2	1	1	0	~			
	A	26	0	~						
	B	27	0							
3200	C	28	2	2	~					
	D	29	15	1	~					
	E	30	0	~						
	A	1								
	B	2								
	C	3								
	D	4								
	E	5								
	A	6								
	B	7								
	C	8								
	D	9								
	E	0								
Technician Initials		JWS	~	~	JWS	~	~	AMP/SKS	JWS	

Sample Description: clear, colorless
Data Verified By: Galyik
Date Verified: Oct. 27/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 09-0302-54
EVS Work Order No.: 0400384

Start Date (Day 0): August 27, 2004
Sample ID: Cu Reftox
Balance Type/Serial Number: Sartorius BP211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
791L								AW/SA
Control	A	A 1	1236.92	1240.48	5	5		
	B	2	1234.84	1239.67	5	5		
	C	3	1233.83	1238.43	5	5		
	D	4	1234.81	1239.99	5	5	pre-wt: 1234.82 reweighed: 1240.01 mg ✓	
	E	5	1236.88 1236.85	1241.27	5	5		
320	A	6	1236.55	1239.45	4	4		
	B	7	1223.58	1227.87	5	5		
	C	8	1228.35	1233.01	5	5		
	D	9	1236.84	1240.60	5	5	reweighed: 1240.62 mg ✓	
	E	10	1230.58	1235.34	5	5		
560	A	11	1240.99	1244.89	5	5		
	B	12	1240.22	1243.80	5	5		
	C	13	1232.03	1236.09	5	5		
	D	14	1222.70	1228.06	5	5	reweighed 1228.01 mg ✓	
	E	15	1227.91	1232.58	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qalfish
Date Verified: Oct. 20/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris) | Start Date (Day 0): August 27, 2004

EVS Project No.: 09-0302-54 | Sample ID: Cu Ref/tox

EVS Work Order No.: 0400384 | Balance Type/Serial Number: Sartorius BP 211D

Sample ID 49/L	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
100.0	A	A16	1231.06	1234.17	23 4	23 4		~
	B	17	1232.73	1336.19	5	5		
	C	18	1227.40	1232.10	5	5		
	D	19	1225.62	1227.27	2	2		
	E	20	1229.98	1233.36	3	3		
180.0	A	21	1233.34	1235.48	2	2	pre-wt: 1233.29	
	B	22	1226.36		0			
	C	23	1228.36					
	D	24	1229.37					
	E	25	1226.55					
320.0	A	26	1219.08					
	B	27	1224.60					
	C	28	1229.45					
	D	29	1236.52					
	E	30	1236.61					

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Qalfish | Date Verified: Oct 20/04

Test: LF-Larval Fish Growth and Survival Test
Test ID: RTAACu39
Species: AA-Atherinops affinis
Protocol: EPAW 95-EPA West Coast
Sample ID: REF-Ref Toxicant
Sample Type: CU-Copper
Start Date: 8/27/2004 End Date: 9/3/2004
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1240.48	1236.92
	2	2	D-Control	5							5	5	1239.67	1234.84
	3	3	D-Control	5							5	5	1238.43	1233.83
	4	4	D-Control	5							5	5	1239.99	1234.81
	5	5	D-Control	5							5	5	1241.27	1236.78
	6	1	32.000	5							4	4	1239.45	1236.55
	7	2	32.000	5							5	5	1227.87	1223.58
	8	3	32.000	5							5	5	1233.01	1228.35
	9	4	32.000	5							5	5	1240.6	1236.84
	10	5	32.000	5							5	5	1235.34	1230.58
	11	1	56.000	5							5	5	1244.89	1240.99
	12	2	56.000	5							5	5	1243.8	1240.22
	13	3	56.000	5							5	5	1236.09	1232.03
	14	4	56.000	5							5	5	1228.06	1222.7
	15	5	56.000	5							5	5	1232.58	1227.91
	16	1	100.000	5							4	4	1234.17	1231.06
	17	2	100.000	5							5	5	1236.19	1232.73
	18	3	100.000	5							5	5	1232.1	1227.4
	19	4	100.000	5							2	2	1227.27	1225.62
	20	5	100.000	5							3	3	1233.36	1229.98
	21	1	180.000	5							2	2	1235.48	1233.34
	22	2	180.000	5							0	0	0	0
	23	3	180.000	5							0	0	0	0
	24	4	180.000	5							0	0	0	0
	25	5	180.000	5							0	0	0	0
	26	1	320.000	5							0	0	0	0
	27	2	320.000	5							0	0	0	0
	28	3	320.000	5							0	0	0	0
	29	4	320.000	5							0	0	0	0
	30	5	320.000	5							0	0	0	0

Comments: 09-0302-54, 0400384

Reviewed by: Galfich 04-20104

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	8/27/2004	Test ID:	RTAACu39	Sample ID:	REF-Ref Toxicant
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400384				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
32	0.8000	1.0000	1.0000	1.0000	1.0000
56	1.0000	1.0000	1.0000	1.0000	1.0000
100	0.8000	1.0000	1.0000	0.4000	0.6000
180	0.4000	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

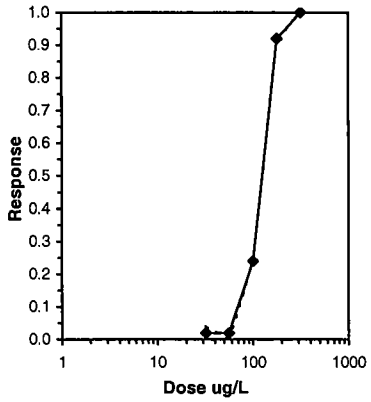
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	17.00	0	25
100	0.7600	0.2608	1.0737	0.6847	1.3453	26.959	5	20.00	17.00	6	25
*180	0.0800	0.1789	0.3174	0.2255	0.6847	64.711	5	15.00	17.00	23	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.87543	0.888	0.19148	2.19139
Equality of variance cannot be confirmed				

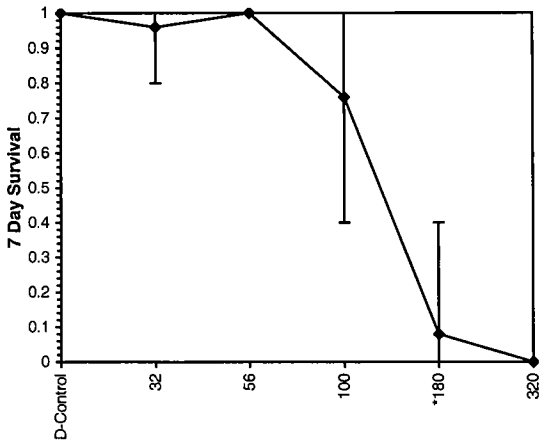
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	180	134.164	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	121.21	107.05	137.25	
10.0%	122.51	106.69	140.68	
20.0%	124.90	100.06	155.92	
Auto-2.0%	121.16	107.14	137.03	ug/L Cu



Dose-Response Plot



Reviewed by: Oct 20/04

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/27/2004	Test ID:	RTAACu39	Sample ID:	REF-Ref Toxicant
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 0400384				

Conc-ug/L	1	2	3	4	5
D-Control	0.7120	0.9660	0.9200	1.0360	0.8980
32	0.5800	0.8580	0.9320	0.7520	0.9520
56	0.7800	0.7160	0.8120	1.0720	0.9340
100	0.6220	0.6920	0.9400	0.3300	0.6760
180	0.4280	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

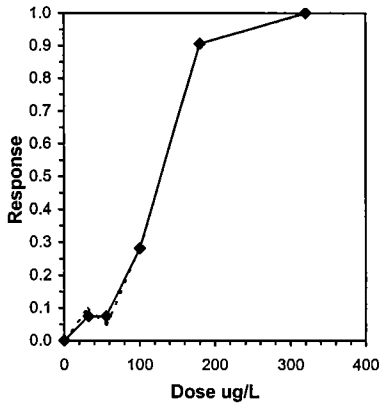
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.9064	0.1208	0.9064	0.7120	1.0360	13.330	5				0.9064	1.0000
32	0.8148	0.1529	0.8148	0.5800	0.9520	18.764	5	0.859	2.300	0.2451	0.8388	0.9254
56	0.8628	0.1413	0.8628	0.7160	1.0720	16.373	5	0.409	2.300	0.2451	0.8388	0.9254
*100	0.6520	0.2178	0.6520	0.3300	0.9400	33.401	5	2.387	2.300	0.2451	0.6520	0.7193
*180	0.0856	0.1914	0.0856	0.0000	0.4280	223.607	5	7.701	2.300	0.2451	0.0856	0.0944
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0000	0.0000

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.97983		0.888		0.24836	0.34826
Bartlett's Test indicates equal variances (p = 0.81)					1.6194		13.2767			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	56	100	74.8331		0.24513	0.27045	0.56964	0.0284	9.0E-07	4, 20

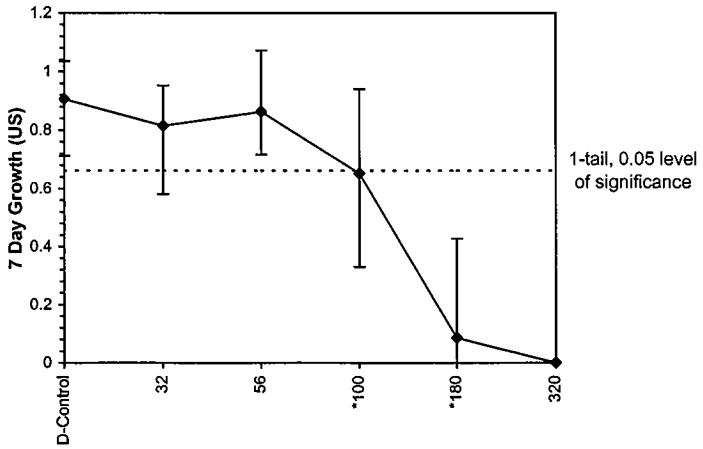
Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew	
IC05*	21.45	21.58	1.69	91.64	0.6918	
IC10	61.43	22.13	0.00	103.56	-0.1239	
IC15	72.10	20.41	1.19	118.52	-0.5135	
IC20	82.78	15.91	41.12	121.23	-0.0104	
IC25	93.45	13.98	53.16	124.15	0.0254	
IC40	115.28	11.42	71.83	139.88	-0.3487	
IC50	128.08	10.81	84.76	150.27	-0.4718	ug/L Cu

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by: Oct-20/04

APPENDIX B

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09-0302-54/04-1424-044
EVS Work Order No.: 0400385
EVS Analysts: KES / AKN
Test Initiation Date: 27 AUGUST 2004

SAMPLE

Identification: G-CREEK-082404
Amount Received: 5X20L
Date Collected: 24 AUGUST 2004
Date Received: 27 AUGUST 2004
Temperature (°C): 15.0
pH: 8.0
Dissolved Oxygen (mg/L): 10.0 ① 8.5
Conductivity (µmhos/cm): 9240
Salinity (ppt): 5 ① 28
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: ① Salinity adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westcoast Sealab Supplies / 27 Aug 2004
Date Received: 27 August 2004
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 27 August 2004
IC50 (and 95% CL): 2.3 (2.1-2.4) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.6 mg/L SDS; CV% = 60

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Sterilized, 0.5µm filtered SW
Temperature (°C): 16.0
pH: 8.0
Dissolved Oxygen (mg/L): 8.3
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 15.0 - 16.0
pH Range: 8.0 - 8.1
Dissolved Oxygen Range (mg/L): 8.2 - 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC50: 50.7 (48.1 — 53.6) % v/v
IC25: 17.5 (11.6 - 22.6) % v/v
NOEC: 4.7 % v/v
LOEC: 9.4 % v/v

Data Verified By: [signature]
Date Verified: Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: Azimuth Consulting Group
EVS Project No.: 09-0302-54/04-1424-044
EVS Work Order No.: 0400385
Logbook: Echinoid #13 Pages: 53-57

Test Initiation Date/Time: 27 August 2004 @ 13:34
Test Species: Dendraster excentricus
Source/Date Received: Westwind Sealab Supplies/27 August 2004
Test Duration: 10:10

Sample ID Q-CREEK 082404	Conc/Rep % V/V	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
CONTROL		16.0	8.0	28	8.3	
BRINE CTL		16.0	8.1	28	8.3	
	4.7	16.0	8.0	28	8.2	
	9.4	16.0	8.0	28	8.3	
	18.8	16.0	8.0	28	8.3	
	37.5	15.5 16.0	8.0	28	8.2	
	75.1	15.0 16.0	8.0	28	8.5	
Tech. Init.	Kaf	Kaf	Kaf	Kaf	Kaf	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-030303 DO II-A-011202

Data Verified By: Ralph Date Verified: Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: AZIMUTH CONSULTING GROUP
EVS Project No.: 09-0302-54/04-1424-044
EVS Work Order No.: 0400385
Logbook: Echinoid #13 Pages: 53-57

Test Initiation Date/Time: 27 AUGUST 2004 @ 13:34
Test Species: Dendraster excentricus
Source/Date Received: Westwind Sealab Supplies/27 August 2004
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID (% v/v)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
4.7	A	78	22		
	B	74	26		
	C	76	24		
	D	72	28		
9.4	A	61	39		
	B	62	38		
	C	62	38		
	D	60	40		
18.8	A	56	44		
	B	58	42		
	C	~~41~~ 59	41		
	D	55	45		
37.5	A	49	51		
	B	50	50		
	C	50	50		
	D	48	52		
75.1	A	25	75		
	B	27	73		
	C	24	76		
	D	27	73		
CONTROL SEA WATER	A	77	~~29~~ 23		
	B	80	20		
	C	74	26		
	D	77	23		

Data Verified By: Qalfish
Date Verified: Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: Azimuth Consulting Group.
EVS Project No.: 09-0302-54/04-1424-044
EVS Work Order No.: 0400385
Logbook: Echinoid #13 Pages: 53 – 57

Test Initiation Date/Time: 27 August 2004 @ 13:34
Test Species: Dendraster excentricus
Source/Date Received: Westwind Sealab Supplies/27 August 2004
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
BRINE CONTROL	A	76	24		KF
	B	73	27		↓
	C	79	21		↓
	D	77	23		↓
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Data Verified By: Ralph Ky Date Verified: Oct. 21/04

Test: SC-Sperm Cell Fertilization test					Test ID: 0400385		
Species: DE-Dendraster excentricus					Protocol: EPS1/RM/27-EC 92 (Sperm Cell)		
Sample ID: G CREEK-082404					Sample Type: EFF2-Industrial		
Start Date: 8/27/2004 10:10			End Date: 8/27/2004		Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	77	23	
	2	2	D-Control	100	80	20	
	3	3	D-Control	100	74	26	
	4	4	D-Control	100	77	23	
	5	1	B-Control	100	76	24	
	6	2	B-Control	100	73	27	
	7	3	B-Control	100	79	21	
	8	4	B-Control	100	77	23	
	9	1	4.700	100	78	22	
	10	2	4.700	100	74	26	
	11	3	4.700	100	76	24	
	12	4	4.700	100	72	28	
	13	1	9.400	100	61	39	
	14	2	9.400	100	62	38	
	15	3	9.400	100	62	38	
	16	4	9.400	100	60	40	
	17	1	18.800	100	56	44	
	18	2	18.800	100	58	42	
	19	3	18.800	100	59	41	
	20	4	18.800	100	55	45	
	21	1	37.500	100	49	51	
	22	2	37.500	100	50	50	
	23	3	37.500	100	50	50	
	24	4	37.500	100	48	52	
	25	1	75.100	100	25	75	
	26	2	75.100	100	27	73	
	27	3	75.100	100	24	76	
	28	4	75.100	100	27	73	

Comments: Azimuth Consulting Group (Polaris), 09-0302-54 (0400385)

Reviewed by: Oct 26/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/27/2004 10:10	Test ID:	400385	Sample ID:	G CREEK-082404
End Date:	8/27/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/24/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0400385)				

Conc-%	1	2	3	4
D-Control	0.7700	0.8000	0.7400	0.7700
B-Control	0.7600	0.7300	0.7900	0.7700
4.7	0.7800	0.7400	0.7600	0.7200
9.4	0.6100	0.6200	0.6200	0.6000
18.8	0.5600	0.5800	0.5900	0.5500
37.5	0.4900	0.5000	0.5000	0.4800
75.1	0.2500	0.2700	0.2400	0.2700

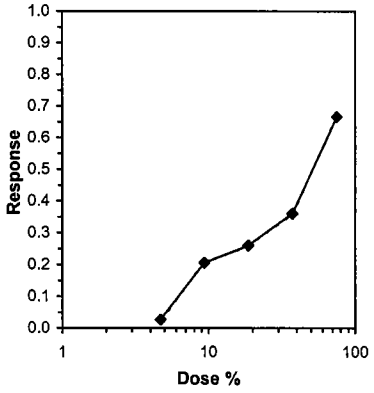
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.7700	0.0245	0.7700	0.7400	0.8000	3.181	4				0.7700	1.0000
B-Control	0.7625	0.0250	0.7625	0.7300	0.7900	3.279	4					
4.7	0.7500	0.0258	0.7500	0.7200	0.7800	3.443	4	1.546	2.410	0.0312	0.7500	0.9740
*9.4	0.6125	0.0096	0.6125	0.6000	0.6200	1.563	4	12.175	2.410	0.0312	0.6125	0.7955
*18.8	0.5700	0.0183	0.5700	0.5500	0.5900	3.203	4	15.460	2.410	0.0312	0.5700	0.7403
*37.5	0.4925	0.0096	0.4925	0.4800	0.5000	1.944	4	21.450	2.410	0.0312	0.4925	0.6396
*75.1	0.2575	0.0150	0.2575	0.2400	0.2700	5.825	4	39.616	2.410	0.0312	0.2575	0.3344

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96771	0.884	-0.0461	-0.3022
Bartlett's Test indicates equal variances (p = 0.47)	4.56528	15.0863		
The control means are not significantly different (p = 0.68)	0.42857	2.44691		

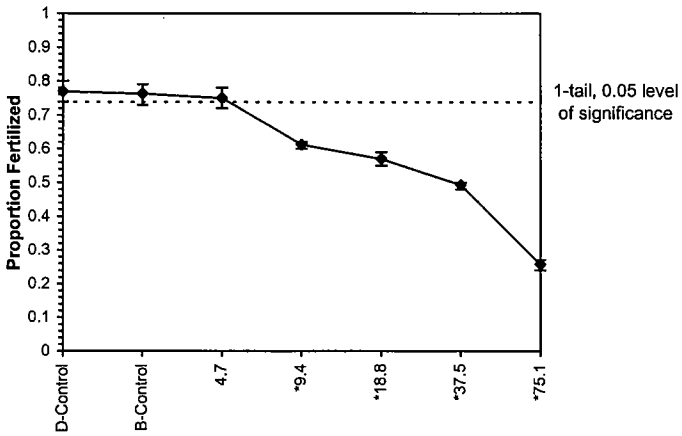
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	4.7	9.4	6.6468	21.2766	0.03118	0.04049	0.14215	0.00033	5.1E-18	5, 18

Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05	5.180	0.661	1.565	6.056	-2.4799	
IC10	6.314	0.363	5.072	7.317	-0.3761	
IC15	7.655	0.380	6.468	8.804	-0.0227	
IC20	9.242	0.946	8.159	13.672	1.6390	
IC25	16.673	2.353	10.367	23.598	0.0429	
IC40	41.060	0.897	38.450	44.063	-0.0075	
IC50	51.581	0.976	49.063	54.697	0.0961	%v/v



Dose-Response Plot



Statistical comparisons were against the D-control

Reviewed by: Oct-26/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/27/2004 10:10	Test ID:	400385	Sample ID:	G CREEK-082404
End Date:	8/27/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	8/24/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0400385)				

Conc-%	1	2	3	4
D-Control	0.7700	0.8000	0.7400	0.7700
B-Control	0.7600	0.7300	0.7900	0.7700
4.7	0.7800	0.7400	0.7600	0.7200
9.4	0.6100	0.6200	0.6200	0.6000
18.8	0.5600	0.5800	0.5900	0.5500
37.5	0.4900	0.5000	0.5000	0.4800
75.1	0.2500	0.2700	0.2400	0.2700

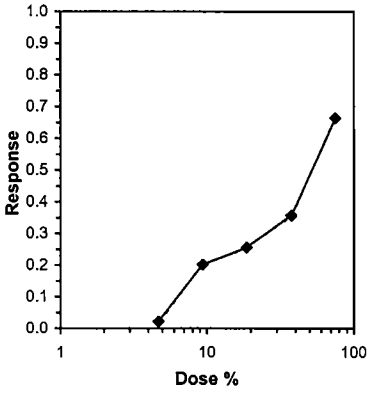
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.7663	0.0233	0.7663	0.7300	0.8000	3.036	8				0.7663	1.0000
4.7	0.7500	0.0258	0.7500	0.7200	0.7800	3.443	4	1.390	2.508	0.0293	0.7500	0.9788
*9.4	0.6125	0.0096	0.6125	0.6000	0.6200	1.563	4	13.156	2.508	0.0293	0.6125	0.7993
*18.8	0.5700	0.0183	0.5700	0.5500	0.5900	3.203	4	16.793	2.508	0.0293	0.5700	0.7439
*37.5	0.4925	0.0096	0.4925	0.4800	0.5000	1.944	4	23.424	2.508	0.0293	0.4925	0.6427
*75.1	0.2575	0.0150	0.2575	0.2400	0.2700	5.825	4	43.533	2.508	0.0293	0.2575	0.3361

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98075	0.896	-0.1412	-0.2089
Bartlett's Test indicates equal variances (p = 0.44)	4.83474	15.0863		
The control means are not significantly different (p = 0.68)	0.42857	2.44691		

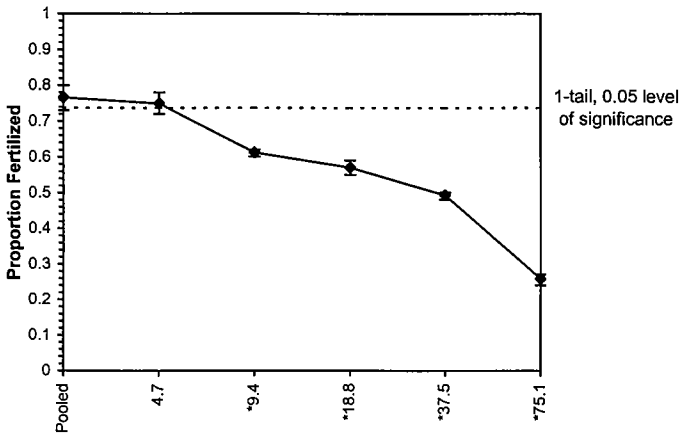
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	4.7	9.4	6.6468	21.2766	0.02931	0.03826	0.16613	0.00036	1.9E-21	5, 22

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05	5.346	0.452	3.380	6.032	-1.8281	
IC10	6.555	0.307	5.439	7.178	-0.4707	
IC15	7.892	0.273	6.858	8.579	-0.3014	
IC20	9.379	0.715	8.461	12.502	1.9342	
IC25	17.460	2.031	11.554	22.636	0.0330	
IC40	40.999	0.628	38.998	42.863	0.1265	
IC50	50.738	0.809	48.086	53.622	0.1685	%v/v



Dose-Response Plot



Statistical comparisons were against the ~~B-control~~
Pooled Control

Reviewed by: Qualified
Oct-26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Project No.: 09-0302-54/04-1424-044
EVS Work Order No.: 0400385
EVS Analysts: KES, AKN
Test Initiation Date: 27 AUGUST 2004

SAMPLE

Identification: SDS RefTox Stock Sol^n
Amount ~~Received~~ Prep'd: 1X1L
Date ~~Collected~~ Prep'd: 26 April 2004
Date Received: n/a
Temperature (°C):
pH:
Dissolved Oxygen (mg/L):
Conductivity (µmhos/cm):
Salinity (ppt):
Ammonia (mg/L N):
Chlorine (mg/L Cl):
Other:

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab Supplies
Date Received: 27 August 2004
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 27 August 2004
IC50 (and 95% CL): 2.3 (2.1-2.4) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.6 mg/L SDS, CV% = 60

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV Sterilized, 0.5µm filtered SW
Temperature (°C): 16.0
pH: 8.0
Dissolved Oxygen (mg/L): 8.3
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 16.0
pH Range: 8.0
Dissolved Oxygen Range (mg/L): 8.3
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: 2.3 (2.1-2.4) mg/L SDS
IC 25: 1.3 (1.2-1.4) mg/L SDS
NOEC: <1 mg/L SDS
LOEC: 1 mg/L SDS

Data Verified By: [signature]
Date Verified: Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth Consulting Group
EVS Project No. 09-0302-54 / 04-1424-044
EVS Work Order No. 0400385
Logbook Echinoid #13 Pages 53 - 57

Test Initiation Date/Time 27 August 2004 @ 13:34
Test Species Dendraster excentricus
Source/Date Received Westcoast Sealab Supplies / 27 Aug 2004
Test Duration 10:10

Sample ID	Conc/Rep	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
SDS mg/L	CONTROL	16.0	8.0	28	8.3	
	1.0	16.0	8.0	28	8.3	
	1.8	16.0	8.0	28	8.3	
	3.2	16.0	8.0	28	8.3	
	5.6	16.0	8.0	28	8.3	
	10.0	16.0	8.0	28	8.3	
Tech. Init.	KAF	KAF	KAF	KAF	KAF	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-030303 DO II-A-011202
Data Verified By Ralph K Date Verified Oct 21/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: Azimuth Consulting Group
Test Initiation Date/Time: 27 August 2004 @13:34
EVS Project No.: 09-0302-54/04-1424-044
Test Species: Dendraster excentricus
EVS Work Order No.: 0400385
Test Duration: 10:10
Logbook: Echinoid #13 Pages: 53-57
Sperm:Egg Ratio: 2000:1

Concentration SDS mg/L	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	70	30		[illegible]
	B	72	28		↓
	C	69	31		
	D	68	32		↓
1.8	A	45	55		[illegible]
	B	47	53		↓
	C	46	54		
	D	49	51		↓
3.2	A	25	75		[illegible]
	B	26	74		↓
	C	24	76		
	D	27	73		↓
5.6	A	10	90		[illegible]
	B	14	86		↓
	C	9	91		
	D	10	90		↓
10.0	A	2	98		[illegible]
	B	2	98		↓
	C	1	99		
	D	2	98		↓
Control Seawater					
	A	~~81~~ 77	23		[illegible]
	B	~~76~~ 80	20		↓
	C	74	26		
	D	77	23		↓

Data Verified By: [signature] Date Verified: Oct. 21/04

Test: SC-Sperm Cell Fertilization test					Test ID: rtscsds9		
Species: DE-Dendraster excentricus					Protocol: EPS1/RM/27-EC 92 (Sperm Cell)		
Sample ID: REF-Ref Toxicant					Sample Type: SDS-Sodium dodecyl sulfate		
Start Date: 8/27/2004 10:10			End Date: 8/27/2004		Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	77	23	
	2	2	D-Control	100	80	20	
	3	3	D-Control	100	74	26	
	4	4	D-Control	100	77	23	
	5	1	1.0	100	70	30	
	6	2	1.0	100	72	28	
	7	3	1.0	100	69	31	
	8	4	1.0	100	68	32	
	9	1	1.8	100	45	55	
	10	2	1.8	100	47	53	
	11	3	1.8	100	46	54	
	12	4	1.8	100	49	51	
	13	1	3.2	100	25	75	
	14	2	3.2	100	26	74	
	15	3	3.2	100	24	76	
	16	4	3.2	100	27	73	
	17	1	5.6	100	10	90	
	18	2	5.6	100	14	86	
	19	3	5.6	100	9	91	
	20	4	5.6	100	10	90	
	21	1	10.0	100	2	98	
	22	2	10.0	100	2	98	
	23	3	10.0	100	1	99	
	24	4	10.0	100	2	98	

Comments: Azimuth Consulting Group 09-0302-54 (0400385)

Reviewed by: 04/21/06

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/27/2004 10:10	Test ID:	rtscsds9	Sample ID:	REF-Ref Toxicant
End Date:	8/27/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 09-0302-54 (0400385)				

Conc-mg/L	1	2	3	4
D-Control	0.7700	0.8000	0.7400	0.7700
1	0.7000	0.7200	0.6900	0.6800
1.8	0.4500	0.4700	0.4600	0.4900
3.2	0.2500	0.2600	0.2400	0.2700
5.6	0.1000	0.1400	0.0900	0.1000
10	0.0200	0.0200	0.0100	0.0200

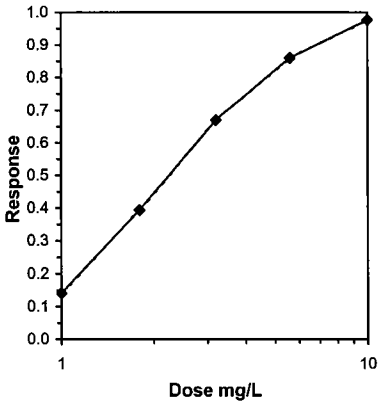
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.7700	0.0245	0.7700	0.7400	0.8000	3.181	4					
*1	0.6975	0.0171	0.6975	0.6800	0.7200	2.448	4	5.813	2.410	0.0301		
*1.8	0.4675	0.0171	0.4675	0.4500	0.4900	3.653	4	24.254	2.410	0.0301		
*3.2	0.2550	0.0129	0.2550	0.2400	0.2700	5.063	4	41.292	2.410	0.0301		
*5.6	0.1075	0.0222	0.1075	0.0900	0.1400	20.627	4	53.118	2.410	0.0301		
*10	0.0175	0.0050	0.0175	0.0100	0.0200	28.571	4	60.334	2.410	0.0301		

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.94353		0.884		0.48689	0.03974
Bartlett's Test indicates equal variances (p = 0.33)					5.73659		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	<1	1			0.03006	0.03904	0.38532	0.00031	3.5E-22	5, 18

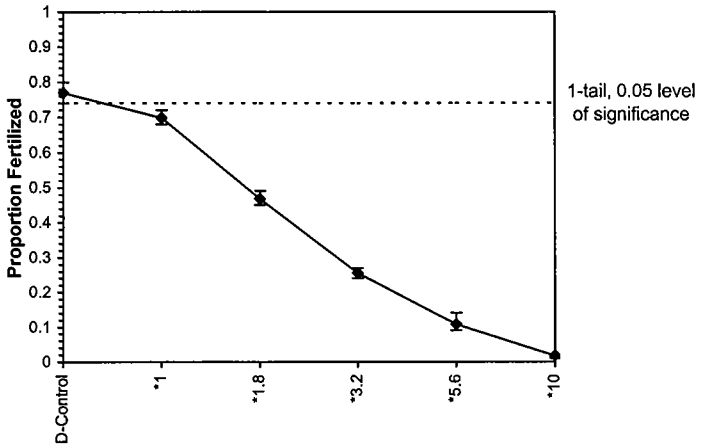
Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew	
IC05*	0.2818	0.0398	0.1777	0.4281	0.4398	
IC10*	0.6429	0.1027	0.3830	1.0315	0.5219	
IC15	1.0278	0.0806	0.6655	1.1534	-1.2547	
IC20	1.1671	0.0441	1.0139	1.2853	-0.3348	
IC25	1.3159	0.0419	1.1718	1.4292	-0.2285	
IC40	1.8295	0.0507	1.6670	1.9678	-0.0985	
IC50	2.2774	0.0469	2.1219	2.4035	-0.2200	mg/L SDS

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by: Oct-21/04

APPENDIX C

Chain-of-Custody Form

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Azimuth Consulting for TEQK Comined
Client Contact Name: Cheryl Mackintosh / Bruce Donald
Address: 218-2902 West Broadway Vancouver BC, V6K 2G8
Phone: 604-730-1220
Fax: 604-739-9070
Sampled By: ~~Randy Baker~~ C. Mackintosh

Ship to: EVS Environment Consultants
195 Pemberton Ave.
North Vancouver, BC, V7P 2R4
Shipping Date: Aug. 25, 2004
Attn: Edmund Canavia

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: Rainbow trout 96-hr LC50	Daphnia magna 48-hr LC50	7-day Topsmelt	Echinoderm 48h fertilization			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Lab Use Only
For composite sample record date & time starting and ending															
24/Aug/04	15:00	G-Creek ~~081704~~ 082404 (1)	E		Grab	5x20L	CC	✓	✓	✓	✓			Freshwater ~2.4 ppt	1574

PO/Reference No.: TC-03-03
Project Title: Polaris MMER
Results Needed By:

Comments/Instructions: (1) The sample ID was changed from G-Creek 081704 to G-Creek 082404 by the client's request.

EVS Receipt Check List

EVS Project #: 04-1168-01
EVS Workorder #: 04000382 1383 1384 1385
Sample Storage Location: RAT CHEM DPHM TOPSMT ECH
Sample Receipt Documentation/Other Information Attached, if applicable: Y N
1. Signatures & dates correct? Y N
2. Chain of custody fully completed? Y N
3. Containers received in good condition (unbroken)? Y N
4. Container labels completed (i.e., dates, preservation)? Y N
5. Container labels agreed with custody papers? Y N
6. Sample receipt temperature within acceptable range? Y N
7. Sediment testing logged to be initiated within 24 days? Y N
7b. If no, are samples under Nitrogen? If not, why?
8. Chain of custody generated upon receipt? Y N
9. Sample containers originate from EVS? Y N

A) Released By: C. Mackintosh Date: Aug. 25/04
Company: Azimuth Time: 9:00am
Courier name: First air / FedEx
Shipping containers secured by: (Tape) Straps Lock Other _____ (circle one)
Custody seals used? Yes No METAL STRIPS

B) Received by: AXF Date: 27 AUG 04
Company: EUS Time: 0945
Shipping containers received secure? (Yes) No
Custody seals intact? (Yes) No N/A

C) Released By: Date:
Company: Time:
Courier name:
Shipping containers secured by: Tape Straps Lock Other _____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies:
White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

APPENDIX F

Letter from Environment Canada to Teck Cominco Metals, Ltd. re: Polaris 2004 Annual Report (dated August 9, 2005)

Environment Canada | Environnement Canada
Prairie & Northern Region
Environment Canada
Rm 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Bruce Donald
Cominco Mining Partnership & Teck Cominco Metals Ltd.
Bag 2000
Kimberley, BC
V1A3E1

August 9, 2005

Dear Bruce Donald,

RE: Polaris 2004 Annual Report

In our review of the Polaris 2004 Annual Effluent and Water Quality Report, due March 31, 2005, it was noted that some Environmental Effects Monitoring (EEM) information does not appear to have been provided as required under Metal Mining Effluent Regulations (Schedule 5, Part 1). Please see the appended list of deficiencies relating to effluent characterization, water quality monitoring and sublethal toxicity testing for your facility.

If missing information was collected but not included in the above report, please submit this information to Environment Canada by September 30, 2005. Please ensure that all deficiencies are addressed in future reports. Failure to provide all information required under the Environmental Effects Monitoring Program will result in non-compliance.

Please be reminded that guidance is provided on the National EEM Website to assist you, at http://www.ec.gc.ca/eem/English/Publications/web_publication/ec_water/.
If you have any questions, please do not hesitate to contact me [Phone (780) 951-8754, jenny.ferone@ec.gc.ca].

Sincerely,

Paula Siwik (for)
Jenny Ferone, Regional EEM Coordinator

cc Peter Blackall
Chuck Brumwell
Ken Russell

Recycled Paper / Papier Recyclé

Polaris (7834-3-37/C263-9)
2004 Annual Effluent and Water Quality Review

General:

- Methods, detection limits, and QA/QC need to be included in the future.
- Latitude/longitude and description of reference and exposure areas need to be included in hard copy.
- No units given in the hard copy for measured parameters in the Effluent or Water Quality tables.

Effluent Characterization:

- Collected and analyzed four effluent samples, but due to short discharge period (July and August only) only two were more than one month apart. Remaining two were only three days short of being one month apart.
- No methods described or detection limits, no QA/QC data or description.

Water Quality:

- Only two water sampling dates were more than one month apart due to short sampling period (July and August). Three samples were analyzed.
- No latitude or longitude of reference or exposure sampling areas in hard copy; No description of the ref or exp area – both described as Garrow Bay.
- No methods described or detection limits, no QA/QC data or description.

Sublethal Toxicity:

Please note that laboratories performing sublethal tests should provide all information required on the Environment Canada checklists (Annex C of the Metal Mining Guidance Document).

- A subset of the sublethal reports submitted by mines in the Prairie and Northern Region were sent for independent verification by Environment Canada toxicologists. This subset includes the test results submitted by your facility. We will inform you of any additional sublethal deficiencies identified by our reviewers once they have finished their review.
- For first sampling LC50 reported twice for fish species.
- First and second sampling: No LC50 done for sand dollar.
- All comments below are for both sampling dates (July 27 and August 24) unless otherwise stated

Atherinops affinis

- Information on labeling/coding of sample was not reported.
- Temperature of sample upon arrival at lab was not reported.
- The date that the sample was received at the lab was not reported.
- Dates or days during test when sub-samples or multiple samples were used, was not reported.
- The date for test completion was not reported.
- Temperature, DO, pH, and salinity of test solution and controls were not reported for each 24hr exposure period. They were only reported for the start of the test.
- Only give the final average mortality for each test concentration instead of the mortality as noted during each 24hr observation period

- Only give the average dry weight of each concentration instead of for each replicate of each concentration – also no indication if preserved in formalin/ethanol or not. If not preserved then 2 test concentration have weights <0.85mg (17.3% & 69%).
- No preparation procedure of salinity adjustment was reported.

Champia parvula

- Information on labeling and coding of sample was not reported.
- The date for sample receipt at the lab was not reported.
- The date for test completion was not reported.
- Procedure and preparation of the hypersaline brine was not reported.
- The type and quantity of chemicals (if any) added to the control/dilution water was not reported.
- Temperature, DO, pH and salinity of test solutions and controls were not reported for the start and 48hr of the exposure period or for the beginning and end of the recovery period.
- No note if there was anything unusual about the test organism prior to the test or if there was anything unusual about the test itself.
- Only the mean # of cystocarps per plant for each test concentration was reported. Needed to report the mean # of cystocarps per plant in each test vessel (in each replicate of each conc. and controls).
- No indication of quantitative statistic used to determine IC25 value.

Dendraster excentricus

- Information on labeling/coding of sample, the date it was received and its temperature upon arrival at lab were all not reported.
- There was no mention of the condition of the adult organisms prior to use.
- No note if there was anything unusual about the test organisms prior to use or anything unusual about the test itself.
- No procedure for salinity adjustment was reported – only statement that they followed EC guidance document.
- Only 100eggs/ vessel were used – should have been 2000 for the 10mL test volume.
- No indication of quantitative statistic used to determine the IC25 value.

APPENDIX G

Letter from Azimuth Consulting Group, Inc. to Environment Canada re: Clarification of reporting issues outlined in August 9, 2005 letter (dated September 14, 2005)

Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC
Canada V6K 2G8

Phone: 604-730-1220
Fax: 604-739-8511
www.azimuthgroup.ca

Jenny Ferone
Regional EEM Coordinator
Prairie & Northern Region
Environment Canada
Rm 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

September 14, 2005

Dear Ms. Ferone,

Re: Clarification of reporting issues outlined in Environment Canada's letter to Teck Cominco regarding the Polaris 2004 EEM Annual Report

This letter is being written on behalf of Teck Cominco Metals Ltd. in response to Environment Canada's letter to Teck Cominco, dated August 9, 2005, regarding purported deficiencies in the Polaris 2004 Annual Effluent and Water Quality Report. Azimuth staff prepared the report and will be addressing the issues outlined in your letter by providing a revised 2004 EEM Annual Report. However, there are a few questions and clarifications that we would like to draw to your attention, to ensure that we include all required information in the revised report and that there are no misunderstandings or further deficiencies. Our specific responses to each of the points raised in the review letter are as follows:

General:

- Methods, detection limits and QA/QC will be included in all future reports
- Latitude and longitude and a description of the reference and exposure areas will be provided in the hard copy
- Units for water quality will be provided

Effluent Characterization:

- Effluent was collected and tested within allowable time periods, given the short duration of effluent discharge at Polaris.
- Methods, detection limits and QA/QC will be provided in the hard copy

Water Quality:

- Sampling of water quality was optimized to collect as many samples as possible, given short duration of discharge
- Latitude and longitude of exposure and reference areas were provided in the electronic copy; these will also be provided in the hard copy
- Methods, detection limits and QA/QC will be provided in the hard copy

Sublethal Toxicity:

- *"The first sampling LC50 reported twice for fish species."* We presume the reviewers referring to the topsmelt tests. If so, we conducted 3 acute lethality tests on topsmelt in 2004. Results of all three tests are reported in the EEM under point *iii* of the Results. These values are listed as >72.6%, >69.0% and >71.0%.
- *"First and second sampling: No LC50 done for sand dollar."* The sand dollar test is strictly a sublethal fertilization test, and no LC50 is measured.

Atherinops affinis

- Information on labeling and coding of samples will be reported
- Temperature on sample receipt at the lab will be reported.
- Date of sample receipt at the lab will be reported
- Dates or days when sub- or multiple samples were used will be reported
- Date for test completion will be reported
- *"Temperature, DO, pH, and salinity of test solution and controls were not reported for each 24hr exposure period…"* The laboratory (EVS) hand writes temperature, DO and pH on hard copy forms and does not enter these electronically. PDF copies of these forms will be provided with our hard copy report.
- *"Only give the final average mortality for each test concentration instead of the mortality as noted during each 24hr observation period."* As above, these are written by hand in hard copy by the lab. PDF copies will be provided with the final report.
- *Comment regarding the dry weights of each replicate for each test concentration… "If not preserved then 2 test concentration have weights <0.85mg (17.3%, and 69%)."* Dry weights will be reported for each replicate of each concentration. Note that the 0.85mg test validity benchmark only refers to the **controls**. If there is a sublethal effect, such as slower growth, exposed animals will necessarily weigh less than the control and may weigh less than 0.85 mg.
- *"No preparation procedure of salinity adjustment was reported."* Information regarding salinity adjustment was presented under point *ix* under Test Facilities and Conditions. The following text was included:

    ix. Indication that EC guidance document for salinity adjustment was followed

    - *The following was done for all 3 tests:*
        - *No deviations from EC guidance document on preparation of hypersaline brine (HSB)*

- *HSB prepared from natural seawater concentrated to 90ppt (by freezing/refreezing to remove frozen layer and concentrate salts)*
- *No deviations from EC guidance document for salinity adjustment of sample*
- *HSB was added to samples to salinity adjust them to 30ppt*

We presume that this level of information is sufficient. If not, please let us know what additional information is required. Note that for the topsmelt and echinoderm tests, the lab reports state: *"Salinity: 30±2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment – July 1997)"*

Champia parvula

- Information on labeling and coding will be provided in the revised final report
- Date for sample receipt at the lab will be reported
- Date for test completion will be reported
- *"Procedure and preparation of the hypersaline brine was not reported."* Under point *vii*. of Test Conditions and Facilities we indicate:
  - *No deviations from EC guidance document on preparation of hypersaline brine*
  - *HSB prepared from natural seawater at 90ppt*
  - *No deviations from EC guidance document for salinity adjustment of sample*
  - *Salinity adjustment: 600mL effluent + 250mL HSB + 8.5mL test nutrient solution*
  - *Salinity of samples adjusted from 4ppt to 30ppt*

The lab report indicated for hypersaline brine that it was *"Prepared from natural seawater, at 90 ppt salinity.* As per EC guidance document on salinity adjustment"*. We presume that this is a sufficient level of detail. If not, please advise us what additional information the laboratory can provide to satisfy this comment.

- *"No note if there was anything unusual about the test organism prior to the test or if there was anything unusual about the test itself".* We will include appropriate observations about the test in future reports. With regards to the organisms, under point *iii* of Test Organisms we indicated that *"[test species]…*
  - *Sexually mature male and female branches*
  - *Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995*
  - *Appear in good health*
  - *Females have trichogynes, males have sori with spermatia*

  We presume this is a sufficient level of detail. If not, please advise us on what additional information the laboratory can provide to satisfy this comment.
- *"No indication of quantitative statistic used to determine the IC25 value."* Under point *iii*. of Results, we stated *"Quantal statistic method was linear interpolation"* We presumed this was sufficient. Please advise if the reviewer wishes us to elaborate on this method.

Dendraster excentricus

- Information on labeling/coding, date of receipt, temperature at arrival at laboratory will be provided
- *"There was no mention of the condition of the adult organisms prior to use."* Under point *xi* (Test Organisms) it is stated that *"organisms appear healthy"*. We presumed this was sufficient information. If not, please elaborate on what additional level of detail is required.
- Future reports will note if there is anything unusual observed about the organisms or the test.
- *"No procedure for salinity adjustment was reported – only statement that they followed EC guidance document"* Under point *ix* (Test Facilities and Conditions) we make the following comments on hypersaline brine and salinity adjustment.
    - *x. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997*
        - *Test 1: na*
        - *Test 2: 30 ppt adjusted with hypersaline brine (HSB). Preparation of HSB and salinity adjustment as per EC guidance document on Salinity adjustment – July 1997*
        - *Test 2: 30 ppt adjusted with hypersaline brine (HSB). Preparation of HSB and salinity adjustment as per EC guidance document on Salinity adjustment – July 1997*
    - *xi. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997*
        - *No deviations from EC guidance for salinity adjustment*
        - *Test 1: na*
        - *Test 2: salinity adjusted from 2.8 to 28 ppt*
        - *Test 3: salinity adjusted from 5 to 28 ppt*

  We presume that this is a sufficient level of detail and was according to EC guidance. For both topsmelt and echinoderm tests the original lab report methods for salinity state *"30±2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment – July 1997)"* Please advise if your reviewers would like us to obtain more information from the laboratory.
- The laboratory does use 2000 eggs/10 mL, although a subset of 100 eggs are evaluated to determine the overall fertilization rate. We will clarify this.
- Quantitative statistic for determining IC25 will be provided.

We have raised a few issues where further guidance from your office is required. These are stated above as assumptions where clarification is requested from your office. We have incorporated all other appropriate additional information requested by the reviewers into a revised 2004 Polaris Annual Report. Once we have received a response from your office we will finalize this revised report. If we do not have a response from your office by Monday September 26, 2005, we will finalize the report

following our assumptions as stated in this letter, and submit the revised report by the September 30, 2005 deadline.

We would also like to communicate to Environment Canada that the electronic and hardcopy versions of the EEM report are not harmonized, as different information is requested for the two reports. As it is currently, the addition of the electronic report results in a duplication of effort and confuses the reporting requirements, rather than resulting in a more streamlined reporting process.

Sincerely,

Cheryl Mackintosh, M.R.M., R.P.Bio.

Azimuth Consulting Group Inc.
218-2902 Broadway West
Vancouver, BC, V6K 2G8
P: 604-730-1220
F: 604-739-8511
e-mail: cmackintosh@azimuthgroup.ca

APPENDIX H

Polaris Mine – Revised 2004 3rd Quarter Metal Mining Effluent Regulations Report (dated March 22, 2005)

March 22, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – Revised 2004 3rd Quarter Metal Mining Effluent Regulations Report

Please find attached a **revised** Polaris Mine 3rd Quarter MMER regulatory data tables. The reason for the revision is to ensure consistency between the data entered electronically online through the RISS system, and the hard copy Annual and 3rd Quarter reports provided. As explained in the original 3rd Quarter report cover letter, effluent from Garrow Lake ceased flowing by mid-August but surface run off from adjacent slopes maintained minimal water flow at the designated final discharge point into August. By August 17, there was water at the final discharge point in a pool, but flow was too low to be measured. As a result, regulatory concentration data in the 3rd Quarter had originally been submitted with average daily flows of 0 m^3 per day for the weeks of Aug. 17, Aug. 24, and Aug. 31, 2004. However, we continued to collect effluent, water quality and acute and sublethal toxicity samples on these latter three dates. Upon submitting the regulatory data into the online RISS system for the annual report, these August concentration data were not accepted with a flow rate of zero. Thus a nominal flow rate of 1 m^3 per day was entered. As a result the loadings data set is slightly different from the data submitted in the original 3rd Quarter report. Note that these low flow conditions during August, as well as their implications for effluent sampling, were discussed with Environment Canada representatives early in August.

If you have any questions regarding the annual report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me at any time.

Yours truly,

Original signed by B. Donald
Bruce Donald

Attachments: Revised 2003 3rd Quarter Regulatory Data
cc: Walter Kuit (Teck Cominco Limited)
Randy Baker (Azimuth Consulting Group)

2004 3rd QUARTER MMER REPORT - REVISED

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
5-Jul-04	7-Jul-04	0.00100	0.00265	0.0050	0.00269	0.00442	0.1980	117	0.0200	8.05	Grab
12-Jul-04	13-Jul-04	0.00200	0.00070	0.0050	0.00032	0.00204	0.1060	5.7	0.0070	7.90	Grab
19-Jul-04	20-Jul-04	0.00200	0.00043	0.0050	0.00084	0.00088	0.0435	3.0	0.0050	7.86	Grab
26-Jul-04	27-Jul-04	0.00100	0.00052	0.0050	0.00157	0.00207	0.0429	3.0	0.0050	7.87	Grab
2-Aug-04	3-Aug-04	0.00020	0.00082	0.0050	0.00280	0.00338	0.0349	3.3	0.0060	8.00	Grab
9-Aug-04	10-Aug-04	0.00100	0.00100	0.0055	0.00120	0.00748	0.0482	3.0	0.0050	8.04	Grab
16-Aug-04	17-Aug-08	0.00020	0.00121	0.0050	0.00177	0.00644	0.0418	5.3	0.0100	7.95	Grab
23-Aug-04	24-Aug-04	0.00020	0.00134	0.0050	0.00119	0.00967	0.0498	4.4	0.0080	7.84	Grab
30-Aug-04	31-Aug-04	0.00020	0.00137	0.0050	0.00261	0.01340	0.0794	14.5	0.0080	7.90	Grab
6-Sep-04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
13-Sep-04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
20-Sep-04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
27-Sep-04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
July/04	0.0015	0.00107	0.0050	0.00135	0.00235	0.0976	32	0.0093
August/04	0.0004	0.00115	0.00510	0.00191	0.00807	0.0508	6.1	0.0074
September/04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
5-Jul-04	7-Jul-04	0.018	0.048	0.091	0.049	0.080	3.588	2120	362,440	18,122
12-Jul-04	13-Jul-04	0.752	0.264	1.880	0.120	0.767	39.850	2143	2,631,608	375,944
19-Jul-04	20-Jul-04	0.205	0.044	0.512	0.086	0.090	4.458	307	512,395	102,479
26-Jul-04	27-Jul-04	0.028	0.015	0.141	0.044	0.058	1.211	85	141,090	28,218
2-Aug-04	3-Aug-04	0.005	0.022	0.132	0.074	0.089	0.923	87	158,700	26,450
9-Aug-04	10-Aug-04	0.026	0.026	0.142	0.031	0.194	1.248	78	129,470	25,894
16-Aug-04	17-Aug-08	0.000	0.000	0.000	0.000	0.000	0.000	0	0	1
23-Aug-04	24-Aug-04	0.000	0.000	0.000	0.000	0.000	0.000	0	0	1
30-Aug-04	31-Aug-04	0.000	0.000	0.000	0.000	0.000	0.000	0	0	1
6-Sep-04	nd[2]	0	0	0	0	0	0	0	0	0
13-Sep-04	nd[2]	0	0	0	0	0	0	0	0	0
20-Sep-04	nd[2]	0	0	0	0	0	0	0	0	0
27-Sep-04	nd[2]	0	0	0	0	0	0	0	0	0

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note[2] - "nd" refers to no effluent discharge to sample

MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
July/04	7.77	2.87	20.33	2.31	7.71	380.58	36,078.15	28,268,381	131,191	4,066,913
August/04	0.19	0.29	1.70	0.65	1.76	13.46	1,022.95	1,786,654	10,469	324,551
September/04	0	0	0	0	0	0	0	0	0	0

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the month x days in month

2005 POLARIS MINE MMER 2ND QUARTER REPORT

Bruce J. Donald
Reclamation Manager

August 8, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Sir;

Re: Polaris Mine – 2005 2nd Quarter Metal Mining Effluent Regulations Report

Please find attached the Metal Mining Effluent Report for the Polaris Mine for the 2nd Quarter of 2005. Flow initiated at the end of June (approximately June 25th, 2005), thus only one sample was collected during the 2nd quarter. This first MMER routine monitoring sample was collected on Wednesday June 29, 2005. All MMER routine parameters, plus additional EEM water quality parameters were analyzed on this sample. However, only the final discharge point (i.e., Garrow Creek station) was accessible at this time due to ice conditions in Garrow Bay precluding sample collection from the receiving and reference stations. An oversight by the ALS lab resulted in mercury, nitrate, and alkalinity analysis being conducted slightly after the holding times. A written explanation of this oversight is attached as APPENDIX E. Concentrations of all deleterious substances were well within Schedule 4 limits.

While a toxicity program (acute and sublethal) was considered for this event, EVS and Stantec laboratories were not able to accommodate sample receiving or testing at this time, due to the statutory holiday (i.e., Friday July 1, 2005). Toxicity sample shipment to meet holding times would also have been problematic due to the holiday. Thus, toxicity testing was attempted at the earliest possible timing, which was in July, and will be discussed in the 3rd quarter report.

2005 2nd quarter MMER regulatory data has been submitted electronically through the online RISS system, on August 8, 2005. I will forward a paper copy of this report by mail. Please contact me if there are any questions related to enclosed information.

Yours truly,
Original signed by B Donald

Bruce Donald

Attachments: 2nd Quarterly Monitoring Report

cc:

Walter Kuit (Teck Cominco Limited)
Randy Baker (Azimuth Consulting Group)
Cheryl Mackintosh (Azimuth Consulting Group)

POLARIS MINE – MMER MONITORING REPORT

2nd QUARTER 2005

APPENDIX A (96-hour Rainbow Trout Toxicity Test)

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test

APPENDIX B (72-hour Daphnia Magna Toxicity Test)

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test

APPENDIX C (Mass Loadings)

i. Concentration & monthly mean concentrations of each deleterious substance of Schedule 4
ii. pH of the effluents samples as required by subsection 12(1)
iii. Description of sample collection method
iv. Total volume of effluent deposited during each month of the quarter as per section 19
v. Mass loading of the deleterious substances set out in Schedule 4 and as per section 20

APPENDIX D (Effluent Characterization Results)

i. Results of the effluent characterization as per paragraph 4(1) of Schedule 5

APPENDIX E (Letter regarding monthly parameter holding times)

i. Letter from ALS Environmental

APPENDIX A

96-h Acute Rainbow Trout Toxicity Test

Reporting Requirements for Reference Method EPS 1/RM/13

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as effluent discharge began in the final days of June, and the EVS laboratory could not accommodate testing due to the July 1 statutory holiday. The statutory holiday also precluded sample shipment within toxicity testing holding times. Testing was conducted at the next possible time, which was July and will be discussed in the 3rd quarter report.

iii. Type of sample
   - No toxicity sampling conducted, see ii.

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No toxicity sampling conducted, see ii.

vi. Name of person submitting samples
   - No toxicity sampling conducted, see ii.

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Percent mortality of fish in stock tank(s)
   - None to report. There were no tests conducted during the period

v. Species of test organism
   - None to report as there were no tests conducted during the period

vi. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vii. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

ix. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

x. Indication of aeration of test solutions before introduction of fish
   - None to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Number of fish added to each test vessel
   - No fish added as there were no tests conducted during the period

xiv. Mean and range of fork length of control fish at end of test
   - No data to report as there were no tests conducted during the period

xv. Mean wet weight of individual control fish at end of the test
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPS 1/RM/13

xvi. Estimated loading density of fish in test solutions
- No data to report as there were no tests conducted during the period

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
- None to report. No tests conducted during the period

ii. Number of control fish showing atypical/stressed behaviour
- None to report. No tests conducted.

iii. Mean mortality rate in solutions of effluent and control water
- None to report. No tests conducted

iv. Estimate of 96-h LC50 in multi-concentration tests
- No data to report. No tests conducted

v. Most recent 96-h LC50 for reference toxicity test(s)
- No data to report. No tests conducted

APPENDIX B

72-h Acute *Daphnia magna* Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - No sampling conducted as effluent discharge began in the final days of June, and the EVS laboratory could not accommodate testing due to the July 1 statutory holiday. The statutory holiday also precluded sample shipment within toxicity testing holding times. Testing was conducted at the next possible time, which was July and will be discussed in the 3rd quarter report.

iii. Type of sample
   - No toxicity sampling conducted, see ii.

iv. Brief description of sampling point
   - Discharge point of siphon at Garrow Lake dam

v. Sampling method
   - No toxicity sampling conducted, see ii.

vi. Name of person submitting samples
   - No toxicity sampling conducted, see ii.

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - No testing conducted during the quarter

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations to report as there was no testing conducted during the quarter

iii. Name and city of testing laboratory
   - No laboratory used during the quarter

iv. Species of test organism
   - None to report as there were no tests conducted during the period

v. Date and time for start of definitive test
   - None to report as there were no tests conducted during the period

vi. Person(s) performing the test and verifying the results
   - No tests performed during the quarter

vii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - No data to report as there were no tests conducted during the period

viii. Confirmation that no adjustment of sample or solution pH occurred
   - No adjustment to report as there were no tests conducted during the period

ix. Indication of any adjustment of hardness of effluent sample
   - No adjustment to report as there were no tests conducted during the period

x. Indication of any aeration of sample
   - No indication to report as there were no tests conducted during the period

xi. Concentrations and volumes tested
   - No data to report as there were no tests conducted during the period

xii. Measurements of dissolved oxygen, pH and temperature
   - No data to report as there were no tests conducted during the period

xiii. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
   - No data to report as there were no tests conducted during the period

xiv. Number of neonates per test vessel and milliliters of solution per daphnid
   - No data to report as there were no tests conducted during the period

Reporting Requirements for Reference Method EPA/600/4-91/003 Method 1009.0

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
   - No data to report. No tests conducted during the period.

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
   - No data to report. No tests conducted during the period.

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
   - No data to report. No tests conducted during the period

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
   - No data to report. No tests conducted during the period.

APPENDIX C

Effluent Metals Concentrations and Loadings

2005 2nd QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
3-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
10-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
17-Apr-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
24-Apr-05	nd[3]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
1-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
8-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
15-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
22-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
29-May-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
5-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
12-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
19-Jun-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
26-Jun-05	29-Jun-05	*0.00020*	*0.00050*	*0.0050*	0.00037	0.00075	0.0137	*3.0*	*0.0050*	7.98	Grab

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
April/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
May/05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
June/05	0.0002	0.0005	0.005	0.000368	0.000754	0.0137	3	0.005

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
3-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
10-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
17-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
24-Apr-05	nd[2]	0	0	0	0	0	0	0	0	0
1-May-05	nd[2]	0	0	0	0	0	0	0	0	0
8-May-05	nd[2]	0	0	0	0	0	0	0	0	0
15-May-05	nd[2]	0	0	0	0	0	0	0	0	0
22-May-05	nd[2]	0	0	0	0	0	0	0	0	0
29-May-05	nd[2]	0	0	0	0	0	0	0	0	0
5-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
12-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
19-Jun-05	nd[2]	0	0	0	0	0	0	0	0	0
26-Jun-05	29-Jun-05	0.002	0.005	0.048	0.004	0.007	0.133	29.030	0.048	9,677

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note [2] - "nd" refers to no effluent discharge to sample

MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
April/05	-	-	-	-	-	-	-	-	-	-
May/05	-	-	-	-	-	-	-	-	-	-
June/05	0.015	0.036	0.363	0.027	0.055	0.994	217.728	0.363	16,934	58,061

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the week of June 26, 2005 x 6 days of flow

APPENDIX D

Results of Effluent Characterization

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 4(1) in Schedule 5

The final discharge point on Garrow creek began to thaw and flow on approximately June 25, 2005. An MMER routine monitoring sample was collected at the first opportunity, which was on Wednesday June 29, 2005. For this sample, the suite of routine weekly parameters plus additional quarterly EEM parameters were analyzed. EEM effluent characterization parameters for this sample are presented in Table 1. Due to an oversight by ALS, mercury, nitrate and alkalinity were analyzed slightly after the holding times (see attached letter in Appendix E). At this time, only the effluent station (i.e., Garrow Creek) was accessible due to unsafe ice conditions in Garrow Bay, which precluded collection of receiving (exposure) or reference water samples.

While a toxicity program (both sublethal and acute) was considered for this event, the labs were not able to accommodate sample receiving and testing at this time, due to the statutory holiday (i.e., Friday July 1, 2005). Shipment during the holiday would also have been problematic and would have resulted in missed holding times for the samples. Thus, a toxicity program (acute and sublethal) was attempted at the first suitable time, which was in July. This program and the results will be discussed in the 3rd quarter report.

Concentrations of deleterious substances in effluent water from the June 29, 2005 sample were all below Schedule 4 limits. Zinc is the primary contaminant of potential concern (COPC) identified in mine effluent and was only slightly above BC Ambient Water Quality Guidelines (BC AWQG) of 10µg/L in the effluent sample collected on June 29, 2005 (i.e., concentration was 13.7µg/L), and well below the MMER effluent limit of 500µg/L.

Appendix D - Table 1. Effluent Characterization Results - June 29, 2005.

Facility Name	FDP Name	Effluent Characterization Date	Sample Method	Hardness	Alkalinity	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Ammonia	Nitrate
Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)	Garrow Lake Syphons	6/29/2005	Grab	132	30.7	< 0.1	0.000035	0.024	< 0.00001	< 0.005	0.089	0.0382

Notes:
Only the effluent sample was collected during this event, as the receiving (exposure) and reference stations were frozen. No toxicity samples were collected as the labs (EVS and Stantec) could not receive samples and accommodate testing at this time due to the July 1 holiday, followed by the weekend. Holding times for Hg, alkalinity and nitrate were slightly exceeded due to an oversight by the lab (ALS). A letter explaining this oversight is presented in Appendix E.

APPENDIX E

Letter from ALS Regarding Monthly Parameter Holding Times

2005 POLARIS MINE MMER 3RD QUARTER REPORT

Bruce J. Donald
Reclamation Manager

November 10, 2005

Prairie & Northern Region
Environment Canada
Room 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

Attention: Peter Blackall, Regional Director of Environmental Protection

Dear Peter Blackall;

Re: Polaris Mine 2005 3rd Quarter MMER Report

Please find attached the Metal Mining Effluent Regulation (MMER) Report for Polaris Mine for the 3rd Quarter of 2005. As Polaris is a remote mine and operations on the site have ceased, collection of MMER and Environmental Effects Monitoring (EEM) data for this year was conducted by small field crews stationed onsite for the first part of the season, and then by flying scientists/ technicians to site on a weekly basis for the latter part of the season. Field crews were onsite when flow initiated in Garrow Creek on approximately June 25, 2005. Flow continued through July and August, and Garrow Creek was observed to be frozen on September 13, 2005.

The MMER effluent characterization monitoring, bioassay testing, and environmental effects monitoring were conducted throughout the quarter. Due to the short season of flow, two sets of acute and sublethal toxicity tests were conducted within the quarter on July 16 and August 9, 2005, corresponding to the dates of EEM quarterly water quality monitoring samples collected at effluent, exposure and reference stations. A quarterly effluent sample plus acute and sublethal toxicity samples were also collected on July 6, 2005, but due to fog conditions at the mine, the toxicity samples did not make it to the labs within holding times are were discarded. The effluent sample was analyzed for the MMER and EEM parameters. No exposure or reference samples were collected on July 6, 2005, since Garrow Bay was still ice-covered.

MMER water quality monitoring was conducted on a weekly basis throughout most of the season. Between August 20 – 23 and after August 27, 2005, access to the site was not possible due to weather conditions. Ken Russell and Jenny Ferone were informed of failed sampling attempts and were updated with weather and safety conditions at the site on a regular basis. On September 13, 2005, a quarterly event with acute toxicity testing was planned. However, upon arrival onsite, it was observed that Garrow Creek (final discharge point) was frozen. A chronology of the 2005 sampling season is presented in Appendix I.

There were no exceedances of MMER Schedule 4 Limits for the 2005 season, and there was no acute toxicity in Rainbow trout and *Daphnia* tests. Holding times for nitrate and alkalinity were exceeded in the July 6, 2005 sample due to an oversight by the ALS lab. This situation is explained in a letter from ALS provided in Appendix J, and is not likely to influence the results.

The following information is included in our 2005 3rd Quarter MMER Report:

- Table 1a – Concentrations Of Effluent For MMER Schedule 4 Sampled Weekly
- Table 1b – Monthly Mean Concentrations Of Effluent For MMER Schedule 4
- Table 1c – Mass Loading Of Deleterious Substance For Each Day Sampled
- Table 1d – Mass Loading Per Calendar Month For Each Deleterious Substance
- Table 2 – Results of Acute Lethality Tests and Daphnia Magna Monitoring Tests
- Table 3 – Effluent Characterization Water Quality Results (studies conducted under Part 1, Section 4) (Effluent Characterization) (Table 3, Table 5)
- Table 4 – Water Quality Monitoring in Exposure and Reference Stations (Results of studies conducted under Part 1, Section 7)
- Table 5 – QAQC of Effluent and Water Quality Data

Additional Appendices

- Appendix A – Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test
- Appendix B – Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test
- Appendix C – 7-d Topsmelt Growth and Survival Sublethal Toxicity Test
- Appendix D – 92-h Echinoderm Fertilization Sublethal Toxicity Test
- Appendix E – 7-d Sublethal Champia (Algae) Sublethal Toxicity Test
- Appendix F – Results of Effluent Characterization, as per Paragraph 15(1)(a)
- Appendix G – Acute Toxicity Testing Reports
- Appendix H – Sublethal Toxicity Testing Reports
- Appendix I – Polaris 2005 Sampling Event Chronology
- Appendix J – Letter from ALS explaining missed holding times of alkalinity and nitrate for July 6,2005 sample

The MMER and EEM data required to be reported in electronic format were submitted electronically through the RISS online system on November 10 2005. In addition to this hardcopy report, an electronic pdf version of this report is being emailed to you (e-mailed November 10, 2005).

If you have any questions regarding the annual report or aspects of the application of the MMER to the Polaris Mine, please feel free to contact me.

Yours truly,

Original signed by B. Donald
Bruce Donald

Attachments: 2005 3rd Quarter Regulatory Data Tables
cc: Randy Baker (Azimuth Consulting Group)
Ken Russell (Environment Canada)
Jenny Ferone (Environment Canada)

Polaris Mine 2005 3rd Quarter MMER Report

Prepared for

Environment Canada, Prairie & Northern Region
Room 200, 4999 98th Ave.
Edmonton, AB, T6B 2X3

November 10, 2005

Teck Cominco
Bag 2000
Kimberley, BC, Canada
V1A 3E1

2005 3rd QUARTER MMER REPORT

LOCATION - FINAL DISCHARGE POINT FROM GARROW LAKE (GARROW LAKE DAM SIPHONS)

Table 1a. CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4 SAMPLED WEEKLY

Sample Taken During The Week of	Date Sample Taken	DELETERIOUS SUBSTANCE (mg/L)[1] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	pH[1]	Collection Method
3-Jul-05	6-Jul-05	*0.00020*	0.00024	*0.0050*	0.00017	0.00060	0.0127	4	0.0050	7.49	Grab
10-Jul-05	13-Jul-05	*0.00020*	0.00061	*0.0050*	0.00230	0.00088	0.0205	*3.0*	*0.0050*	7.48	Grab
10-Jul-05	16-Jul-05	*0.00020*	0.00042	0.0444	0.00042	0.00081	0.0179	*3.0*	0.0090	7.59	Grab
17-Jul-05	23-Jul-05	*0.00020*	0.00047	*0.0050*	0.00024	0.00105	0.0325	*3.0*	*0.0050*	7.56	Grab
24-Jul-05	30-Jul-05	0.00021	0.00050	*0.0050*	0.00020	0.00141	0.0405	*3.0*	*0.0050*	7.70	Grab
31-Jul-05	6-Aug-05	*0.00020*	0.00052	*0.0050*	0.00047	0.00166	0.0356	*3.0*	*0.0050*	7.65	Grab
7-Aug-05	13-Aug-05	*0.00020*	0.00052	*0.0050*	0.00111	0.00149	0.0310	*3.0*	0.0080	7.79	Grab
14-Aug-05	24-Aug-05[3]	*0.00020*	0.00101	*0.0050*	0.00093	0.00474	0.0905	4.8	0.0090	8.13	Grab
21-Aug-05	27-Aug-05	*0.00020*	0.00079	*0.0050*	0.00076	0.00356	0.0680	3.7	0.0100	7.92	Grab
28-Aug-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
4-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
11-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
18-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]
25-Sep-05	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note [2] - "nd" refers to no effluent discharge to sample

Note [3] - due to weather conditions samples could not be collected the week of August 14th, two sets were collected the following week.

Concentrations in italicized font are less than the detection limit shown.

Table 1b. MONTHLY MEAN CONCENTRATIONS OF EFFLUENT FOR MMER SCHEDULE 4

MONTH OF	MONTHLY MEAN CONCENTRATION[1] OF DELETERIOUS SUBSTANCE[3] Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226
July/04	0.0002	0.00045	0.0129	0.00066	0.00095	0.0248	3	0.0058
August/04	0.0002	0.00071	0.00500	0.00082	0.00286	0.0563	3.6	0.0080
September/04	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]	nd[2]

Note[1] - All concentrations are in mg/L except Radium 226 which is Bq/L

Note [2] - "nd" refers to no effluent discharge to sample

Note[3] - Monthly Mean Concentrations - the MEAN value of the concentrations measured in all water samples collected during each month when a deleterious substance is deposited.

Table 1c. MASS LOADING OF DELETERIOUS SUBSTANCE FOR EACH DAY SAMPLED

Sample Taken During The Week of	Date Sample Taken	DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day)[1]								Average Daily Flow Rate (m^3/day)[4]
		Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[1]	
3-Jul-05	6-Jul-05	0.002	0.002	0.042	0.001	0.005	0.108	34	42,353	8,471
10-Jul-05	13-Jul-05	0.001	0.002	0.018	0.008	0.003	0.075	11	18,178	3,636
10-Jul-05	16-Jul-05	0.001	0.001	0.148	0.001	0.003	0.060	10	30,086	3,343
17-Jul-05	23-Jul-05	0.001	0.003	0.027	0.001	0.006	0.177	16	27,214	5,443
24-Jul-05	30-Jul-05	0.000	0.001	0.011	0.000	0.003	0.092	7	11,299	2,260
31-Jul-05	6-Aug-05	0.001	0.003	0.034	0.003	0.011	0.240	20	33,734	6,747
7-Aug-05	13-Aug-05	0.002	0.006	0.056	0.012	0.017	0.348	34	89,872	11,234
14-Aug-05	24-Aug-05[3]	0.004	0.018	0.089	0.017	0.084	1.604	85	159,501	17,722
21-Aug-05	27-Aug-05	0.003	0.010	0.063	0.010	0.045	0.856	47	125,830	12,583
28-Aug-05	nd[2]	0	0	0	0	0	0	0	0	0
4-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
11-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
18-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0
25-Sep-05	nd[2]	0	0	0	0	0	0	0	0	0

Note[1] - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note [2] - "nd" refers to no effluent discharge to sample

Note [3] - August 24 data are presented in the week of the August 14th

Note [4] - Discharge for August 6 is an estimate pending verification by Teck Cominco.

Table 1d. MASS LOADING PER CALENDAR MONTH FOR EACH DELETERIOUS SUBSTANCE

CALENDAR MONTH OF	MASS LOADING[1] FOR DELETERIOUS SUBSTANCE (kg/month)[2]								Average Weekly Flow Rate[3] (m^3/week)	Total Monthly Volume[4] (m^3/month)
	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226[2]		
July/04	0.03	0.06	1.53	0.08	0.12	3.16	483.14	800,602	32,412	143,540
August/04	0.07	0.29	1.87	0.32	1.21	23.62	1,438.14	3,169,267	84,501	374,218
September/04	0	0	0	0	0	0	0	0	0	0

Note[1] - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note[2] - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note[3] - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note[4] - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the month x days in month

Table 2

RESULTS OF ACUTE LETHALITY TESTS AND
DAPHNIA MAGNA MONITORING TESTS

Date Sample Collected	Effluent Acutely Lethal to Rainbow Trout (yes or no)	Effluent Acutely Lethal to *Daphnia magna* (yes or no)
16-Jul-05	No	No
6-Aug-05	No	No

Non-compliance Information

If effluent was non-compliant with the aurthorized limits set out in Schedule4, indicate the cause(s) of non-compliance and remedial measures planned or implemented. Also indicate remedial meaures planned or implemented in response to the failure of acute lethality tests.

There were no non-compliant concentrations, and no failed acute lethality toxicity tests during 2005 3rd Quarter for Polaris Mine.

Table 3. 2005 3rd Quarter Polaris Mine Effluent Characterization Results (Part 1, Section 4)

Effluent Characterization from Final Discharge Point - Garrow Lake Former Dam / Syphons
Northing: 75°22'32"
Easting: 96°48'37"

Facility Name:		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)				
FDP Name:		Garrow Lake Syphons				
Sample ID:		G Creek	G-Creek	G-Creek		
Sampling Date:		6-Jul-05	16-Jul-05	6-Aug-05		
Sample Method:		Grab	Grab	Grab		
Parameter	**Units**				***Detection Limit***	**Methods[1]**
Hardness	mg/L	149	184	375	*0.54 - 5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity, Total	mg/L	28.1	29.2	52.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum, Total	mg/L	<0.20	0.0085	<0.20	*0.001 - 0.2*	ICPMS[3]
Cadmium, Total	mg/L	0.000034	0.000044	0.000097	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron, Total	mg/L	0.012	0.043	0.014	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum, Total	mg/L	<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia Nitrogen	mg/L	0.036	0.037	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate Nitrogen	mg/L	0.032	<0.050	0.072	*0.025 - 0.050*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic, Total	mg/L	<0.00020	<0.00020	<0.00020	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper, Total	mg/L	0.000240	0.000424	0.000516	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide, Total	mg/L	<0.0050	0.0444	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode
Lead, Total	mg/L	0.000166	0.000415	0.000467	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel, Total	mg/L	0.000601	0.000807	0.00166	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc, Total	mg/L	0.0127	0.0179	0.0356	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
Total Suspended Solids	mg/L	4.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium-226 (a)	Bq/L	0.0050	0.009	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	7.49	7.59	7.65	*0.010*	APHA Method 4500-H (pH electrode meter)

Notes:

< = Less than the detection limit indicated.

(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

Table 4. 2005 3rd Quarter Polaris Mine Water Quality Monitoring Results (Part 1, Section 7)

Station:		Exposure Area		Reference Area			
Description:		Garrow Bay at Mouth of Garrow Creek Confluence		Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek).			
Northing:		75°22'15"		75°22'40"			
Easting:		96°48'30"		96°47'12"			
Facility Name:		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)		Teck Cominco Metals Limited - Polaris Mine (Little Cornwallis Island)			
FDP Name:		Garrow Lake Syphons		Garrow Lake Syphons			
Area Name:		Garrow Bay Exposure		Garrow Bay Reference			
Sample ID:		G-BAY	G-Bay (b)	T-BAY REF	Ref		
Sampling Date:		16-Jul-05	6-Aug-05	16-Jul-05	6-Aug-05		
Sample Method:		Grab	Grab	Grab	Grab		
Parameters	**Units**					***Detection Limit***	**Methods[1]**
Hardness	mg/L	215	385	271	840	*0.54-5.4*	Calculation - EPA Method 3005A, ICPOES (EPA Method 6010B)[4]
Alkalinity, Total	mg/L	44.2	63.2	23.0	53.5	*2.0*	Colourimetry - APHA Method 2320 (potentiometric titration)
Aluminum, Total	mg/L	0.0519	<0.10	0.0619	<0.10	*0.001-0.2*	ICPMS[3]
Cadmium, Total	mg/L	0.000051	0.000081	<0.000020	<0.000020	*0.000020*	SPR-IDA[2], ICPMS[3]
Iron, Total	mg/L	0.207	0.015	0.217	0.011	*0.010*	SPR-IDA[2], ICPMS[3]
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	*0.000010*	Cold Vapour Atomic Florescence Spectrophotometry
Molybdenum, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	ICPMS[3]
Ammonia Nitrogen	mg/L	0.048	<0.020	<0.020	<0.020	*0.020*	APHA Method 4500-NH3 (selective ion electrode)
Nitrate Nitrogen	mg/L	<0.050	0.092	<0.050	0.0261	*0.025*	APHA Method 4110 (determination of inorganic ions by ion chromatography)
Arsenic, Total	mg/L	<0.00020	<0.00020	0.00050	0.00024	*0.00020*	Hydride-Vapour Atomic Absorption Spectrophotometry
Copper, Total	mg/L	0.000748	0.000608	0.000563	0.000305	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	*0.0050*	Colourimetry - APHA Method 4500-CN (cynate hydrolosis using an ammonia selective electrode
Lead, Total	mg/L	0.00147	0.000517	0.000690	0.000078	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Nickel, Total	mg/L	0.00126	0.00188	0.000554	0.000412	*0.000050*	Chelation SPR-IDA[2], ICPMS[3]
Zinc, Total	mg/L	0.0154	0.0224	0.00323	0.00122	*0.00050*	Chelation SPR-IDA[2], ICPMS[3]
Total Suspended Solids	mg/L	16.7	<3.0	<3.0	<3.0	*3.0*	Gravimetry - APHA Method 2540 (filtration through glass fibre filter)
Radium-226 (a,b)	Bq/L	0.010	n/a	<0.0050	<0.0050	*0.0050*	Radio Chemistry[5]
pH	pH units	7.64	7.96	7.40	7.89	*0.010*	APHA Method 4500-H (pH electrode meter)
Water Temperature[6]	°C	0.2	0.6	-0.1	0.2	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85
Dissolved Oxygen[6]	mg/L	13.2	11.6	15.2	13.9	*n/a*	Field - Campbell Scientific Hydrolab Model H20, or YSI Meter Model 85

Notes

The Garrow Bay exposure area (mouth of the creek), and Garrow Bay reference area were frozen during the July 6, 2005 sampling event.

< = Less than the detection limit indicated.

(a) Results are expressed as Becquerels per litre (Bq/L). This analysis is subcontracted to SRC, Saskatoon.

(b) n/a for August 6, 2005 sample = not available, the sample was lost during analysis by SRC with no additional sample remaining to repeat the analysis.

[1]Original data reports are available upon request

[2]SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).

[3]Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.

[4]This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the USEPA. The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emissionspectrophotometry ICPOES (EPA Method 6010B).

[5]All radium isotopes in the sample solution are separated by coprecipitation with lead sulfate. The precipitate is redissolved and the radium isotopes are separated by coprecipitation with barium sulfate. The precipitate is filtered and mounted on a stainless steel disk. It is then counted on an alpha spectrometer. The radium 226 alpha energy is distinct and the peak can be clearly identified.

[6]Temperature and dissolved oxygen data are estimated pending verification by Teck Cominco.

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Duplicate	Original Sample		Field Duplicate	Original Sample		Field Duplicate	Original Sample	
Sample ID:		Dup	G Creek		DUP	G-Creek		Dup	Ref	
Location:		Garrow Lake Syphons			Garrow Lake Syphons			Garrow Bay Reference		
Description:		Final Discharge Point		RPD[2]	Final Discharge Point		RPD[2]	~1km NE of confluence with Garrow Creek		RPD[2]
Sampling Date:		6-Jul-05		(%)	16-Jul-05		(%)	6-Aug-05		(%)
Parameters	**Parameter Units**									
Hardness	mg/L	140	149	6.0	187	184	1.6	852	840	1.4
Alkalinity, Total	mg/L	28.0	28.1	0.4	29.0	29.2	0.7	53.8	53.5	0.6
Aluminum, Total	mg/L	<0.10	<0.20	n/a	0.0087	0.0085	2.4	<0.10	<0.10	n/a
Cadmium, Total	mg/L	0.000040	0.000034	17.6	0.000049	0.000044	11.4	<0.000020	<0.000020	n/a
Iron, Total	mg/L	0.013	0.012	8.3	0.043	0.043	0.0	0.011	0.011	0.0
Mercury, Total	mg/L	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a	<0.000010	<0.000010	n/a
Molybdenum, Total	mg/L	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a	<0.0050	<0.0050	n/a
Ammonia Nitrogen	mg/L	0.032	0.036	11.1	0.044	0.037	18.9	<0.020	<0.020	n/a
Nitrate Nitrogen	mg/L	0.028	0.032	12.5	<0.050	<0.050	n/a	0.0348	0.0261	33.3
Arsenic, Total	mg/L	0.00021	<0.00020	n/a	<0.00020	<0.00020	n/a	<0.00020	0.00024	n/a
Copper, Total	mg/L	0.000295	0.000240	22.9	0.000376	0.000424	11.3	0.000321	0.000305	5.2
Cyanide, Total	mg/L	<0.0050	<0.0050	n/a	0.0058	0.0444	86.9	<0.0050	<0.0050	n/a
Lead, Total	mg/L	0.000241	0.000166	45.2	0.000409	0.000415	1.4	0.000062	0.000078	20.5
Nickel, Total	mg/L	0.000673	0.000601	12.0	0.000819	0.000807	1.5	0.000460	0.000412	11.7
Zinc, Total	mg/L	0.0136	0.0127	7.1	0.0185	0.0179	3.4	0.00165	0.00122	35.2
Total Suspended Solids	mg/L	<3.0	4.0	n/a	<3.0	<3.0	n/a	<3.0	<3.0	n/a
Radium-226 (a,b)	Bq/L	<0.0050	0.0050	n/a	<0.0050	0.009	n/a	0.0060	<0.0050	n/a
pH	pH units	7.62	7.49	1.7	7.58	7.59	0.1	7.80	7.89	1.1
Salinity	o/oo	<1.0	<1.0	n/a	<1.0	<1.0	n/a	4.6	4.6	0.0
Calcium, Total	mg/L	16.5	19.1	13.6	21.4	21.1	1.4	58.1	57.6	0.9
Magnesium, Total	mg/L	24.0	24.6	2.4	32.3	31.9	1.3	172	169	1.8

Notes

[1]QAQC samples were collected during each EEM monitoring event. At least one field duplicate and/or one blank sample was collected during each event.

[2]RPD = Relative Percent Difference = [Absolute value (DUP-ORIG)/ORIG]*100%

Cells in grey shading have RPD values >50% for co-located field duplicates

[3]Distilled water from onsite distiller, stored for 1 year in jerry cans onsite.

[4]Commercial distilled water transported to mine site.

QAQC Results

A total of 3 duplicate samples and 5 blank samples were collected during the 2005 EEM program at Polaris mine. All RPD values were less than 50%, with the exception of one measurement of cyanide on July 16, 2005. Cyanide is not used in the process and is typically measured at less than the detection limit. With the exception of the aforementioned cyanide measurement, which is questionable, the data generally indicate good reproducibility between co-located field duplicates (i.e., low measurement and analytical variability).

Blank samples from the on-site distilled water that had been stored indicated relatively high levels of zinc, copper, and lead. This contamination was considered to be a result of the storage procedure and metal leaching from the metal jerry cans that the water was stored in for the year. The transport blanks using commmercial distilled water indicated low concentrations of all paramters (i.e., typically less than, or slightly higher than detection limits), which reveals no background contamination issues with the analysis.

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results[1] Including Field Duplicates, Field Blanks, and Transport Blanks.

Sample Type:		Field Blank	Field Blank	Field Blank	ALS Travel Blank	ALS Travel Blank
Sample ID:						
Location:		n/a	n/a	n/a	n/a	n/a
Description:		Distilled Water[3]	Distilled Water[3]	Distilled Water[3]	Distilled Water[4]	Distilled Water[5]
Sampling Date:		6-Jul-05	16-Jul-05	6-Aug-05	24-Aug-05	24-Aug-05
	Parameter					
Parameters	**Units**					
Hardness	mg/L	3.07	<0.54	0.85	<0.50	<0.50
Alkalinity, Total	mg/L	3.2	<2.0	<2.0	<2.0	<2.0
Aluminum, Total	mg/L	<0.0010	<0.0050	<0.10	<0.0010	<0.0010
Cadmium, Total	mg/L	<0.000050	<0.000020	<0.000050	<0.000020	<0.000050
Iron, Total	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury, Total	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum, Total	mg/L	<0.000050	<0.0050	<0.0050	<0.000050	<0.000050
Ammonia Nitrogen	mg/L	<0.020	<0.020	<0.020	-	-
Nitrate Nitrogen	mg/L	<0.0050	<0.0050	<0.0050	-	-
Arsenic, Total	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Copper, Total	mg/L	0.00484	0.00167	0.0244	<0.000050	<0.00010
Cyanide, Total	mg/L	<0.0050	<0.0050	<0.0050	-	-
Lead, Total	mg/L	0.00212	0.00607	0.0445	<0.000050	<0.000050
Nickel, Total	mg/L	<0.00010	<0.000050	<0.00050	<0.000050	<0.00010
Zinc, Total	mg/L	0.0080	0.00440	0.0040	<0.00050	<0.0010
Total Suspended Solids	mg/L	<3.0	<3.0	<3.0	<3.0	<3.0
Radium-226 (a,b)	Bq/L	<0.0050	<0.0050	<0.0050	-	-
pH	pH units	6.27	5.59	6.17	5.51	5.53
Salinity	o/oo	<1.0	<1.0	<1.0	<1.0	<1.0
Calcium, Total	mg/L	1.23	0.084	0.341	<0.050	<0.050
Magnesium, Total	mg/L	<0.10	<0.10	<0.10	<0.050	<0.050

POLARIS MINE – 2005 3rd QUARTER MMER REPORT

APPENDIX A

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/13: 96 hr acute rainbow trout test

APPENDIX B

i. Information specified by Section 8.1 of Reference Method EPS 1/Rm/14: 72 hr acute *Daphnia magna* test

APPENDIX C

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPAW 95-EPA West Coast: 7-day Topsmelt Survival and Growth Tests.

APPENDIX D

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPS 1/Rm/27-EC: 92 hr Echinoderm (sand dollar) Fertilization Test

APPENDIX E

i. Information specified in Schedule 5 of the MMER (June 2002) for Reference Method EPA/600/4-91-003, Method 1009.0: Algae (*Champia parvula*) 7-day Sublethal Growth Tests

APPENDIX F

i. Results of Effluent Characterization, as per Paragraph 15(1)(a)

APPENDIX G

ii. Acute toxicity testing laboratory reports

APPENDIX H

i. Sublethal toxicity testing laboratory reports

APPENDIX I

i. Polaris 2005 Sampling Event Chronology

APPENDIX J

i. Letter from ALS explaining missed holding times for July 6, 2005 sample

APPENDIX A

96-h Acute Rainbow Trout Toxicity Test

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Saturday July 16, 2005 – 0900h
   - Test 2: Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method

- Water was collected from at least 15cm below the surface using a water pump with silicon tubing
- Water was collected from the upstream direction
- The pump was flushed with site water for at least one minute prior to sample collection
- 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Test 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Acute_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Section 8.1.2 Test Facilities and Conditions

i. Test type & method
   - 96-hour Rainbow Trout LC_{50}

ii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements

iii. Name and city of testing laboratory

- EVS Environment Consultants, North Vancouver, BC

iv. Source of test species
   - Sun Valley

v. Percent mortality of fish in stock tank(s)
   - Test 1: 0.1%
   - Test 2: 0.1%

vi. Species of test organism
   - Rainbow Trout (*Oncorhynchus mykiss*)

vii. Date and time for start of definitive test
   - Test 1: July 21, 2005 – 1035h
   - Test 2: August 11, 2005 – 1500h

viii. Person(s) performing the test and verifying the results

- Test 1: Marriah Grey, Robert Harrison, Julianna Kalocai
- Test 2: Anja Fouche, Robert Harrison, Julianna Kalocai

ix. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
- Test 1: pH - 7.3, T - 15.0 °C, DO - 10.4 mg/L, C – 1445 µmhos/cm
- Test 2: pH - 7.4, T - 15.0 °C, DO - 10.1 mg/L, C – 2510 µmhos/cm

x. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

xi. Indication of aeration of test solutions before introduction of fish
- Test 1: 6.5 ± 1 mL/min/L for 30mins
- Test 2: 6.5 ± 1 mL/min/L for 30mins

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- Control (0%) - 10 L (test 1&2)
- 6.25% - 10 L (test 1&2)
- 12.5% - 10 L (test 1&2)
- 25% - 10 L (test 1&2)
- 50% - 10 L (test 1&2)
- 100% - 10 L (test 1&2)

xiii. Measurements of dissolved oxygen, pH and temperature

Sample Collection Date	Test Concentration (% v/v)	Temperature (0hr) (°C)	Temperture (48 hr) (°C)	Dissolved Oxygen (0hr) (mg/L)	Dissolved Oxygen (48hr) (mg/L)	pH (0hr) pH units	pH (48hr) pH units	Conductivity (0hr) umhos/cm
Test 1	0 (Control)	15	15	10.1	9.7	7	6.7	37
16-Jul-05	6.25	15	15	10.1	9.5	7.1	6.8	194
	12.5	15	15	10.1	9.8	7.1	6.8	301
	25	15	15	10.1	9.8	7.1	6.8	418
	50	15	15	10.1	9.8	7.2	6.9	775
	100	15	15	10.2	9.8	7.3	7	1445
Test 2	0 (Control)	15	15	10.1	9.3	7	7	40
19-Aug-05	6.25	15	15	10.1	9.4	7	7	323
	12.5	15	15	10.1	9.4	7	7.1	535
	25	15	15	10.1	9.6	7	7.1	827
	50	15	15	10.1	9.6	7.2	7.2	1373
	100	15	15	10.1	9.7	7.4	7.3	2510

xiv. Number of fish added to each test vessel
- 10 fish/ 10 L vessel (Test 1 & 2)

xv. Mean and range of fork length of control fish at end of test
- Test 1: 30 mm (25 – 33)
- Test 2: 31 mm (27 – 35)

xvi. Mean wet weight of individual control fish at end of the test
- Test 1: 0.29 g (0.20 – 0.37)
- Test 2: 0.33 g (0.22 – 0.46)

xvii. Estimated loading density of fish in test solutions
- Test 1: 0.29 g/L
- Test 2: 0.33 g/L

Section 8.1.3 Results

i. Number of mortalities of fish in each test solution
   - Results were the same for Test 1, and Test 2, except where noted
   - Control (0%) - 0
   - 6.25% - 0
   - 12.5% - 0
   - 25% - 0
   - 50% - 0
   - 100% - 0

ii. Number of control fish showing atypical/stressed behaviour
   - None in Test 1 or Test 2

iii. Mean mortality rate in solutions of effluent and control water
   - Results were the same for Test 1 and Test 2
   - Control (0%) - 0%
   - 6.25% - 0%
   - 12.5% - 0%
   - 25% - 0%
   - 50% - 0%
   - 100% - 0%

iv. Estimate of 96-h LC50 in multi-concentration tests
   - Results were the same for Test 1 and Test 2
   - 96hr LC_{50} concentration > 100% effluent

v. Most recent 96-h LC50 for reference toxicity test(s)
   - Reference toxicity tests for Toxicant: SDS
   - Test 1 & 2: (Jul-12-03) 96-h LC_{50} = 24mg/L SDS, 95% CL = 18-32mg/L

vi. Reference toxicant warning limits (mean +/- 2SD)
   - Reference toxicity tests for Toxicant: SDS
   - Test 1 & 2: 96-h LC_{50} = 29 +/- 12 mg/L SDS

APPENDIX B

72-h Acute *Daphnia magna* Toxicity Test

Section 8.1.1 Effluent

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for monthly acute toxicity testing were collected
   - Test 1: Saturday July 16, 2005 – 0900h
   - Test 2: Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 2 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Test 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Acute_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Section 8.1.2 Test Facilities and Conditions

ii. Test type & method
   - 48-hour *Daphnia magna* LC_{50}

iii. Indications of deviations from requirements in Sections 2 to 7 of Method EPS 1/RM/13
   - No deviations from requirements

iv. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

v. Species of test organism
   - *Daphnia magna*

vi. Date and time for start of definitive test
   - Test 1: July 19, 2005 – 1600h
   - Test 2: August 11, 2005 – 1030h

vii. Person(s) performing the test and verifying the results
   - Test 1: Shiva Behnia, Julianna Kalocai
   - Test 2: Shiva Behnia, Julianna Kalocai

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
   - Test 1: pH - 7.3, T – 21.0 °C, DO - 10.8 mg/L, C – 1566 µmhos/cm
   - Test 2: pH - 7.5, T - 21.0 °C, DO - 10.8 mg/L, C – 2850 µmhos/cm

ix. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

x. Indication of any adjustment of hardness of effluent sample
- Test 1: No hardness adjustment (initial hardness = 160 mg/L)
- Test 2: No hardness adjustment (initial hardness = 300 mg/L)

xi. Indication of any aeration of sample
- Test 1: 25-50 mL/min/L for 12mins
- Test 2: 25-50 mL/min/L for 15mins

xii. Concentrations and volumes tested
- Concentrations (% effluent volume / total volume) tested and total volumes used for both Test 1 and Test 2 were:
- Control (0%) - 200 mL
- 6.25% - 200 mL
- 12.5% - 200 mL
- 25% - 200 mL
- 50% - 200 mL
- 100% - 200 mL

xiii. Measurements of dissolved oxygen, pH and temperature

Sample Collection Date	Test Concentration (% v/v)	Temperature (0hr) (°C)	Temperture (48 hr) (°C)	Dissolved Oxygen (0hr) (mg/L)	Dissolved Oxygen (48hr) (mg/L)	pH (0hr) pH units	pH (48hr) pH units	Conductivity (0hr) umhos/cm	Hardness (0hr) (mg/L)
Test 1	0 (Control)	20	21	9.1	8.7	7.6	7.6	344	94
16-Jul-05	6.25	20	21	9.1	8.7	7.6	7.6	426	
	12.5	20	21.5	9	8.7	7.6	7.7	505	
	25	20.5	21.5	9	8.7	7.6	7.7	648	
	50	20.5	21	9	8.7	7.4	7.7	954	
	100	21	21.5	8.9	8.7	7.4	7.5	1566	160
Test 2	0 (Control)	20	21	9.1	8.6	7.4	7.6	354	94
19-Aug-05	6.25	20	21	9	8.5	7.4	7.7	505	
	12.5	20.5	21	9	8.5	7.5	7.7	654	
	25	20.5	21	8.9	8.5	7.5	7.7	990	
	50	21	21	8.9	8.5	7.5	7.6	1582	
	100	21	21	8.9	8.5	7.6	7.6	2850	300

xiv. Estimates of time to first brood, average number of neonates per brood, and percent mortality during the seven-day period prior to the test
- Test 1: 8 days to brood, >34 neonates/brood, 0% mortality in 7d prior to test
- Test 2: 7 days to brood, >29 neonates/brood, 0% mortality in 7d prior to test

xv. Number of neonates per test vessel and milliliters of solution per daphnid
- Methods for all tests and dilution series were the same:
- 10 neonates per vessel
- 200 mL of solution per vessel
- 20 mL of solution per daphnid

Section 8.1.3 Results

i. Number of dead and/or immobile daphnids in each test solution including controls
   - Results were the same for Test 1 and Test 2
   - Control (0%) - 0 dead / immobile
   - 6.25% - 0 dead / immobile
   - 12.5% - 0 dead / immobile
   - 25% - 0 dead / immobile
   - 50% - 0 dead / immobile
   - 100% - 0 dead / immobile

ii. For single-concentration test the number of daphnids dead in each of three replicate effluent solutions and in each of three replicate control solutions at end of test. Also report the mean value.
   - Single concentration test was not conducted, dilution series tests were conducted

iii. Estimate of 48-h LC50 and 95% confidence limits in multi-concentration tests, 48-h EC50 for immobilization and 95% confidence limits, indication of statistical method on which results are based.
   - Test 1: 48-h LC_{50} = > 100% effluent
   - Test 2: 48-h LC_{50} = > 100% effluent

iv. Most recent 48-h LC50 for reference toxicant test(s), reference chemical(s), date test initiated, historic geometric mean LC50 and warning limits.
   - Reference toxicity tests for Toxicant: Zinc
   - Test 1: (Jul-19-05) 96-h LC_{50} = 426µg/L Zinc, 95% CL = 362 – 504 µg/L
   - Test 2: (Aug-15-05) 96-h LC_{50} = 481µg/L Zinc, 95% CL = 388 – 597 µg/L

v. Reference toxicant warning limits (mean +/- 2 SD)
   - Reference toxicity tests for Toxicant: Zinc
   - Test 1: 96-h LC_{50} = 445 (+/- 280) µg/L Zinc
   - Test 2: 96-h LC_{50} = 445 (+/- 280) µg/L Zinc

APPENDIX C

7-d Topsmelt Growth and Survival Toxicity Test

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water from final discharge point

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 3 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Sublethal_071605
   - Test 2 – Garrow Creek

viii. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

ix. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Test Organisms Imported from External Supplier

i. Species of test organism
   - Topsmelt (*Atherinops affinis*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Aquatic Bio Systems (ABS), Fort Collins, Colorado

iv. Date test species acquired on
   - Test 1 – July 19, 2005
   - Test 2 – August 9, 2005

v. Indications of deviations from EC guidance on the importation of test organisms
   - No deviations from EC requirements

vi. Percent mortality of fish in 24-hour period preceding the test
   - Test 1 - <10% mortality in approximately 450 fish upon receipt
   - Test 2 - <10% mortality in approximately 450 fish upon receipt

vii. Age at start of test
   - Test 1 – 10 days post-hatch
   - Test 2 – 10 days post-hatch

viii. Unusual appearance, behaviour, or treatment of larvae before their use in the test
- Nothing unusual noted for any test

ix. Confirmation that larvae are actively feeding and swimbladders are not inflated
- All tests - Larvae actively feeding and swimbladders not inflated

x. Confirmation that temperature change was <3°C and dissolved oxygen was maintained at >6mg/L during transport
- Temperature change was <2°C and dissolved oxygen supersaturated mg/L during transport

xi. Test organism acclimation rate at the testing laboratory
- For both tests: Organisms were received on the day of set-up
- Organisms were received in holding water conditions of DO=supersaturated, pH = 7.3, T = 21°C, salinity = 33ppt
- Organisms were acclimated to EVS water holding conditions of DO = 7.5 mg/L, pH = 7.8, T=20°C salinity = 28-29ppt,
- Acclimation was conducted in the lab on the day of the test by adding lab seawater at approximately 30 min. intervals. The differences between the water quality upon receipt and EVS holding conditions were minor.

Test Facilities and Conditions

i. Test type & method
- 7-day Topsmelt (*Atherinops affinis*) Survival and Growth Toxicity Test
- Static renewal
- Sample water was renewed daily
- Reference Method - EPA/600/R-95/136 (EPAW 95-EPA West Coast)

ii. Dates or test days during test when subsamples or multiple samples were renewed
- Samples were renewed daily for all tests (Test Day 1,2,3,4,5,6)
- Three subsamples were used on days i) 0-1; ii) 2-3; and iii) 4-5-6-7

iii. Indications of deviations from requirements in Sections 11 of Method EPA/600/R-95/136 (EPAW 95-EPA West Coast)
- No deviations from requirements
- Salinity controls were run
- Sample water salinity for
    - Test 1 was 6 ppt
    - Test 2 was 1.0 ppt

iv. Date and time for start of definitive test
- Test 1 Tuesday July 19, 2005 – 1430h
- Test 2 Tuesday August 9, 2005 – 1500h

v. Date for test completion
- Test 1 July 26, 2005
- Test 2 August 16, 2005

vi. Test vessel description
- For all tests was a 600mL beaker

vii. Person(s) performing the test and verifying the results
- Test 1: Testing and overall setup conducted by: Jenny Shao and QA/QC by: Julianna Kalokai
- Test 2: Testing and overall setup conducted by: Jenny Shao and QA/QC by: Julianna Kalokai

viii. pH, temperature, dissolved oxygen, and conductivity of unadjusted, undiluted effluent
- Test 1: pH 7.7, T 20.0 °C, DO 11.1 mg/L, C 1520 µmhos/cm
- Test 2: pH 7.7, T 20.0 °C, DO 9.8 mg/L, C 2700 µmhos/cm

ix. Confirmation that no adjustment of sample or solution pH occurred
- For both tests, no pH adjustment

x. Indication of aeration of test solutions before introduction of fish
- For both tests, no pre-aeration was conducted, none was required

xi. Indication that EC guidance document for salinity adjustment was followed
- The following was done for all 3 tests:
    - No deviations from EC guidance document on preparation of hypersaline brine (HSB)
    - HSB prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
    - No deviations from EC guidance document for salinity adjustment of sample
    - HSB was added to samples to salinity adjust them to ~30ppt
    - For a 200mL volume the concentrations were prepared by adding:
        - Test 1: 143mL of effluent + 57mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).
        - Test 2: 135mL of effluent + 65mL of HSB for the highest concentration. This solution was then diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions).

xii. Type and source of control/dilution water
- For all 3 tests, control/dilution water was UV-sterilized, 0.45μm-filtered natural seawater from the Vancouver Aquarium

xiii. Concentrations and volumes tested:
- Concentrations (% effluent volume / total volume) tested and total volumes used were:
- For Test 1:
    - Control (0%) - 200 mL
    - Salinity Control (0%) - 200 mL
    - 4.5% - 200mL
    - 8.9% - 200mL
    - 17.9% - 200mL
    - 35.7% - 200mL
    - 71.4% - 200mL
- For Test 2:
    - Control (0%) - 200 mL
    - Salinity Control (0%) - 200 mL
    - 4.2% - 200mL
    - 8.4% - 200mL
    - 16.9% - 200mL
    - 33.7% - 200mL
    - 67.4% - 200mL

xiv. Number of replicated per concentration
- For both tests: 5 replicates per concentration

xv. Number of organisms added to each test vessel
- For both tests: 5 fish per vessel

xvi. Manner and rate of exchange of test solutions
- For both tests: Daily renewal

xvii. Measurements of dissolved oxygen, pH and temperature, and salinity for each 24 hr period

- Test 1: See attached photocopied pages 1 and 2 of original laboratory report
- Test 2: See attached photocopied pages 3 and 4 of original laboratory report

Results

i. Number and % of mortalities of fish in each test solution. Note that this data is presented in units of number of SURVIVORS and % MORTLITY. (Data is entered from original handwritten tables in lab reports)

- Test 1: Totals from all 5 replicates are presented:

Concentration		Number of Survivors - Day of Test							% Mortality on the Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Brine	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Control	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
4.5%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
8.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
17.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
35.7%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
71.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0

- Test 2: Totals from all 5 replicates are presented:

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0

Concentration		Number of Survivors - Day of Test							% Mortality - Day of Test						
(% effluent v/v)	Replicate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
	B	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
Brine	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
Control	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	4	4	4	4	3	0	0	20	0	0	0	20
4.2%	A	5	5	4	4	4	4	4	0	0	20	0	0	0	20
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	4	4	4	4	4	4	0	20	0	0	0	0	0
	E	5	4	4	4	4	4	4	0	20	0	0	0	0	0
8.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	D	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
16.9%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	4	4	4	4	4	0	0	20	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	4	4	4	4	3	0	0	20	0	0	0	20
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20
33.7%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	C	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	D	5	5	4	4	4	4	4	0	0	20	0	0	0	0
	E	5	5	5	5	5	5	5	0	0	0	0	0	0	0
67.4%	A	5	5	5	5	5	5	5	0	0	0	0	0	0	0
	B	5	4	4	4	4	4	4	0	20	0	0	0	0	0
	C	5	5	5	5	5	5	3	0	0	0	0	0	0	40
	D	5	5	5	5	5	5	4	0	0	0	0	0	0	20
	E	5	5	5	5	5	5	4	0	0	0	0	0	0	20

ii. Average dry weight (mg) per original fish in test vessel. No preservation of fish was used. Fish were dried and then weighed.

- Test 1: Mean dry weight (mg) of each replicate and overall means are presented:

Concentration	Replicate					Overall Mean	Standard Deviation
(% effluent v/v)	1	2	3	4	5		
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060	0.9160	0.1284
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900	0.9824	0.1775
4.5	0.7320	0.6840	0.9000	0.5200	1.0080	0.7688	0.1903
8.9	1.0120	1.1320	0.9960	0.5400	0.3960	0.8152	0.3253
17.9	0.9600	1.0280	0.9220	1.2440	0.9020	1.0112	0.1387
35.7	0.8420	1.2900	1.2400	0.9640	0.9900	1.0652	0.1916
71.4	1.2300	0.6620	0.9660	1.1000	0.5680	0.9052	0.2828

- Test 2: Mean dry weight (mg) of each replicate are presented:

Concentration	Replicate						
(% effluent v/v)	1	2	3	4	5	Overall Mean	Standard Deviation
D-Control	0.8000	0.6080	1.0980	0.7760	0.5640	0.7692	0.2105
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620	0.9140	0.1155
4.2	0.8120	0.9280	0.9700	1.0420	0.5720	0.8648	0.1837
8.4	0.8980	0.8560	0.7120	1.0200	1.0200	0.9012	0.1285
16.9	0.9820	0.8880	0.6860	0.5780	0.6420	0.7552	0.1718
33.7	0.7260	0.9700	0.7060	0.6300	0.7240	0.7512	0.1284
67.4	1.0340	0.8380	0.6120	0.8640	0.7040	0.8104	0.1615

iii. Estimate of 7-d LC_{50} (95% CL)

- Test 1: 7-d LC_{50} concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d LC_{50} concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

iv. Estimate of 7-d IC_{25} (95% CL) for growth

- Test 1: 7-d IC_{25} concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d IC_{25} concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)

v. Current reference toxicity tests (95% CL) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1 :Reference toxicity tests for Toxicant: Copper
    - Test conducted on July 19, 2005, same day as effluent test
    - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
    - 7-d LC_{50} survival = 117 mg/L Cu, 95% CL = 100-136 mg/L
    - 7-d IC_{50} growth = 116 mg/L Cu, 95% CL = 81-156 mg/L
- Test 2 :Reference toxicity tests for Toxicant: Copper
    - Test conducted on August 9, 2005, same day as effluent test
    - Reference toxicant test was conducted on the same batch of externally supplied topsmelt used in the effluent test and under the same experimental conditions as the effluent test
    - 7-d LC_{50} survival = 103 mg/L Cu, 95% CL = 91-118 mg/L
    - 7-d IC_{50} growth = 95 mg/L Cu, 95% CL = 75-127 mg/L

vi. Reference toxicity warning limits (+/- SD) for 7-d LC_{50} for survival and 7-d IC_{50} for growth

- Test 1: Reference toxicity tests for Toxicant: Copper
    - 7-d LC_{50} survival = 133 ± 39mg/L Cu
    - 7-d IC_{50} growth = 132 ± 46mg/L Cu
- Test 2: Reference toxicity tests for Toxicant: Copper
    - 7-d LC_{50} survival = 132 ± 40mg/L Cu,
    - 7-d IC_{50} growth = 133 ± 40mg/L Cu

APPENDIX D

92-h Echinoderm Fertilization Test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 4 x 20L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

x. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek_Sublethal_071605
   - Test 2 – Garrow Creek

xi. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1045h
     Test 2 – Tuesday August 9, 2005 – 1015h

xii. Temperature upon sample receipt at laboratory
   - Test 1 – 12.7 °C
   - Test 2 – 19.0 °C

Test Organisms

i. Species of test organism
   - Sandollar Echinoid (*Dendraster excentricus*)

ii. Name and city of testing laboratory
   - EVS Environment Consultants, North Vancouver, BC

iii. Source of test species
   - Westwind Sealab, Victoria BC
   - All adults providing gametes are from the same population and source
   - Gametes are spawned in-house at EVS

iv. Date test species acquired on
   - Test 1: July 19, 2005
   - Test 2: August 9, 2005

v. Holding time and conditions for adults
   - Test 1: Adults received at the testing laboratory the day of the test.
   - Test 2: Adults received at the testing laboratory the day of the test.

vi. Indications of deviations from EC guidance on the importation of test organisms
   - Test 1: No deviations from EC requirements
   - Test 2: No deviations from EC requirements

vii. Weekly percent mortality of adults being held over 7d preceding test

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- Test 1: <2% per day over the 7 days preceding the test
- Test 2: <2% per day over the 7 days preceding the test

viii. Age of test organisms
- Test 1: < 4 hours after spawning
- Test 3: < 4 hours after spawning

ix. Unusual appearance, behaviour, or treatment of adults or gametes before test start, or anything unusual about the test
- Test 1: Organisms appear healthy, in good condition, nothing unusual about test organisms or test
- Test 2: Organisms appear healthy, in good condition, nothing unusual about test organisms or test

Test Facilities and Conditions

i. Test type & method
- Echinoderm (*Dendraster excentricus*) Fertilization Toxicity Test
- Static
- Reference Method – EPS/1/RM/27 with 1997 amendments

ii. Test duration
- Test 1: 10:10 min (10min sperm + 10min sperm & egg)
- Test 2: 10:10 min (10min sperm + 10min sperm & egg)

iii. Date and time for start of definitive test
- Test 1: Tuesday July 19, 2005 – 1514h
- Test 2: Tuesday August 9, 2005 – 1723h

iv. Test vessel description
- Test 1: 16 x 125mm test tubes
- Test 2: 16 x 125mm test tubes

v. Person(s) performing the test and verifying the results
- Test 1: Testing by Shawn Seguin; QA/QC reviewed by Julianna Kalokai.
- Test 2: Testing by Shawn Seguin; QA/QC reviewed by Julianna Kalokai.

vi. Indication of rate and duration of pre-aeration of test solutions before initiation of test
- Test 1: No pre-aeration
- Test 2: No pre-aeration

vii. Confirmation that no adjustment of sample or solution pH occurred
- Test 1: No pH adjustment
- Test 2: No pH adjustment

viii. Procedure for sample filtration
- Test 1: No sample filtration
- Test 2: No sample filtration

ix. Procedure for preparation of hypersaline brine (HSB) as per EC guidance document on salinity adjustment – July 1997

- Test 1: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.28mL of effluent + 2.72mL of HSB for the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.
- Test 2: Hypersaline brine (HSB) was prepared from natural seawater concentrated to 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine). HSB was added to samples to salinity adjust them to 30ppt. For a 10mL volume the concentrations were prepared by adding 7.13mL of effluent + 2.87mL of HSB for

the highest concentration. This solution was diluted using natural seawater for the lower test concentrations (i.e., 50% of the highest concentration + 50% of the dilution water, repeated for subsequent dilutions). No deviations from EC guidance document (July 1997) for salinity adjustment of sample.

x. Procedure for salinity adjustment as per EC guidance document on salinity adjustment – July 1997
- No deviations from EC guidance for salinity adjustment
- Test 1: salinity adjusted from 3.0 to 28 ppt
- Test 2: salinity adjusted from 1.0 to 29 ppt

xi. Type and source of control/dilution water
- Test 1: UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium
- Test 2: UV-sterilized, 0.45µm-filtered natural seawater from the Vancouver Aquarium

xii. Concentrations and volumes tested
- Test 1: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.6% - 10mL
    - 9.1% - 10mL
    - 18.2% - 10mL
    - 36.4% - 10mL
    - 72.8% - 10mL
- Test 2: Concentrations (% effluent volume / total volume) tested and total volumes used were:
    - Control (0%) - 10mL
    - Salinity Control (0%) - 10mL
    - 4.5% - 10mL
    - 8.9% - 10mL
    - 17.8% - 10mL
    - 35.6% - 10mL
    - 71.3% - 10mL

xiii. Number of replicated per concentration
- Test 1: 4 replicates per treatment concentration
- Test 2: 4 replicates per treatment concentration

xiv. Number of organisms per container
- Test 1: 2000 eggs per vessel (100 counted)
- Test 2: 2000 eggs per vessel (100 counted)

xv. Measurements of pH and dissolved oxygen in sample water before use
- Test 1: pH 8.2, DO 8.5
- Test 3: pH 8.3, DO 8.5

xvi. Measurements of pH, temperature, dissolved oxygen, and salinity during test
- Test 1: pH – 7.9 – 8.3, T - 15.0°C, DO - 8.5mg/L, salinity - 28ppt
- Test 2: pH – 7.5 – 8.4, T - 15.0°C, DO – 7.8 – 8.5mg/L, salinity - 29ppt

Results

i. Number and % of fertilized eggs in each test concentration
- Test 1: (Number is equal to percent since totals were 100)
    - Control (0%): # Fert = 64, 60, 66, 69
    - 4.6%: # Fert = 56, 51, 52, 53
    - 9.1%: # Fert = 39, 37, 37, 36
    - 18.2%: # Fert = 33, 28, 29, 30
    - 36.4%: # Fert = 39, 39, 37, 36

Reporting Requirements for Reference Method EPS1/RM/27-EC 92 (Sperm Cell)

- 72.8%: # Fert = 20, 16, 21, 21

- Test 2: (Number is equal to percent since totals were 100)
  - Control (0%): # Fert = 88, 81, 85, 86
  - Salinity Control: # Fert = 91, 86, 85, 87
  - 4.5%: # Fert = 82, 80, 79,78
  - 8.9%: # Fert = 76, 77, 77, 76
  - 17.8%: # Fert = 64, 59, 63, 61
  - 35.6%: # Fert = 50, 54, 54, 53
  - 71.3%: # Fert = 37, 40, 37,35

ii. Estimate of IC_{25} (95% CL) for fertilization success

- Test 1: IC_{25} concentration = 5.2 (4.4 – 6.0)% v/v effluent
- Test 2: IC_{25} concentration = 15.6 (13.6 – 18.3)% v/v effluent
- Quantitative statistic used to generate IC_{25} values was log-linear interpolation (200 resamples) calculated in ToxCalc v5.0.23 (for both Test 1 and Test 2)

iii. Current reference toxicity tests (95% CL) for IC_{50} for fertilization

- Test 1: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on July 19, 2005, same day as effluent test
  - Reference test conducted under same conditions
  - IC_{50} for fertilization = 5.8 mg/L SDS, 95% CL = (5.2 – 6.5)mg/L
- Test 2: Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test conducted on August 9, 2005, same day as effluent test
  - Reference test conducted under same conditions
  - IC_{50} for fertilization = 3.9 mg/L SDS, 95% CL = (3.6 – 4.1) mg/L

iv. Reference toxicant warning limits (+/- 2SD) for IC_{50} for fertilization

- Test 1: 3.6 +/- 4.4 mg/L SDS
- Test 2: 3.9 +/- 4.3 mg/L SDS

APPENDIX E

7-d Sublethal *Champia* (Algae) Toxicity Test

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

Effluent Sample

i. Name & location of operation generating the effluent
   - Polaris Mine, Little Cornwallis Island, Nunavut
   - Final Discharge Point for Garrow Lake is geo referenced as 75° 22' 32" N, 97° 48' 37" W.

ii. Date & time of sampling
   - Samples for yearly sublethal toxicity testing were collected:
     Test 1 – Saturday July 16, 2005 – 0900h
     Test 2 – Saturday August 6, 2005 – 1000h

iii. Type of sample
   - Final effluent water

iv. Brief description of sampling point
   - 20m downstream of the siphon discharge point at Garrow Lake dam

v. Sampling method
   - Water was collected from at least 15cm below the surface using a water pump with silicon tubing
   - Water was collected from the upstream direction
   - The pump was flushed with site water for at least one minute prior to sample collection
   - 1 x 4L sample bottles were filled

vi. Name of person submitting samples
   - Blake Hamer (Gartner Lee) Tests 1
   - Brenda Bolton (Gartner Lee) Test 2

vii. Temperature of water upon receipt at lab
   - Test 1: 18°C
   - Test 2: 22°C

xiii. Labeling/coding of sample (Sample IDs)
   - Test 1 – G-Creek Sublethal 071605
   - Test 2 – Garrow Creek

xiv. Date & time of sample receipt
   - Samples for sublethal toxicity testing were received:
     Test 1 – Tuesday July 19, 2005 – 1300h
     Test 2 – Tuesday August 9, 2005 – 0900h

Test Organisms

i. Species of test organism
   - Algae (*Champia parvula*)

ii. Name and city of testing laboratory
   - Test 1: Stantec Consulting Ltd, Guelph Ontario
   - Saskatchewan Research Council [SRC], Saskatoon, SK

iii. Source of test species and health of organisms
   - Test 1
     - Source was Stantec in-house culture
     - Batch number CH05-07
     - Sexually mature male and female branches
     - Females have trichogynes, males have sori with spermatia
     - No organisms exhibiting unusual appearance, behaviour or undergoing unusual treatment were used in the test
   - Test 2
     - Sexually mature male and female branches
     - Obtained from USEPA, Hatfield Marine Science Center, Newport Oregon, 1995
     - Appear in excellent health, nothing unusual

- Females have trichogynes, males have sori with spermatia

iv. Any unusual appearance, behaviour, or treatment of test organisms, before their use in test
- Test 1 and Test 2
  - Nothing unusual about the appearance, behaviour, or treatment of test organisms, before their use in test; everything is normal
  - Nothing unusual about the tests

Test Facilities and Conditions

i. Test type & method
- Test 1:
- Test of Sexual Reproduction using the Red Macroalga *Champia parvula*, EPA-821-R-02-014, October 2002 Method 1009.0, with Canadian adaptations (Environment Canada 1998, 1999)
- Static, non-renewal
- 48-hour exposure, followed by 7 day recovery period for cystocarp development
- Test 2:
- Test of Sexual Reproduction using the Red Macroalga *Champia parvula*, Reference Method - EPA/600/4-91/003, Method 1009.0
- Static, non-renewal
- 2 day exposure, followed by 5-7 day recovery period for cystocarp development

ii. Date and time for start of definitive test
- Test 1: Tuesday July 19, 2005 17:45h
- Test 3: Tuesday August 9, 2005 – time not noted but lab notes state tests started within 72 hrs of collection

xviii. Date for test completion
- Test 1 – July 28, 2005
- Test 2 – August 16, 2005

iii. Test vessel description
- Test 1: 270mL transparent polystyrene cups with polystyrene lids
- Test 2: 270mL transparent polystyrene cups with polystyrene lids

iv. Person(s) performing the test and verifying the results
- Test 1: E. Jonczyk/ K. Johnson
- Tests 2: Mary Moody

v. Indication of pre-aeration of test solutions
- Test 1: No pre-aeration
- Test 2: No pre-aeration

vi. Confirmation that no pH adjustment of sample or solution occurred
- Test 1: No pH adjustment
- Test 2: - No pH adjustment

vii. Indication that EC guidance document for salinity adjustment was followed
- Test 1:
  - No deviations from EC guidance document on preparation of hypersaline brine (Environment Canada Salinity Adjustment Guidance Document, revised Dec. 2001)
  - HSB prepared from natural seawater at 90ppt (by filtering to at least 10 μm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
  - No deviations from EC guidance document for salinity adjustment of sample
  - Salinity adjustment (for a 1000mL volume): 660mL effluent + 330mL HSB + 10mL test nutrient solution

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

- Salinity of samples adjusted from 0ppt to 32ppt
- Test 2:
  - No deviations from EC guidance document on preparation of hypersaline brine (May 2001)
  - HSB prepared from natural seawater at 90ppt (by filtering to at least 10 µm before placing it into the freezer and then freezing/refreezing to remove frozen layer and concentrate salts in the hypersaline brine)
  - No deviations from EC guidance document for salinity adjustment of sample
  - Salinity adjustment: 600mL effluent + 260mL HSB + 8.6 ml test nutrient solution

Salinity of samples adjusted from 2ppt to 30ppt

viii. Type and source of control/dilution water
- Test 1:
  - Natural seawater collected from Pointe-du-Chene in Shediac Bay, New Brunswick.
  - No chemicals added.
  - Filtered to 0.45µm prior to use
- Test 2
  - Natural seawater collected at the Pacific Environmental Center, Environment Canada, North Vancouver, BC
  - Filtered to 0.2µm and autoclaved prior to use
  - Salinity adjusted as per EC guidance document to 30ppt with HSB from the same source

ix. Type and quantity of any chemicals added to the control dilution water
- Test 1: No chemicals added to dilution water. 10 mL of test nutrients.
- Test 3: No chemicals added. Test nutrients as described in Test Method USEPA/600/4-91/003, Method 1009.0 were added at concentration of 10mL/L, analytical grade, 8.6 mL added

x. Concentrations and volumes of test solutions
- Concentrations (% effluent volume / total volume) tested and total volumes used were:

- Tests 1:
  - Control (Natural Seawater) (0%) - 100mL
  - Salinity Control Brine (0%) - 100mL
  - 2.1% - 100mL
  - 4.4% - 100mL
  - 8.3% - 100mL
  - 16.5% - 100mL
  - 33% - 100mL
  - 66% - 100mL
- Tests 2:
  - Control (Natural Seawater) (0%) - 100mL, 4.5cm depth
  - Salinity Control Brine (0%) - 100mL, 4.5cm depth
  - 4.38% - 100mL, 4.5cm depth
  - 8.75% - 100mL, 4.5cm depth
  - 17.5% - 100mL, 4.5cm depth
  - 35% - 100mL, 4.5cm depth
  - 70% - 100mL, 4.5cm depth

xi. Number of replicates per concentration
- Tests 1& 2: 3 replicates per concentration

xii. Number of organisms per test chamber
- Tests 1 & 2: 5 female branches + 2 male branches per chamber

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

xiii. Measurements of pH, temperature, dissolved oxygen, and salinity of sample before use
- Test 1 (unadjusted effluent): pH – 8.0, T – 22.0 °C, DO – 10.2mg/L, salinity - 0ppt
- Test 1 (before use): pH – 8.0, T – 22.5 °C, DO – 7.0mg/L, salinity - 32ppt
- Test 2 (unadjusted sample): pH - 7.75, T – 23.0 °C, DO – 8.6mg/L, salinity - 2ppt
- Test 2 (before use): pH – 8.35, T – 23.0 °C, DO – 7.6mg/L, salinity - 30ppt

xiv. Measurements of pH, temperature, dissolved oxygen, and salinity of test solution and controls at 0hr, 48hr, and the beginning and end of recovery period
- Test 1: See attached photocopied page 5 of original laboratory report
- Test 2: See attached photocopied pages 6 of original laboratory report

Results

i. Number and % mortality of female plants after recovery in each test solution
- Totals from all 3 replicates are presented:
- Test 1:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 2.1%: 0 (0%) mortality
  - 4.4%: 0 (0%) mortality
  - 8.3%: 0 (0%) mortality
  - 16.5%: 0 (0%) mortality
  - 33%: 0 (0%) mortality
  - 66%: 0 (0%) mortality
- Test 2:
  - Control (0%): 0 (0%) mortality
  - Salinity Control (0%): 0 (0%) mortality
  - 4.38%: 0 (0%) mortality
  - 8.75%: 0 (0%) mortality
  - 17.5%: 0 (0%) mortality
  - 35%: 0 (0%) mortality
  - 70%: 0 (0%) mortality

ii. Mean number of cystocarps per plant in each replicate of each test concentration
- Test 1: (Replicates are A, B, and C)
  - Control (0%): A) 26.8, B) 27.2, C) 26.4
  - Salinity Control (0%): A) 27.6, B) 27.4, C) 28.4
  - 2.1%: A) 29.4, B) 29.0, C) 30.0
  - 4.4%: A) 26.2, B) 26.8, C) 27.4
  - 8.3%: A) 27.6, B) 27.2, C) 28.0
  - 16.5%: A) 25.4, B) 26.4, C) 26.6
  - 33%: A) 18.4, B) 15.0, C) 18.4
  - 66%: A) 0.4, B) 0.2, C) 0.2
- Test 2: (Replicates are A, B, and C)
  - Control (0%): A) 104.0, B) 74.2, C) 79.6
  - Salinity Control (0%): A) 103.8, B) 84.6, C) 99.0
  - 4.38%: A) 89.8, B) 70.0, C) 82.6
  - 8.75%: A) 86.6, B) 98.4, C) 93.6
  - 17.5%: A) 95.6, B) 94.0, C) 88.4
  - 35%: A) 91.8, B) 88.8, C) 67.2
  - 70%: A) 35.0, B) 36.6, C) 28.4

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 (*Champia*)

iii. Estimate of IC_{25} (95% CL) for cystocarp development

- Test 1: IC_{25} concentration = 24.6 (22.2 – 27.2)% effluent v/v
- Quantal statistic method was linear interpolation determined using ToxStat 3.5
- Test 2: IC_{25} concentration = 45.3 (27.5 – 52.4)% effluent v/v
- Quantal statistic method was linear interpolation (200 resamples) determined using ToxCalc v5.0.23

iv. Current reference toxicity tests (95% CL) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
  - Test 1: Test conducted on July 19, 2005, same day as effluent test
    - Reference toxicant test was conducted under the same experimental conditions as the effluent test
    - IC_{50} cystocarp development = 0.134 mg/L SDS, 95% CL = (0.123 – 0.143) mg/L
  - Test 2: Test conducted on August 17, 2005, within 30 days of effluent test
    - Reference toxicant test was conducted under the same experimental conditions as the effluent test
    - IC_{50} cystocarp development = 1.31mg/L SDS, 95% CL = (1.20 - 1.41) mg/L

v. Reference toxicant warning limits (+/- 2SD) for IC_{50} for cystocarp development

- Reference toxicity tests for Toxicant: Sodium Dodecyl Sulfate
- Test 1: 0.155 (0.112 – 0.216) mg/L SDS
- Test 2: 1.41 (1.15 – 1.74) mg/L SDS

Pages 1 to 6 inclusive are included in the hardcopy sent in the mail. This data can also be found in the original lab reports in Appendix H.

APPENDIX F

Results of Effluent Characterization as per Paragraph 15(1)(a)

RESULTS OF EFFLUENT CHARACTERIZATION

AS PER PARAGRAPH 15(1)(a)

Nine MMER effluent samples were collected during the 3nd Quarter of 2005 between July 6, 2005 and August 27, 2005. "Quarterly" EEM samples were collected from the effluent, exposure, and reference stations on July 16, 2005 and August 6, 2005 and analyzed for a wider suite of elements, as per the guidance document. Monthly loadings of metals to Garrow Bay were calculated based on average weekly discharge volumes from Garrow Lake to Garrow Bay via the creek outflow. The August 6, 2005 effluent volume discharge is estimated and will be finalized by Teck Cominco.

Holding times for nitrate and alkalinity were missed during the July 6, 2005 event due to an oversight by the laboratory. The oversight is explained in Appendix I and is not likely to influence results. A quarterly event with toxicity testing was planned for this event; however, due to a delay in shipment because of weather conditions at the mine site, toxicity samples missed holding times and were discarded at the labs. The parameters that missed holding times were "quarterly" parameters, and additional measurements were taken on July 16, 2005, corresponding to acute and sublethal toxicity testing.

Due to the high Arctic, remote location of the mine, travel into or out of the mine site can be hazardous due to weather conditions such as fog and snow. As the mine has ceased operations and little infrastructure exists onsite, sampling this season was conducted by small field crews stationed onsite, or by flying technicians in on a weekly basis to collect the MMER samples. In August and September, several planned MMER sampling attempts did not proceed due to hazardous weather conditions that prevented flights from getting into the mine site or from departing Resolute Bay. MMER samples were collected at the next possible time, and Ken Russell and Jenny Ferone were kept informed of this situation. The 2005 sampling chronology is presented in Appendix I. The last sample was collected on August 27, 2005. After this event, the mine was inaccessible due to weather until September 13, 2005, when Garrow Creek (final discharge point) was frozen with no discharge.

There were no exceedances of any Schedule 4 discharge limits during the quarter.

Water samples for acute and sublethal toxicity testing were collected using a pump system from about 20 m downstream of the historic dam location on Garrow Lake, within the main flow of the creek. Acute Lethality Testing was conducted on samples collected July 16, 2005 and August 6, 2005. There were no adverse effects observed for either the 96-hr Rainbow Trout toxicity test, or the 48-hr *Daphnia magna* toxicity test. LC_{50} values were >100% effluent for both species in all testing events.

Sublethal Toxicity Testing was conducted on samples collected July 16, 2005 and August 6, 2005. As this is considered a marine discharge, marine species were used for sublethal testing following brine adjustment of the brackish effluent (as per EC test protocols). Testing for fish (7-d Topsmelt growth and survival) and invertebrates (Sand dollar) was conducted at EVS Environment Consultants, Vancouver, BC, while algae (48-h *Champia*) testing was undertaken at Stantec Guelph, ON, for the July test, and at the Saskatchewan Research Council, Saskatoon SK, for the August test.

There were no effects observed in the Topsmelt Survival and Growth Test at the highest concentrations tested (>71.4%, and >67.4% effluent v/v).

Sublethal effects were observed for the echinoid and algal species in both tests. In the echinoid *(Dendraster excentricus)* fertilization test,

- the IC_{25}'s were 5.2, and 15.6% v/v, and
- the IC_{50}'s were 13.2, and 55% v/v

In the *Champia parvula* sexual reproduction test

- the IC_{25}'s were 24.6, and 45.3% v/v,
- the IC_{50} was 61.4% v/v in the second test (not reported in the first test).

Zinc is the primary contaminant of potential concern (COPC) identified in mine effluent. Concentrations of zinc during 2005 averaged 39 µg/L and ranged between 13 and 91 µg/L, which are well below the MMER effluent limit of 500µg/L. These concentrations are also lower than those measured in 2003, 128µg/L (range 48 – 186µg/L), and in 2004, 72 µg/L (range 35 – 198 µg/L), and show a decreasing pattern over the last three years. Note the CCME guideline for zinc is 30 µg/L and the BC AWQG guidelines are 7.5 and 33 µg/L, for the chronic and acute guidelines, respectively. Concentrations of zinc in Polaris mine effluent were not substantially higher than these guidelines in 2005.

On July 16, 2004 and August 6, 2005, the concentrations of zinc in the effluent were 17.9 and 35.6 µg/L, respectively. The echinoid test endpoints converted into concentrations of zinc results in values of 0.93 and 5.5 µg Zn/L for the IC_{25}'s, and 2.4 and 19.6 µg Zn/L for the IC_{50}. Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC_{50} concentrations of 8.5 – 60 µg Zn/L (Dinnel et al. 1983). The reported range of *Dendratster* EC_{50}'s correspond to the August 6, 2005 IC_{50} of 19.6 µg Zn/L. The IC_{50} zinc concentration in the July 16, 2005 sample is lower than the literature EC_{50}'s and may indicate that other substances in the effluent were contributing to the sublethal effects in this sample. The echinoid test is quite sensitive to zinc, with IC25 (converted) zinc concentrations being less than the BC AWQG chronic guideline of 7.5 µg/L.

Endpoints for the *Champia* test in terms of zinc concentrations were 4.4 and 16.1 µg Zn/L (IC_{25}'s), and 21.9 µg Zn/L (IC_{50} in the August 6, 2005 sample). The reference IC_{25} endpoint for zinc in the *Champia* test performed in-house at SRC, reported in 2003, was 27 µg Zn/L (95% confidence limits 16-42µg/L). This reference concentration is similar to the zinc concentrations corresponding to the IC25 an IC50 in the August 6, 2005 sample. Like the echinoid results, the IC25 converted zinc concentration in the July 16, 2005 sample was lower than reference endpoints and may indicate that other substances in this sample were contributing to toxicity. *Champia* also appears to be sensitive to zinc concentrations between the BC AWQG chronic guideline of 7.5 µg/L and maximum guideline of 33 µg/L.

Given the similarity between zinc concentrations in the effluent samples and the effects concentrations of zinc in reference tests, it is likely that zinc is responsible for the sublethal effects observed in both the *Dendraster* and *Champia* tests.

Reference: Dinnel, P.A., Q.J. Stober, J.M. Link, M.W. Letourneau, W.E. Roberts, S.P. Felton, and R.E. Nakatan. 1983. Methodology and Validation of a Sperm Cell Toxicity Test for Testing Toxic Substances in Marine Waters. Final Report, FRI-UW-8306, Fisheries Research Inst., School of Fisheries, University of Washington, Seattle, WA :208. Source: EPA EcoTox database.

APPENDIX G

Acute Toxicity Testing Laboratory Reports

EVS environment consultants

A member of the Golder group of companies

Golder Associates

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

E/05/0336
04-1424-044

August 17, 2005

Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Attention: Ms. Cheryl Mackintosh

RE: WORK ORDERS: 0500296, 297
TOXICITY TEST RESULTS ON THE SAMPLES COLLECTED JULY 16, 2005

Dear Ms. Mackintosh

We are pleased to provide you with the results of the toxicity tests performed on the effluent sample identified as G-Creek-acute-071605 collected July 16, 2005. The sample was tested with the 48-h *Daphnia magna* and the 96-h rainbow trout LC50 toxicity tests. The tests were performed according to the Environment Canada protocol for conducting acute toxicity tests using *D. magna* (EPS 1/RM/14, Second Edition, 2000) and rainbow trout (EPS 1/RM/13, Second Edition, 2000). An independent EVS/Golder QA/QC review confirmed that all acceptability criteria specified by the protocol were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Yours very truly,
EVS ENVIRONMENT CONSULTANTS
A Member of the Golder Group of Companies

for Jennifer Young, B.Sc.
Bioassay Team Leader – Cladoceran Team

Verified By:

QA/QC Committee:
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.

Attachment: Table 1
RH/clz
O:\Data\Final\2004\1424\04-1424-044\LET 0817 2005 Tox Test WO 0500296 297 1.doc

Table 1
Toxicity Test Results

SAMPLE ID	SAMPLE DATE	48h *Daphnia magna* LC50 (95% CL) % (v/v)	96-h Rainbow Trout - LC50 (95% CL) % (v/v)
G-Creek-Acute-071605	July 16, 2005	>100	>100

CL – confidence limits.

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500297
EVS Analysts: SXB
Test Type: 48h LC50
Test Initiation Date: 19 July 05

SAMPLE INFORMATION

Identification: G-Creek-Acute-071605
Amount Received: 1x2L Subsampled from 1x20L RBT
Date Collected: 16 July 05
Date Received: July 19, 2005
Temperature (°C): 21.0
pH: 7.3 ① 7.4
Dissolved Oxygen (mg/L): 10.8 ① 8.9
Conductivity (µmhos/cm): 1566
Hardness (mg/L as $CaCO_3$): 160
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

pH adjustment details: —
① Pre-aeration rate and duration: 12 min @ 25-50 mL/min/L

DILUTION/CONTROL WATER (initial water quality)

Water Type: moderately Hard water (July13B)
Temperature (°C): 20.0
pH: 7.6
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 344
Hardness (mg/L as $CaCO_3$): 94
Alkalinity (mg/L as $CaCO_3$): 64
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): 05 July A/B
Age (on Day 0): < 24hr
Days to First Brood: 8
Avg. Young/Brood (after 1st brood): 34
% Mortality in 7 d Before Test: 0
Reference Toxicant: Zinc
Current Reference Toxicant Result
Reference Toxicant Test Date: July 19, 2005
48-h LC50 and 95% CL: 426 (362-504) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 mg/L Zn ; CV = 31

TEST CONDITIONS

Temperature Range (°C): 20.0 - 21.0
pH Range: 7.4 - 7.7
Dissolved Oxygen Range (mg/L): ~~5~~ 8.7 - 9.1
Conductivity Range (µS/cm): 344 - 1566
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48hr LC50 of G-Creek-Acute-071605 is >100% (V/V).

Data Verified By: [signature]
Date Verified: Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth
Sample ID: G-Greek-Acute-071605
EVS Project No.: 04-1424-044
Date Collected: 16 July 05
EVS Work Order No.: 0500297
Test Initiation Date/Time: 19 July 05 @ 16:00
Daphnid Broodstock Batch: 05 July A/B
No. Organisms/Volume: 10/200 ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.1	8.7	8.7	20.0	21.0	21.0	7.6	7.5	7.6	344	344
6.25				10	10	9.1	8.8	8.7	20.0	21.0	21.0	7.6	7.5	7.6	426	425
12.5				10	10	9.0	8.8	8.7	20.0	21.0	21.5	7.6	7.5	7.7	505	506
25				10	10	9.0	8.7	8.7	20.5	21.0	21.5	7.6	7.5	7.7 SK2	648	647
50				10	10	~~8.8~~ 9.0	8.7	8.7	20.5	21.0	21.0	7.4	7.5	7.7	958	944
100				10	10	8.9	8.7	8.7	21.0	21.0	21.5	7.4	7.4	7.5	1566	1532
Technician Initials					TL	SXB	SXB	TL	SXB	SXB	TL	SXB	SXB	TL	SXB	TL

Sample Description: clear - colourless
WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-020501 DO II-A-011201 Cond. IIA-990901
Comments:

Test Set Up By: SXB Data Verified By: [signature] Date Verified: Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth
Golder ~~EVS~~ RGH Project No.: 04-1424-044
EVS Work Order No.: OS00296

EVS Analysts: MJG, RGH
Test Type: 96-h LC50
Test Initiation Date: July 21/05 @ 1035

SAMPLE
Identification: G-Creek 071605 Acute
Amount Received: 2 x 20L
Date Collected: July 16/05
Date Received: July 19/05
Other:

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15
pH: 7.0
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 37
Hardness (mg/L as $CaCO_3$): 14
Alkalinity (mg/L as $CaCO_3$): 8
Other: -

TEST SPECIES INFORMATION
Source: Sun Valley
Collection Date/Batch: 062205
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: July 25/05
Fork Length (mm): 30 ± 3 (25-33)
Wet Weight (g): 0.29 ± 0.07 (0.20-0.37)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: July 12/05
Duration of Acclimation (days): 20
96-h LC50 (and 95% CL): 24 (18 and 32)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV: 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.5 - 10.2
Temperature Range (°C): 15
pH Range: 6.7 - 7.3
Conductivity Range (µS/cm): 37 - 1463
Aeration Provided? (give rate): 6.5 ± 1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/10L
Loading Density (g/L): 0.29
Acclimation Before Testing (days): 29
Mortality In Previous Week of Acclimation (%): 0.1
Other: ✓

TEST RESULTS The 96-h LC50 is estimated to be > 100% (v/v)

Data Verified By: Ralph K
Date Verified: Aug. 4/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	15		15
pH	7.3		7.3
DO (mg/L)	10.4		10.2
Cond. (µS/cm)	1445		1445

1. Document pH adjustment procedure (if used) under "Comments".

Client: Azimuth
Golder ~~EVS~~ Project No.: 04-1424-044
EVS Work Order No.: 05002296
Trout Batch No. and 7-d Acclimation Mortality: 062205/0.5%
No. Fish/Volume: 10/10L
Sample ID: G-Creek 071605 Acute
Date/Time Collected: July 16/05 @ 0900
Test Initiation Date/Time: July 21/05 @ 1035

Total Pre-Aeration Time: 30 min

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
control				10	10	10	10	10.5	9.8	9.6	9.5	9.7	15	15	15	15	15	7.0	6.8	6.9	7.0	6.7	37	41
6.25				10	10	10	10	10.1	10.0	9.8	9.6	9.5	15	15	15	15	15	7.1	6.9	6.9	6.9	6.8	194	197
12.5				10	10	10	10	10.1	9.9	9.8	9.6	9.8	15	15	15	15	15	7.1	6.9	6.9	6.9	6.8	301	305
25				10	10	10	10	10.1	9.9	9.9	9.6	9.8	15	15	15	15	15	7.1	7.0	7.1	7.0	6.8	418	423
50				10	10	10	10	10.1	9.7	9.8	9.6	9.8	15	15	15	15	15	7.2	7.0	7.1	7.0	6.9	775	784
100				10	10	10	10	10.2	10.0	9.6	9.8	9.8	15	15	15	15	15	7.3	7.1	7.2	7.2	7.0	1445	1463
Technician Initials				ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA	TTL	TTL	ROA	ROA	ROA

WQ Instruments Used: Temperature calibrated Hg thermometer pH II-A-030302 DO II-A-3 Conductivity II-A-030363
Sample Description: clear
Comments:

Test Set Up By: ROA
Data Verified By: [signature]
Date Verified: Aug. 4/05

CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

Client Name: Teck Cominco | Client Contact Name: Bruce Donald | Ship to: BILL TO AZIMUTH CONSULTING GROUP.

Address: Bag 2000 | Phone: (250)427-8405

Kimberley, BC | Fax: (250)427-5451

V1A 3E1 | Sampled By: Blake Hamer | Attn: Edmond Canuia

Shipping Date: July 16/05

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: 96-hr LC50 Rainbow Trout	48-hr LC50 Daphnia Magna	7-Day Toxicity Test	20 min. Echinoderm Fertilization			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (°C)	4 Condition/Integrity
For composite sample record date & time starting and ending																
16/07/05	0900	G-Creek_Acute_071605	E		G	2×20	P	X	X					Effluent Water		
16/07/05	0900	G-Creek_Sublethal_071605	E		G	3×20	P			X	X			Effluent Water		

EVS Receipt Check List - SAP

EVS Project #: 04-1424-00049

EVS Workorder #: 0500296/7/879

Sample Storage Location: 4°C [X] Chemical [ ] Other

Supporting documentation/other information attached if applicable:

1.	Signatures & dates correct?	Y N
2.	Chain-of-custody fully completed?	Y N
3.	Containers arrived in good condition (unbroken)?	Y N
4.	Container labels completed (i.e., dates, ID's)?	Y N
5.	Container labels agreed with custody papers?	Y N
6.	Sample receipt temperature within acceptable range?	Y N
7a.	Sediment testing going to be initiated within 14 days?	Y N
7b.	If no, are samples under Nitrogen? If not, why?	Y N
8.	Chain-of-custody generated upon receipt.	[ ]
9.	Sample containers originate from EVS.	[ ]

PO/Reference No.:

Project Title: Polaris MMER -

Results Needed By: Routine Turn Around.

Comments/Instructions: Bill to: Azimuth Consulting Group. Temp: 12.7 C

Electronic Results to: Cheryl Mackintosh, Azimuth, cmackintosh@azimuthgroup.ca

Bruce Donald, Teck Cominco, ~~bdonald~~ bruce.donald@teckcominco.com.

A) Released By: Blake Hamer Date: July 16, 2005

Company: GLL Time: 1030

Courier name:

Shipping containers secured by: ~~Tape~~ Straps Lock Other (circle one)

Custody seals used? Yes No

B) Received by: SAP Date: 19 July 05

Company: Golder Time: 10:45

Shipping containers received secure? Yes No

Custody seals intact? Yes No N/A

C) Released By: Date:

Company: Time:

Courier name:

Shipping containers secured by: Tape Straps Lock Other (circle one)

Custody seals used? Yes No

D) Received by: Date:

Company: Time:

Shipping containers received secure? Yes No

Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies: White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

EVS environment consultants
A member of the Golder group of companies

Golder Associates

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

E/05/0341
04-1424-044

August 31, 2005

Azimuth Consulting Group
218 – 2902 West Broadway
Vancouver, BC V6K 2G8

Attention: Ms. Cheryl Mackintosh

RE: WORK ORDERS: 0500334, 335
TOXICITY TEST RESULTS ON THE SAMPLES COLLECTED AUGUST 6, 2005

Dear Ms. Mackintosh

We are pleased to provide you with the results of the toxicity tests performed on the effluent sample identified as Garrow Creek collected August 6, 2005. The sample was tested with the 48-h *Daphnia magna* and the 96-h rainbow trout LC50 toxicity tests. The tests were performed according to the Environment Canada protocol for conducting acute toxicity tests using *D. magna* (EPS 1/RM/14, Second Edition, 2000) and rainbow trout (EPS 1/RM/13, Second Edition, 2000). An independent EVS/Golder QA/QC review confirmed that all acceptability criteria specified by the protocol were met. The results of these tests are summarized from the appended data and are presented in Table 1.

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Yours very truly,
EVS ENVIRONMENT CONSULTANTS
A Member of the Golder Group of Companies

Jennifer Young, B.Sc.
Bioassay Team Leader – Cladoceran Team

Verified By:

QA/QC Committee:
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.

Attachment: Table 1
RH/clz
O:\Data\Final\2004\1424\04-1424-044\LET 0831 2005 Tox Test 0500334 335 .doc

Table 1
Toxicity Test Results

SAMPLE ID	SAMPLE DATE	48h *Daphnia magna* LC50 (95% CL) % (v/v)	96-h Rainbow Trout - LC50 (95% CL) % (v/v)
Garrow Creek	August 6, 2005	>100	>100

CL – confidence limits.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, nor for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting Group
EVS Analysts: SXB
EVS Project No.: 04-1424-044
Test Type: 48h LC50
EVS Work Order No.: 0500335
Test Initiation Date: 11 Aug 05

SAMPLE INFORMATION

Identification: Garrow Creek
Amount Received: 5x20L
Date Collected: 06 Aug 05
Date Received: 09 Aug 05
Temperature (°C): 21.0 → 21.0
pH: 7.5 → 7.6
pH adjustment details: none
Dissolved Oxygen (mg/L): 10.8 → 8.9
Pre-aeration rate and duration: 15 Min @ 25 to 50 ml/L/min
Conductivity (µmhos/cm): 2850
Hardness (mg/L as $CaCO_3$): ~~300~~
Alkalinity (mg/L as $CaCO_3$): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —

DILUTION/CONTROL WATER (initial water quality)

Water Type: Moderately Hard water (July 30)
Temperature (°C): 20.0
pH: 7.4
Dissolved Oxygen (mg/L): 9.1
Conductivity (µS/cm): 354
Hardness (mg/L as $CaCO_3$): ~~300~~ 94
Alkalinity (mg/L as $CaCO_3$): ~~of~~ 70
Other: —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture): 18 July A/B/C
Age (on Day 0): <24hr
Days to First Brood: 7.0
Avg. Young/Brood (after 1st brood): ~~7~~ 29
% Mortality in 7 d Before Test: 0
Reference Toxicant: ZinC
Current Reference Toxicant Result
Reference Toxicant Test Date: Aug 15, 2005
48-h LC50 and 95% CL: 481 (388-597) mg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 mg/L Zn ; CV = 31

TEST CONDITIONS

Temperature Range (°C): 20.0-21.0
pH Range: 7.4-7.7
Dissolved Oxygen Range (mg/L): 8.5-9.1
Conductivity Range (µS/cm): 350-2850
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/200ml
Other: —

TEST RESULTS The 48hr LC50 of Garrow Creek is >100% (v)

Data Verified By: Ralph
Date Verified: Aug. 31/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client: Azimuth Consulting Group
Sample ID: ~~6 Creek~~ Garrow Creek
EVS Project No.: 04-1424-044
Date Collected: 06 Aug 05
EVS Work Order No.: 0500335
Test Initiation Date/Time: 11 Aug 05 @ 10:30
Daphnid Broodstock Batch: 18 July A/B/C
No. Organisms/Volume: 10/200 ml

Concentration % (v/v)	Number of Survivors (1 to 48 h)					Dissolved Oxygen (mg/L)			Temperature (°C)			pH			Conductivity (µmhos/cm)	
	1	2	4	24	48	0	24	48	0	24	48	0	24	48	0	48
Control				10	10	9.1	8.9	8.6	20.0	21.0	21.0	7.4	7.7	7.6	354	350
6.25				10	10	9.0	8.8	8.5	20.0	21.0	21.0	7.4	7.7	7.7	505	508
12.5				10	10	9.0	8.8	8.5	20.5	21.0	21.0	7.5	7.7	7.7	654	667
25				10	10	8.9	8.8	8.5	20.5	21.0	21.0	7.5	7.7	7.7	990	992
50				10	10	8.9	8.7	8.5	20.5	21.0	21.0	7.5	7.7	7.6	1458	1593
100				10	10	8.9	8.7	8.5	21.0	21.0	21.0	7.6	7.7	7.6	2850	2766
Technician Initials				SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB	SXB

Sample Description: clear - colourless
WQ Instruments Used: Temp: Calibrated Hg thermometer pH II-A-020501 DO II-A-011201 Cond. IIA-990901
Comments:

Test Set Up By: SXB Data Verified By: Qualified Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client: Azimuth
EVS Project No.: 04-1424-044 (Golder Ref)
EVS Work Order No.: 0500334

EVS Analysts: AXF, RCH
Test Type: 96-h LC50
Test Initiation Date: Aug 11/05 @ 1500

SAMPLE
Identification: Garrow Creek
Amount Received: 5 + 20L
Date Collected: Aug 6/05
Date Received: Aug 9/05
Other: —

DILUTION/CONTROL WATER (initial water quality)
Fresh Water (dechlorinated): ✓
Temperature (°C): 15
pH: 7.0
Dissolved Oxygen (mg/L): 10.1
Conductivity (µS/cm): 40
Hardness (mg/L as $CaCO_3$): 14
Alkalinity (mg/L as $CaCO_3$): 8
Other: —

TEST SPECIES INFORMATION
Source: Sun Valley
Collection Date/Batch: 062205
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: Aug 15/05
Fork Length (mm): 31 ± 3 (27 and 35)
Wet Weight (g): 0.33 ± 0.08 (0.22 and 0.46)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: July 12/05
Duration of Acclimation (days): 20
96-h LC50 (and 95% CL): 24 (18 and 32)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV: 21%

TEST CONDITIONS
Dissolved Oxygen Range (mg/L): 9.0 – 10.1
Temperature Range (°C): 15
pH Range: 6.8 – 7.4
Conductivity Range (µS/cm): 40 – 2850
Aeration Provided? (give rate): 6.5 ± 1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10 / 10L
Loading Density (g/L): 0.33
Acclimation Before Testing (days): 50
Mortality In Previous Week of Acclimation (%): 0.1
Other: —

TEST RESULTS: The 96-h LC50 is estimated to be > 100% (v/v)

Data Verified By: [signature]
Date Verified: Aug. 30/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

	Initial	pH Adjustment[1]	After 30-min Pre-aeration
Temp. (°C)	15		15
pH	7.4		7.4
DO (mg/L)	10.1		10.1
Cond. (µS/cm)	2510		2510

1. Document pH adjustment procedure (if used) under "Comments".

Golder

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 05003334
Trout Batch No. and 7-d Acclimation Mortality: 060205/0.1%
No. Fish/Volume: 10 / 10L
Sample ID: Garrow Creek
Date/Time Collected: Aug 6/05 @ 1100
Test Initiation Date/Time: Aug 11/05 @ 1500

Total Pre-Aeration Time: 30 min

Concentration % (v/v)	Number of Survivors (1 to 96 hours)							Dissolved Oxygen (mg/L)					Temperature (°C)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
control				10	10	10	10	10.1	9.2	9.4	10.0 ~~10~~ AXF	9.3	15	15	15	15	15	7.0	7.1	6.8	6.9	7.0	40	51
6.25				10	10	10	10	10.1	9.0	10.0	10.0 ~~10.2~~	9.4	15	15	15	15	15	7.0	7.1	6.9	7.0	7.0	323	349
12.5				10	10	10	10	10.1	9.2	10.0	10.0 ~~10.2~~	9.4	15	15	15	15	15	7.0	7.1	6.9	7.1	7.1	535	571
25				10	10	10	10	10.1	9.4	10.0	10.0 ~~10.2~~	9.6	15	15	15	15	15	7.0	7.1	6.9	7.1	7.1	827	864
50				10	10	10	10	10.1	9.4	10.1 ~~10.4~~ AXF	10.1 ~~10.3~~ AXF	9.6	15	15	15	15	15	7.2	7.2	7.0	7.1	7.2	1373	1431
100				10	10	10	10	10.1	9.8	10.1 ~~10.8~~ AXF ①	10.1 ~~10.5~~ AXF ①	9.7	15	15	15	15	15	7.4	7.3	7.0	7.1	7.3	2510	2850
Technician Initials				RAH	AXF	AXF	RAH	RAH	RAH	AXF ①	AXF ①	RAH	RAH	RAH	AXF	AXF	RAH	RAH	RAH	AXF	AXF	RAH	RAH	RAH

WQ Instruments Used: Temperature calibrated thermometre pH II-A-030302 DO II-A-3 Conductivity II-A-030304

Sample Description: clear

Comments: ① Re-calibrated D.O. meter

Test Set Up By: RAH Data Verified By: [signature] Date Verified: Aug. 30/05

CHAIN-OF-CUSTODY / TEST REQUEST FORM

SRS 0743

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:

Address: Box 2000
Kimberley BC
V1A 3G1
Phone: 250-427-5405
Fax: 250-427-2451
Sampled by: B. Patton
Attn.: Edmund Canavia
Shipping Date: Aug 6/05

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sublethal toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	1x20L		X					Client is actually Azimuth Consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Patton Date: Aug 6/05
Company: Gartner Lee Ltd. Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt.

Golder Project No.: 0500327 / 328 / 334 / 33
Golder Work Order No.: 04-1424-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow – accompany the shipment
Pink – kept by consignor (e.g. shipper)
Yellow – kept by consignee (e.g. receiver)
White – returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

APPENDIX H

Sublethal Toxicity Testing Laboratory Reports

Stantec Consulting Ltd.
11B Nicholas Beaver Road RR3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

stantec.com

Stantec

Work Order : 207782
Sample Number : 13103

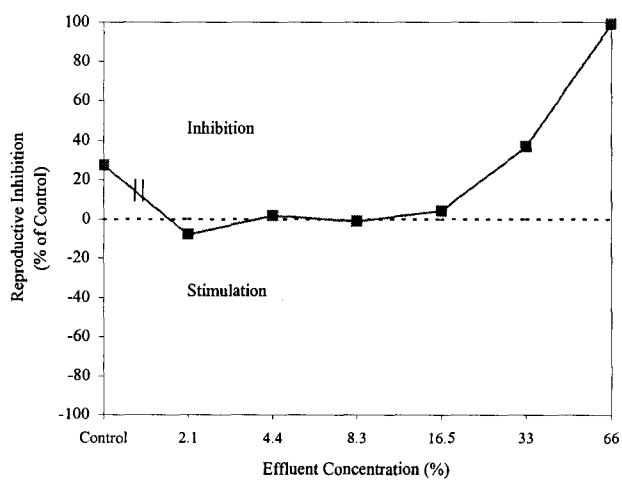
Sample Identification

Company :	Azimuth Consulting Group Inc.		
Location :	Vancouver, BC	Date Collected :	2005-07-16
Substance :	G-Creek Sublethal 071605	Time Collected :	09:00
Sampling Method :	Grab	Date Received :	2005-07-19
Sampled By :	B. Hamer	Time Received :	13:00
Shipped By:	Fed Ex/Rd	Date Tested :	2005-07-19
Temp. on arrival :	18.0°C	Lab Storage:	4±2 °C
Sample Description:	Clear, colourless, odourless.		

Test Results

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Reproduction)	24.6%	22.2-27.2	Linear Interpolation (Toxstat 3.5) b

Champia parvula Reproductive Inhibition



Note: Statistical analyses were performed using pooled control and salt control data.

Work Order Number: 207782
Sample Number: 13103

Test Conditions

Test Organism [a]	:	*Champia parvula*	Test Vessel	:	240 mL polystyrene cup
Organism Batch Number	:	CH05-07	Number of Replicates	:	3
Source	:	Stantec in-house culture	Number of Organisms per Replicate	:	5 females / 2 males
Life Stage [c]	:	Sexually mature	Test Volume (per replicate)	:	100 mL
Mean Organism Mortality	:	0% (7 days prior to testing)	Test Solution Depth	:	5 cm
Salinity Adjustment [d]	:	Yes	Recovery Volume (per replicate)	:	200 mL
pH Adjustment	:	None	Recovery Solution Depth	:	7 cm
Sample Filtration	:	None	Recovery Water Filtered (prior to dilution)	:	Yes (60µm)
Test Aeration (during exposure)	:	None	Date of Test Initiation	:	2005-07-19
Test Aeration (during recovery)	:	Yes (continuous, gentle aeration)	Time of Test Initiation	:	17:45
Photoperiod (h)	:	16 light / 8 dark	Date of Recovery Initiation	:	2005-07-21
Light Intensity	:	1000 - 1600 lux	Date of Test Completion	:	2005-07-28
Test Temperature (°C)	:	23.0 – 26.0	Test Duration	:	48 hours
Control/Dilution Water [e]	:	Natural seawater	Recovery Duration	:	7 days
Test Type	:	Static non-renewal	Analyst(s)	:	EJ/KJ

[a] Test Organism : No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test. All test organisms were from the same culture.

[c] Life Stage : Test organisms were sexually mature males having sori with spermatia and sexually mature females having trichogynes.

[d] Salinity Adjustment : Salinity adjustment was performed following the procedure for Hypersaline Brine Addition (Environment Canada Salinity Adjustment Guidance Document, revised December 2001).

[e] Control/Dilution Water : Filtered (0.45 µm) natural seawater from Pointe-du-Chene in Shediac Bay, New Brunswick. No chemicals added.

Test Method : Test of Sexual Reproduction using the Red Macroalga *Champia parvula.* EPA-821-R-02-014, October 2002, Method 1009.0, with Canadian adaptations (Environment Canada 1998, 1999).

Comments

Nutrient addition of 10 mls to the 100% salinity adjusted sample, prior to test initiation, reduced the maximum concentration tested from 66.7% to 66%.

Noted Deviation(s): The maximum test temperature of 24.0 °C, as specified by the test method, was exceeded on Day 4 of the recovery period. There were no other unusual conditions or deviations from the test protocol. The results reported relate only to the sample tested.

Reference Toxicant Data

Substance :	Sodium Dodecyl Sulphate (SDS)	Historical Mean IC50 :	0.155 mg/L
Test Date :	2005-07-19	Warning Limits (± 2 SD) :	0.112-0.216
Test Duration :	48 hrs exposure, 7 days recovery	Statistical Method :	Linear Interpolation (Toxstat 3.5)[b]
IC50 Reproduction	0.134 mg/L	Test Conducted By :	E. Jonczyk/K. Johnson
95% Confidence Limits:	0.123-0.143	Organism Batch :	CH05-07

The reference toxicant test was conducted under conditions identical to the test.

References

[b] West, Inc. and D. Gulley. 1996. Toxstat Release 3.5. Western Ecosystems Technology. Cheyenne, WY, U.S.A.

Date: 2005-08-25

Approved By: Project Manager

Work Order : 207782
Sample Number : 13103

Cystocarp Counts

Concentration (%)	Replicate	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Replicate Mean	Treatment Mean	Standard Deviation
Control	A	19	27	34	30	24	26.8	26.8	6.98
	B	32	21	36	25	22	27.2		
	C	23	42	29	21	17	26.4		
Salt Control	A	31	26	24	18	39	27.6	27.8	7.94
	B	24	29	32	37	15	27.4		
	C	17	22	28	35	40	28.4		
2.1	A	27	24	37	25	34	29.4	29.5	7.50
	B	33	19	39	28	26	29.0		
	C	24	31	42	16	37	30.0		
4.4	A	11	29	34	22	35	26.2	26.8	8.13
	B	27	24	38	15	30	26.8		
	C	28	31	22	38	18	27.4		
8.3	A	34	30	21	25	28	27.6	27.6	7.14
	B	16	24	32	29	35	27.2		
	C	39	34	25	13	29	28.0		
16.5	A	22	26	23	13	43	25.4	26.1	8.41
	B	29	19	31	29	24	26.4		
	C	15	24	32	41	21	26.6		
33	A	13	17	12	23	27	18.4	17.3	5.55
	B	16	20	15	13	11	15.0		
	C	10	18	26	24	14	18.4		
66	A	0	1	0	1	0	0.4	0.3	0.46
	B	0	0	1	0	0	0.2		
	C	1	0	0	0	0	0.2		

Plant Mortality Data

Exposure Period

	♂ 0 Hours		♀ 0 Hours		♂ 48 Hours		♀ 48 Hours		♀ Test Completion	
Concentration (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)	Number Dead	Mortality (%)
Control	0	0	0	0	0	0	0	0	0	0
Salt Control	0	0	0	0	0	0	0	0	0	0
2.1	0	0	0	0	0	0	0	0	0	0
4.4	0	0	0	0	0	0	0	0	0	0
8.3	0	0	0	0	0	0	0	0	0	0
16.5	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0

Test Data Reviewed By: [signature]
Date: 2005-08-11

Work Order : 207782
Sample : 13103

Water Chemistry Data

Initial Water Chemistry (100% Effluent)

	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	O2 Saturation (%)*	Salinity (‰)
Initial Parameters:	22.0	8.0	10.2	122	0
Parameters after Salinity Adjustment [1]:	22.5	8.0	7.0	98	32
Chemistry after Pre-Aeration [1,2]:	-	-	-	-	-

Exposure Period Water Chemistry

0 hours

Date & Time : 2005-07-19 17:45
Analyst(s) : EJ/KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	7.8	7.8	106	32	22.5
33	7.7	7.3	102	32	22.5
16.5	7.7	7.2	100	32	22.5
8.3	7.7	7.1	100	32	22.5
4.4	7.7	7.3	103	32	22.5
2.1	7.7	7.0	99	32	23.0
Salt Control	7.7	5.9	83	30	24.0
Control	7.7	6.4	91	30	22.0

48 hours

Date & Time : 2005-07-21 16:00
Analyst(s) : KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	8.8	7.7	99	31	23.0
33	8.9	7.0	98	31	23.0
16.5	8.7	6.9	98	31	23.0
8.3	9.1	6.9	97	31	22.0
4.4	8.7	6.8	96	30	22.5
2.1	8.9	6.6	94	30	22.0
Salt Control	9.0	6.2	91	30	22.0
Control	9.1	6.7	95	30	22.0

Initial Water Chemistry (Recovery Water)

	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	O2 Saturation (%)*	Salinity (‰)
Initial Parameters:	22.0	7.5	6.6	93	30

Recovery Period Water Chemistry

0 hours

Date & Time : 2005-07-21 16:00
Analyst(s) : KJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	7.5	6.6	93	30	22.0
33	7.5	6.6	93	30	22.0
16.5	7.5	6.6	93	30	22.0
8.3	7.5	6.6	93	30	22.0
4.4	7.5	6.6	93	30	22.0
2.1	7.5	6.6	93	30	22.0
Salt Control	7.5	6.6	93	30	22.0
Control	7.5	6.6	93	30	22.0

Test Completion

Date & Time : 2005-07-28 16:00
Analyst(s) : EJ

Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Temperature (°C)
66	8.0	7.4	92	30	22.0
33	8.0	7.5	93	30	22.0
16.5	8.0	7.3	91	30	22.0
8.3	8.1	7.4	92	30	22.0
4.4	8.0	7.5	93	30	22.0
2.1	8.0	7.5	93	30	22.0
Salt Control	8.1	7.5	93	30	22.0
Control	7.8	7.6	95	30	22.0

Daily Temperature Monitoring

Date:	2005-07-19	2005-07-20	2005-07-21	2005-07-22	2005-07-23	2005-07-24	2005-07-25	2005-07-26	2005-07-27	2005-07-28
Temp. (°C):	23.0	24.0	24.0	24.0	23.0	24.0	26.0	24.0	23.0	23.0

[1] if applicable
[2] @ <100 bubbles/min
* adjusted for barometric pressure

August 2005

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

July 16, 2005 Sample

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

JULY 16, 2005 SAMPLE

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants (A Member of the Golder Group of Companies)
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

04-1424-044

August 2005

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1. INTRODUCTION

EVS Environment Consultants (a member of the Golder Group of Companies) conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as G Creek-071605, was collected from the Polaris Mine Site on July 16, 2005 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on July 19, 2005 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendices I and II respectively, and the chain-of-custody form is provided in Appendix III.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d survival and growth toxicity and reference toxicant tests using topsmelt (*A. affinis*) was conducted in accordance with U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods are summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time, the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and

record-keeping, and use of standard operating procedures (SOPs). To ensure data and reporting meet quality standards, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, or for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 8.9, 17.9, 35.7, 71.4% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.6, 9.1, 18.3, 36.6, 72.8% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 1 and the raw statistical analyses are provided in Appendix I.

The highest concentration tested was approximately 71.4% due to salinity adjustment. The mean survival in both the negative and brine controls was 100%. Mean dry weight in the pooled controls was 0.95mg. The negative and brine controls were not significantly different for both the growth and survival endpoints ($p = 0.52$ and $p = 1.00$, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). For the survival and growth endpoints the NOEC was 71.4, and the LOEC was >71.4% (v/v). The LC50 for survival was >71.4% (v/v). The IC50 and IC25 for growth were both >71.4% (v/v).

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 2 and the raw statistical analyses are provided in Appendix II.

The highest concentration tested was 72.8% due to salinity adjustment. Mean fertilization in the pooled controls was 66.9%. The negative and brine controls were not significantly different ($p = 0.09$).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was <4.6 and LOEC was 4.6 % (v/v). The IC50 and IC25 (95% confidence limits) values were 13.2 (10.6 – 17.1) and 5.2 (4.4 – 6.0) % (v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% V/V)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
D-Control	100.0 ± 0.0	0.92 ± 0.13
Brine Control	100.0 ± 0.0	0.98 ± 0.18
Pooled Controls	100.0 ± 0.0	0.95 ± 0.15
4.5	96.0 ± 8.9	0.77 ± 0.19
8.9	96.0 ± 8.9	0.82 ± 0.33
17.9	100.0 ± 0.0	1.01 ± 0.14
35.9	100.0 ± 0.0	1.07 ± 0.19
71.4	96.0 ± 8.9	0.91 ± 0.28
TEST ENDPOINT	**SURVIVAL (% V/V)**	**GROWTH (% V/V)**
NOEC	71.4	71.4
LOEC	>71.4	>71.4
LC50	>71.4	na
IC50	na	>71.4
IC25	na	>71.4

SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus*) fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	64.8 ± 3.8
Brine Control	69.0 ± 1.8
Pooled Control	66.9 ± 3.6
4.6	53.0 ± 2.2*
9.1	37.2 ± 1.3*
18.2	30.0 ± 2.2*
36.5	23.5 ± 2.9*
72.8	19.5 ± 2.4*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	<4.6
LOEC	4.6
IC50 (95% CL)	13.2 (10.6 – 17.1)
IC25 (95% CL)	5.2 (4.4 – 6.0)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

EVS (EVS Environment Consultants). 2004. Topsmelt (*Atherinops affinis*) 7-d larval survival and growth test. EVS SOP 1100-5. In: EVS Consultants Laboratory Standard Operating Procedures (SOP) Manual. Volume II: Water Toxicity Tests. EVS Environment Consultants, North Vancouver, BC.

US EPA (U.S. Environmental Protection Agency). 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 3rd edition. US Environmental Protection Agency, Office of Water (4303T). US Environmental Protection Agency, Washington, DC. EPA/821/R-02/014. 464 pp.

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Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX I

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Polaris
EVS Project No. 04-1424-0644
EVS Work Order No. 0500~~258~~[RST] 298

EVS Analysts JxS, SxB, MJG, AxF
Test Initiation Date 19-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0 Sublethal	Day 2	Day 4
Identification	G Creek ~~NO~~ 71605	G Creek	G Creek
Amount Received	1 ~~20~~[RST] x 20L	1x20L	1x20L
Date Collected	16Jul05	16Jul05	16Jul05
Date Received	19Jul05	19Jul05	19Jul05
Temperature (°C)	20.0	20.0	20.0
pH	7.7 ① → 8.2	7.8 ① → 8.2	7.7 ① → 8.3
DO (mg/L)	11.1 ① → 7.6	11.0 ① → 7.6	10.8 ① → 7.6
Conductivity (µmhos/cm)	1520	1520	1520
Salinity (ppt)	6 ① → 29	6 ① → 29	6 ① → 29
Ammonia (mg/L N)	-	-	-
Chlorine (mg/L Cl)	-	-	-
Other	① After Salinity Adjustment		

DILUTION/CONTROL WATER (initial water quality)
Water Type Filtered, UV sterilized seawater
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.5
Salinity 28

TEST SPECIES INFORMATION
Source ABS
Date Received 19-July-05
Age (on Day 0) 10-d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 19Jul05
7-d survival LC50 ~~122 (106-140)~~[RST] 117 (100-136) ug/L Cu
7-d growth IC50 ~~112 (80-149)~~[RST] 116 (81-156) ug/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 133 ± 39 ug/L Cu CV=15%
7-d growth IC50 132 ± 46 ug/L Cu CV=17%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 - 8.3
Dissolved Oxygen Range (mg/L) 6.2 - 7.7
Salinity (ppt) 28 - ~~29~~[RST] 30
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	71.4	>71.4	>71.4		
Growth		71.4	>71.4		>71.4	>71.4

Other

Data Verified By [signature]
Date Verified Aug. 22/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client: Polaris

Sample ID: G-Creek Subletha1 C7/6 05

EVS Project No.: 04-1424-044

Test Initiation Date/Time: 19-July-05/1430

EVS Work Order No.: 0500298

Source/Date Received: ABS / 19-July-05

~~%~~ Concentration	Temperature (°C)													
	0	1		2		3		4		5		6		7
D-control	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
B-control	20.5	20.5	20.5	20.5	20.5	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
4.5	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
8.9	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
~~35.7~~ 17.9	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
~~71.4~~ 35.7	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
71.4	20.0	20.5	20.0	20.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	MV	MV	MV	MV	MV	MV	TM

~~%~~ Concentration	pH													
	0	old 1 new		2		3		4		5		6 7.9		7
D-control	7.8	7.7	7.7	7.7	7.8	7.8	7.8 SXB	7.8	7.8	7.8	7.8	7.8	7.8	8.0
B-control	7.9	7.7	8.0	7.7	7.9	7.8	7.9	7.8	7.8	7.8	7.8	7.8	7.9	8.0
4.5	7.9	7.7	8.0	7.7	7.9	7.8	7.9	7.9	7.9	7.8	7.9	7.9	7.9	7.7
8.9	7.9	7.8	8.0	7.7	7.9	7.8	8.0	7.9	7.9	7.8	8.0	7.9	8.0	7.7
17.9	8.0	7.8	8.1	7.7	8.0	7.9	8.0	8.0	8.0	7.9	8.1	8.0	8.1	7.7
35.7	8.1	7.9	8.1	7.8	8.1	7.9	8.1	8.0	8.2	7.9	8.2	8.0	8.2	7.8
71.4	8.2	7.9	8.2 SXB	7.8	8.2	7.9	8.3	8.0	8.3	8.0	8.2	8.0	8.3	7.8
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	MV	MV	MV	MV	MV	MV	TM

WQ Instruments Used: Temp. Calibrated Hg thermometer pH I-A-03031

Comments: D used I-A-51

Test Set Up By: TM, SXB Data Verified By: [signature] Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Polaris

Sample ID G-Creek Sublethal C7160S

EVS Project No. 04-1424-044

Test Initiation Date/Time 19-July-05 /1430

EVS Work Order No. 0500~~28~~298

Source/Date Received ABS /19-July-05

% (v/v) Concentration	Salinity (ppt)													
	0	1		2		3		4		5		6		7
D-control	28	28	28	28	28	28	28	28	28	28	28	28	28	28
B-control	30	30	30	30	30	30	30	30	30	30	30	30	30	30
4.5	28	28	28	28	28	28	28	28	28	28	28	28	28	28
8.9	28	28	28	28	28	28	28	28	28	28	28	28	28	28
17.9	28	28	28	28	28	28	28	28	28	28	28	28	28	28
35.7	28	28	28	28	28	28	28	28	28	28	28	28	28	28
71.4	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	SXB	ML	SXB	ML	SXB	ML	TM

% (v/v) Concentration	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
D-control	7.5	6.6	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.6	7.7	6.6	7.7	6.4
B-control	7.5	6.6	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.7	7.7	6.6	7.6	6.2
4.5	7.5	6.5	7.5	6.7	7.5	6.5	7.5	6.5	7.7	6.6	7.7	6.5	7.7	6.6
8.9	7.5	6.5	7.5	6.8	7.6	6.6	7.5	6.4	7.6	6.6	7.7	6.6	7.7	6.7
17.9	7.6	6.5	7.5	6.7	7.6	6.7	7.5	6.4	7.6	6.5	7.7	6.6	7.7	6.6
35.7	7.6	6.6	7.5	6.8	7.6	6.6	7.6	6.5	7.6	6.5	7.6	6.6	7.6	6.2
71.4	7.6	6.5	7.5	6.7	7.6	6.6	7.6	6.5	7.6	6.6	7.6	6.6	7.6	6.4
Tech. Initials	TM	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	TM

WQ Instruments Used: Salinity II-A-030303 DO II-A-14

Comments

Test Set Up By TM. SXB Data Verified By [signature] Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Polaris
EVS Project No. 04-1424-044
EVS Work Order No. 0500 ~~358~~ 398

Sample ID G-Creek Sublethal 071605
Test Species/Batch A affinis / 19-July-05
Test Initiation Date/Time 19-July-05 / 1430h
No. of Organisms/Volume 5 / 200 ml

% V/V Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D-control	A	T1	5	5	5	5	5	5	5	
	B	T2	5	5	5	5	5	5	5	
	C	T3	5	5	5	5	5	5	5	
	D	T4	5	5	5	5	5	5	5	
	E	T5	5	5	5	5	5	5	5	
B-control	A	T6	5	5	5	5	5	5	5	
	B	T7	5	5	5	5	5	5	5	
	C	T8	5	5	5	5	5	5	5	
	D	T9	5	5	5	5	5	5	5	
	E	T10	5	5	5	5	5	5	5	
4.5	A	T11	5	5	5	5	5	5	5	
	B	T12	5	5	5	5	5	5	5	
	C	T13	5	5	5	5	5	5	5	
	D	T14	5	5	5	5	5	5	4	
	E	T15	5	5	5	5	5	5	5	
8.9	A	T16	5	5	5	5	5	5	5	
	B	T17	5	5	5	5	5	5	5	
	C	T18	5	5	5	5	5	5	5	
	D	T19	5	5	5	5	5	5	5	
	E	T20	5	5	5	5	5	5	4	
Technician Initials		TM	SKB	SKL	SKB	MML	MML	MM	TM	

Sample Description colorless, clear.
Data Verified By [signature] Date Verified Aug 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Polaris

EVS Project No. 04-1424-044

EVS Work Order No. 0500~~858~~398

Sample ID G-Creek 071605 Sublethal

Test Species/Batch 4 affinis / 19-July-05

Test Initiation Date/Time 19-July-05 / 1430h

No. of Organisms/Volume 5/200ml

% (v/v) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
17.9	A	T21	5	5	5	5	5	5	5	
	B	T22	5	5	5	5	5	5	5	
	C	T23	5	5	5	5	5	5	5	
	D	T24	5	5	5	5	5	5	5	
	E	T25	5	5	5	5	5	5	5	
~~35.9~~ RSD 35.7	A	T26	5	5	5	5	5	5	5	
	B	T27	5	5	5	5	5	5	5	
	C	T28	5	5	5	5	5	5	5	
	D	T29	5	5	5	5	5	5	5	
	E	T30	5	5	5	5	5	5	5	
71.4	A	T31	5	5	5	5	5	5	5	
	B	T32	5	5	5	5	5	5	4	
	C	T33	5	5	5	5	5	5	5	
	D	T34	5	5	5	5	5	5	5	
	E	T35	5	5	5	5	5	5	5	
	A									
	B									
	C									
	D									
	E									
Technician Initials		TM	SXB	SXB	SXB	MM	MM	MM	MM	

Sample Description colorless clear.

Data Verified By Gail Fink

Date Verified Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Polaris — Start Date (Day 0): 19-July-05 07/605 sublethal

EVS Project No.: 04-1424-044 — Sample ID: G-Creek

EVS Work Order No.: 0500288 — Balance Type/Serial Number: Sartorius / BP-211D

Sample ID % (N)	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
D-CTL	A	T1	1237.86	1242.66	5	5		AXF/
	B	T2	1223.60	1228.84	5	5		
	C	T3	1234.30	1238.08	5	5		
	D	T4	1221.57	1226.62	5	5	confirmed 1226.58 mg ✓	
	E	T5	1215.08	1219.11	5	5		
B-CTL	A	T6	1236.55	1241.94	5	5		
	B	T7	1230.84	1236.48 (9)	5	5		
	C	T8	1223.70	1229.06	5	5		
	D	T9	1242.73	1247.44	5	5		
	E	T10	1228.47	1231.92	5	5		
4.5	A	T11	1221.11	1224.77	5	5	confirmed 1224.75 mg ✓	
	B	T12	1237.55	1240.97	5	5		
	C	T13	1221.54	1226.04	5	5		
	D	T14	1229.99	1232.59	4	4		
	E	T15	1220.96	1226.00	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph G — Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Polaris

EVS Project No. 04-1424-044

EVS Work Order No. 0500788

Start Date (Day 0) 19-July-05

Sample ID G-Creek ~~07605~~ 07605 Sublethal 07/605

Balance Type/Serial Number Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
8.9	A	T16	1221.54	1226.60	5	5		AXF 1-2-3
	B	T17	1235.48	1241.14	5	5		
	C	T18	1237.41	1242.39	5	5		
	D	T19	1236.28	1238.98	5	5	Confirmed 1238.99 mg ✓	
	E	T20	1219.90	1221.88	4	4		
17.9	A	T21	1227.04	1231.84	5	5		
	B	T22	1246.60	1251.74	5	5		
	C	T23	1239.07	1243.68	5	5		
	D	T24	1231.19	1237.41	5	5		
	E	T25	AXF 1229.72	1234.23	5	5		
~~35.9~~ 35.7	A	T26	1230.92	1235.13	5	5	Confirmed 1235.14 mg ✓	
	B	T27	1228.42	1234.87	5	5		
	C	T28	1231.53	1237.73	5	5		
	D	T29	1235.66	1240.48	5	5		
	E	T30	1228.20	1233.15	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Ralph K

Date Verified Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Polaris

EVS Project No. 04-1424-044

EVS Work Order No. 05002838

Start Date (Day 0) 19-July-05

Sample ID G-Creek ~~07/60S~~ Sublethal 07/60S

Balance Type/Serial Number Sartorius / BP-211D

Sample ID 7.4%	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
71.4	A	T31	1227.99	1234.14	5	5		AXH 7.7
	B	T32	1230.90	1234.21	4	4		
	C	T33	1234.94	1239.77	5	5		
	D	T34	1230.30	1235.80	5	5		
	E	T35	1232.19	1234.5~~4~~.03	5	5		
	A							
	B							
	C							
	D							
	E							
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By Qaqji 4

Date Verified Aug. 17/05

Test: LF-Larval Fish Growth and Survival Test — Test ID: 0500298
Species: AA-Atherinops affinis — Protocol: EPAW 95-EPA West Coast
Sample ID: G_CREEK_Sublethal_071605 — Sample Type: EFF2-Industrial
Start Date: 7/19/2005 End Date: 7/26/2005 — Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1237.86	1242.66
	2	2	D-Control	5							5	5	1223.6	1228.84
	3	3	D-Control	5							5	5	1234.3	1238.08
	4	4	D-Control	5							5	5	1221.57	1226.62
	5	5	D-Control	5							5	5	1215.08	1219.11
	6	1	B-Control	5							5	5	1236.55	1241.94
	7	2	B-Control	5							5	5	1230.84	1236.49
	8	3	B-Control	5							5	5	1223.7	1229.06
	9	4	B-Control	5							5	5	1242.73	1247.44
	10	5	B-Control	5							5	5	1228.47	1231.92
	11	1	4.5	5							5	5	1221.11	1224.77
	12	2	4.5	5							5	5	1237.55	1240.97
	13	3	4.5	5							5	5	1221.54	1226.04
	14	4	4.5	5							4	4	1229.99	1232.59
	15	5	4.5	5							5	5	1220.96	1226
	16	1	8.9	5							5	5	1221.54	1226.6
	17	2	8.9	5							5	5	1235.48	1241.14
	18	3	8.9	5							5	5	1237.41	1242.39
	19	4	8.9	5							5	5	1236.28	1238.98
	20	5	8.9	5							4	4	1219.9	1221.88
	21	1	17.9	5							5	5	1227.04	1231.84
	22	2	17.9	5							5	5	1246.6	1251.74
	23	3	17.9	5							5	5	1239.07	1243.68
	24	4	17.9	5							5	5	1231.19	1237.41
	25	5	17.9	5							5	5	1229.72	1234.23
	26	1	35.7	5							5	5	1230.92	1235.13
	27	2	35.7	5							5	5	1228.42	1234.87
	28	3	35.7	5							5	5	1231.53	1237.73
	29	4	35.7	5							5	5	1235.66	1240.48
	30	5	35.7	5							5	5	1228.2	1233.15
	31	1	71.4	5							5	5	1227.99	1234.14
	32	2	71.4	5							4	4	1230.9	1234.21
	33	3	71.4	5							5	5	1234.94	1239.77
	34	4	71.4	5							5	5	1230.3	1235.8
	35	5	71.4	5							5	5	1232.19	1235.03

Comments: Azimuth(Polaris) 04-1424-044

Reviewed by Aug. 18/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

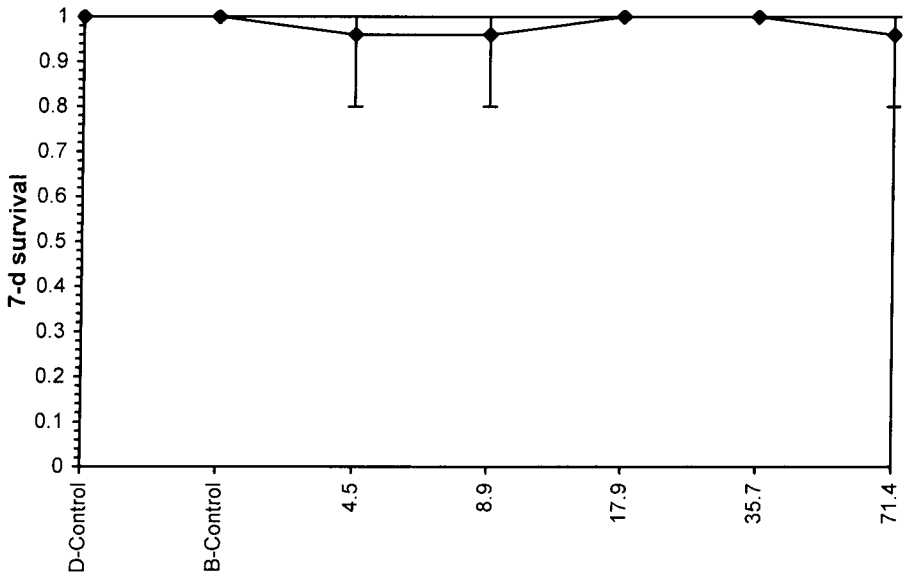
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
B-Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	0.8000	1.0000
8.9	1.0000	1.0000	1.0000	1.0000	0.8000
17.9	1.0000	1.0000	1.0000	1.0000	1.0000
35.7	1.0000	1.0000	1.0000	1.0000	1.0000
71.4	1.0000	0.8000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
B-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5		
4.5	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
8.9	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00
17.9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
35.7	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	16.00
71.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	16.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.59678	0.9	-2.2346	4.3922
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	71.4	>71.4		1.40056

Dose-Response Plot



Statistical comparisons were against the negative control.

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

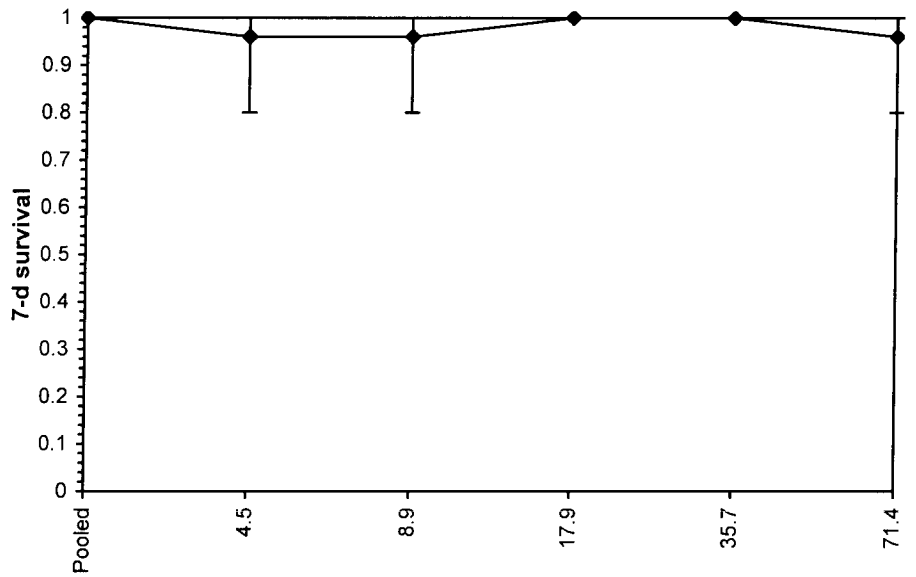
Conc-%	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
B-Control	1.0000	1.0000	1.0000	1.0000	1.0000
4.5	1.0000	1.0000	1.0000	0.8000	1.0000
8.9	1.0000	1.0000	1.0000	1.0000	0.8000
17.9	1.0000	1.0000	1.0000	1.0000	1.0000
35.7	1.0000	1.0000	1.0000	1.0000	1.0000
71.4	1.0000	0.8000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	10		
4.5	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
8.9	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00
17.9	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
35.7	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	40.00	21.00
71.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	35.00	21.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.58129	0.91	-2.3952	5.50568
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 1.00)	0	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Wilcoxon Rank Sum Test	71.4	>71.4		1.40056

Dose-Response Plot



Statistical comparisons were agianst the pooled controls.

Reviewed by: Aug. 18/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

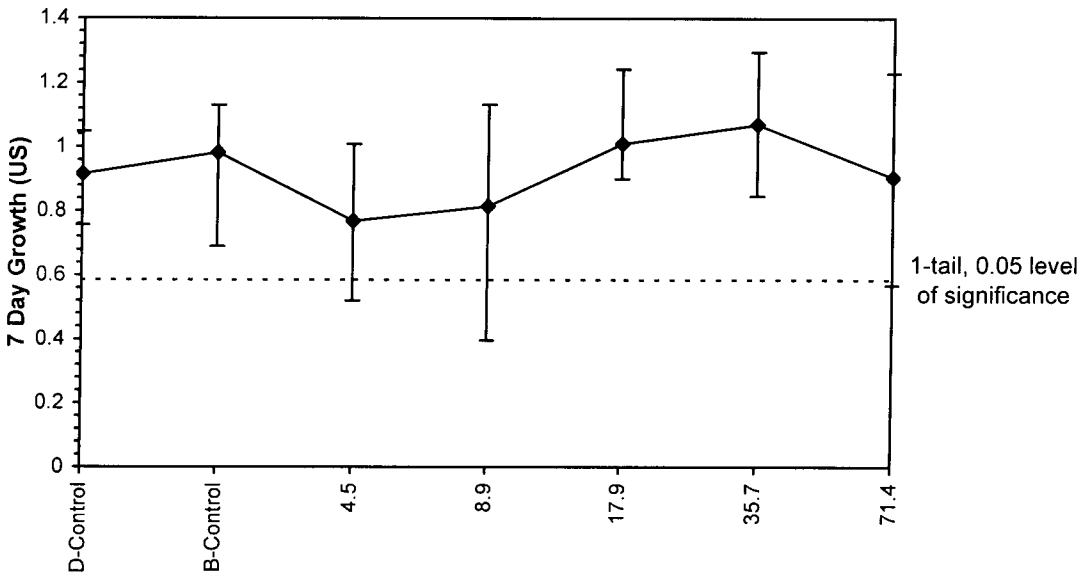
Conc-%	1	2	3	4	5
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900
4.5	0.7320	0.6840	0.9000	0.5200	1.0080
8.9	1.0120	1.1320	0.9960	0.5400	0.3960
17.9	0.9600	1.0280	0.9220	1.2440	0.9020
35.7	0.8420	1.2900	1.2400	0.9640	0.9900
71.4	1.2300	0.6620	0.9660	1.1000	0.5680

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9160	0.1284	0.9160	0.7560	1.0480	14.012	5			
B-Control	0.9824	0.1775	0.9824	0.6900	1.1300	18.072	5			
4.5	0.7688	0.1903	0.7688	0.5200	1.0080	24.755	5	1.051	2.360	0.3307
8.9	0.8152	0.3253	0.8152	0.3960	1.1320	39.903	5	0.719	2.360	0.3307
17.9	1.0112	0.1387	1.0112	0.9020	1.2440	13.719	5	-0.679	2.360	0.3307
35.7	1.0652	0.1916	1.0652	0.8420	1.2900	17.985	5	-1.065	2.360	0.3307
71.4	0.9052	0.2828	0.9052	0.5680	1.2300	31.246	5	0.077	2.360	0.3307

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96171	0.9	-0.2156	-0.8642
Bartlett's Test indicates equal variances (p = 0.42)	4.97608	15.0863		
The control means are not significantly different (p = 0.52)	0.67773	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	71.4	>71.4		1.40056	0.33065	0.36097	0.06323	0.04907	0.30153	5, 24

Dose-Response Plot



Statistical comparisons were against the negative control.

Reviewed by: Aug. 18/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	500298	Sample ID:	G_CREEK_Sublethal_071605
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris) 04-1424-044				

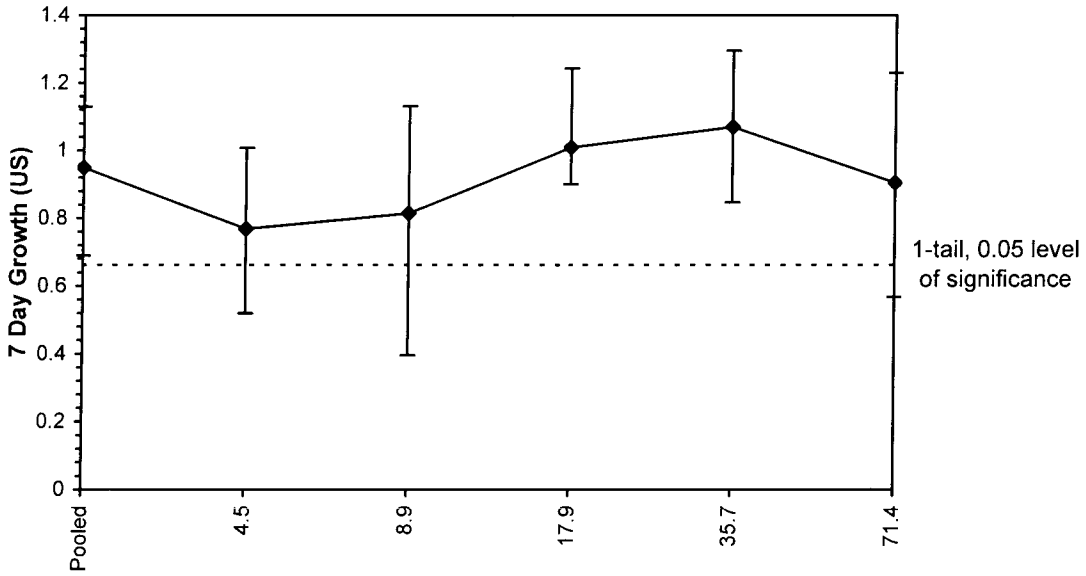
Conc-%	1	2	3	4	5
D-Control	0.9600	1.0480	0.7560	1.0100	0.8060
B-Control	1.0780	1.1300	1.0720	0.9420	0.6900
4.5	0.7320	0.6840	0.9000	0.5200	1.0080
8.9	1.0120	1.1320	0.9960	0.5400	0.3960
17.9	0.9600	1.0280	0.9220	1.2440	0.9020
35.7	0.8420	1.2900	1.2400	0.9640	0.9900
71.4	1.2300	0.6620	0.9660	1.1000	0.5680

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.9492	0.1502	0.9492	0.6900	1.1300	15.822	10			
4.5	0.7688	0.1903	0.7688	0.5200	1.0080	24.755	5	1.547	2.462	0.2871
8.9	0.8152	0.3253	0.8152	0.3960	1.1320	39.903	5	1.149	2.462	0.2871
17.9	1.0112	0.1387	1.0112	0.9020	1.2440	13.719	5	-0.532	2.462	0.2871
35.7	1.0652	0.1916	1.0652	0.8420	1.2900	17.985	5	-0.995	2.462	0.2871
71.4	0.9052	0.2828	0.9052	0.5680	1.2300	31.246	5	0.377	2.462	0.2871

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9613	0.91	-0.2544	-0.8676
Bartlett's Test indicates equal variances (p = 0.38)	5.3243	15.0863		
The control means are not significantly different (p = 0.52)	0.67773	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	71.4	>71.4		1.40056	0.28714	0.30251	0.06509	0.04534	0.24132	5, 29

Dose-Response Plot



Statistical comparisons were against the ~~negative control~~ Pooled controls

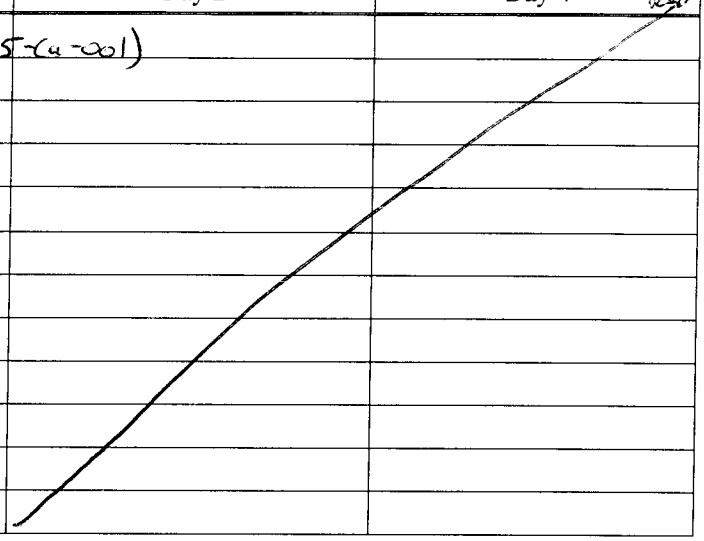
Reviewed by Aug-18/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~5298~~ 5298

EVS Analysts JXS, SXB, MJC, AKF
Test Initiation Date 19-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100 mg/L Cu Stock (05-Cu-001)		
Amount ~~Received~~ Prepared	1 x 1L		
Date ~~Collected~~ Prepared	7 Mar 05		
Date Received	Ma		
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			



DILUTION/CONTROL WATER (initial water quality)
Water Type Filtered, UV sterilized seawater
Temperature (°C) 20.0
pH 7.8
Dissolved Oxygen (mg/L) 7.5
Salinity 28

TEST SPECIES INFORMATION
Source ABS
Date Received 19-July-05
Age (on Day 0) 10-d
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 19 Jul 05
7-d survival LC50 ~~122 (106-140)~~ 117 (100-136) ug/L Cu
7-d growth IC50 ~~112 (80-147)~~ 116 (81-156) ug/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 133 ± 39 ug/L Cu CV = 15%
7-d growth IC50 132 ± 46 ug/L Cu CV = 17%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 - 8.0
Dissolved Oxygen Range (mg/L) ~~6.3~~ 6.2 - 7.7
Salinity (ppt) 28
Photoperiod (L:D h) 16:8
Aeration Provided? No
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	ug/L Cu	100	180	117 (100-136) ~~122 (106-140)~~		
Growth		56	100		116 (81-156) ~~112 (80-147)~~	83 (68-114) ~~80 (65-114)~~

Other

Data Verified By Qualfish
Date Verified Aug 22/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client (Polaris) Azimuth
Sample ID Cu Reference Toxicant
EVS Project No. 04-1424-044
Test Initiation Date/Time 19-July-05/1440h
EVS Work Order No. 0500~~258~~ 298 RSD
Source/Date Received ABS/19-July-05

Cu (µg/L) Concentration	Temperature (°C)													
	0	old	1 new	2		3		4		5		6		7
D-control	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
32	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
56	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
100	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
180	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.5
320	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0 ~~21.0~~	—	—	—	—	—	—
								MG						
Tech. Initials	TH	SxB	SxB	SxB	SxB	SxB	SxB	MG	MG	MG	MG	MG	MG	TH

Cu (µg/L) Concentration	pH													
	0	old	1 new	2		3		4		5		6		7
D-control	7.8	7.7	7.7	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
32	7.8	7.7	7.7	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
56	7.8	7.7	7.8	7.7	7.8	7.7	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9
100	7.8	7.7	7.7	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
180	7.8	7.7	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
320	7.8	7.7	7.8	7.7	7.8	7.8	7.9	7.8	7.9	7.8	7.8	8.0	7.9	7.9
Tech. Initials	TH	SxB	SxB	SxB	SxB	SxB	SxB	MG	MG	MG	MG	MG	MG	TH

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-030301
Comments

Test Set Up By JMS. SxB Data Verified By Qalfish Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~558~~ 298 RSP

Sample ID Cu Reference Toxicant
Test Initiation Date/Time 19-July-05/1440h
Source/Date Received ABS/19-July-05

Cu (mg/L) Concentration	Salinity (ppt)													
	0	1		2		3		4		5		6		7
0-control	28	28	28	28	28	28	28	28	28	28	28	28	28	28
32	28	28	28	28	28	28	28	28	28	28	28	28	28	28
56	28	28	28	28	28	28	28	28	28	28	28	28	28	28
100	28	28	28	28	28	28	28	28	28	28	28	28	28	28
180	28	28	28	28	28	28	28	28	28	28	28	28	28	28
320	28	28	28	28	28	28	28	28	—	—	—		—	—
Tech. Initials	TJ	SXB	SXB	SXB	SXB	SXB	SXB	SXB	MC	SXB	MC	SXB	MC	SXB

Cu (mg/L) Concentration	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6 MC 7.7		7
0-control	7.5	6.8	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.5	7.7	6.6	~~7.9~~	6.2
32	7.5	6.5	7.5	6.7	7.5	6.5	7.5	6.6	7.7	6.5	7.7	6.6	7.7	6.3
56	7.5	6.6	7.5	6.8	7.5	6.6	7.5	6.5	7.7	6.5	7.7	6.7	7.7	6.6
100	7.5	6.6	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.4	7.7	6.7	7.7	6.4
180	7.5	6.6	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.5	7.7	6.6	7.7 MC	6.6
320	7.5	6.6	7.5	6.7	7.5	6.7	7.5	6.5	~~7.7~~ 7.7 MC	—	—	—	—	
Tech. Initials	TJ	SXB	SXB	SXB	SXB	SXB	SXB	MC	MC	MC	MC	MC	MC	TJ

WQ Instruments Used: Salinity I-A-050505 DO I-A-0814
Comments

Test Set Up By TJ SXB Data Verified By [signature] Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0589 ~~458~~ 298
RSO

Sample ID Cu Reference Toxicant
Test Species/Batch A. affinis/19-July-05
Test Initiation Date/Time 19-July-05/1440h
No. of Organisms/Volume 5/200mL

Cu (mg/L) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D-control	A	A80	5	5	5	5	5	5	5	
	B	A81	5	5	5	5	5	5	5	
	C	A82	5	5	5	5	5	5	5	
	D	A83	5	5	5	5	5	5	dead 4	
	E	A84	5	5	5	5	5	5	5	
32	A	A85	5	5	5	5	5	5	5	
	B	A86	5	5	5	5	5	5	5	
	C	A87	5	5	5	5	5	5	5	
	D	A88	5	5	5	5	5	5	5	
	E	A89	5	5	5	5	5	5	4	
56	A	A91	5	5	4	4	4	4	4	
	B	A92	5	5	5	5	5	5	5	
	C	A93	5	5	5	5	5	5	5	
	D	A94	5	5	5	5	5	5	5	
	E	A95	5	5	5	5	5	5	5	
100	A	A66	5	3	2	2	2	2	2	
	B	A67	4	1	1	1	1	1	1	
	C	A68	5	4	4	4	4	4	4	
	D	A69	5	4	4	4	4	5	4	
	E	A70	5	5	5	5	5	5	5	
Technician Initials		TM	SXB	SXB	SXB	TM	TM	TM	TM	

Sample Description clear, colorless.
Data Verified By Original signed
Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client (Polaris) Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500~~158~~ 298
(150)

Sample ID Cu Reference Toxicant
Test Species/Batch A. affinis/19-July-05
Test Initiation Date/Time 19-July-05/1440h
No. of Organisms/Volume 5/200 ml

Cu (mg/L) Concentration	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
180	A		4	3	0	0	0	0 MK	—	
	B	471	5	5	4	4	4	~~3~~ 4	3	
	C		5	3	2	1	0	0	—	
	D		4	2	2	1	0	0	—	
	E	472	5	3	2	2	1	1	1	
320	A		3	2	1	0	0	0	-	
	B		2	2	0	0	0	0	—	
	C		2	2	1	0	0	0	—	
	D		2	2	0	0	0	0	—	
	E		3	2	0	0	0	0	—	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials		TM	SxB	SxB	SxB	MK	MK	MK	TM	

Sample Description clear, colorless
Data Verified By Malfish Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500298

Start Date (Day 0): 19-July-05
Sample ID: Cu Reference Toxicant
Balance Type/Serial Number: Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
D-CTL	A	A80	1225.71	1231.08	5	5		JxT/TJ
	B	A81	1228.66	1232.69	5	5		
	C	A82	1235.20	1239.66	5	5	Confirmed 1239.84 mg ✓	
	D	A83	1233.97	1239.36	~~5~~ 4	~~5~~ 4	1 fish lost when transferring	
	E	A84	1228.91	1234.00	5	5		

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: [signature]

Date Verified: Aug. 18/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)

EVS Project No.: 04-1424-044

EVS Work Order No.: 0500298

Start Date (Day 0): 19-Jul-05

Sample ID: Cu Reference Toxicant

Balance Type/Serial Number: Sartorius/BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
32	A	A85	1229.51	1236.23	5	5		AXF/TH
	B	A86	1233.16	1239.24	5	5		
	C	A87	1234.56	1238.84	5	5		
	D	A88	1225.13	1231.48	5	5		
	E	A89	1236.28	1241.25	4	4		
56	A	A91	1245.68	1249.99	4	4		
	B	A92	1222.48	1227.32	5	5		
	C	A93	1240.76	1246.95	5	5		
	D	A94	1233.51	1239.05	5	5		
	E	A95	1239.61	1245.85	5	5		
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph

Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client: Azimuth (Polaris)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500248

Start Date (Day 0): 19-Jul-05
Sample ID: Cu Reference Toxicant
Balance Type/Serial Number: Sartorius/BP-211D

Sample ID mg/L	Rep.	Pan No.	Pan Weight (mg) [1]	Final Weight (mg) (pan + biomass) [1]	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
100	A	A66	1227.36	1229.94	2	2		AXF
	B	A67	1237.38	1238.70	1	1		
	C	A68	1224.68	1228.~~49~~ 24	4	4	Confirmed 1228.25 mg ✓	
	D	A69	1232.31	1236.61	4	4		
	E	A70	1244.03	1247.98	5	5		
180	~~A~~ B	A71	1239.12	1241.93	3	3	Confirmed 1241.90 mg ✓	
	~~B~~ E	A72	1214.89	1215.67	1	1		
	~~C~~	~~A73~~	~~1221.50~~					
	~~D~~	~~A74~~	~~1238.30~~					
	~~E~~							
	A							
	B							
	C							
	D							
	E							

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be ≤10% of organism weight.

Data Verified By: Ralph

Date Verified: Aug. 17/05

Test: LF-Larval Fish Growth and Survival Test | Test ID: RTAACu45
Species: AA-Atherinops affinis | Protocol: EPAW 95-EPA West Coast
Sample ID: REF-Ref Toxicant | Sample Type: CU-Copper
Start Date: 7/19/2005 End Date: 7/26/2005 | Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1225.71	1231.08
	2	2	D-Control	5							5	5	1228.66	1232.69
	3	3	D-Control	5							5	5	1235.2	1239.86
	4	4	D-Control	5							5	5	1233.97	1239.36
	5	5	D-Control	5							5	5	1228.91	1234
	6	1	32.0	5							5	5	1229.51	1236.23
	7	2	32.0	5							5	5	1233.16	1239.24
	8	3	32.0	5							5	5	1234.56	1238.84
	9	4	32.0	5							5	5	1225.13	1231.48
	10	5	32.0	5							4	4	1236.28	1241.25
	11	1	56.0	5							4	4	1245.68	1249.99
	12	2	56.0	5							5	5	1222.48	1227.32
	13	3	56.0	5							5	5	1240.76	1246.95
	14	4	56.0	5							5	5	1233.51	1239.05
	15	5	56.0	5							5	5	1239.61	1245.85
	16	1	100.0	5							2	2	1227.36	1229.94
	17	2	100.0	5							1	1	1237.38	1238.7
	18	3	100.0	5							4	4	1224.68	1228.24
	19	4	100.0	5							4	4	1232.31	1236.61
	20	5	100.0	5							5	5	1244.03	1247.98
	21	1	180.0	5							0	0	0	0
	22	2	180.0	5							3	3	1239.12	1241.93
	23	3	180.0	5							0	0	0	0
	24	4	180.0	5							0	0	0	0
	25	5	180.0	5							1	1	1214.89	1215.67
	26	1	320.0	5							0	0	0	0
	27	2	320.0	5							0	0	0	0
	28	3	320.0	5							0	0	0	0
	29	4	320.0	5							0	0	0	0
	30	5	320.0	5							0	0	0	0

Comments: Azimuth Polaris 04-1424-044 (0500298)

Reviewed by: Aug. 22/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	7/19/2005	Test ID:	RTAACu45	Sample ID:	REF-Ref Toxicant
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth Polaris 04-1424-044 (0500298)				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000
32	1.0000	1.0000	1.0000	1.0000	0.8000
56	0.8000	1.0000	1.0000	1.0000	1.0000
100	0.4000	0.2000	0.8000	0.8000	1.0000
180	0.0000	0.6000	0.0000	0.0000	0.2000
320	0.0000	0.0000	0.0000	0.0000	0.0000

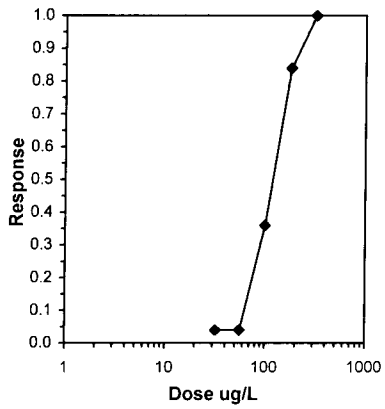
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
100	0.6400	0.3286	0.9416	0.4636	1.3453	38.004	5	17.50	17.00	9	25
*180	0.1600	0.2608	0.4053	0.2255	0.8861	71.039	5	15.00	17.00	21	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.90309	0.888	0.17519	1.66432
Equality of variance cannot be confirmed				

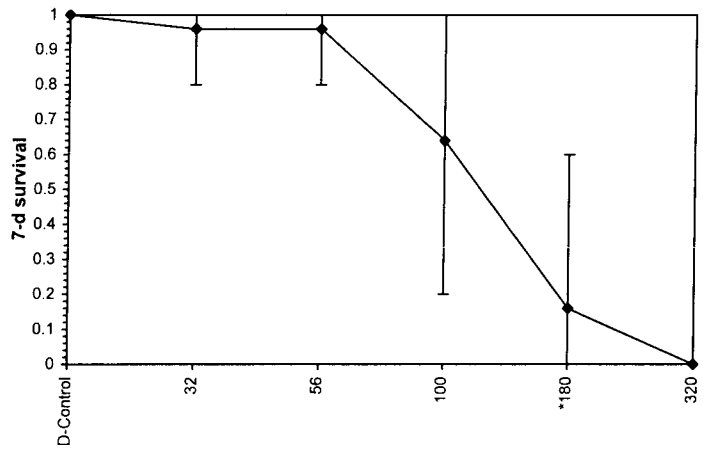
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	180	134.164	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	116.88	100.05	136.55	
10.0%	116.41	98.86	137.08	
20.0%	117.22	94.25	145.79	
Auto-4.0%	117.04	100.39	136.44	ug/L Cu



Dose-Response Plot



Reviewed by [signature] Aug. 22/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	7/19/2005	Test ID:	RTAACu45	Sample ID:	REF-Ref Toxicant
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth Polaris 04-1424-044 (0500298)				

Conc-ug/L	1	2	3	4	5
D-Control	1.0740	0.8060	0.9320	1.0780	1.0180
32	1.3440	1.2160	0.8560	1.2700	0.9940 ✓
56	0.8620	0.9680	1.2380	1.1080	1.2480
100	0.5160	0.2640 ✓	0.7120	0.8600	0.7900
180	0.0000	0.5620	0.0000	0.0000	0.1560 ✓
320	0.0000	0.0000	0.0000	0.0000	0.0000

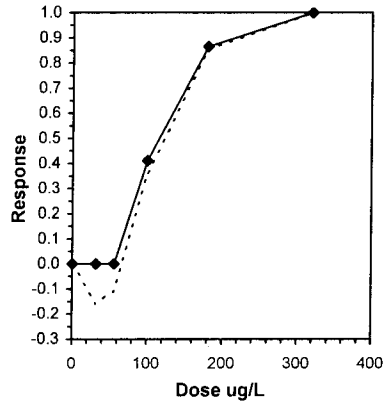
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.9816	0.1145	0.9816	0.8060	1.0780	11.666	5				1.0675	1.0000
32	1.1360	0.2038	1.1360	0.8560	1.3440	17.943	5	-1.219	2.300	0.2913	1.0675	1.0000
56	1.0848	0.1688	1.0848	0.8620	1.2480	15.557	5	-0.815	2.300	0.2913	1.0675	1.0000
*100	0.6284	0.2409	0.6284	0.2640	0.8600	38.338	5	2.789	2.300	0.2913	0.6284	0.5887
*180	0.1436	0.2435	0.1436	0.0000	0.5620	169.535	5	6.618	2.300	0.2913	0.1436	0.1345
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9755	0.888	0.077	-0.1953
Bartlett's Test indicates equal variances (p = 0.66)	2.41004	13.2767		

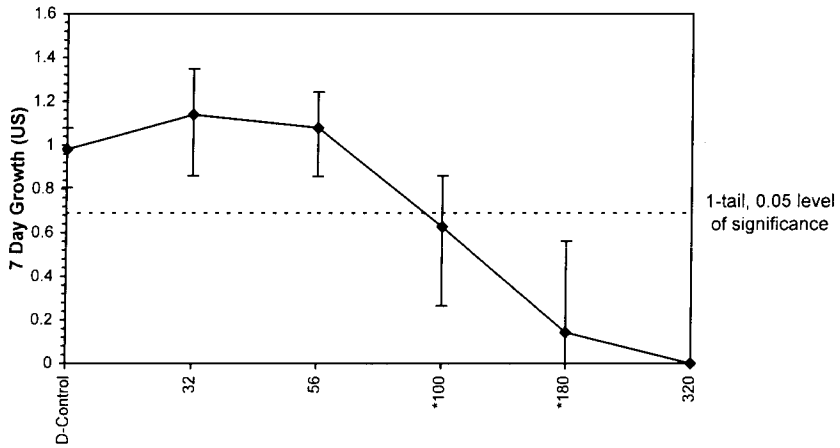
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	56	100	74.8331		0.29126	0.29672	0.85895	0.04009	5.4E-07	4, 20

Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew	
IC05	61.35	6.16	30.65	67.13	-1.9529	
IC10	66.70	4.93	43.95	78.27	-0.6852	
IC15	72.05	5.63	55.64	91.09	0.5478	
IC20	77.39	6.77	62.96	102.78	1.0777	
IC25	82.74	7.81	67.65	114.17	0.9592	
IC40	98.79	11.11	78.22	135.91	0.5373	
IC50	115.62	14.64	80.73	156.41	0.6255	ug/L Cu



Dose-Response Plot



Reviewed by Aug 22/05

APPENDIX II

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299

EVS Analysts: SRS
Test Initiation Date: 19 July 05

SAMPLE

Identification: G-creek sublethal 071605
Amount Received: 3x20L
Date Collected: 16-Jul-05
Date Received: 19-Jul-05
Temperature (°C): 14.0 ① → 15.0
pH: 7.5 ① → 8.2
Dissolved Oxygen (mg/L): 11.1 ① → 8.5
Conductivity (µmhos/cm): 1520
Salinity (ppt): 3.0 ① → 28
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

① Brine Adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sea Lab
Date Received: ~~SDS~~ SRS 19 Jul 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 19 Jul 05
IC50 (and 95% CL): 5.8 (5.2 - 6.5) mg/L
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.6 ± 4.4 mg/L SDS; CV = 60%

DILUTION/CONTROL WATER (initial water quality)

Water Type: uv sterilized; 0.45µm filtered SW
Temperature (°C): 15
pH: 7.9
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 15.0
pH Range: ~~7.8~~ SRS 7.9 - 8.3
Dissolved Oxygen Range (mg/L): ~~7.9~~ SRS 7.9 - 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

Statistical comparisons were against pooled controls
IC_{50}: 13.2 (10.8 - ~~16.9~~ SRS 16.9) % v/v
IC_{25}: 5.2 (4.4 - 6.1) % v/v
NOEC: < 4.6 % v/v
LOEC: 4.6 % v/v

Data Verified By: [signature]
Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299
Logbook: Edmonds #13 Pages: 68-71

Test Initiation Date/Time: 19 July 05 / 1514
Test Species: Dendraster excentricus
Source/Date Received: Westmar Seatab / 19 July 05
Test Duration: 10:10

Sample ID G-Creek sublethal 071605	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Control	15	7.9	28	8.5	
Brine Control	15	8.3	28	8.5	
4.6 %v/v	15	8.0	28	8.5	
9.1% v/v	15	8.1	28	8.5	
18.2 ~~SDS~~ ±8.3% v/v	15	8.1	28	8.5	
36.4 ~~SDS~~ ±6.6% v/v	15	8.1	28	8.5	
Max (72.8%)	15	8.2	28	8.5	
Technician Initials	SRS	SRS	SRS	SRS	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-030301 Salinity II-A-030304 DO II-A-20

Sample Description: Sample is clear with no odour.

Data Verified By: Qaljf Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimuth (Polaris Mine)
EVS Project No. 04-1424-044
EVS Work Order No. 0500299
Logbook Echinoid #13 Pages 68-71

Test Initiation Date/Time 19 July 05 / 1514
Test Species Dendraster excentricus
Source/Date Received 19 July 05 / Westwind SeaLab
Test Duration 10:10
Sperm:Egg Ratio 2000:1

Sample ID % (V/V)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Control	A	64	36		SRS
	B	60	40		
	C	66	34		
	D	69	31		
G-Creek Subsurface 071605 4.6	A	56	44		SRS
	B	51	49		
	C	52	48		
	D	53	47		
G-Creek Subsurface 071605 9.1	A	39	61		SRS
	B	37	63		
	C	37	63		
	D	36	64		
G-Creek Subsurface 071605 18.2 SRS	A	33	67		SRS
	B	~~38~~ 28	72		
	C	29	71		
	D	30	70		
G-Creek Subsurface 071605 36.4 SRS	A	20	80		SRS
	B	27	73		
	C	23	77		
	D	24	76		
G-Creek Subsurface 071605 Max (72.8)	A	20	80		SRS
	B	16	84		
	C	21	79		
	D	21	79		

Data Verified By Qualified
Date Verified Aug. 17/05

Test: SC-Sperm Cell Fertilization test					Test ID: 0500299		
Species: DE-Dendraster excentricus					Protocol: EPS1/RM/27-EC 92 (Sperm Cell)		
Sample ID: g_creek sublethal 071605					Sample Type: GW-groundwater		
Start Date: 7/19/2004 10:10			End Date: 7/19/2004		Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	64	36	
	2	2	D-Control	100	60	40	
	3	3	D-Control	100	66	34	
	4	4	D-Control	100	69	31	
	5	1	B-Control	100	70	30	
	6	2	B-Control	100	68	32	
	7	3	B-Control	100	71	29	
	8	4	B-Control	100	67	33	
	9	1	4.600	100	56	44	
	10	2	4.600	100	51	49	
	11	3	4.600	100	52	48	
	12	4	4.600	100	53	47	
	13	1	9.100	100	39	61	
	14	2	9.100	100	37	63	
	15	3	9.100	100	37	63	
	16	4	9.100	100	36	64	
	17	1	18.200	100	33	67	
	18	2	18.200	100	28	72	
	19	3	18.200	100	29	71	
	20	4	18.200	100	30	70	
	21	1	36.400	100	20	80	
	22	2	36.400	100	27	73	
	23	3	36.400	100	23	77	
	24	4	36.400	100	24	76	
	25	1	72.800	100	20	80	
	26	2	72.800	100	16	84	
	27	3	72.800	100	21	79	
	28	4	72.800	100	21	79	

Comments: Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)

Reviewed by: Aug 19/04

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2004 10:10	Test ID:	500299	Sample ID:	g_creek sublethal 071605
End Date:	7/19/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	GW-groundwater
Sample Date:	7/16/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm (	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)				

Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.6688	0.0356	0.6688	0.6000	0.7100	5.328	8				0.6688	1.0000
*4.6	0.5300	0.0216	0.5300	0.5100	0.5600	4.076	4	8.308	2.508	0.0419	0.5300	0.7925
*9.1	0.3725	0.0126	0.3725	0.3600	0.3900	3.378	4	17.739	2.508	0.0419	0.3725	0.5570
*18.2	0.3000	0.0216	0.3000	0.2800	0.3300	7.201	4	22.080	2.508	0.0419	0.3000	0.4486
*36.4	0.2350	0.0289	0.2350	0.2000	0.2700	12.284	4	25.972	2.508	0.0419	0.2350	0.3514
*72.8	0.1950	0.0238	0.1950	0.1600	0.2100	12.208	4	28.367	2.508	0.0419	0.1950	0.2916

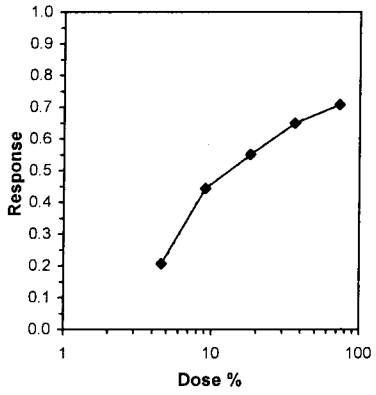
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96577	0.896	-0.6264	0.89125
Bartlett's Test indicates equal variances (p = 0.59)	3.72999	15.0863		
The control means are not significantly different (p = 0.09)	2.02707	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	<4.6	4.6			0.04189	0.06264	0.18978	0.00074	1.0E-18	5, 22

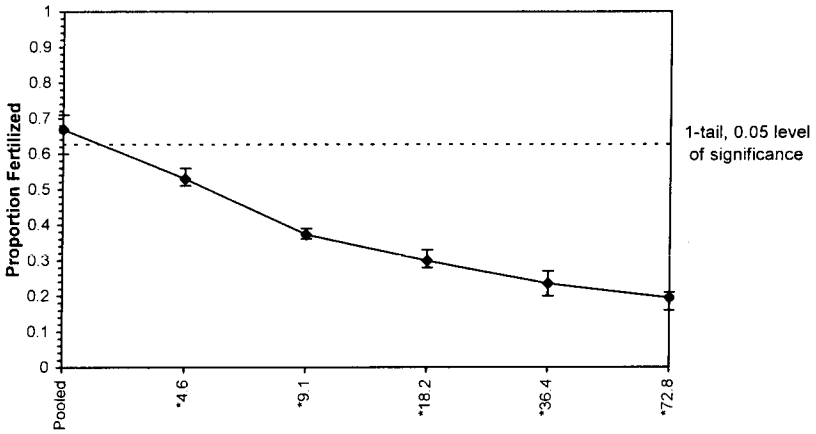
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.515	0.065	0.376	0.746	1.1707	
IC10*	1.294	0.204	0.886	2.030	1.4723	
IC15*	2.475	0.454	1.574	4.227	1.0928	
IC20*	4.263	0.546	2.495	5.437	-0.5325	
IC25	5.229	0.268	4.417	6.073	-0.2992	
IC40	8.069	0.268	7.197	8.864	-0.1114	
IC50	13.159	1.074	10.756	16.853	0.9349	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: Statistical comparisons were against pooled controls

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2004 10:10	Test ID:	500299	Sample ID:	g_creek sublethal 071605
End Date:	7/19/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	GW-groundwater
Sample Date:	7/16/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)				

Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

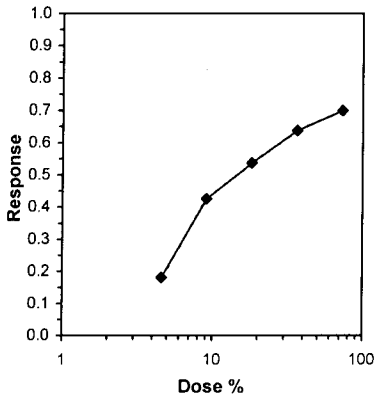
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6475	0.0377	0.6475	0.6000	0.6900	5.830	4				0.6475	1.0000
B-Control	0.6900	0.0183	0.6900	0.6700	0.7100	2.646	4					
*4.6	0.5300	0.0216	0.5300	0.5100	0.5600	4.076	4	6.504	2.410	0.0435	0.5300	0.8185
*9.1	0.3725	0.0126	0.3725	0.3600	0.3900	3.378	4	15.222	2.410	0.0435	0.3725	0.5753
*18.2	0.3000	0.0216	0.3000	0.2800	0.3300	7.201	4	19.235	2.410	0.0435	0.3000	0.4633
*36.4	0.2350	0.0289	0.2350	0.2000	0.2700	12.284	4	22.833	2.410	0.0435	0.2350	0.3629
*72.8	0.1950	0.0238	0.1950	0.1600	0.2100	12.208	4	25.047	2.410	0.0435	0.1950	0.3012

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.98059		0.884		-0.1047	-0.1759
Bartlett's Test indicates equal variances (p = 0.67)					3.19845		15.0863			
The control means are not significantly different (p = 0.09)					2.02707		2.44691			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	<4.6	4.6			0.04354	0.06724	0.12461	0.00065	6.1E-15	5, 18

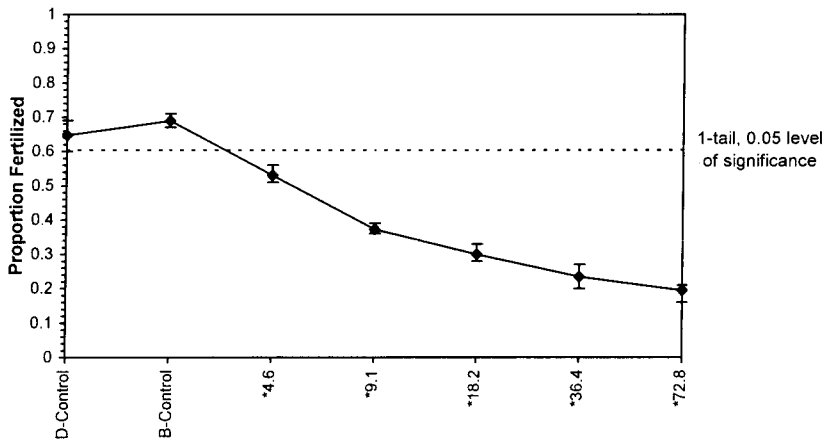
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	0.607	0.161	0.394	1.360	2.3644	
IC10*	1.584	0.557	0.927	4.356	2.4779	
IC15*	3.154	0.865	1.634	6.106	0.5417	
IC20	4.857	0.524	3.042	6.173	-0.5720	
IC25	5.612	0.375	4.664	6.952	0.2814	
IC40	8.513	0.444	7.515	10.306	1.0512	
IC50	14.556	1.689	10.887	21.343	0.9377	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: Statistical comparisons were against the dilution control

Reviewed by

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500299

EVS Analysts: SRS
Test Initiation Date: 19 July 05

SAMPLE

Identification: SDS Reftox Stock Soln #05-3-004
Amount ~~Received~~ Prep'd: 1 x 1L
Date ~~Collected~~ Prep'd: 7-Jun-05
Date Received: N/A
Temperature (°C):
pH:
Dissolved Oxygen (mg/L):
Conductivity (µmhos/cm):
Salinity (ppt):
Ammonia (mg/L N):
Chlorine (mg/L Cl):
Other:

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 19 July 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 19 July 05
IC50 (and 95% CL): 5.8 (5.2 - 6.5) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.6 ± 4.4 mg/L SDS, CV% = 60

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized; 0.45 µm filtered SW
Temperature (°C): 15
pH: 7.9
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 28
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 - 7.9
Dissolved Oxygen Range (mg/L): 8.5
Salinity Range (ppt): 28
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC50: 5.8 (5.2 - 6.5) mg/L SDS
IC25: 3.0 (2.6 - 3.5) mg/L SDS
NOEC: 1.0 mg/L SDS
LOEC: 1.8 mg/L SDS

Data Verified By: [signature]
Date Verified: Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth (Polaris Mine)
EVS Project No. 04-1424-044
EVS Work Order No. 0500299
Logbook #13 Pages 68-71'

Test Initiation Date/Time 19 July 05 / 1514
Test Species Dendraster excentricus
Source/Date Received Westwind Seatab / 19 July 05
Test Duration 10:10

Reftox

Sample ID SDS (mg/L)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Control	15	7.9	29	8.5	
1.0	15	7.8	28	8.5	
1.8	15	7.8	28	8.5	
3.2	15	7.8	28	8.5	
5.6	15	7.8	28	8.4 8.5	
10.0	15	7.8	28	8.4 8.5	
Technician Initials	SRS	SRS	SRS	SRS	

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH ID-A-030301 Salinity ID-A-030304 DO ID-A-20

Sample Description

Data Verified By [signature] Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: Azimuth (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0508299
Logbook: #13 Pages: 68-71

Test Initiation Date/Time: 19 Aug 05 / 1514
Test Species: Dendraster excentricus
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Concentration SDS (mg/L)	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	71	29		SRS
	B	69	31		
	C	71	29		
	D	70	30		
1.8	A	56	44		
	B	60	40		
	C	62	38		
	D	60	40		
3.2	A	~~51~~ 51	~~49~~ 49		
	B	47	53		
	C	51	49		
	D	50	50		
5.6	A	34	66		
	B	37	63		
	C	32	68		
	D	36	64		
10	A	20	80		
	B	21	79		
	C	18	82		
	D	19	81		
Control Seawater					
Brine Control	A	70	30		SRS
	B	68	32		
	C	71	29		
	D	67	33		

Data Verified By: [signature] Date Verified: Aug 17/05

Test: SC-Sperm Cell Fertilization test						Test ID: rtdesds051	
Species: DE-Dendraster excentricus						Protocol: EPS1/RM/27-EC 92 (Sperm Cell)	
Sample ID: REF-Ref Toxicant						Sample Type: SDS-Sodium dodecyl sulfate	
Start Date: 7/19/2005 10:10			End Date: 7/19/2005			Lab ID: BCEVS-EVS Environment Consultants	
Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	64	36	
	2	2	D-Control	100	60	40	
	3	3	D-Control	100	66	34	
	4	4	D-Control	100	69	31	
	5	1	1.000	100	71	29	
	6	2	1.000	100	69	31	
	7	3	1.000	100	71	29	
	8	4	1.000	100	70	30	
	9	1	1.800	100	56	44	
	10	2	1.800	100	60	40	
	11	3	1.800	100	62	38	
	12	4	1.800	100	60	40	
	13	1	3.200	100	51	49	
	14	2	3.200	100	47	53	
	15	3	3.200	100	51	49	
	16	4	3.200	100	50	50	
	17	1	5.600	100	34	66	
	18	2	5.600	100	37	63	
	19	3	5.600	100	32	68	
	20	4	5.600	100	36	64	
	21	1	10.000	100	20	80	
	22	2	10.000	100	21	79	
	23	3	10.000	100	18	82	
	24	4	10.000	100	19	81	

Comments: Azimuth Consulting Group 04-1424-044 (0500299)

Reviewed by Aug. 17/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	7/19/2005 10:10	Test ID:	rtdesds051	Sample ID:	REF-Ref Toxicant
End Date:	7/19/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 04-1424-044 (0500299)				

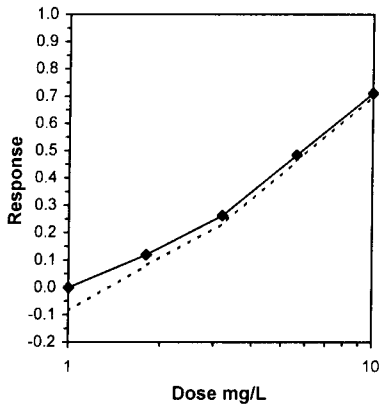
Conc-mg/L	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
1	0.7100	0.6900	0.7100	0.7000
1.8	0.5600	0.6000	0.6200	0.6000
3.2	0.5100	0.4700	0.5100	0.5000
5.6	0.3400	0.3700	0.3200	0.3600
10	0.2000	0.2100	0.1800	0.1900

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.6475	0.0377	0.6475	0.6000	0.6900	5.830	4				0.6750	1.0000
1	0.7025	0.0096	0.7025	0.6900	0.7100	1.363	4	-3.386	2.410	0.0391	0.6750	1.0000
*1.8	0.5950	0.0252	0.5950	0.5600	0.6200	4.230	4	3.232	2.410	0.0391	0.5950	0.8815
*3.2	0.4975	0.0189	0.4975	0.4700	0.5100	3.805	4	9.234	2.410	0.0391	0.4975	0.7370
*5.6	0.3475	0.0222	0.3475	0.3200	0.3700	6.381	4	18.468	2.410	0.0391	0.3475	0.5148
*10	0.1950	0.0129	0.1950	0.1800	0.2100	6.620	4	27.855	2.410	0.0391	0.1950	0.2889

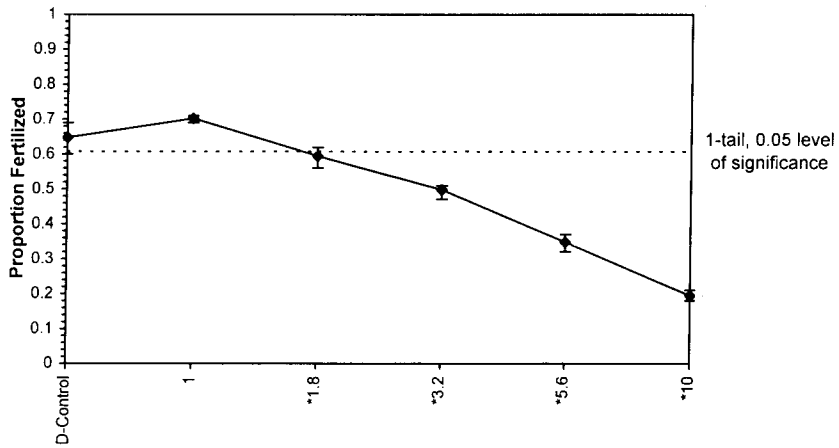
Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.96443		0.884		-0.4619	0.4979
Bartlett's Test indicates equal variances (p = 0.33)					5.80467		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	1	1.8	1.34164		0.03915	0.06046	0.15043	0.00053	1.8E-16	5, 18

Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew	
IC05	1.3050	0.0620	1.1588	1.5675	0.7327	
IC10	1.6566	0.1267	1.3262	2.1192	0.1987	
IC15	2.0587	0.1538	1.5036	2.4959	-0.3268	
IC20	2.5196	0.1504	2.0886	3.0277	-0.0752	
IC25	3.0499	0.1581	2.5656	3.5441	-0.1894	
IC40	4.5501	0.1485	4.0503	5.0634	-0.0472	
IC50	5.8248	0.2258	5.1944	6.4999	-0.1156	mg/L SDS



Dose-Response Plot



Reviewed by: Aug. 17/05

APPENDIX III

Chain-of-Custody Form

CHAIN-OF-CUSTODY/TEST REQUEST FORM

Please see instructions for completion on back. Shaded areas to be completed by EVS Laboratory upon sample receipt.

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.evsenvironment.com

Client Name: Teck Cominco
Client Contact Name: Bruce Donald
Ship to: BILL TO AZIMUTH CONSULTING GROUP.
Address: Bay 2000 Kimberley BC V1A 3E1
Phone: (250)427-8405
Fax: (250)427-8451
Sampled By: Blake Hamer
Attn: Edmond Cenerio
Shipping Date: July 16/05

Collection Date (dd/mmm/yy)	Time (24-h clock)	Sample Identification	1 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G = grab; C = composite	Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L)	2 Sample Container Type by Code	Test(s) Requested: 96-hr LC50 Rainbow Trout	48-hr LC50 Daphnia Magna	7-Day Toxicity Test	20 min Echinoderm Fertilization			3 Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (°C)	4 Condition/Integrity
For composite sample record date & time starting and ending																
16/07/05	0900	C-Creek_Acute_071605	E		G	2x20	P	X	X					Effluent Water		
16/07/05	0900	C-Creek_Sublethal_071605	E		G	3x20	P			X	X			Effluent Water		

EVS Receipt Check List SAP

EVS Project #: 04-1424-00044
EVS Workorder #: 0500296/7/8/9
Sample Storage Location: 4°C [X], Chemical [ ], Other ____
Supporting documentation/other information attached if applicable.

1.	Signatures & dates correct?	Y N
2.	Chain-of-custody fully completed?	Y N
3.	Containers arrived in good condition (unbroken)?	Y N
4.	Container labels completed (i.e., dates, ID's)?	Y N
5.	Container labels agreed with custody papers?	Y N
6.	Sample receipt temperature within acceptable range?	Y N
7a.	Sediment testing going to be initiated within 14 days?	Y N
7b.	If no, are samples under Nitrogen? If not, why?	Y N
8.	Chain-of-custody generated upon receipt.	[ ]
9.	Sample containers originate from EVS.	[ ]

PO/Reference No.:
Project Title: Polaris MMER.
Results Needed By: Routine Turn Around.

Comments/Instructions: Bill to: Azimuth Consulting Group.
Electronic Results to: Cheryl Mackintosh, Azimuth, cmackintosh@azimuthgroup.ca
Bruce Donald, Teck Cominco ~~tek~~ bruce.donald@teckcominco.com.
Temp: 12.7°C

A) Released By: Blake Hamer Date: July 16, 2005
Company: GLL Time: 1030
Courier name: ____
Shipping containers secured by: ~~Tape~~ Straps Lock Other ____ (circle one)
Custody seals used? Yes No

B) Received by: SAP Date: 19 July 05
Company: Golder Time: 10:45
Shipping containers received secure? (Yes) No
Custody seals intact? (Yes) No N/A

C) Released By: Date:
Company: Time:
Courier name: ____
Shipping containers secured by: Tape Straps Lock Other ____ (circle one)
Custody seals used? Yes No

D) Received by: Date:
Company: Time:
Shipping containers received secure? Yes No
Custody seals intact? Yes No N/A

1 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
2 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
3 Please note any conditions the lab should be aware of for safety and storage concerns
4 Acceptable (A); Unacceptable (U). Please note specifics (e.g., broken, leaking, lid not on) under Comments/Instructions

Revision Date: Sept. 25, 2000

Distribution of copies:
White, yellow, pink - accompany the shipment
Orange - retained by consignor (e.g., shipper)
Yellow - retained by consignee (e.g., receiver)
Pink - for use as needed
White - returned to consignor by consignee

smart science solutions

Champia parvula Sexual Reproduction Test Results

for Sample E452

for

Azimuth Consulting Group

by

Mary Moody
Environment and Minerals Division
Saskatchewan Research Council

SRC Publication No. 11020-7C05

August 2005

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Champia parvula Sexual Reproduction Test Quality Assurance Summary

Client	Azimuth Consulting Group	SRC Sample #	E452
File #	MM478	Test Initiation Date	Aug 9/05
Analyst	M. Moody	Test Completion Date	Aug 16/05
Sample Identity/Name	Garrow Creek		

This report is based on the Report Assessment Checklist for EEM Cycle Two: Test of Sexual Reproduction using the Red Macroalga *Champia parvula.* (May 1999)

Test Organisms, Method and Conditions - Species: *Champia parvula,* sexually mature male and female branches, in good health, males having sori with spermatia, females having trichogynes. Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day effluent exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Exposure/Dilution Medium: natural seawater collected at Pacific Environmental Science Centre, Environment Canada, North Vancouver, B.C., filtered to 0.2µm and autoclaved before use, adjusted as necessary to salinity 30 ppt. with hypersaline brine made from the same source water. Test medium is natural seawater enriched with 10 ml/L Test Nutrient Solution. Recovery Medium is natural seawater as above, enriched with 10 ml/L Culture Nutrient Solution (method section 16.10.1.3).

Reference Toxicant Test - Method: EPA/600/4-91/003, Method 1009.0, static, non-renewal; 2-day toxicant exposure followed by 5 to 7 day recovery period in control medium for cystocarp development. Test conditions: performed under same experimental conditions as effluent sample. Compound: sodium dodecyl sulphate mg/L

Date of test: Aug 17/05	Historic value, warning limits ±2SD
IC_{50} (95 % CL) mg/L 1.31 (1.20 - 1.41)	1.41 (1.15 - 1.74)

Quality Control Data - There was no unusual appearance or treatment of test organisms before their use in the test. There was nothing unusual about the test, no deviation from the test method or problems encountered. No control mortality was observed in any control solution during observation periods. Sample was tested within 72 hours of collection. The mean number of cystocarps per plant counted in this test must be >10 to be acceptable. Data for this test is as follows.

natural seawater controls	85.9
brine controls	95.8
pooled control cystocarp count*	90.9

* this number used in calculation of IC values as required in EC guidance document on salinity adjustment, July 1997

Toxicity Test Results

IC_{25} (95 % CL) %v/v	45.3 (27.5 - 52.4)
Signature	M. Moody
Date	Aug 24/05

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Test Data Summary

SAMPLE

				SRC#	E452
Identification/Name	Garrow Creek			Analyst	Mary Moody
Date/Time Received	Aug 9/05@ 0900	Date Collected	Aug 6/05	Temperature Upon Receipt (°C)	22 with ice packs
Test Initiation Date	Aug 9/05	Test Completion Date	Aug 16/05		

ORGANISM INFORMATION

Species	*Champia parvula*	Appearance/Health of *Champia*	excellent
Source	sexually mature male and female branches, obtained from USEPA, Hatfield Marine Science Center, Newport, Oregon, 1995		
Females, Presence of Trichogynes	yes	Males, Presence of Sori with Spermatia	yes

TEST CONDITIONS

Test Method	USEPA/600/4-91/003, Method 1009.0	Dilution water	Natural seawater from Pacific Environmental Science Centre, North Vancouver B.C.
Test Type	static, non-renewal; 2 day effluent exposure followed by 5-7 day recovery period in control medium for cystocarp development		
Test Vessels (Exposure & Recovery)	270 ml transparent polystyrene cups, transparent polystyrene lids		
Exposure Volume / Depth	100 ml / 4.5 cm	Recovery Volume / Depth	200 ml / 7.3 cm
Replicates/Conc.	3	No. of organisms (female/male)	5/2
Number and Concentrations of Test Solutions (%v/v)	Controls: (two) natural sea water, brine Tests: 70, 35, 17.5, 8.75, 4.38		
Chemicals added to control/dilution water	Test Nutrients as described in method cited at 10 ml/L, analytical grade		

Sample Treatment

D.O. on unadjusted sample salinity adjustment (mg/L)	8.6	D.O. after salinity adjustment (mg/L)	7.7		
Aeration (duration/rate)	none	Filtration	none	pH Adjustment	none
Salinity Adjustment*	600 mL effluent + 260 mL hypersaline brine + 8.6 mL test nutrient solution				
Hypersaline Brine for Salinity Adjustment*	Prepared from natural seawater, at 90 ppt salinity				

* *as per EC guidance document on salinity adjustment, May 2001*

Exposure Period (48 h) and Recovery Period (5-7 days)

Temperature, pH, D.O. and Salinity of test solutions and controls on following page

Photoperiod (L:D h)	16:8	Agitation of tests and controls during exposure	gentle rotary shaking

Recovery Medium: natural sea water containing 10 ml/L Culture Nutrients (section 16.10.1.3 of cited method)

Aeration during recovery: gentle aeration supplied

TOXICITY TEST RESULTS

IC_{25} (%v/v) (95% CL)	45.3 (27.5 - 52.4)	IC_{50} (%v/v), (95% CL)	61.4 (50.4 - 66.6)
Mean control cystocarps/female (pooled natural sea water and brine controls)			90.9

Submitted By: Mary Moody **Date:** Aug 24/05

Saskatchewan Research Council
15 Innovation Boulevard, Saskatoon, SK S7N 2X8
Phone: 306-933-5469

Water Quality Data

Sample Identification/Name Garrow Creek SRC# E452

INITIAL WATER QUALITY	UNADJUSTED SAMPLE at test start, without salinity adjustment	TEST MEDIUM	RECOVERY MEDIUM
Temperature (°C)	23	23	23
Dissolved Oxygen (mg/L)	8.6	7.6	7.8
pH	7.75	8.35	8.10
Salinity (ppt):	2	30	30

Sample Description clear colourless liquid Length of Recovery Period (days) 5

Water Quality Data during Exposure Period (0, 48 hr) and Recovery Period (0 and end)

Concentration % (v/v)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Salinity (ppt)			
	exposure		recovery		exposure		recovery		exposure		recovery		exposure		recovery	
	0	48	0	end	0	48	0	end	0	48	0	end	0	48	0	end
Control-NSW*	23	23	23	23	7.6	7.8	7.8	7.9	8.34	8.37	8.10	7.98	30	30	30	30
Control-brine	23	23	23	23	7.8	7.8	7.8	7.8	8.11	8.59	8.10	8.01	30	30	30	30
A 70	23	23	23	23	7.7	7.8	7.8	7.9	8.05	8.54	8.10	8.03	30	30	30	30
C 17.5	23	23	23	23	7.8	7.8	7.8	7.9	8.29	8.64	8.10	8.67	30	30	30	30
E 4.38	23	23	23	23	7.6	7.8	7.8	7.9	8.34	8.47	8.10	8.05	30	30	30	30

RECOVERY PERIOD - TEMPERATURE MONITORING (initial daily entries)

Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
23	23	23	23	23	23		

Comments

pH before salt addition: 7.75, after salt addition 8.12

*NSW natural sea water

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Phone: 306-933-5469

Test Data

Sample Identification Garrow Creek E452

Concentration % (v/v) #		Rep	Mortality #	Mortality %	Individual Plant Cystocarp Counts 1	2	3	4	5	mean	SD*	Comments
Control, Natural Sea Water		A	0	0	130	80	119	96	95	104.0	20.1	Mean and SD 85.9, 23.8 Healthy red colour, normal growth
		B	0	0	63	86	60	60	102	74.2	19.0	
		C	0	0	95	106	54	54	89	79.6	24.2	
Control, brine		A	0	0	96	98	129	106	90	103.8	15.2	Mean and SD 95.8, 15.3 Healthy red colour, normal growth
		B	0	0	75	74	103	91	80	84.6	12.3	
		C	0	0	97	96	104	118	80	99.0	13.8	
E	4.38	A	0	0	105	60	81	103	100	89.8	19.2	Mean and SD 80.8, 17.4 Healthy red colour, normal growth
		B	0	0	88	53	65	84	60	70.0	15.3	
		C	0	0	103	75	85	64	86	82.6	14.5	
D	8.75	A	0	0	110	88	75	72	88	86.6	15.0	Mean and SD 92.9, 22.9 Healthy red colour, normal growth
		B	0	0	109	127	75	71	110	98.4	24.3	
		C	0	0	82	50	124	121	91	93.6	30.5	
C	17.5	A	0	0	100	138	92	71	77	95.6	24.6	Mean and SD 92.7, 19.1 Healthy red colour, normal growth
		B	0	0	107	107	65	100	91	94.0	17.5	
		C	0	0	99	101	63	94	85	88.4	15.5	
B	35	A	0	0	82	67	118	115	77	91.8	23.2	Mean and SD 82.6, 24.2 Healthy red colour, normal growth
		B	0	0	67	88	76	138	75	88.8	28.5	
		C	0	0	55	75	58	57	91	67.2	15.5	
A	70	A	0	0	35	27	40	37	36	35.0	4.8	Mean and SD 33.3, 8.3 Healthy red colour, normal growth
		B	0	0	44	41	18	40	40	36.6	10.5	
		C	0	0	22	41	23	25	31	28.4	7.9	

* Standard Deviation

Submitted by: [signature] Date: Aug 24/05

Algal Reproduction Test-Reproduction

Start Date:	8/9/2005	Test ID:	CP478IM	Sample ID:	E452
End Date:	8/16/2005	Lab ID:	SRC-Saskatchewan Researc	Sample Type:	effluent
Sample Date:	8/6/2005	Protocol:	EPA MARINE	Test Species:	CP-Champia parvula
Comments:	Azimuth, Garrow Creek				

Conc-%	1	2	3
control NSW	104.0	74.2	79.6
control salt	103.8	84.6	99.0
4.38	89.8	70.0	82.6
8.75	86.6	98.4	93.6
17.5	95.6	94.0	88.4
35	91.8	88.8	67.2
70	35.0	36.6	28.4

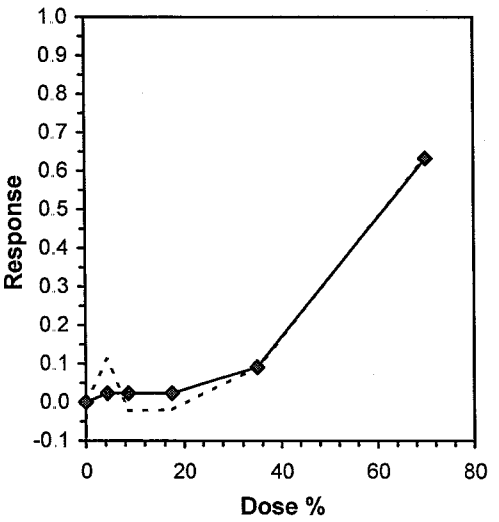
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	90.867	1.0000	90.867	74.200	104.000	14.348	6				90.867	1.0000
4.38	80.800	0.8892	80.800	70.000	89.800	12.403	3	1.401	2.602	18.693	88.778	0.9770
8.75	92.867	1.0220	92.867	86.600	98.400	6.390	3	-0.278	2.602	18.693	88.778	0.9770
17.5	92.667	1.0198	92.667	88.400	95.600	4.080	3	-0.251	2.602	18.693	88.778	0.9770
35	82.600	0.9090	82.600	67.200	91.800	16.248	3	1.151	2.602	18.693	82.600	0.9090
*70	33.333	0.3668	33.333	28.400	36.600	13.040	3	8.010	2.602	18.693	33.333	0.3668

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95534	0.873	-0.382	-0.7392
Bartlett's Test indicates equal variances (p = 0.41)	5.05585	15.0863		
The control means are not significantly different (p = 0.41)	0.91096	2.77645		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test Treatments vs Pooled Controls	35	70	49.4975	2.85714	18.6933	0.20572	1647.03	103.188	1.5E-05	5, 15

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	24.453	14.175	0.000	46.034	-0.2407
IC10	35.583	10.745	0.000	44.063	-1.3971
IC15	38.810	6.323	10.646	46.832	-1.1329
IC20	42.038	5.167	19.403	49.607	-1.0896
IC25	45.266	4.472	27.509	52.378	-1.0088
IC40	54.949	3.252	41.542	60.787	-1.0203
IC50	61.404	2.558	50.439	66.550	-0.9526



SRC

CHAIN-OF-CUSTODY / TEST REQUEST FORM

№ 0744

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Client Name: Bruce Donald
Client Contact: Bruce Donald
Ship to: SRC

Address: 200 2000 Kimberly BC V1A 3E1
Phone: 250-427-8905
Fax: 250-427-8451
15 Innovation Boulevard Saskatoon SK S7N 2X8

Sampled by: B Bolton
Attn.: Mary Moody
Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
								Sat the [illegible] to [illegible]					
Aug/8/05	10:00	Gorrow Creek	E		G	2x2L							
		received Aug 9/05				2x2L		at 22°C		with ice packs			

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Bolton Date: Aug 6/05
Company: Gartner Lee Time: 1400 hrs
Courier Name:

1) Received by: M Moody Date: Aug 9/05
Company: SRC Time: 0900

2) Released by: Date:
Company: Time:
Courier Name:

2) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt

Golder Project No.:
Golder Work Order No.:
Condition Upon Receipt:
Receipt Sample Temp. (°C):

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies:
White, Yellow — accompany the shipment
Pink — kept by consignor (e.g. shipper)
Yellow — kept by consignee (e.g. receiver)
White — returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

September 2005

LABORATORY REPORT

Azimuth Consulting Group

POLARIS MINE

ENVIRONMENTAL EFFECTS MONITORING PROGRAM

August 6, 2005 Sample

PREPARED FOR:

Azimuth Consulting Group
Vancouver, BC

PREPARED BY:

EVS environment consultants
A Member of the Golder Group of Companies
North Vancouver, BC

AZIMUTH CONSULTING GROUP

POLARIS MINE ENVIRONMENTAL EFFECTS MONITORING PROGRAM

AUGUST 6, 2005 SAMPLE

LABORATORY REPORT

Prepared for

Azimuth Consulting Group
218-2902 W. Broadway
Vancouver, BC
V6K 2G8

Prepared by

EVS Environment Consultants (A Member of the Golder Group of Companies)
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

EVS Project No.

04-1424-044

September 2005

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GLOSSARY

Control	A treatment in an investigation or study that duplicates all the conditions and factors that might affect the results of the investigation, except the specific condition that is being studied. In an aquatic toxicity test, the control must duplicate all the conditions of the exposure treatment(s), but must contain no test substance. The control is used to determine the absence of measurable toxicity due to basic test conditions (e.g., quality of the dilution water, health of test organisms, or effects due to handling of test organisms). (Environment Canada, 1998)
Dilution water	Water used to dilute the test material in an aquatic toxicity test in order to prepare either different concentrations of a test chemical or different percentages of an effluent for the various test treatments. The water (negative) control in a test is prepared with dilution water only. (Rand, 1995)
Effluent	Any liquid waste (e.g., industrial, municipal) discharged to the aquatic environment. (Environment Canada, 1998)
Endpoint	The reaction of the organisms to show the effect which is intended to mark completion of the test, and also the measurement(s) or value(s) derived, that characterize the results of the test (e.g., IC*p*). (Environment Canada, 1998)
IC*p*	The inhibiting concentration for a (specified) percent effect. It represents a point estimate of the concentration of test substance that is estimated to cause a designated percent impairment in a quantitative biological function such as the size attained by fish during a growth period. This term should be used for any toxicological test which measures a quantitative effect or change in rate, such as growth, reproduction, or respiration. (Environment Canada, 1998)
LC50	The median lethal concentration, i.e., the concentration of substance in water estimated to be lethal to 50% of the test organisms. The LC50 and its 95% confidence limits are usually derived by statistical analysis of mortalities in several test concentrations, after a fixed period of exposure. The duration of exposure must be specified (e.g., 96-h LC50). (Environment Canada, 1998)

LOEC	The lowest-observed-effect-concentration. This is the lowest concentration of a test substance to which organisms are exposed, that causes adverse effects on the organism which are detected by the observer and are statistically significant. For example, the LOEC might be the lowest test concentration at which growth of fish was decreased significantly from that of the control groups. LOEC is generally reserved for adverse sublethal effects but can also be used for mortality, which might sometimes be the most sensitive effect observed. (Environment Canada, 1998)
NOEC	The no-observed-effect-concentration. This is the highest concentration of a test substance or material to which organisms are exposed, that does not cause any observed and statistically significant adverse effects on the organism. For example, the NOEC might be the highest test concentration at which growth was not decreased significantly from that of the control groups. NOEC customarily refers to adverse sublethal effects, and to the most sensitive effect unless otherwise specified. (Environment Canada, 1998)
Percentage (%)	A concentration expressed in parts per hundred parts. One percentage represents one unit or part of substance (e.g., effluent, elutriate, leachate or receiving water) diluted with water or medium to a total of 100 parts. Depending on the test substance, concentrations can be prepared on a weight-per-weight, weight-per-volume, or volume-per-volume basis, and are expressed as the percentage of test substance in the final sediment mixture or solution. (Environment Canada, 1999b)
Quality assurance (QA)	A program organized and designed to provide accurate and precise results. Included are selection of proper technical methods; tests, or laboratory procedures; sample collection and preservation; selection of limits; evaluation of data; quality control; and qualifications and training of personnel. (Rand, 1995)
Quality control (QC)	Specific actions required to provide information for the quality assurance program. Included are standardization, calibration, replicates, and control and check samples suitable for statistical estimates of confidence of the data. (Rand, 1995)

Reference toxicant	A standard chemical used to measure the sensitivity of the test organisms to establish confidence in the toxicity data obtained for a test substance. In most instances, a toxicity test with a reference toxicant is performed to assess the sensitivity of the organisms at the time the test substance is evaluated, and to determine the precision of results obtained by the laboratory for that chemical. (Environment Canada, 1999b)
Significant difference	A quantitative determination of the probability that two measurements of the same parameter are different, given the variability of the measurements.

1. INTRODUCTION

EVS Environment Consultants (a member of the Golder Group of Companies) conducted sublethal Metal Mining Effluent Regulations (MMER) toxicity testing for Azimuth Consulting Group as part of the Environmental Effects Monitoring (EEM) program for Polaris Mine.

A sample, identified as Garrow Creek, was collected from the Polaris Mine Site on August 6, 2005 in 20-L collapsible polyethylene containers. It was received at the EVS laboratory on August 9, 2005 and was stored in the dark at 4°C prior to test initiation. The sample was evaluated for toxicity using the 7-d topsmelt (*Atherinops affinis*) survival and growth toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. Toxicity testing was initiated on the day of initial sample receipt.

This report describes the methods and results of the 7-d topsmelt (*Atherinops affinis*) toxicity test and the echinoderm (*Dendraster excentricus*) fertilization toxicity test. The raw data and statistical analyses are provided in Appendices I and II respectively, and the chain-of-custody form is provided in Appendix III.

2. METHODS

2.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

A static-renewal 7-d survival and growth toxicity and reference toxicant tests using topsmelt (*A. affinis*) was conducted in accordance with U.S. Environmental Protection Agency (USEPA, 1995). Test conditions and methods are summarized in Table 1.

This 7-day test exposes topsmelt larvae to different concentrations of a given sample. Fish are fed on a daily basis and both survival and growth endpoints are measured at test termination. These observations are assessed in comparison to the pooled negative and brine controls.

2.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The echinoderm (*Dendraster excentricus*) fertilization toxicity test was conducted in accordance with Environment Canada (1992 with 1997 amendments). Test conditions and methods are summarized in Table 2.

This fertilization test involves exposing echinoderm sperm to a series of test concentrations for ten minutes, echinoderm eggs are then added allowing fertilization to occur for ten minutes. Following the ten minutes exposure time, the eggs are preserved and the number of fertilized and unfertilized eggs in each replicate are counted. These observations are assessed in comparison to the pooled negative and brine controls.

2.3 STATISTICAL ANALYSIS

Statistical analyses for all tests were conducted using the computer software program TOXCALC (version 5.0.23; Tidepool Scientific Software, 1994).

2.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

This study followed a comprehensive QA/QC Program to ensure full documentation and minimize possible errors in computation and reporting of results. The following general QA/QC guidelines were applied in this test: use of negative controls, use of positive controls, use of brine controls, replication, instrument calibration, water quality maintenance and

record-keeping, and use of standard operating procedures (SOPs). To ensure data and reporting meet quality standards, all data and statistical analyses were reviewed by a member of our QA/QC Committee prior to reporting the results.

Toxicity testing was carried out in accordance with applicable test methodologies and/or standards of practice. Our liability is limited solely to the cost of re-testing in the event of non-compliance with such test specifications or standards of practice. Golder/EVS accepts no responsibility or liability for the interpretation or use of these testing results by others, or for any delay, loss, damage or interruptions of testing, collection, preparation, and delivery of samples or test results resulting from events or circumstances beyond our control.

Table 1. 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static-renewal
Test duration	7 d
Test chamber	600-mL beaker
Test solution volume	200 mL
Number of replicate chambers per treatment	5
Number of organisms per test chamber	5
Age of test organisms at test initiation	10 d
Food	Newly hatched *Artemia* nauplii (<24 hours old)
Feeding Regime	Fed 0.5 mL/ beaker twice daily of concentrated nauplii suspension (prepared to provide 200 nauplii in 0.5 mL); no feeding at test termination
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.2, 8.4, 16.9, 33.7, 67.4% (v/v)
Renewal of dilutions	Daily
Aeration	None
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity daily
Temperature	20 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Overhead full-spectrum fluorescent lights; 538 – 1076 lux; 16:8 light:dark photoperiod
Reference toxicant	Initiated concurrently with sample using copper to generate LC50 and IC50 values; results compared to lab mean ± 2 SD
Endpoints	Survival and growth (dry weight)
Test validity	≥ 80% mean control survival; ≥ 0.85 mg/fish mean dry weight for surviving control fish
Reference protocol	US EPA (1995), EPA/600/R-95/136

Table 2. Echinoderm (*Dendraster excentricus*) fertilization toxicity test methods

TEST PARAMETER	TEST CONDITION
Test type	Static
Test duration	10:10 min
Test chamber	16 X 125 mm test tubes
Test solution volume	10 mL
Number of replicate chambers per treatment	4
Number of eggs per test chamber	2000
Age of test organisms	< 4 hours after spawning
Sample manipulations (e.g. pre-aeration, pH adjustment, filtration)	Salinity-adjusted
Control/dilution water	UV-sterilized and 0.5μm-filtered natural sea water from Vancouver Aquarium, BC
Dilutions	4.5, 8.9, 17.8, 35.6, 71.3% (v/v)
Renewal of dilutions	None
Aeration	None during testing
Water quality parameters and frequency	Temperature, pH, dissolved oxygen, and salinity
Temperature	15 ± 1°C
Salinity	30 ± 2 (sample adjusted with hypersaline brine [HSB]. Preparation of HSB and salinity adjustment as per EC guidance document on salinity adjustment –July 1997)
Lighting	Ambient laboratory illumination (moderate intensity)
Reference toxicant	Initiated concurrently with test; same test methods as above using SDS to generate an EC50 value; results compared to lab mean ± 2 SD
Endpoint	Fertilization of eggs
Test validity	≥ 50% and ≤ 100% mean control fertilization
Reference protocols	Environment Canada (1992), (EPS/1/RM/27 with 1997 amendments)

3. RESULTS

3.1 7-D TOPSMELT (*ATHERINOPS AFFINIS*) SURVIVAL AND GROWTH TOXICITY TEST

The test results are summarized in Table 3 and the raw statistical analyses are provided in Appendix I.

The highest concentration tested was approximately 67.4% due to salinity adjustment. The mean survival for the negative and brine controls was 92 and 88%, respectively. Mean dry weight in the pooled controls was 0.86mg. The negative and brine controls were not significantly different for both the growth and survival endpoints (p = 0.40 and p = 0.70, respectively).

The *A. affinis* survival and growth toxicity test showed no adverse effects on survival or growth in all tested concentrations relative to the pooled controls ($p \leq 0.05$). For the survival and growth endpoints, the NOEC was 67.4, and the LOEC was >67.4% (v/v). The LC50 for survival was >67.4% (v/v). The IC50 and IC25 for growth were both >67.4% (v/v).

3.2 ECHINODERM (*DENDRASTER EXCENTRICUS*) FERTILIZATION TOXICITY TEST

The test results are summarized in Table 4 and the raw statistical analyses are provided in Appendix II.

The highest concentration tested was 71.3% due to salinity adjustment. Mean fertilization in the pooled controls was 86%. The negative and brine controls were not significantly different (p =0.30).

The *D. excentricus* fertilization toxicity test exhibited adverse effects on egg fertilization in all test concentrations relative to the pooled controls ($p \leq 0.05$). The NOEC was <4.5 and LOEC was 4.5% (v/v). The IC50 and IC25 (95% confidence limits) values were 55.0 (49.2 – 61.1) and 15.6 (13.6 – 18.3) % (v/v), respectively.

3.2 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The tests met all passing criteria for test validity as outlined in the respective protocols. Water quality parameters during the test were all within the acceptable range of values. Point estimates for the reference toxicant tests were all within the laboratory mean ± 2 standard deviations, indicating that the tests were within acceptable limits of variability.

Table 3. Summary of results for the 7-d Topsmelt (*Atherinops affinis)* survival and growth toxicity test

TEST CONCENTRATION (% v/v)	SURVIVAL (%)(MEAN ± SD)	GROWTH (DRY WEIGHT MG) (MEAN ± SD)
Negative Control	92.0 ± 11.0	0.81 ± 0.24
Brine Control	88.0 ± 17.9	0.91 ± 0.12
Pooled Controls	90.0 ± 11.0	0.86 ± 0.18
4.2	88.0 ± 11.0	0.86 ± 0.18
8.4	96.0 ± 8.9	0.90 ± 0.13
16.9	80.0 ± 14.1	0.76 ± 0.17
33.7	92.0 ± 11.0	0.75 ± 0.13
67.4	80.0 ± 14.1	0.81 ± 0.16
TEST ENDPOINT	**SURVIVAL (% v/v)**	**GROWTH (% v/v)**
NOEC	67.4	67.4
LOEC	>67.4	>67.4
LC50	>67.4	na
IC50	na	>67.4
IC25	na	>67.4

SD – Standard Deviation; na – not applicable.

Table 4. Summary of results for the Echinoderm (*Dendraster excentricus)* fertilization toxicity test

TEST CONCENTRATION (% v/v)	PROPORTION FERTILIZED (%) (MEAN ± SD)
Negative Control	85.0 ± 2.9
Brine Control	87.2 ± 2.6
Pooled Controls	86.1 ± 2.8
4.5	79.8 ± 1.7*
8.9	76.5 ± 0.6*
17.8	61.8 ± 2.2*
35.6	52.8 ± 1.9*
71.3	37.2 ± 2.1*
TEST ENDPOINT	**PROPORTION FERTILIZED %(v/v)**
NOEC	<4.5
LOEC	4.5
IC50 (95% CL)	55.0 (49.2 – 61.1)
IC25 (95% CL)	15.6 (13.6– 18.3)

*Indicates significant difference ($p \leq 0.05$) relative to the pooled controls.
SD – Standard Deviation; CL – Confidence Limits.

4. REFERENCES

Environment Canada. 1992. Biological test method: fertilization of echinoids (sea urchins and sand dollars). Environmental Protection Series, Report EPS 1/RM/27, December 1992. Environment Canada, Conservation and Protection, Ottawa, ON. 68 pp + appendices. Amended November 1997.

US EPA. 1995. Short term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. 2nd edition. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Office of Research and Development, Washington, DC. EPA/600/R-95/136. 563 pp.

Tidepool Scientific Software. 1994. TOXCALC: Comprehensive Toxicity Data Analysis and Database Software, Version 5.0.23. Tidepool Scientific Software, McKinleyville, CA. 80 pp.

APPENDIX I

Raw Data and Statistical Analyses:

Atherinops affinis

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

EVS Analysts MJG SxB JxS RSO
Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	Garrow Creek	Garrow Creek	Garrow Creek
Amount Received	5 x 20L	5 x 20L	5 x 20L
Date Collected	6-Aug-05	6 Aug 05	6 Aug 05
Date Received	9-Aug-05	9 Aug 05	9 Aug 05
Temperature (°C)	20.0	20.0	20.0
pH	7.7 ① → 8.3	7.8 ① → 8.4	7.9 ① → 8.4
DO (mg/L)	9.8 ① → 7.6	10.0 ① → 7.6	10.5 ① → 7.6
Conductivity (µmhos/cm)	-	-	-
Salinity (ppt)	1.0 ① → 30.0	1.0 ① → 30.0	1.0 ① → 30.0
Ammonia (mg/L N)	-	-	
Chlorine (mg/L Cl)	-	-	
Other	① After salinity adjustment	① After salinity adjustment	① After salinity adjustment

DILUTION/CONTROL WATER (initial water quality)
Water Type unsterilized filtered SW
Temperature (°C) 20.0
pH 7.9
Dissolved Oxygen (mg/L) 7.7
Salinity 29

TEST SPECIES INFORMATION
Source ABS Inc.
Date Received 9-Aug-05
Age (on Day 0) 10 days
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 9 Aug 05
7-d survival LC50 103 (91-118) ~~107 (88-124)~~ mg/L Cu
7-d growth IC50 95 ~~(75-125)~~ (76-127) mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 132 ± 40 mg/L Cu CV=15%
7-d growth IC50 133 ± 40 mg/L Cu CV=15%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 21.0
pH Range 7.7 ~~7.9~~ - 8.4
Dissolved Oxygen Range (mg/L) 6.4-7.7
Salinity (ppt) 28-31
Photoperiod (L:D h) 16:8
Aeration Provided? None
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (v/v)	67.4	>67.4	> 67.4		
Growth		67.4	> ~~67.4~~		>67.4	>67.4

Other

Data Verified By Qualfish
Date Verified Sept 1/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth

EVS Project No. 04-1424-044

EVS Work Order No. 0500327

Sample ID G. Creek (Garrow Creek)

Test Initiation Date/Time 9 Aug 05 / 1500h

Source/Date Received ABS Inc / 9 Aug 05

Concentration % (v/v)	Temperature (°C)													
	0	1		2		3		4		5		6		7
D-Control	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0
B-Control	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
4.2	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
8.4	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	20.5	20.0	21.0
16.9	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
33.7	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
67.4	20.0	20.5	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5	20.0	21.0	20.0	21.0
Tech. Initials	SxB	SxB	SxB	VL	VL	SxB	SxB	SxB	SxB	SxB	SxB	TM	TM	TM

Concentration % (v/v)	pH													
	0	old	New	2		3		4		5		6		7
D-Control	7.9	7.9	8.0	7.9	7.9	7.7	7.9	7.7	SxB 8.0 / SxB 7.9	7.8	7.9	8.0	7.9	8.0
B-Control	8.0	7.9	8.1	8.0	8.0	7.7	7.9	7.7	SxB 7.9	7.8	7.9	8.0	7.9	7.9
4.2	8.0	7.9	8.2	7.9	8.1	7.7	8.0	7.7	8.1	7.8	8.0	8.0	7.9	7.9
8.4	8.0	8.0	8.2	7.9	8.1	7.8	8.0	7.8	8.1	7.8	8.0	8.0	8.0	8.0
16.9	8.1	8.0	8.3	8.0	8.2	7.9	8.1	7.8	8.2	7.9	8.1	8.1	8.0	8.0
33.7	8.1	8.0	8.3	8.1	8.3	8.1	8.1	7.9	8.3	7.9	8.2	8.2	8.1	8.1
67.4	8.3	8.1	8.4	8.1	8.4	8.1	8.2	8.0	8.4	8.0	8.3	8.4	8.1	8.1
Tech. Initials	SxB	SxB	SxB	VL	VL	SxB	SxB	SxB	SxB	SxB	SxB	TM	TM	TM

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH 030302

Comments

Test Set Up By SxB Data Verified By Qualified Date Verified Aug. 31/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth

EVS Project No. C4-1424-044

EVS Work Order No. 0500327

Sample ID C. Creek Cypress Creek

Test Initiation Date/Time 9 Aug 05 / 1500

Source/Date Received ABS Inc. / 9 Aug 05

Concentration %(v/v)	Salinity (ppt)													
	0	1		2		3		4		5		6 D		7
D-Control	29	29	29	29	29	30	30	30	30	31	30	28	28	29
B-Control	30	30	30	30	30	30	30	31	30	30	30	30	30	30
4.2	30	31	30	30	30	30	30	30	30	30	30	30	28	29
8.4	30	30	30	30	30	30	30	30	30	30	30	30	28	29
16.9	30	30	30	30	30	30	30	30	30	30	30	30	28	29
33.7	30	31	30	30	30	31	30	30	30	30	30	30	28	29
67.4	30	30	30	30	30	31	30	31	30	31	30	30	29	30
Tech. Initials	SxB	SxB	SxB	MJG	MJG	SxB	SxB	SxB	SxB	SxB	SxB	TT	TT	TT

Concentration %(v/v)	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
D-Control	7.7	6.7	7.7	6.6	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.4	7.5	6.4
B-Control	7.6	6.6	7.6	6.4	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.6	7.5	6.6
4.2	7.6	6.7	7.6	6.4	7.6	6.4	7.6	6.5	7.6	6.5	7.6	6.6	7.5	6.6
8.4	7.6	6.7	7.6	6.5	7.6	6.7	7.6	6.6	7.6	6.6	7.6	6.4	7.5	6.4
16.9	7.7	6.6	7.6	6.4	7.6	6.5	7.6	6.5	7.6	6.6	7.6	6.5	7.5	6.6
33.7	7.6	6.6	7.6	6.8	7.6	6.8	7.6	6.6	7.6	6.5	7.6	6.5	7.5	6.6
67.4	7.6	6.7	7.6	6.6	7.6	6.6	7.6	6.7	7.6	6.7	7.6	6.4	7.6	6.4
Tech. Initials	SxB	SxB	SxB	MJG	MJG	SxB	SxB	SxB	SxB	SxB	SxB	TT	TT	TT

WQ Instruments Used: Salinity ~~II~~ III (Acc) II C3 DO II-A-20

Comments (1) meet II-14-030306

Test Set Up By SxB Data Verified By Qa/QC Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

Sample ID G-Creek (Perran Creek)
Test Species/Batch Atherinops affinis, Petagos
Test Initiation Date/Time 9 Aug 05 1500
No. of Organisms/Volume 5 / 200mL

Concentration %(v/v)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
D.CTL	A	1T	5	5	5	5	5	5	5	
	B	2T	5	5	5	5	5	5	4	
	C	3T	5	5	5	5	5	5	5	
	D	4T	5	5	5	5	5	5	5	
	E	5T	5	5	5	5	5	5	4	
B-CTL	A	6T	5	5	5	5	5	5	5	
	B	7T	5	5	5	5	5	5	5	
	C	8T	5	5	5	5	5	5	5	
	D	9T	5	5	5	5	5	5	4	
	E	10T	5	5	4 ①	4	4	4	3	
4.2	A	11T	5	4	SXB 4	4	4	4	4	
	B	12T	5	5	5	5	5	5	5	
	C	13T	5	5	5	5	5	5	5	
	D	14T	5	4	SXB 4	4	4	4	4	
	E	15T	5	4 ①	4 SXB	4	4	4	4	① No Body
8.4	A	16T	5	5	5	5	5	5	5	
	B	17T	5	5	5	5	5	5	5	
	C	18T	5	5	5	5	5	5	4	
	D	19T	5	5	5	5	5	5	5	
	E	20T	5	5	5	5	5	5	5	
Technician Initials		SXB	SXB	ML	SXB	SXB	SXB	JH	SXB	

Sample Description light brown, no smell
Data Verified By [signature] Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500327

Sample ID: Garrow Creek
Test Species/Batch: Atherinops affinis
Test Initiation Date/Time: 9 Aug 05 / 1500
No. of Organisms/Volume: 5/200mL

Concentration V(v/v)	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
16.9	A	21 T	5	5	5	5	5	5	5	① no dead body - ~~Technician~~ SXB
	B	22	5	5	4	4	4	4	4	
	C	23	5	5	5	5	5	5	4	
	D	24	5	5	①4	4	4	4	3	
	E	25	5	5	5	5	5	5	4	
33.7	A	26	5	5	5	5	5	5	5	
	B	27	5	5	~~5~~5	4	4	4	4	
	C	28	5	5	5	5	5	5	5	
	D	~~29~~	5	5	4	4	4	*	4	
	E	30	5	5	5	5	5	5	5	
67.4	A	31	5	5	5	5	5	5	5	
	B	32	5	4	4	4	4	4	4	
	C	33	5	5	5	5	5	5	~~4~~3 SXB	
	D	34	5	5	5	5	5	5	4	
	E	35	SXB ~~4~~5	5	5	5	5	5	4	
	A									
	B									
	C									
	D									
	E									
Technician Initials		~~SXB~~	SXB	ML	SXB	SXB	SXB	MS	SXB	

Sample Description: clear - colourless
Data Verified By: Qualified
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS

Larval Fish Toxicity Tests - Dry Weight Data

CLIENT:	Azimuth	TEST TYPE:	7-d Survival and Growth
PROJECT #	04-1424-044	TEST SPECIES:	*Atherinops affinis*
WORK ORDER #:	0500327	TEST INITIATION DATE:	9-Aug-05
BALANCE TYPE:	Sartorius BP211D		

Pan No.	Rep	Sample ID: Garrow Creek % (v/v)	Survival At Start	Number of Survivors	Number Weighed	Pan weight (mg)	Final Weight (mg) Pan + Biomass	Tech'n Initials	Comments
T-1	A	Control	5	5	4	1218.92	1222.92	RSD	Fish lost in transfer.
T-2	B		5	4	4	1231.52	1234.56	RSD	
T-3	C		5	5	5	1229.15	1234.64	RSD	
T-4	D		5	5	5	1235.47	1239.35	RSD	
T-5	E		5	4	4	1241.65	1244.47	RSD	
T-6	A	Brine Control	5	5	5	1217.25	1221.44	RSD	
T-7	B		5	5	5	1229.47	1234.85	RSD	
T-8	C		5	5	5	1233	1237.96	RSD	
T-9	D		5	4	4	1236.48	1240.49	RSD	
T-10	E		5	3	3	1237.67	1241.98	RSD	
T-11	A	4.2	5	4	4	1236.79	1240.85	RSD	
T-12	B		5	5	5	1221.62	1226.26	RSD	
T-13	C		5	5	5	1236.85	1241.7	RSD	
T-14	D		5	4	4	1231.67	1236.88	RSD	
T-15	E		5	4	4	1227.6	1230.46	RSD	
T-16	A	8.4	5	5	5	1232.12	1236.61	RSD	
T-17	B		5	5	5	1221.55	1225.83	RSD	
T-18	C		5	4	4	1226.4	1229.96	RSD	
T-19	D		5	5	5	1224.88	1229.98	RSD	
T-20	E		5	5	5	1228.72	1233.82	RSD	
T-21	A	16.9	5	5	5	1226.33	1231.24	RSD	
T-22	B		5	4	4	1227.45	1231.89	RSD	
T-23	C		5	4	4	1223.67	1227.1	RSD	
T-24	D		5	3	3	1228.16	1231.05	RSD	
T-25	E		5	4	4	1218.71	1221.92	RSD	
T-26	A	33.7	5	5	5	1229.33	1232.96	RSD	
T-27	B		5	4	4	1223.13	1227.98	RSD	
T-28	C		5	5	5	1222.55	1226.08	RSD	
T-29	D		5	4	4	1231.12	1234.27	RSD	
T-30	E		5	5	5	1230.86	1234.48	RSD	
T-31	A	67.4	5	5	5	1234.04	1239.21	RSD	
T-32	B		5	4	4	1236.02	1240.21	RSD	
T-33	C		5	3	3	1229.02	1232.08	RSD	
T-34	D		5	4	4	1231.66	1235.98	RSD	
T-35	E		5	4	4	1231.22	1234.74	RSD	
T-16	(d)						1236.52 ✓	RSD	
T-21	(d)						1231.16 ✓	RSD	
T-35	(d)						1234.81 ✓	RSD	

(d) - duplicate; pan reweighed after being placed in the oven and desiccated a second time.

Aug. 31/05

Test: LF-Larval Fish Growth and Survival Test
Species: AA-Atherinops affinis
Sample ID: Garrow_Creek
Start Date: 8/9/2005 End Date: 8/16/2005

Test ID: 0500327
Protocol: EPAW 95-EPA West Coast
Sample Type: EFF2-Industrial
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	4	1218.92	1222.92
	2	2	D-Control	5							4	4	1231.52	1234.56
	3	3	D-Control	5							5	5	1229.15	1234.64
	4	4	D-Control	5							5	5	1235.47	1239.35
	5	5	D-Control	5							4	4	1241.65	1244.47
	6	1	B-Control	5							5	5	1217.25	1221.44
	7	2	B-Control	5							5	5	1229.47	1234.85
	8	3	B-Control	5							5	5	1233	1237.96
	9	4	B-Control	5							4	4	1236.48	1240.49
	10	5	B-Control	5							3	3	1237.67	1241.98
	11	1	4.2	5							4	4	1236.79	1240.85
	12	2	4.2	5							5	5	1221.62	1226.26
	13	3	4.2	5							5	5	1236.85	1241.7
	14	4	4.2	5							4	4	1231.67	1236.88
	15	5	4.2	5							4	4	1227.6	1230.46
	16	1	8.4	5							5	5	1232.12	1236.61
	17	2	8.4	5							5	5	1221.55	1225.83
	18	3	8.4	5							4	4	1226.4	1229.96
	19	4	8.4	5							5	5	1224.88	1229.98
	20	5	8.4	5							5	5	1228.72	1233.82
	21	1	16.9	5							5	5	1226.33	1231.24
	22	2	16.9	5							4	4	1227.45	1231.89
	23	3	16.9	5							4	4	1223.67	1227.1
	24	4	16.9	5							3	3	1228.16	1231.05
	25	5	16.9	5							4	4	1218.71	1221.92
	26	1	33.7	5							5	5	1229.33	1232.96
	27	2	33.7	5							4	4	1223.13	1227.98
	28	3	33.7	5							5	5	1222.55	1226.08
	29	4	33.7	5							4	4	1231.12	1234.27
	30	5	33.7	5							5	5	1230.86	1234.48
	31	1	67.4	5							5	5	1234.04	1239.21
	32	2	67.4	5							4	4	1236.02	1240.21
	33	3	67.4	5							3	3	1229.02	1232.08
	34	4	67.4	5							4	4	1231.66	1235.98
	35	5	67.4	5							4	4	1231.22	1234.74

Comments: Azimuth - Polaris 04-1424-044

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	Garrow_Creek
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

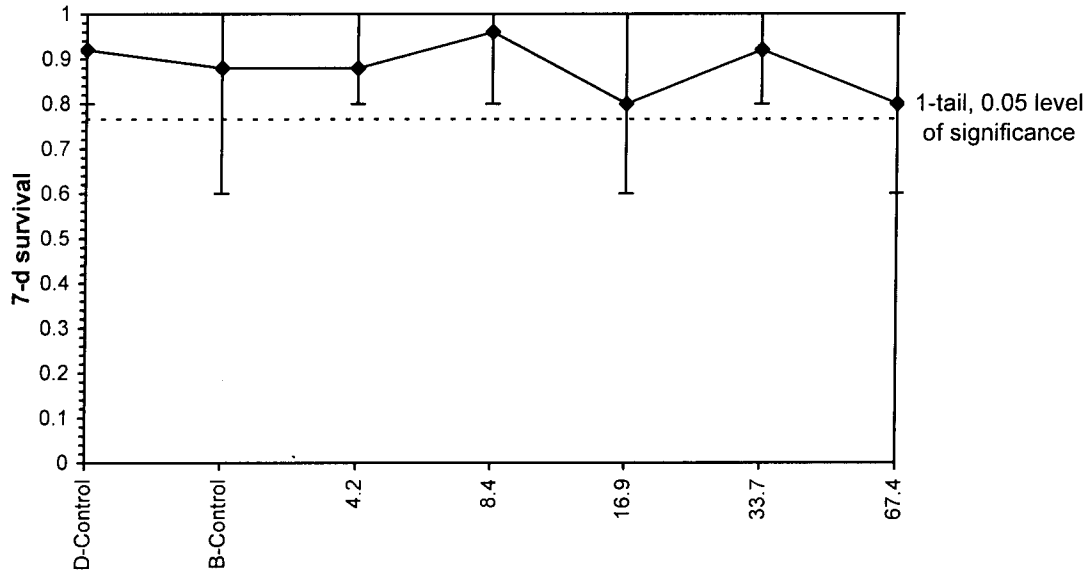
Conc-%	1	2	3	4	5
D-Control	1.0000	0.8000	1.0000	1.0000	0.8000
B-Control	1.0000	1.0000	1.0000	0.8000	0.6000
4.2	0.8000	1.0000	1.0000	0.8000	0.8000
8.4	1.0000	1.0000	0.8000	1.0000	1.0000
16.9	1.0000	0.8000	0.8000	0.6000	0.8000
33.7	1.0000	0.8000	1.0000	0.8000	1.0000
67.4	1.0000	0.8000	0.6000	0.8000	0.8000

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5			
B-Control	0.8800	0.1789	1.2058	0.8861	1.3453	17.113	5			
4.2	0.8800	0.1095	1.2024	1.1071	1.3453	10.848	5	0.544	2.360	0.2068
8.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	-0.544	2.360	0.2068
16.9	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.592	2.360	0.2068
33.7	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	0.000	2.360	0.2068
67.4	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.592	2.360	0.2068

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94769	0.9	-0.1197	-0.6919
Bartlett's Test indicates equal variances (p = 0.97)	0.91421	15.0863		
The control means are not significantly different (p = 0.70)	0.405	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.154	0.171	0.03047	0.01919	0.20149	5, 24

Dose-Response Plot



Statistical analysis performed with the negative control.

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	Garrow_Creek
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

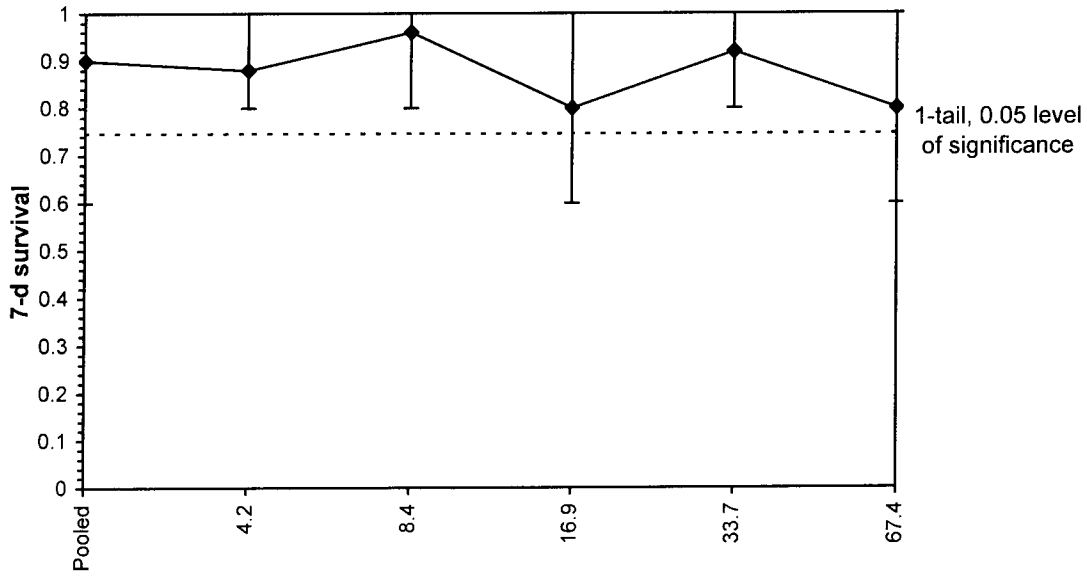
Conc-%	1	2	3	4	5
D-Control	1.0000	0.8000	1.0000	1.0000	0.8000
B-Control	1.0000	1.0000	1.0000	0.8000	0.6000
4.2	0.8000	1.0000	1.0000	0.8000	0.8000
8.4	1.0000	1.0000	0.8000	1.0000	1.0000
16.9	1.0000	0.8000	0.8000	0.6000	0.8000
33.7	1.0000	0.8000	1.0000	0.8000	1.0000
67.4	1.0000	0.8000	0.6000	0.8000	0.8000

			Transform: Arcsin Square Root					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.9000	0.1414	1.2279	0.8861	1.3453	13.389	10			
4.2	0.8800	0.1095	1.2024	1.1071	1.3453	10.848	5	0.315	2.462	0.1997
8.4	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	-0.860	2.462	0.1997
16.9	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.447	2.462	0.1997
33.7	0.9200	0.1095	1.2500	1.1071	1.3453	10.434	5	-0.273	2.462	0.1997
67.4	0.8000	0.1414	1.1106	0.8861	1.3453	14.625	5	1.447	2.462	0.1997

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95136	0.91	-0.4731	-0.265
Bartlett's Test indicates equal variances (p = 0.95)	1.19442	15.0863		
The control means are not significantly different (p = 0.70)	0.405	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	67.4	>67.4		1.48368	0.15355	0.17312	0.0295	0.02192	0.27347	5, 29

Dose-Response Plot



Statistical analysis performed with pooled controls.

Reviewed by: Aug 31/05

Larval Fish Growth and Survival Test-7 Day Growth (CND)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CREEK
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

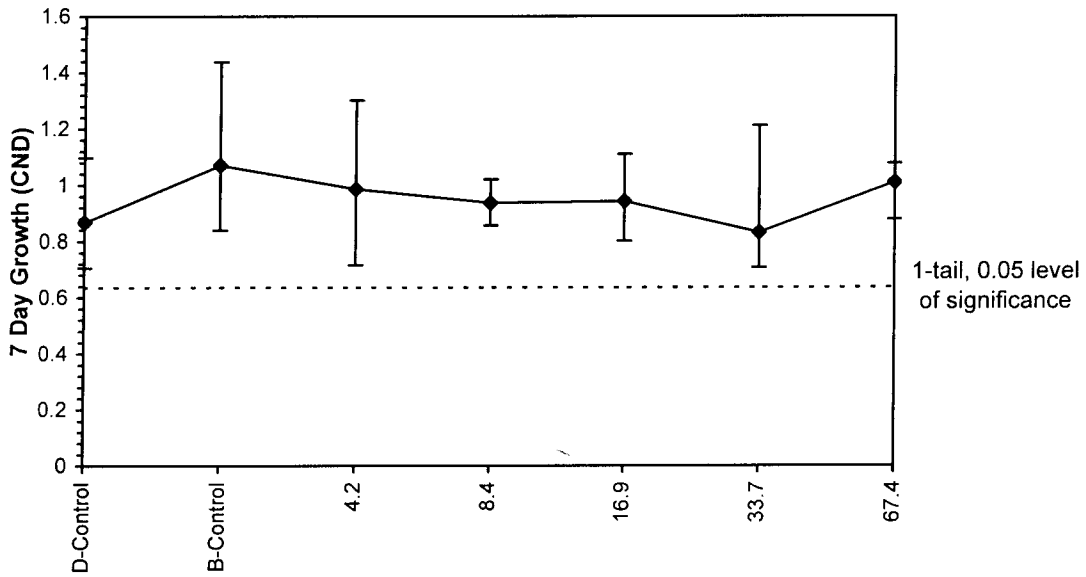
Conc-%	1	2	3	4	5
D-Control	1.0000	0.7600	1.0980	0.7760	0.7050
B-Control	0.8380	1.0760	0.9920	1.0025	1.4367
4.2	1.0150	0.9280	0.9700	1.3025	0.7150
8.4	0.8980	0.8560	0.8900	1.0200	1.0200
16.9	0.9820	1.1100	0.8575	0.9633	0.8025
33.7	0.7260	1.2125	0.7060	0.7875	0.7240
67.4	1.0340	1.0475	1.0200	1.0800	0.8800

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.8678	0.1710	0.8678	0.7050	1.0980	19.710	5			
B-Control	1.0690	0.2230	1.0690	0.8380	1.4367	20.861	5			
4.2	0.9861	0.2110	0.9861	0.7150	1.3025	21.397	5	-1.198	2.360	0.2331
8.4	0.9368	0.0776	0.9368	0.8560	1.0200	8.280	5	-0.699	2.360	0.2331
16.9	0.9431	0.1192	0.9431	0.8025	1.1100	12.644	5	-0.762	2.360	0.2331
33.7	0.8312	0.2154	0.8312	0.7060	1.2125	25.910	5	0.371	2.360	0.2331
67.4	1.0123	0.0772	1.0123	0.8800	1.0800	7.629	5	-1.463	2.360	0.2331

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94085	0.9	0.90895	1.11753
Bartlett's Test indicates equal variances (p = 0.22)	7.00651	15.0863		
The control means are not significantly different (p = 0.15)	1.60103	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.23312	0.26863	0.02377	0.02439	0.45333	5, 24

Dose-Response Plot



Statistical analysis performed on negative control using Canadian method to assess test validity criteria.

Reviewed by: Aug. 31/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CRE
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

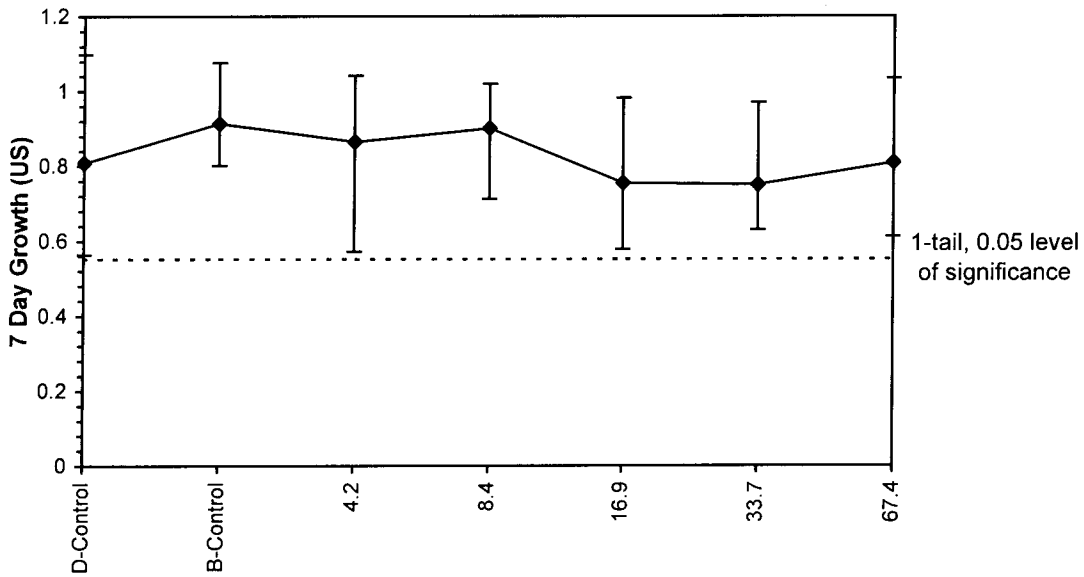
Conc-%	1	2	3	4	5
D-Control	1.0000	0.6080	1.0980	0.7760	0.5640
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620
4.2	0.8120	0.9280	0.9700	1.0420	0.5720
8.4	0.8980	0.8560	0.7120	1.0200	1.0200
16.9	0.9820	0.8880	0.6860	0.5780	0.6420
33.7	0.7260	0.9700	0.7060	0.6300	0.7240
67.4	1.0340	0.8380	0.6120	0.8640	0.7040

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
D-Control	0.8092	0.2353	0.8092	0.5640	1.0980	29.082	5			
B-Control	0.9140	0.1155	0.9140	0.8020	1.0760	12.636	5			
4.2	0.8648	0.1837	0.8648	0.5720	1.0420	21.242	5	-0.511	2.360	0.2569
8.4	0.9012	0.1285	0.9012	0.7120	1.0200	14.262	5	-0.845	2.360	0.2569
16.9	0.7552	0.1718	0.7552	0.5780	0.9820	22.750	5	0.496	2.360	0.2569
33.7	0.7512	0.1284	0.7512	0.6300	0.9700	17.097	5	0.533	2.360	0.2569
67.4	0.8104	0.1615	0.8104	0.6120	1.0340	19.927	5	-0.011	2.360	0.2569

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96877	0.9	0.03752	-0.9001
Bartlett's Test indicates equal variances (p = 0.85)	1.98489	15.0863		
The control means are not significantly different (p = 0.40)	0.89395	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	67.4	>67.4		1.48368	0.25689	0.31747	0.01761	0.02962	0.70433	5, 24

Dose-Response Plot



Statistical analysis performed with D-control

Reviewed by: Sept 1/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	500327	Sample ID:	GARROW_CRE
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

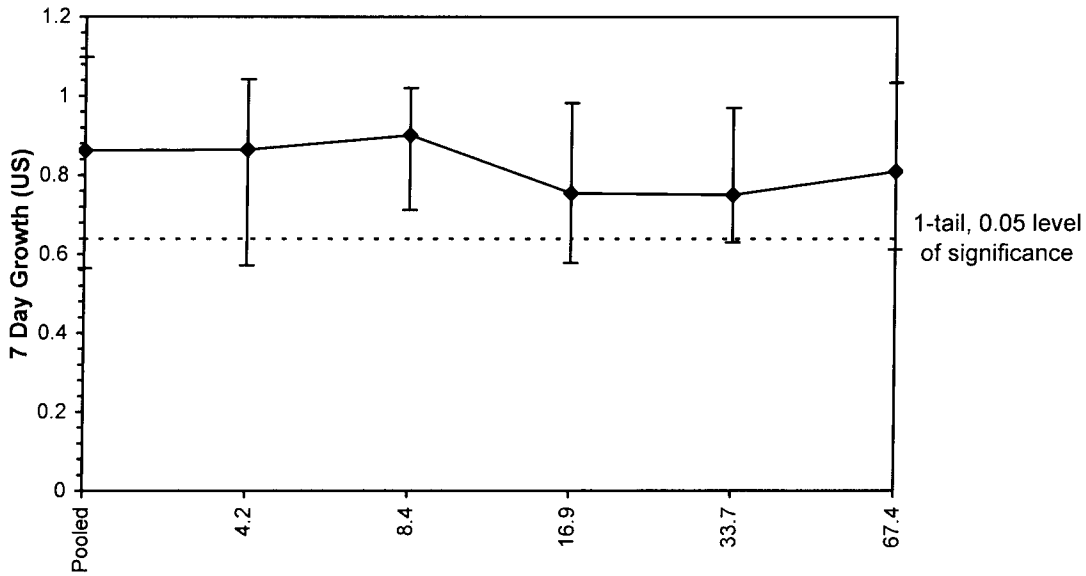
Conc-%	1	2	3	4	5
D-Control	1.0000	0.6080	1.0980	0.7760	0.5640
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620
4.2	0.8120	0.9280	0.9700	1.0420	0.5720
8.4	0.8980	0.8560	0.7120	1.0200	1.0200
16.9	0.9820	0.8880	0.6860	0.5780	0.6420
33.7	0.7260	0.9700	0.7060	0.6300	0.7240
67.4	1.0340	0.8380	0.6120	0.8640	0.7040

			Transform: Untransformed					1-Tailed		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Pooled	0.8616	0.1833	0.8616	0.5640	1.0980	21.272	10			
4.2	0.8648	0.1837	0.8648	0.5720	1.0420	21.242	5	-0.035	2.462	0.2228
8.4	0.9012	0.1285	0.9012	0.7120	1.0200	14.262	5	-0.438	2.462	0.2228
16.9	0.7552	0.1718	0.7552	0.5780	0.9820	22.750	5	1.176	2.462	0.2228
33.7	0.7512	0.1284	0.7512	0.6300	0.9700	17.097	5	1.220	2.462	0.2228
67.4	0.8104	0.1615	0.8104	0.6120	1.0340	19.927	5	0.566	2.462	0.2228

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.95378	0.91	-0.1738	-0.7645
Bartlett's Test indicates equal variances (p = 0.96)	1.08676	15.0863		
The control means are not significantly different (p = 0.40)	0.89395	2.306		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	67.4	>67.4		1.48368	0.22282	0.25861	0.02046	0.0273	0.59313	5, 29

Dose-Response Plot



Statistical analysis performed with pooled controls.

Reviewed by: Qualph
9/1 sent 1/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST DATA SUMMARY

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

EVS Analysts SxB MJG JxS RS
Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100mg/L Cu Stock (05Cu001)		
Amount ~~Received~~ Prepared	1X1L		
Date ~~Collected~~ Prepared	1-Mar-05		
Date Received	na		
Temperature (°C)			
pH			
DO (mg/L)			
Conductivity (µmhos/cm)			
Salinity (ppt)			
Ammonia (mg/L N)			
Chlorine (mg/L Cl)			
Other			

DILUTION/CONTROL WATER (initial water quality)
Water Type UV sterilized filtered Sw
Temperature (°C) 20.0
pH 7.9
Dissolved Oxygen (mg/L) 7.7
Salinity 29

TEST SPECIES INFORMATION
Source ABS Inc
Date Received 9 Aug 05
Age (on Day 0) 10 days
Reference Toxicant Cu
Current Reference Toxicant Result (incl. 95% CL)
Reference Toxicant Test Date 9 Aug 05
7-d survival LC50 103 (91-118) ~~107 (88-129)~~ RSS mg/L Cu
7-d growth IC50 95 (76-127) ~~95 (75-125)~~ RSS mg/L Cu
Reference Toxicant Warning Limits (mean ± 2SD) and CV
7-d survival LC50 132 ± 40 mg/L Cu CV=15%
7-d growth IC50 133 ± 40 mg/L Cu CV=15%

TEST CONDITIONS
Temperature Range (°C) 20.0 - 20.5
pH Range 7.8 - 8.0
Dissolved Oxygen Range (mg/L) 6.4 - 7.7
Salinity (ppt) 28 - 31
Photoperiod (L:D h) 16:8
Aeration Provided? None
Other -

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L Cu	56	100	103 (91-118) ~~107 (88-129)~~ RSS		
Growth		~~32~~ 56 RSS	~~32~~ 100		95 (76-127) ~~95 (75-125)~~ RSS	71 (11-91) ~~64 (7-91)~~ RSS

Other

Data Verified By [signature] Date Verified Sept. 1/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Azimuth — Sample ID Cu Reftox

EVS Project No. 04-1424-044 — Test Initiation Date/Time 9 Aug 05 1500

EVS Work Order No. C500327 — Source/Date Received ABS Inc. / 9 Aug 05

Concentration mg/L Cu	Temperature (°C)													
	0	old 1	New 1	2		3		4		5		6		7
CTL	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5
32	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5
56	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5	20.0	20.5
100	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.5
180	20.0	20.0	20.0	20.0	20.0	20.0	20.0	~~20.0~~	~~20.0~~	20.0	20.0			
320	20.0	20.0	20.0	20.0	20.0									
Tech. Initials	SxB	SxB	SxB	MTL	MTL	SRS	SRS	SxB	SxB	SxB	SxB	TM	TM	TM

Concentration mg/L Cu	pH													
	0	1		2		3		4		5		6		7
CTL	7.9	7.9	8.0	7.9	7.9	7.8	7.9	7.8	8.0	7.9	7.9	7.9	8.0	7.9
32	7.9	8.0	8.0	7.9	7.9	7.8	7.9	~~7.8~~ 7.9	7.9	7.9	7.9	7.9	8.0	8.0
56	7.9	7.9	8.0	8.0	7.9	7.8	7.9	~~7.8~~ 7.9	8.0	7.9	7.9	8.0	8.0	8.0
100	7.9	7.9	8.0	8.0	7.9	7.8	7.9	7.8	8.0	7.9	7.9	8.0	8.0	8.0
180	7.9	7.8	8.0	~~7.9~~ 7.9	7.9	7.8	7.9	~~7.8~~	~~8.0~~	~~7.9~~	~~7.9~~			
320	7.9	7.9	8.0	~~7.9~~	7.9									
				MTL										
Tech. Initials	SxB	SxB	SxB	MTL	MTL	SRS	SRS	SxB	SxB	SxB	SxB	TM	TM	TM

WQ Instruments Used: Temp. Calibrated Ag Thermometer — pH 030302

Comments

Test Set Up By SxB — Data Verified By [signature] — Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500327

Sample ID Cu Reftox
Test Initiation Date/Time 9 Aug -05 / 1500
Source/Date Received ABS In 9 Aug 05

Concentration Mg/L Cu	Salinity (ppt)													
	0	1		2		3		4		5		6 D		7
CTL	29	29	29	29	29	30	30	31	30	30	30	30	28	29
32	29	29	29	29	29	30	30	30	30	30	30	29	28	29
56	29	29	29	29	29	30	30	30	30	30	30	29	28	29
100	29	29	29	29	29	30	30	30	30	30	30	29	28	29
180	29	29	29	29	29	~~30~~	30	~~30~~	~~30~~	~~30~~	~~30~~			
320	29	29	29	29	29									
Tech. Initials	SXB	SXB	SXB	MC	MC	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

Concentration Mg/L Cu	Dissolved Oxygen (mg/L)													
	0	1		2		3		4		5		6		7
CTL	7.7	6.8	7.7	6.6	7.6	6.8	7.6	6.6	7.6	6.7	7.6	6.6	~~7.6~~ 7.5	6.6
32	7.7	6.9	7.7	6.5	7.6	6.9	7.6	6.7	7.6	6.9	7.6	6.4	7.5	6.6
56	7.7	6.8	7.7	6.7	7.6	7.0	7.6	6.8	7.6	6.9	7.6	6.6	7.5	6.4
100	7.7	6.8	7.7	6.6	7.6	7.0	7.6	6.9	7.6	7.0	7.6	6.6	7.5	6.4
180	7.7	6.9	7.7	6.5	7.6	7.1	7.6	~~6.9~~	~~7.6~~	~~7.0~~				
320	7.7	6.8	7.7	6.5	7.6	X								
Tech. Initials	SXB	SXB	SXB	MC	MC	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

WQ Instruments Used: Salinity II-C-3 DO II-A-20
Comments Dosed II-A-050506

Test Set Up By SXB Data Verified By Qualified Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500327

Sample ID: Cu_Lofton
Test Species/Batch: Atherinops affinis
Test Initiation Date/Time: 9 Aug 05 1500
No. of Organisms/Volume: 5/200mL

Concentration mg/L Cu	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
CTL	A	36 T	5	5	5	5	5	5	5	
	B	37	5	5	5	5	5	5	5	
	C	38	5	5	5	5	5	5	5	
	D	39	5	5	4	4	4	4	4	
	E	40	5	5	5	5	5	5	5	
32	A	41	5	5	5	5	5	5	5	
	B	42	5	5	5	5	5	5	4	① one fish stuck on wall while feeding – technician error.
	C	43	5	5	4	4	4	4	4	
	D	44	5	5	①4	4	4	4	4	
	E	45	5	5	4	4	4	3①	3	
56	A	46	5	5	5	5	5	5	5	
	B	47	5	5	5	5	5	5	5	
	C	48	5	5	5	5	5	5	5	
	D	49	5	5	5	5	5	5	5	
	E	50	5	5	5	5	5	5	5	
100	A	51	5	3	3	3	3	3	3	
	B	52	5	~~3~~ 2	2	2	2	2	2	
	C	53	5	4	3	3	3	3	3	
	D	54	5	4	4	4	3	3	3	
	E	55	5	3	2	2	2	2	2	
Technician Initials		SXB	SXB	MH	SXB	SXB	SXB	TM	SXB	

Sample Description: clear colourless
Data Verified By: [signature]
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client: Azimuth
EVS Project No.: 041424049
EVS Work Order No.: 0500327

Sample ID: Cu Reftox
Test Species/Batch: Atherinops affinis
Test Initiation Date/Time: 9 Aug 05 / 1500
No. of Organisms/Volume: 5 / 200mL

Concentration mg/L Cu	Rep.	Pan No.	Number of Survivors – Day of Test 1	2	3	4	5	6	7	Comments
18	A	56	3	2	2	2	2	2	1	
	B		4	0	0	-	-	-	-	
	C		5	0	0	-	-	-	-	
	D		4	1	0	-	-	-	-	
	E		2	0	0	-	-	-	-	
32	A		SXB 0	0	0	-	-	-	-	
	B		2	0	0	-	-	-	-	
	C		SXB 0	0	0	-	-	-	-	
	D		SXB 0	0	0	-	-	-	-	
	E		1	0	0	-	-	-	-	
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials		SXB	SXB	MV	SXB	SXB	SXB	MV	SXB	

Sample Description: clear - colourless
Data Verified By: Qa/Qc
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS

Larval Fish Toxicity Tests - Dry Weight Data

CLIENT: Azimuth
PROJECT #: 04-1424-044
WORK ORDER #: 0500327
BALANCE TYPE: Sartorius BP211D

TEST TYPE: 7-d Survival and Growth
TEST SPECIES: *Atherinops affinis*
TEST INITIATION DATE: 9-Aug-05

Pan No.	Rep	Sample ID: Cu ug/L	Survival At Start	Number of Survivors	Number Weighed	Pan weight (mg)	Final Weight (mg) Pan + Biomass	Tech'n Initials	Comments
T-36	A	Control	5	5	5	1227.73	1231.65	RSD	
T-37	B		5	5	5	1237.69	1243.76	RSD	
T-38	C		5	5	5	1233.73	1238.72	RSD	
T-39	D		5	4	4	1228.92	1231.78	RSD	
T-40	E		5	5	5	1227.75	1233.44	RSD	
T-41	A	32	5	5	5	1231.67	1236.17	RSD	
T-42	B		5	4	4	1224.44	1228.26	RSD	
T-43	C		5	4	4	1238.77	1241.92	RSD	
T-44	D		4	4	4	1227	1230.34	RSD	Tech error --fish killed during testing.
T-45	E		4	3	3	1236.71	1239.86	RSD	Tech error - fish killed during testing.
T-46	A	56	5	5	5	1230.75	1234.97	RSD	
T-47	B		5	5	5	1220.44	1224.77	RSD	
T-48	C		5	5	5	1226.91	1231.88	RSD	
T-49	D		5	5	5	1227.66	1232.44	RSD	
T-50	E		5	5	5	1233.65	1238.33	RSD	
T-51	A	100	5	3	3	1063.07	1065.92	RSD	
T-52	B		5	2	2	1070.3	1071.8	RSD	
T-53	C		5	3	3	1061.53	1063.78	RSD	
T-54	D		5	3	3	1059.1	1061.99	RSD	
T-55	E		5	2	2	1037.82	1038.91	RSD	
T-56	A	180	5	1	1	1044.2	1044.67	RSD	
T-57	B		5	0	0	1036.78	0	RSD	
T-58	C		5	0	0	1044.68	0	RSD	
T-59	D		5	0	0	1044.41	0	RSD	
T-60	E		5	0	0	1045.27	0	RSD	
T-61	A	320	5	0	0	0	0	RSD	
T-62	B		5	0	0	0	0	RSD	
T-63	C		5	0	0	0	0	RSD	
T-64	D		5	0	0	0	0	RSD	
T-65	E		5	0	0	0	0	RSD	
T-36	(d)						1231.53 ✓	RSD	
T-50	(d)						1238.37 ✓	RSD	
T-51	(d)						1065.88 ✓	RSD	

(d) - duplicate; pan reweighed after being placed in the oven and desiccated a second time.

QA/QC review: Ralph 4
Sept. 1/05

Test: LF-Larval Fish Growth and Survival Test												Test ID: rtaacu46		
Species: AA-Atherinops affinis												Protocol: EPAW 95-EPA West Coast		
Sample ID: REF-Ref Toxicant												Sample Type: CU-Copper		
Start Date: 8/9/2005			End Date: 8/16/2005									Lab ID: BCEVS-EVS Environment Consultants		
Pos	ID	Rep	Group	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	No. Fish Weighed	Total Wgt(mg)	Tare Wgt(mg)
	1	1	D-Control	5							5	5	1227.73	1231.65
	2	2	D-Control	5							5	5	1237.69	1243.76
	3	3	D-Control	5							5	5	1233.73	1238.72
	4	4	D-Control	5							4	4	1228.92	1231.78
	5	5	D-Control	5							5	5	1227.75	1233.44
	6	1	32.0	5							5	5	1231.67	1236.17
	7	2	32.0	5							4	4	1224.44	1228.26
	8	3	32.0	5							4	4	1238.77	1241.92
	9	4	32.0	4							4	4	1227	1230.34
	10	5	32.0	4							3	3	1236.71	1239.86
	11	1	56.0	5							5	5	1230.75	1234.97
	12	2	56.0	5							5	5	1220.44	1224.77
	13	3	56.0	5							5	5	1226.91	1231.88
	14	4	56.0	5							5	5	1227.66	1232.44
	15	5	56.0	5							5	5	1233.65	1238.33
	16	1	100.0	5							3	3	1063.07	1065.92
	17	2	100.0	5							2	2	1070.3	1071.8
	18	3	100.0	5							3	3	1061.53	1063.78
	19	4	100.0	5							3	3	1059.1	1061.99
	20	5	100.0	5							2	2	1037.82	1038.91
	21	1	180.0	5							1	1	1044.2	1044.67
	22	2	180.0	5							0	0	1036.78	0
	23	3	180.0	5							0	0	1044.68	0
	24	4	180.0	5							0	0	1044.41	0
	25	5	180.0	5							0	0	1045.27	0
	26	1	320.0	5							0	0	0	0
	27	2	320.0	5							0	0	0	0
	28	3	320.0	5							0	0	0	0
	29	4	320.0	5							0	0	0	0
	30	5	320.0	5							0	0	0	0

Comments: Azimuth - Polaris 04-1424-044

Reviewed by Aug 31/05

Larval Fish Growth and Survival Test-7-d survival

Start Date:	8/9/2005	Test ID:	rtaacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

Conc-ug/L	1	2	3	4	5
D-Control	1.0000	1.0000	1.0000	0.8000	1.0000
32	1.0000	0.8000	0.8000	1.0000	0.7500
56	1.0000	1.0000	1.0000	1.0000	1.0000
100	0.6000	0.4000	0.6000	0.6000	0.4000
180	0.2000	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

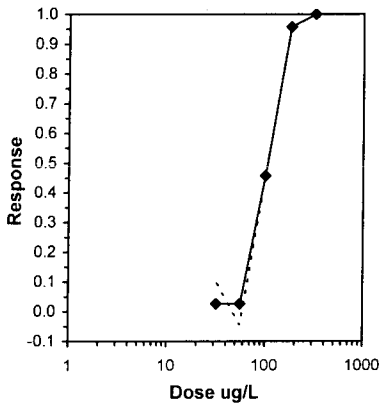
			Transform: Arcsin Square Root					Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5			1	25
32	0.8700	0.1204	1.1850	1.0472	1.3453	11.519	5	20.00	17.00	3	23
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	17.00	0	25
*100	0.5200	0.1095	0.8055	0.6847	0.8861	13.691	5	15.00	17.00	12	25
*180	0.0400	0.0894	0.2731	0.2255	0.4636	38.990	5	15.00	17.00	24	25
320	0.0000	0.0000	0.2255	0.2255	0.2255	0.000	5			25	25

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98032	0.888	0.05175	-0.2912
Equality of variance cannot be confirmed				

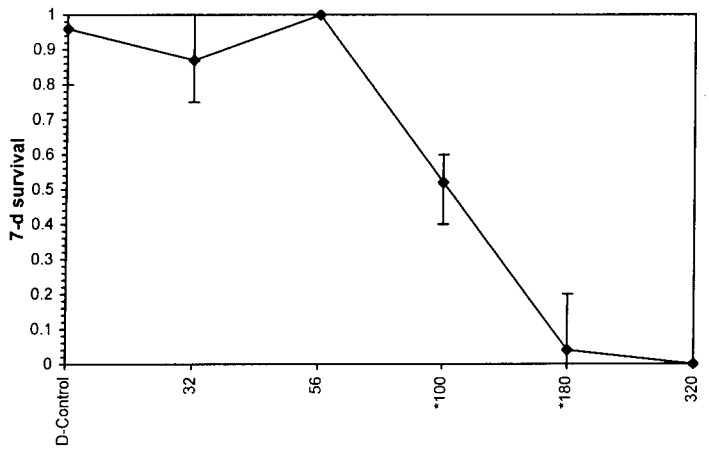
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	56	100	74.8331	

Trimmed Spearman-Karber

Trim Level	EC50	95% CL		
0.0%				
5.0%	103.41	90.52	118.14	
10.0%	103.63	89.27	120.30	
20.0%	104.05	85.12	127.20	
Auto-2.6%	103.48	90.82	117.90	ug/L Cu



Dose-Response Plot



Reviewed by [signature] Aug-31/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

Start Date:	8/9/2005	Test ID:	rtaacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 04-1424-044				

Conc-ug/L	1	2	3	4	5
D-Control	0.7840	1.2140	0.9980	0.5720	1.1380
32	0.9000	0.7640	0.6300	0.8350	0.7875
56	0.8440	0.8660	0.9940	0.9560	0.9360
100	0.5700	0.3000	0.4500	0.5780	0.2180
180	0.0940	0.0000	0.0000	0.0000	0.0000
320	0.0000	0.0000	0.0000	0.0000	0.0000

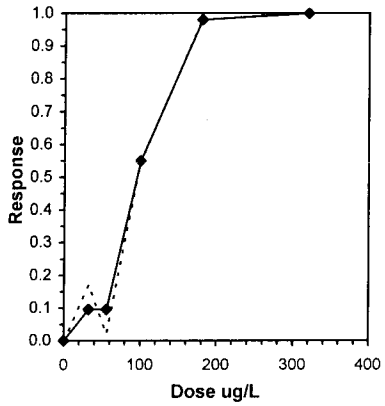
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
D-Control	0.9412	0.2633	0.9412	0.5720	1.2140	27.979	5			0.9412	1.0000
32	0.7833	0.1002	0.7833	0.6300	0.9000	12.796	5	23.00	17.00	0.8512	0.9044
56	0.9192	0.0627	0.9192	0.8440	0.9940	6.819	5	25.00	17.00	0.8512	0.9044
*100	0.4232	0.1609	0.4232	0.2180	0.5780	38.013	5	16.00	17.00	0.4232	0.4496
*180	0.0188	0.0420	0.0188	0.0000	0.0940	223.607	5	15.00	17.00	0.0188	0.0200
320	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5			0.0000	0.0000

Auxiliary Tests				Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)				0.96904	0.888	-0.5637	1.29994
Bartlett's Test indicates unequal variances (p = 8.40E-03)				13.6784	13.2767		
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**			
Steel's Many-One Rank Test	56	100	74.8331				

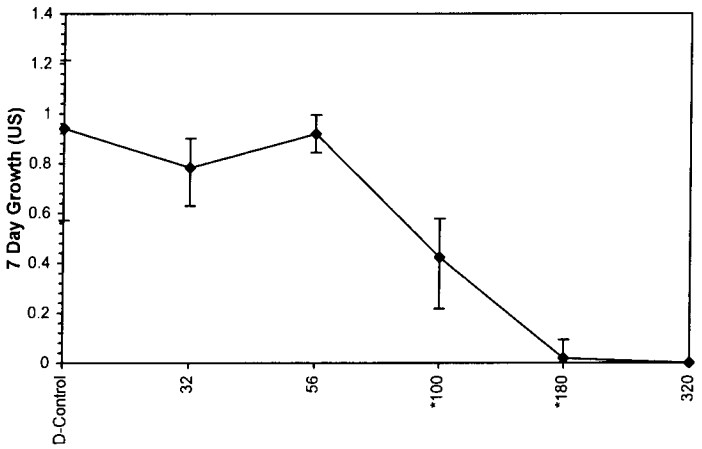
Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)		Skew	
IC05*	16.742	22.428	0.966	84.151	0.6591	
IC10	56.429	21.864	0.000	72.829	0.0540	
IC15	61.266	19.804	0.000	78.932	-0.6284	
IC20	66.103	16.425	4.297	85.035	-1.1939	
IC25	70.941	10.605	11.216	91.139	-1.6164	
IC40	85.453	7.896	65.694	112.047	0.4556	
IC50	95.128	8.949	75.508	127.164	0.6374	ug/L Cu

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Reviewed by Aug. 31/05

APPENDIX II

Raw Data and Statistical Analyses:

Dendraster excentricus

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Pebble Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328

EVS Analysts: SRS, JAP
Test Initiation Date: 09 Aug 05

SAMPLE

Identification: Garrow Creek
Amount Received: 5x20L
Date Collected: 06 Aug 05
Date Received: 09 Aug 05
Temperature (°C): 16 ① → 15
pH: 7.3 ① → 8.3
Dissolved Oxygen (mg/L): 10.0 ① → 8.5
Conductivity (µmhos/cm): 2700
Salinity (ppt): 1.0 ① → 29.0
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

① Brine Adjustment

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 09 Aug 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 09 Aug 05
IC50 (and 95% CL): 3.9 (3.6-4.1) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.3 mg/L SDS, CV = 55%

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized, 0.5µm filtered SW
Temperature (°C): 15
pH: 8.0
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 29
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 → ~~8.04~~ 8.2 ~~8.3~~ 8.4
Dissolved Oxygen Range (mg/L): ~~7.8~~ 7.8 → 8.5
Salinity Range (ppt): 29
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: 55.0 (49.2 - 61.1) % v/v
IC 25: 15.6 (13.6 - 18.3) % v/v
NOEC: < 4.5 % v/v
LOEC: 4.5 % v/v
Statistical comparisons were against pooled controls

Data Verified By: Gal Fitz
Date Verified: Aug. 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth Consulting (Polaris Mine)
EVS Project No. 04-1424-04
EVS Work Order No. 0500328
Logbook Echinoid #13 Pages 71-74

Test Initiation Date/Time 9Aug05 / 1723
Test Species Dendraster excentricus
Source/Date Received Westwind Seafds / 9 Aug 05
Test Duration 10:10

Sample ID %(v/v)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Garrow Creek - Max	15	8.3	29	8.5	
Garrow Creek - 36	15	8.1	29	8.4	
Garrow Creek - 18	15	7.9	29	8.4	
Garrow Creek - 9	15	7.9	29	8.4	
Garrow Creek - 4.5	15	7.8	29	8.4	
Cntl	15	8.0	29	8.5	
Brine Cntl	15	8.4	29	7.8	
Technician Initials	SRS/JAP	SRS/JAP	SRS/JAP	SRS/JAP	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-030303 DO II-A-20

Sample Description Clear with no odour

Data Verified By [signature] Date Verified Aug-31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328
Logbook: Echinoid Pages: 71-74

Test Initiation Date/Time: 09 Aug 05 / 1723
Test Species: Dendraster excentricus
Source/Date Received: Westcoast Sealab / 09 Aug 05
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Control	A	88	12		SRS
	B	81	19		
	C	85	15		
	D	86	14		
Brine Control	A	91	9		
	B	86	14		
	C	85	15		
	D	87	13		
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Data Verified By: Ralph
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client: Azimuth Consulting (Polaris Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328
Logbook: Echinoid Pages: 71-74

Test Initiation Date/Time: 09 Aug 05 / 1723
Test Species: Dendraster excentricus
Source/Date Received: Westcoast Seafoods / 09 Aug 05
Test Duration: 10:10
Sperm:Egg Ratio: 2000:1

Sample ID (Y-U10 Sawmill Creek)	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
Max 71.3%	A	37	63		SRS
	B	40	60		
	C	37	63		
	D	35	65		
35.6 36%	A	50	50		
	B	54	46		
	C	54	46		
	D	53	47		
17.8 18.9% RD	A	64	36		
	B	59	41		
	C	63	37		
	D	61	39		
8.9%	A	76	24		
	B	77	23		
	C	77	23		
	D	76	24		
4.5%	A	82	18		
	B	80	20		
	C	79	21		
	D	78	22		
	A				
	B				
	C				
	D				

Data Verified By: Ralph
Date Verified: Aug 31/05

Test: SC-Sperm Cell Fertilization test
Species: DE-Dendraster excentricus
Sample ID: Garrow Creek
Start Date: 8/9/2004 10:10 End Date: 8/9/2004

Test ID: 0500328
Protocol: EPS1/RM/27-EC 92 (Sperm Cell)
Sample Type: ~~GW-groundwater~~ Effluent
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	88	12	
	2	2	D-Control	100	81	19	
	3	3	D-Control	100	85	15	
	4	4	D-Control	100	86	14	
	5	1	B-Control	100	91	9	
	6	2	B-Control	100	86	14	
	7	3	B-Control	100	85	15	
	8	4	B-Control	100	87	13	
	9	1	4.500	100	78	22	
	10	2	4.500	100	79	21	
	11	3	4.500	100	80	20	
	12	4	4.500	100	82	18	
	13	1	8.900	100	76	24	
	14	2	8.900	100	77	23	
	15	3	8.900	100	77	23	
	16	4	8.900	100	76	24	
	17	1	17.800	100	61	39	
	18	2	17.800	100	63	37	
	19	3	17.800	100	59	41	
	20	4	17.800	100	64	36	
	21	1	35.600	100	53	47	
	22	2	35.600	100	54	46	
	23	3	35.600	100	54	46	
	24	4	35.600	100	50	50	
	25	1	71.300	100	35	65	
	26	2	71.300	100	37	63	
	27	3	71.300	100	40	60	
	28	4	71.300	100	37	63	

Comments: Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)

Reviewed by: Aug-31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2004 10:10	Test ID:	500328	Sample ID:	Garrow Creek
End Date:	8/9/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	~~GW-groundwater~~ Effluent
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)				

Conc-%	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
B-Control	0.9100	0.8600	0.8500	0.8700
4.5	0.7800	0.7900	0.8000	0.8200
8.9	0.7600	0.7700	0.7700	0.7600
17.8	0.6100	0.6300	0.5900	0.6400
35.6	0.5300	0.5400	0.5400	0.5000
71.3	0.3500	0.3700	0.4000	0.3700

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.8500	0.0294	0.8500	0.8100	0.8800	3.463	4				0.8500	1.0000
B-Control	0.8725	0.0263	0.8725	0.8500	0.9100	3.014	4					
*4.5	0.7975	0.0171	0.7975	0.7800	0.8200	2.141	4	3.662	2.410	0.0346	0.7975	0.9382
*8.9	0.7650	0.0058	0.7650	0.7600	0.7700	0.755	4	5.929	2.410	0.0346	0.7650	0.9000
*17.8	0.6175	0.0222	0.6175	0.5900	0.6400	3.591	4	16.217	2.410	0.0346	0.6175	0.7265
*35.6	0.5275	0.0189	0.5275	0.5000	0.5400	3.589	4	22.494	2.410	0.0346	0.5275	0.6206
*71.3	0.3725	0.0206	0.3725	0.3500	0.4000	5.534	4	33.305	2.410	0.0346	0.3725	0.4382

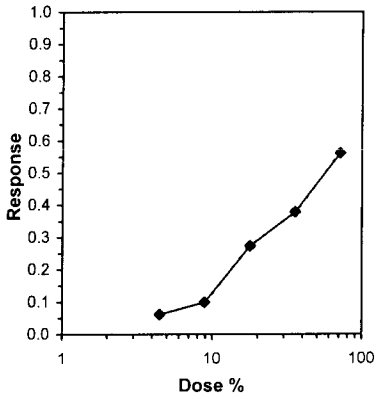
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96944	0.884	-0.376	-0.1401
Bartlett's Test indicates equal variances (p = 0.37)	5.40444	15.0863		
The control means are not significantly different (p = 0.30)	1.13994	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<4.5	4.5			0.03455	0.04065	0.13432	0.00041	5.3E-17	5, 18

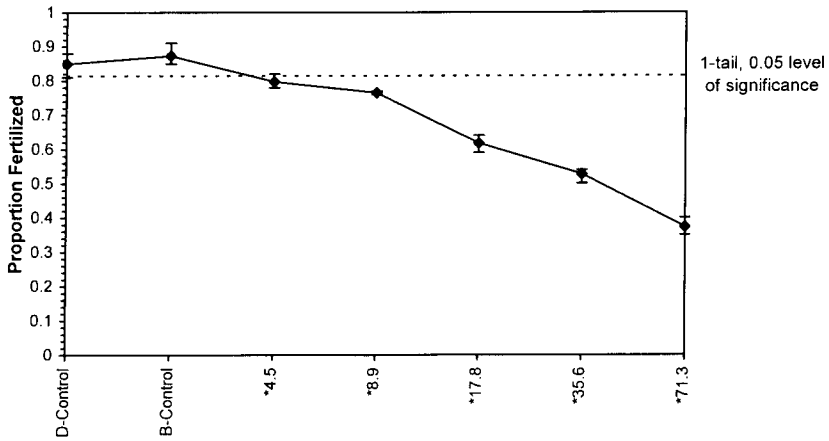
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	2.975	1.400	0.565	7.600	0.6911
IC10	8.900	1.288	3.027	10.418	-0.8297
IC15	10.909	0.614	9.311	12.929	0.4646
IC20	13.326	0.777	11.427	15.949	0.5340
IC25	16.234	1.070	13.604	20.191	0.7205
IC40	38.524	1.817	32.550	43.489	-0.4616
IC50	56.411	2.378	49.614	64.710	0.5505

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: statistical comparisons are against dilution control

Reviewed by: Aug 31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2004 10:10	Test ID:	500328	Sample ID:	Garrow Creek
End Date:	8/9/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	~~GW-groundwater~~ Effluent
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)				

Conc-%	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
B-Control	0.9100	0.8600	0.8500	0.8700
4.5	0.7800	0.7900	0.8000	0.8200
8.9	0.7600	0.7700	0.7700	0.7600
17.8	0.6100	0.6300	0.5900	0.6400
35.6	0.5300	0.5400	0.5400	0.5000
71.3	0.3500	0.3700	0.4000	0.3700

			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.8613	0.0285	0.8613	0.8100	0.9100	3.310	8				0.8613	1.0000
*4.5	0.7975	0.0171	0.7975	0.7800	0.8200	2.141	4	4.768	2.508	0.0335	0.7975	0.9260
*8.9	0.7650	0.0058	0.7650	0.7600	0.7700	0.755	4	7.199	2.508	0.0335	0.7650	0.8882
*17.8	0.6175	0.0222	0.6175	0.5900	0.6400	3.591	4	18.231	2.508	0.0335	0.6175	0.7170
*35.6	0.5275	0.0189	0.5275	0.5000	0.5400	3.589	4	24.962	2.508	0.0335	0.5275	0.6125
*71.3	0.3725	0.0206	0.3725	0.3500	0.4000	5.534	4	36.555	2.508	0.0335	0.3725	0.4325

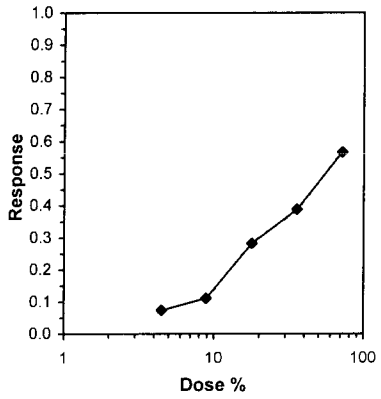
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97972	0.896	-0.1255	1.3485
Bartlett's Test indicates equal variances (p = 0.30)	6.1116	15.0863		
The control means are not significantly different (p = 0.30)	1.13994	2.44691		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Bonferroni t Test	<4.5	4.5			0.03354	0.03894	0.16656	0.00048	3.5E-20	5, 22

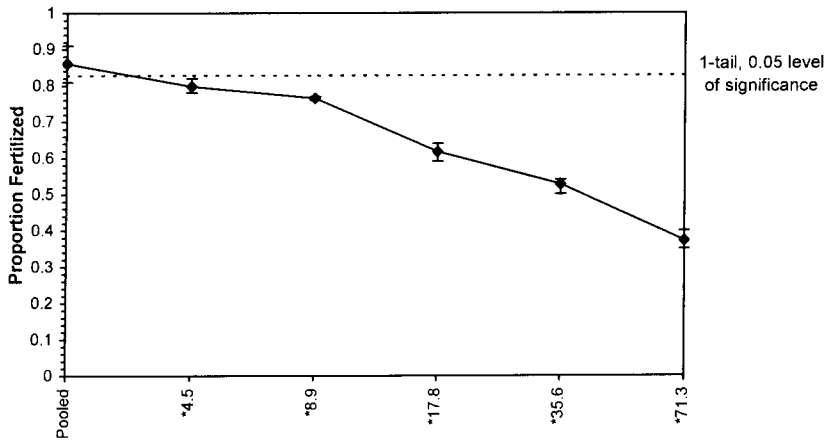
Log-Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew	
IC05*	2.163	0.950	0.835	6.375	1.2352	
IC10	7.243	1.368	2.765	10.506	-0.2796	
IC15	10.424	0.446	9.200	11.908	0.1462	
IC20	12.777	0.574	11.163	14.753	0.1484	
IC25	15.613	0.797	13.605	18.305	0.1477	
IC40	37.370	1.848	30.582	42.085	-0.6715	
IC50	55.010	2.043	49.176	61.090	0.1372	%v/v

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Note: statistical comparisons are against pooled controls

Reviewed by: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client: Azimuth Consulting (Pebble Mine)
EVS Project No.: 04-1424-044
EVS Work Order No.: 0500328

EVS Analysts: SRS, JAP
Test Initiation Date: 09 Aug 05

SAMPLE

Identification: SDS Reflux Soil's #05-5-009
Amount ~~Received~~ Prep'd: 1L
Date ~~Collected~~ Prep'd: 05 Aug 05
Date Received: —
Temperature (°C): —
pH: —
Dissolved Oxygen (mg/L): —
Conductivity (µmhos/cm): —
Salinity (ppt): —
Ammonia (mg/L N): —
Chlorine (mg/L Cl): —
Other: —

TEST SPECIES

Organism: Dendraster excentricus
Source: Westwind Sealab
Date Received: 09 Aug 05
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: 09 Aug 05
IC50 (and 95% CL): 3.9 (3.6 - 4.1) mg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
3.9 ± 4.3 mg/L SDS; CV = 55%

DILUTION/CONTROL WATER (initial water quality)

Water Type: UV sterilized, 0.5µm filtered SW
Temperature (°C): 15
pH: 8.0
Dissolved Oxygen (mg/L): 8.5
Salinity (ppt): 29
Other: —

TEST CONDITIONS

Temperature Range (°C): 15
pH Range: 7.8 - 8.0
Dissolved Oxygen Range (mg/L): 8.4 - 8.5
Salinity Range (ppt): 29
Sperm:Egg Ratio: 2000:1
Test Duration: 10:10
Other: —

TEST RESULTS

IC 50: 3.9 (3.6-4.1) mg/L SDS
IC 25: 2.3 (2.2-2.4) mg/L SDS
NOEC: 1.0 mg/L SDS
LOEC: 1.8 mg/L SDS

Data Verified By: [signature]
Date Verified: Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client Azimuth Consulting (Polaris Mine)
EVS Project No. 04-1424-8044
EVS Work Order No. 0500328
Logbook Echinoid #13 Pages 71-74

Test Initiation Date/Time 9 Aug 05 / 1723
Test Species Dendraster excentricus
Source/Date Received Westwind Seclab / 9 Aug 05
Test Duration 10:16

Reftox

Sample ID SDS (mg/L)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Cnt1	15	8.0	29	8.5	
1.0	15	7.8	29	8.4	
1.8	15	7.8	29	8.4	
3.2	15	7.8	29	8.4	
5.6	15	7.9	29	8.4	
10.0	15	7.9	29	8.4	
Technician Initials	SRS/JAP	SRS/JAP	SRS/JAP	SRS/JAP	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-57 Salinity II-A-030303 DO II-A-20

Sample Description

Data Verified By Ralph K Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client: Azimuth Consulting (Polaris Mine) | Test Initiation Date/Time: 09/Aug/05 / 1723
EVS Project No.: 04-1424-044 | Test Species: Dendraster excentricus
EVS Work Order No.: 0500328 | Test Duration: 10:10
Logbook: Echinoid | Pages: 71-74 | Sperm:Egg Ratio: 2000:1
Reftox

Concentration 5 DS (mg/L)	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	88	12		SRS
	B	84	16		
	C	89	11		
	D	87	13		
1.8	A	75	25		
	B	~~74~~ SRS 73	27		
	C	~~72~~ SRS 74	26		
	D	73	27		
3.2	A	49	51		
	B	52	48		
	C	53	47		
	D	49	51		
5.6	A	26	74		
	B	28	72		
	C	26	74		
	D	27	73		
10.0	A	16	84		
	B	11	89		
	C	14	86		
	D	15	85		
Control Seawater					
Cntl	A	88	12		SRS
	B	81	19		
	C	85	15		
	D	86	14		

Data Verified By: Gaff | Date Verified: Aug 31/05

Test: SC-Sperm Cell Fertilization test
Test ID: rtdesds052
Species: DE-Dendraster excentricus
Protocol: EPS1/RM/27-EC 92 (Sperm Cell)
Sample ID: REF-Ref Toxicant
Sample Type: SDS-Sodium dodecyl sulfate
Start Date: 8/9/2005 10:10
End Date: 8/9/2005
Lab ID: BCEVS-EVS Environment Consultants

Pos	ID	Rep	Group	Total Counted	Number Fertilized	Number Unfertilized	Notes
	1	1	D-Control	100	88	12	
	2	2	D-Control	100	81	19	
	3	3	D-Control	100	85	15	
	4	4	D-Control	100	86	14	
	5	1	1.000	100	88	12	
	6	2	1.000	100	84	16	
	7	3	1.000	100	89	11	
	8	4	1.000	100	87	13	
	9	1	1.800	100	75	25	
	10	2	1.800	100	73	27	
	11	3	1.800	100	74	26	
	12	4	1.800	100	73	27	
	13	1	3.200	100	49	51	
	14	2	3.200	100	52	48	
	15	3	3.200	100	53	47	
	16	4	3.200	100	49	51	
	17	1	5.600	100	26	74	
	18	2	5.600	100	28	72	
	19	3	5.600	100	26	74	
	20	4	5.600	100	27	73	
	21	1	10.000	100	16	84	
	22	2	10.000	100	11	89	
	23	3	10.000	100	14	86	
	24	4	10.000	100	15	85	

Comments: Azimuth Consulting Group 04-1424-044 (0500328)

Reviewed by: Aug 31/05

Sperm Cell Fertilization test-Proportion Fertilized

Start Date:	8/9/2005 10:10	Test ID:	rtdesds052	Sample ID:	REF-Ref Toxicant
End Date:	8/9/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 04-1424-044 (0500328)				

Conc-mg/L	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
1	0.8800	0.8400	0.8900	0.8700
1.8	0.7500	0.7300	0.7400	0.7300
3.2	0.4900	0.5200	0.5300	0.4900
5.6	0.2600	0.2800	0.2600	0.2700
10	0.1600	0.1100	0.1400	0.1500

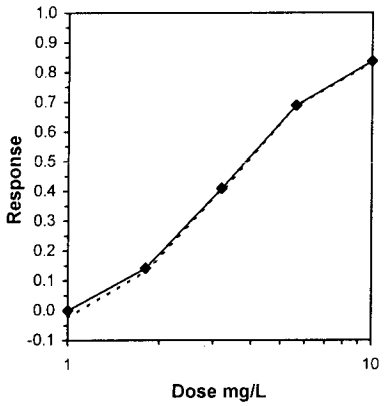
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-mg/L	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	0.8500	0.0294	0.8500	0.8100	0.8800	3.463	4				0.8600	1.0000
1	0.8700	0.0216	0.8700	0.8400	0.8900	2.483	4	-1.412	2.410	0.0341	0.8600	1.0000
*1.8	0.7375	0.0096	0.7375	0.7300	0.7500	1.298	4	7.941	2.410	0.0341	0.7375	0.8576
*3.2	0.5075	0.0206	0.5075	0.4900	0.5300	4.062	4	24.176	2.410	0.0341	0.5075	0.5901
*5.6	0.2675	0.0096	0.2675	0.2600	0.2800	3.579	4	41.118	2.410	0.0341	0.2675	0.3110
*10	0.1400	0.0216	0.1400	0.1100	0.1600	15.430	4	50.118	2.410	0.0341	0.1400	0.1628

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95791		0.884		-0.5718	-0.0762
Bartlett's Test indicates equal variances (p = 0.43)					4.8475		15.0863			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	1	1.8	1.34164		0.03414	0.04017	0.38111	0.0004	3.8E-21	5, 18

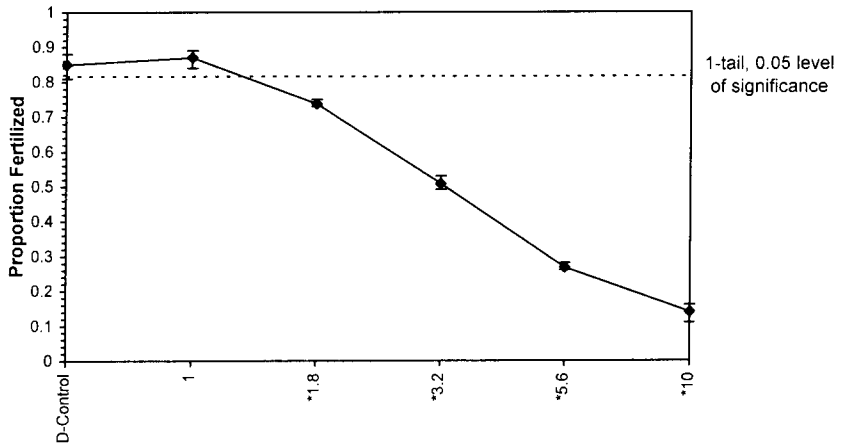
Log-Linear Interpolation (200 Resamples)

Point	mg/L	SD	95% CL(Exp)		Skew
IC05	1.2507	0.0219	1.1728	1.3194	0.2839
IC10	1.5329	0.0430	1.4377	1.6889	1.2146
IC15	1.8323	0.0408	1.7124	1.9570	0.2306
IC20	2.0553	0.0391	1.9513	2.1828	0.4191
IC25	2.2959	0.0426	2.1872	2.4359	0.3093
IC40	3.1375	0.0735	2.9274	3.3760	0.1213
IC50	3.8600	0.0706	3.6272	4.0719	-0.0638

mg/L SDS



Dose-Response Plot



Reviewed by: Aug 31 05

APPENDIX III

Chain-of-Custody Form

CHAIN-OF-CUSTODY / TEST REQUEST FORM

09 0743

Client Name: Teck Cominco
Address: Box 2000, Kimberley BC V1A 3E1
Client Contact: Bruce Donald
Phone: 250-427-5405
Fax: 250-427-8451
Sampled by: B Bolton
Ship to:
Attn.: Edmund Canonia
Shipping Date: Aug 6/05

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sublethal toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	1 x 20L		X					Client is actually Azimuth Consulting

PO/Reference No.
Project Title
Results Needed By

Comments/Instructions

1) Released by: B Bolton Date: Aug 6/05
Company: Gartner Lee Ltd. Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder Laboratory upon sample receipt.

Golder Project No. 0500327 / 328 / 334 / 335
Golder Work Order No. 04-1424-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow — accompany the shipment
Pink — kept by consignor (e.g. shipper)
Yellow — kept by consignee (e.g. receiver)
White — returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

CHAIN-OF-CUSTODY / TEST REQUEST FORM

No. 0742

Golder Associates

195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Client Name: Teck Cominco
Address: Box 2000, Kimberly, BC, V1A 3E1
Client Contact: Bruce Donald
Phone: 250-427-8405
Fax: 250-427-8451
Sampled by: B Bolton
Ship to:
Attn.: Edmund Camacia
Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Sub-lethal toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00 am	Garrow Creek	E		G	2x20L	P	X					Client is actually Azimuth consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: B Bolton — Date: Aug 6/05 — Time: 14 hrs
Company: Gartner Lee Ltd
Courier Name:

2) Released by: — Date: — Time:
Company:
Courier Name:

1) Received by: (SRS) — Date: 9 Aug 05 — Time: 10:15
Company: Golder

1) Received by: — Date: — Time:
Company:

Shaded area to be completed by Golder Laboratory upon sample receipt

Golder Project No.: 0500327 /328/334/335
Golder Work Order No.: 04-1924-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, Yellow — accompany the shipment
Pink — kept by consignor (e.g. shipper)
Yellow — kept by consignee (e.g. receiver)
White — returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

CHAIN-OF-CUSTODY / TEST REQUEST FORM

19 0741

Client Name: Teck Cominco
Client Contact: Bruce Donald
Ship to:
Address: Box 2000, Kimberly, BC V1A 3E1
Phone: 250-427-8405
Fax: 250-427-8451
Sampled by: B Bolton
Attn.: Edmund Camaria

Golder Associates
195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date: Aug 6/05

1 Collection Date (DD/MMM/YYYY)	1 Time (24-h clock)	Sample Identification	2 Type of Each Sample	Material Safety Data Sheet Attached? (✓)	Sample Collection Method G=grab C=composite	Number of Sample Containers x Volume of Sample Containers (1 x 20L)	3 Sample Container Type by Code	Test(s) Requested: Acute toxicity					4 Sample Notes (preserved, saltwater, freshwater, may contain sewage...)
06/Aug/05	10:00	Garrow Creek	20L		G	2x20L	P	X					Client is actually Azimuth consulting

PO/Reference No.:
Project Title:
Results Needed By:

Comments/Instructions:

1) Released by: Brenda Bolton Date: Aug 6/05
Company: Gartner Lee Time: 14:00 hrs
Courier Name:

2) Released by: Date:
Company: Time:
Courier Name:

1) Received by: (SRS) Date: 9 Aug 05
Company: Golder Time: 10:15

1) Received by: Date:
Company: Time:

Shaded area to be completed by Golder laboratory upon sample receipt.

Golder Project No.: 0500327 / 328/334/335
Golder Work Order No.: 04-1429-044
Condition Upon Receipt: Good
Receipt Sample Temp. (°C): 19.0

1 For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
2 Receiving Water (RW): Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); glass jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies:
White, Yellow – accompany the shipment
Pink – kept by consignor (e.g. shipper)
Yellow – kept by consignee (e.g. receiver)
White – returned to consignor by consignee

Please see instructions for completion on back of form

Revision Date: November 22, 2004

APPENDIX I

Polaris 2005 Sampling Event Chronology

Appendix I - Polaris 2005 Sampling and Event Chronology

Becasue mine activities at the Polaris Mine Site ceased during the 2005 season, collection of the MMER and EEM data was conducted by small field crews stationed on-site for limited time periods (early season) and then by flying technicians into the site on a weekly basis in the latter part of the season. Because of the remote location of the high Arctic mine site and the unpredictable weather conditions, sample shipping and transport issues typically arise throughout the season. This season there were several flight attempts into the mine site during the latter part of the season that were unsuccessful due to hazardous weather conditions. The following is a chronology of the 2005 MMER/EEM sampling program, including sample attempts that were prevented due to weather conditions and/or shipping difficulties.

Date	Event Type	Observation/ Comments
Sat. Jun-25-05	-	Flow initiated in Garrow Creek
Wed. Jun-29-05	Monthly/Quarterly	FDP accessible; exposure (Garrow Bay) and reference (Garrow Bay) stations were ice covered precluding sample collection; no exceedances of MMER Schedule 4 limits; T-Hg, alkalinity and nitrate were analyzed after holding times due to an oversight by the ALS lab; a letter explaining this oversight was included in the 2nd quarter report. The EVS and Stantech labs were not able to accommodate a toxicity testing program for this event, as samples would have arrived during a statutory holiday (i.e., Friday July 1, 2005)
Wed. Jul-06-05	Monthly/Quarterly Failed attempt for collecting toxicity samples	FDP accessible; exposure (Garrow Bay) and reference (Garrow Bay) stations were ice covered precluding sample collection; no exceedances of MMER Schedule 4 limits; alkalinity and nitrate were analyzed after holding time due to an oversight by the ALS lab; a letter explaining this oversight is included in the 3nd quarter report Samples for toxicity testing were collected. However, due to fog conditions at the mine site, the flight into and out of the mine site was delayed and missed the connecting flight out of Resolute Bay. Toxicity samples missed holding times and were discarded by the labs, or stopped en-route.
Wed. Jul-13-05	Weekly	A weekly sample was collected as the program schedule was adjusted to Saturday collections to enable sample delivery to the labs earlier in the week (i.e., Tuesday). Although this shipping schedule adds an extra day in transit, if there are no weather delays, then samples should arrive at the labs within the holding time for all toxicity tests.
Sat. Jul-16-05	Monthly/Quarterly Acute Toxicity Sublethal Toxicity	All effluent and water quality monitoring stations were accessible for sample collection. Samples arrived at the labs on Tuesday July 19, 2005 within holding times for all tests. No exceedances of Schedule 4 limits. No acute toxicity.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Jul-23-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Aug-06-05	Monthly/Quarterly Acute Toxicity Sublethal Toxicity	All effluent and water quality monitoring stations were accessible for sample collection. Samples arrived at the labs on Tuesday August 9, 2005 within holding times for all tests. No exceedances of Schedule 4 limits. No acute toxicity.
Sat. Aug-13-05	Weekly	No exceedances of Schedule 4 limits.
Sat. Aug-20-05	Failed attempt for Weekly sample	Flight to Polaris Mine site from Resolute was attempted but did not land due to thick fog and therefore unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Sun. Aug-21-05	Failed attempt for Weekly sample	Flight to Polaris Mine site from Resolute was attempted but did not land due to thick fog and therefore unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Mon. Aug-22-05	Failed attempt for Weekly sample	Fog conditions from satellite photos indicated weather was the same or worse than the previous 2 days. No flight attempted over to site due to unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Tue. Aug-23-05	Failed attempt for Weekly sample	Fog conditions from satellite photos indicated weather was the same or worse than the previous 3 days. No flight attempted over to site due to unsafe landing conditions. Jenny Ferone and Ken Russell were notified of this and the following failed attempts on August 29, 2005.
Wed. Aug-24-05	Weekly	The sample attempt made on Wed August 24, 2005, was successful, following the failed attempts since the previous Saturday. No exceedances of Schedule 4 limits.
Sat. Aug-27-05	Weekly	No exceedances of Schedule 4 limits.

Date	Event Type	Observation/ Comments
Wed. Aug-31-05	Failed attempt for Weekly sample	An attempt to fly into Polaris was made. However, due to fog conditions at the mine site, and the plane was unable to land. Ken Russell and Jenny Ferone were notified of this failed attempt on September 1, 2005.
Sat. Sep-03-05	Failed attempt for Weekly sample	Thick fog and poor visibility prevented the plane from leaving Resolute. Ken Russell and Jenny Ferone were notified of this failed attempt on September 6, 2005.
Wed. Sep-07-05	Failed attempt for Weekly sample	The planned flight into Polaris was cancelled by the pilot due to snow conditions (5-10cm) in Resolute and potentially unsafe conditions for landing at the mine site. Ken Russell and Jenny Ferone were notified of this failed attempt on September 7, 2005.
Sat. Sep-10-05	Failed attempt for Weekly sample	A monthly chemistry plus acute toxicity testing event was planned. However, due to blowing snow conditions, it was deemed by the pilot too hazardous to land an aircraft at the mine site. Ken Russell (Environment Canada) was informed on September 13, 2005.
Tue. Sep-13-05	-	A monthly chemistry plus acute toxicity testing event was planned. However, upon arrival at the mine site, the creek was found to be frozen. Ken Russell was informed on September 13, 2005

APPENDIX J

Letter from ALS explaining missed holding times for July 6, 2005 sample

ALS Environmental

August 5, 2005

Mr. Bruce Donald
Teck Cominco
Bag 2000
Kimberley, BC V1A 3E1

Dear Mr. Donald,

RE: Concerns Regarding Analytical Service

This is in response to email correspondence dated July 29, 2005 through August 3, 2005 expressing concerns over the services provided by ALS Environmental on some Teck Cominco / Azimuth Consulting Group submissions from late June and early July. The examples noted in the emails and the overall concerns over the service provided are taken very seriously by ALS Environmental, and this response letter will hopefully help to address the concerns that were expressed.

In order to provide some clarity and to help resolve the various items of concerns, the following are some of the details that relate to the individual concerns expressed in the emails.

1) missed analyses for samples submitted,
2) missed holding times for Nitrate, Mercury, Alkalinity.

Details of Expressed Concerns

Missed Analysis / Missed Holding Times for Samples Submitted for 2 Submissions:

Polaris MMER (ALS W1416) analysed for pH, Salinity, Total Cyanide, Ammonia, Total Suspended Solids, Radium 226 and total metals
Date / Time Received: Monday, July 11, 2005 @ 10:10 am.
Date / Time Reported: Monday, July 25, 2005 @ 2:23 pm for all but the Radium 226 via email
Wednesday, July 27, 2005 @ 2:42 pm for all analysis via email

Polaris MMER (ALS W1458) analysed for pH, Salinity, Total Cyanide, Ammonia, Total Suspended Solids, Radium 226 and total metals including Mercury
Date / Time Received: Tuesday, July 12, 2005 @ 9:30 am.
Date / Reported: Monday, July 25, 2005 @ 2:23 pm for all but the Radium 226 via email
Wednesday, July 27, 2005 @ 2:42 pm for all analysis via email.

On July 28, 2005, Cheryl Mackintosh of Azimuth Consulting Group called Leanne Harris and expressed concern over the fact that the Mercury analysis for W1416 was missing. Upon investigation, it was

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discovered that the Mercury was missed at the time of receipt; although it was indicated on the chain of custody. The Mercury analysis for this sample was completed at Ms. Mackintosh's request, but it should be noted that it was one day past the recommended holding time of 28 days for Mercury analysis in water.

On July 29, 2005, Ms. Mackintosh emailed Ms. Harris to inquire about the missing analysis of Nitrate and Alkalinity on the two above referenced submissions. The 48 hour recommended holding time for Nitrate had been exceeded prior to receipt of the samples, but the analysis was carried out as per request. The 14 day holding time for Alkalinity had been exceeded by the time the analysis was completed.

Ms. Mackintosh indicated in subsequent email correspondence that these samples had been identified in an email as MMER monthly samples; which meant that they should have been analysed for a fuller suite of analyses. ALS missed the analysis requests and in future will work toward improved communication internally to prevent a similar situation from occurring again.

The results for the Mercury and Alkalinity analysis with holding time exceedences were compared to other routine monitoring results. Historically, the samples compare well with previous submissions analysed within the holding times. Future submissions will be analysed within the appropriate holding times for Mercury and Alkalinity as long as the samples are received with sufficient time to do the analysis. For the Nitrate analysis, with the very short holding time of 48 hours, these samples will not be able to reach a lab within the holding time due to the remote nature of the site. The recommended holding time for these analyses is usually based on studies done with chemically active samples (such as waste waters or discharge samples), which chemically change over short periods of time. While there is no way to tell exactly how these samples are changing over time (without doing a detailed study that incorporates time studies), in general clean water samples from groundwater or surface water sources usually don't have a large amount of chemical activity.

Hopefully, this letter has summarized and addressed the concerns that have been raised. Most of the issue relates to communication. Increased effort in ensuring that there is excellent communication between our staff and the client, as well as thorough communication internally, helps to yield a successful project.

Thank you for bringing this matter to our attention as it helps us to assess our operation and continuously adjust and improve. Please feel free to contact either of the undersigned if you would like to discuss the matter further.

Sincerely,

Joyce Chow, B. Sc.
Branch Manager

Heather Ross-Easton, B.Sc.
Client Services Representative

cc: Cheryl Mackintosh, Azimuth Consulting Group Inc.
Patrick Allard, Azimuth Consulting Group Inc.
Randy Baker, Azimuth Consulting Group Inc.

Limnology and Ecology of Garrow Lake, Little Cornwallis Island, Nunavut – August 2003

Prepared for

Teck Cominco Metals Ltd.
Bag 2000
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May 2005

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TC–03–03

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Randy Baker (Azimuth Consulting Group) authored this report. Patrick Allard and Gary Mann (Azimuth) provided field assistance and Beth Power (Azimuth) is thanked for her technical review. I would also like to thank Bruce Fallis (Department of Fisheries and Oceans, Winnipeg) for sharing his historical experience at Garrow Lake with me.

GLOSSARY

Aquatic – Pertaining to plants or animals that live in freshwater or marine environments.

Arctic – The Arctic is a geographic region that is circumpolar in extent and generally characterized as being north of the treeline, in an area of continuous permafrost.

Benthic – Pertaining to the bottom region of a water body, such as a lake.

Benthic invertebrates / Benthos – Assemblage of organisms living in or on the bottom sediment of a water body and dependent upon the decomposition cycle for most, if not all, of their food supply.

Biomass – The total mass of living organisms usually expressed as a weight per unit area or volume (e.g., mg/m^3 of water).

Bivalves – Mollusks with shells consisting of two halves (i.e., valves) such as clams.

Chironomids – Midges (two-winged insects) in the order Diptera. The aquatic larval form of this insect is typically the most abundant and diverse group of insects found in lakes.

Density of organisms – A term that describes abundance. The total number of living organisms expressed per unit area (e.g., $no./m^2$) or volume ($\#/m^3$).

Dissolved concentrations (water) – The concentration of chemical parameters in water filtered through a 0.45µm glass fiber filter. This is operationally defined as the dissolved fraction in water.

Dipteran insects – Insects of the Order Diptera, consisting of flies having two-wings that includes chironomids, flies, and mosquitoes.

Diversity – A measure (e.g., Shannon-Weaver index) of the variety of living organisms in an area (e.g., number or richness of species).

Drainage basin – The term given to a geographic area that contributes surface and groundwater to a particular lake, river, or stream (also see watershed).

Ecosystem – A community of interacting organisms considered together with the chemical and physical factors that make up their environment.

Environment – Components of the earth including land, water, air, and all layers of the atmosphere. Also included are organic and inorganic matter, living organisms, and all interacting natural systems.

Food chain – Organisms that are linked together in a series that, by consuming lower level organisms, transfer nutrients and energy from one group to another.

Food web – The concept used to describe the relationships of organisms within an ecosystem that are interconnected through various feeding linkages, resulting in the transfer of nutrients and energy.

Freshet – The increased flow of water over a relatively short period of time, usually during spring, caused by snowmelt.

Global Positioning System (GPS) – A sophisticated system used to define a precise geographic location with the aid of a satellite system. Units are typically expressed as UTM (Universal Transverse Mercator) or in latitude and longitude.

Habitat – Any area that provides food, water and/or shelter for an organism.

Invertebrates – A collective term for all animals without a backbone or spinal column and includes all aquatic animal organisms except fish.

Larva – The immature stage, between egg and pupa, of an insect with complete metamorphosis. Many insect larvae are aquatic, including chironomids, mayflies, stoneflies and caddisflies.

Limnology – The study of freshwater lakes including biological, geological, physical, and chemical aspects.

Littoral – The region of a lake, including water and sediment, from the surface to a depth at which photosynthesis ceases, usually within the upper 10m of the water column.

Meromictic – A permanently stratified lake, usually without oxygen (or fish) in its deeper portions due to a density gradient and lack of turnover.

Micro (μ) – A unit of measurement denoting a factor of one-millionth, such as μg/g.

Milligram (mg) – A unit of measurement denoting a factor of one-thousandth, such as mg/g.

Mixolimnion – The low-density surface layer above the pycnocline in a meromictic layer.

Monimolimnion – The high-density bottom layer below the pycnocline in a meromictic lake.

Nutrient – Any substance that provides essential nourishment for the maintenance of life (e.g., carbon, nitrogen, and phosphorous).

Oligochaete – True worms from the Phylum Annelida (segmented worms) that are common in sediment of freshwater habitats.

Oligotrophic – Nutrient deficient waters with low productivity. The vast majority of Arctic lakes are oligotrophic.

Organic Carbon (sediments) – The non-mineral fraction of the sediments that consists of organic carbon, expressed as a percent (%) of the total weight of sediment. This includes all forms of carbon except carbonates.

Phytoplankton – Microscopic or small floating plants suspended in the water column of aquatic ecosystems.

Planktonic – Referring to organisms with limited mobility that are free-floating and living in the water column.

Predator – Any organism that consumes another organism.

Prey – Any organism that is consumed by another organism.

Primary consumers – Organisms such as zooplankton that feed on primary producers (e.g., phytoplankton) for their source of nutrients and energy.

Primary production – Production by photosynthetic organisms, such as algae, phytoplankton and periphyton. Photosynthetic organisms comprise the bottom of the food chain.

Primary productivity – A term given to the rate at which new biomass (i.e., plant tissue) is generated by photosynthetic organisms (i.e., plants) using energy captured from the sun.

Pycnocline – The term given to the density layer of rapid change in temperature and salinity that separates the surface water (epilimnion) from the bottom water (hypolimnion).

Quality Assurance / Quality Control [QA/QC] – Sampling and analytical procedures (such as lab replicate sample analysis) that are integrated in field collection and analytical procedures to ensure acceptable data quality.

Richness – The number of unique taxa (e.g., species) found at a particular location.

Secondary productivity – The rate of increase in biomass of organisms that consume plants or other primary producers.

Secondary consumer – Organisms such as forage fish that consume primary consumers (e.g., zooplankton) for their source of nutrients and energy.

Sediment grain size – Refers to the size and relative size distribution of the particles that make up the sediment. Typically they are divided into four groups including clay, silt, sand and gravel.

Stratification – Vertical differences in water temperature, causing a density difference between warm, less dense surface water and cold, more dense bottom water, retarding or preventing mixing of surface and bottom water.

Terrestrial – Pertaining to plants or animals that live on land.

Total metals concentrations (water) – The total concentration of a metal in the water, which includes both freely dissolved and particle-bound forms of the metal.

Total Suspended Solids [TSS] – The weight of solids that are suspended in a given volume of water, expressed as weight per unit volume (e.g., mg/L).

Trophic Levels – A functional classification of organisms in an ecosystem according to feeding relationships, from primary producers through primary consumers, through secondary consumers.

Tundra – Habitat typically found in the Arctic north of the treeline that is adapted to cold temperatures, a short growing season, and low precipitation. Typical tundra vegetation includes moss, lichen, Labrador tea, and small shrubs.

Turbidity – A condition of reduced transparency in water caused by suspended colloidal or particulate material; measured by a turbidimeter and recorded as nephelometric turbidity units (NTU).

Ultra-oligotrophic – Lakes with extremely low nutrient levels, high water clarity, low primary productivity, and a dominance of small unicellular phytoplankton species. Total phosphorous concentrations are typically <0.005ug/L in these lakes (Vollenweider 1968).

Watershed – An entire geographic area that contributes surface and groundwater to a particular lake, river, or stream.

Water Quality Guidelines – Reference concentrations of contaminants in water that, if exceeded, indicates that organism-level effects may occur.

Zooplankton – Small, floating or weakly swimming animals found in fresh and marine waters, such as copepods and cladocerans.

EXECUTIVE SUMMARY

The objective of this study was to determine the limnology and ecology of Garrow Lake and assess changes to the lake after more than 20 years of tailings disposal. Prior to mining, the lake supported a depauperate biological community including a small, dwarf population of landlocked fourhorn sculpin (*Myoxocephalus quadricornis*). Teck Cominco has regularly monitored lake water quality and stratification since pre-mine investigations. However, no study of sediment quality or biological studies have been conducted since disposal of tailings to the lake began in 1980. As part of a 2002 DFO habitat authorization (02-HCAA-000-000063), Teck Cominco was specifically required to determine TSS and turbidity in different strata of Garrow Lake, metals concentration in littoral zone sediment and whole-body metal concentration in fourhorn sculpin.

Teck Cominco Ltd.'s Polaris Mine (75°23'N 96°50'W) on southern Little Cornwallis Island, Nunavut used Garrow Lake for tailings disposal pursuant to its designation as a Tailings Impoundment Area (*Fisheries Act* Schedule 2). as a Tailings Impoundment Area (*Fisheries Act* Schedule 2). Underground zinc-lead mining permanently ceased in September 2002. Since then the mine has undergone reclamation and decommissioning that concluded in fall 2004. Polaris Mine is undergoing a full cycle of Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations that will conclude in 2005.

Garrow Lake is small, ultra-oligotrophic, permanently chemically and thermally stratified (i.e., meromictic) lake with a surface area of 4.18 km^2, maximum depth of 42 m and a depauperate biological community. Prior to tailings deposition, the biologically active mixolimnion ranged between zero and 12 m – 14 m in depth and was well oxygenated, cold and brackish (3 – 7 ppt salinity). The deep monimolimnion extended from about 18 m to the bottom and was unusually warm (8°C), completely anoxic, sulphide rich and hypersaline, with a salinity of up to 90 ppt. These layers were separated by a 6 m thick pycnocline where temperature increased, oxygen concentrations fell and salinity increased rapidly with increasing depth.

Between 1981 and 2002, approximately 15 million tonnes of tailings solids were deposited into the monimnolimnion. Gradual displacement of water upwards has reduced total depth of the lake from 46 m to 42 m, and reduced depth of the mixolimnion and thickness of the pycnocline. Discharge of tailings into the monimolimnion has also reduced mean salinity, from 90 ppt to 70 ppt, and caused complete mixing within the monimolimnion, such that temperature and salinity profiles are uniform from just beneath the pycnocline to the bottom.

Tailings deposition has not changed limnological conditions of the mixolimnion. Winter and summer water temperatures remain cold, ranging from –0.5 °C to 4 °C with little difference between seasons. Salinity ranged from 3.8 ppt at the surface to 7.1 ppt at the

pycnocline (9 m) with slight inverse stratification. Oxygen concentration was stratified and high in winter (13 – 20 mg/L) and supersaturated, a condition also noted during pre-mine conditions, presumably from algae and photosynthetic bacteria. In August oxygen was uniform at 11.5 mg/L, but was not supersaturated because absence of ice cover and mixing by wind, allowing oxygen to escape to the atmosphere.

Depth of the mixolimnion extends to 9 m at the top of the pycnocline. Maximum salinity is reached at the top of the monimolimnion at 12 m, a depth of only 3 m. Formerly, mixolimnion depth extended to 12 m and the bottom of the pycnocline ended at about 20 m. Oxygen concentration in the monimolimnion was nil and there was a strong hydrogen sulphide odor to the water.

Tailings deposition has displaced the mixolimnion depth by 4 – 5 m. Lake elevation in 2003 was 2 m higher than pre-mine elevation because of the dam that was still in place at the lake outlet. Removal of the dam in spring 2004 has allowed water level in the lake to return to near pre-dam elevations and will have reduced lake level and total depth of the mixolimnion to about 8 m, a further reduction of 2 m.

Prior to tailings deposition, sediment metals concentrations did not differ with depth and were relatively low, but reflected natural mineralization of the area, with elevated lead and zinc. A pipeline break in 1984/1985 caused tailings to spill into the littoral zone along the western shore of the lake, resulting in widespread contamination of lead and zinc in littoral zone sediment. This caused an increase in dissolved zinc concentration in surface waters of Garrow Lake and the outflow creek. Currently, zinc concentration in the Garrow Lake mixolimnion averages about 0.22 ppm, below the permit limit of 0.5 ppm established in 1992.

The only species of zooplankton known to be present in Garrow Lake is *Limnocalanus macrurus*, which was captured during pre-mine surveys. Amphipods (*Gammarus* sp.) and a mysid species (*Mysis oculata*) were also present in Garrow Lake prior to mining. No zooplankton species were captured during the 2003 survey. It is not known why zooplankton appeared to be absent. It is possible zooplankters were deeper in the water column than was sampled, or that changes to mixolimnion water chemistry may have caused a decline or extirpation of *L. macrurus* or its primary food source, phytoplankton. Phytoplankton were not collected in 2003.

Oligochaetes (F. Enchytraidae), nematodes and Foraminifera were the only benthic invertebrates identified in sediment collected at four stations within the mixolimnion zone in 2003. Although chironomid larvae were not collected from sediment, they were observed in stomachs of fourhorn sculpin. Pre-mining surveys also indicated a depauperate benthic fauna dominated by Foraminifera and a few harpacticoid copepods and chironomids. Garrow Creek sediment contained nematodes, oligochaetes a single mayfly (Ephemeroptera) species *Baetis bicaudatus* and several chironomid species.

All 19 sculpins captured in 2003 appeared to be healthy with no external or internal tumors, scars or other abnormalities. Mean length (149 mm), weight (25 g) and condition (0.70) of sculpins from 2003 were similar to sculpins collected in 1976 (155 mm, 26 g, 0.72) using the same gear. Length – frequency distributions of sculpins from 1976, 1977 and 2003 also demonstrated that the basic size distribution of adult sculpins has not changed over time.

Mean age of sculpins captured in 2003 was 5.7 years, with a range of 3 – 9 years. The small size, low lipid content (10%) and small size at age confirm that Garrow Lake sculpins are slow growing relative to other Arctic sculpin populations because of limitations in food and habitat.

Four of 11 sculpins stomachs examined contained food, with only a few chironomid larvae distinguishable. Pre-mine examination of stomachs indicated that half were empty while copepods, unidentified eggs, plant material, and a few amphipods were present in the other half. Copepods were not identified in stomachs in 2003, providing circumstantial evidence that zooplankton may not be abundant and comprise a very small component of the aquatic community in Garrow Lake post-mining.

Gonads of most sculpins examined appeared ripe or nearly ripe and these individuals would certainly spawn within the next few months during mid-winter, a trend that is consistent for this species.

Whole body concentration of manganese, lead (0.81 mg/kg ww) and zinc (72 mg/kg) in sculpins was higher in 2003 than prior to mining. Other metals including arsenic, cadmium, copper, mercury, and nickel were lower or did not differ among years. Elevated lead and zinc concentrations in sediment and the water column as a result of the spill may be responsible for elevated tissue concentration, however, the magnitude of increase in tissue was small, only 2 – 3 times higher than pre-mining concentration, despite a two-order of magnitude increase in lead and zinc concentration in sediment.

Overall, it appears as if the size, distribution, growth rate and reproductive status of the sculpin community has not changed markedly since pre-mining studies. Although catch-per-unit-effort was not recorded, sculpins were more difficult to capture and did not appear to be as abundant or as easy to capture as pre-mine surveys indicate. This may be related to the absence of zooplankton and reduced benthic habitat available to sculpins and their food sources because of gradual upward displacement of the mixolimnion. Nevertheless, sculpins have survived in Garrow Lake throughout the history of mining and tailings deposition to the lake, which is still designated as a tailings disposal facility.

Tailings introduction and upward displacement the pycnocline and mixolimnion will have reduced depth of the mixolimnion above the pycnocline to about 8 m in 2004, after removal of the dam. It has been determined that the magnitude of the thermal and salinity

difference between the mixolimnion and the monimolimnion in the lake will be sufficient to maintain separation of the two layers and prevent turnover and mixing.

1 INTRODUCTION

1.1. Background

Teck Cominco Metals Ltd.'s Polaris Mine (75°23'N 96°50'W) is situated on southern Little Cornwallis Island, Nunavut, in the high Arctic, approximately 90 km northwest of Resolute Bay (Figure 1). This region is characterized by short, cold summers and extremely cold, long and dark winters. Mean average air temperature is –17°C with an average of only 8 frost-free days annually. Precipitation is very low and is typical of desert conditions with only 25 cm of annual precipitation, most of this as snowfall. Winds are strong and predominantly from the northeast with an average wind speed of 20 kph (Gartner Lee, 2001).

Underground zinc-lead mining operations, which initially began in 1981, permanently ceased on September 3, 2002 with the final shipment of concentrate, taking place later that same month. The Polaris Mine has undergone a two-year reclamation and decommissioning phase (Garner Lee, 2001) that concluded in September 2004. In addition to remediation of upland soils, Polaris Mine is undergoing a full cycle of Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations (MMER; DFO, 2002). The MMER document (Azimuth Consulting Group, 2004) describes how the three main components of MMER are to be applied; routine effluent monitoring (chemistry, toxicity, mass loading) in Garrow Creek, emergency response, and Environmental Effects Monitoring (EEM) of receiving environment biota (benthic community and fish survey) in Garrow Bay.

As part of mine closure activities, Teck Cominco was required to undertake a basic ecological study of Garrow Lake as part of a Department of Fisheries and Oceans Habitat Authorization (see Section 1.4 and Appendix A). This document satisfies that directive.

1.2. Limnology

Garrow Lake is a small, permanently chemically and thermally stratified (i.e., meromictic) lake with a surface area of 4.18 km^2, a maximum depth of 46 m and unique limnological characteristics (BC Research, 1975; Ouellet and Dickman, 1984; Fallis et al., 1987). The lake is ultra-oligotrophic with very low nutrient concentration and a depauperate biological community (Fallis et al., 1987; BC Research, 1978). Because of its unique physical/chemical features, Garrow Lake has been the subject of much study, notwithstanding its designation as a Tailings Impoundment Area for Polaris Mine. Garrow is still considered a Tailings Impoundment under the current MMER (DFO, 2002).

The meromictic nature of Garrow Lake means that there are three distinct depth zones within the lake that never inter-mix, because of their particular thermal and chemical properties. These are the mixolimnion, pycnocline layer and monimolimnion, from top to bottom.

Prior to mining, the mixolimnion of Garrow Lake ranged from the surface to about 12 m – 14 m depth. It was well oxygenated, cold (0°C to 4°C) and brackish, ranging from 3 ppt at the surface to 7 ppt above the pycnocline. The monimolimnion ranged in depth from about 18 – 20 m to the bottom of the lake, at a maximum depth of 46 m. This deep layer was unusually warm (8°C), completely anoxic, sulphide rich and hypersaline, with a salinity of up to 90 ppt, nearly triple the salinity of seawater. These two very different layers were separated by a pycnocline. The pycnocline represents the transition zone between the mixolimnion and monimolimnion where temperature increases, oxygen concentration falls and salinity increases rapidly with increasing depth. The large increase in density transitioning from the mixolimnion to the monimolimnion through the pycnocline is great enough to maintain complete separation of the layers and prevent mixing, even over thousands of years.

Garrow Lake is situated in an area of continuous permafrost and is ice-covered for much of the year (Photo 1). In some years, the ice does not completely melt, leaving an ice cover. The lake slopes steeply from the narrow littoral zone into the anoxic, hyper-saline profundal zone within tens of meters from shore. The drainage area of Garrow Lake is very small and is only double the surface area of the lake. The small drainage area and low precipitation means that total annual discharge from the lake via Garrow Creek is correspondingly small.

Discharge to Garrow Bay, 1.4 km south of the lake outlet occurs during the brief open water period from mid to late July through late-August or early September. In the nearly 3,000 years since its separation from adjacent marine waters, the annual freeze-thaw cycle at the lake's surface has transferred and concentrated salt in the deeper parts of the lake. Interestingly, bottom temperature is nearly 8°C, much warmer than surface waters that are always near zero.

1.3. Mining Operations

Polaris was a zinc-lead mine that operated between 1981 and 2002 inclusive. Mined ore was crushed underground and moved by conveyor to a mill. Ore concentrate was stockpiled above ground in a covered building and shipped by ocean going bulk carrier to Europe during the brief open water period. Garrow Lake is a designated Tailings Disposal Facility. Over the life of the mine approximately 15 million tonnes of tailings solids were deposited to the bottom of Garrow Lake at a rate of up to 100 tonnes per hour (Gartner-Lee, 2001). Mill tailings were pumped via a 4 km long tailings line to a

thickener before being discharged to Garrow Lake via a submerged pipe. The pipe extended between 600 m and 1.2 km offshore and to a depth of 30 m (BC Research, 1988), at least 10 m below the pycnocline and 15 m above the bottom. The tailings line was moved every year to distribute tailings over the bottom. Small piles of tailings are apparent from lake bathymetry (Figure 2).

This disposal system was very effective, except for an incident in 1984/85 where a failure of the pipe resulted in tailings discharge into near-surface waters of Garrow Lake. This spill caused tailings to be deposited along the western shore of the lake near the tailings line and caused dissolved zinc concentration in surface waters to increase to more than 0.4 mg/L. Since the spill, zinc concentration in the mixolimnion has been slowly declining. Currently, zinc concentration in Garrow Lake averages about 0.23 ppm, below the permit limit (0.5 ppm) that was established in 1992.

To dilute zinc concentration in the mixolimnion and hence reduce zinc concentration in water discharged to Garrow Bay via Garrow Creek, Teck Cominco constructed a dam in 1989/1990 across the creek, about half way between the outlet and the mouth (Figure 2). Water was retained within the lake for three years, causing in increase in lake elevation and mixolimnion depth by about 2 m. Between 1994 and 2003 stream discharge and lake level was controlled by active siphoning of water over the dam into Garrow Creek between mid-July and early-September. Therefore, discharge was relatively constant throughout the discharge period, ranging between 0.19 m^3/s and 0.55 m^3/s, depending on the number of siphons in operation. The dike and siphons were removed in spring 2004 to allow the lake to return to its former level and in future, fluctuate naturally.

Prior to installation of the dam, flow in Garrow Creek was ephemeral with discharge typically occurring over a six to eight week period beginning in mid-July, once the stream mouth and channel had thawed. Stream flow began with melting and freshet, which lasts about two weeks (0.5 – 1.5 m^3/sec) before rapidly diminishing to relatively low discharge volume (0.1 m^3/sec) for the remainder of the summer/fall until freeze-up in early September. It is expected that since the dam and siphons have been removed, discharge will return to normal patterns, except with smaller discharge volume as no water is displaced by the addition of mine tailings.

1.4. Objective

Our objective was to describe the current limnology and ecology of Garrow Lake and assess changes after more than 20 years of use of Garrow as a tailings disposal facility. Prior to mining, the surface waters and littoral sediment of Garrow Lake supported a small community of zooplankton and benthos that sustained a small, dwarf population of landlocked fourhorn sculpin (*Myoxocephalus quadricornis*). It was not known if surface water conditions had deteriorated sufficiently as to cause unfavorable conditions for

aquatic life. Since pre-mine investigations in 1977 (BC Research, 1977), 1979 (Fallis et al. 1987) and 1980 (BC Research, 1981), very few studies on water quality have been conducted, outside of routine monitoring by Teck Cominco two or three times per year. No study of surface sediment quality (e.g., BC Research, 1988) or ecology of the lake has been conducted since deposition of mine tailings began. Therefore, as part of a 2002 DFO habitat authorization (02-HCAA-000-000063; Appendix A) during the decommissioning and dam removal process, Teck Cominco was specifically required to determine the following (see Section 4.0 of authorization; Appendix A):

- "TSS and turbidity in different strata of Garrow Lake to confirm the absence of contaminants in surface waters;

  metals concentration in sediment in the littoral zone of Garrow Lake; and
- whole-body metal concentration in fourhorn sculpin".

This report describes limnological and ecological features of Garrow Lake several months after cessation of more than 20 years of tailings disposal and satisfies requirements of the DFO Habitat Authorization. The data reported here extends beyond the requirements of the Habitat Authorization to review historical trends and provide a broader base of information.

2. MATERIALS AND METHODS

2.1. Limnology and Water Chemistry

Water sampling was conducted from a 3 m aluminum boat with 12 hp motor on August 8, 2003 (Photo's 2 and 3). Shifting ice pans covered at least 50% of the lake. One week earlier, ice cover on the lake was at least 80% (Photo 1). Based on historic bathymetric data and using a hand-held depth meter, the deepest depth on Garrow Lake that could be accessed because of ice, was located in 42.5 m of water (Figure 2). At this point, a vertical pH, temperature (°C), oxygen (ppm), conductivity (mS) and salinity (ppt) profile of the lake was acquired using a Hydrolab™ meter. Measurements were recorded at 1 m intervals between the surface and bottom. Vertical temperature and salinity profiles were compared with pre-mine profiles (BC Research, 1975; Fallis et al. 1987; BC Research, 1978) and during-mining profiles (BC Research, 1988) to determine the effects of mine tailings disposal on lake stratification, limnological parameters and water chemistry (Appendix B).

To acquire water samples for chemical analysis from this location (WQ-1), water was pumped from discrete depths using a direct pumping system. Depths were selected based on temperature and salinity data acquired with the Hydrolab. Weighted, ultra-clean metered Teflon tubing was deployed from the boat and lowered to the desired depth. A diaphragm pump was attached and water was pumped from depth for at least 1 minute before being discharged directly into sample collection bottles that were triple rinsed and held on ice. Water samples requiring filtering were filtered in the field by placing a 45 µm inline Gelman filter onto the end of the hose and discharging water directly into sample bottles.

Water was collected from the surface, mid-epilimnion (6 m), pycnocline (11 m) and hypolimnion layers (15 m and 30 m) to characterize each discrete layer. A 1-L plastic bottle with no preservative was used to hold water for determination of pH, conductivity, salinity, total suspended solids (TSS), alkalinity, sulphate and fluoride. A 250 ml glass amber bottle with no preservative was used to hold water for determination of DOC. Total metals and dissolved metals were collected in 250 mL plastic bottles preserved with nitric acid. Standard field collection and quality assurance/quality control (QA/QC) procedures were followed (BCMELP, 2003). Water samples were held on ice and during shipping to ALS Environmental Laboratory, Vancouver for analysis.

2.2. Sediment Chemistry

Sediment was collected from six littoral zone stations around the lake as ice conditions permitted using a 0.024 m^2 petite Ponar grab (Figure 2). Four stations were synoptically

sampled for sediment metals (GL-X-SED), benthos and zooplankton. Two stations (GL-N, GL-S) in the vicinity of the historic spill were only sampled for sediment metals. Stations were selected based on depth (<9 m) using a hand-held depth meter to ensure that sampling occurred within the mixolimnion layer of the lake to ensure consistency in grain size and avoid shallow depths with coarse substrate (Table 1).

Sediment was collected using proven sample collection and handling techniques (Environment Canada, 1994; BCMELP, 2003). Each deployed grab sample was examined to ensure acceptable sample quality (i.e., no large foreign objects; adequate penetration; not overfilled; no leaking water; no disturbance or winnowing). Once the grab sample quality was determined to be acceptable, overlying water was siphoned off and the top few cm of sediment was removed from the center of each grab using a pre-cleaned stainless steel spoon and placed in a pre-cleaned stainless steel mixing bowl. Two samples were acquired from each station and composited in the same bowl. Sediment was mixed using the spoon until it was homogenous in texture and colour. Aliquots of sediment were placed into 250-mL glass jars for analysis of total metals including mercury, total organic carbon (TOC) and grain size by ALS, Vancouver BC. Samples were stored in coolers with frozen gel packs on ice until analysis by the laboratory.

Total metals were analyzed using procedures from the BC Contaminated Sites Regulations (CSR) Analytical Method 8 *Strong Acid Leachable Metals (SALM) in Soil* and procedures adapted from *Test Methods for Evaluating Solid Waste SW-846* (US EPA Method 3050B or Method 3051). Sediment samples were manually homogenized, dried at 60 °C, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material was weighed. The sample was then digested at 90 °C for two hours by either hotplate or block digester using a 1:1 ratio of concentrated nitric and hydrochloric acids. Instrumental analysis was by atomic absorption/fluorescence spectrometry (CVAAS/CVAFS)(US EPA Method 7000 series) and/or inductively coupled plasma – optical emission spectrometry (US EPA Method 6010B).

2.3. Biota

2.3.1. Zooplankton

Vertical zooplankton tows were conducted from the four synoptic stations (Figure 2) using a 2 m long, 0.5 m diameter conical net, with 250 µm mesh size. The mouth of the net was lowered to a depth of 8 m and after waiting 30 sec, was towed vertically towards the lake surface. Two vertical tows were conducted and composited to determine zooplankton density (# organisms/m^3). Contents of the cod end were washed into a 500 mL HDPE jar and preserved with a 10% formalin solution. In addition, a horizontal tow was conducted at station 3. The net was weighted and towed behind the boat at a depth of

1 m for 3 minutes, to attempt to collect zooplankton for taxonomic analysis. Preserved samples were shipped to Applied Technical Services, Victoria BC for taxonomic identification.

2.3.2. Benthic Invertebrates

Sediment was acquired using a petite Ponar grab (0.024 m^2) at each of the four synoptic stations (Table 1). The top 5 cm of acceptable grabs was removed and sieved through a 500 μm sieve. Three grab samples were acquired at each station and composited (i.e., 0.072 m^2) to determine density of organisms (#/m^2).

Garrow Creek, just downstream from its outlet from Garrow Lake (i.e., below the dam) was sampled for benthic invertebrates using a kick-style sampler. Substrate upstream of a 250 μm net was disturbed, causing attached or burrowed organisms to drift into the net. This sampling was non-quantitative and was intended to determine species composition and relative abundance of benthic organisms in this ephemeral stream. Material retained by the sieve was transferred to a 500 mL HDPE container and preserved in a 10% buffered formalin solution. Preserved benthos samples were shipped to Applied Technical Services, Victoria BC for taxonomic identification and enumeration.

2.3.3. Fish

Pre-mining ecological surveys of Garrow Lake in 1976 (Fallis et al., 1987), 1977 (BC Research, 1987) and 1980 (BC Research, 1981) confirmed that Garrow Lake contained a glacial relict population of fourhorn sculpin (*Myoxocephalus quadricornis*). Since tailings deposition in Garrow Lake began in 1980, no sculpins have been collected from the lake, although divers have purportedly observed sculpins on an annual basis during maintenance and movement of the tailings line (W. Gzowski, Arctic Divers Ltd., August 2003). We collected sculpins in August 2003 using small-mesh (20 mm – 50 mm) Swedish gill nets and a baited prawn trap at various locations around the lake, as ice conditions permitted. Fallis et al. (1987) used similar size nets (19 – 64 mm stretch mesh) to catch sculpins in 1976.

All sculpins captured were measured for total length (mm), weight (g) and examined externally for any abnormalities. A subsample of sculpins were sacrificed and examined internally for gender, state of sexual maturity, stomach contents, parasites and internal condition and abnormalities. These sculpins were retained and frozen for subsequent whole-body analysis of metals concentration by ALS, Vancouver.

Length-frequency distribution, condition factor (K = length^3/weight x 10^5), sex ratio, maturity and diet from 2003 fish were compared with data collected from the pre-mining (1978 – 1979) period to determine changes in biology and life history characteristics.

3. RESULTS AND DISCUSSION

3.1. Limnology

3.1.1. Physical Attributes and History

Garrow Lake is one of the few meromictic (i.e., permanently stratified) lakes found in the Arctic and has the highest salinity content of all polar lakes (Ouellet et al., 1989). Strong vertical stratification due to large differences in salinity and temperature between the cold (~0°C), slightly brackish (2 – 7 ppt salinity) mixolimnion and the warm (8°C), anoxic, hypersaline, hydrogen sulphide rich monimolimnion maintains complete separation of these two discrete layers.

Garrow Lake was formed by isostatic rebound during the most recent Wisconsin glaciation period that ended 10,000 years ago. A marine depression was progressively uplifted, eventually isolating the marine water-filled depression from the surrounding ocean. Several independent estimates place the age of Garrow Lake (i.e., when it was physically separated from the marine environment) at between 2,500 and 3,500 years ago. ^{14}Carbon dating of marine bivalve shells collected near the shoreline elevation of Garrow Lake indicated a date of 3,350 years before present (BP). Isotopic examination of bottom water from Garrow Lake by Page et al. (1984) revealed that exposure of this water to air last took place at least 2,580 years ago. Using post-glacial rebound rates Thornsteinsson and Kerr (1968), Stewart and Platford (1986) and Fallis et al. (1987) independently estimated the age of Garrow Lake as 3,000, 2,600 and 2,500 – 3,000 years BP, respectively.

How the deep monimolimnion of Garrow Lake became to be nearly three times the salinity of sea water is a matter of some debate and several theories have been advanced to explain how this situation arose. Stuart and Platford (1986) favor the idea that brine currents were formed during the freeze-out of salts from surface waters that sank and, over time, accumulated to form the hypersaline monimolimnion. They contended that the ionic proportion and ratio between surface and deep waters was very similar and did not demonstrate the major differences that would necessarily occur if there was differential mineral precipitation in the monimolimnion or intrusion of hypersaline ground water from freeze-out. Furthermore, if freeze-out of salts beneath lakes was prevalent, this should be observed in many Arctic lakes, but it is not.

Alternatively, Ouellet and Dickman (1983) and Dickman and Ouellet (1987) hypothesized that after separation of Garrow Lake 3,000 years ago, gradually advancing permafrost froze out the freshwater, concentrating salts in deeper water of the lake over time. Ouellet et al. (1989) theorized that pore water trapped between sediment particles

would have been progressively frozen during isostatic rebound as Garrow Lake rose and "advanced" inland. The formation and presence of an unfrozen column of water or talik beneath Garrow Lake would favor the movement or displacement and gradual accumulation of frozen-out salts in the bottom of the lake. Based on their results and citing other similar studies on Antarctic lakes, Ouellet et al. (1989) concluded that cryogenic concentration of salts from surface waters or freeze-out of salts from surface soils over time were only of minor importance and refute the Stewart and Platford (1986) theory of major contribution by surface sources. This matter is still unresolved. A more thorough discussion of this can be found in the above papers and Fallis et al. (1987).

Fallis et al. (1987) and Ouellet et al. (1989) also offered an explanation as to why the monimolimnion is so warm relative to the mixolimnion. Lack of snow cover and clear ice allows light to penetrate through the mixolimnion and be absorbed by a bacterial layer within and just below the pycnocline boundary atop the monimnolimnion. The strong density difference between the surface and bottom layers does not allow mixing and allowed more heat to be absorbed within the deep layer than escapes. Over time, heat has been accumulated within the monimolimnion, eventually reaching an equilibrium temperature.

The chemical and thermal structure of the monimolimnion has been disturbed by the physical disturbance of tailings disposal into the mid-water column. Vertical mixing action within the monimolimnion caused by buoyant tailings water and tailings solids falling through the water column has gradually caused temperature and salinity profiles to become more uniform or homogeneous. This has also resulted in a less saline, slightly cooler and more uniformly mixed monimnolimnion than existed prior to mining (Figure 3; Appendix B).

3.1.2. pH, Temperature, Salinity and Oxygen

3.1.2.1. Pre-Mining Profiles

Pre-mining studies in 1976 and 1981 (Fallis et al., 1987), 1977 and 1980 (BC Research, 1978; 1981), and 1980 and 1981 (Dickman and Ouellet, 1987) recorded very similar vertical pH, temperature, oxygen and salinity profiles and stratification parameters in Garrow Lake. Studies conducted in 1982 (Stewart and Platford, 1986), and 1983 and 1984 (Ouellet and Dickman, 1987; Ouellet et al., 1989), shortly after commencement of mining, also reported similar results to pre-mining. In all studies, mixolimnion depth extended to about 12 m at which point temperature and salinity began to increase rapidly with increasing depth (the pycnocline) to reach a maximum at about 20 m, the top of the monimolimnion (Figure 3). This zone extended to the bottom of Garrow Lake at its deepest depth (46 m).

Water column pH typically ranged between 6.9 and 8.0 and tended to be slightly lower within the monimolimnion than in the mixolimnion (BC Research, 1977; Fallis et al., 1987).

Water temperature in the mixolimnion ranged between just above zero to four or five degrees Celsius, depending on the month (cold in June, warmer in August), and tended to gradually increase with depth towards the pycnocline (BC Research, 1978; Stewart and Platford, 1987; Ouellet et al., 1989). Wind mixing during open water conditions in late fall resulted in more uniform temperature between surface and deeper water of the mixolimnion (BC Research, 1978).

Oxygen concentration was always high, reflecting surface mixing in summer and biological activity by plankton in the mixolimnion. Fallis et al. (1987), Ouellet and Dickman (1987) and Stewart and Platford (1986) observed supersaturation (>100%) of normal oxygen solubility at deeper depths in the mixolimnion especially in spring. Supersaturation is believed to result from freezing-out of oxygen during ice formation and from biological productivity. A dense plate of photosynthetic bacteria exists just above the pycnocline (Fallis et al. 1987). During late winter and spring, these bacteria and phytoplankton produce an excess of oxygen that accumulates and is trapped in the water column beneath the ice cover.

Total suspended solids (TSS) concentration (mg/L) was measured in effluent from Garrow Lake, which represents concentrations found in the upper few meters of the mixolimnion. In all cases, TSS was less than detection limits (i.e., either 1 mg/L or 3 mg/L, depending on the laboratory). Visual observations of the lake from water sampling throughout the water column confirmed that there was no visible turbidity to the water, regardless of depth.

Salinity of the mixolimnion varied between slightly brackish at the surface to about 7 or 8 ppt in all studies showing slight vertical stratification (Table 2; Figure 2). Salinity in the upper water column is lower in summer and fall than in winter because of dilution by ice melt. Anion and cation concentrations and conductivity mirrored salinity and increased proportionately with depth (Ouellet et al., 1989). In January 1983, two years after commencement of tailings disposal, salinity of the mixolimnion was 4.8 ppt and did not differ from pre-mine conditions. Sampling of the water column beneath the ice in June 1984, three years after discharge of tailings, revealed dilute surface water salinity (0.5 ppt at 1 m) with uniform salinity to 12 m (5.7 ppt)(Ouellet et al. 1989).

Within the top of the pycnocline (12 – 14 m) oxygen concentration diminished while temperature and salinity increased with increasing depth. All researchers observed this trend. At the bottom of the pycnocline (18 m – 20 m), oxygen had diminished to zero while temperature had increased to 9°C in the upper monimolimnion. The bacterial plate near the bottom of the pycnocline observed by BC Research (1980) and Ouellet and

Dickman (1983) is likely responsible for increased turbidity at this depth as well as increased hydrogen sulphide concentration, which continued to increase with increasing depth. Salinity increased very strongly between 12 m (9 ppt) and 20 m (66 ppt)(Stewart and Platford, 1986; Fallis et al, 1987). Ouellet et al. (1989) also observed that salinity increased rapidly with increasing depth through the pycnocline from 5.7 ppt at 12 m to 35.2 ppt at 17 m and 76.7 ppt at 21 m. Stewart and Platform (1986) and Fallis et al. (1987) observed similar salinities at the same depths.

Within the monimolimnion extending from 20 m to the lake bottom, oxygen concentration was nil and water temperature decreased very gradually from 9°C to 5°C and did not differ among seasons or years (BC Research, 1977; 1981; Stewart and Platford, 1986; Fallis et al., 1987; Ouellet et al., 1989). Salinity also gradually increased with depth, reaching maximum salinity (between 80 and 90 ppt depending on the study) at the lake bottom (46 m). Because of the isolated, undisturbed nature of the monimolimnion prior to mining, temperature and salinity profiles were virtually identical among studies, regardless of season or year.

3.1.2.2. Post-Mining Profiles

BC Research (1988) analysed surveillance water quality data from Garrow Lake between 1982 and 1987 to evaluate changes in metals concentrations within the different layers during the period of discharge of mine tailings to the monimolimnion. Vertical temperature and conductivity profiles were essentially unchanged except for the fact that the salinity gradient within the monimolimnion was steeper, suggesting that stratification within this layer was disturbed. As expected, continuous discharge of tailings to 30 m depth, 12 m above the bottom, was causing vertical mixing within the monimolimnion beneath the pycnocline, resulting in more uniform salinity and temperature profile and raising metals concentrations. Teck Cominco continued to collect vertical temperature and salinity profiles of Garrow Lake during winter and summer periods to monitor the limnology of the lake in order to ensure that the integrity of the pycnocline was maintained and that mixing of the monimolimnion into surface water was not occurring.

In 2003, Garrow Lake was completely ice-covered until late-July. During mid- to late-August, the lake became mostly ice-free, although ice pans persisted over about 20% of the lake and shifted around according to wind direction. In 2004, the lake remained completely ice-covered and sampling was not possible. Effective mixing of surface waters is only possible during ice-free conditions when sufficient surface area of the lake is exposed to wind to cause turn-over and vertical mixing.

Teck Cominco staff sampled water during February and March 2003 from a single location near the middle of the lake. In August, we collected a single vertical profile from the lake from the deepest accessible location (42.5 m), GL-1-WQ (Figure 2). Winter and

summer vertical profiles of temperature, oxygen and salinity were very similar to pre-mining data (Figure 3) with two notable differences. Salinity of the monimolimnion and depth of the mixolimnion have both diminished, reflecting the physical effects of tailings deposition to the lake bottom.

Mixolimnion salinity ranged from 3.8 ppt (6.7 mS) at the surface to 7.1 ppt (12.5 mS) at the top of the pycnocline (9 m). Melting ice caused lower salinity and conductivity at the surface than at deeper depths, with a slight inverse stratification. In winter 2003, salinity and conductivity within the epilimnion was uniform (Appendix B). Oxygen concentration was stratified and high in winter (13 – 20 mg/L) and supersaturated, a condition also noted during pre-mine conditions, presumably from photosynthetic bacteria. In August oxygen was also high and uniform (11.5 mg/L), but was not supersaturated because absence of ice cover and mixing by wind allowed oxygen to escape to the atmosphere (Figure 3).

Winter and summer water temperatures were cold, ranging from –0.5 °C to 4 °C with very little difference between seasons. Surface water temperature (<2 m) was slightly warmer in summer than in winter. Below 2 m depth, water temperature ranged between 3° and 4°C. Field pH was 8.2 in the mixolimnion and declined through the pycnocline and monimolimnion to 7.35 that was unchanged with depth to the bottom (Appendix B). Limnological conditions within the mixolimnion were very similar in 2003 as pre-mining conditions and do not appear to have changed substantially.

Pycnocline depth below the surface is shallower and has become thinner compared to pre-mining profiles (BC Research, 1981; Fallis et al., 1987; Ouellet et al., 1989). The depth of the surface of the pycnocline, where large, rapid salinity increases occurred in 2003 was at 10 m, reaching near maximum salinity of the monimolimnion by 12 m, a thickness of only 2 m. Formerly, mixolimnion depth extended to 12 m and the bottom of the pycnocline ended at about 20 m. Salinity of the monimolimnion (field based Hydrolab data) was 58 ppt (Appendix B; Figure 3), which is about 32 ppt less than maximum salinity observed in pre-mining studies. Laboratory analysis of mixolimnion water showed a maximum salinity of 64 ppt. Nevertheless, salinity has diminished gradually over time as expected (AXYS, 2001) owing to the large amount of tailings deposited to the lake over more than 20 years, diluting bottom waters. Oxygen concentration was nil and there was a strong hydrogen sulphide odor to the water.

Tailings deposition between 1981 and 2002 has displaced the mixolimnion upwards and is 3 – 4 m shallower than pre-mining, beginning at 9 m, up from the pre-mine depth of about 12.5 m. However, lake elevation in 2003 was also about 2 m higher than pre-mine elevation because of the dam structure that was still in place at the lake outlet (Figure 2). The dam was installed in 1990 to increase water level of the lake to reduce zinc concentration in water discharged to Garrow Bay (see Section 1.3). Removal of the dam in spring 2004 will allow water level in the lake to return to near pre-dam elevations and

will reduce lake level and depth of the mixolimnion by a further 2 m, beginning at a depth of approximately 7 or 8 m.

In 2000, Teck Cominco commissioned AXYS (2001) to determine if diminishing mixolimnion depth would risk turnover and mixing of the mixolimnion and monimolimnion. If this occurred, water chemistry of the entire lake and Garrow Creek would be considerably altered. AXYS (2001) concluded that the density barrier of the pycnocline is strong enough that it cannot be broken down or compromised by wind and wave action after decommissioning of the dam and lake drawdown. Thus, no mixing of the mixolimnion and monimolimnion is possible. Furthermore, AXYS (2001) stated that zinc concentration in the mixolimnion will remain below 300 µg/L and that levels should decline over time, however, no time frame was given.

3.1.3. Metals

Between 1980 and 2002 approximately 15 million tonnes of tailings solids were deposited to the monimolimnion of Garrow Lake (Gartner-Lee, 2001). Tailings were discharged via a pipe suspended in the water column, well below the pycnocline at a depth of about 26 – 31 m. The location of the pipe was moved horizontally and laterally on an annual basis, to distribute tailings more evenly over the bottom. Small, discrete piles of tailings are evident from the bathymetric map of Garrow Lake (Figure 2). These piles are spread out over the deep basin opposite the tailings disposal line. Maximum depth of Garrow Lake has diminished to about 42 m, which is approximately equivalent to the depth that the mixolimnion has been displaced upwards.

Prior to mining, it was believed that discharging tailings to the monimolimnion of Garrow Lake would prevent dissolved metals from diffusing upwards through the pycnocline and into the mixolimnion. The high density of the pycnocline presents a physical barrier, while the abundance of sulphides would bind and scavenge metals from the water column and act as a chemical barrier. The tailings disposal system has been effective at preventing upward migration of metals. However, as discussed below, three spills of tailings into surface waters has been responsible for elevated metal concentrations in the mixolimnion.

In winter 1981 the tailings pipe became clogged and resulted in a small tailings spill on the ice surface near the northwest corner of the lake (Dickman and Ouellet, 1987). This material was deposited into nearshore water and may have contributed to elevated metal concentrations in surface waters. A more substantive spill occurred in the winter of 1984 – 1985. At that time, the down-leg section of the pipe broke at about 0.6 m depth and discharged a considerable amount of thickened tailings under the ice. The break was not detected for about three months until results of water sampling indicated elevated zinc (150 µg/L) at 10 m depth. Repairs were made in February 1985.

The total amount of zinc spilled into the mixolimnion was estimated by BC Research (1988) to be in the order of 800 tonnes, based on a zinc content of 0.5%, assuming a discharge rate of tailings at 1,600 tonnes/day. They further estimated that 42.7 tonnes of zinc was dissolved in the upper 20 m of Garrow Lake. Another spill occurred in the winter of 1989 (Gartner Lee, 2001), however we could not determine how much tailings were spilled or at what location. In 1992, a submerged, double-walled pipe was installed to eliminate the possibility of future spills.

The tailings spill caused a minor increase in lead concentration and a large increase in zinc concentration within the mixolimnion from 10 µg/L (1977) to 230 µg/L (1987) (BC Research, 1988). The extent of surface contamination was not realized because zinc concentration in Garrow Creek continued to be relatively low (61 µg/L) in summer 1986. However, vertical mixing of water during summer and under-ice caused zinc trapped above the pycnocline to become mixed into the mixolimnion, causing zinc to increase from 170 µg/L to 280 µg/L throughout the upper water column. Sampling of the lake beneath the ice in January 1988 revealed a sharp increase in zinc concentration in the upper pycnocline at 11 and 12 m depth (BC Research, 1988) and an increase in the mixolimnion to 310 µg/L. At the time, it was not known if the pycnocline would continue to be a "reservoir" of dissolved zinc or if zinc would be precipitated by sulphides within the pycnocline, and removed from the active mixolimnion by settling. Dissolved lead concentration continued to be low and was likely precipitated by sulphides. BC Research (1988) speculated that upward displacement of the pycnocline would increase average and peak zinc concentrations discharged from Garrow Lake over time, threatening to exceed Teck Cominco's permitted discharge concentration of 100 µg/L. Ice melt usually sufficiently diluted discharge of surface water to Garrow Creek such that limits were not exceeded except perhaps during first or last weeks of discharge from the lake.

In 1990 AXYS (1991) measured dissolved zinc concentrations of 410 µg/L and 1,800 µg/L within the mixolimnion and pycnocline respectively. Concentrations of total and dissolved zinc were very similar, suggesting that precipitation and loss to the monimolimnion was not occurring. These concentrations exceeded the discharge permit concentration. Therefore, Teck Cominco constructed a small dam across the creek in 1990 and 1991 about half way between the lake outlet and the creek mouth at Garrow Bay. The purpose of the dam was to prevent zinc contaminated surface water from reaching Garrow Bay by allowing lake level to increase by about 2.5 m and 10 Mm^3 in volume over a period of three years, diluting the mixolimnion and allowing tailings contaminated particulates in the lake to settle.

Water was not discharged from Garrow Lake until spring of 1994. During the intervening period several studies were undertaken to examine the effects of lead and zinc on receiving environment biota in Garrow Bay (AXYS, 1991; EVS, 1992). Results of these studies suggested that harmful effects of elevated zinc concentration were unlikely.

Consequently, the discharge limit for zinc was increased to 500 µg/L in 1992 (AXYS, 2001). This concentration was not exceeded during the remainder of mine life.

Subsequent to 1994, until removal of the dam, siphons were used to discharge water over the dam that allowed control over timing and volume of release. Gartner Lee (2001) reported that zinc concentration in the mixolimnion of Garrow Lake had gradually diminished from 400 µg/L in 1990 to 280 µg/L in 1999 and 2000. In 2003, mixolimnion dissolved zinc concentration was 240 µg/L, similar to 2000 data (Table 3).

Sampling of the water column at discrete depths in 2003 (GL-WQ-1) revealed that total metals concentrations within the mixolimnion (2 m and 6 m), pycnocline (11 m) upper monimolimnion (15 m) and deep monimolimnion (31 m) did not differ in concentration with the exception of lead and zinc (Table 3). Lead was more than an order of magnitude higher in concentration in the monimolimnion (12.1 µg/L) than the mixolimnion (0.8 µg/L). Zinc was higher in the monimolimnion (338 µg/L) than in the mixolimnion (240 µg/L) and highest within the pycnocline (1,140 µg/L), a pattern that was also observed in 1988 (1,800 µg/L at 16 m; BC Research, 1988) and 1990 (1,820 µg/L at 13 m; AXYS, 1991)(Table 2). Cadmium, lead and copper concentrations were also highest in the pycnocline. These data suggest that the pycnocline is a barrier, preventing transfer of metals from the monimolimnion upwards, but it also may prevent sinking of metals. Bacteria near the bottom of the pycnocline may be partly responsible for maintaining elevated metals in water owing to accumulation of zinc within the bacterial tissue.

Pre-mining, mining and post-mining water column metals data within the mixolimnion, pycnocline and monimolimnion are compared in Table 3. Concentrations of most metals, including arsenic, cadmium and copper, did not appear to change with any discernable pattern over mine life. Arsenic concentrations were low in the mixolimnion and pycnocline and were one to two orders of magnitude higher in the monimolimnion. Cadmium concentration was uniformly low and near detection limits in most water samples. Copper data were variable and did not demonstrate any trend or pattern over time or within discrete layers. Lead concentration in the mixolimnion increased after the metals spill in 1985 and has remained somewhat elevated since then, but has diminished over time.

Only zinc has demonstrated consistent trends in concentration over time and within discrete layers in Garrow Lake. During tailings discharge, prior to the spill, zinc concentration in the mixolimnion was low, less than 24 µg/L (0.024 mg/L) (Fallis et al., 1987; BC Research, 1978). BC Research (1981) measured higher concentrations in 1980, although Dickman and Ouellet (1987) measured low concentrations (16 µg/L) in 1981, the same year that tailings discharge was initiated. Zinc concentration increased in the monimolimnion shortly after tailings disposal was initiated, reflecting the addition of zinc rich material dispersed into the mid-water column. Zinc concentration in the monimolimnion has consistently been measured between 200 and 300 µg/L since tailings

disposal began. Note that this concentration is still below the discharge limit in Garrow Creek of 500 µg/L and is only slightly higher than zinc concentration in the mixolimnion.

As discussed above, the tailings spill into surface waters of Garrow Lake has caused dissolved zinc concentration to become and remain elevated (~250 µg/L) in the mixolimnion and especially the pycnocline layer (1,140 µg/L). This concentration has remained consistent since the mid-1990s. Elevated concentrations of dissolved zinc will likely be maintained for some time due to high concentration in the pycnocline, but also by elevated zinc concentration in the sediment due to the spill in 1985. The widespread zinc contamination throughout nearshore, littoral zone sediment of the lake (see following section) may present an on-going source of dissolved zinc to the mixolimnion.

3.2. Sediment Chemistry

No study has examined sediment chemistry of Garrow Lake since deposition of mine tailings was initiated. This is because tailings were especially deposited into the monimolimnion, which has proven to be an effective barrier at preventing movement of metals upwards through the pycnocline into surface waters (see Section 3.1). Despite the tailing spill to shallow sediment in 1984/85, no survey of sediment chemistry was undertaken.

In 1976, prior to mining, Fallis et al. (1987) collected sediment from 9 stations around Garrow Lake from depths ranging between 3 m and 48 m (Table 4). Six stations were situated within littoral zone sediments in depths of 12 m or less, within the mixolimnion. Three stations were in depths of greater than 12 m within the pycnocline or monimolimnion, in the anoxic, lifeless (except bacteria) zone of the lake. BC Research (1978) collected sediment from only two stations (12 m and 19 m) in 1977 and from 19 stations in May (5) and August (14) in 1980 (BC Research, 1981) at depths ranging from 5 – 48 m.

Concentrations of most metals including lead (<0.25 – 11 mg/kg), zinc (30 – 103 mg/kg), cadmium (0.25 – 3.1 mg/kg), arsenic (4.2 – 11.4 mg/kg), copper (15 – 31 mg/kg) and manganese (59 – 209 mg/kg) did not differ markedly with depth, even between littoral zone (<12 m) and monimolimnion zone sediment. Metal concentrations were only slightly higher in the deepest part of the lake, otherwise there were no meaningful differences among depths or between different areas of the lake in both the BC Research (1978 and 1981) and Fallis et al. (1987) studies. Interestingly, Fallis et al. (1987) found that metal concentration tended to be positively correlated with grain size.

Unfortunately, several spills of tailings (1981, 1985/85, 1989) introduced metals contaminated material to littoral zone sediment. The substantive spill under the ice during the winter of 1984 – 1985 discharged approximately 800 tonnes of zinc in thickened

tailings (BC Research, 1988). No study was conducted to determine the spatial extent and magnitude of contamination until the present study. However, given the designation of Garrow Lake as a tailings disposal facility, this was not necessary.

We sampled surface sediments from between 6 and 8 m within the mixolimnion at four locations around the lake, as well as two locations within the area of the 1984/85 tailings spill along the western shore of the lake (Figure 2). Grain size was predominantly silty-clay at all stations with a very fine, flocculent, oxidized surface layer with some organics, over grey colored sediment of uniform color, consistency and appearance (Table 1). With the exception of lead and zinc, sediment metal concentration throughout the littoral zone was no more than double pre-mining metal concentration (Table 5). Mean lead (137 µg/g dw) and zinc (742 µg/g dw) concentrations in littoral sediments from around the lake however, were considerably higher than pre-mine concentrations (0.25 µg/g and 61 µg/g dw respectively; Fallis et al., 1987) and are a reflection of the spill.

Given that sampling of sediment was conducted at similar depths over most of the lake that was accessible by boat (ice conditions permitting), these data indicate that the spill of metal contaminated tailings resulted in lake-wide contamination of surface sediment. Lead and zinc concentrations were only slightly higher at GL-2, nearest the historic spill area, than at the other three littoral stations. Suspended sediment introduced into the water column during the spill settled throughout most of the lake, causing contamination of surface (at least upper 1 – 2 cm) sediment in the littoral zone.

Two sediment samples collected from the immediate vicinity of the historic spill area had similar or lower concentrations for several metals (aluminum, barium, chromium, mercury, molybdenum, nickel, strontium) than littoral sediment and higher concentrations of lead (1,000 µg/g dw) and zinc (7360 µg/g dw)(Table 5). Most other metals for which pre-mine data were available are not substantially elevated or are lower than pre-mining concentrations.

3.3. Ecology

3.3.1. Zooplankton

No true zooplankton species were captured during the 2003 survey from the vertical tows at each of the four sediment stations (Figure 2), nor from a horizontal tow, conducted <1 m below the water surface. However, a single oligochaete worm and at least one cyclopoid copepod of benthic origin were sampled from each station.

Limnocalanus macrurus is the only species of zooplankton known to be present in Garrow Lake. This species was identified in 1976 by Fallis et al. (1987) and in 1977 and 1980 by BC Research (1978 and 1981 respectively). *L. macrurus* is a relatively common

species in the Arctic and is also present in many large, deep freshwater lakes. *L. macrurus* is known as a glacial relict species (Pennack, 1978). BC Research (1978) also captured or observed amphipods (*Gammarus* sp.) and a mysid species (*Mysis oculata*). Apparently, mysids were relatively abundant and of a large size, based on observations made during SCUBA surveys of Garrow Lake by BC Research (1978). Each of these species was also observed in nearby Frustration Lake in 1977 beach seines (BC Research, 1978).

In 1980, BC Research (1981) determined the density of plankton in vertical hauls from different depths (10 m, 15 m and 19 m, just above the pycnocline) and found that abundance of *L. macrurus* was much greater at the deepest depth, corresponding with the depth where the greatest abundance of phytoplankton was found.

It is not known why zooplankton were apparently absent from the lake during the present survey. Abundance of zooplankters is normally low in oligotrophic Arctic lakes, however, if plankton were present, at least a few individuals should have been captured. Perhaps plankton were situated at a deeper depth than was sampled in 2003 (8 m), or the mesh size used in the current study (250 µm) was too large; Fallis et al. (1987) used a 73 µm net. However, adult zooplankters of this species reach 2 mm in length (Pennack, 1978) so this may not explain their absence.

It is also possible that changes in water quality of the mixolimnion since pre-mine surveys have diminished abundance of the primary food source of *L. macrurus*, phytoplankton, or has directly affected zooplankton abundance. Phytoplankton were not collected during the 2003 survey.

3.3.2. Benthic Invertebrates

Oligochaete worms of the Family Enchytraidae, nematodes and Foraminifera were the only benthic invertebrates retained on a 250 µm sieve from petite ponar sampling in Garrow Lake in 2003 (Table 6). Abundance and density of oligochaetes was reasonably good, however, diversity of species was low. Chironomid larvae were present in the lake because several larvae were collected from the stomachs of fourhorn sculpin (see Section 3.3.3). However, density of chironomids in the lake appears to be quite low because none were collected from sieving of sediment. Given the high northern latitude and brief open water period, abundance of flying insects is naturally very low in this region. In fact, few flying insects were observed, with no mosquitoes or blackflies, which was a blessing.

Nematodes and Foraminifera were not included in the density estimate because these organisms are smaller than the mesh size used (250 µm) although they can be retained in small numbers. Nematodes and Foraminifera are very abundant and widespread in all lakes and their density is very infrequently estimated.

Fallis et al. (1987) also found a depauperate benthic fauna in Garrow Lake, dominated by Foraminifera. They identified 19 species with *Protelphidium orbiculare* being most abundant, followed by *Elphidium translucens*, *Ammotium cassis* and *Trochamina rotaliformis*. A single mollusk species, *Astarte warhami*, and an unidentified harpacticoid copepod were the only other species identified. Fossils of polychaetes, echinoderms and ostracods were identified in sediments, probably species that had been weathered out of historic, marine sediments as the lake has risen since the most recent glaciation.

BC Research (1978) identified nematodes, oligochaetes and harpacticoid copepods from Garrow Lake, although their abundance was not determined.

Garrow Creek sediment contained nematodes, oligochaetes a single mayfly (Ephemeroptera) species *Baetis bicaudatus* and several chironomid species (Table 6). These data indicate that, despite the ephemeral flow of the creek, it is capable of supporting aquatic life, dominated by oligochaetes. Chironomids were present in low abundance and their presence confirms that these organisms are capable of surviving in the creek and therefore, presumably Garrow Lake.

3.3.3. Fish

Nineteen fourhorn sculpins (*M. quadricornis*) were captured in gill nets and a prawn trap from Garrow Lake in 2003 (Table 7). Eleven sculpins were sacrificed to determine gender, sexual maturity, gut contents, age (using otoliths), internal condition and tissue metals concentration (whole fish). All 19 fish were measured for total length and weight to determine condition factor (Table 8) and length-weight relationship (Table 9).

Fallis et al. (1987) and BC Research (1978, 1980) were the first investigators to document sculpin biology (length, weight, growth, age, metals) prior to mining. No biological study of the sculpin population of Garrow Lake had been conducted until the present investigation. So, comparisons made here represent data collected prior to mining and after mining had ceased.

3.3.3.1. Size

All sculpins captured in 2003 appeared to be healthy with no external or internal tumors (Photo's 4 and 5), scars or other abnormalities (Table 7). Sculpins ranged from 85 mm to 184 mm (mean 149 mm) in length and 4.2 g to 40.3 g (mean 24.9 g) in weight. Mean condition factor (K) was 0.70 (Table 8). Fallis et al. (1987) captured 51 sculpins in 1976 using small-mesh, Swedish style gill nets, similar in size to the nets used in the current survey. All fish were acquired from above the pycnocline and none were found below 15 m. BC Research (1978) captured 137 sculpins using beach seines and observed that sculpins were found throughout the lake and appeared to be abundant and easily captured. Sculpins continued to be observed in the lake throughout the period of mining during

SCUBA maintenance of the tailings line (Gartner Lee, 2001; W. Gzowski, Arctic Divers Ltd., Yellowknife NWT personal communication, May 5, 2003), although no biological study was conducted.

Meristic data from 2003 were very similar to mean length (155 mm), weight (26.6 g) and condition factor (0.72) of sculpins captured by Fallis et al. (1987) using the same fishing gear (Table 8) prior to mining. Fish captured by BC Research (1978) in beach seines and nets had a wider size distribution (20 – 170 mm) and had a lower mean weight and condition factor.

Length – frequency distributions of sculpins from 1976 (Fallis et al. 1987), 1977 (BC Research, 1978) and 2003 demonstrate that the basic size distribution of adult sculpins has not changed markedly (Figure 4) since prior to mining. The maximum size of fish captured in 1976 was greater than in 2003, however, this is likely due to the small number of fish captured in 2003. Small, juvenile fish were collected, indicating that successful reproduction of fish had occurred and that recruitment of small fish into the population was occurring. Unfortunately, seining was not conducted, so many of the small fish captured in 1977 by BC Research (1978) were not represented here.

Length-weight relationships derived for each year (Table 9) were also quite similar suggesting that growth of sculpins, based on weight at length, has not changed since mining began. The 1976 data are most relevant to 2003 because similar fishing gear was used. Sculpins captured in 2003 (modal length of 155 mm) may have been slightly smaller than in 1976 (modal length of 175 mm). However, given the similarity in mean size and condition of fish caught in 1976 as in 2003 (Figure 4), suggests that the current size, size distribution and health of sculpins is similar to pre-mining conditions (Fallis et al. 1987).

3.3.3.2. Age

Mean age of sculpins captured in 2003 was 5.7 years, with a range of 3 – 9 years (Table 7). Fallis et al. (1987) and BC Research (1977) did not age sculpins. However, the small size, low lipid content (10%) and small size at age confirm that the sculpin population of Garrow Lake is very slow growing. Fallis et al. (1987) also stated that Garrow Lake sculpin have very slow growth rates relative to other Arctic sculpin populations (Bohn and Fallis, 1978), because of limited food as well as habitat. The deep, circular shape of the lake basin and the anoxic monimolimnion prevents sculpins from existing beneath the pycnocline, thus limiting benthic habitat for sculpins to littoral zone sediments. Given that 2 m of this shoreline habitat is eliminated during winter by ice, available habitat for food production is very limited indeed. The lack of food and cold water temperature explain their small size and slow growth rate relative to fish age.

3.3.3.3. Diet

Stomachs of 7 of 11 sculpins were empty. Of the four stomachs containing food, only a few chironomid larvae were distinguishable, as well as some unidentifiable plant matter and algae (Table 7). The presence of chironomids confirms that they do exist in Garrow Lake, despite the fact that chironomids were not identified from benthic grabs. This suggests that benthic productivity is very limited and even during the "height of summer" there is little food to be had.

Fallis et al. (1987) examined 27 sculpin stomachs of which half (14) were empty. Stomach contents included unidentified eggs, plant material, copepods and a few amphipods. BC Research (1977) found that the copepod *L. macrurus* dominated the diet. We did not identify copepods in the water column or in stomachs, suggesting that this species no longer comprises a significant portion of the sculpin diet. If the zooplankton community has diminished in Garrow Lake, and sculpins have been forced to become strictly dependent on benthic food sources, their population abundance would be expected to have declined. Although catch-per-unit-effort statistics were not recorded, Fallis et al. (1987) captured 51 sculpins in three net sets of 24 h each. The 2003 survey captured only 8 sculpins using gillnets over three days, with a baited prawn trap responsible for the remaining catch. Sculpins seemed to be more difficult to catch in 2003 and therefore may be less abundant than prior to mining (Fallis et al. 1987; BC Research, 1978). Given the lesser amount of habitat available to the population because of the reduced size of the mixolimnion, this result is not surprising.

3.3.3.4. Sex and Maturity

Sex ratio of sculpins captured in 2003 was split evenly between males and females and all fish autopsied appeared sexually mature, with nearly ripe gonads. Fallis et al. (1987) found that most sculpins were female (22 of 27) with 12 having developing eggs. Spawning by sculpins takes place in late fall or winter (Scott and Scott, 1988). Eggs are laid in a small clump within a shallow depression and are guarded by the male during incubation. Given the very slow growth rate and maturation of gonads, it is possible that all of the apparently mature sculpins may not have spawned in winter of 2003/2004 and some individuals may have waited an additional year. Nevertheless, the gonads of most individuals did appear to be quite ripe and these individuals would certainly spawn within the next few months. Fallis et al. (1987) observed eggs in sculpin stomachs in 1976. Presuming these were from sculpins, it is possible that some individuals may spawn during late summer.

3.3.3.5. *Tissue Metals*

Whole body concentrations of manganese, lead and zinc in sculpins were higher in 2003 than was measured in sculpin tissue prior to mining (Fallis et al., 1987; BC Research, 1978) (Appendix C; Table 10). Other metals including arsenic, cadmium, copper, mercury, and nickel were lower or did not differ among years. Elevated lead and zinc concentrations in sediment and the water column as a result of the spill have resulted in increased tissue metals concentrations, however the magnitude of increase is relatively small. Prior to mining, mean zinc concentration was about 30 mg/kg and increased to only 72 mg/kg in 2003. The magnitude increase in lead concentration between pre-mining (0.58 mg/kg) and post mining (0.81 mg/kg) was also similar (Fallis et al., 1987). Fallis et al. (1987) stated that only copper and iron were significantly positively correlated with fish size while all other metals showed no relationship or a declining trend.

Relative to metals in sculpins elsewhere, Bohn and Fallis (1978) found that Garrow Lake sculpins were higher in lead and zinc but lower in cadmium and arsenic than Strathcona Sound sculpins. Elevated lead and zinc concentration prior to mining is presumably due to naturally higher mineralization. The tailings spill has caused a further increase in lead and zinc concentration.

3.3.4. Summary

The sculpin community of Garrow Lake is unique and has survived in this small, brackish water meromictic lake since glacial uplift isolated it from the marine environment nearly 3,000 years ago. The sculpin population has survived twenty years of mining tailings disposal to the monimolimnion and at least one significant tailings spill into the mixolimnion.

Overall, it appears as if the size, distribution, growth rate and reproductive status of the sculpin community has not changed markedly since pre-mining studies by Fallis et al. (1987) and BC Research (1978; 1980) although population size appears to have diminished. Only concentrations of lead and zinc in tissue have increased over the course of mining, likely as a result of the tailings spill in 1984/85. However, based on a survey of the zooplankton and benthic communities and diet of sculpins, it appears that the planktonic invertebrate community of Garrow Lake may have declined since tailings deposition began and that sculpins may be relying solely on benthos as a food source.

Introduction of tailings into the monimolimnion of the lake has caused the bottom layer to become less saline, more homogeneous and has caused a gradual displacement of the pycnocline and mixolimnion upwards in the water column. In 2004, once the lake has been drawn down to its original level, the depth of the mixolimnion above the pycnocline should diminish to about 7.5 or 8 m. Although the magnitude of the thermal and salinity

difference between the mixolimnion and the monimolimnion in the lake will be sufficient to maintain separation of the two layers and prevent turnover and mixing (AXYS, 2001) the largest change in the limnology of the lake is the reduced depth of the mixolimnion and surface area of the littoral zone.

Garrow Lake is very unproductive with low water column nutrient concentrations, a depauperate planktonic community and a benthic community dominated by oligochaetes, with very few insect larvae. A reduction in the planktonic community and diminishment in mixolimnion depth and littoral zone area will necessarily reduce habitat area and benthic invertebrate abundance. This loss of habitat and diminishment of food resources will ultimately, reduce population abundance. Sculpins seemed to be more difficult to capture in 2003 than in fishing efforts by Fallis et al. (1987) and BC Research (1978; 1980), which supports the hypothesis of a smaller population size in 2003 than pre-mining.

Nevertheless, sculpins have survived in Garrow Lake throughout the history of mining and tailings deposition to the lake, which is still designated as a tailings disposal facility (DFO, 2002). Provided that sufficient habitat and food resources exist within the spatially small littoral zone, the sculpin population will be sustained through the future.

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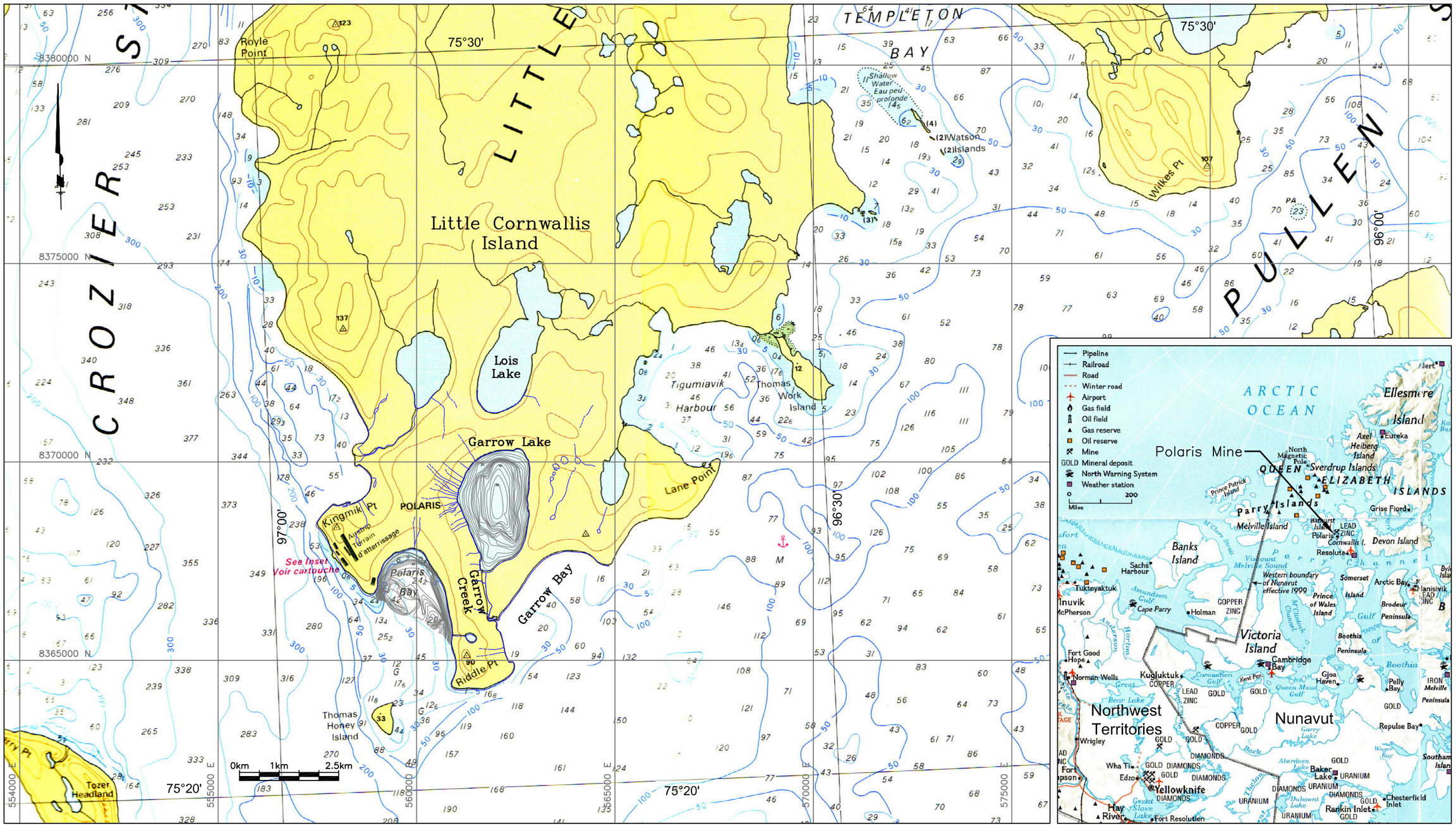
FIGURES



Carrow Lake, Polaris Bay contour data and surrounding creeks digitized from Map 1 Sampling Sites 1980 *prepared by B.C. Research January 1978*

Other data from Crozier Strait And/Et Pullen Strait 7935 *corrected 2003-03-28 published by the Canadian Hydrographic Service*

Insert Location Map from The Modern North: Roads, Radar Stations, and the End of Isolation, *Produced by National Geographic Maps for National Geographic Magazine, Sept. 1997*

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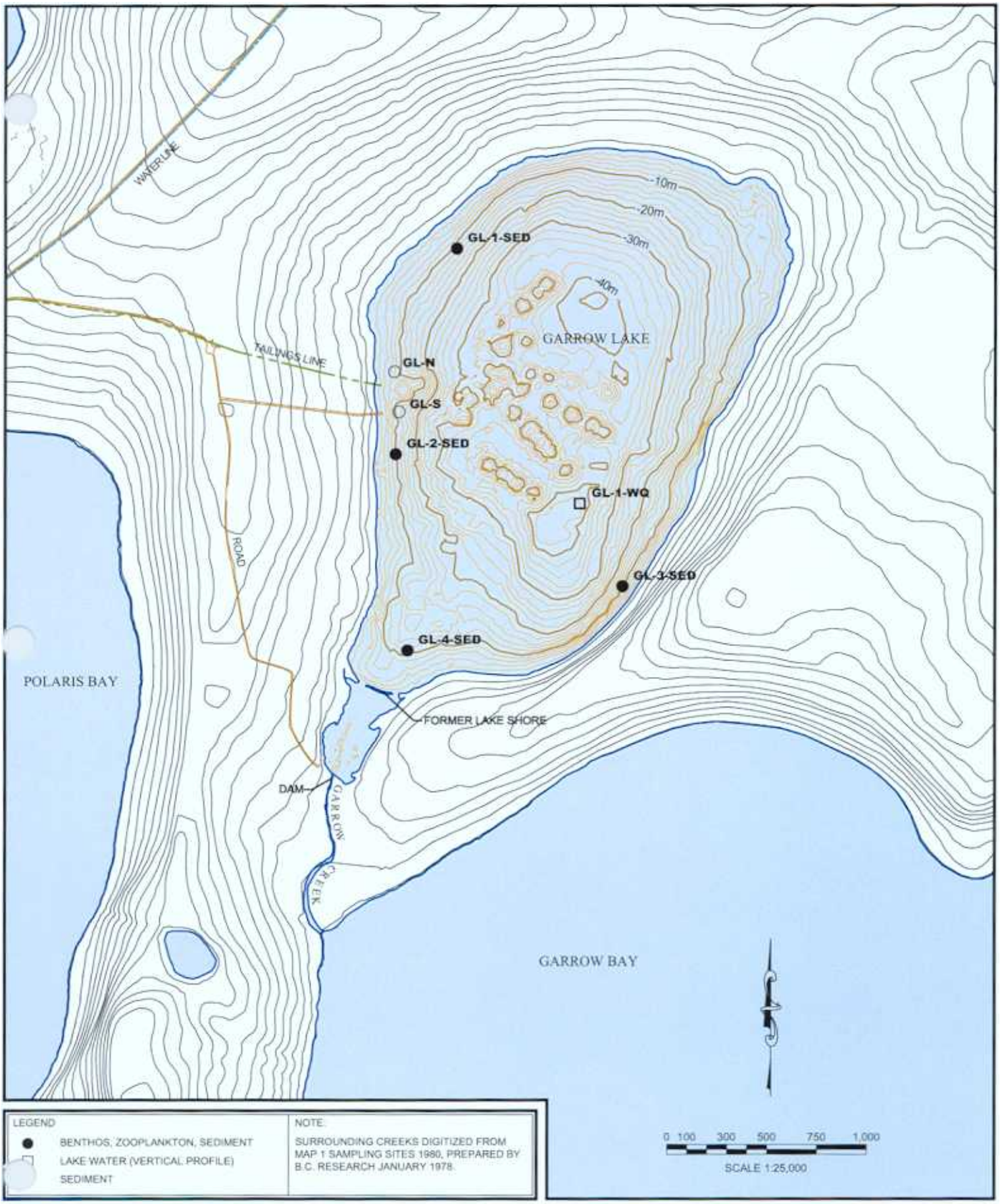
PROJECT: Polaris

TITLE: **Polaris Mine Study Area**

CLIENT: Teck Cominco

Figure 1-1



LEGEND

- BENTHOS, ZOOPLANKTON, SEDIMENT
- LAKE WATER (VERTICAL PROFILE)
- SEDIMENT

NOTE:

SURROUNDING CREEKS DIGITIZED FROM MAP 1 SAMPLING SITES 1980, PREPARED BY B.C. RESEARCH JANUARY 1978.

AZIMUTH

TECK COMINCO

LOCATION OF LITTORAL ZONE SEDIMENT / BIOTA STATIONS AND WATER QUALITY PROFILE STATION - GARROW LAKE, AUGUST 2003

POLARIS

REVISIONS

DESIGNED BY: RB

SCALE: 1:25,000

Charone www.charone.ca

JOB NO: TC-03-03

DATE: 11-22-2004

DRAWN BY: CCL

FIGURE: 002

Figure 3a. Temperature (C) depth profile in Garrow Lake, 2003.

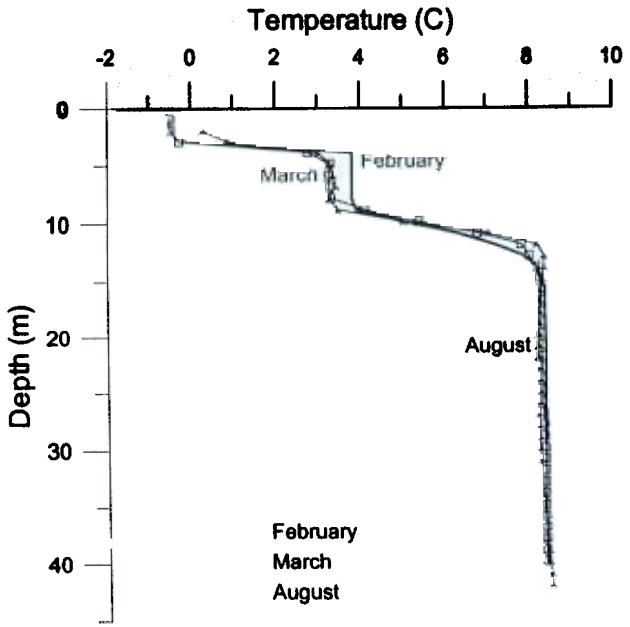


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 2003.

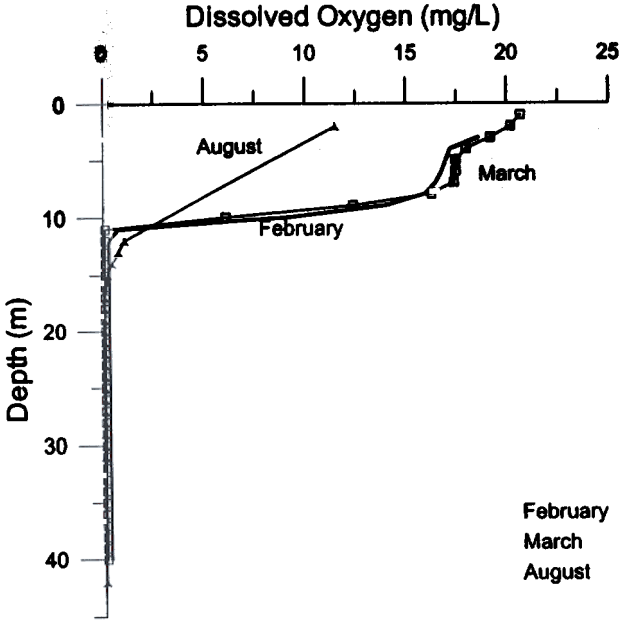


Figure 3a. Temperature (C) depth profile in Garrow Lake, 1976.

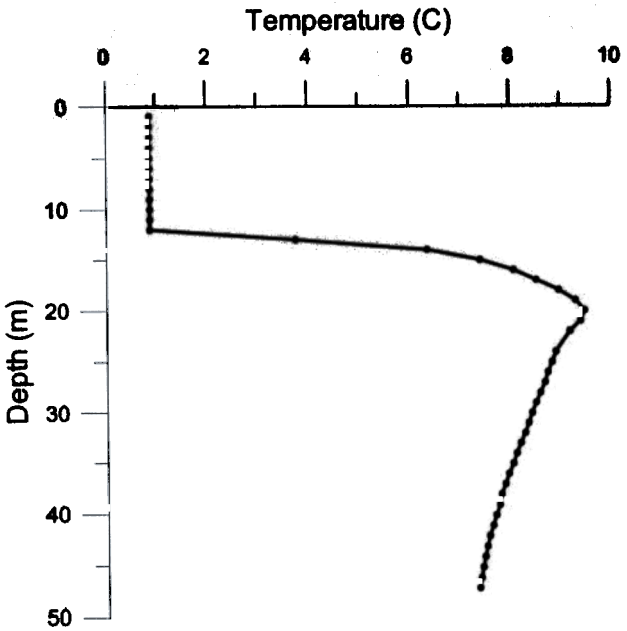
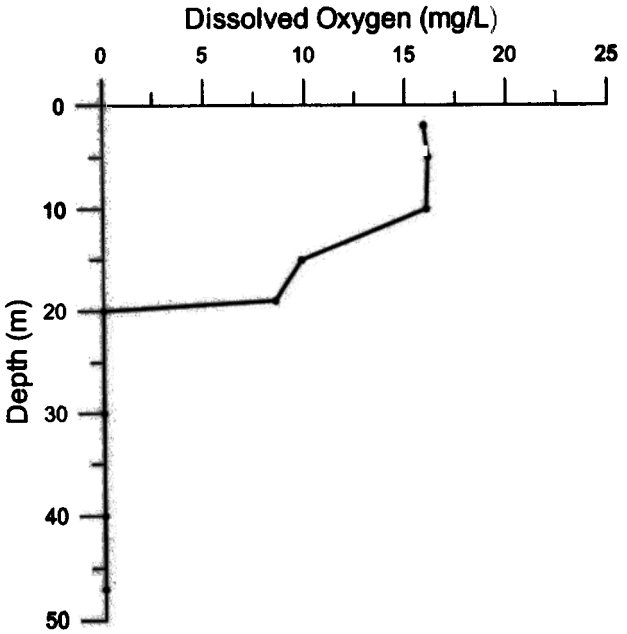
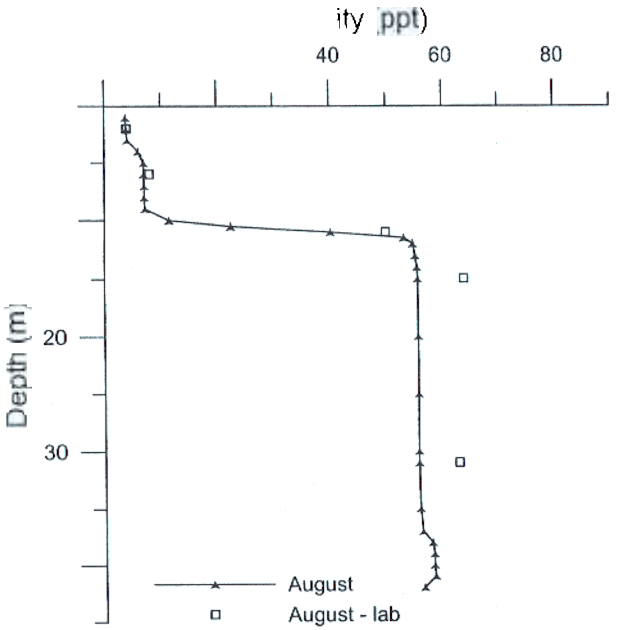


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 1976.



Figur 30 Salinity 20 profi Garr 03



igu 3c. Salinity (ppt) depth profile in Garrow Lake.

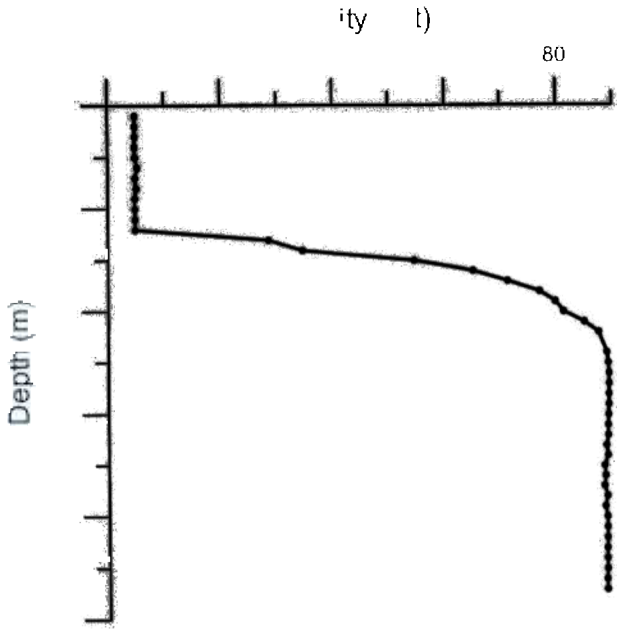
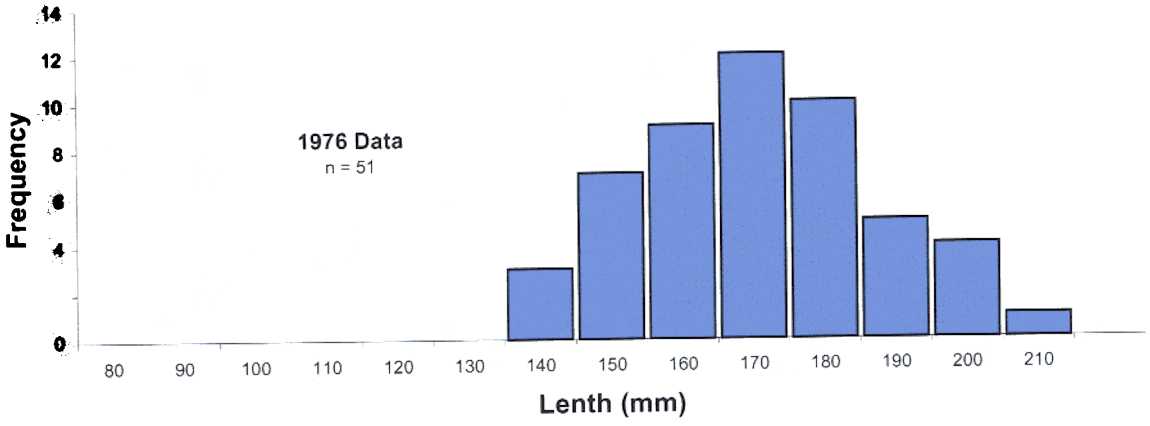
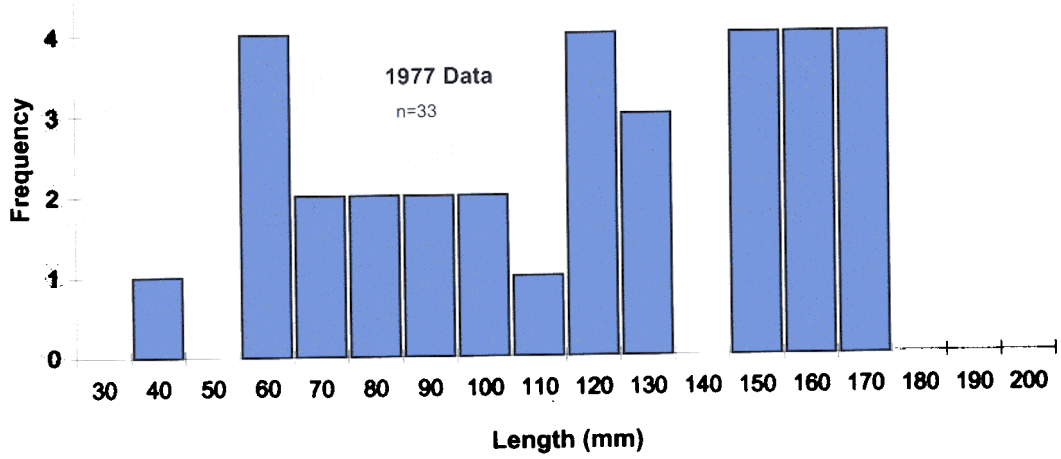
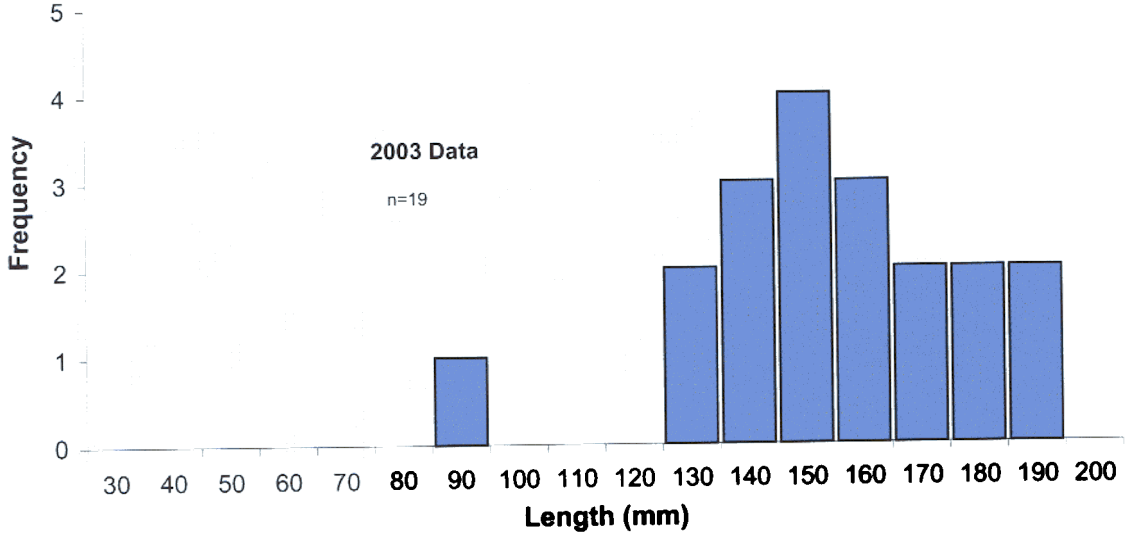


Figure 4. Comparison of length - frequency distribution of fourhorn sculpin from 1976 (Fallis et al., 1987) 1977 (BC Research (1978) and 2003.







TABLES

Table 1. Details of sediment, water and biota collections from Garrow Lake, August 8 – 10, 2003.

Station	UTM N	UTM E	Depth (m)	Parameter: Water	Benthos	Zooplankton	Sediment	Observations
GL-1-SED	8369695	0561130	7.5		X	X	X	Thin light brown soft flocculent surface layer. Some algal growth on surface. Beneath, sediment is uniform grey clay, uniform consistency and appearance.
GL-2-SED	8368612	0561266	6.5 – 8.5		X	X	X	Similar in appearance to SED-1; rusty oxidized, brown surface layer over battleship grey layer of uniform consistency with fine organic matter.
GL-3-SED	8368424	0562669	6 – 8		X	X	X	Fine brown organic 2 – 3 mm layer over grey-brown clay. Grab 3 different from 1 and 2 with darker sediment and more organically rich layer.
GL-4-SED	8367556	0561764	7		X	X	X	Fine orangey-brown layer (2 – 3 mm) over grey-brown silty clay. Benthos not apparent.
GL-N-SED			8				X	Sediment appeared to be consistent with tailings; chalky white, fine grain flocculent sediment throughout grab with black sticky varves.
GL-S-SED			8				X	
GL-1-WQ	8369695	0561130	0 – 42	X				

Table 2. Summary of Garrow Lake water column metals concentration (mean, range; ug/L), 1976 - present.

			Arsenic		Cadmium		Copper		Lead		Nickel		Zinc	
		n	mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
June 1976[AB]	**Mixolimnion**	**19**	**0.3**	**0.1 - 1.1**	**0.3**	**0.1 - 1.3**	**1**	**0.2 - 2.7**	**0.3**	**0.1 - 0.5**			**3**	**1.3 - 6.7**
(Fallis et al., 1987)	**Pycnocline**	**4**	**1.9**	**0.3 - 3.5**	**0.2**		**2.8**	**1.5 - 4.1**	**0.4**				**2.9**	**1.9 - 3.8**
	Monimolimnion	**7**	**13.4**	**4.7 - 20.4**	**0.2**	**0.1 - 0.2**	**4**	**0.9 - 14.5**	**0.3**	**0.1 - 0.5**			**1**	**0.1 - 2.2**
August 1977	**Mixolimnion**	**12**	**<1**		**0.2**	**<0.1 - 0.6**	**10**	**1 - 60**	**5**	**<1 - 16**			**24**	**6 - 100**
(BC Research 1978)	**Pycnocline**	**17**	**<1**		**0.3**	**<0.1 - 0.6**	**12**	**2 - 22**	**3**	**<1 - 7**			**21**	**4 - 50**
	Monimolimnion	**13**	**4.6**	**<1 - 6.4**	**<0.5**	**<0.5**	**18**	**5 - 22**	**8**	**<5 - 27**			**18**	**8 - 28**
May & August 1980	**Mixolimnion**	**14**	**<1**		**>0.5**		**19**	**6 - 32**	**<1**				**49**	**20 - 95**
(BC Research 1981)	**Pycnocline**	**24**	**<1**		**>0.5**		**23**	**13 - 36**	**<5**				**46**	**28 - 85**
	Monimolimnion	**18**	**8**	**3.4 - 13**	**>0.5**		**16**	**3 - 50**	**<10**				**48**	**15 - 113**
August 1981	**Mixolimnion**	**2**			**>0.5**		**1.0**		**<10**		**7**		**10**	**9 - 12**
(Ouellet & Dickman 87)	**Pycnocline**	**1**			**1.0**		**>1**		**<10**		**10**		**9**	
	Monimolimnion	**7**			**<1.2**		**<2.4**		**<24**		**11**		**16**	**7 - 34**
October 1981	**Mixolimnion**	**2**	**0.06**	**0.06 - 0.06**	**0.06**	**0.06 - 0.06**	**0.35**	**0.3 - 0.4**	**0.35**	**0.3 - 0.4**			**3.3**	**2 - 4.6**
(Fallis et al. 1987)	**Pycnocline**	**3**	**0.29**	**0.17 - 0.34**	**0.3**	**0.2 - 0.4**	**5.5**	**1.5 - 8.9**	**1.0**	**0.8 - 1.2**			**5.7**	**4.2 - 6.8**
	Monimolimnion	**27**	**13.3**	**1.6 - 20**	**0.1**	**<0.05 - 0.2**	**1.3**	**<0.1 - 6.4**	**0.3**	**<0.1 - 1.8**			**4.1**	**1.2 - 6.3**
September 1984	**Mixolimnion**	**1**							**5**				**20**	
(BC Research, 1988)	**Pycnocline**	**1**							**5**				**40**	
	Monimolimnion	**1**							**14**				**30**	
September 1987	**Mixolimnion**	**1**							**7**				**230**	
(BC Research, 1988)	**Pycnocline**	**1**							**5**				**220**	
	Monimolimnion	**2**							**25**				**45**	
May 1990	**Mixolimnion**	**1**							**10**				**410**	
(BC Research, 1988)	**Pycnocline**	**1**							**21**				**1,820**	
August 1998	Mixolimnion	4	<1		1.0	<1 - 1	1.0	<1 - 1	2	<1 - 5	<2		198	150 - 320
(Teck Cominco)														
August 1999	Mixolimnion	4	<1		1.0		2.3	<1 - 4	15.3	13 - 22	5	4 - 5	233	220 - 270
(Teck Cominco)														
August 2001	Mixolimnion	4	<1		<2		1.5	<1 - 2	1.8	<1 - 3	4	3 - 5	223	180 - 330
(Teck Cominco)														
August 2003	Mixolimnion	2	<1	<1 - 1	0.5	0.3 - 0.6	1	0.9 - 1.4	0.8		3	2.1 - 3.7	184	127 - 240
	Pycnocline	1	<1		2.5		7		4		9		1,140	
	Monimolimnion	2	1	<1 - 1	0.4	0.3 - 0.5	5	3.8 - 5.2	12	11.8 - 12.1	9	8.8 - 9.0	278	217 - 338

[A] Values below detection limit were treated as absolute values.

[B] Dissolved metals, otherwise, total metals

Table 3. Conventional parameters and total metal concentration (ug/L) in water samples collected from Garrow Lake, August 2003.

Sample ID	GL-1-WQ-2m	GL-1-WQ-6m	GL-1-WQ-11m	GL-1-WQ-15m	GL-1-WQ-31m
CONVENTIONAL PARAMETERS					
pH	8.2	8.0	7.2	7.3	7.4
Salinity o/oo	4.0	8.0	50.0	64.0	63.0
Temperature (C)	0.2	3.4	7.1	8.3	8.3
TOTAL METALS (µg/L)					
Aluminum	<100	<100	<100	<100	<100
Arsenic	<1	<1	<1	1.0	<1
Cadmium	0.3	0.6	2.5	0.3	0.5
Copper	0.9	1.4	7.1	5.2	3.8
Lead	0.8	0.8	4.3	11.8	12.1
Molybdenum	<2	3	2	4	<2
Nickel	2	4	9	9	9
Zinc	127	240	1140	338	217

Table 4. Total metals (mg/kg dw) in Garrow Lake sediment, prior to mining.

	Fallis et al. (1987) June 1976 (n=9)		BC Research (1978) August 1977 (n=2)		BC Research (1981) May and August 1980 (n~19)	
Total Metals	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Arsenic	6	2 - 11	5	4 - 6	4.7	3.2 - 57.6
Cadmium	1.00	<0.25 - 3.1	0.7	0.4 - 1.0	1.3	0.3 - 3.0
Copper	23	15 - 31	18.5	18 - 19	22	12 - 27
Lead	0.25	<0.25 - 0.75	8	8	8.4	5.9 - 11
Manganese	150	59 - 209				
Mercury	0.15	0.005 - 0.025			<0.05	<0.5 - 0.6
Nickel	19	12 - 39				
Zinc	61	30 - 103	65	59 - 70	84	52 - 96
Depth Range (m)		3 - 48		12 and 19		5 - 48

Table 5. Conventional sediment parameters and total metals concentration (mg/kg) in Garrow Lake littoral zone sediment.

Sample ID	Garrow Lake Stations (Aug 2003)					Tailings Spill Area		1976 (Pre-Mine)
	GL-1	GL-2	GL-3	GL-4		GL-N North	GL-S South	Fallis et al. 1987
Depth (m)	7.5	6.5 - 8.5	6 - 8	2 - 7	Mean	7 - 8	7 - 8	3 - 48
CONVENTIONAL PARAMETERS								
Organic Parameters								
Total Organic Carbon (% dw)	<0.8	1.2	<0.9	2.4	1.3			
Particle Size (%)								
Gravel (>2.00mm)	<0.1	<0.1	0.9	<0.1	0.3			
Sand (2.00mm - 0.063mm)	5.4	7.5	12.3	6.8	8.0			
Silt (0.063mm - 4um)	64.2	68.3	70.3	76.1	69.7			
Clay (<4um)	30.4	24.2	16.5	17.1	22.1			
Total Metals								
Aluminum	8560	7380	6030	6680	7162	781	547	
Antimony	<10	<10	<10	<10	<10	<20	<20	
Arsenic	11	9	<5	9	8.5	<10	<10	6
Barium	1420	1070	1040	1150	1170	122	124	
Beryllium	0.6	<0.5	<0.5	<0.5	0.5	<1	<1	
Cadmium	1.9	3	1.1	1.4	1.9	17	15	1.0
Chromium	19	18	15	16	17	22	9	
Cobalt	6	6	4	5	5.3	<4	<4	
Copper	31	32	17	24	26	68	24	23
Lead	114	308	47	78	137	1000	680	0.25
Manganese	183	222	175	172	188	487	493	150
Mercury	0.1	0.09	0.05	0.17	0.1	0.08	0.06	0.15
Molybdenum	4	<4	<4	<4	4	<8	<8	
Nickel	36	30	19	26	28	<10	<10	19
Strontium	268	209	217	289	246	64	52	
Zinc	700	1210	498	560	742	7360	5980	61

Table 6. Abundance and density of benthic invertebrates in Garrow Lake and Garrow Creek, Little Cornwallis Island, August, 2003.

Location Date Species/Group	Stage**	Creek-mid 4-Aug-03	Creek-up 4-Aug-03	GL-1 7-Aug-03	GL-2 7-Aug-03	GL-3 8-Aug-03	GL-4 8-Aug-03
FORAMINIFERA							
Unidentified							350
NEMATODA							
Unidentified		5		1		20	
OLIGOCHAETA							
Unidentified	juv*	5		17	65	200	100
Enchytraidae		471	10	418	390	1470	550
COPEPODA							
Cyclopoida	juv*						
EPHEMEROPTERA							
Baetidae							
Baetis bicaudatus	N	2					
DIPTERA							
Chironomidae	P	1					
Tanypodinae							
Procladius	L	1					
Orthocladiinae							
Eukiefferiella	L	1					
Orthocladius	L						
Diamesinae							
Diamesa	L	4	1				
Total		491	11	436	455	1690	1001
Oligochaete Abundance				435	455	1670	650
Oligochaete Density (#/m^2)				18125	18958	69583	27083

**Key:

L = Larva

N = Nymph

P - Pupa

juv = Juvenile

* = Too small to be idetified further, damaged

Table 7. Biological data for fourhorn sculpin from Garrow Lake, August 2003.

Code	Total Length (mm)	Body Weight (g)	Lipid (%)	Age (yrs)	K[1]	Gender	Maturity	Stomach Content	Condition	
									Liver	External
SC-1-03	149	24.8	14.3	6	0.75	F	Ripe	1 chironomid and plant material	large, healthy	good
SC-2-03	129	16.0	8.8	5	0.75	F	Ripe	3 chironomids, small stomach	healthy, pink	good
SC-3-03	138	20.5	12.8	6	0.78	M	Ripe	Empty	large, healthy	good
SC-4-03	163	34.5	15.7	4	0.80	F	Ripe	Empty	healthy	healthy
SC-5-03	184	37.9	7.2	9	0.61	M	Ripe	Unidentified material in stomach	healthy	healthy
SC-6-03	160	25.7	8.9	6	0.63	M	Ripe	Empty	healthy	healthy
SC-7-03	121	12.2	10.6	4	0.69	M	Ripe	Empty	healthy	healthy
SC-8-03	182	40.3	7.8	6	0.67	F	Ripe,well-developed, large	Empty	healthy	healthy
SC-9-03	146	21.4	10.6	7	0.69	M	Ripe	Empty	healthy	healthy
SC-10-03	142	20.0	8.7	7	0.70	F	Ripe	Empty, algae lower in intestine	healthy	healthy
SC-11-03	85	4.2	9.9	3	0.68	F	Ripe, large GSI, may spawn.	Empty	healthy	healthy
SC-12-03	176	34.8	-	-	0.64	-	-	-	-	-
SC-13-03	157	31.3	-	-	0.81	-	-	-	-	-
SC-14-03	159	31.2	-	-	0.78	-	-	-	-	-
SC-15-03	141	21.2	-	-	0.76	-	-	-	-	-
SC-16-03	139	17.7	-	-	0.66	-	-	-	-	-
SC-17-03	174	41.2	-	-	0.78	-	-	-	-	-
SC-18-03	132	14.9	-	-	0.65	-	-	-	-	-
SC-19-03	161	24.0	-	-	0.58	-	-	-	-	-
Mean	149	24.9	10.5	5.7	0.70	-	-	-	-	-
SD	23.8	10.1	2.7	1.7	0.07	-	-	-	-	-

[1]K = Condition Factor = (body weight x 10^5) / total length^3

Note: SC-1-03 to SC-11-03 used for tissue chemistry analyses, the other 8 were measured live and released.

Table 8. Mean (range) total length (mm), weight (g) and condition (K) of Garrow Lake sculpin from pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978) and 2003.

Year	n	Total Length (mm)			Body Weight (g)			Condition Factor (K)		
		Mean	Range	SD	Mean	Range	SD	Mean	Range	SD
1976	51	155	120 - 194	2	26.6	10 - 45		- (0.72^)	-	-
1977	33	112	38 - 168	40	10.8	0.9 - 26.6	8.2	0.56[#] (0.77^)	(0.43 - 0.70)[#]	0.07[#]
2003	19	149	85 - 184	24	24.9	4.2 - 41.2	10.1	0.70 (0.75^)	(0.58 - 0.81)	0.07

[1]K = Condition Factor = (body weight x 10^5) / total length^3
^ calculated from mean length and weight
[#] using fish with minimum length of 90mm

Table 9. Length - weight relationship for Garrow Lake sculpin, 1976, 1977 and 2003.

Year	n	Regression	R^2
1976[A]	51	$Log_{10}(weight) = 2.82 * Log_{10}(length) - 4.78$	0.99[A]
1977	33	$Log_{10}(weight) = 2.40 * Log_{10}(length) - 3.98$	0.97
2003	19	$Log_{10}(weight) = 2.96 * Log_{10}(length) - 5.06$	0.97

[A] Regression equation for 1976 data derived using curvilinear plot.
1976 (Fallis et al. 1987); 1977 (BC Research, 1978)

Table 10. Mean (range) of fourhorn sculpin whole body metal concentration (mg/kg ww) from Garrow Lake during pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978; 1980, BC Research 1981) and 2003 (post-mine).

	Pre - Mine						Post-Mine	
	1976 (n=10)		1977 (n=34)		1980 (n = 35)		2003 (n=11)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Body Length (mm)			112	38 - 168	132	78 - 164	145	85 - 184
Body Weight (g)			11	1 - 27	10	2 - 19.2	23	4 - 40
Total Metals (mg/kg ww)								
Aluminum							16	3 - 40
Antimony							<0.01	
Arsenic	0.74	0.47 - 1.18	1.15	0.53 - 2.58	0.55	0.22 - 1.1	0.88	0.53 - 1.48
Barium							3.33	1.59 - 5.36
Beryllium							<0.1	
Cadmium	0.07	0.04 - 0.12	0.11	0.01 - 0.24	0.1	0.02 - 0.33	0.057	0.026 - 0.103
Chromium							<0.1	
Cobalt							0.12	0.07 - 0.19
Copper	1.17	0.53 - 1.67	2.16	1.09 - 12.69	2.4	1.0 - 10.7	0.95	0.46 - 1.55
Lead	0.58	0.25 - 0.96	0.38	0.09 - 0.84	0.24	0.10 - 0.67	0.81	0.43 - 1.71
Manganese	0.77	0.56 - 1.03					3.15	1.24 - 6.46
Mercury	0.01	<0.01 - 0.02					0.006	<0.005 - 0.012
Molybdenum							<0.01	<0.01 - 0.01
Nickel	0.35	0.06 - 1.06					0.1	<0.1 - 0.2
Strontium							32	21 - 46.1
Zinc	28.9	15.6 - 41.8	34.4	16.0 - 66.7	34.5	16.3 - 55	72.3	50.4 - 120

PHOTOS

Photo 1 Garrow Lake showing ice cover August 4, 2003.

Photo 2 Launching the boat in Garrow Lake, August 8, 2003.

Photo 3 Garrow Lake showing gravel shoreline and mostly ice-free, August 8, 2003.

Photo 4 Garrow Lake Fourhorn sculpin *Myoxocephalus quadricornis*.

Photo 5 Garrow Lake fourhorn sculpin (140 mm total length) prior to dissection.

APPENDICES

Appendix A Department of Fisheries and Oceans Habitat Authorization

Fisheries and Oceans | Pêches et Océans

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

Authorization Issued To/Autorisation délivrée à

Name: Bruce Donald

Address: Teck Cominco Ltd.
Polaris Operations
Box 188
Resolute Bay, Nunavut
Canada X0A 0E0

Telephone: (867) 253-2201

Facsimile: (867) 253- 6862

Location of Project/Emplacement du projet

Polaris Mine is located on Little Cornwallis Island (centred at 391500 E, 8 369 000 degrees N UTM zone 15) in the Qikiqtalluk Region of Nunavut (approximately 100 km northwest of Resolute Bay). The project site encompasses fish habitat at Garrow Lake, Garrow Creek, and Crozier Strait.

Valid Authorization Period/Période de validité

From/De: June 2, 2003 **To/À:** October 30th , 2004

Description of HADD Works or Undertakings/Description des ouvrages ou entreprises

In order to decommission Teck Cominco's (TCL) Polaris Mine, draining of water from the surface layer of Garrow Lake (the mine's tailings facility) and partial removal of Garrow Lake Dam will be required. This will result in the harmful alteration, disruption and/or destruction of fish habitat (HADD) due to lowering of the level of the lake and excavation of benthic fish habitat adjacent to the dam. Partial removal of a sheet-pile dock on Crozier Strait, and excavation to contour the adjacent marine foreshore area will also temporarily alter fish habitat during construction. The above works will hereafter be referred to as the "Project Activities".

Summary of Habitat Loss

- Lowering the lake level of Garrow Lake and removal of the Garrow Lake Dam will dewater approximately 30 ha. of fish habitat. Garrow Lake has been documented to be habitat for fourhorn

sculpin *(Myoxocephalus quadricornus)* and has the potential to provide habitat for other fish species. Garrow Lake drains into Garrow Bay via Garrow Creek and provides supporting habitat for other fish species in Crozier Strait.

- Partial removal of the dock and excavation of the marine foreshore area at Polaris will alter 2512 m^2 of fish habitat. The marine foreshore area at Polaris is habitat for arctic charr, arctic cod, and marine mammals (e.g., narwhal, ringed seals, walrus).

Conditions of Authorization/Conditions de l'autorisation

1.0 All works and undertakings shall be undertaken in accordance with the documents approved by DFO entitled:

1.1 Application for Authorization for Works or Undertakings Affecting Fish Habitat submitted to DFO, dated October 5th, 2001 and signed by Bruce Donald, TCL.

1.2 The approved documents include the works or undertakings, proposed mitigative measures and compensation requirements (the *Project Plan*).

2.0 To compensate for the harmful alteration, disruption or destruction of fish habitat as a result of the Project Activities, the following shall be implemented, maintained and monitored by TCL, as indicated in the *Project Plan* or otherwise specified by DFO:

2.1 To rehabilitate and enhance fish habitat in Garrow Lake, upon completion of water withdrawal and dam removal, TCL shall conduct the following as indicated in the *Project Plan*:

Restore a natural stream channel to Garrow Bay by removing at least 19,000 cubic metres of dam fill material. The constructed 500 m long by 15 metre wide stream channel through the decommissioned dam will emulate natural stream conditions with a gravel/cobble streambed. Enhancement efforts will result in the banks of the remaining dam having a slope of at least 4:1.
The enhanced stream channel draining Garrow Lake will be on average 11 m wide and restore natural drainage patterns in the Garrow Lake area. Clean rock rip-rap will be placed to prevent erosion in the vicinity of the decommissioned dam;

2.1.3 A Fish Habitat Monitoring Report shall be submitted to DFO, including detailed photographs of Garrow Lake, stream channel development, prior to completion of the work. The intent of this Monitoring Report shall be to assess the success of fish habitat compensation upon implementation.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

2.2 To rehabilitate and enhance fish habitat in the area of the dock and marine foreshore area, TCL shall conduct the following as indicated in the *Project Plan*:

2.2.1 Partial removal of the dock pilings to a depth of 3m below the low tide water level will develop natural inter-tidal conditions with slope and substrate adequate to control erosion into Crozier Strait.

2.2.2 Excavation of the inter-tidal shoreline adjacent to the dock to develop 12,800 m^2 of marine nearshore habitat with a slope of less than 17.5:1 to prevent erosion.

2.2.3 A Fish Habitat Monitoring Report shall be submitted to DFO, including detailed photographs of the marine foreshore area adjacent to the dock. Underwater photographs or video footage of the dock will be provided to DFO. The intent of this Monitoring Report shall be to assess the success of fish habitat compensation upon implementation.

3.1 The following mitigation measures are intended to minimize or prevent further harmful alteration, disruption or destruction of fish habitat adjacent to Garrow Lake and Garrow Creek:

3.1.1 Excavation of the dam will be conducted prior to spring break-up in 2004 and all silt and loose fines shall be removed from the construction area prior to spring break-up.

3.1.2 Rock rip-rap will be placed on the banks of the stream channel adjacent to the dam to prevent erosion and sedimentation.

3.1.3 Appropriate mitigation measures will be implemented to control TSS, including the construction of a dam at the discharge of Garrow Lake, if water quality deteriorates due to release of sediment. Other contingencies may be required as mitigation measures to protect fish habitat such as silt fences.

3.2 Appropriate mitigation measures will be implemented in the marine foreshore area, at and adjacent to the dock, as follows:

3.2.1 To minimize erosion in the marine foreshore area mitigation measures will be implemented to prevent deposition of sediment into the marine waters by use of silt fences and a floating silt curtain along the perimeter of the marine foreshore area if this is deemed necessary.
Water quality sampling for turbidity will be conducted daily during work and mitigation measures will be implemented to address potential sediment release.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
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4.0 Monitoring will be conducted to ensure that compensation measures are successfully implemented and identify potential long-term project effects:

4.1 Sampling of TSS and turbidity will be undertaken by TCL in different strata of Garrow Lake to monitor stability of the halocline and to confirm the absence of contaminants in the upper strata of the lake.

4.2 A study of the metal concentrations in sediments adjacent to the shore of Garrow Lake, Garrow Creek, and the centre of Garrow Bay will be commissioned by TCL. TCL will provide a study design prior to July 2003 for approval by DFO.

4.3 TCL will conduct a study on fish in Garrow Lake and Garrow Bay to examine metal levels in fish muscle tissue. A study design will be proposed by TCL to collect fish tissue samples for analysis by DFO. TCL will propose a sampling protocol for this study prior to July 2003.

4.4 Erosion will be monitored on the shore of Garrow Lake and Garrow Creek Stream channel. The study objective will be to quantify erosion rates adjacent to the lake and stream channel. This study will be proposed by TCL for DFO approval prior to July 2003.

4.5 TCL will conduct water quality sampling for TSS and turbidity at the Garrow Lake outflow in Garrow Creek. TCL will provide a Water Quality Sampling Report of TSS levels to the DFO Eastern Arctic Office on an annual basis for the duration of this authorization. Water quality sampling for TSS will not cease at the Garrow Lake outflow prior to 2004.

4.6 TCL will conduct water quality sampling for TSS and turbidity along the marine foreshore area prior to, during, and immediately following work in the inter-tidal zone. At least seven water quality samples will be routinely collected on a daily basis in the marine foreshore area during work in the inter-tidal zone. Two water quality samples per day will be collected adjacent to the dock.

5.0 A DFO Fishery Officer shall be notified at the Iqaluit Office ((867) 979-8000) of the proposed start time prior to commencement of the work.

6.0 Any deviation from the *Project Plan*, the construction schedule or the mitigation and compensation measures stated above that may potentially affect fish or fish habitat, must be discussed and approved in writing by DFO prior to implementation.

7.0 A copy of this Authorization shall be at the Polaris work site during all work periods. Work crews shall be made familiar with the conditions of this Authorization prior to implementation of the works or undertakings.

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

The holder of this Authorization is hereby authorized under the authority of subsection 35(2) of the *Fisheries Act*, R.S.C., 1985, c. F. 14, to carry out the work or undertaking described herein. This Authorization is valid only with respect to fish habitat and for no other purposes. It does not purport to release the applicant from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies.

Failure to comply with any condition of this Authorization may result in charges being laid under the *Fisheries Act*.

This Authorization form should be held on site and work crews should be made familiar with the terms and conditions of this authorization.

Le détenteur de la présente est autorisé en vertu du paragraphe 35(2) de la *Loi sur les pêches*, L.R.C. 1985, ch. F. 14, à exploiter les ouvrages ou entreprises décrits aux présentes.
L'autorisation n'est valide qu'en ce qui concerne l'habitat du poisson et pour aucune autre fin. Elle ne dispense pas le requérant de l'obligation d'obtenir la permission d'autres organismes réglementaires concernés ou de se conformer à leurs exigences.

En vertu de la *Loi sur les pêches*, des accusations pourront être portées contre ceux qui ne respectent pas les conditions prévues dans la présente autorisation.

Cette autorisation doit être conservée sur les lieux des travaux, et les équipes de travail devraient en connaître les conditions.

Date of Issuance: Following NIRB Environmental Assessment

Signed by:

Burt Hunt
Area Director
Eastern Arctic Area
Fisheries and Oceans Canada
Central and Arctic Region

Prepared by:

Jordan DeGroot
Area Habitat Biologist
Fish Habitat Management
Eastern Arctic Area
Fisheries and Oceans Canada

Bruce Donald- Reclamation Manager, Environment and Corporate Affairs

AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT

AUTHORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

DFO File No. 02-HCAA-000-000063
Authorization No./N° de l'autorisation

Witness:

Teck Cominco Ltd.

Signature: Brian McKenzie

Teck Cominco Ltd.

Signature: B McDonald

Copy signed by TCL received by DFO

Signature: Stephanie Critch

Date: July 23, 2003

Canada

Appendix B Garrow Lake Water Chemistry Data

Appendix B. Vertical profile of water chemistry parameters pre-mining (Fallis et al. 1987) and in 2003, after mining.

	Pre-Mine Profile			Post-Mine Profile							
	June 1976 (Fallis et al. 1987)			Winter 2003 (Teck Cominco)			August 2003				
Depth (m)	Temperature (oC)	Salinity ppt	D.O. mg/L	Temperature (oC)	Conductivity (mS)	D.O. mg/L	Temperature (oC)	Conductivity (mS)	pH	Salinity ppt	D.O. mg/L
1	0.85	4.9		-0.5	14.5	20.7	0	6.74	8.18	3.8	11.5
2	0.85	4.9	15.9	-0.5	14.8	20.2	0.24	6.93	8.18	3.9	11.5
3	0.85	4.9		-0.3	13.8	18.9	0.86	7.38	8.14	4.1	11.5
4	0.85	4.8	16.1	3.3	14.6	17.6	3	11.45	7.98	6	11.5
5	0.85	4.9		3.5	14.5	17.2	3.28	12.18	8	7	11.5
6	0.85	5.3		3.5	14.5	17.1	3.35	12.28	8	7	11.5
7	0.85	4.9		3.5	14.6	16.9	3.42	12.37	8.07	7.1	11.5
8	0.85	5.1		3.6	14.6	16.1	3.25	12.43	8.08	7.1	11.5
9	0.85	4.8		4.0	15.3	13.2	3.45	12.51	8.07	7.2	11.5
10	0.85	4.8	16	5.2	27.1	7.7	5.01	18	7.83	11.5	11.5
10.5							6.0		7.26	22.5	6.7
11	0.85	4.9		6.6	77.4	0.4	7.05	65.6	7.16	40.2	4.3
12	0.85	4.9		7.5	94.0	0.2	8.2	78.9	7.2	54.9	1.1
13	3.76	28.6		8.0	94.2	0.2	8.37	79.8	7.24	55.3	0.8
14	6.34	34.6		8.2	94.4	0.2	8.37	80.1	7.26	55.6	0.45
15	7.4	54.6	9.8	8.3	94.4	0.2	8.33	80.3	7.27	55.7	0.23
16	8.06	65.2		8.4	94.5	0.2	8.28	80.4	7.3	55.7	0.0
17	8.51	71.3		8.4	94.5	0.2	8.27	80.4	7.3	55.7	0.0
18	8.96	77.0		8.4	94.5	0.2	8.25	80.5	7.31	55.7	0.0
19	9.29	79.8	8.5	8.4	94.5	0.2	8.25	80.5	7.31	55.7	0.0
20	9.47	81.3	0.0	8.4	94.5	0.2	8.24	80.5	7.32	55.8	0.0
21	9.39	85.0		8.4	94.5	0.2	8.24	80.4	7.33	55.8	0.0
22	9.18	87.5		8.4	94.5	0.2	8.24	80.5	7.33	55.8	0.0
23	9.0	88.8		8.4	94.5	0.2	8.24	80.5	7.33	55.8	0.0
24	8.9	89.0		8.4	94.5	0.2	8.24	80.5	7.34	55.8	0.0
25	8.82	89.2		8.4	94.6	0.2	8.24	80.5	7.34	55.8	0.0
26	8.74	89.4		8.4	94.6	0.2	8.24	80.5	7.34	55.8	0.0
27	8.68	89.3		8.4	94.6	0.2	8.22	80.5	7.35	55.8	0.0
28	8.59	89.3		8.4	94.6	0.2	8.23	80.5	7.35	55.8	0.0
29	8.5	89.3		8.4	94.5	0.2	8.24	80.5	7.35	55.8	0.0
30	8.42	89.2	0.0	8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
31	8.35	89.1		8.4	94.6	0.2	8.25	80.5	7.35	55.8	0.0
32	8.28	89.1		8.4	94.6	0.2	8.25	80.5	7.35	55.8	0.0
33	8.19	88.8		8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
34	8.11	89.1		8.4	94.7	0.2	8.25	80.5	7.35	55.8	0.0
35	8.04	88.5		8.4	94.6	0.2	8.27	80.5	7.35	55.8	0.0
36	7.95	88.7		8.4	94.6	0.2	8.27	80.5	7.35	56	0.0
37	7.88	88.4		8.4	94.7	0.2	8.27	80.5	7.35	56.4	0.0
38	7.8	89.0		8.4	94.7	0.2	8.4	83.4	7.35	58.1	0.0
39	7.76	88.6		8.4	94.7	0.2	8.43	83.9	7.35	58.4	0.0

Appendix C Fish Metals Concentrations, Garrow Lake 2003.

Appendix C. Total metal concentration (mg/kg ww) for individual fourhorn sculpin, Garrow Lake, August 2003.

Sample ID Total Metals (mg/kg ww)	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	SC-7	SC-8	SC-9	SC-10	SC-11	Mean	SD	Range
Aluminum	20	13	21	19	5	9	23	3	21	40	7	16	10.61	3 - 40
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Arsenic	0.59	0.93	0.59	1.10	1.42	1.48	0.66	0.82	0.77	0.81	0.53	0.88	0.33	0.53 - 1.48
Barium	3.63	2.93	3.70	3.00	2.55	2.32	2.83	1.59	5.36	5.15	3.61	3.33	1.14	1.59 - 5.36
Beryllium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	
Cadmium	0.087	0.051	0.044	0.038	0.062	0.042	0.103	0.026	0.051	0.075	0.043	0.057	0.023	0.026 - 0.103
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0	
Cobalt	0.14	0.15	0.09	0.09	0.09	0.10	0.13	0.07	0.14	0.19	0.10	0.12	0.04	0.07 - 0.19
Copper	0.74	0.65	0.59	1.06	0.75	0.94	0.74	0.46	1.55	1.43	1.52	0.95	0.39	0.46 - 1.55
Lead	0.80	0.57	0.83	0.73	0.87	0.92	0.78	0.43	0.63	1.71	0.62	0.81	0.33	0.43 - 1.71
Manganese	3.37	6.46	2.29	3.15	1.24	2.78	3.34	1.60	3.36	4.31	2.77	3.15	1.40	1.24 - 6.46
Mercury	<0.005	<0.005	<0.005	0.005	0.012	0.006	<0.005	<0.005	<0.005	0.005	0.006	0.006	0.002	<0.005 - 0.012
Molybdenum	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0.00	<0.01 - 0.01
Nickel	0.1	0.1	0.1	0.1	0.1	0.1	0.2	<0.1	0.2	0.2	0.2	0.1	0.1	<0.1 - 0.2
Strontium	21	30.4	27.9	36	46.1	41.5	25.1	35.7	30.8	29.8	25.6	31.8	7.4	21 - 46.1
Zinc	53.1	71.5	60.9	78.6	120	86.5	54.3	50.4	85.1	78	57.3	72.3	20.6	50.4 - 120

APPENDIX 4

2005 Update

of

Reclamation and Monitoring Costs

POLARIS MINE

POST-RECLAMATION PHASE MONITORING / SITE MAINTENANCE COST REVIEW and FORECAST

	2005 Monitoring/Mtce Costs[1]		FORECAST COSTS BY YEAR					
			2006	2007	2008	2009	2010	2011
Garrow Lake Effluent Monitoring								
Field Staff for Sampling Final Discharge Point	$ 62,100							
Travel	$ 16,500							
Charter Aircraft	$ 34,300							
Resolute Hotels / Camp Food / Camp Supplies	$ 8,200							
Laboratory Costs	$ 24,600							
Freight for Samples / Sampling Supplies	$ 8,900							
Coordinating With Labs / Reporting/Planning	$ 11,800							
		$ 166,400	$ 167,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000
Garrow Lake Water Column Monitoring								
Field Staff for Sampling Lake	$ 15,200							
Travel	$ 8,200							
Charter Aircraft	$ 6,800							
Resolute Hotels / Camp Food / Camp Supplies	$ 2,800							
Laboratory Costs	$ 29,100							
Freight for Samples / Sampling Supplies	$ 1,600							
Coordinating With Labs / Reporting/Planning	$ 1,800							
		$ 65,500	$ 65,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000
Annual Geotechnical Inspection								
Field Staff for Sampling Lake	$ 16,700							
Travel	$ 5,500							
Charter Aircraft	$ -							
Resolute Hotels / Camp Food / Camp Supplies	$ 800							
Misc. Supply / Survey Costs	$ 4,000							
Coordinating With Labs / Reporting/Planning	$ 13,100							
		$ 40,100	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
Site Support / Site & Equipment Maintenance								
Labour	$ 45,800		$ 75,000	$ 3,500	$ 3,500	$ 3,500	$ 3,500	$ 3,500
Travel	$ -		$ 26,500	$ -	$ -	$ -	$ -	$ -
Materials / Camp Supplies	$ 17,100		$ 25,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Site Communications	$ 7,000		$ 9,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
		$ 69,900						
TCML Site Management Costs								
Labour	$ 51,000		$ 33,000					
Expenses	$ 15,000		$ 12,500					
		$ 66,000		$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
Studies / Major Reporting								
2004 Contaminated Soils Close Out Reporting	$ 82,900		$ -	$ -	$ -	$ -	$ -	$ -
2005 EEM Interpretive Report	$ 15,000		$ 10,000	$ -	$ -	$ -	$ -	$ -
2006 Proposals for Revised Monitoring Requirements	$ -		$ 55,000	$ -	$ -	$ -	$ -	$ -
2011 Final Review of Site Closure Performance	$ -		$ -	$ -	$ -	$ -	$ 100,000	$ 60,000
		$ 97,900						
TOTAL ANNUAL COST		**$ 407,900**	**$ 508,000**	**$ 190,500**	**$ 190,500**	**$ 190,500**	**$ 290,500**	**$ 250,500**

Note 1 : Costs are for monitoring / site maintenance costs that ocurred in 2005
Costs exclude reclamation project wrap-up costs, financial security, property taxes, lease costs, and insurance costs

APPENDIX 5

Garrow Lake Water Column

Monitoring Data

FIGURE 1
GARROW LAKE - January 2004
Comparision of Zinc Concentrations In The Water Column Between Monitoring Stations 262-3 and 262-3A

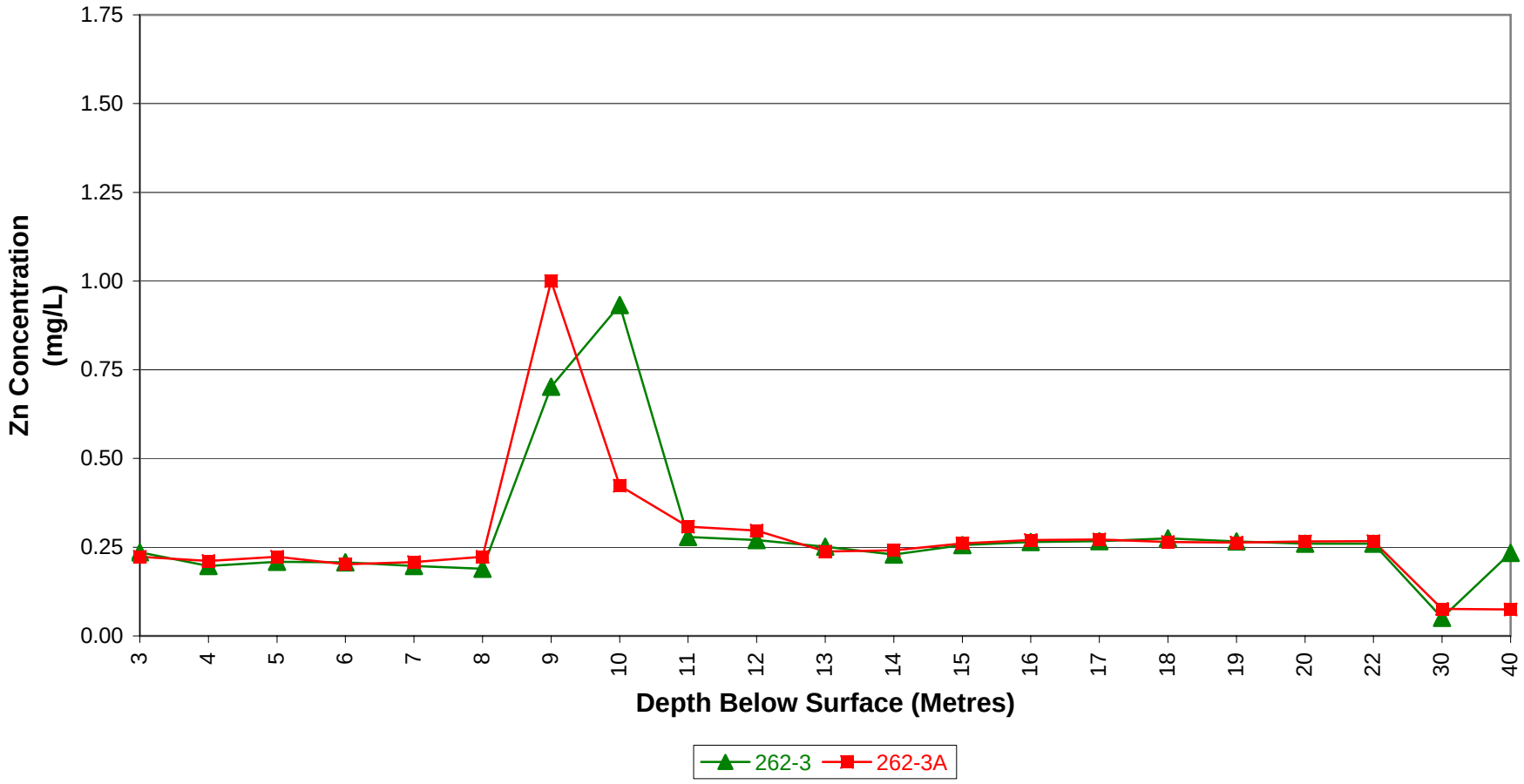


FIGURE 2
GARROW LAKE - May 2004
Comparision of Zinc Concentrations In The Water Column Between Monitoring Stations 262-3 and 262-3A

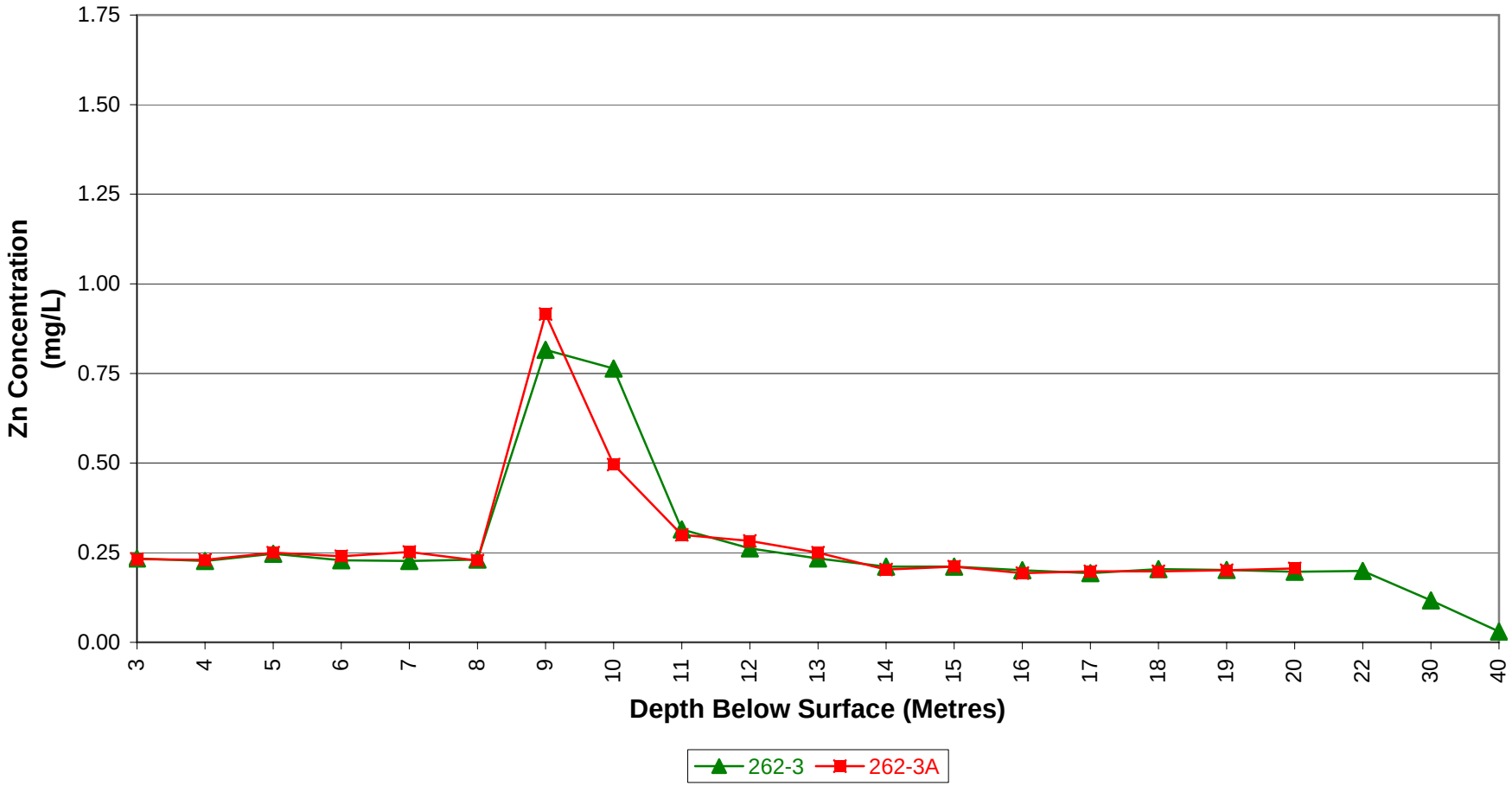


FIGURE 3
GARROW LAKE - May 2005
Comparision of Zinc Concentrations In The Water Column Between Monitoring Stations 262-3 and 262-3A

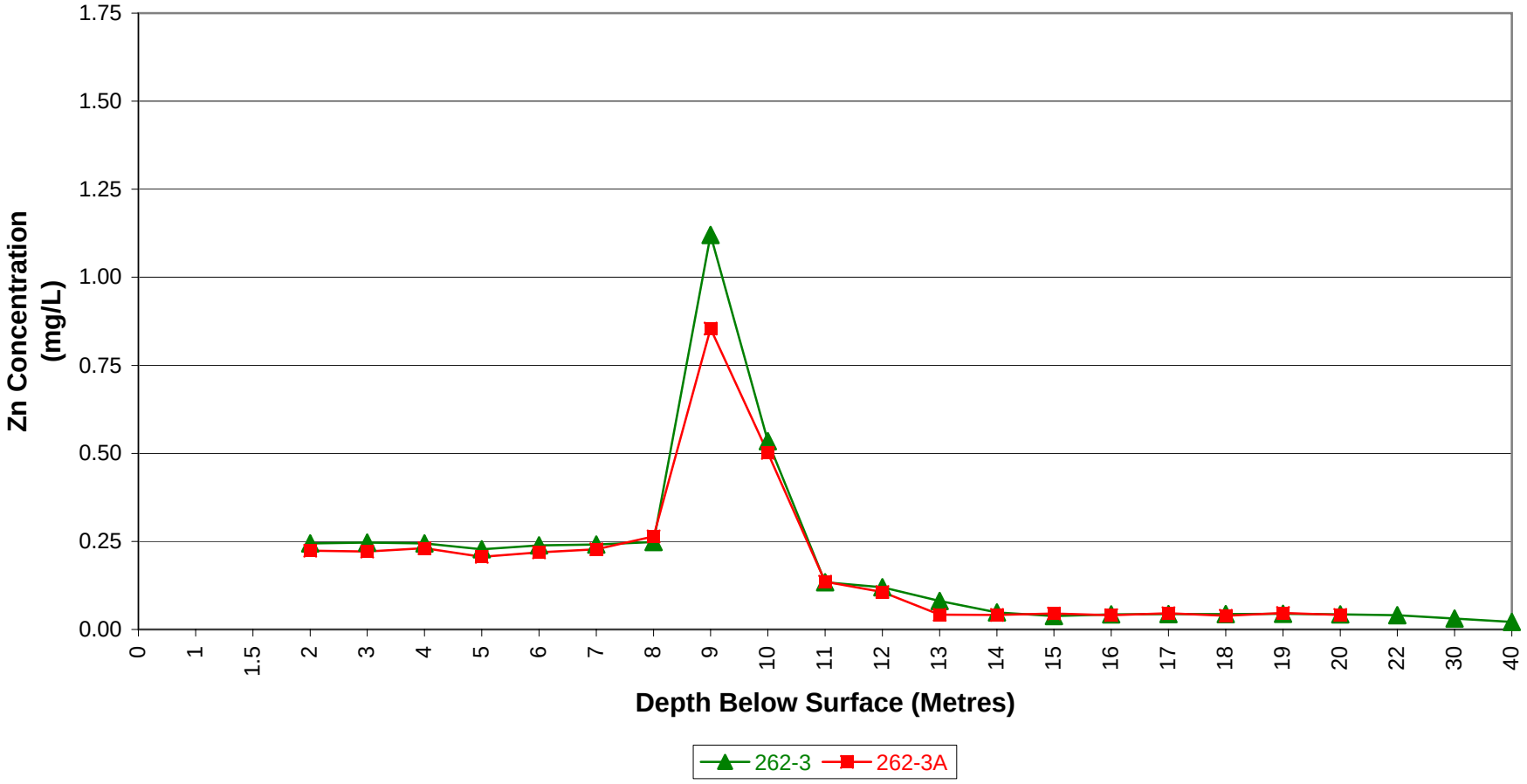


FIGURE 4
GARROW LAKE - August 2005
Comparision of Zinc Concentrations In The Water Column Between Monitoring Stations 262-3 and 262-3A

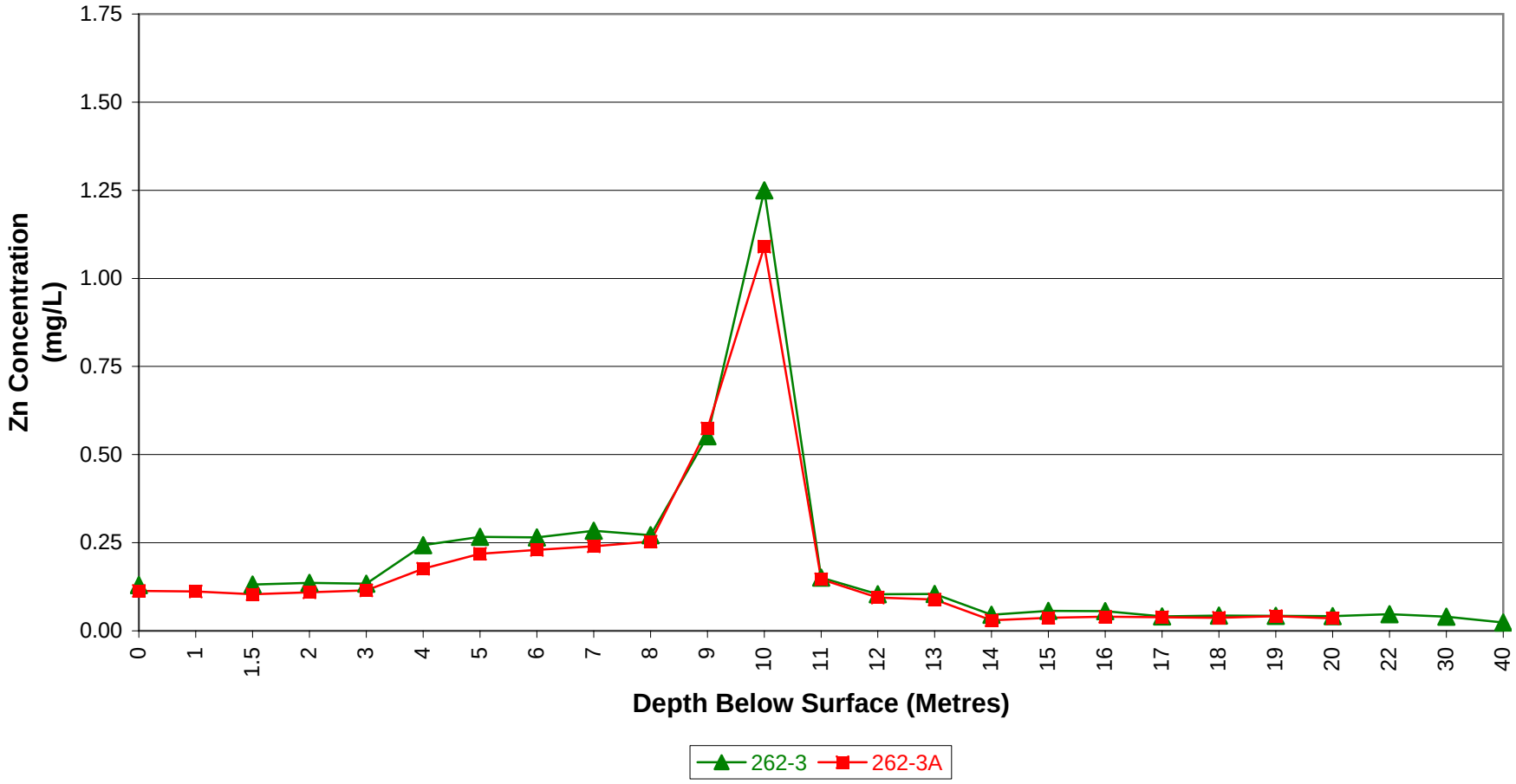
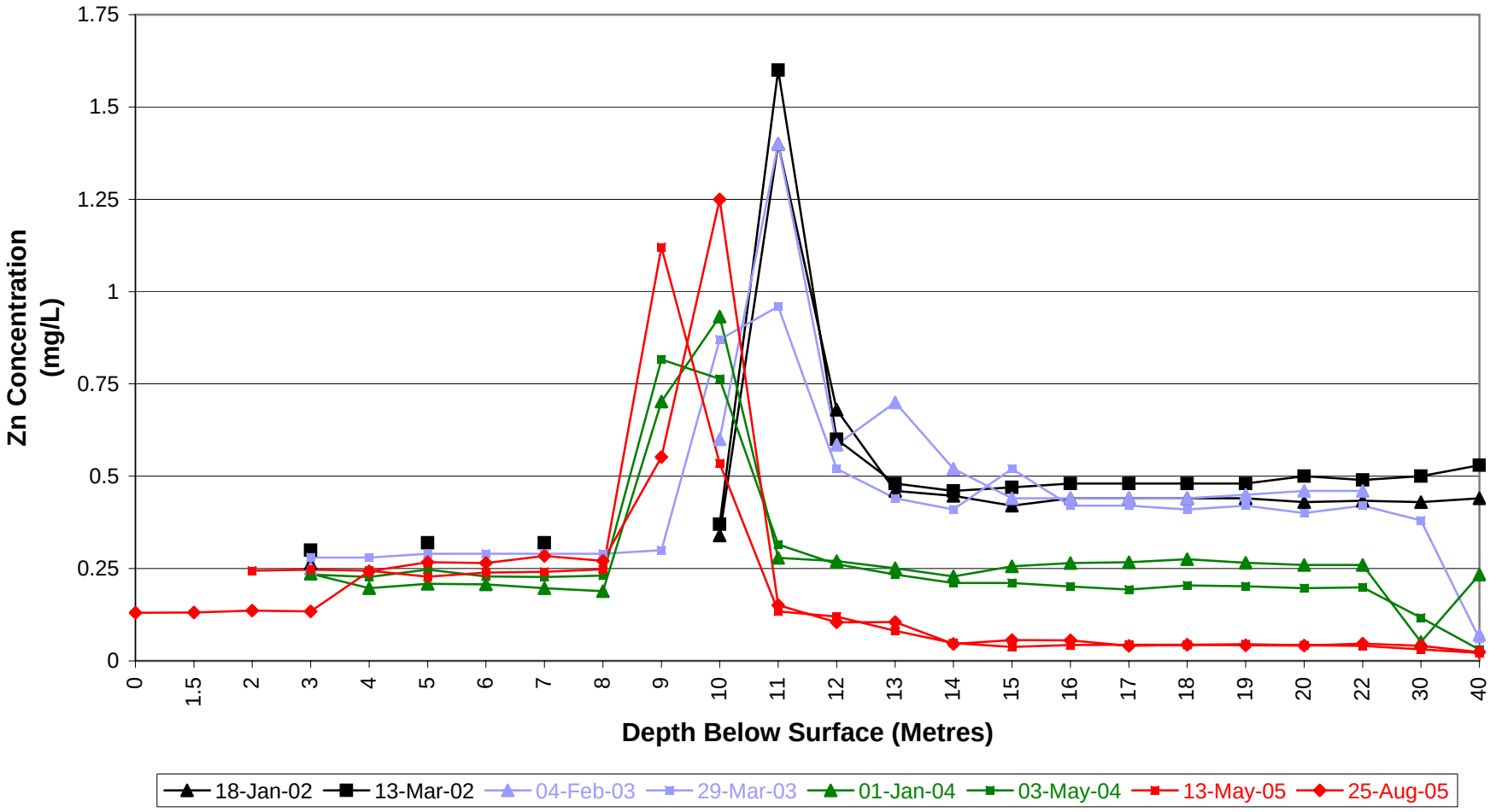


FIGURE 5
GARROW LAKE - Station 262-3
Trend In Zinc Concentrations In The Water Column 2002 to 2005



GARROW LAKE
WATER COLUMN MONITORING
STATION 262-3: Garrow Lake at Centre

Depth	Zinc Concentrations (mg/L)							
	18-Jan-02	13-Mar-02	04-Feb-03	29-Mar-03	01-Jan-04	03-May-04	13-May-05	25-Aug-05
0								0.130
1.5								0.131
2							0.244	0.136
3	0.26	0.30	0.25	0.28	0.236	0.234	0.247	0.134
4				0.28	0.197	0.227	0.244	0.243
5		0.32		0.29	0.209	0.247	0.228	0.267
6				0.29	0.207	0.229	0.239	0.265
7		0.32		0.29	0.197	0.227	0.241	0.284
8				0.29	0.189	0.231	0.248	0.271
9				0.30	0.702	0.816	1.120	0.552
10	0.34	0.37	0.60	0.87	0.932	0.764	0.535	1.250
11	1.40	1.6	1.40	0.96	0.279	0.315	0.134	0.151
12	0.68	0.60	0.585	0.52	0.27	0.262	0.120	0.104
13	0.46	0.48	0.70	0.44	0.251	0.234	0.0812	0.105
14	0.45	0.460	0.52	0.41	0.229	0.211	0.0482	0.0457
15	0.42	0.47	0.44	0.52	0.256	0.211	0.0378	0.0565
16	0.44	0.48	0.44	0.42	0.265	0.201	0.0429	0.0556
17	0.44	0.48	0.44	0.42	0.267	0.193	0.0435	0.0409
18	0.44	0.48	0.44	0.41	0.275	0.204	0.0440	0.0435
19	0.44	0.48	0.45	0.42	0.266	0.202	0.0448	0.0425
20	0.43	0.50	0.46	0.40	0.260	0.197	0.0425	0.0413
22	0.43	0.49	0.46	0.42	0.260	0.199	0.0407	0.0468
30	0.43	0.50		0.38	0.0514	0.117	0.0310	0.0404
40	0.44	0.53	0.07	0.06	0.234	0.0301	0.0214	0.0235

GARROW LAKE
WATER COLUMN MONITORING
STATION 262-3A: Garrow Lake Near Discharge

Depth	Zinc Concentrations (mg/L)			
	27-Jan-04	03-May-04	13-May-05	25-Aug-05
0				0.113
1				0.112
1.5				0.104
2			0.224	0.109
3	0.223	0.232	0.221	0.115
4	0.211	0.230	0.231	0.176
5	0.223	0.250	0.206	0.219
6	0.202	0.240	0.219	0.23
7	0.208	0.252	0.228	0.24
8	0.223	0.228	0.264	0.253
9	1.000	0.916	0.854	0.574
10	0.423	0.496	0.501	1.09
11	0.308	0.300	0.136	0.146
12	0.297	0.283	0.106	0.0944
13	0.238	0.250	0.0418	0.0888
14	0.241	0.203	0.0412	0.03
15	0.261	0.211	0.045	0.037
16	0.27	0.193	0.0408	0.0398
17	0.272	0.198	0.0458	0.0383
18	0.265	0.198	0.0391	0.0372
19	0.263	0.201	0.047	0.0417
20	0.266	0.206	0.0415	0.0354
22	0.267			
30	0.076			
40	0.0747			