
APPENDIX D

EFFLUENT AND WATER QUALITY DATA: 2003 to 2005



2003 POLARIS MINE MMER 3RD QUARTER REPORT





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 LC₅₀
- 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 LC₅₀ 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 LC₅₀ = 36mg/L SDS, 95% CL = 30-42mg/L
 - Test 2: (Aug-5-03) 96-h LC₅₀ = 24mg/L SDS, 95% CL = 18-32mg/L
 - Test 3: (Sep-3-03) 96-h LC₅₀ = 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° 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
 - 48-hour *Daphnia magna* LC₅₀
- 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 LC₅₀ = > 100% effluent
 - Test 2: 48-h LC₅₀ = > 100% effluent
 - Test 3: 48-h LC₅₀ = > 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 LC₅₀ = 453µg/L Zinc, 95% CL = 377-544µg/L
 - Test 2: (Aug-7-03) 96-h LC₅₀ = 453µg/L Zinc, 95% CL = 377-544µg/L
 - Test 3: (Sep-23-03) 96-h LC₅₀ = 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 O₂ 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 LC₅₀ (95% CL)
 - 7-d LC₅₀ concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Quantal statistic methods not applicable
- iv. Estimate of 7-d IC₂₅ (95% CL) for growth
 - 7-d IC₂₅ 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 LC₅₀ for survival and 7-d IC₅₀ 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 LC₅₀ survival = 122mg/L Cu, 95% CL = 111-135mg/L
 - 7-d IC₅₀ growth = 122mg/L Cu, 95% CL = 106-132mg/L
- vi. Reference toxicity warning limits (+/- SD) for 7-d LC₅₀ for survival and 7-d IC₅₀ for growth
 - Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 139 ± 63mg/L Cu,
 - 7-d IC₅₀ 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 – EPS1/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	<i>0.000</i>	0.001	<i>0.005</i>	0.008	0.001	0.048	<i>3.0</i>	<i>0.005</i>	7.77	Water Pump
28-Jul-03	30-Jul-03	<i>0.000</i>	0.001	<i>0.005</i>	0.003	0.001	0.063	<i>3.0</i>	<i>0.005</i>	7.84	Water Pump
04-Aug-03	05-Aug-03	<i>0.001</i>	0.001	<i>0.005</i>	0.001	0.001	0.089	<i>3.0</i>	<i>0.005</i>	7.85	Water Pump
11-Aug-03	12-Aug-03	<i>0.001</i>	0.001	<i>0.005</i>	0.001	0.003	0.151	<i>3.0</i>	<i>0.005</i>	7.94	Water Pump
18-Aug-03	19-Aug-03	<i>0.001</i>	0.001	<i>0.005</i>	0.000	0.003	0.146	8.0	<i>0.005</i>	8.1	Water Pump
25-Aug-03	26-Aug-03	<i>0.001</i>	0.001	<i>0.005</i>	0.001	0.003	0.160	<i>3.0</i>	<i>0.005</i>	7.96	Water Pump
01-Sep-03	02-Sep-03	<i>0.000</i>	0.001	<i>0.005</i>	0.003	0.003	0.150	10.0	<i>0.005</i>	8.06	Water Pump
08-Sep-03	09-Sep-03	<i>0.002</i>	0.001	<i>0.005</i>	0.001	0.003	0.158	11.0	0.010	7.94	Water Pump
15-Sep-03	16-Sep-03	<i>0.001</i>	0.001	-	0.000	0.004	0.186	5.0	<i>0.005</i>	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

Note¹ - 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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L

Note² - 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

Note¹ - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note² - Flow Rate must be taken at the same time as samples are effluent quality samples are taken

Note³ - "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

Note¹ - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note² - Mass loading units are in kg per month except Radium 226, which is in Bq per month

Note³ - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note⁴ - 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 or 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. LC₅₀ 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 IC₂₅ was 3.8% v/v, and the IC₅₀ was 13.0% v/v. In the *Champia parvula* sexual reproduction test (Saskatchewan Research Council) the LOAEL was 17.8% v/v effluent, the IC₂₅ 13.6% v/v, and the IC₅₀ 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 $128 \pm 49 \mu\text{g/L}$ (range 48 – 186 $\mu\text{g/L}$), which is well below the MMER effluent limit of 500 $\mu\text{g/L}$. The BC AWQG is 10 $\mu\text{g/L}$. On August 19, 2003, when the sublethal samples were collected, the concentration of Zn in the effluent was 146 $\mu\text{g/L}$. Converting the echinoid test endpoints into Zn concentrations results in a Lowest Observed Adverse Effect Level (LOAEL) of 6.7 $\mu\text{g/L}$ Zinc, an IC₂₅ of 5.5 $\mu\text{g/L}$, and an IC₅₀ of 19.0 $\mu\text{g/L}$. Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC₅₀ concentrations of 8.5-60 $\mu\text{g/L}$ (Dinnel et al. 1983). The concentration of zinc in the effluent that corresponds to the IC₅₀ (i.e., 19.0 $\mu\text{g/L}$) 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 (IC₂₅), and 27.4µg/L (IC₅₀). The reference IC₂₅ 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



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 75⁰ 22' 32" N, 96⁰ 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 (m³)
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	<i>0.005</i>	0.102	<i>3</i>
2003-08-19	8.10	8.70	1.22	4.94	1130	103	0.03	<i>0.005</i>	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	<i>0.1</i>	0.00016	0.02	<i>0.00005</i>	<i>0.002</i>	<i>0.0004</i>	0.00057	0.00319	0.00115	0.0625	<i>0.005</i>
2003-08-19	<i>0.1</i>	0.00037	0.03	<i>0.00005</i>	<i>0.002</i>	<i>0.0010</i>	0.00097	0.00046	0.00265	0.1460	<i>0.005</i>
2003-09-16	<i>0.1</i>	0.00047	0.04	<i>0.00005</i>	<i>0.005</i>	<i>0.0010</i>	0.00099	0.00046	0.00365	0.1860	<i>0.005</i>

NA - Not Available (no sample).

Note¹ - 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 O₂ 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 LC₅₀ (95% CL)
 - 7-d LC₅₀ concentration > 72.3% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Quantal statistic methods not applicable
- iv. Estimate of 7-d IC₂₅ (95% CL) for growth
 - 7-d IC₂₅ 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 LC₅₀ for survival and 7-d IC₅₀ 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 LC₅₀ survival = 122mg/L Cu, 95% CL = 111-135mg/L
 - 7-d IC₅₀ growth = 122mg/L Cu, 95% CL = 106-132mg/L
- vi. Reference toxicity warning limits (+/- SD) for 7-d LC₅₀ for survival and 7-d IC₅₀ for growth
 - Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 139 ± 63mg/L Cu,
 - 7-d IC₅₀ 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 – EPS1/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	Dissolved	Hardness	Alkalinity	Ammonia	Cyanide	Nitrate	TSS
			Temperature	Oxygen						
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

Note¹ - 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	<i>0.005</i>	<i>0.005</i>	<i>3</i>
2003-08-19	7.87	8.32	0.18	5.50	5830	115	<i>0.02</i>	<i>0.005</i>	<i>0.005</i>	32
2003-09-16	7.78	8.35	-1.36	3.42	5930	113	0.08	<i>0.005</i>	<i>0.005</i>	9

Dissolved Metal Concentrations											
Sample Date	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Arsenic	Copper	Lead	Nickel	Zinc	Radium ²²⁶
2003-07-29	<i>0.1</i>	<i>0.00002</i>	0.01	<i>0.00005</i>	<i>0.002</i>	<i>0.0004</i>	0.00023	0.00032	0.00021	0.0010	<i>0.005</i>
2003-08-19	<i>0.1</i>	0.00003	<i>0.01</i>	<i>0.00005</i>	0.010	0.0020	0.00044	0.00021	0.00033	0.0007	<i>0.005</i>
2003-09-16	<i>0.1</i>	0.00003	0.02	<i>0.00005</i>	0.011	<i>0.0010</i>	0.00028	0.00052	0.00026	0.0011	<i>0.005</i>

Note¹ - 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.

Insert 2003 Acute Toxicity Test Reports Here



October 2003

LABORATORY REPORT

Polaris Mine
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

September 2003

PREPARED FOR:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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
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 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 performed 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 FERTILIZED (% 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 <i>Artemia</i> 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 [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	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 $\pm$ 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
D-Control	96.0 $\pm$ 8.9	1.18 $\pm$ 0.19
Brine Control	100 $\pm$ 0.0	1.14 $\pm$ 0.20
Pooled	98.0 $\pm$ 6.3	1.16 $\pm$ 0.18
4.5	100 $\pm$ 0.0	1.13 $\pm$ 0.26
9	100 $\pm$ 0.0	1.32 $\pm$ 0.21
18.1	100 $\pm$ 0.0	1.09 $\pm$ 0.12
36.2	100 $\pm$ 0.0	1.11 $\pm$ 0.23
72.3	96.0 $\pm$ 8.9	1.14 $\pm$ 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 $\pm$ SD)
Negative Control	51.6 $\pm$ 1.7
Brine Control	51.0 $\pm$ 0.8
Pooled Control	51.3 $\pm$ 1.3
4.6	37.3 $\pm$ 6.8*
9.1	30.5 $\pm$ 4.9*
18.2	21.0 $\pm$ 2.6*
36.5	9.3 $\pm$ 2.2*
73.0	0.8 $\pm$ 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 $\pm$ SD)
Negative Control	50.4 $\pm$ 8.4
Brine Control	51.9 $\pm$ 14.4
Pooled	51.1 $\pm$ 11.6
4.5	53.7 $\pm$ 8.6
8.9	55.3 $\pm$ 13.9
17.8	27.8 $\pm$ 12.6*
35.6	6.7 $\pm$ 2.7*
71.3	1.3 $\pm$ 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 (Pacaris Marine)
 EVS Project No. 09-0302-54.01
 EVS Work Order No. 0300439

EVS Analysts KMG, SLK.
 Test Initiation Date 22-Aug-03

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	<u>6-CREEK</u>		
Amount Received	<u>1 x 20L</u>	<u>1 x 20L</u>	<u>2 x 20L</u>
Date Collected	<u>20 Aug 03</u>		
Date Received	<u>22-Aug-03</u>		
Temperature (°C)	<u>20.0</u>	<u>21.0</u>	<u>21.0</u>
pH	<u>7.9</u>	<u>7.9</u>	<u>7.8</u>
DO (mg/L)	<u>11.0 * 7.8</u>	<u>11.0 * 7.8</u>	<u>10.8 7.8</u>
Conductivity (µmhos/cm)	<u>9570</u>	<u>9580</u>	<u>9580</u>
Salinity (ppt)	<u>5.3</u>	<u>5.3</u>	<u>5.3</u>
Ammonia (mg/L N)	<u>-</u>	<u>-</u>	<u>-</u>
Chlorine (mg/L Cl)	<u>-</u>	<u>-</u>	<u>-</u>
Other	<u>-</u>	<u>-</u>	<u>-</u>

DILUTION/CONTROL WATER (initial water quality)

Water Type SEA H₂O (FILTERED & O₂ SUPP.)
 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 - 8.2
 Dissolved Oxygen Range (mg/L) 6.6 - 7.8
 Salinity (ppt) 29 - 31
 Photoperiod (L:D h) 16:8
 Aeration Provided? no
 Other -

TEST SPECIES INFORMATION

Source AQUATIC BIO SYSTEMS (ABE)
 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 135 ± 53 µg/L Cu; CV=19%.
136 ± 54 µg/L Cu CV=20%.

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	<u>1 (U/V)</u>	<u>72.3</u>	<u>>72.3</u>	<u>772.3</u>		
Growth		<u>72.3</u>	<u>>72.3</u>		<u>>72.3</u>	<u>>72.3</u>

Other * SUPER SATURATED DUE TO HEATING SAMPLE TO 20°C.

① AERATED 30 mins. & SAL. ADJUSTED.

Data Verified By James T. Grey

Date Verified September 24, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client AZUMUTH (POLARIS MINE)
 EVS Project No. 01-0302-54.01
 EVS Work Order No. 0300439

Sample ID G-CREEK
 Test Species/Batch TOPSMET / 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		umb	umb	umb	umb	umb	umb	umb	umb	

Sample Description CLEAR / LONGEVITY
 Data Verified By Remond Torg

Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azumuth (Polaris MINE)
 EVS Project No. 09-0302-54.01
 EVS Work Order No. 0300439

Sample ID G-CREEK
 Test Species/Batch TOPSMEET / 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 / no obvious

Data Verified By Kenneth Torg

Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST - WATER QUALITY DATAClient Azimuth (PARIS MINE)Sample ID G-CREEKEVS Project No. 09-0302-SY-01Test Initiation Date/Time 22-AUG-03 / 1700hEVS Work Order No. 0300439Source/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
BLANK 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	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt

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
BLANK 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	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt	unt

WQ Instruments Used: Temp. CARB. Hg THERM.pH II-A-51

Comments _____

Test Set Up By KMG Date Verified By Aurelio Tery Date Verified Sept 22/03

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST - WATER QUALITY DATAClient Azimath (Parais Mine)Sample ID G-CEEVEVS Project No. 09-0302-54.01Test Initiation Date/Time 22-AUG-03/1700hEVS Work Order No. 0300439Source/Date Received ABS / 21-AUG-03

Concentration (% v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Nec. ctrl	29	29	30	30	30	30	30	30
Beine ctrl	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	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh

Concentration (% v/v)	Dissolved Oxygen (mg/L)													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Nec. ctrl	7.6	7.6	6.7	7.7	7.6	7.6	7.0	7.5	7.0	7.6	7.0	7.6	6.8	7.0
Beine ctrl	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	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh	kmh

WQ Instruments Used: Salinity H-A-030303DO H-A-011202

Comments _____

Test Set Up By KMGData Verified By Armeda Torg Date Verified Sept 22/03

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Ariz. munt (Peters Munt) Start Date (Day 0) 22-AUG-03
 EVS Project No. 04-0302-54.01 Sample ID G-CEEEK
 EVS Work Order No. 0300439 Balance Type/Serial Number SATORUS BLAID

Sample ID (% v/v)	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
NEG. CTRL	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		
BENEF. CTRL	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	30	① technician 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.

Date Verified By Armeda Terry

Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d Atherinops affinis SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client AZIMUTH (Ovarian Males) Start Date (Day 0) 82-AUG-03
 EVS Project No. 09-0302-57.01 Sample ID G-CR-E-E-K
 EVS Work Order No. 0300439 Balance Type/Serial Number Sartorius US 682117

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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	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.

Date Verified By Armeda Tare Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client ARMUTH (PETERS MINE)
EVS Project No. 09-0302-54101
EVS Work Order No. 0300439

[illegible]

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be $\leq 10\%$ of organism weight.

Data Verified By

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


 507 24/03

Larval Fish Growth and Survival Test-7 Day Survival

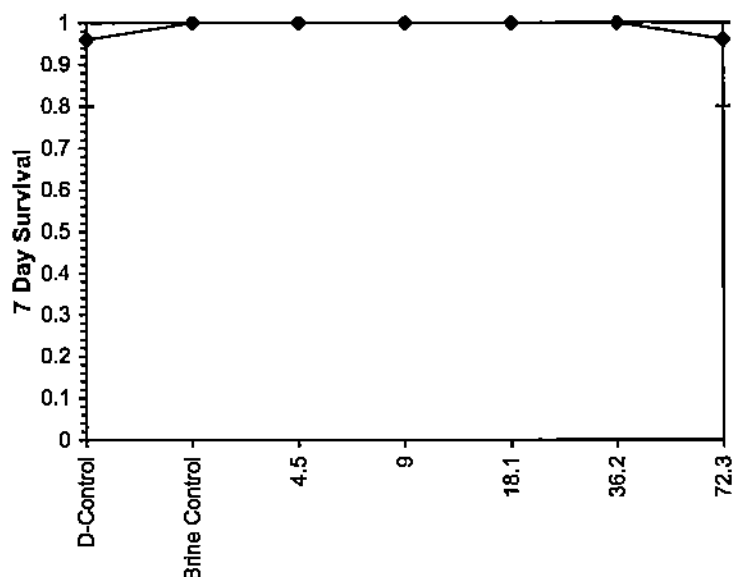
Start Date: 8/22/2003 Test ID: 300439 Sample ID: G-CREEK-082003
 End Date: 8/29/2003 Lab ID: BCEVS-EVS Environment Cc Sample Type: EFF2-Industrial
 Sample Date: 8/20/2003 Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

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

Conc-%	Mean	SD	Transform: Untransformed					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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



Larval Fish Growth and Survival Test-7 Day Survival

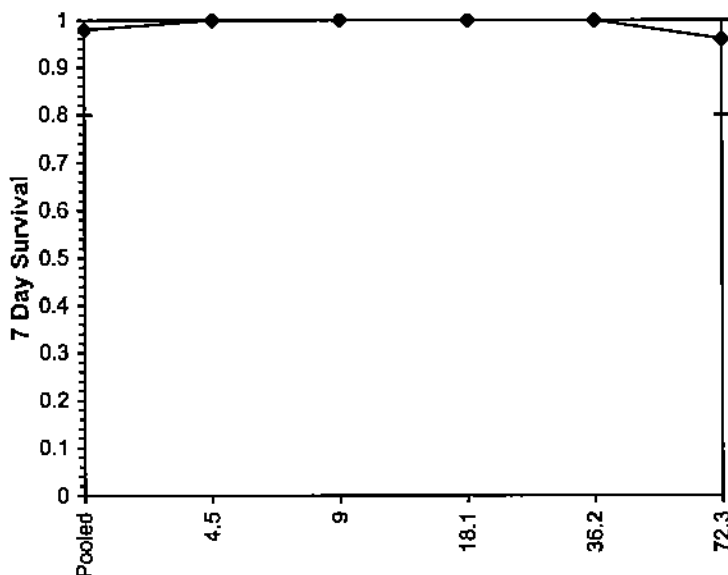
Start Date: 8/22/2003 Test ID: 300439 Sample ID: G-Creek
 End Date: 8/29/2003 Lab ID: BCEVS-EVS Environment Co Sample Type: EFF2-Industrial
 Sample Date: 8/20/2003 Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

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

Conc-%	Mean	SD	Transform: Untransformed					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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



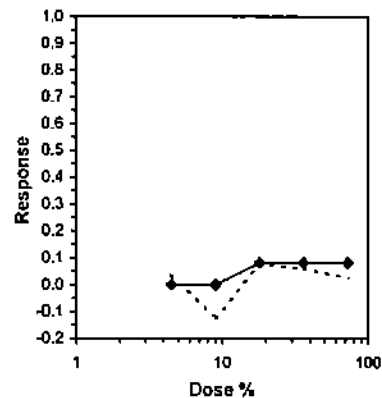
Larval Fish Growth and Survival Test-7 Day Growth (U.S.)			
Start Date: 8/22/2003	Test ID: 300439	Sample ID: G_Creek	
End Date: 8/29/2003	Lab ID: BCEVS-EVS Environment	Sample Type: EFF2-Industrial	
Sample Date: 8/20/2003	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis	
Comments: Azimulh - 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

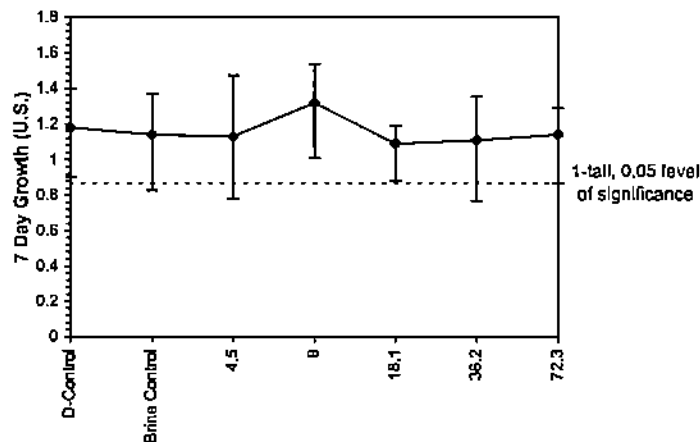
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N		Critical	MSD	Mean	N-Mean
D-Control	1.1752	0.1852	1.1752	0.8980	1.3940	15.756	5				1.2100	1.0000
Brine Control	1.1372	0.2033	1.1372	0.8240	1.3660	17.878	5					
4.5	1.1328	0.2624	1.1328	0.7860	1.4760	23.160	5	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
Dunnell'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

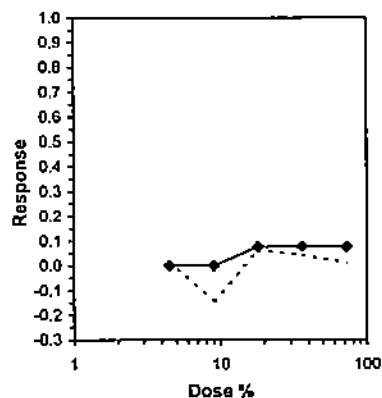


Larval Fish Growth and Survival Test-7 Day Growth (U.S.)					
Start Date:	8/22/2003	Test ID:	300439	Sample ID:	G_Creek
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Cx	Sample Type:	EFF2-Industrial
Sample Date:	8/20/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimulth - 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

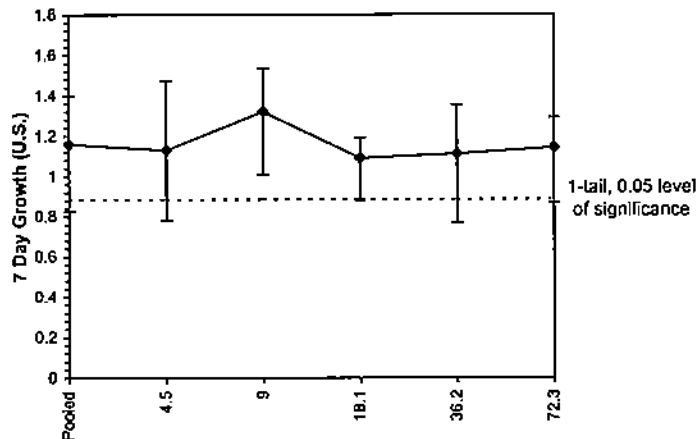
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				Mean	N-Mean
Pooled	1.1562	0.1844	1.1562	0.8240	1.3940	15.950	10				1.2037	1.0000
4.5	1.1328	0.2624	1.1328	0.7860	1.4760	23.160	5	0.213	2.462	0.2711	1.2037	1.0000
9	1.3220	0.2051	1.3220	1.0100	1.5380	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	0.1893	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	15.0563					
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



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 Project No. 09-0302-54
 EVS Work Order No. 0300349

EVS Analysts KMG, SLK
 Test Initiation Date 22 Aug 03

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	<u>Cu RefTox (03-CU-001 100mg/L Cu)</u>		
Amount Received ^{AS} Prepared	<u>1X16</u>		
Date Collected ^{PS} Prepared	<u>18-Apr-03</u>		
Date Received	<u>n/a</u>		
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) µg/L Cu

7-d growth IC50 121 (106-134) 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 135 ± 53 µg/L Cu CV: 19%
136 ± 54 µg/L Cu CV: 20%
 19

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	<u>µg/L Cu</u>	<u>100</u>	<u>320</u>	<u>122 (110-135)</u>		
Growth		<u>56</u>	<u>100</u>		<u>121 (106-134)</u>	<u>96 (31-115)</u>

Other

Data Verified By

Leonardo Tere

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-SA.01
 EVS Work Order No. 0300439

Sample ID Cu REFROX
 Test Species/Batch TOPSMELT / 210803
 Test Initiation Date/Time 22-AUG-03 / 1730
 No. of Organisms/Volume 5 / 200ml

Concentration ($\mu\text{g/L}$)	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			mm	mm	mm	mm	mm	mm	mm	

Sample Description REFROX

Data Verified By Armeda Torg

Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimoth - (Polaris Mine)
 EVS Project No. DA-0302-SA.01
 EVS Work Order No. 0300439

Sample ID Cu REFROX
 Test Species/Batch TOPMELT / 210803
 Test Initiation Date/Time 22 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	
180	A	21	4	2	1	0	—	—	—	
	B	22	2	0	—	—	—	—	—	
	C	23	3	3	2	2	2	1	0	
	D	24	4 ²⁰	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			me	me	me	me	me	me	me	

Sample Description REFROX
 Data Verified By Armeda Tey Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATAClient Azimuth (Polaris Mine)Sample ID Cu RefractorEVS Project No. 09-0302-SA-01Test Initiation Date/Time 22 Aug 03 / 1730EVS Work Order No. 0300439Source/Date Received ABS / 21-Aug-03

Concentration ($\mu\text{g/L}$)	Temperature ($^{\circ}\text{C}$)													
	0	1	2	3	4	5	6	7						
NEG. CTL	20.0	20.0	19.0	20.0	20.0	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	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

Concentration ($\mu\text{g/L}$)	pH													
	0	1	2	3	4	5	6	7						
NEG. CTL	7.8	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	8.0
Tech. Initials	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

WQ Instruments Used: Temp. CARB. Hg THERM.pH IF-A-51

Comments _____

Test Set Up By KMGData Verified By Armeda Lopez 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 Refractor

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 (mg/L)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
NEG ctrl	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	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

Concentration (mg/L)	Dissolved Oxygen (mg/L)													
	0	1	2	3	4	5	6	7						
NEG. ctrl	7.6	7.4	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	7.4	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	7.4	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	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB	KMB

WQ Instruments Used: Salinity II-A-030303

DO II-A-011202

Comments _____

Test Set Up By KMG

Date Verified By Armeds Targ 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. 09-0502-54.01 Sample ID Cu REF-008
 EVS Work Order No. 0300439 Balance Type/Serial Number SNOWBOWS 88211

Sample ID (mg 1-5)	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
NEG. CTRL	A	Cu 1	966.95	973.10	5	5	(967.04)	SK
	B	Cu 2	968.37	973.88	5	5		
	C	Cu 3	968.02	973.93	5	5		
	D	Cu 4	968.18	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	966.96	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 $\leq 10\%$ of organism weight.

Date Verified By Armeds Tare

Date Verified September 22, 2003

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Azimoth (Polaris Mine) Start Date (Day 0) 22-AUG-03
 EVS Project No. 09-0302-54.01 Sample ID Cu LEFTY
 EVS Work Order No. 0300439 Balance Type/Serial Number Sartorius BL211A

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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		SLW
	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.

Date Verified By Armedo Tere

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

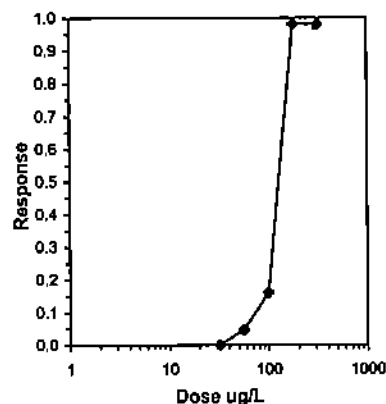
Comments: Azimuth - Polaris Mine; 09-0302-54.01; 0300439

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 Cx	Sample Type:	CU-Copper
Sample Date:	4/18/2003	Protocol:	EPAW 85-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

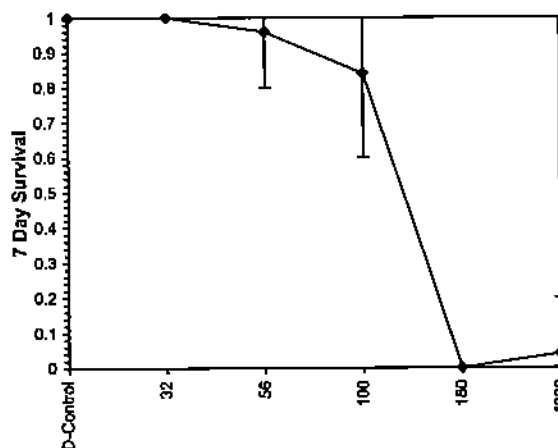
Transform: Arcsin Square Root								Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	17.00	0	25
56	0.8600	0.0894	1.2705	1.1071	1.3453	8.549	5	22.50	17.00	1	22
100	0.8400	0.1673	1.1562	0.8661	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 ($p \leq 0.01$)	0.87628	0.688	-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-Kärber			
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	138.00
Auto-2.0%	121.76	109.89	134.92



Dose-Response Plot



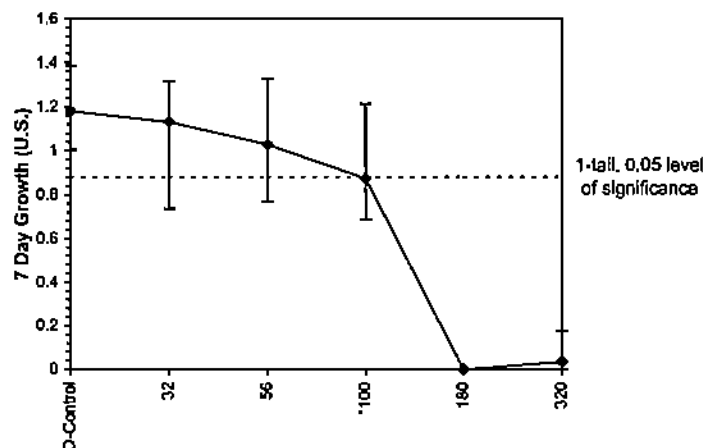
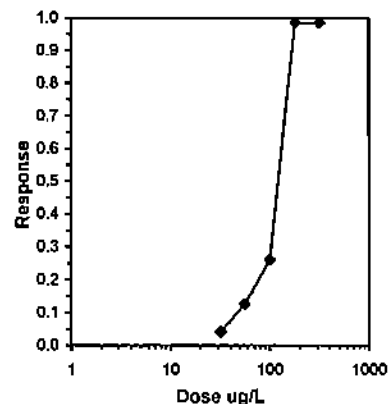
Larval Fish Growth and Survival Test-7 Day Growth (U.S.)					
Start Date:	8/22/2003	Test ID:	RTAACu26	Sample ID:	REF-Ref Toxicant
End Date:	8/29/2003	Lab ID:	BCEVS-EVS Environment Cx	Sample Type:	CU-Copper
Sample Date:	4/18/2003	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	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	0.1780	0.0000	0.0000

Conc-ug/L	Mean	SD	Transform: Untransformed				N	1-Tailed			Isotonic	
			Mean	Min	Max	CV%		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	0.8580
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	0.8880	1.2140	23.788	5	2.290	2.230	0.2998	0.8736	0.7386
180	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	5				0.0178	0.0149
320	0.0352	0.0787	0.0352	0.0000	0.1780	223.607	5				0.0178	0.0149

Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.97905	0.868	-0.0084	-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	58	100	74.8331		0.29959	0.25363	0.09228	0.04512	0.14808	3, 16

Log-Linear Interpolation (200 Resamples)

Point	ug/L	SD	95% CL(Exp)	Skew	
IC05	33.98	18.83	0.00	77.24	0.0739
IC10	47.34	20.32	0.00	91.83	-0.0882
IC15	62.25	20.53	0.00	120.68	-0.0019
IC20	77.18	19.25	11.84	118.54	-0.0781
IC25	95.84	18.91	31.35	115.05	-0.4907
IC40	112.01	8.08	94.87	125.46	-0.5098
IC50	121.49	5.14	108.38	134.11	-0.0182 ug/L cov



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 → 8.3
Dissolved Oxygen (mg/L) 10.4 → 8.4
Conductivity (µmhos/cm) 9570
Salinity (ppt) 5 → 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

Armedo Tor

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 Dendroaster excentricus
 EVS Work Order No. 0300440 Source/Date Received M-REP / Aug 23, 2003
 Logbook # 13 Pages 43-48 Test Duration 10:10

Sample ID	Conc/Rep Y. U/V	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
G Creek						
	SW C+1	15.5	7.9	29	8.1	
	Brine C+1	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.		RSO	RSO	RSO	RSO	

WQ Instruments Used: Temp. Calibrated H₂ Thermometer pH IIA 51 Salinity IIA 030304 DO IIA 011202
 Data Verified By Annexa Tery 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		JGh
	B	50	50		↓
	C	52	49		↓
	D	54	46		↓
BRINE CONTROL	A	51	49		JGh
	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

Armeda Terry

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. 03 00 440
 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		JGh
	B	40	60		↓
	C	29	71		↓
	D	45	55		↓
9.1	A	36	64		JGh
	B	28	72		↓
	C	33	67		↓
	D	25	75		↓
18.2	A	22	78		JGh
	B	24	76		↓
	C	18	82		↓
	D	20	80		↓
36.5	A	12	88		JGh
	B	8	92		↓
	C	7	93		↓
	D	10	90		↓
73	A	1	99		JGh
	B	0	100		↓
	C	2	98		↓
	D	0	100		↓
	A				
	B				
	C				
	D				

Data Verified By

Armedo Tey

Date Verified

September 18, 2003

Test: SC-Sperm Cell Fertilization test

Species: DE-Dendraster excentricus

Sample ID: G CREEK 082003

Start Date: 8/22/2003 16:39

End Date: 8/22/2003

Test ID: 0300440

Protocol: EPS1/RM/27-EC 92 (Sperm Cell)

Sample Type: EFF2-Industrial

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)

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-Dendroaster excentricus	
Comments:	Azimuth Consulting Group (Polaris), 09-0302-54 (0300440)				

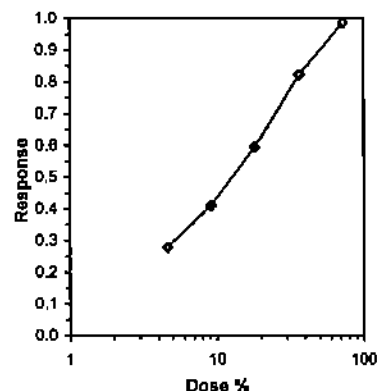
Conc-%	1	2	3	4
D-Control	0.5100	0.5000	0.5149	0.5400
B-Control	0.5100	0.5200	0.5000	0.5100
4.6	0.3500	0.4000	0.2900	0.4500
9.1	0.3800	0.2800	0.3300	0.2500
18.2	0.2200	0.2400	0.1800	0.2000
36.5	0.1200	0.0800	0.0700	0.1000
73	0.0100	0.0000	0.0200	0.0000

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	0.1782
*73	0.0075	0.0096	0.0855	0.0500	0.1419	51.910	4	22.013	2.410	0.0784	0.0075	0.0145

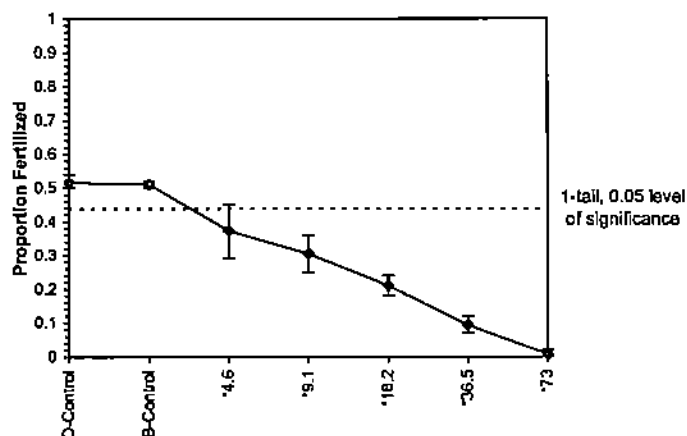
Auxiliary Tests					Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.98646	0.884	-0.0081	-0.3462
Bartlett's Test indicates equal variances (p = 0.38)					5.27856	15.0863		
The control means are not significantly different (p = 0.53)					0.65859	2.44691		
Hypothesis Test (1-tail, 0.05)					NOEC	LOEC	ChV	TU
Dunnnett'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	12.669	1.264	7.929	16.074	-0.6849

* Indicates IC estimate less than the lowest concentration



Dose-Response Plot



Statistical comparisons were against the D-Control only

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 02 (Sperm (	Test Species:	DE-Dendroaster excentricus
Comments:	Azimuth Consulting Group (Polaris), 09-0302-S4 (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	

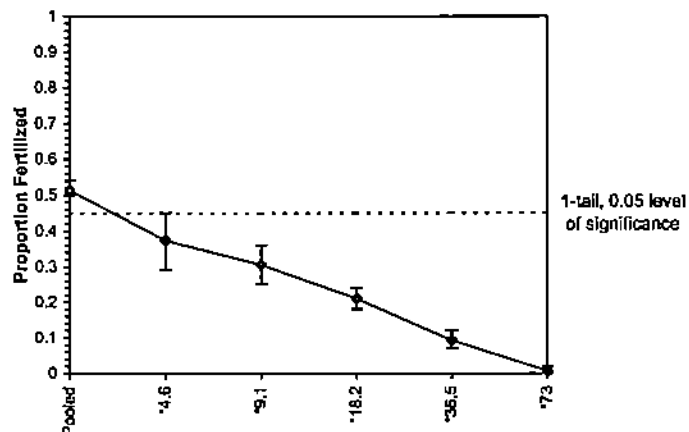
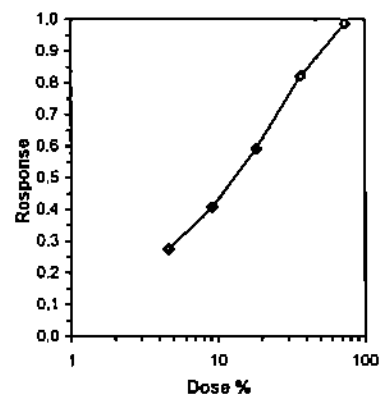
Transform: Arcsin Square Root								1-Tailed		Isotonic		
Conc-%	Mean	SD	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
Pooled	0.5131	0.0128	0.7985	0.7854	0.8254	1.604	8				0.5131	1.0000
*4.6	0.3725	0.0685	0.6554	0.5687	0.7353	10.884	4	5.594	2.508	0.0642	0.3725	0.7260
*9.1	0.3050	0.0493	0.5842	0.5236	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*	0.875	0.329	0.392	2.349	2.8131
IC15*	1.588	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

Point	% (v/v)	Y-axis Value
IC05*	0.369	0.75
IC10*	0.875	0.80
IC15*	1.588	0.85
IC20*	2.516	0.90
IC25*	3.815	0.95
IC40	8.850	0.98
IC50	13.015	1.00

* Indicates IC estimate less than the lowest concentration



Pooled Controls were used for statistical comparisons

Sept 23/03

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY**

Client Azimuth Consulting Group
EVS Project No. 09-0302-54
EVS Work Order No. 0300440

EVS Analysts JGK, PSD
Test Initiation Date August 22, 2003

SAMPLE

TEST SPECIES

Identification SDS Ref Tox Stock Lot #03-5000
Amount ^{Prepared} 1 x 1 L
Date ^{Prepared} 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 ↓

Organism Dendroaster 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)

TEST CONDITIONS

Water Type UV Sterilized, 0.45 µ Filtered SW
Temperature (°C) 16.0
pH 7.9
Dissolved Oxygen (mg/L) 8.1
Salinity (ppt) 29
Other —

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

Shirley Tey

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.		850	850	850	850	

WQ Instruments Used: Temp Calibrated H₂ Thermometer pH HA 51 Salinity HA 030304 DO HA 011202
 Data Verified By Armando Tere Date Verified September 23, 2003

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client Azimuth Consulting Group
 EVS Project No. 09-0302454
 EVS Work Order No. 0300440
 Logbook # 13 Pages 43-48

Test Initiation Date/Time August 22, 2003 / 1639h
 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 <u>SDS</u>					
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	~~100~~ 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 Armedo Terry

Date Verified September 18, 2003

Test: SC-Sperm Cell Fertilization test

Species: DE-Dendraster excentricus

Sample ID: REF-Ref Toxicant

Start Date: 8/22/2003 10:10

End Date: 8/22/2003

Test ID: rtseds7

Protocol: EPS1/RM/27-EC 92 (Sperm Cell)

Sample Type: SDS-Sodium dodecyl sulfate

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)

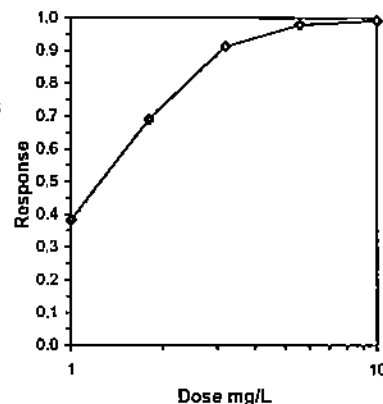
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	8/22/2003 10:10	Test ID:	riscsds7	Sample ID:	REF-Ref Toxicant
End Date:	8/22/2003	Lab ID:	BCEVS-EVS Environment Cx	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm + Test Species:	DE-Dendroaster 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	8.372	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	28.377	2.410	0.0714	0.0050	0.0088

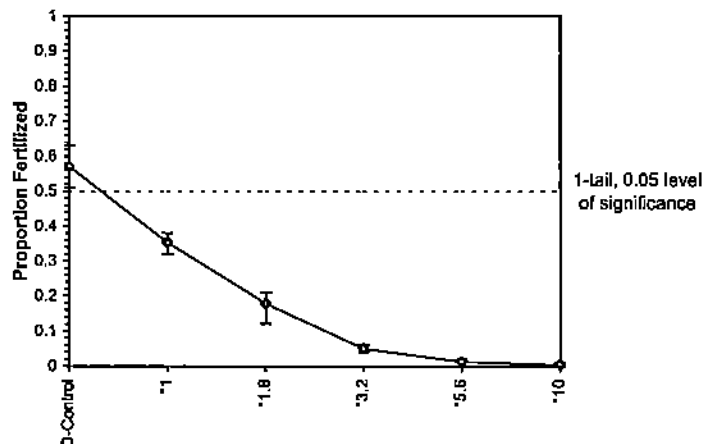
Auxiliary Tests					Statistic	Critical	Skew	Kurt			
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95469	0.884	-0.4898	-0.5931			
Bartlett's Test indicates equal variances (p = 0.46)					4.62079	15.0863					
Hypothesis Test (1-tail, 0.05)		NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	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

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



ART
Sept 18/03

APPENDIX C

Raw Data and Statistical Analyses:

Champia parvula

***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 $\pm 2SD$
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	<i>m moody</i>
Date	<i>sep 2/03</i>



Test Data Summary

SAMPLE		SRC#	<u>P359</u>
Identification/Name	<u>Teck Cominco/Azimuth Consulting Group, Polaris effluent water</u>	Analyst	<u>Mary Moody</u>
Date/Time Received	<u>Aug 22/03 @ 10 am</u>	Date Collected	<u>Aug 19/03</u>
		Temperature Upon Receipt (°C)	<u>13</u>
Test Initiation Date	<u>Aug 22/03</u>	Test Completion Date	<u>Aug 29/03</u>

ORGANISM INFORMATION

Species	<u>Champia parvula</u>	Appearance/Health of <i>Champia</i>	<u>excellent</u>
Source	<u>sexually mature male and female branches, obtained from USEPA, Hatfield Marine Science Center, Newport, Oregon, 1995</u>		
Females, Presence of Trichogynes	<u>yes</u>	Males, Presence of Sori with Spermatia	<u>yes</u>

TEST CONDITIONS

Test Method	<u>USEPA/600/4-91/003, Method 1009.0</u>	Dilution water	<u>Natural seawater from Pacific Environmental Science Centre, North Vancouver B.C.</u>
Test Type	<u>static, non-renewal; 2 day effluent exposure followed by 5-7 day recovery period in control medium for cystocarp development</u>		
Test Vessels (Exposure & Recovery)	<u>270 ml transparent polystyrene cups, transparent polystyrene lids</u>		
Exposure Volume / Depth	<u>100 ml / 4.5 cm</u>	Recovery Volume / Depth	<u>200 ml / 7.3 cm</u>
Replicates/Conc.	<u>3</u>	No. of organisms (female/male)	<u>5/2</u>
Number and Concentrations of Test Solutions (%v/v)	<u>Controls: (two) natural sea water, brine Tests: 71.3, 35.65, 17.83, 8.91, 4.46, 2.23, 1.11%</u>		
Chemicals added to control/dilution water	<u>Test Nutrients as described in method cited at 10 mL/L, analytical grade</u>		

Sample Treatment

D.O. on unadjusted sample salinity adjustment (mg/L)	<u>9.4</u>	D.O. after salinity adjustment (mg/L)	<u>8.0</u>
Aeration (duration/rate)	<u>none</u>	Filtration	<u>none</u>
Salinity Adjustment*	<u>642 mL effluent + 258 mL hypersaline brine + 9 mL test nutrient solution</u>		
Hypersaline Brine for Salinity Adjustment*	<u>Prepared from natural seawater, at 90 ppt salinity</u>		

* 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)	<u>16:8</u>	Agitation of tests and controls during exposure	<u>gentle rotary shaking</u>
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)	<u>13.56 (9.04 - 16.0)</u>	IC ₅₀ (%v/v), (95% CL)	<u>18.8 (13.8 - 25.3)</u>
Mean control cystocarps/female (pooled natural sea water and brine controls)	<u>51.1</u>		
Submitted By:	<u>M. Moody</u>	Date:	<u>Sep 2/03</u>

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



Test Data

Sample Identification Teck Cominco/Azimuth Consulting Group, Polaris effluent water

P359

Concentration % (v/v)		Rep	Mortality		Individual Plant Cystocarp Counts					mean	SD*	Comments
#			#	%	1	2	3	4	5			
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. Mosley

Date:

Sept 10 3

Algal Reproduction Test-Reproduction

Start Date: 8/22/2003	Test ID: CP478FJ	Sample ID: P359
End Date: 8/29/2003	Lab ID: SRC-Saskatchewan Research	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		

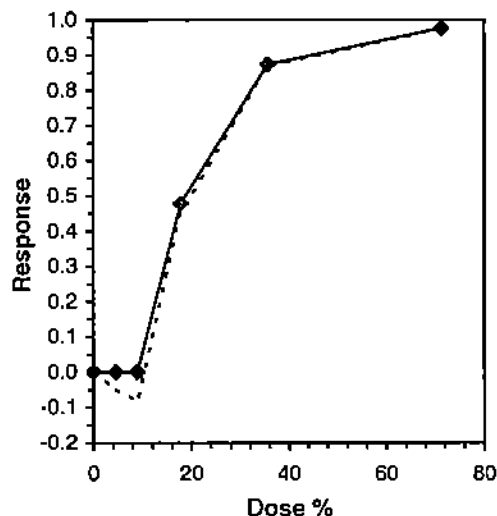
Conc-%	1	2	3	4	5	6
NSW Control	57.4	49.6	44.2			
Brine Control	66.4	44.0	45.2			
4.46	52.2	51.4	57.4			
8.91	61.2	63.6	41.2			
17.83	30.4	34.4	18.6			
35.65	6.6	6.0	7.6			
71.3	0.0	2.4	1.4			

Conc-%	Mean	N-Mean	Transform: Untransformed					t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N		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					8.91	17.83	12.6042	11.2233	14.029	0.27436	1962.38	58.1173	1.2E-07	5, 15
Treatments vs Controls														

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



APPENDIX D

Chain-of-Custody Forms

185 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-888-4331
Fax: 604-882-8548

Randy Baker

Handy Baker

Phone:

Fax:

Sampled By:

Attn: Med Hughes

20 Aug 03

[illegible]

Common Instructions:

Project Title:

Results Needed By:

A) Released By: _____ Date: _____
 Company: _____ Time: _____
 Courier name: _____
 Shipping containers secured by: Type Stamp Lock (circle one)
 Customs seals used? Yes No

B) Received by: **RJW** Date: **22 Aug 03**
 Company: **EVS** Time: **0930**
 Shipping container sealed secure? Yes No
 Custody seals intact? Yes No

C7 Released By: Company:	Date:	Tape		Straps	Lock	Other
	Time:				(circle one)	
Counter name:	_____					
Shipping containers secured by:	Tape		Straps		Lock	
Customs seals used?	Yes	No				

D) Received by:	Date:
Company:	Time:
Shipping containers received secure?	Yes No
Custody seals intact?	Yes No N/A

Receiving Water (RW); Effluent (E); Eutectic (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
Collapsible Canby (CC); Glass Jar (GLJ); Jerry Can (JC); Plastic HDPE (P); Plastic Bucket (PB); Other (Please Specify)
Please note any conditions the lab should be aware of for safety and storage concerns
Assemble (A); Incurable (I); Please print numbers in a broken layout (it will not print) under Comments/Instructions

Expiry Date: Sep. 25, 2000

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





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 :	<u>Polaris Mine</u>
Mine Operator :	<u>Cominco Mining Partnership and Teck Cominco Metals Ltd.</u>
Address :	<u>Bag 2000</u>
	<u>Kimberley, BC</u>
	<u>V1A 3E1</u>
Telephone :	<u>(250) 427-8405 Bruce Donald</u>
E-mail :	<u>bruce.donald@teckcominco.com</u>
Location of Final Discharge point :	<u>Garrow Lake Former Dam at 75o22'32"N, 96o48'37"W.</u>
Reporting Period :	<u>January 1, 2004 to December 31, 2004.</u>
Date of Report :	<u>March 21, 2005.</u>

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 authorities 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 dated 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 <i>Daphnia magna</i> (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"

		Teck Cominco Metals Limited - Polaris Mine					
Facility Name:		(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 (cyanate hydrolysis 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:

¹Original data reports are available upon request

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

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

⁴This analysis is carried out using procedures adapted from "Standard Methods 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).

⁵All 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				
	Garrow Bay at Mouth of Garrow Creek			Garrow Bay ~1km NE of				
Description:	Confluence			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			Teck Cominco Metals Limited -				
FDP Name:	Mine (Little Cornwallis Island)			Polaris Mine (Little Cornwallis			Island)	
Area Name:	Garrow Lake Syphons			Garrow Lake Syphons				
Sampling Date:	Garrow Bay Exposure			Garrow Bay Reference				
Sample Method:	7/27/2004	8/17/2004	8/24/2004	8/17/2004	8/24/2004			
	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 Fluorescence 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 (cyanide hydrolysis 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.

¹Original data reports are available upon request

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

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

⁴This analysis is carried out using procedures adapted from "Standard Methods 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 emissions spectrophotometry ICPOES (EPA Method 6010B).

⁵All 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 Results¹ 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			Mouth of Garrow Creek Confluence			Final Discharge Point		
Sampling Date:		7/7/2004			7/27/2004			8/17/2004		
		RPD ²			RPD ²			RPD ²		
		7/7/2004			7/27/2004			8/17/2004		
Parameters	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

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

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

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

³Distilled 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 Results¹ 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			Distilled Water ³	Distilled Water ³	Distilled Water ³
Sampling Date:		8/24/2004			7/7/2004	7/7/2004	8/17/2004
Parameter							
Parameters	Units			RPD ² (%)			
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

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

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

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

³Distilled 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 Upper Confidence Limit	Notes
		EC25 or IC25	Lower Confidence Limit		
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 O₂ 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:
 - o 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).
 - o 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).
 - o 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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality on the Day of Test						
		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

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Concentration (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality on the Day of Test						
		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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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

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Concentration (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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

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Concentration (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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 (% effluent v/v)	Replicate					Overall Mean	Standard Deviation
	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 (% effluent v/v)	Replicate					Overall Mean	Standard Deviation
	1	2	3	4	5		
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 (% effluent v/v)	Replicate					Overall Mean	Standard Deviation
	1	2	3	4	5		
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 LC₅₀ (95% CL)

- Test 1: 7-d LC₅₀ concentration > 72.6% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 2: 7-d LC₅₀ concentration > 69.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- Test 3: 7-d LC₅₀ concentration > 71.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- Quantal statistic methods not applicable

- iv. Estimate of 7-d IC₂₅ (95% CL) for growth

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- Test 1: 7-d IC₂₅ concentration > 72.6% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Test 2: 7-d IC₂₅ concentration > 69.0% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Test 3: 7-d IC₂₅ concentration > 71.0% effluent (highest concentration tested due to dilution for salinity adjustment)
- v. Current reference toxicity tests (95% CL) for 7-d LC₅₀ for survival and 7-d IC₅₀ 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 LC₅₀ survival = 161mg/L Cu, 95% CL = 139-188mg/L
 - 7-d IC₅₀ 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 LC₅₀ survival = 130mg/L Cu, 95% CL = 115-147mg/L
 - 7-d IC₅₀ 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 LC₅₀ survival = 121mg/L Cu, 95% CL = 107-137mg/L
 - 7-d IC₅₀ growth = 128mg/L Cu, 95% CL = 85-150mg/L
- vi. Reference toxicity warning limits (+/- SD) for 7-d LC₅₀ for survival and 7-d IC₅₀ for growth
- Test 1: Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 137 ± 56mg/L Cu
 - 7-d IC₅₀ growth = 135 ± 51mg/L Cu
 - Test 2: Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 129 ± 48mg/L Cu,
 - 7-d IC₅₀ growth = 130 ± 52mg/L Cu
 - Test 3: Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 132 ± 48mg/L Cu,
 - 7-d IC₅₀ 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° 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
- 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.

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

- 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 – EPS1/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 IC₂₅ (95% CL) for fertilization success
- Test 1: na
 - Test 2: IC₂₅ concentration = 8.7 (7.6 – 9.9)% v/v effluent
 - Test 3: IC₂₅ concentration = 17.5 (11.6 – 22.6)% v/v effluent
 - Quantitative statistic used to generate IC₂₅ 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 IC₅₀ 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

¹NSW = 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

¹NSW = 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

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

(Champia)

- 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 IC₂₅ (95% CL) for cystocarp development
 - Test 1: na
 - Test 2: IC₂₅ concentration = 26.6 (20.8 – 31.5)% effluent v/v
 - Test 3: IC₂₅ 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 IC₅₀ 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
 - IC₅₀ cystocarp development = 1.48mg/L SDS, 95% CL = (1.38 - 1.62) mg/L
 - Reference toxicity warning limits 1.40 (+/- 2SD) for IC₅₀ 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
 - IC₅₀ cystocarp development = 1.48mg/L SDS, 95% CL = (1.38 - 1.62) mg/L
 - Reference toxicity warning limits 1.40 (+/- 2SD) for IC₅₀ for cystocarp development
- v. Reference toxicant warning limits (+/- 2SD) for IC₅₀ 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



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	48-h <i>Daphnia magna</i>
		LC50 (95% CL) (% v/v)	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 Analysts RET, AWD
EVS Project No. 09-0302-S4 Test Type 96h LC50
EVS Work Order No. 0400304 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 CaCO₃) 12
Alkalinity (mg/L as CaCO₃) 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) µg/L SDS
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 µg/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% (u/u)

Data Verified By

Armeda Terry

Date Verified

August 5, 2004

**EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA**

WHOLE SAMPLE WATER QUALITY

Temp. (°C)	Initial	pH Adjustment ¹	After 30-min Pre-aeration
	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".

Client Ar. muth (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 C7-Creek acute 070704
 Date/Time Collected July 7/04
 Test Initiation Date/Time July 12/04 @ 1445

Total Pre-Aeration Time 30 min

Concentration % (w/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	15.0	15	7.4	7.3	7.0	7.2	7.1	37	43
6.25				16	10	10	10	10.1	9.5	9.6	9.7	9.8	15.0	15.0	15.0	15.0	15	7.6	7.3	7.1	7.1	7.2	1520	540
12.5				10	10	10	10	10.1	9.6	9.3	9.7	9.9	14.5	15.0	15.0	15.0	15	7.8	7.5	7.3	7.4	7.7	2270	2100
25				10	10	10	10	10.1	9.7	9.8	9.6	9.9	14.5	15.0	15.0	15.0	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	15.0	15	8.0	7.8	7.7	7.8	7.9	6070	6220
100				10	10	10	10	10.1	9.8	9.8	9.7	9.9	14.0	15.0	15.0	15.0	15	8.1	8.3	8.2	7.9	8.1	11730	11840
Technician Initials				1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274	1274

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 1274 Date Verified By 1274 Date Verified July 30, 2004

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* TOXICITY TEST DATA SUMMARY

Client A2imuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400307

EVS Analysts AKN, JRY
Test Type 48hr - LC50
Test Initiation Date July 11, 2004

SAMPLE INFORMATION

Identification G-Creek. 070704

Amount Received 1 x 2L subsampled from 2 x 20L @ EVS

Date Collected July 7, 2004

Date Received 10 July 2004

Temperature (°C) 22.0 → 20.0

pH 7.9 → 7.8

Dissolved Oxygen (mg/L) 11.4 → 9.1

Conductivity (μmhos/cm) 11850

Hardness (mg/L as CaCO₃) 1440

Alkalinity (mg/L as CaCO₃) —

Ammonia (mg/L N) —

Chlorine (mg/L Cl) —

pH adjustment details: None.

Pre-aeration rate and duration: ① aerated 8min

DILUTION/CONTROL WATER (initial water quality)

Water Type Moderately Hard H₂O (July 7B)

Temperature (°C) 20.0

pH 8.0

Dissolved Oxygen (mg/L) 9.1

Conductivity (μS/cm) 357

Hardness (mg/L as CaCO₃) 98

Alkalinity (mg/L as CaCO₃) 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 4.8% 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) μg/L Zn

Reference Toxicant Warning Limits (mean ± 2SD) and CV

462 ± 315 μg/L Zn % CV = 34

TEST CONDITIONS

Temperature Range (°C) 20.0 - 21.5

pH Range REA 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 Armeds Top

Date Verified August 5, 2004

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimuth - Polaris
 EVS Project No. 09-0302-S4
 EVS Work Order No. 0400307
 Daphnid Broodstock Batch June 15A

Sample ID G-Creek. 070704
 Date Collected July 7, 2004
 Test Initiation Date/Time July 11th/04 @ 1400
 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
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				mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm

Sample Description Clear colourless
 WQ Instruments Used: Temp. Calibrated Hg Thermometer pH II-A-20502 DO II-A-011201 Cond. II-A-990901
 Comments _____

Test Set Up By AKN Data Verified By Armeda Tere Date Verified August 5, 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	48-h <i>Daphnia magna</i>
		LC50 (95% CL) (% v/v)	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

Tel: 604.986.4331

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, AWJ
Test Type 48h LC50
Test Initiation Date July 30, 2004

SAMPLE INFORMATION

Identification G-Creek 270704

Amount Received 3F²² 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 CaCO₃) 590

Alkalinity (mg/L as CaCO₃) —

Ammonia (mg/L N) —

Chlorine (mg/L Cl) —

pH adjustment details: none

Pre-aeration rate and duration: 10 minutes
gentle aeration

DILUTION/CONTROL WATER (initial water quality)

Water Type Moderately Hard Water (July 27)

Temperature (°C) 20.0

pH 7.8

Dissolved Oxygen (mg/L) 9.1

Conductivity (µS/cm) 363

Hardness (mg/L as CaCO₃) 96

Alkalinity (mg/L as CaCO₃) 56

Other —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture) July 28

Age (on Day 0) < 24 hrs.

Days to First Brood 7

Avg. Young/Brood (after 1st brood) 24

% Mortality in 7 d Before Test 6%

Reference Toxicant Zinc

Current Reference Toxicant Result

Reference Toxicant Test Date 27-Jul-04

48-h LC50 and 95% CL 683 (578-807) µg/L Zn

Reference Toxicant Warning Limits (mean ± 2SD) and CV

463 ± 315 µg/L Zn % CV = 39

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 W. H. H. 4

Date Verified Sept-10-04

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimuth (Polaris)
 EVS Project No. 09-0302-5401
 EVS Work Order No. 0400348
 Daphnid Broodstock Batch July 2B

Sample ID G-Creek 270704
 Date Collected July 27, 2004
 Test Initiation Date/Time July 30, 2004 @ 14:00
 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	9.1	8.9	8.7	20.0	21.0	21.0	7.8	7.9	7.9	363	374
6.25				10	10	9.0	8.5	8.6	20.5	21.0	21.0	7.8	7.8	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																

Sample Description Clear, colourless
 WQ Instruments Used: Temp. ^{Calibrated} Hg Thermometers pH IL-A-030533 DO IL-A-011201 Cond. IL-A-990901
 Comments _____

Test Set Up By JR24 Data Verified By [Signature] Date Verified Sept 8/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client Azimuth
EVS Project No. 09-0302-S4
EVS Work Order No. 0400340 342
RSO

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 CaCO₃) 16
Alkalinity (mg/L as CaCO₃) 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) 30-4865 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 Jan 17/04

Date Verified Sept. 10/04

EVS ENVIRONMENT CONSULTANTS RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

Temp. (°C)	pH	Initial	pH Adjustment ¹	After 30-min Pre-aeration
14				14
7.6				7.7
10.1				10.1
4870				4870

1. Document pH adjustment procedure (if used) under "Comments".

Client Polaris Aquatics
EVS Project No. 09-0302-54
EVS Work Order No. 0400842342
Trout Batch No. and 7-d Acclimation Mortality 070504/0.25%
No. Fish/Volume 10/10L
Sample ID G-Guck
Date/Time Collected July 27-04 08:45 2130
Test Initiation Date/Time Aug 1-04 10:30

Total Pre-Aeration Time 30 min

Concentration % (w/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	24	48	72	96
Control			10	10	10	10	10	10.1	9.8	9.6	9.7	9.9	14	14	14	14	14	6.8	7.1	7.4	7.2	7.3	30	30	30	41	
6.25			10	10	10	10	10	10.1	9.8	9.6	9.7	9.9	14	14	14	14	14	7.1	7.4	7.5	7.4	7.2	3300	3200	540		
12.5			10	10	10	10	10	10.1	9.6	9.6	9.7	9.6	14	14	14	14	14	7.4	7.4	7.7	7.5	7.2	900	900	940		
25			10	10	10	10	10	10.1	9.7	9.7	9.6	9.6	14	14	14	14	14	7.5	7.9	8.0	7.6	7.4	1670	1670	160		
50			10	10	10	10	10	10.1	9.9	9.8	9.7	9.7	14	14	14	14	14	7.6	8.0	7.9	7.8	7.9	4800	4800	210		
100			10	10	10	10	10	10.1	9.7	9.7	9.7	9.7	14	14	14	14	14	7.7	8.1	8.2	8.3	8.1	4870	4870	450		
Technician Initials																											

WQ Instruments Used: Temperature Calibrated Hg Thermometer pH II-A-030202 DO II-A-3 Conductivity II-A-030306
Sample Description Clear
Comments

Test Set Up By M Data Verified By Chad H K Date Verified Sept. 10/04

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.

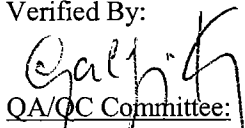
Sample ID	Sample Date (Time h)	96-h Rainbow Trout	48-h <i>Daphnia magna</i>
		LC50 (95% CL) (% v/v)	LC50 (95% CL) (% v/v)
G-Creek acute 081704	24-Aug-04 (1500h)	>100	>100

Should you have any questions or comments regarding this report, please do not hesitate to contact the undersigned at 604-986-4331.

Sincerely,


For: 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 AND
Test Type 48 hr 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 @ 22.0
pH 7.8 @ 8.1
Dissolved Oxygen (mg/L) 10.2 @ 8.7
Conductivity (µmhos/cm) 9320
Hardness (mg/L as CaCO₃) 1220
Alkalinity (mg/L as CaCO₃) —
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 CaCO₃) 84
Alkalinity (mg/L as CaCO₃) 50
Other —

TEST SPECIES INFORMATION

Broodstock Culture ID (in-house culture) Aug 6A
Age (on Day 0) <24 hrs
Days to First Brood 7
Avg. Young/Brood (after 1st brood) 21
% Mortality in 7 d Before Test 0
Reference Toxicant Zn
Current Reference Toxicant Result

Reference Toxicant Test Date August 24, 2004
48-h LC50 and 95% CL 536(438-656) µg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
481 ± 322 µg/L 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 Qualifit Date Verified Nov. 16/04

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimuth (Pobris)
 EVS Project No. 09-1108-01.01
 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	353*
6.25				10	10	9.0	8.7	8.7	20.5	21.5	21.5	8.0	7.6	7.7	919	921
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	2850
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				^	^	pm	^	^	pm	^	^	pm	^	^	pm	^

Sample Description clear, colourless
 WQ Instruments Used: Temp. Calibrated HS Thermometer pH II-A-000501 DO II-A-011201 Cond. II-A-990901
 Comments _____

Test Set Up By JRY Data Verified By Qualifit Date Verified Nov. 16/04

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client Azimuth (Polaris)
EVS Project No. 09-0302-54
EVS Work Order No. 0400382

EVS Analysts AND, RTH
Test Type 96-h LCSO
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 CaCO₃) 16
Alkalinity (mg/L as CaCO₃) 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 est
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 LCSO was estimated to be >100% (w/o)

Data Verified By Opal pth

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 072804/096
 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	416	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	7.4	7.4	7.4	556	601
12.5				10	10	10	10	10.1	9.9	9.8	9.3	9.6	15	15	15	15	15	7.6	7.5	7.8	7.5	7.6	1030	1054
25				10	10	10	10	10.1	9.9	9.9	9.1	9.5	15	15	15	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	15	15	15	15	7.7	7.8	7.8	7.6	7.7	3950	3983
100				10	10	10	10	10.1	9.9	9.9	9.6	9.5	15	15	15	15	15	7.7	7.8	7.9	7.8	7.8	7416	7533
Technician Initials																								

WQ Instruments Used: Temperature Calibrated Hg Thermo pH II-A-020601 DO II-A-3 Conductivity II-A-030306
 Sample Description rest clear with slight cloudy
 Comments

Test Set Up By REH Data Verified By Qualif Date Verified Nov. 16/04

CHAIN-OF-CUSTODY/TEST REQUEST FORM



195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-966-4331
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: ANIMUS CONSULTING, INC. Client Contact Name: Phyllis Markham/Billy Dwyer Ship to: EVS Environment Consultants
Address: 100-1100 West Broadway Phone: 604-734-1220 195 Pemberton Ave.
Vancouver BC, V6R 2G8 Fax: 604-734-9070 North Vancouver, BC, V1P 2R4 Shipping Date: Aug. 26, 2004
Sampled By: Brenda Beale/C. Markham Attn: Edmond Cassia

Collection Date (dd/mm/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)	4 Receipt Sample Temp. (°C)	5 Condition/Integrity	EVS Receipt Check List
								RAINBOW TANK	GLASS JAR	JERRY CAN	PLASTIC HDPE	PLASTIC BUCKET	OTHER				
19/AUG/04 15:00		G-CORE 02704	E	✓	5-2000L		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	EVS Project #: <u>09-1103-01</u> EVS Workorder #: <u>040035 / 383 / 384 / 385</u> Sample Storage Location: <u>4°C</u> ☒ 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, IDs)? ☐ 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? ☐ Y ☐ N Sample containers originate from EVS: ☐ Yes ☒ No

PO/Reference No.: 11-05-03 Comments/Instructions:
Project Title: Black River
Results Needed By:

A) Released By: <u>Markham</u> Date: <u>19 Aug 2004</u> Company: <u>ANIMUS</u> Time: <u>15:00</u> Courier name: <u>Billy Dwyer</u> Shipping containers secured by: <u>Tape</u> <u>Straps</u> <u>Lock</u> <u>Other</u> Custody seals used? Yes No <u>CHEMICAL STRAPS</u>	B) Received by: <u>AXI</u> Date: <u>19 AUG 04</u> Company: <u>EVS</u> Time: <u>0945</u> 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: <u>Tape</u> <u>Straps</u> <u>Lock</u> <u>Other</u> Custody seals used? Yes No <u>(circle one)</u>	D) Received by: _____ Date: _____ Company: _____ Time: _____ Shipping containers received secure? Yes No Custody seals intact? Yes No <u>N/A</u>

- 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 E

Sublethal Toxicity Testing Laboratory Reports

September 2004

LABORATORY REPORT

Azimuth Consulting Group
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

July 10, 2004

PREPARED FOR:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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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ACKNOWLEDGEMENTS

Toxicity testing was conducted by Andy Diewald, Anja Fouche, Keven Goodearle, Ann-Marie Norris and Jenny Shao. Statistical analyses were performed 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 <i>Artemia</i> 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 $\pm$ 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
D-Control	96.0 $\pm$ 8.9	0.93 $\pm$ 0.18
Brine Control	96.0 $\pm$ 8.9	1.08 $\pm$ 0.17
Pooled Controls	96.0 $\pm$ 8.4	1.00 $\pm$ 0.18
4.5	100 $\pm$ 0.0	1.00 $\pm$ 0.08
9.1	100 $\pm$ 0.0	1.04 $\pm$ 0.09
18.2	100 $\pm$ 0.0	0.96 $\pm$ 0.09
36.3	96.0 $\pm$ 8.9	1.10 $\pm$ 0.15
72.6	92.0 $\pm$ 11.0	0.99 $\pm$ 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 SUMMARYClient PAZIMUTH (POLARIS MINE)EVS Analysts KMG, AKW, HWD, AXF, JXSEVS Project No. 09-0302-S4EVS Work Order No. 0400303Test Initiation Date 10-Jul-04

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-CREEK 070707	-	-
Amount Received		-	-
Date Collected		-	-
Date Received	10-Jul-04	-	-
Temperature (°C)	19.5 $\rightarrow$ 19.0	-	-
pH	8.1 $\rightarrow$ 8.0	-	-
DO (mg/L)	9.3 $\rightarrow$ 7.9	-	-
Conductivity (μ mhos/cm)	11600	-	-
Salinity (ppt)	7 $\rightarrow$ 28	-	-
Ammonia (mg/L N)	-	-	-
Chlorine (mg/L Cl)	-	-	-
Other	-	-	-

DILUTION/CONTROL WATER (initial water quality)

Water Type UN STERILIZED FILTERED SEA H₂OTemperature (°C) 20.0pH 8.0Dissolved Oxygen (mg/L) 7.6Salinity 28

TEST CONDITIONS

Temperature Range (°C) 19.0 - 21.0pH Range 7.8 - 8.3Dissolved Oxygen Range (mg/L) 6.1 - 7.9Salinity (ppt) 28 - 31Photoperiod (L:D h) 16:8Aeration Provided? NOOther -

TEST SPECIES INFORMATION

Source AQUATIC BIO SYSTEMS (ABS)Date Received 08-Jul-04Age (on Day 0) 11dReference Toxicant Cu

Current Reference Toxicant Result (incl. 95% CL)

Reference Toxicant Test Date 10-Jul-047-d survival LC50 161 μ g/L Cu + 95% CI (139.138)7-d growth IC50 147 μ g/L Cu (119-169)Reference Toxicant Warning Limits (mean $\pm$ 2SD) and CV7-d survival LC50 131 μ g/L Cu $\pm$ 28% CV = 21%7-d growth IC50 135 μ g/L Cu $\pm$ 26% CV = 19%① SAL. ADJ. TO 30 ± 2 ppt.

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 Gail HDate Verified August 18/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Peters Mine)
 EVS Project No. 09-0302-S4
 EVS Work Order No. 0400303

Sample ID G-CREEK-70704
 Test Initiation Date/Time 10-Jul-04 / 1730h
 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		
Nitri. Cn	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
Bene. Cn	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	20.0	21.0	20.0	21.0	20.0	20.5	20.0	21.0	20.5
Tech. Initials	ent	A	A	A	A	A	JLJ	JLJ	JLJ	A	A	JLJ	JLJ	A

Concentration (% v/v)	pH													
	0	1	2	3	New 4		5	6	7					
Nitri. Cn	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
Bene. Cn	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	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	ent	A	A	A	AXF	A	JLJ	JLJ	JLJ	A	A	JLJ	JLJ	A

WQ Instruments Used: Temp. CAL. Hg THERM. pH II-A-030301
 Comments _____

Test Set Up By ent Data Verified By Qualifit Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client AZIMUTH (POLARIS Mine)
 EVS Project No. 09-0302-S4
 EVS Work Order No. 0406303

Sample ID G-CREEK-070704
 Test Initiation Date/Time 10-JUL-04 / 1730h
 Source/Date Received ABS / 08-JUL-04

Concentration (% v/v)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Neg. Ctrl	28	30	28	28	28	28	28	29
Beine Ctrl	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	umb	AL	~	~	JLJ	~	JLJ	~

Concentration (% v/v)	Dissolved Oxygen (mg/L)													
	0	1	2	3	N2O4		5	6	7					
Neg. Ctrl	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
Beine Ctrl	7.6	7.6	7.5	7.5	6.2	7.5	6.2	7.5	6.6	7.5	6.9	7.5	6.6	6.6
4.5	7.4	7.6	7.3	7.4	6.1	7.4	6.2	7.6	6.6	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	6.9	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	7.2	6.4	7.6	6.2	7.6	6.5	7.4	6.8	7.6	6.6	6.7
Tech. Initials	umb	AL	AL	AL	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 umb Data Verified By Qualifit Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth (POLARS MINE)
 EVS Project No. 09-0302-S4
 EVS Work Order No. 0403303

Sample ID 6th 67-0222-07070f
 Test Species/Batch A. AFFINIS / 6-29-04
 Test Initiation Date/Time 10-22-04 / 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	
Net. Ctrl.	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. Ctrl.	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	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		JCS	AM	AK	(2)	(2)	JCS	JCS	m	

Sample Description LIGHT GREEN TRANSPARENT, NO ODOR.
 Data Verified By Gulphik Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth (Powers Mine)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400303

Sample ID GT-CREEK - 070704
 Test Species/Batch A. AFFINIS / 6 04.04
 Test Initiation Date/Time 10-30-07 / 1730h
 No. of Organisms/Volume 5 / 200ml

Concentration (% S/L)	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		Taj	A	W/m	J-S	J-S	J-S	J-S	~	

Sample Description LIGHT GREEN, TRANSPARENT, NO COLOUR.
 Data Verified By Qualifit Date Verified August 17/09

**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 5 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.
Cell	A	T 1	1265.92	1271.98	5	5		127
	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 Cell	A	T 6	1275.52	1281.17	5	5		127
	B	7	1262.43	1266.70	5 84	4		
	C	8	1261.98	1268.48	5	5		
	D	9	1264.82	1270.38	5	5		
	E	✓ 10	1262.05	1267.02	5	5	confirmed: 1270.27 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 Galt H

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 F.d Survival and Growth
 Test Species Atherinops affinis (Topsmelt)
 Start Date (Day 0) July 10-04
 Sample ID G 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		JCS
↓	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		JCS
↓	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 Gaeliff

Date Verified August 17/04

**EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA**

Client Azinuth (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 Creek - 070704

Sample ID % (S/D)	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
18.2	A	T 21	1257.35	1262.90	5	5		JCS
↓	B	22	1273.94	1278.48	5	5	confirmed: 1273.26. ✓	↓
	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	T 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	1265.87	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 Gaith

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 F.d Survival and Growth
 Test Species Aequidens affinis (Topsmelt)
 Start Date (Day 0) July 10-04
 Sample ID G-Creek-070704

Sample ID 90 (90)	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	A	T 31	1251.66	1256.44	5	5	confirmed: 1256.42 mg	JCS
↓	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	✓ 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 Galtik

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

Quail
August 18/04

Larval Fish Growth and Survival Test-7 Day Survival

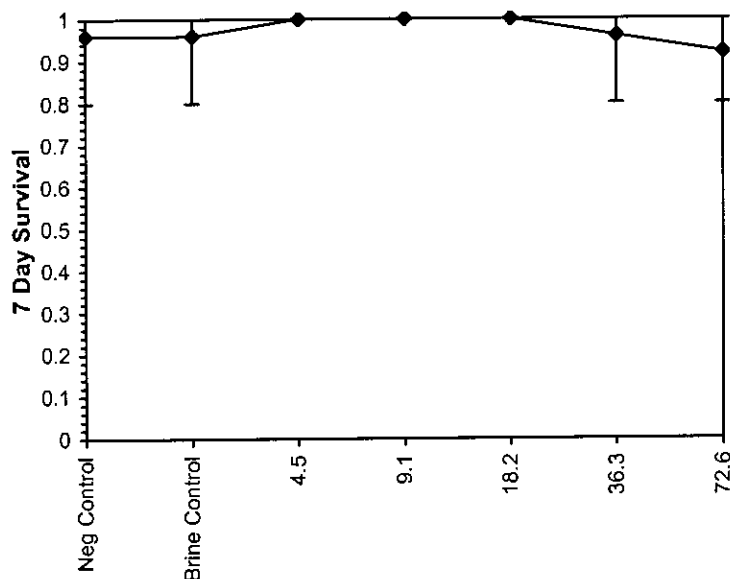
Start Date: 7/10/2004	Test ID: 400303	Sample ID: G-Creek-070704
End Date: 7/17/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth(Polaris Mine)09-0302-54; 0400303		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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 against the Neg Control only

Larval Fish Growth and Survival Test-7 Day Survival

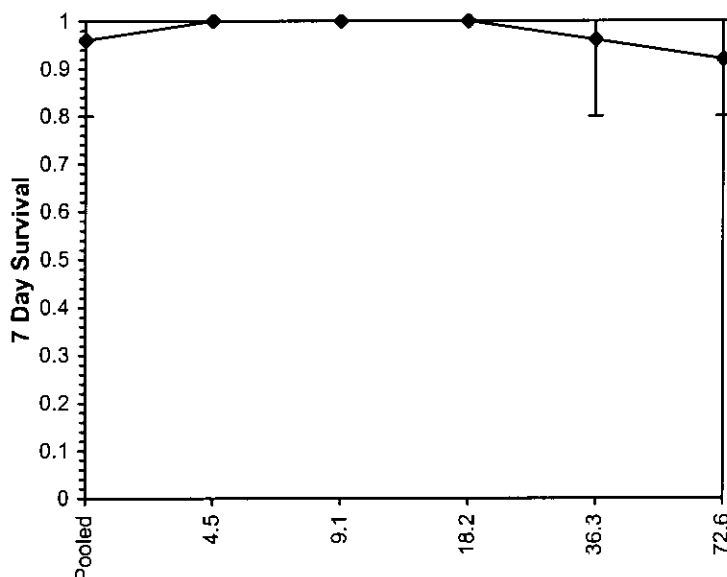
Start Date: 7/10/2004	Test ID: 400303	Sample ID: G-Creek-070704
End Date: 7/17/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth(Polaris Mine)09-0302-54; 0400303		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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

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				

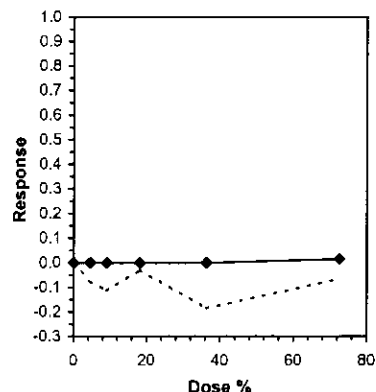
Conc-%	1	2	3	4	5
Neg Control	1.2120	1.0040	0.7980	0.7880	0.8460
Brine Control	1.1300	0.8540	1.3000	1.1120	0.9940
4.5	0.9500	0.9440	0.9500	1.1360	1.0260
9.1	1.0520	1.0060	0.9040	1.0820	1.1360
18.2	1.1100	0.9080	0.9340	0.9140	0.9160
36.3	1.0560	1.2980	0.9260	1.0120	1.2220
72.6	0.9560	1.3320	0.8120	0.8060	1.0460

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				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

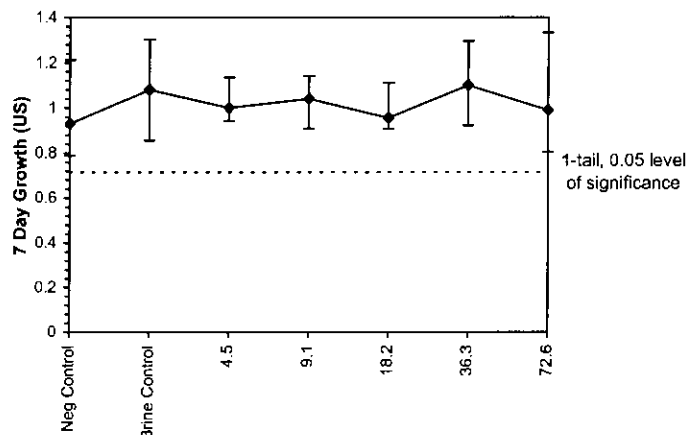
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.93465	0.9	0.85573	0.53805
Bartlett's Test indicates equal variances ($p = 0.27$)	6.38263	15.0863		
The control means are not significantly different ($p = 0.21$)	1.35465	2.30601		

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			



Dose-Response Plot



Statistical comparisons were against the Neg Control only

Qaliph
August 18/04

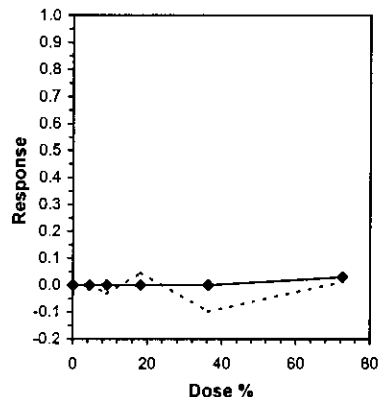
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	7/10/2004	Test ID:	400303	Sample ID:	G-Creek-070704
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth(Polaris 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

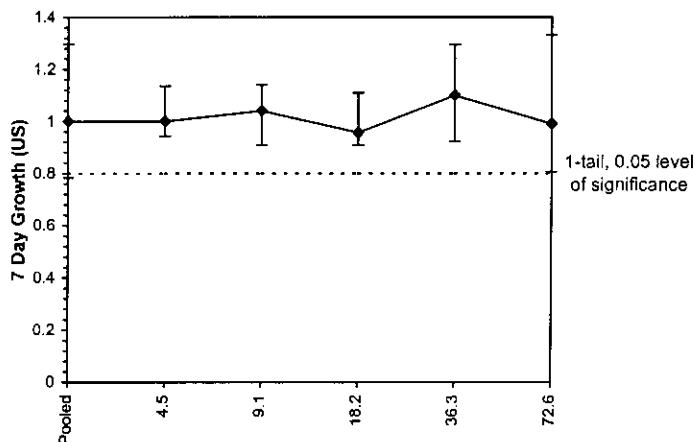
Conc-%	Mean	SD	Transform: Untransformed				N	1-Tailed			Isotonic	
			Mean	Min	Max	CV%		t-Stat	Critical	MSD	Mean	N-Mean
Pooled	1.0038	0.1811	1.0038	0.7880	1.3000	18.038	10				1.0200	1.0000
4.5	1.0012	0.0826	1.0012	0.9440	1.1360	8.252	5	0.031	2.462	0.2040	1.0200	1.0000
9.1	1.0360	0.0876	1.0360	0.9040	1.1360	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			



Dose-Response Plot



Statistical comparisons were against the Pooled controls

Quality
August 18/04

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, AVF, JXS
 Test Initiation Date 10-Jun-04

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	<u>Cu Refresher (04-Cu-001)</u>	-	-
Amount Received ^{RECEIVED}	<u>1 x 1L</u>	-	-
Date Collected ^{RECEIVED}	<u>15-MAR-04</u>	-	-
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 UNSTABILIZED FILTERED SEA H₂O
 Temperature (°C) 20.0
 pH 8.0
 Dissolved Oxygen (mg/L) 7.6
 Salinity 28

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 - 30
 Photoperiod (L:D h) 16:8
 Aeration Provided? NO
 Other -

TEST SPECIES INFORMATION

Source Aquatic Bio Systems (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 10-JUL-04
 7-d survival LC50 143 µg/L Cu (139-133)
 7-d growth IC50 147 µg/L Cu (119-169)

Reference Toxicant Warning Limits (mean ± 2SD) and CV
 7-d survival LC50 137 µg/L Cu ± 23⁵⁰ (CV = 21%)
 7-d growth IC50 135 µg/L Cu ± 26⁵⁰ (CV = 19%)

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	<u>µg/L Cu</u>	<u>100</u>	<u>180</u>	<u>161 (139-183)</u>		
Growth		<u>100</u>	<u>180</u>		<u>147 (119-169)</u>	<u>101 (63-133)</u>

Other -

Data Verified By Qualifit Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimut (Pouébo Mine)
 EVS Project No. 09-0302-SY
 EVS Work Order No. 0400303

Sample ID Cu Restox
 Test Initiation Date/Time 10-Jul-04 / 1715h
 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	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
32	20.0	20.0	19.5	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
56	20.0	20.0	19.5	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
100	20.0	20.0	19.5	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
180	20.0	20.0	19.5	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
320	20.0	20.0	19.5	20.0	20.0	20.5	20.0	20.0	20.0	20.5	20.0	20.0	20.0	20.0
Tech. Initials	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW

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	7.9	8.0	7.9	7.9
Tech. Initials	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW	AKW

WQ Instruments Used: Temp. CAL. Hg THERM. pH I-A-030301
 Comments _____

Test Set Up By AKW Data Verified By Qualifit Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Polaris Mine)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400303

Sample ID Cu Refox
 Test Initiation Date/Time 10-Jul-04 / 1715h
 Source/Date Received ABS / 08-Jul-04

Concentration (µg/L Cu)	Salinity (ppt)							
	0	1	2	3	4	5	6	7
Ctrl	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	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>

Concentration (µg/L Cu)	Dissolved Oxygen (mg/L)													
	0	1	2	3	New 4.21	5	6	7						
Ctrl	7.6	7.6	7.5	7.5	5.4	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	6.6	6.7
56	7.6	7.6	7.4	7.5	6.7	7.4	6.5	7.6	6.6	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	6.7	7.6	6.7	6.6
Tech. Initials	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>	<u>AKW</u>

WQ Instruments Used: Salinity II-A-030306 DO II-A-3 / II-A-011202
 Comments _____

Test Set Up By AKW Data Verified By Qualifit Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimut (Peters Mine)

Sample ID Cu LEFTX

EVS Project No. 09-0302-54

Test Species/Batch A. AFFINIS / 6.29.04

EVS Work Order No. 0400303

Test Initiation Date/Time 10-Jul-04 / 1715h

No. of Organisms/Volume 5 / 200 mL

Concentration (mg/L Cu)	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
CN	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	4	4	
	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	3	3	
	E	T55	5	5	5	5	5	5	5	
Technician Initials		TJ	AW	AW	AW	TJ	TJ	TJ	AW	

Sample Description CLEAR, COLORLESS, ODOURLESS

Data Verified By AW

Date Verified August 17/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimuth (Pacaris Mine)
 EVS Project No. C9-0302-S4
 EVS Work Order No. 0400303

Sample ID Cu Deftox
 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	
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		TLS	AW	APC	N	TLS	TLS	TLS	N	

Sample Description CLEAR, COLORLESS, ODDLESS
 Data Verified By Qualifit 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 Acharinops affinis (Topsmelt)
 Start Date (Day 0) July 10-04
 Sample ID Cu Ref tot

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								
320	A	T61	1255.61	—	0	0		ms
↓	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		ms
↓	B	57	1247.43	1248.02	1	1		↓
	C	58	1270.37	1272.49	2	2	confirmed 1272.56 mg ✓	
	D	59	1280.94	1281.59	1	1		
↓	E	60	1280.02	1282.95	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 Galpi

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 Reflot

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		J21
↓	B	52	1242.48	1247.54	5	5		↓
	C	53	1265.30	1269.67	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	confirmation 12870.95 mg ✓	J21
↓	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 Qualifit

Date Verified August 17/04

**EVS ENVIRONMENT CONSULTANTS
LARVAL FISH TOXICITY TESTS – DRY WEIGHT DATA**

Client Azimuth (Polars 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 (Topsnell)
 Start Date (Day 0) July 10-04
 Sample ID Li Ref/ot

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 Ca 32	A	T41	1280.70	1283.71	5	5		325
	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		325
	B	37	1275.33	1280.65	5	5	confirmed: 1230.57 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 Galjit

Date Verified August 17/04

Test: LF-Larval Fish Growth and Survival Test

Test ID: RTAACu36

Species: AA-Atherinops affinis

Protocol: EPAW 95-EPA West Coast

Sample ID: REF-Ref Toxicant

Sample Type: CU-Copper

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	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

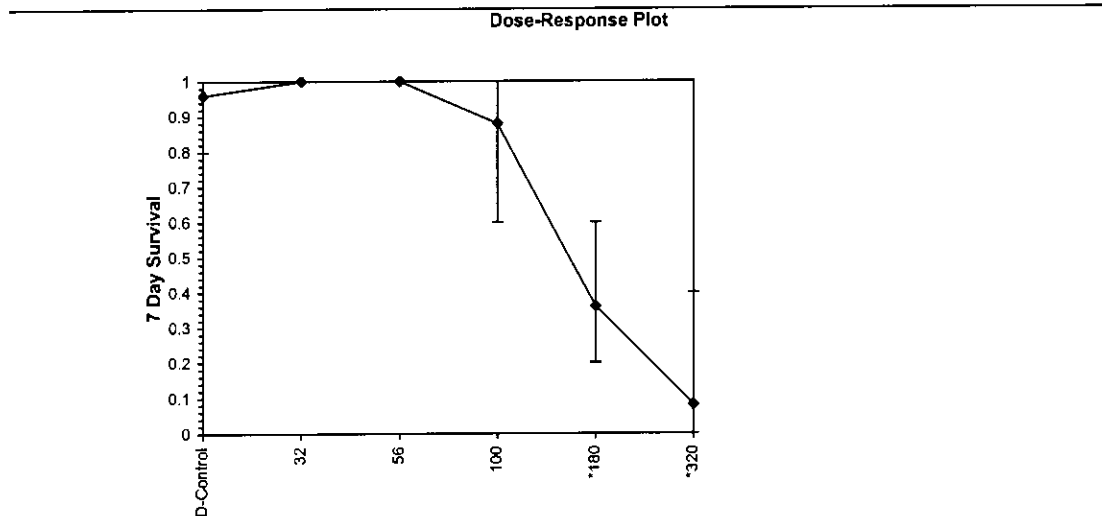
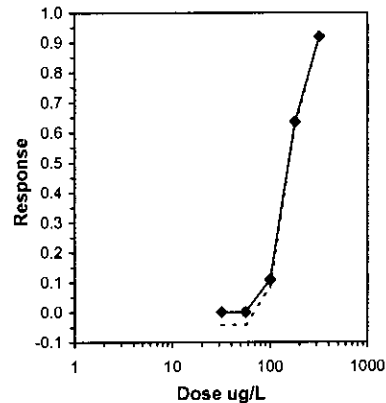
Comments: 09-0302-54, 0400303

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 Ct	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-Kärber			
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



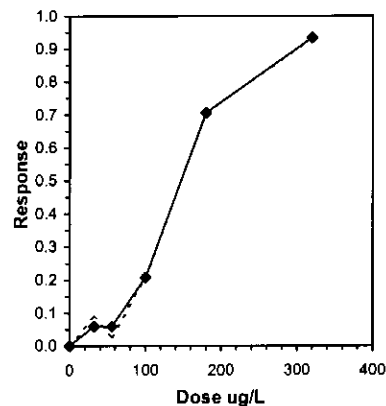
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	7/10/2004	Test ID:	RTAACu36	Sample ID:	REF-Ref Toxicant
End Date:	7/17/2004	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 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

Conc-ug/L	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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

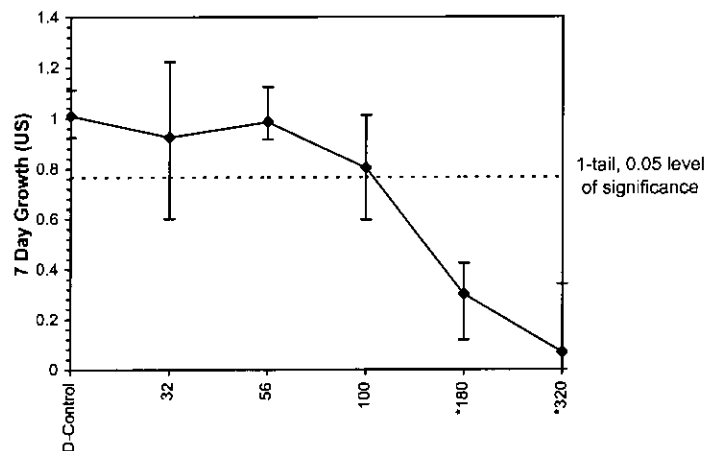
Auxiliary Tests					Statistic	Critical	Skew	Kurt						
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.97039	0.9	0.15928	-0.3767						
Bartlett's Test indicates equal variances (p = 0.21)					7.13123	15.0863								
Hypothesis Test (1-tail, 0.05)					NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	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



APPENDIX B

Chain-of-Custody Form

AZIMUTH (POLARIS)

CHAIN-OF-CUSTODY/TEST REQUEST FORM



195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

Tel: (604) 986-4331
Fax: (604) 662-8548
www.evsenvironment.com

Client Name: Tech Camino Client Contact: Bruce Donald Ship to: _____
Address: Bag 2000 Phone: 250 427-8405
Knutberley, BC Fax: 250 427-8451
VIA 3EP Sampled by: Dennis Lu Attn: _____
Shipping Date: _____

1 Collection Date (DD/MM/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					4 Sample Notes (e.g. preserved, saltwater, freshwater, may contain sewage)
								48h LC50	Rainbow Trout	Topsoil / Fertilizer	D. magna	48h LC50	
~~07/jul/2004~~	~~22:00~~	~~G-Creek - 070704~~											
07/jul/2004	22:00	G-Creek - route - 070704	E		G	2x20L		X			X		
07/jul/2004	22:00	G-Creek - sub - 070704	E		G	3x20L			X				

PO/Reference No.: _____ Comments/Instructions: _____
Project Title: _____
Results Needed By: _____

1) Released by: _____ Date: _____ Company: _____ Time: _____ Courier name: _____	2) Released by: _____ Date: _____ Company: _____ Time: _____ Courier name: _____	Shaded area to be completed by EVS Laboratory upon sample receipt. EVS Project No. <u>09-0302-54</u> EVS Work Order (WO) No. <u>0400302/303/304/307</u> Condition Upon Receipt <u>GOOD</u> <u>EOH</u> <u>TORM.</u> <u>RBT</u> <u>DAPH.</u> Receipt Sample Temp. (C) <u>11.6°</u>
1) Received: <u>JGK</u> Date: <u>10 JUL 04</u> Company: <u>EVS</u> Time: <u>1425</u>	2) Received by: _____ Date: _____ Company: _____ Time: _____	

- For composite effluent or water samples, the sample collection date/time is the **end** of the compositing period.
- Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
- Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
- 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

September 2004

LABORATORY REPORT

Azimuth Consulting Group
POLARIS MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM

July 30, 2004

PREPARED FOR:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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
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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 <i>Artemia</i> 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 $\pm$ 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
D-Control	100.0 $\pm$ 0.0	0.98 $\pm$ 0.09
Brine Control	100.0 $\pm$ 0.0	0.99 $\pm$ 0.14
Pooled Controls	100.0 $\pm$ 0.0	0.98 $\pm$ 0.11
4.3	96.0 $\pm$ 8.9	0.91 $\pm$ 0.15
8.6	96.0 $\pm$ 8.9	0.87 $\pm$ 0.14
17.3	100.0 $\pm$ 0.0	0.78 $\pm$ 0.14*
34.5	100.0 $\pm$ 0.0	0.90 $\pm$ 0.03
69.0	96.0 $\pm$ 8.9	0.77 $\pm$ 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 $\pm$ SD)
Negative Control	60.0 $\pm$ 4.1
Brine Control	60.0 $\pm$ 2.1
Pooled Control	60.0 $\pm$ 3.0
4.6	60.0 $\pm$ 4.3
9.1	43.8 $\pm$ 2.1*
18.3	37.0 $\pm$ 1.4*
36.6	30.2 $\pm$ 3.8*
73.1	20.0 $\pm$ 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

- 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). 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.
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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 Project No. 09-0302-54
 EVS Work Order No. 0400339

EVS Analysts AWD, JES, AKV
 Test Initiation Date July 30, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G-Creek - sublethal-20704	/	/
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 sea H₂O
 Temperature (°C) 20.0
 pH 8.1
 Dissolved Oxygen (mg/L) 7.4
 Salinity 28 ppt

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 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 RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (1%)	69	>69	>69		
Growth		8.6 34.5 ^{ms}	17.3 69 ^{ms}		>69	>69

Other _____

Data Verified By Qualifly

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 - Route 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	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	20.5	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	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
Tech. Initials	JD	~	~	~	~	~	~	~	~	~	~	~	~	~

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	JD	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temp. Calibrated Hg thermometer

pH II-A-51

Comments _____

Test Set Up By AWD, JES, AKN

Date Verified By Chaplin

Date Verified Sept. 13/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST - WATER QUALITY DATAClient Azimuth (Polaris)Sample ID G-Creek - Acute - 270704EVS Project No. 09-0302-54Test Initiation Date/Time July 30 / 15:00 LEVS Work Order No. 0400339Source/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	JCS	~	~	~	~	~	~	~

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	7.2	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	7.2	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	7.4	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	6.8	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	JCS	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Salinity II-A-030304DO II-A-011202

Comments _____

Test Set Up By AWD, JCS, AKNData Verified By GalpinDate 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 BP211 D

Sample ID % %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	A1	1239.31	1244.31	5	5		Jag 2/3/10
	B	A2	1249.28	1254.89	5	5		
	C	A3	1245.80	1250.56	5	5		
	D	A4	1249.65	1254.46	5	5		
	E	A5	1272.31	1276.64	5	5		
Brine CTL	A	A6	1247.06	1252.91	5	5		
	B	A7	1253.79	1257.85	5	5	confirmed 1257.82 ✓	
	C	A8	1281.77	1286.98	5	5		
	D	A9	1251.58	1255.98	5	5		
	E	A10	1259.93	1265.08	5	5		
4.3	A	A11	1257.42	1261.19	4	4		
	B	A12	1236.86	1242.25	5	5	confirmed 1242.19 ✓	
	C	A13	1239.81	1248.13	5	5		
	D	A14	1242.85	1246.92	5	5		
	E	A15	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 Gael

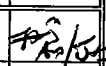
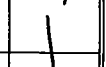
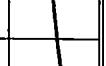
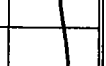
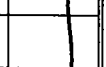
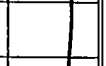
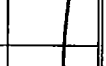
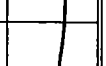
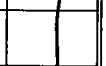
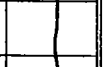
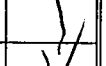
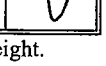
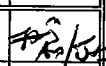
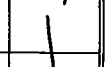
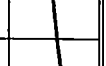
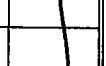
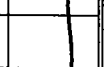
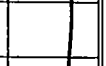
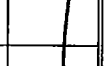
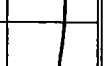
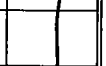
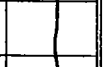
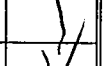
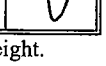
Date Verified Sept. 13/04

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 - 270709
 Balance Type/Serial Number Serious 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.
8.6	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 ³⁸	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 Galkin

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 % $\frac{1}{4}$	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.
69	A	A31	1239.64	1242.07	4	4		<i>[Signature]</i>
	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 $\leq 10\%$ 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 - Azite - 270704
 Test Species/Batch A. affinis
 Test Initiation Date/Time July 30 / 15:00 2004
 No. of Organisms/Volume 5 / 200 ml

Concentration <i>1/2 1/4</i>	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			m	m	m	m	m	m	m	

Sample Description clear, colorless
 Data Verified By Gulhich 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 - Aute - 270704

Test Species/Batch A. affinis / July 29, 04

Test Initiation Date/Time July 30 / 15:00

No. of Organisms/Volume 5/200ml

Concentration <u>1/4</u>	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 Qualifit

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

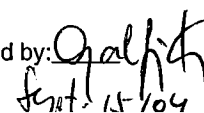
Start Date: 7/30/2004

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



Larval Fish Growth and Survival Test-7 Day Survival

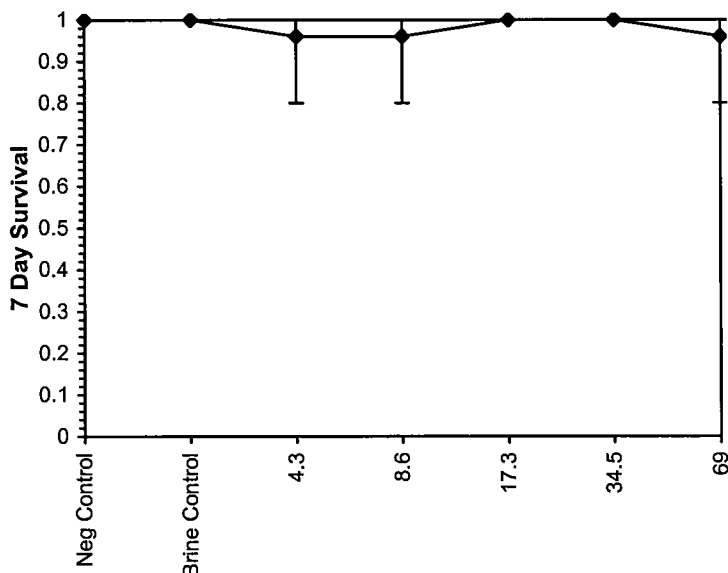
Start Date: 7/30/2004	Test ID: 400339	Sample ID: G-Creek-sublethal-270704
End Date: 8/6/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date: 7/27/2004	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth(Polaris Mine)09-0302-54		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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

Larval Fish Growth and Survival Test-7 Day Survival

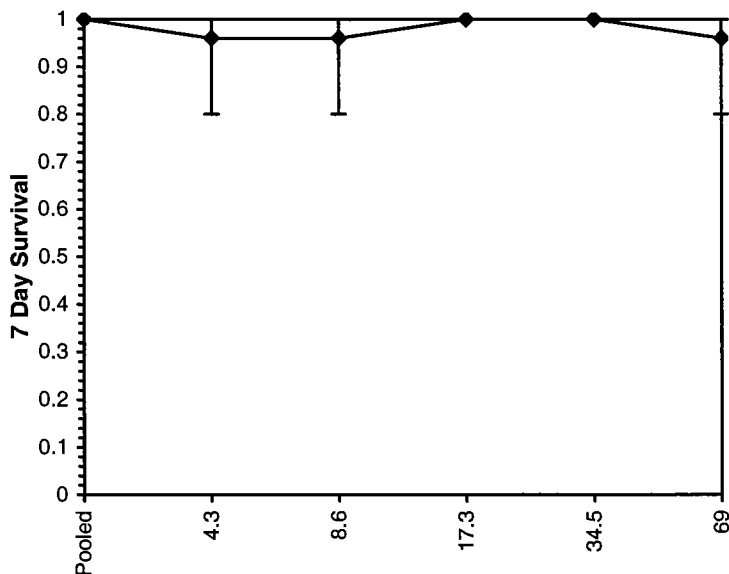
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End Date: 8/6/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date: 7/27/2004	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth(Polaris Mine)09-0302-54		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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.

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				

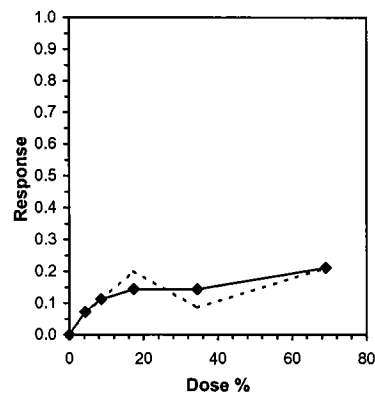
Conc-%	1	2	3	4	5
Neg Control	1.0000	1.1220	0.9520	0.9620	0.8660
Brine Control	1.1700	0.8120	1.0420	0.8800	1.0300
4.3	0.7540	1.0780	1.0640	0.8140	0.8400
8.6	1.0980	0.8660	0.8840	0.7260	0.7780
17.3	0.7100	0.7940	0.9440	0.5960	0.8720
34.5	0.9120	0.8740	0.9180	0.8540	0.9240
69	0.4860	0.8180	0.7560	0.8080	1.0000

Conc-%	Mean	SD	Transform: Untransformed					N	1-Tailed			Isotonic	
			Mean	Min	Max	CV%	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	

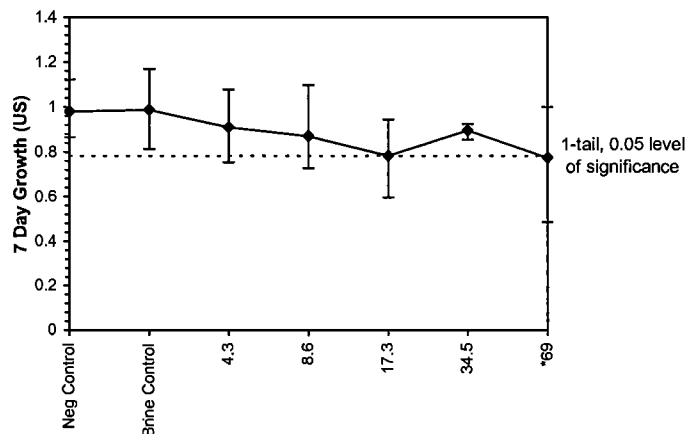
Auxiliary Tests						Statistic	Critical	Skew	Kurt						
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.97283	0.9	-0.0321	0.12793						
Bartlett's Test indicates equal variances (p = 0.10)						9.1539	15.0863								
The control means are not significantly different (p = 0.93)						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

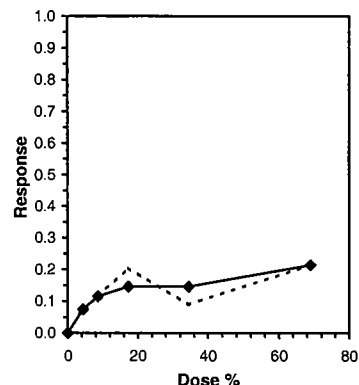
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	7/30/2004	Test ID:	400339	Sample ID:	G-Creek-sublethal-270704
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Cc	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
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

Conc-%	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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

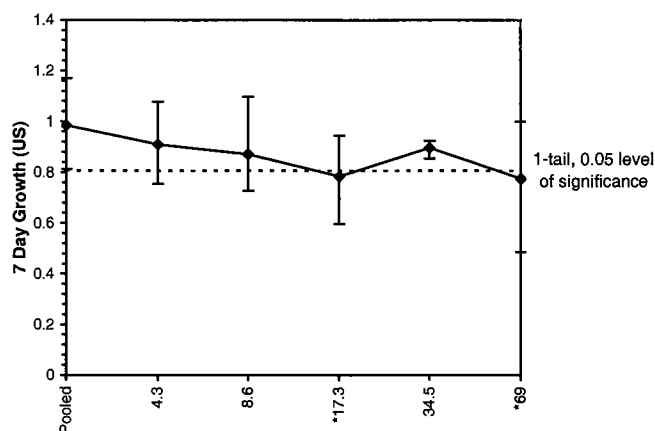
Auxiliary Tests						Statistic	Critical	Skew	Kurt	
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)						0.97705	0.91	-0.0216	-0.1535	
Bartlett's Test indicates equal variances (p = 0.11)						8.86442	15.0863			
The control means are not significantly different (p = 0.93)						0.08436	2.30601			
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.

Galit
Sent: 11/1/04

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. 0400339

EVS Analysts JLS, AWD
 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 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 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 124 (87-144) mg/L Cu
119 (89-138)

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 RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	mg/L	100	180	130 (115-147)		
Growth	Cu	56	100		124 (87-144) 119 (89-138)	85 (3.6-124) 82 (0.4-124)

Other _____

Data Verified By Gail H

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 refax

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 <i>Cu</i> mg/L	Temperature (°C)													
	0	old	1	new	2	3	4	5	6	7	8	9	10	11
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	20.5	20.0	20.5	20.0	20.5	20.0	20.5	20.0	20.5
Tech. Initials	MS	~	~	~	~	~	~	~	~	~	~	~	~	~

Concentration <i>Cu</i> mg/L	pH													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
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	7.9	8.1	7.8	7.9	7.8	8.1	8.0	7.9	7.9
Tech. Initials	MS	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temp. Calibrated Hg thermometer

pH II-A-51

Comments _____

Test Set Up By JR/AM Data Verified By Galich Date Verified Sept-10/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth

Sample ID Cn. reflex

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 Cn 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	JMS	~	~	~	~	~	~	~

Concentration Cn mg/L	Dissolved Oxygen (mg/L)													
	0	1	and 2 ₀ L		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	JMS	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Salinity II-A030304

DO II-A-011202

Comments _____

Test Set Up By JMS/ANB Data Verified By Galick 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 (Reflux)
 Test Species/Batch A. affinis / July 29, 2004
 Test Initiation Date/Time July 30, 2004 / 1430 L
 No. of Organisms/Volume 5/200ml

Cu μ g/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	32	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	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			r	r	r	r	-	r	m	

Sample Description clear, colorless
 Data Verified By Qualifit 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 reflex
 Test Species/Batch A. affinis / July 29, 2004
 Test Initiation Date/Time July 30, 04/1430 h
 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	
180	A	~~A57~~	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			r	r	r	r	r	r	r	

Sample Description _____
 Data Verified By Qaefh 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-reflex
 Balance Type/Serial Number Sartorius BP211D

Sample ID <i>Cu mg/L</i>	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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/12
	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	1228.29 ¹⁵	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				
	C	A49	1224.29	1229.03	5	5		
	56D	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

Qualifit

Date Verified

Sept. 13/04

Concentration 56mg/L E *Pan #* A51 *pan wt* 1228.55 *Final pan wt* 1233.48 *# Survival* 5 *# Weighed* 5

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client A21muth
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400339

Start Date (Day 0) July 30-04
 Sample ID Cu Effort
 Balance Type/Serial Number Sartorius BP 211D

Sample ID <i>Cu 45/L</i>	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		JTS
	B	A53	1230.92	1234.72	4	4		
	C	A54	1226.04	1230.33	5	5		
	D	A55	1228.91	1234.05	5	5	confirm 1234.07 ✓	
	E	A56	1226.61	1231.21	4	4		
180	C	~~A58~~ A57	~~1214.40~~ 1216.23	1215.67	2	2		
	D	~~A59~~ A57	~~1229.90~~ 1225.71	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 Gail H

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

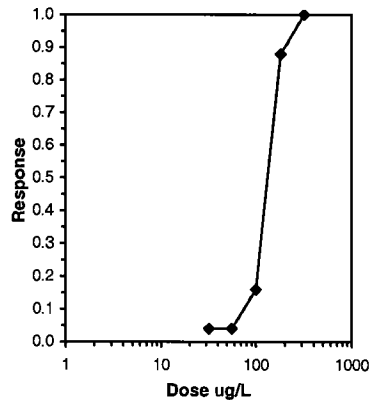
Comments: 09-0302-54, 0400339

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

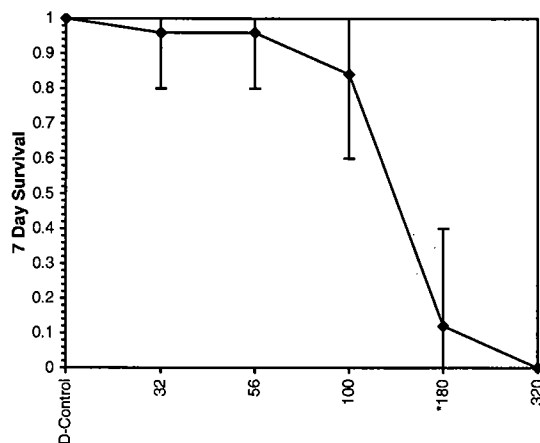
Transform: Arcsin Square Root								Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	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-Kärber			
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



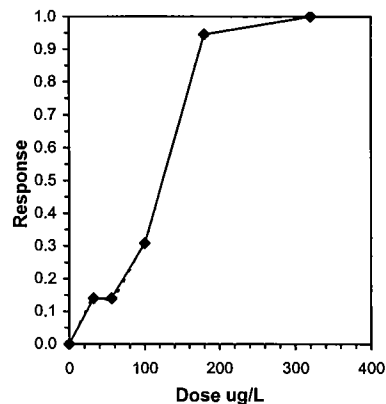
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	7/30/2004	Test ID:	RTAACu37	Sample ID:	REF-Ref Toxicant
End Date:	8/6/2004	Lab ID:	BCEVS-EVS Environment Ct	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 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

Conc-ug/L	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N		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

* indicates IC estimate less than the lowest concentration



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 @ 15.0
pH 7.7 @ 8.1
Dissolved Oxygen (mg/L) 9.6 @ 8.5
Conductivity (µmhos/cm) 4940
Salinity (ppt) 2.6 @ 2.8
Ammonia (mg/L N) -
Chlorine (mg/L Cl) -
Other -

① Brie adjustment

TEST SPECIES

Organism Dendroaster ~~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) ~~2.1~~ (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 Sterilized, 0.45µm filtered SW
Temperature (°C) 16.0
pH 8.0
Dissolved Oxygen (mg/L) 8.2
Salinity (ppt) 2.8
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) 2.8
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 Qualifit

Date Verified Sept. 10/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client ~~09-0302-54~~ ^{#4} AZIMUTH CONSULTING GROUP Test Initiation Date/Time 30 JULY 2004
 EVS Project No. 09-0302-54 Test Species Dendrosteus excentricus
 EVS Work Order No. 0400340 Source/Date Received 30 JULY 2004 / Westwind Seelab
 Logbook #13 Pages 50-53 Test Duration 10:10 ^{Supplies}

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 #	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.	<i>Kef</i>	<i>Kef</i>	<i>Kef</i>	<i>Kef</i>	<i>Kef</i>	

WQ Instruments Used: Temp. Calibrated Hg pH II-A-51 Salinity II-A-030303 DO II-A-011202
 Data Verified By *Qualtek* Date Verified Sept. 8, 2004

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client AZIMUTH CONSULTING GROUP

Test Initiation Date/Time 30 JULY 2004 @ 16:20

EVS Project No. 09-0302-54

Test Species Dendroaster ~~sp~~ excentricus

EVS Work Order No. 0400340

Source/Date Received Westwind Sealab Supplies/30 July 2004

Logbook Echinoid #13 Pages 50-53

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		ket
	B	62	38		↓
	C	56	44		↓
	D	65	35		↓
4.6	A	60	40		ket
	B	66	34		↓
	C	56	44		↓
	D	58	42		↓
9.1	A	46	54		ket
	B	42	58		↓
	C	45	55		↓
	D	42	58		↓
18.3	A	39	61		ket
	B	36	64		↓
	C	37	63		↓
	D	36	64		↓
36.6	A	31	69		ket
	B	34	66		↓
	C	25	75		↓
	D	31	69		↓
73.1	A	19	81		ket
	B	20	80		↓
	C	21	79		↓
	D	20	80		↓

Data Verified By Gail H

Date Verified Sept - 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 Dendroaster ~~sp~~ 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		Kst
	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 Galt

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 (10:10) 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)

Sept. 8/04

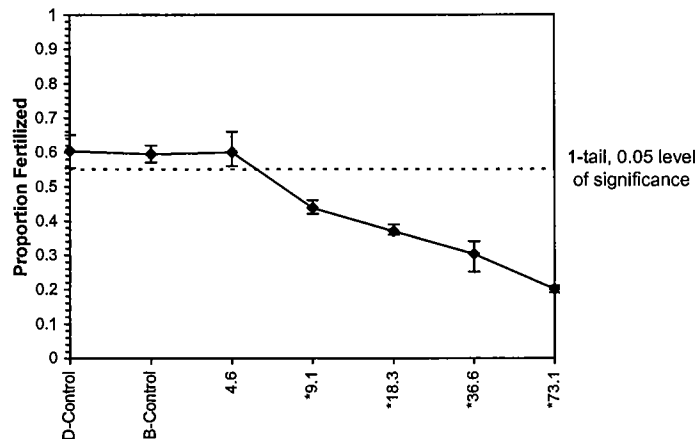
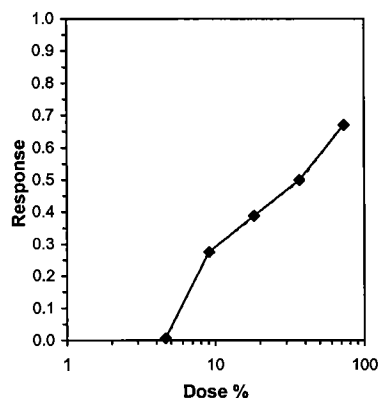
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	7/30/2004 10:10	Test ID:	400340	Sample ID:	G CREEK 270704E
End Date:	7/30/2004	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendroaster excentricus
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

Conc-%	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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



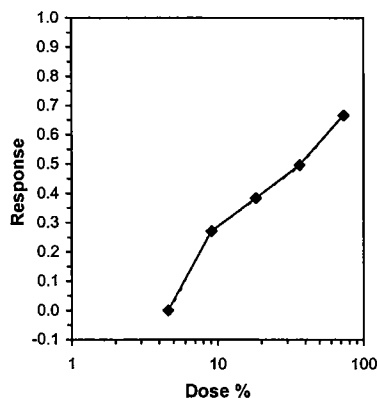
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	7/30/2004 10:10	Test ID:	400340	Sample ID:	G CREEK 270704E
End Date:	7/30/2004	Lab ID:	BCEVS-EVS Environment Cx	Sample Type:	EFF2-Industrial
Sample Date:	7/27/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm + Test Species:	DE-Dendroaster excentricus	
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

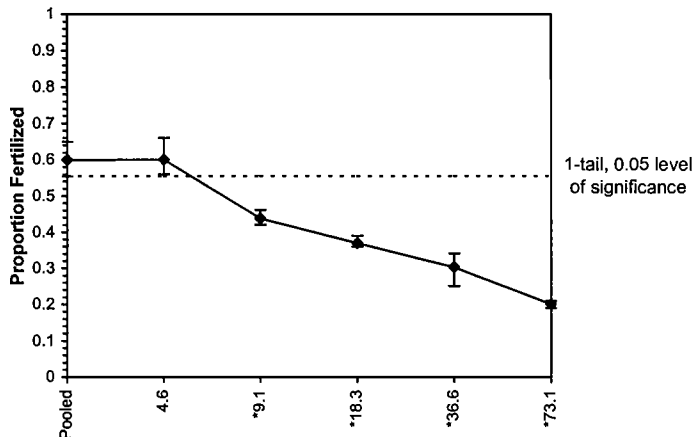
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				Mean	N-Mean
Pooled	0.5993	0.0304	0.5993	0.5545	0.6500	5.073	8				0.5996	1.0000
4.6	0.6000	0.0432	0.6000	0.5600	0.6600	7.201	4	-0.039	2.508	0.0444	0.5996	1.0000
*9.1	0.4375	0.0206	0.4375	0.4200	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

Qualifit
Sent: 10/10/04

**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 Prep'd SDS Ref Tox Stock Solⁿ #04-5-005
Amount Received 1X1L
Date Collected 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 Dendroaster eccentricus
Source Westwind Sealab Supply
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 Sterilized, 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 : 2.1 (1.9-2.4) mg/L SDS
IC 25 : 1.3 (0.9-1.5) mg/L SDS
NOEC : <1 mg/L SDS
LOEC : 1 mg/L SDS

Data Verified By Cheryl H

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 Dendroaster ~~sp~~ 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.	Kef	Kef	Kef	Kef	Kef	

WQ Instruments Used: Temp. Calibrated Hy thermometer pH II-A-51 Salinity II-A-03-03 DO II-A-011202
 Data Verified By Qualtek 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 Dendroster# excentricus

Test Duration 10:10

Sperm:Egg Ratio ~~1:1600~~ 1600:1
~~Ref~~

Concentration SDS mg/L	Replicate	No. Fertilized Eggs	No. Unfertilized Eggs	Comments	Tech. Initials
Reference Toxicant					
1.0	A	47	53		Ref
	B	55	45		↓
	C	50	50		↓
	D	48	52		↓
1.8	A	33	67		Ref
	B	36	64		↓
	C	39	61		↓
	D	35	65		↓
3.2	A	14	86		Ref
	B	11	89		↓
	C	~~16/13~~ 15	85		↓
	D	18	82		↓
5.6	A	5	~~89~~ 95		Ref
	B	8	92		↓
	C	7	93		↓
	D	5	~~82~~ 95		↓
10.0	A	2	98		Ref
	B	3	97		↓
	C	2	98		↓
	D	2	98		↓
Control Seawater					
	A	59	41		Ref
	B	62	38		↓
	C	56	44		↓
	D	65	35		↓

Data Verified By Gulphith

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)

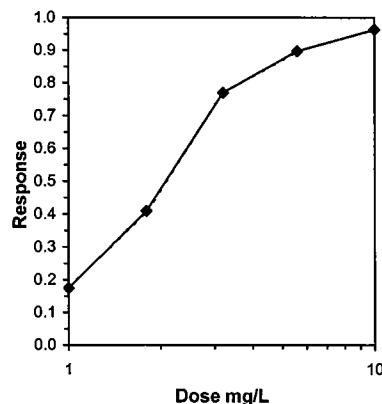
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	7/30/2003 10:10	Test ID:	rtscsds8	Sample ID:	REF-Ref Toxicant
End Date:	7/30/2003	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm t	Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 09-0302-54 (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

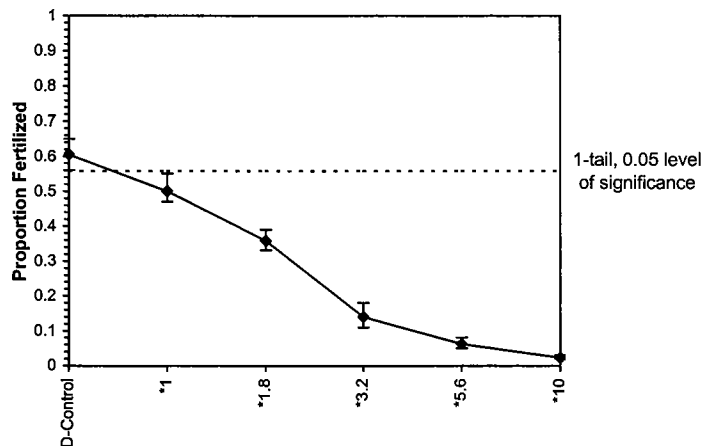
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.95924	0.884	0.47024	-0.048		
Bartlett's Test indicates equal variances (p = 0.10)					9.12722	15.0863				
Hypothesis Test (1-tail, 0.05)					NOEC	LOEC	ChV	TU		
					MSDu	MSDp	MSB	MSE	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



APPENDIX C

Chain-of-Custody Form

Photocopy of original
because 3 cooler.

Photo copy of Original
because 3 coolers

October 2004

LABORATORY REPORT

Azimuth Consulting Group
POLARIS MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM
August 24, 2004

PREPARED FOR:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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**

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North Vancouver, BC
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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 <i>Artemia</i> 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 ($p\leq0.05$). 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 ($p\leq0.05$). 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 $\pm$ 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
D-Control	100.0 $\pm$ 0.0	0.93 $\pm$ 0.06
Brine Control	100.0 $\pm$ 0.0	0.96 $\pm$ 0.18
Pooled Controls	100.0 $\pm$ 0.0	0.95 $\pm$ 0.13
4.4	100.0 $\pm$ 0.0	1.06 $\pm$ 0.26
9.0	100.0 $\pm$ 0.0	0.87 $\pm$ 0.06
18.0	100.0 $\pm$ 0.0	0.97 $\pm$ 0.17
36.0	96.0 $\pm$ 8.9	0.92 $\pm$ 0.13
71.0	100.0 $\pm$ 0.0	0.87 $\pm$ 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 $\pm$ SD)
Negative Control	77.0 $\pm$ 2.4
Brine Control	76.2 $\pm$ 2.5
Pooled Control	76.6 $\pm$ 2.3
4.7	75.0 $\pm$ 2.6
9.4	61.2 $\pm$ 1.0*
18.8	57.0 $\pm$ 1.8*
37.5	49.2 $\pm$ 1.0*
75.1	25.8 $\pm$ 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.

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.
- 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 Azimukh (Polons)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

EVS Analysts AWD, JxS
 Test Initiation Date Aug 27, 2004

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	G - Creek 082404	→	→
Amount Received	1 x 20 L	→	→
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 ^B 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 ²
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/ 90 ppt 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 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 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 27, 2004
 7-d survival LC50 121 (107-137) ⁸⁵⁻¹⁵⁰ μg/L
 7-d growth IC50 128 (111-153) ⁸⁵⁻¹⁵⁰ μg/L

Reference Toxicant Warning Limits (mean ± 2SD) and CV

7-d survival LC50 132 ± 48 ⁸⁵⁻¹⁵⁰ μg/L CV: 18%
 7-d growth IC50 138 ± 51 ⁸⁵⁻¹⁵⁰ μg/L CV: 20%

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	% (✓/✓)	71	> 71	> 71		
Growth		71	> 71		> 71	> 71

Other _____

Data Verified By Quilley Date Verified Oct-27/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Polaris)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

Sample ID G-Creek @ 082404
 Test Initiation Date/Time Aug 27, 2004 @ 1230 L
 Source/Date Received ABS / Aug 28, 2004

Concentration ‰ (v/v)	Temperature (°C)													
	0	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	20.5	20.0	20.5	20.5
Tech. Initials	~	~	~	~	~	~	~	~	~	~	~	~	~	~

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	8.3	8.0	8.3	8.2	8.3	8.3	8.2	8.2	8.1	8.1
Tech. Initials	~	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH H-A-52
 Comments _____

Test Set Up By AWB Date Verified By Qacph 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 26th, 2004 @ 1230h

EVS Work Order No. 0400384

Source/Date Received ABS / Aug 26th, 2004

Concentration ‰ (ppt)	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	~	~	~	~	~	~	~	~

Concentration ‰ (ppt)	Dissolved Oxygen (mg/L)													
	0	1	2	3	4	5	6	7	0	1	2	3	4	5
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	~	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Salinity II-A-030304

DO II-A-3

Comments _____

Test Set Up By AWO

Data Verified By Galpin

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 Cr. Creek 082404
 Test Species/Batch A. affinis / Aug 17-04
 Test Initiation Date/Time Aug 23, 2004 @ 1230L
 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		Jes	m	n	ms	n	n	ms	ms	

Sample Description clear, colorless
 Data Verified By Galt 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 7-04
 Test Initiation Date/Time Aug 27, 2004 @ 1220h
 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	²³ A 51 ⁴⁶	5	5	5	5	5	5	5	
	B	²³ 52 ⁴⁷	5	5	5	5	5	5	5	
	C	²³ 53 ⁴⁸	5	5	5	5	5	5	5	
	D	²³ 54 ⁴⁹	5	5	5	5	5	5	5	
	E	²³ 55 ⁵⁰	5	5	5	5	5	5	5	
36	A	²³ 56 ⁵¹	5	5	5	5	5	5	5	
	B	²³ 57 ⁵²	5	5	5	5	5	5	5	
	C	²³ 58 ⁵³	5	5	5	5	5	5	4	
	D	²³ 59 ⁵⁴	5	5	5	5	5	5	5	
	E	²³ 60 ⁵⁵	5	5	5	5	5	5	5	
71	A	61	5	5	5	5	5	²³ 45 ⁵	²³ 45 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	0								
Technician Initials		JCS	m	-	JCS	r	~	JCS	JCS	

Sample Description clear, colorless
 Data Verified By Galpin Date Verified Oct 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Arimath (Polonia)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

Start Date (Day 0) August 28th, 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	A 31	1228.40	1233.24	5	5	pre-wt: 1228.42 mg	<i>[Signature]</i>
	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	<i>[Signature]</i>

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 A21m w/b (Polaris)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

Start Date (Day 0) August 27, 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	1217.86	1222.48	5	5		<i>[Signature]</i>
	B	47	1225.29	1228.77	5	5		
	C	48	1236.54	1242.18	5	5		
	D	49	1239.07	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	1232.98	1237.03	5	5		
	E	60	1222.96	1227.12	5	5	pre wt: 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 *[Signature]*

Date Verified Oct 20/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Arimath (Polaris)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

Start Date (Day 0) August 28, 2004
 Sample ID G-Creek 082404
 Balance Type/Serial Number Sartorius BP211.D

Sample ID % (y/o)	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.
²⁷ 72 71	A	A 61	1236.40	1239.74	5	5		JS
	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	10						
	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 Galpin G

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

Quality
Oct 27/04

Larval Fish Growth and Survival Test-7 Day Survival

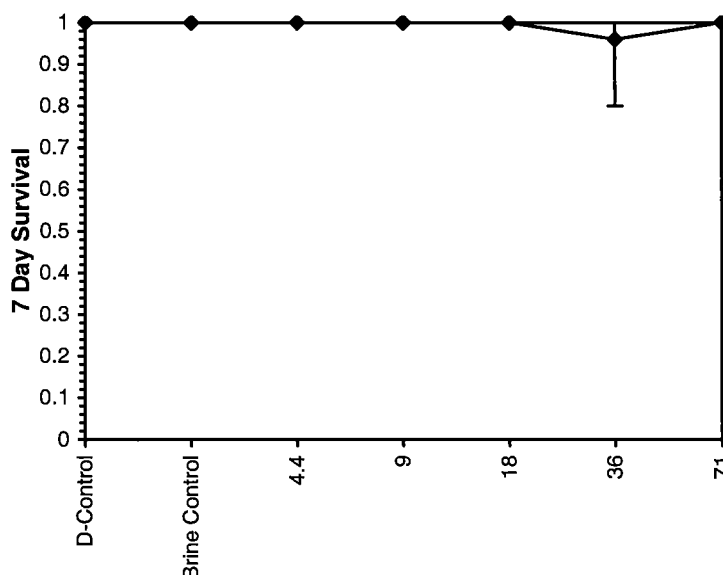
Start Date: 8/27/2004 Test ID: 400384 Sample ID: G_CREEK-082404
 End Date: 9/3/2004 Lab ID: BCEVS-EVS Environment Cc Sample Type: EFF2-Industrial
 Sample Date: 8/24/2004 Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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.

Galley
Oct-20/04

Larval Fish Growth and Survival Test-7 Day Survival

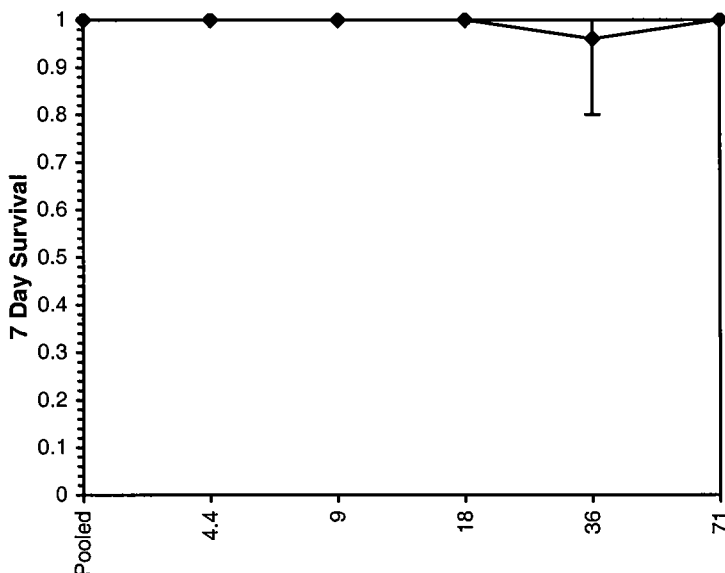
Start Date: 8/27/2004	Test ID: 400384	Sample ID: G_CREEK-082404
End Date: 9/3/2004	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date: 8/24/2004	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth - Polaris Mine; G-Creek, 09-0302-54 ;0400384		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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



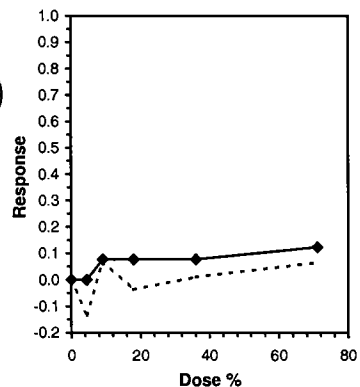
Statistical comparison were against the pooled control.

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

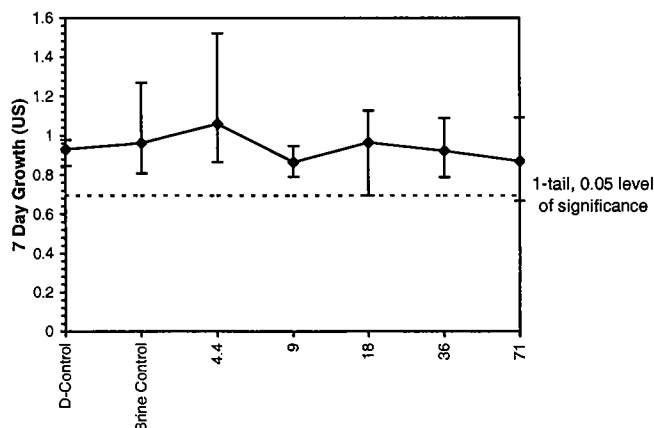
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed			Isotonic	
			Mean	Min	Max	CV%	N		Critical	MSD	Mean	N-Mean	
D-Control	0.9312	0.0585	0.9312	0.8460	0.9780	6.283	5				0.9938	1.0000	
Brine Control	0.9624	0.1811	0.9624	0.8080	1.2680	18.820	5						
4.4	1.0564	0.2642	1.0564	0.8620	1.5180	25.007	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			



Dose-Response Plot



Statistical comparison were against the D-control.

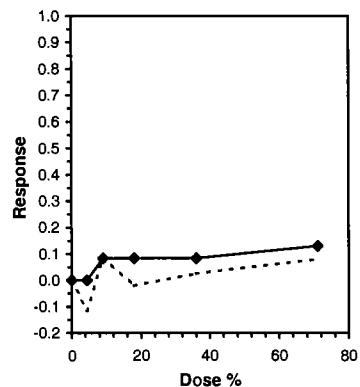
Galpin
Oct-20-104

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

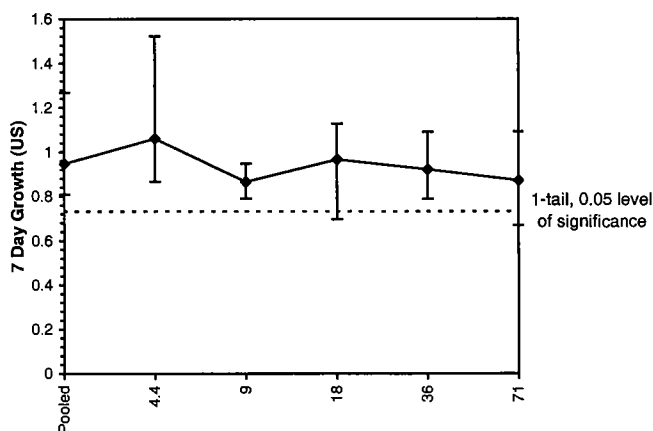
Conc-%	Mean	SD	Transform: Untransformed					N	1-Tailed			Isotonic	
			Mean	Min	Max	CV%	t-Stat		Critical	MSD	Mean	N-Mean	
Pooled	0.9468	0.1280	0.9468	0.8080	1.2680	13.514	10				1.0016	1.0000	
4.4	1.0564	0.2642	1.0564	0.8620	1.5180	25.007	5	-1.258	2.462	0.2146	1.0016	1.0000	
9	0.8652	0.0604	0.8652	0.7900	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			



Dose-Response Plot



Statistical comparison were against the pooled control.

Qalif K
Oct 70/04

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 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 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) µg/L Cu
 7-d growth IC50 128 (85-150) µg/L Cu
 Reference Toxicant Warning Limits (mean ± 2SD) and CV
 7-d survival LC50 132 ± 48 µg/L CV: 18%
 7-d growth IC50 131 ± 52 µg/L CV: 20%

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	µg/L	100	180	121 (107-137)		
Growth		56	100		128 (85-150)	93 (53-124)

Other _____

Data Verified By Gulick

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/fox

EVS Project No. 09-0302-54

Test Initiation Date/Time Aug 27, 2004 / 1245h

EVS Work Order No. 0400384

Source/Date Received ABS / Aug 28, 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
320	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
560	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
1000	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
1800	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
3200	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
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
320	7.8	8.0	8.0	8.0	7.9	8.0	7.9	8.0	7.9	7.9	7.9	7.9	7.8	7.8
560	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
1000	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
1800	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
3200	7.8	8.0	8.0	8.0	7.9	8.0	7.9							
Tech. Initials	~	~	~	~	~	~	~	~	~	~	~	~	~	~

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH H-A-52

Comments _____

Test Set Up By AWB Data Verified By Qalif Date Verified Oct. 20/04

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azimuth (Polaris)

Sample ID Lu K/L/10

EVS Project No. 09-0302-54

Test Initiation Date/Time Aug 28, 2004 @ 1245L

EVS Work Order No. 0400384

Source/Date Received ABS / Aug 28, 2004

Concentration <u>49/L</u>	Salinity (ppt)							
	0	1	2	3	4	5	6	7
<u>Control</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
<u>320</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
<u>560</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
<u>1000</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
<u>1800</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
<u>3200</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>	<u>28</u>
Tech. Initials	<u>^</u>	<u>^</u>	<u>^</u>	<u>JMS</u>	<u>^</u>	<u>^</u>	<u>JMS</u>	<u>JMS</u>

Concentration <u>49/L</u>	Dissolved Oxygen (mg/L)													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
<u>Control</u>	<u>7.4</u>	<u>6.7</u>	<u>7.5</u>	<u>6.6</u>	<u>7.5</u>	<u>6.9</u>	<u>7.5</u>	<u>7.0</u>	<u>7.7</u>	<u>6.7</u>	<u>7.4</u>	<u>7.6</u>	<u>6.7</u>	<u>6.6</u>
<u>320</u>	<u>7.4</u>	<u>6.4</u>	<u>7.5</u>	<u>6.7</u>	<u>7.5</u>	<u>6.9</u>	<u>7.5</u>	<u>6.9</u>	<u>7.5</u>	<u>6.6</u>	<u>7.4</u>	<u>7.6</u>	<u>6.8</u>	<u>6.7</u>
<u>560</u>	<u>7.4</u>	<u>6.5</u>	<u>7.5</u>	<u>6.6</u>	<u>7.5</u>	<u>6.9</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>6.6</u>	<u>7.4</u>	<u>7.6</u>	<u>6.9</u>	<u>6.8</u>
<u>1000</u>	<u>7.4</u>	<u>6.5</u>	<u>7.5</u>	<u>6.7</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>7.1</u>	<u>7.5</u>	<u>6.7</u>	<u>7.4</u>	<u>7.6</u>	<u>6.7</u>	<u>6.7</u>
<u>1800</u>	<u>7.4</u>	<u>6.6</u>	<u>7.5</u>	<u>6.7</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>6.4</u>	<u>7.4</u>	<u>7.7</u>	<u>6.7</u>	<u>6.7</u>
<u>3200</u>	<u>7.4</u>	<u>6.6</u>	<u>7.5</u>	<u>6.7</u>	<u>7.5</u>	<u>7.1</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>7.0</u>	<u>7.5</u>	<u>7.0</u>
Tech. Initials	<u>^</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>JMS</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>^</u>	<u>JMS</u>	<u>JMS</u>

WQ Instruments Used: Salinity II-A-030304 DO II-A-3

Comments _____

Test Set Up By AWD Data Verified By Galpin 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 Reflot
 Test Species/Batch *A. affinis* / 1st Aug 2004
 Test Initiation Date/Time Aug 27, 2004 @ 1245L
 No. of Organisms/Volume 5/200mL

Concentration <u>49/L</u>	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
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	10	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		Jes	~	~	123	2	2	AXF JXS	Jes	

Sample Description clear, colorless
 Data Verified By Galfrk 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 refbox
 Test Species/Batch A. affinis / Aug 27-04
 Test Initiation Date/Time Aug 27, 2004 @ 12:45
 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 180.0	A	21	2	2	2	2	2	2	2	
	B	22	2	0	0	~				
	C	23	5	3	3	3	3	2	0	
	D	24	1	1	1	1	1	0		
	E	25	2	1	1	0				
320.0	A	26	0							
	B	27	0							
	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			Jes	~	~	Jes	~	~	AKP/SKS Jes	

Sample Description clear, colorless
 Data Verified By Qalikh Date Verified Oct. 27/04

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST – DRY WEIGHT DATA

Client Arimath (Polonia)
 EVS Project No. 09-0302-54
 EVS Work Order No. 0400384

Start Date (Day 0) August 27th, 2004
 Sample ID Cu Pellet
 Balance Type/Serial Number Sartorius BP211.D

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	Number of Survivors	Number Weighed	Comments (e.g., confirmation weights, organisms lost in transfer)	Tech. Init.
7916								
Control	A	A 1	1236.92	1240.48	5	5		Awo/S
	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	1236.85	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 Galfi

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 27th, 2004
 Sample ID Cu Re/tox
 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.
49/L								
100.0	A	A 16	1231.06	1234.17	84	84		
	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 Galpin

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

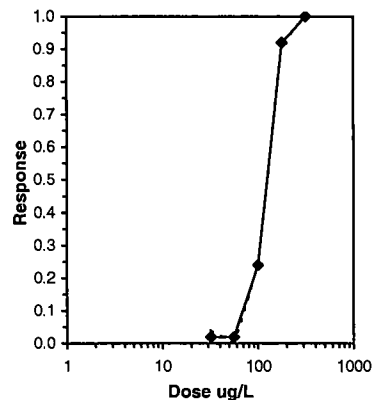
Comments: 09-0302-54, 0400384

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

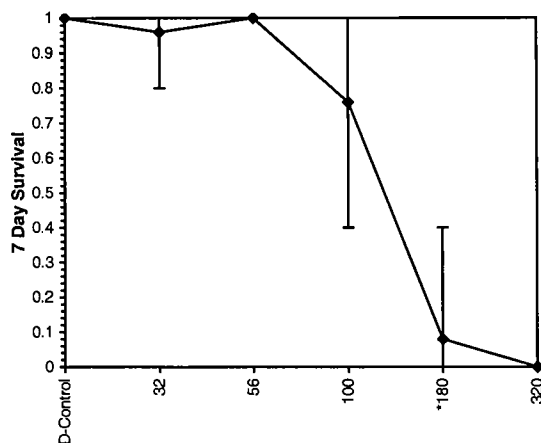
Transform: Arcsin Square Root								Rank	1-Tailed	Number	Total
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%	N	Sum	Critical	Resp	Number
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	27.50	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 ($p \leq 0.01$)	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-Kärber			
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



Galpin
Oct 22/06

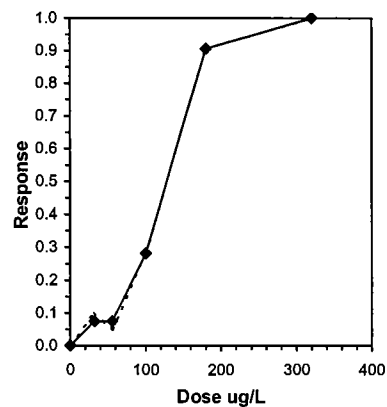
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	8/27/2004	Test ID:	RTAACu39	Sample ID:	REF-Ref Toxicant
End Date:	9/3/2004	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	09-0302-54, 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

Conc-ug/L	Mean	SD	Transform: Untransformed				N	1-Tailed		Isotonic	
			Mean	Min	Max	CV%		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

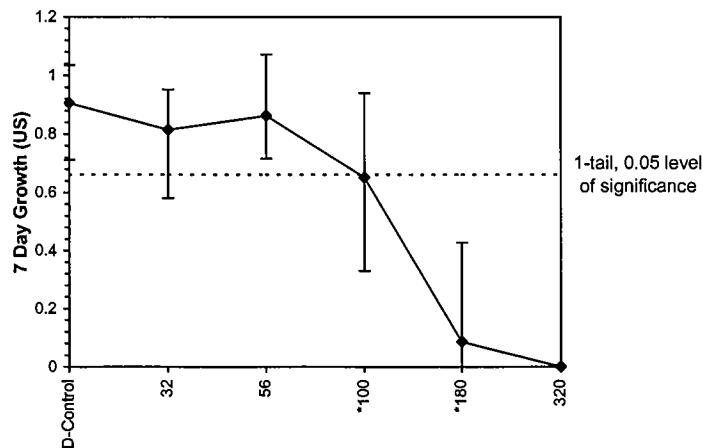
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)					0.97983	0.888	0.24836	0.34826		
Bartlett's Test indicates equal variances ($p = 0.81$)					1.6194	13.2767				
Hypothesis Test (1-tail, 0.05)					MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test					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

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



APPENDIX B

Raw Data and Statistical Analyses:

Dendraster excentricus

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY**

Client AZIMUTH CONSULTING GROUP EVS Analysts KES / AKN
EVS Project No. 09-0302-J4/04-1424-044 Test Initiation Date 27 AUGUST 2004
EVS Work Order No. 0400385

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 @ 8.5
Conductivity (µmhos/cm) 9240
Salinity (ppt) 5 @ 28
Ammonia (mg/L N) -
Chlorine (mg/L Cl) -
Other ① Salinity adjustment

TEST SPECIES

Organism Dendroaster eccentricus
Source Westwind Sealab Supply, 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 Qualifly

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 eccentricus
 Source/Date Received Westwind Sealab Supplies/27 August 2004
 Test Duration 10:10

Sample ID 9-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	8.42	
	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.	Kef	Kef	Kef	Kef	Kef	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-03030 DO II-A-011202
 Data Verified By Galf Date Verified Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

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 eccentricus

EVS Work Order No. 0400385

Source/Date Received Westwind Sealab Supplies/27 August 2004

Logbook Echinoid #13 Pages 53-57

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		def
	B	74	26		↓
	C	76	24		
	D	72	28		↓
9.4	A	61	39		def
	B	62	38		↓
	C	62	38		
	D	60	40		↓
18.8	A	56	44		def
	B	58	42		↓
	C	41 59	41		↓
	D	55	45		↓
37.5	A	49	51		def
	B	50	50		↓
	C	50	50		
	D	48	52		↓
75.1	A	25	75		↓
	B	27	73		def
	C	24	76		↓
	D	27	73		↓
CONTROL SEA WATER	A	77	4/29 23		def
	B	80	20		↓
	C	74	26		
	D	77	23		↓

Data Verified By Galhif

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 eccentricus
 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		Jef ↓
	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				

Data Verified By Galfin

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	

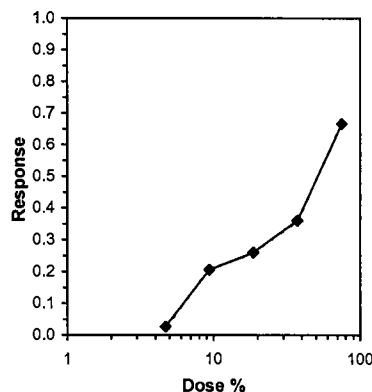
Comments: Azimuth Consulting Group (Polaris), 09-0302-54 (0400385)

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-Dendroaster 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	

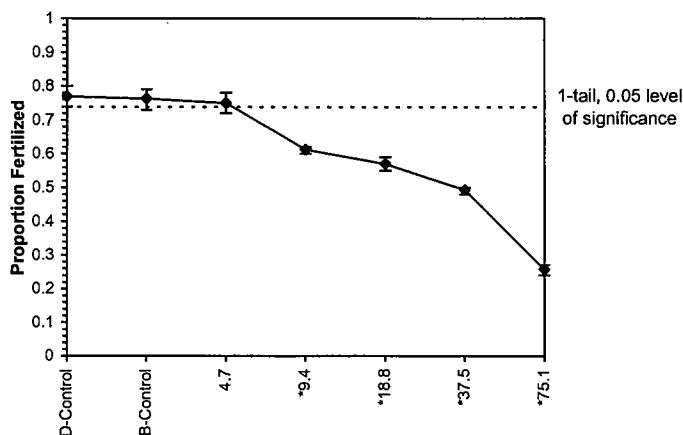
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N		Critical	MSD	Mean	N-Mean
D-Control	0.7700	0.0245	0.7700	0.7400	0.8000	3.181	4				0.7700	1.0000
B-Control	0.7625	0.0250	0.7625	0.7300	0.7900	3.279	4					
4.7	0.7500	0.0258	0.7500	0.7200	0.7800	3.443	4	1.546	2.410	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
IC10	6.314	0.363	5.072	7.317
IC15	7.655	0.380	6.468	8.804
IC20	9.242	0.946	8.159	13.672
IC25	16.673	2.353	10.367	23.598
IC40	41.060	0.897	38.450	44.063
IC50	51.581	0.976	49.063	54.697



Dose-Response Plot



Statistical comparisons were against the D-control

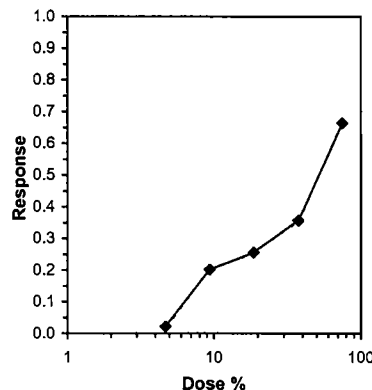
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Oct-26/04

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-Dendroaster 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	

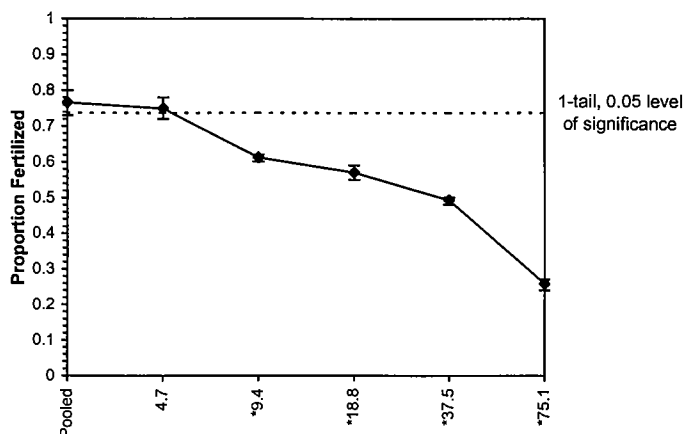
Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				Mean	N-Mean
Pooled	0.7663	0.0233	0.7663	0.7300	0.8000	3.036	8				0.7663	1.0000
4.7	0.7500	0.0258	0.7500	0.7200	0.7800	3.443	4	1.390	2.508	0.0293	0.7500	0.9788
*9.4	0.6125	0.0096	0.6125	0.6000	0.6200	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

Quelch
Oct. 26/04

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY**

Client Azimuth Consulting Group EVS Analysts KES, AKN
EVS Project No. 09-0302-54/04-1424-044 Test Initiation Date 27 AUGUST 2004
EVS Work Order No. 0400385

SAMPLE

Identification SDS Ref Tox Stock Sol
Amount ^{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 Dendroaster eccentricus
Source Westwind Sealab Supplier
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 Qualifit

Date Verified Oct. 26/04

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY

Client AZIMOTH 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 Dendroaster eccentricus
 Source/Date Received Westwind Seabed 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.	<i>del</i>	<i>del</i>	<i>del</i>	<i>del</i>	<i>del</i>	

WQ Instruments Used: Temp. Calibrated Hg thermometer pH II-A-51 Salinity II-A-020203 DO II-A-011202
 Data Verified By *Galpik* 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		ket
	B	72	28		↓
	C	69	31		↓
	D	68	32		↓
1.8	A	45	55		ket
	B	47	53		↓
	C	46	54		↓
	D	49	51		↓
3.2	A	25	75		ket
	B	26	74		↓
	C	24	76		↓
	D	27	73		↓
5.6	A	10	90		ket
	B	14	86		↓
	C	9	91		↓
	D	10	90		↓
10.0	A	2	98		ket
	B	2	98		↓
	C	1	99		↓
	D	2	98		↓
Control Seawater					
	A	81 77	23		ket
	B	74 80	20		↓
	C	74	26		↓
	D	77	23		↓

Data Verified By Galpin

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)

Sperm Cell Fertilization test-Proportion Fertilized				
Start Date:	8/27/2004 10:10	Test ID:	rtscsds9	Sample ID:
End Date:	8/27/2004	Lab ID:	BCEVS-EVS Environment Cr	Sample Type:
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm t Test Species:	DE-Dendraster excentricus
Comments:	Azimuth Consulting Group 09-0302-54 (0400385)			

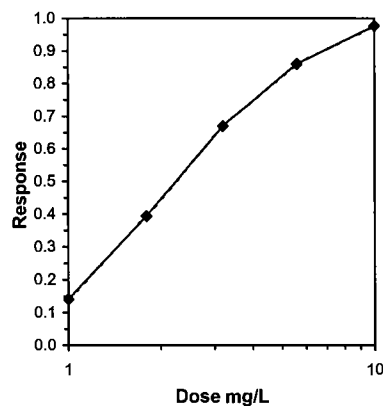
Conc-mg/L	1	2	3	4
D-Control	0.7700	0.8000	0.7400	0.7700
1	0.7000	0.7200	0.6900	0.6800
1.8	0.4500	0.4700	0.4600	0.4900
3.2	0.2500	0.2600	0.2400	0.2700
5.6	0.1000	0.1400	0.0900	0.1000
10	0.0200	0.0200	0.0100	0.0200

		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	

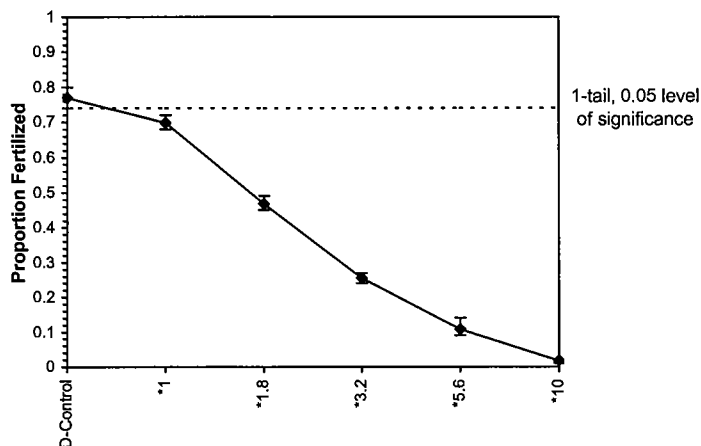
Auxiliary Tests					Statistic	Critical	Skew	Kurt						
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)					0.94353	0.884	0.48689	0.03974						
Bartlett's Test indicates equal variances ($p = 0.33$)					5.73659	15.0863								
Hypothesis Test (1-tail, 0.05)					NOEC	LOEC	ChV	TU	MSDu	MSDp	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

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



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.

Client Name: ALZIMUTH CONSULTING FOR

Client Contact Name: Cheryl Mackintosh/Bruce Donald

Ship to: EVS Environment Consultants

Address: 1500 COMPLEO

Phone: 604-730-1220

195 Pemberton Ave.

218-2902 West Broadway

Fax: 604-739-9070

North Vancouver, BC, V7P 2R4

Vancouver BC V6K 2G8

Sampled By: Randy Butler C. Mackintosh

Alt: Edmund Canavia

EVS environment
consultants

195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4

Tel: 604-986-4331
Fax: 604-662-8548

www.evsenvironment.com

Shipping Date: Aug. 25, 2004

Collection Date (dd/mm/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 Test(s) Requested				Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	3
							Sample Container Type by Code	1	2	3		
24 8/Aug/04	15:00	G-Creek ~~081704~~ 082404	E		5x20LCC	✓	✓	✓	✓	Freshwater ~2.4ppt		

PO/Reference No.: TC-03-03

Comments/Instructions: ① The sample ID was changed from G-Creek 081704 to G-Creek 082404 by the client's request.

Project Title: Polaris MMER

Results Needed By:

A) Released By: C. Mackintosh Date: Aug. 28/04

Company: Alzimuth Time: 9:00am

Courier name: First Air / FedEx

Shipping containers secured by: Tape Straps Lock Other

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

Custody seals used? Yes No (circle one)

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,


Jenny Ferone, Regional EEM Coordinator

cc Peter Blackall
Chuck Brumwell
Ken Russell

Recycle Paper / Papier Recycle



Canada

www.ec.gc.ca

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:*
 - o *No deviations from EC guidance document on preparation of hypersaline brine (HSB)*

- o *HSB prepared from natural seawater concentrated to 90ppt (by freezing/refreezing to remove frozen layer and concentrate salts)*
- o *No deviations from EC guidance document for salinity adjustment of sample*
- o *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 topmelt 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 m³ 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 m³ 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		DELETERIOUS SUBSTANCE (mg/L) ¹									Collection Method
During The Week of	Date Sample Taken	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 ¹	pH ¹	
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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note² - "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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L

Note² - "nd" refers to no effluent discharge to sample

Note³ - 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		DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day) ¹								Average Daily
During The	Date									Flow Rate
Week of	Sample Taken	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 ¹	(m ³ /day)
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

Note¹ - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note² - "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

Note¹ - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note² - Mass loading units are in kg per month except Radium 226, which is in Bq permonth

Note³ - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note⁴ - Total Monthly Volume calculated by multiplying Average Daily Flow Rate for the month x days in month

2005 POLARIS MINE MMER 2ND QUARTER REPORT



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		DELETERIOUS SUBSTANCE (mg/L) ¹									Collection Method
During The Week of	Date Sample Taken	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 ¹	pH ¹	
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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note² - "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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L

Note² - "nd" refers to no effluent discharge to sample

Note³ - 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

Note¹ - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note² - "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

Note¹ - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note² - Mass loading units are in kg per month except Radium 226, which is in Bq per month

Note³ - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note⁴ - 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	Sample	Hardness	Alkalinity	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Ammonia	Nitrate
		Characterization Date										
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 and 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		DELETERIOUS SUBSTANCE (mg/L) ¹									Collection Method
Week of	Date Sample Taken	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 ¹	pH ¹	
3-Jul-05	6-Jul-05	<i>0.00020</i>	0.00024	<i>0.0050</i>	0.00017	0.00060	0.0127	4	0.0050	7.49	Grab
10-Jul-05	13-Jul-05	<i>0.00020</i>	0.00061	<i>0.0050</i>	0.00230	0.00088	0.0205	<i>3.0</i>	<i>0.0050</i>	7.48	Grab
10-Jul-05	16-Jul-05	<i>0.00020</i>	0.00042	0.0444	0.00042	0.00081	0.0179	<i>3.0</i>	0.0090	7.59	Grab
17-Jul-05	23-Jul-05	<i>0.00020</i>	0.00047	<i>0.0050</i>	0.00024	0.00105	0.0325	<i>3.0</i>	<i>0.0050</i>	7.56	Grab
24-Jul-05	30-Jul-05	0.00021	0.00050	<i>0.0050</i>	0.00020	0.00141	0.0405	<i>3.0</i>	<i>0.0050</i>	7.70	Grab
31-Jul-05	6-Aug-05	<i>0.00020</i>	0.00052	<i>0.0050</i>	0.00047	0.00166	0.0356	<i>3.0</i>	<i>0.0050</i>	7.65	Grab
7-Aug-05	13-Aug-05	<i>0.00020</i>	0.00052	<i>0.0050</i>	0.00111	0.00149	0.0310	<i>3.0</i>	0.0080	7.79	Grab
14-Aug-05	24-Aug-05 ³	<i>0.00020</i>	0.00101	<i>0.0050</i>	0.00093	0.00474	0.0905	4.8	0.0090	8.13	Grab
21-Aug-05	27-Aug-05	<i>0.00020</i>	0.00079	<i>0.0050</i>	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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L and pH which is in pH units

Note² - "nd" refers to no effluent discharge to sample

Note³ - 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

Note¹ - All concentrations are in mg/L except Radium 226 which is Bq/L

Note² - "nd" refers to no effluent discharge to sample

Note³ - 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		DAILY MASS LOADING OF DELETERIOUS SUBSTANCE (kg/day) ¹								Average Daily
During The	Date									Flow Rate
Week of	Sample Taken	Arsenic	Copper	Cyanide	Lead	Nickel	Zinc	TSS	Radium 226 ¹	(m ³ /day) ⁴
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

Note¹ - Mass Loading is in kilograms per day of the deleterious substance deposited except Radium 226 which is in Bq per day

Note² - "nd" refers to no effluent discharge to sample

Note³ - August 24 data are presented in the week of the August 14th

Note⁴ - 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

Note¹ - Total Mass Loading for Calendar month calculated by multiplying the Average Daily Mass Loading for the Month x # days in the month

Note² - Mass loading units are in kg per month except Radium 226, which is in Bq per month

Note³ - Average Weekly Flow Rate calculated by multiplying Average Daily Flow Rate x 7 days per week

Note⁴ - 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 <i>Daphnia magna</i> (yes or no)
16-Jul-05	No	No
6-Aug-05	No	No

Non-compliance Information

If effluent was non-compliant with the authorized limits set out in Schedule 4, indicate the cause(s) of non-compliance and remedial measures planned or implemented. Also indicate remedial measures 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"

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 (cyanate hydrolysis 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.

¹Original data reports are available upon request²SPR-IDA = Suspended Particulate Resin consisting of immobilized iminodiacetate on a divinyl benzene polymer is used to chelate and preconcentrate metals in seawater (preparation technique).³Instrumental analysis is by ICPMS = Inductively Coupled Mass Spectrometry.⁴This analysis is carried out using procedures adapted from "Standard Methods 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 emissions spectrophotometry ICPOES (EPA Method 6010B).⁵All 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: Northing: Easting:	Garrow Bay at Mouth of Garrow Creek Confluence		Garrow Bay ~1km NE of exposure station (confluence with Garrow Creek).				
	75°22'15"		75°22'40"				
	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.

¹Original data reports are available upon request

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

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

⁴This analysis is carried out using procedures adapted from "Standard Methods 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 emissions spectrophotometry ICPOES (EPA Method 6010B).

⁵All 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.

⁶Temperature and dissolved oxygen data are estimated pending verification by Teck Cominco.

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results¹ 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			Final Discharge Point			~1km NE of confluence with Garrow Creek		
Sampling Date:		6-Jul-05			16-Jul-05			6-Aug-05		
		RPD ²			RPD ²			RPD ²		
		RPD ²			RPD ²			RPD ²		
		RPD ²			RPD ²			RPD ²		
		RPD ²			RPD ²			RPD ²		
		RPD ²			RPD ²			RPD ²		
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		RPD ²			RPD ²			RPD ²		

Table 5. 2005 3rd Quarter Polaris Mine QAQC Sample Results¹ 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

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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 LC₅₀
- 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	Temperature (0hr)	Temperature (48 hr)	Dissolved Oxygen (0hr)	Dissolved Oxygen (48hr)	pH (0hr) pH units	pH (48hr) pH units	Conductivity (0hr) umhos/cm
	(% v/v)	(°C)	(°C)	(mg/L)	(mg/L)			
Test 1 16-Jul-05	0 (Control)	15	15	10.1	9.7	7	6.7	37
	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 19-Aug-05	0 (Control)	15	15	10.1	9.3	7	7	40
	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 LC₅₀ 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 LC₅₀ = 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 LC₅₀ = 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* LC₅₀
- 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 16-Jul-05	0 (Control)	20	21	9.1	8.7	7.6	7.6	344	94
	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 19-Aug-05	0 (Control)	20	21	9.1	8.6	7.4	7.6	354	94
	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 LC₅₀ = > 100% effluent
 - Test 2: 48-h LC₅₀ = > 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 LC₅₀ = 426 µg/L Zinc, 95% CL = 362 – 504 µg/L
 - Test 2: (Aug-15-05) 96-h LC₅₀ = 481 µg/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 LC₅₀ = 445 (+/- 280) µg/L Zinc
 - Test 2: 96-h LC₅₀ = 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 $<3^{\circ}\text{C}$ and dissolved oxygen was maintained at $>6\text{mg/L}$ during transport
 - Temperature change was $<2^{\circ}\text{C}$ 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 $\text{DO}=\text{supersaturated}$, $\text{pH} = 7.3$, $T = 21^{\circ}\text{C}$, salinity = 33ppt
 - Organisms were acclimated to EVS water holding conditions of $\text{DO} = 7.5 \text{ mg/L}$, $\text{pH} = 7.8$, $T=20^{\circ}\text{C}$ 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: $\text{pH} 7.7$, $T 20.0^{\circ}\text{C}$, $\text{DO} 11.1 \text{ mg/L}$, $C 1520 \mu\text{mhos/cm}$
 - Test 2: $\text{pH} 7.7$, $T 20.0^{\circ}\text{C}$, $\text{DO} 9.8 \text{ mg/L}$, $C 2700 \mu\text{mhos/cm}$
- 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 μ m 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:
 - o 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).
 - o 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, 0.45 μ m-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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality on the Day of Test						
		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
4.5%	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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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 (% effluent v/v)	Replicate	Number of Survivors - Day of Test							% Mortality - Day of Test						
		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 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	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 (% effluent v/v)	Replicate					Overall Mean	Standard Deviation
	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 LC₅₀ (95% CL)
 - Test 1: 7-d LC₅₀ concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Test 2: 7-d LC₅₀ concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Quantal statistic methods not applicable
- iv. Estimate of 7-d IC₂₅ (95% CL) for growth
 - Test 1: 7-d IC₂₅ concentration > 71.4% effluent (highest concentration tested due to dilution for salinity adjustment)
 - Test 2: 7-d IC₂₅ concentration > 67.4% effluent (highest concentration tested due to dilution for salinity adjustment)
- v. Current reference toxicity tests (95% CL) for 7-d LC₅₀ for survival and 7-d IC₅₀ 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 LC₅₀ survival = 117 mg/L Cu, 95% CL = 100-136 mg/L
 - 7-d IC₅₀ 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 LC₅₀ survival = 103 mg/L Cu, 95% CL = 91-118 mg/L
 - 7-d IC₅₀ growth = 95 mg/L Cu, 95% CL = 75-127 mg/L
- vi. Reference toxicity warning limits (+/- SD) for 7-d LC₅₀ for survival and 7-d IC₅₀ for growth
 - Test 1: Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 133 ± 39mg/L Cu
 - 7-d IC₅₀ growth = 132 ± 46mg/L Cu
 - Test 2: Reference toxicity tests for Toxicant: Copper
 - 7-d LC₅₀ survival = 132 ± 40mg/L Cu,
 - 7-d IC₅₀ 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 – EPS1/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

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

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 IC₂₅ (95% CL) for fertilization success
 - Test 1: IC₂₅ concentration = 5.2 (4.4 – 6.0)% v/v effluent
 - Test 2: IC₂₅ concentration = 15.6 (13.6 – 18.3)% v/v effluent
 - Quantitative statistic used to generate IC₂₅ 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 IC₅₀ 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
 - IC₅₀ 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
 - IC₅₀ for fertilization = 3.9 mg/L SDS, 95% CL = (3.6 – 4.1) mg/L
- iv. Reference toxicant warning limits (+/- 2SD) for IC₅₀ 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

Reporting Requirements for Reference Method EPA/600/4-91-003, Method 1009.0 **(Champia)**

- 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 3rd 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. LC₅₀ 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 IC₂₅'s were 5.2, and 15.6% v/v, and
- the IC₅₀'s were 13.2, and 55% v/v

In the *Champia parvula* sexual reproduction test

- the IC₂₅'s were 24.6, and 45.3% v/v,
- the IC₅₀ 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 IC₂₅'s, and 2.4 and 19.6 µg Zn/L for the IC₅₀. Reference toxicity tests of zinc on *Dendraster* fertilization give mean EC₅₀ concentrations of 8.5 – 60 µg Zn/L (Dinnel et al. 1983). The reported range of *Dendratster* EC₅₀'s correspond to the August 6, 2005 IC₅₀ of 19.6 µg Zn/L. The IC₅₀ zinc concentration in the July 16, 2005 sample is lower than the literature EC₅₀'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 (IC₂₅'s), and 21.9 µg Zn/L (IC₅₀ in the August 6, 2005 sample). The reference IC₂₅ 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 and 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

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

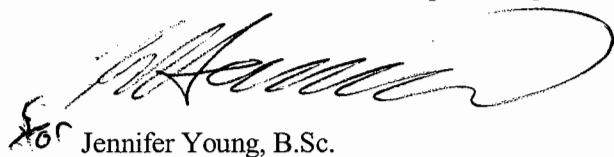
We are pleased to provide you with the results of the toxicity tests performed on the effluent sample identified as G-Creek-acute-071605 collected July 16, 2005. The sample was tested with the 48-h *Daphnia magna* and the 96-h rainbow trout LC50 toxicity tests. The tests were performed according to the 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.

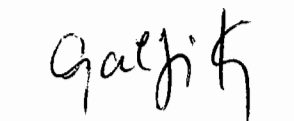
Yours very truly,

EVS ENVIRONMENT CONSULTANTS
A Member of the Golder Group of Companies

Verified By:


for Jennifer Young, B.Sc.

Bioassay Team Leader – Cladoceran Team


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 <i>Daphnia magna</i>	96-h Rainbow Trout -
		LC50 (95% CL) % (v/v)	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 Azimoth
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 @ 7.4
Dissolved Oxygen (mg/L) 10.8 @ 8.9
Conductivity (µmhos/cm) 1566
Hardness (mg/L as CaCO₃) 160
Alkalinity (mg/L as CaCO₃) —
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 (July 13B)
Temperature (°C) 20.0
pH 7.6
Dissolved Oxygen (mg/L) 9.1
Conductivity (µS/cm) 344
Hardness (mg/L as CaCO₃) 94
Alkalinity (mg/L as CaCO₃) 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) µg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 µg/L Zn ; CV = 31

TEST CONDITIONS

Temperature Range (°C) 20.0 - 21.0
pH Range 7.4 - 7.7
Dissolved Oxygen Range (mg/L) 8.7 - 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 Gachif

Date Verified Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimvth
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500297
 Daphnid Broodstock Batch 05 July A/B

Sample ID G-Greek-Acute-071605
 Date Collected 16 July 05
 Test Initiation Date/Time 19 July 05 @ 16:00
 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	848	647
50				10	10	8.8	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						ML	SXB	SXB	ML	SXB	SXB	ML	SXB	SXB	ML	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 Date Verified By Gach Date Verified Aug. 16/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client Azimuth
EVS Project No. 04-1424-044
EVS Work Order No. 050096

EVS Analysts MSG, RCH
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 CaCO₃) 14
Alkalinity (mg/L as CaCO₃) 8
Other ✓

TEST SPECIES INFORMATION

Source San 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% (6/6)

Data Verified By Galpi

Date Verified Aug. 4/05

**EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA**

WHOLE SAMPLE WATER QUALITY

Temp. (°C)	pH	After 30-min Pre-aeration
15	7.3	15
DO (mg/L)	10.4	10.2
Cond. (µS/cm)	1445	1445

1. Document pH adjustment procedure (if used) under "Comments".

Client Arizona
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500296
 Trout Batch No. and 7-d Acclimation Mortality 062205/0.1%
 No. Fish/Volume 10/10L
 Sample ID C7-Creek
 Date/Time Collected July 16/05 @ 0900
 Test Initiation Date/Time July 21/05 @ 1035

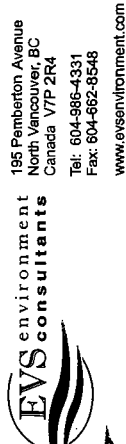
Total Pre-Aeration Time 30 min

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	10.1	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	6.8	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	6.8	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																										

WQ Instruments Used: calibrated Hg
 Sample Description: clear
 Comments: Fluorometer

Test Set Up By RCH Date Verified By Gajich Date Verified Aug. 4/05

CHAIN-OF-CUSTODY/TEST REQUEST FORM



195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-682-8548
www.evsenvironment.com

Shipping Date: July 16/05

Ship to: BILL TO AZIMUTH CONSULTING GROUP

Client Name: Blake Hamer Phone: (250) 427-5451
Address: Bay 2000 Fax: (250) 427-5451
VIA 3EI Sampled By: Blake Hamer

Collection Date (dd/mm/yy)	Time (24-h clock)	Sample Identification	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 (ie., 1 x 20 L)	Sample Container Type by Code	Test(s) Requested				Notes? (e.g. preserved, saltwater, freshwater, may contain sewage)	Receipt Sample Temp. (C)	Condition/Integrity	EVS Receipt Check List
								96-hr LC50	48-hr LC50	7-day Toxicity Test	20 min. Equilibrium				
16/07/05	0900	G-Creek-Acute-071605 E			G	2 x 20 P	P	X	X			Eluent Water			1. Signatures & dates correct? ☒ Y N
16/07/05	0900	G-Creek-Sublethal-071605 E			G	3 x 20 P	P		X	X		Eluent Water			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.: Temp: 12.7C
Project Title: Polaris MMR -
Results Needed By: Rolling Two Around
Comments/Instructions: Bill to Azimuth Consulting Group
Electronic Receipt, for Check Mark at job, Azimuth, email: info@azimuthgroup.ca
Brice Donald, Test for az, ~~Brice Donald, Test for az, Brice.Donald@azimuthgroup.ca~~

A) Released By: Blake Hamer Date: July 16, 2005
Company: GCL Time: 1030
Courier name: _____
Shipping containers secured by: Tape Straps Lock Other _____
Custody seals used? Yes No

B) Received by: Spp Date: 19 July 05
Company: Golden Time: 10:45
Shipping containers received secure? ☒ Yes No
Custody seals intact? ☒ Yes No

C) Released By: _____ Date: _____
Company: _____ Time: _____
Courier name: _____
Shipping containers secured by: _____ Tape Straps Lock Other _____
Custody seals used? Yes No

D) Received by: _____ Date: _____
Company: _____ Time: _____
Shipping containers received secure? Yes No
Custody seals intact? Yes No

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

Revision Date: Sept. 25, 2000

Golder Associates Ltd.

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

August 31, 2005

E/05/0341
04-1424-044

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**

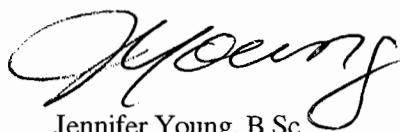
Dear Ms. Mackintosh

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

Verified By:


Jennifer Young, B.Sc.
Bioassay Team Leader – Cladoceran Team


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 <i>Daphnia magna</i>	96-h Rainbow Trout -
		LC50 (95% CL) % (v/v)	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
Dissolved Oxygen (mg/L) 10.8 → 8.9
Conductivity (μmhos/cm) 2850
Hardness (mg/L as CaCO₃) ~ 300
Alkalinity (mg/L as CaCO₃) —
Ammonia (mg/L N) —
Chlorine (mg/L Cl) —

pH adjustment details: none
Pre-aeration rate and duration: 15 Min @ 25 to 50 m³/min

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 CaCO₃) 300 94
Alkalinity (mg/L as CaCO₃) 70
Other —

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 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) μg/L Zn
Reference Toxicant Warning Limits (mean ± 2SD) and CV
445 ± 280 μg/L Zn / CV = 31

TEST RESULTS The 48hr LC50 of Garrow Creek is >100% (V)

Data Verified By Galpin Date Verified Aug. 31/05

EVS ENVIRONMENT CONSULTANTS
48-h *Daphnia magna* ACUTE TOXICITY TEST DATA

Client Azimuth Consulting Group
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500335
 Daphnid Broodstock Batch 18 July A/B/C

Sample ID 6-Creek Garrow Creek
 Date Collected 06 Aug 05
 Test Initiation Date/Time 11 Aug 05 @ 10:30
 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	2760
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 HA-020501 DO HA-011201 Cond. HA-990901
 Comments _____

Test Set Up By SXB Date Verified By Galpin Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY

Client Arimuth
EVS Project No. 04-1424-044
EVS Work Order No. 0500334

EVS Analysts AXF RER
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 CaCO₃) 14
Alkalinity (mg/L as CaCO₃) 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% (0/10)

Data Verified By Qualifit

Date Verified Aug. 30/05

EVS ENVIRONMENTAL CONSULTANTS RAINBOW TROUT ACUTE TOXICITY TEST DATA

WHOLE SAMPLE WATER QUALITY

Temp. (°C)	Initial	pH Adjustment ¹	After 30-min Pre-aeration
	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".

Client Azimut
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500334
 Trout Batch No. and 7-d Acclimation Mortality 06220510.16
 No. Fish/Volume 10/10L
 Sample ID Charron 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				16	10	10	10	10.1	9.2	9.4	9.4	9.3	15	15	15	15	15	7.0	7.1	6.8	6.9	7.0	410	51		
6.25				10	10	10	10	10.1	9.0	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	10.2	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	10.2	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	10.3	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	10.5	10.5	9.7	15	15	15	15	15	7.4	7.3	7.0	7.1	7.3	2510	2850		
Technician Initials																										

WQ Instruments Used: calibrated DO meter
 Sample Description: clear
 Comments: Re-calibrated DO meter

pH II-A-3 DO II-A-3 Conductivity II-A-030304

Test Set Up By port Date Verified By gajich Date Verified Aug 30/05

62-117000



195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date_

Client Name Tack Cominco Client Contact B. Bruce Dorman D Ship to _____
Address Box 2000 Phone 250-427-8408 _____
Kimberly BC Fax 250-427-8451 _____
VIA 361 Sampled by B. Botton Attn. Edward Cominco

[illegible]

- 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

Work Order : 207782
Sample Number : 13103

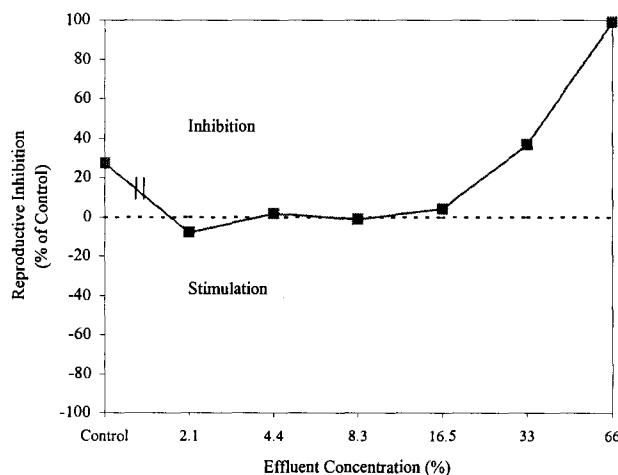
Sample Identification

Company :	Azimuth Consulting Group Inc.	Date Collected :	2005-07-16
Location :	Vancouver, BC	Time Collected :	09:00
Substance :	G-Creek Sublethal 071605	Date Received :	2005-07-19
Sampling Method :	Grab	Time Received :	13:00
Sampled By :	B. Hamer	Date Tested :	2005-07-19
Shipped By:	Fed Ex/Rd	Lab Storage:	4±2 °C
Temp. on arrival :	18.0°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	: <i>Champia parvula</i>	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

Concentration (%)	Exposure Period									
	♂ 0 Hours		♀ 0 Hours		♂ 48 Hours		♀ 48 Hours		♀ Test Completion	
	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: 
 Date: 2025-08-11

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						48 hours					
Date & Time : 2005-07-19 17:45						Date & Time : 2005-07-21 16:00					
Analyst(s) : EJ/KJ						Analyst(s) : KJ					
Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O ₂ Sat. (%) [†]	Salinity (‰)	Temperature (°C)	Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O ₂ Sat. (%) [†]	Salinity (‰)	Temperature (°C)
66	7.8	7.8	106	32	22.5	66	8.8	7.7	99	31	23.0
33	7.7	7.3	102	32	22.5	33	8.9	7.0	98	31	23.0
16.5	7.7	7.2	100	32	22.5	16.5	8.7	6.9	98	31	23.0
8.3	7.7	7.1	100	32	22.5	8.3	9.1	6.9	97	31	22.0
4.4	7.7	7.3	103	32	22.5	4.4	8.7	6.8	96	30	22.5
2.1	7.7	7.0	99	32	23.0	2.1	8.9	6.6	94	30	22.0
Salt Control	7.7	5.9	83	30	24.0	Salt Control	9.0	6.2	91	30	22.0
Control	7.7	6.4	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						Test Completion					
Date & Time : 2005-07-21 16:00						Date & Time : 2005-07-28 16:00					
Analyst(s) : KJ						Analyst(s) : EJ					
Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O ₂ Sat. (%) [†]	Salinity (‰)	Temperature (°C)	Test Conc. (%)	pH	Dissolved Oxygen (mg/L)	O ₂ Sat. (%) [†]	Salinity (‰)	Temperature (°C)
66	7.5	6.6	93	30	22.0	66	8.0	7.4	92	30	22.0
33	7.5	6.6	93	30	22.0	33	8.0	7.5	93	30	22.0
16.5	7.5	6.6	93	30	22.0	16.5	8.0	7.3	91	30	22.0
8.3	7.5	6.6	93	30	22.0	8.3	8.1	7.4	92	30	22.0
4.4	7.5	6.6	93	30	22.0	4.4	8.0	7.5	93	30	22.0
2.1	7.5	6.6	93	30	22.0	2.1	8.0	7.5	93	30	22.0
Salt Control	7.5	6.6	93	30	22.0	Salt Control	8.1	7.5	93	30	22.0
Control	7.5	6.6	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 applicable² @ <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:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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 <i>Artemia</i> 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
D-Control	100.0 $\pm$ 0.0	0.92 $\pm$ 0.13
Brine Control	100.0 $\pm$ 0.0	0.98 $\pm$ 0.18
Pooled Controls	100.0 $\pm$ 0.0	0.95 $\pm$ 0.15
4.5	96.0 $\pm$ 8.9	0.77 $\pm$ 0.19
8.9	96.0 $\pm$ 8.9	0.82 $\pm$ 0.33
17.9	100.0 $\pm$ 0.0	1.01 $\pm$ 0.14
35.9	100.0 $\pm$ 0.0	1.07 $\pm$ 0.19
71.4	96.0 $\pm$ 8.9	0.91 $\pm$ 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 $\pm$ SD)
Negative Control	64.8 $\pm$ 3.8
Brine Control	69.0 $\pm$ 1.8
Pooled Control	66.9 $\pm$ 3.6
4.6	53.0 $\pm$ 2.2*
9.1	37.2 $\pm$ 1.3*
18.2	30.0 $\pm$ 2.2*
36.5	23.5 $\pm$ 2.9*
72.8	19.5 $\pm$ 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.
- 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 Polaris
 EVS Project No. 04-1424-064
 EVS Work Order No. 0500258^m 298

EVS Analysts JXS, SxR, MJG, AXF
 Test Initiation Date 19-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	<u>G Creek</u> ^{sublethal} <u>1071605</u>	<u>G Creek</u>	<u>G Creek</u>
Amount Received	<u>18³⁰ x 20L</u>	<u>1 x 20L</u>	<u>1 x 20L</u>
Date Collected	<u>16 Jul 05</u>	<u>16 Jul 05</u>	<u>16 Jul 05</u>
Date Received	<u>19 Jul 05</u>	<u>19 Jul 05</u>	<u>19 Jul 05</u>
Temperature (°C)	<u>20.0</u>	<u>20.0</u>	<u>20.0</u>
pH	<u>7.7</u> ^⓪ <u>8.2</u>	<u>7.8</u> ^⓪ <u>8.2</u>	<u>7.7</u> ^⓪ <u>8.3</u>
DO (mg/L)	<u>11.1</u> ^⓪ <u>7.6</u>	<u>11.0</u> ^⓪ <u>7.6</u>	<u>10.8</u> ^⓪ <u>7.6</u>
Conductivity (umhos/cm)	<u>1520</u>	<u>1520</u>	<u>1520</u>
Salinity (ppt)	<u>6</u> ^⓪ <u>29</u>	<u>6</u> ^⓪ <u>29</u>	<u>6</u> ^⓪ <u>29</u>
Ammonia (mg/L N)	<u>-</u>	<u>-</u>	<u>-</u>
Chlorine (mg/L Cl)	<u>-</u>	<u>-</u>	<u>-</u>
Other	<u>⓪ After Salinity Adjustment</u>		

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 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^{0.5} 30
 Photoperiod (L:D h) 16:8
 Aeration Provided? No
 Other -

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)^{RS?} 117 (100-136) ug/L Cu
 7-d growth IC50 112 (80-149) 110 (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 RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	<u>Y (100)</u>	<u>71.4</u>	<u>> 71.4</u>	<u>771.4</u>		
Growth		<u>71.4</u>	<u>> 71.4</u>		<u>> 71.4</u>	<u>> 71.4</u>

Other -

Data Verified By Gulph

Date Verified Aug. 22/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Polaris
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500298

Sample ID G-Creek ^{Sublethal} 071605
 Test Initiation Date/Time 19-July-05/1430
 Source/Date Received ABS/19-July-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	21.0	20.0	21.0	20.0	21.0	20.0	21.0	20.0	20.0
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
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
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	TS	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	ML

Concentration % (v/v)	pH													
	0	old	1 new	2	3	4	5	6	7					
D-control	7.8	7.7	7.7	7.7	7.8	7.8	7.8	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	7.8	8.2	7.9	8.3	8.0	8.3	8.0	8.2	8.0	8.3	7.8
Tech. Initials	TS	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	TS

WQ Instruments Used: Temp. Calibrated Hg thermometer

pH I-A-030301

Comments D 132 I-A-51

Test Set Up By TS, SXB

Data Verified By Qualif

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} 07/605

EVS Project No. 04-1424-044

Test Initiation Date/Time 19-July-05 / 1430

EVS Work Order No. 050028 298

Source/Date Received ABS / 19-July-05

Concentration % (v/v)	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	107	SXB	SXB	SXB	SXB	SXB	SXB	SXB	ML	SXB	ML	SXB	ML	107

Concentration % (v/v)	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	107	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	107

WQ Instruments Used: Salinity FA-020303

DO II-A-14

Comments _____

Test Set Up By JMS, SXB

Date Verified By _____

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 ~~258~~ 298

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 5/200ml

Concentration <i>✓</i>	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	SXB	SXB	SXB	M7L	M7L	MT	TM	

Sample Description colorless, clear.

Data Verified By Galpin

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. 0500258398

Sample ID G-Creek ^{Sublethal} 071605

Test Species/Batch 4 - affinis / 19-July-05

Test Initiation Date/Time 19-July-05 / 1430h

No. of Organisms/Volume 5/200ml

Y. (%) 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~~ ^{res} 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	5	
	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		Taj	SXB	SXB	SXB	MIL	MIL	MIL	Taj	

Sample Description colorless clear

Data Verified By Gulick

Date Verified Aug. 18/05

EVS ENVIRONMENTAL CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST - DRY WEIGHT DATA

Client Pelamis Start Date (Day 0) 19-July-05 sublethal
 EVS Project No. 04-1424-044 Sample ID G-Creek
 EVS Work Order No. 0500288 Balance Type/Serial Number Scout/101 / Bp-211D

Sample ID (% $\sqrt{N}$)	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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		AKC/101
	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	1236.489	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	1220.90	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 $\leq 10\%$ of organism weight.

Data Verified By Opah Date Verified Aug. 17/05

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST - DRY WEIGHT DATA

EVS ENVIRONMENTAL CONSULTANTS

Client Polaris
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500188

Start Date (Day 0) 19-July-05
 Sample ID G-creek 077605 Sublethal 07/605
 Balance Type/Serial Number Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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/12.3
	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	1229.72	1234.23	5	5		
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 $\leq 10\%$ of organism weight.

Data Verified By Galpi 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
 EVS Project No. 04-1424-044 Sample ID G-creek 07/05
 EVS Work Order No. 0500188 Balance Type/Serial Number Sartorius / BP-211D

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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		AYW
	B	T32	1236.90	1234.21	4	4		
	C	T33	1234.94	1239.77	5	5		
	D	T34	1230.30	1235.80	5	5		
	E	T35	1232.19	1234.503	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 Qachif 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

Qalyh
Aug. 18/05

Larval Fish Growth and Survival Test-7-d survival

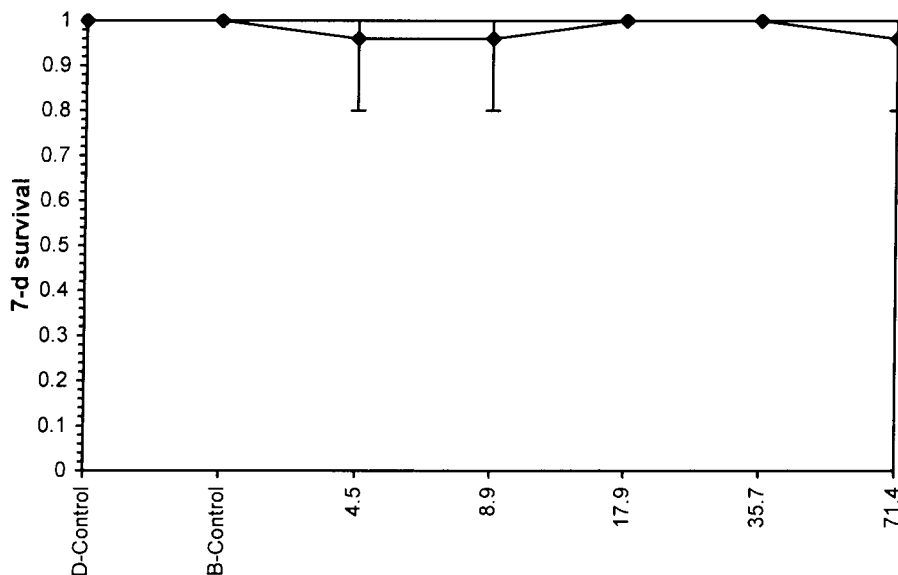
Start Date: 7/19/2005 Test ID: 500298 Sample ID: G_CREEK_Sublethal_071605
 End Date: 7/26/2005 Lab ID: BCEVS-EVS Environment Co Sample Type: EFF2-Industrial
 Sample Date: Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth(Polaris) 04-1424-044

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 ($p \leq 0.01$)	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.

Qay
Aug. 18, 2005

Larval Fish Growth and Survival Test-7-d survival

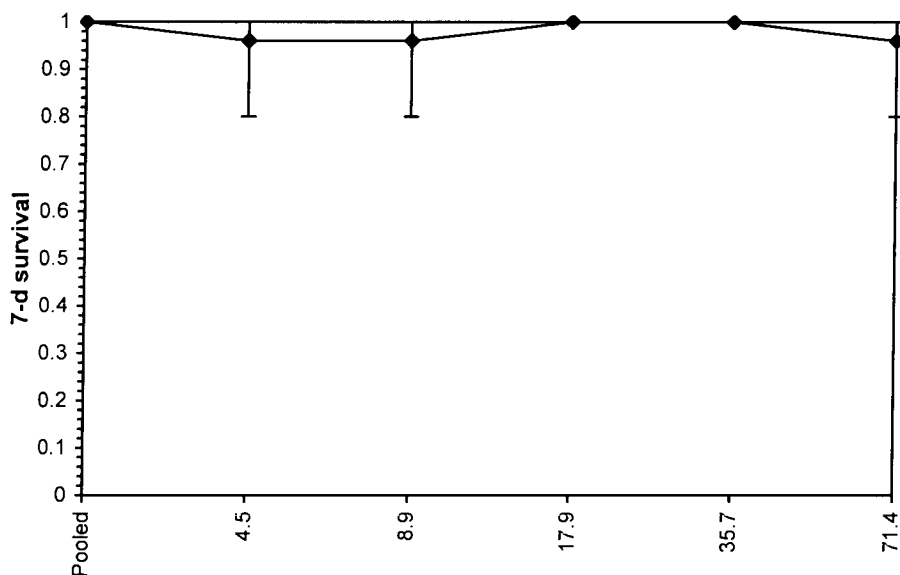
Start Date: 7/19/2005	Test ID: 500298	Sample ID: G_CREEK_Sublethal_071605
End Date: 7/26/2005	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth(Polaris) 04-1424-044		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
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 against the pooled controls.

Larval Fish Growth and Survival Test-7 Day Growth (US)

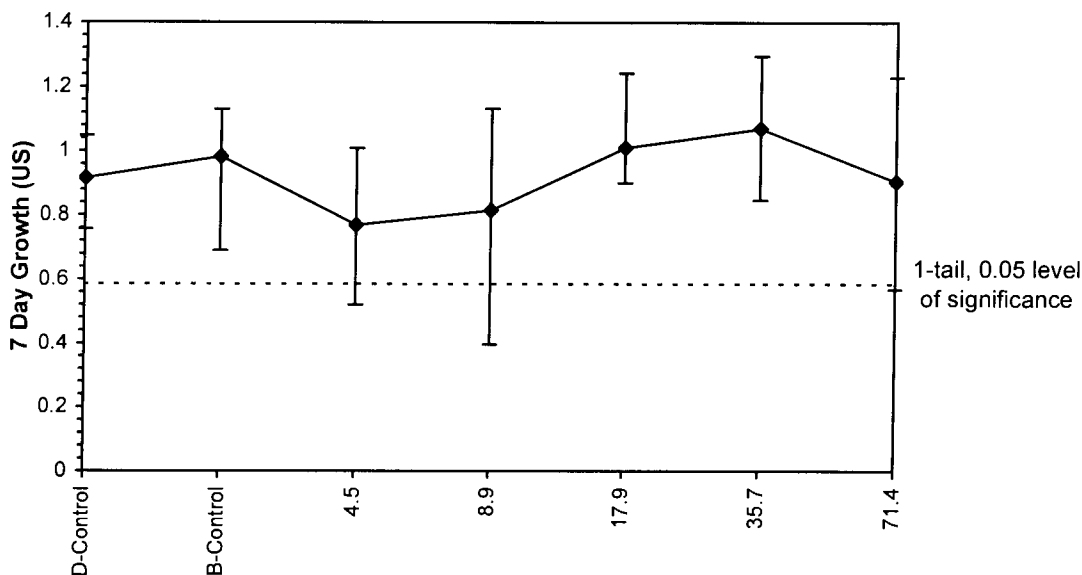
Start Date: 7/19/2005 Test ID: 500298 Sample ID: G_CREEK_Sublethal_071605
 End Date: 7/26/2005 Lab ID: BCEVS-EVS Environment Co Sample Type: EFF2-Industrial
 Sample Date: Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth(Polaris) 04-1424-044

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

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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.

Larval Fish Growth and Survival Test-7 Day Growth (US)

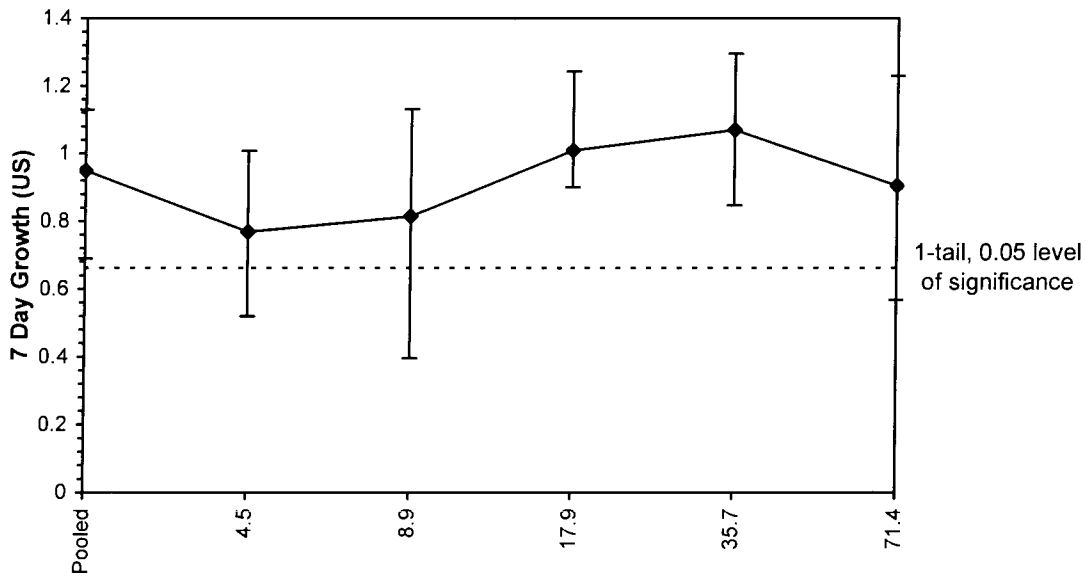
Start Date: 7/19/2005 Test ID: 500298 Sample ID: G_CREEK_Sublethal_071605
 End Date: 7/26/2005 Lab ID: BCEVS-EVS Environment Co Sample Type: EFF2-Industrial
 Sample Date: Protocol: EPAW 95-EPA West Coast Test Species: AA-Atherinops affinis
 Comments: Azimuth(Polaris) 04-1424-044

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

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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}.

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. 0500258292

EVS Analysts JXS, SxB, MJC, AXF
 Test Initiation Date 17-July-05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100 mg/L Cu Stock (05-14-001)		
Amount Received	1 x 1 L		
Date Collected	7 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 Filtered, UV sterilized seawater
 Temperature (°C) 20.0
 pH 7.8
 Dissolved Oxygen (mg/L) 7.5
 Salinity 28

TEST CONDITIONS

Temperature Range (°C) 20.0 - 21.0
 pH Range 7.7 - 8.0
 Dissolved Oxygen Range (mg/L) 6.3 - 7.7
 Salinity (ppt) 28
 Photoperiod (L:D h) 16:8
 Aeration Provided? No
 Other -

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 July 05
 7-d survival LC50 122 (106-140) 117 (100-136) µg/L Cu
 7-d growth IC50 112 (80-147) 116 (81-156) µg/L Cu
 Reference Toxicant Warning Limits (mean ± 2SD) and CV
 7-d survival LC50 133 ± 39 µg/L Cu CV=15%
 7-d growth IC50 132 ± 46 µg/L Cu CV=17%

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	µg/L Cu	100	180	117 (100-136)		
Growth		56	100	122 (106-140)	116 (81-156)	83 (68-114)

Other -

Data Verified By Galpich

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. 0500258 298
RSO

Source/Date Received ABS/19-July-05

Cu (µg/L) Concentration	Temperature (°C)													
	0	old	new	2		3		4		5		6		7
0-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	20.0
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	20.0	21.0	20.0	21.0	20.0	20.5
								21.0						
								MyG						
Tech. Initials	WJ	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	ML

Cu (µg/L) Concentration	pH													
	0	old	new	2		3		4		5		6		7
0-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	WJ	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	ML

WQ Instruments Used: Temp. Calibrated Hg thermometer

pH IL-A-030301

Comments

Test Set Up By Jos. SXB

Data Verified By

Galpi

Date Verified

Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client (Polaris) Azimoth

Sample ID Cu Reference Toxicant

EVS Project No. 04-1424-044

Test Initiation Date/Time 19-July-05/1440h

EVS Work Order No. 050058 298
RSP

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	72	SXB	SXB	SXB	SXB	SXB	SXB	SXB	ML	SXB	ML	SXB	ML	SXB

Cu (mg/L) Concentration	Dissolved Oxygen (mg/L)													
	0	1	2	3	4	5	6	7						
0-control	7.5	6.3	7.5	6.7	7.5	6.6	7.5	6.6	7.7	6.5	7.7	6.6	7.7	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	6.6
320	7.5	6.6	7.5	6.7	7.5	6.7	7.5	6.5	7.7	—	—	—	—	—
									ML					
Tech. Initials	72	SXB	SXB	SXB	SXB	SXB	SXB	ML	ML	ML	ML	ML	ML	72

WQ Instruments Used: Salinity I-A-030303

DO I-A-814

Comments

Test Set Up By JLS SXB

Date Verified By Galt

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. 0588 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	5	
	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		TL	SXB	SXB	SXB	ML	ML	ML	ML	

Sample Description clear, colorless.
 Data Verified By Galfin Date Verified Aug. 17/05

7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

EVS Work Order No. 0500-48 292
150

No. of Organisms/Volume $5/200 \text{ ml}$

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	—	
	B	471	5	5	4	4	4	3 ^{ML}	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		MS	SXB	SXB	SXB	ML	ML	ML	MS	

Date Verified Aug. 17/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST - DRY WEIGHT DATA

Zimuth (Polaris)

19-July-05

54-1424-544

in Reference Toxicant

05002098

Number Scoring/BP-211D

[illegible]

1. Re-confirm weights for 10% of final weights and record under "Comments"; relative percent difference (RPD) between pairs of weights should be $\leq 10\%$ of organism weight.

galic

Aug. 18/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST - DRY WEIGHT DATA

Client

Azinath (Polaris)

EVS Project No.

04-1424-044

EVS Work Order No.

0500248

Start Date (Day 0)

19-Jul-05

Sample ID

On Reference Toxicant

Balance Type/Serial Number

Sartorius/BP-211 D

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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		AKF/27
	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 $\leq 10\%$ of organism weight.

Data Verified By

Qapich

Date Verified

Aug. 17/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* SURVIVAL AND GROWTH TOXICITY TEST - DRY WEIGHT DATA

Client

Azinuth (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

Sintering/BP-211 D

Sample ID	Rep.	Pan No.	Pan Weight (mg)	Final Weight (mg) (pan + biomass)	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		AKF
	B	A67	1237.38	1238.70	1	1		
	C	A68	1224.68	1228.49	4	4	confirmed 1228.25 mg	
	D	A69	1232.31	1236.61	4	4		
	E	A70	1244.03	1247.98	5	5		
180	A	A71	1239.12	1241.93	3	3	confirmed 1241.90 mg	
	B	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 $\leq 10\%$ of organism weight.

Data Verified By

Gajpich

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)

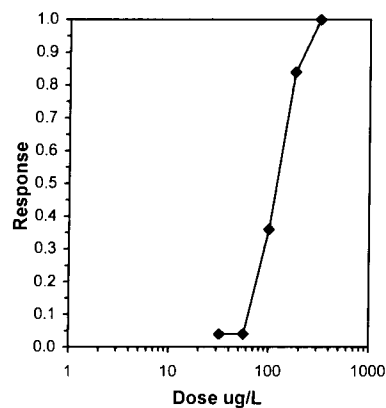
Galjit
Aug. 22/05

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

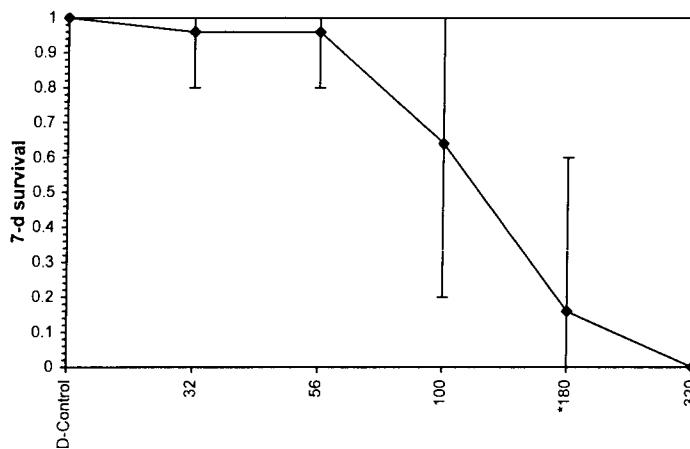
Transform: Arcsin Square Root							Rank Sum	1-Tailed Critical	Number Resp	Total Number	
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%					N
D-Control	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5			0	25
32	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	17.00	1	25
56	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5	25.00	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-Kärber			
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



Dose-Response Plot

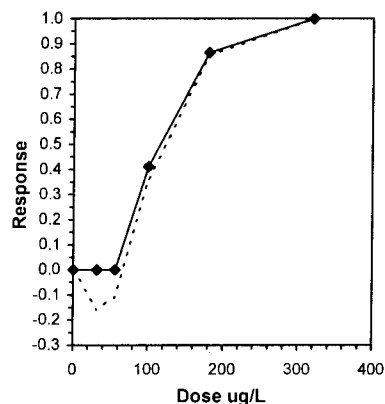


Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	7/19/2005	Test ID:	RTAACu45	Sample ID:	REF-Ref Toxicant
End Date:	7/26/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth 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

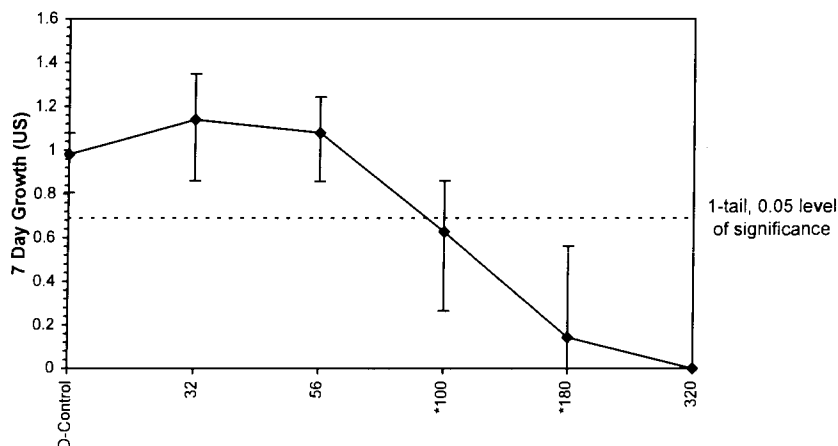
Conc-ug/L	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				Mean	N-Mean
D-Control	0.9816	0.1145	0.9816	0.8060	1.0780	11.666	5				1.0675	1.0000
32	1.1360	0.2038	1.1360	0.8560	1.3440	17.943	5	-1.219	2.300	0.2913	1.0675	1.0000
56	1.0848	0.1688	1.0848	0.8620	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



Qaif
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 $\rightarrow$ 15.0
pH 7.5 $\rightarrow$ 8.2
Dissolved Oxygen (mg/L) 11.1 $\rightarrow$ 8.5
Conductivity (μ mhos/cm) 1520
Salinity (ppt) 3.0 $\rightarrow$ 28
Ammonia (mg/L N) —
Chlorine (mg/L Cl) —
Other —
① Brine Adjustment

TEST SPECIES

Organism Dendrosten excentricus
Source Westwind Sea Lab
Date Received ~~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 $\pm$ 2SD) and CV
3.6 $\pm$ 4.4 mg/L SDS; CV = 60%

DILUTION/CONTROL WATER (initial water quality)

Water Type unsterilized; 0.45 μ m 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 $\rightarrow$ 8.3
Dissolved Oxygen Range (mg/L) ~~7.9~~ ^{SRS} 8.5
Salinity Range (ppt) 28
Sperm:Egg Ratio 2000:1
Test Duration 10:10
Other —

TEST RESULTS

Statistical comparisons were against pooled controls

IC₅₀: 13.2 (10.8 - 16.7) % v/v

IC₂₅: 5.2 (4.4 - 6.1) % v/v

NOEC: < 4.6 % v/v

LOEC: 4.6 % v/v

Data Verified By Golf 4

Date Verified Aug. 7/05

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 Echinoid #13 Pages 68-71

Test Initiation Date/Time 19 July 05 / 1514
 Test Species Dendraster excentricus
 Source/Date Received Westward Sealab / 19 July 05
 Test Duration 10:10

Sample ID	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
<u>G-Creek Sustained 071605</u>					
<u>Control</u>	<u>15</u>	<u>7.9</u>	<u>28</u>	<u>8.5</u>	
<u>Brine Control</u>	<u>15</u>	<u>8.3</u>	<u>28</u>	<u>8.5</u>	
<u>4.6% v/v</u>	<u>15</u>	<u>8.0</u>	<u>28</u>	<u>8.5</u>	
<u>9.1% v/v</u>	<u>15</u>	<u>8.1</u>	<u>28</u>	<u>8.5</u>	
<u>18.2% ^{SRS} v/v</u>	<u>15</u>	<u>8.1</u>	<u>28</u>	<u>8.5</u>	
<u>36.4% ^{SRS} v/v</u>	<u>15</u>	<u>8.1</u>	<u>28</u>	<u>8.5</u>	
<u>Max (22.8‰)</u>	<u>15</u>	<u>8.2</u>	<u>28</u>	<u>8.5</u>	
Technician Initials	<u>SRS</u>	<u>SRS</u>	<u>SRS</u>	<u>SRS</u>	

WQ Instruments Used: Temp. calibrated H₂ thermometer pH HA-03030 Salinity II-A-030304 DO II-A-20
 Sample Description sample is clean with no odour.
 Data Verified By Galpin 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 Dendrosten 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 Sublethal 071605 4.6	A	56	44		SRS
	B	51	49		
	C	52	48		
	D	53	47		
G-Creek Sublethal 071605 9.1	A	39	61		SRS
	B	37	63		
	C	37	63		
	D	36	64		
G-Creek Sublethal 071605 18.8 ^{ser}	A	33	67		SRS
	B	~~38~~ 28	72		
	C	29	71		
	D	30	70		
G-Creek Sublethal 071605 36.8 ^{ser}	A	20	80		SRS
	B	27	73		
	C	23	77		
	D	24	76		
G-Creek Sublethal 071605 Max (72.8)	A	20	80		SRS
	B	16	84		
	C	21	79		
	D	21	79		

Data Verified By

Galpin

Date Verified

Aug. 17/05

Test: SC-Sperm Cell Fertilization test

Species: DE-Dendraster excentricus

Sample ID: g_creek sublethal 071605

Start Date: 7/19/2004 10:10

End Date: 7/19/2004

Test ID: 0500299

Protocol: EPS1/RM/27-EC 92 (Sperm Cell)

Sample Type: GW-groundwater

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)

Galpik
Aug 19/07

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-Dendroaster excentricus
Comments:	Azimuth Consulting Group (Polaris) 04-1424-044 (0500299)				

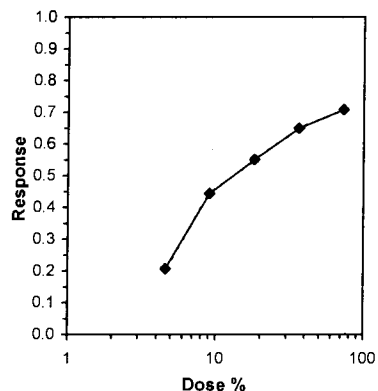
Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

Conc-%	Mean	SD	Transform: Untransformed					1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	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

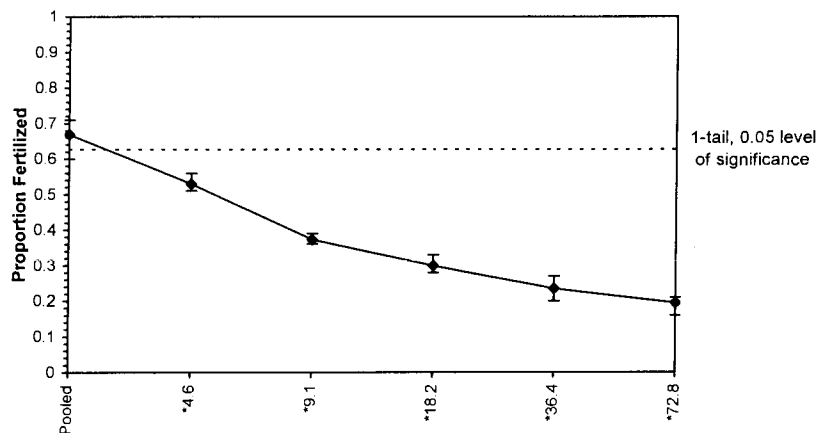
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.96577	0.896	-0.6264	0.89125		
Bartlett's Test indicates equal variances (p = 0.59)					3.72999	15.0863				
The control means are not significantly different (p = 0.09)					2.02707	2.44691				
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

Aug 19/05

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)				

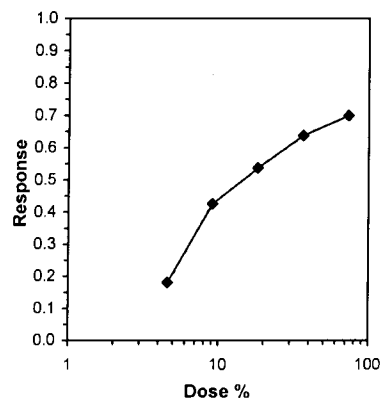
Conc-%	1	2	3	4
D-Control	0.6400	0.6000	0.6600	0.6900
B-Control	0.7000	0.6800	0.7100	0.6700
4.6	0.5600	0.5100	0.5200	0.5300
9.1	0.3900	0.3700	0.3700	0.3600
18.2	0.3300	0.2800	0.2900	0.3000
36.4	0.2000	0.2700	0.2300	0.2400
72.8	0.2000	0.1600	0.2100	0.2100

Conc-%	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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

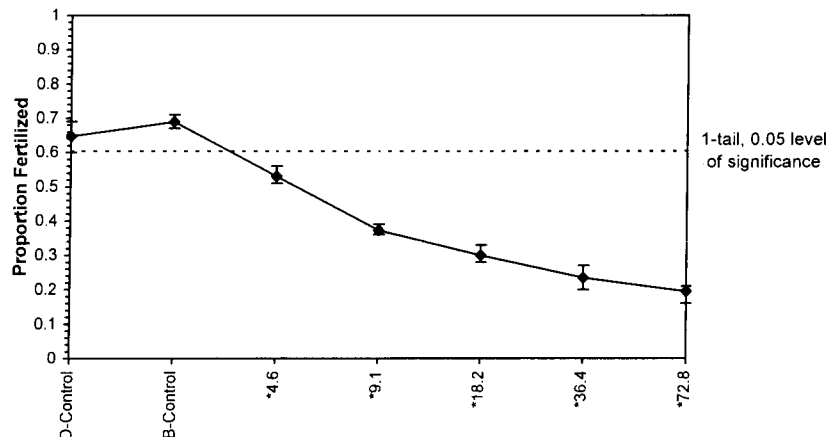
Auxiliary Tests					Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.98059	0.884	-0.1047	-0.1759
Bartlett's Test indicates equal variances (p = 0.67)					3.19845	15.0863		
The control means are not significantly different (p = 0.09)					2.02707	2.44691		
Hypothesis Test (1-tail, 0.05)					NOEC	LOEC	ChV	TU
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

[Signature]
Aug 19 10

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY

Client Azimuth Consulting (Pleasant Hill) EVS Analysts SRS
EVS Project No. 04-1424-044 Test Initiation Date 19 July 05
EVS Work Order No. 0500299

SAMPLE

Identification SDS Leftover Stock Silt #05-5-008
Amount Received 1 x 1 L
Date Collected 17-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 Dendroster excentricus
Source Westwind Seabeds
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

Gulph

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 Seabed / 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	8.5	
10.0	15	7.8	28	8.5	
Technician Initials	SRS	SRS	SRS	SRS	

WQ Instruments Used: Temp. Calibrated H₂ thermometer pH II-A-030301 Salinity II-A-080304 DO II-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. 0500299
 Logbook #13 Pages 68-71

Test Initiation Date/Time 19 July 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	~~46~~ 51	~~44~~ 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 Galpin

Date Verified Aug 17/05

Test: SC-Sperm Cell Fertilization test

Species: DE-Dendraster excentricus

Sample ID: REF-Ref Toxicant

Start Date: 7/19/2005 10:10

End Date: 7/19/2005

Test ID: rtdesds051

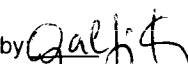
Protocol: EPS1/RM/27-EC 92 (Sperm Cell)

Sample Type: SDS-Sodium dodecyl sulfate

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)


 Aug. 17/05

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 Cr	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92	Sperm Test Species:	DE-Dendroaster excentricus
Comments:	Azimuth Consulting Group 04-1424-044 (0500299)				

Conc-mg/L	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%			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

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	



APPENDIX III

Chain-of-Custody Form

***Champia parvula* Sexual Reproduction Test Results**

for Sample E452

for

Azimuth Consulting Group

by

Mary Moody
Environment and Minerals Division
Saskatchewan Research Council

***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 $\pm 2SD$
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	<i>M. Moody</i>
Date	<i>Aug 24/05</i>

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	<u>Champia parvula</u>	Appearance/Health of <i>Champia</i>	<u>excellent</u>
Source	<u>sexually mature male and female branches, obtained from USEPA, Hatfield Marine Science Center, Newport, Oregon, 1995</u>		
Females, Presence of Trichogynes	<u>yes</u>	Males, Presence of Sori with Spermatia	<u>yes</u>

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)	<u>270 ml transparent polystyrene cups, transparent polystyrene lids</u>		
Exposure Volume / Depth	<u>100 ml / 4.5 cm</u>	Recovery Volume / Depth	<u>200 ml / 7.3 cm</u>
Replicates/Conc.	<u>3</u>	No. of organisms (female/male)	<u>5/2</u>
Number and Concentrations of Test Solutions (%v/v)	<u>Controls: (two) natural sea water, brine Tests: 70, 35, 17.5, 8.75, 4.38</u>		
Chemicals added to control/dilution water	<u>Test Nutrients as described in method cited at 10 ml/L, analytical grade</u>		

Sample Treatment

D.O. on unadjusted sample salinity adjustment (mg/L)	<u>8.6</u>	D.O. after salinity adjustment (mg/L)	<u>7.7</u>
Aeration (duration/rate)	<u>none</u>	Filtration	<u>none</u>
Salinity Adjustment*	<u>600 mL effluent + 260 mL hypersaline brine + 8.6 mL test nutrient solution</u>		
Hypersaline Brine for Salinity Adjustment*	<u>Prepared from natural seawater, at 90 ppt salinity</u>		

* 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)	<u>16:8</u>
Agitation of tests and controls during exposure	<u>gentle rotary shaking</u>
Recovery Medium: natural sea water containing 10 ml/L Culture Nutrients (section 16.10.1.3 of cited method)	Aeration during recovery: <u>gentle aeration supplied</u>

TOXICITY TEST RESULTS

IC ₂₅ (%v/v) (95% CL)	<u>45.3 (27.5 - 52.4)</u>	IC ₅₀ (%v/v), (95% CL)	<u>61.4 (50.4 - 66.6)</u>
Mean control cystocarps/female (pooled natural sea water and brine controls)	<u>90.9</u>		

Submitted By:	<u>cm moody</u>	Date:	<u>Aug 24/05</u>

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

CM

Test Data

Sample Identification Garrow Creek

E452

Concentration % (v/v)		Rep	Mortality		Individual Plant Cystocarp Counts					mean	SD*	Comments
#			#	%	1	2	3	4	5			
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:

M. Hardy

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 Research	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

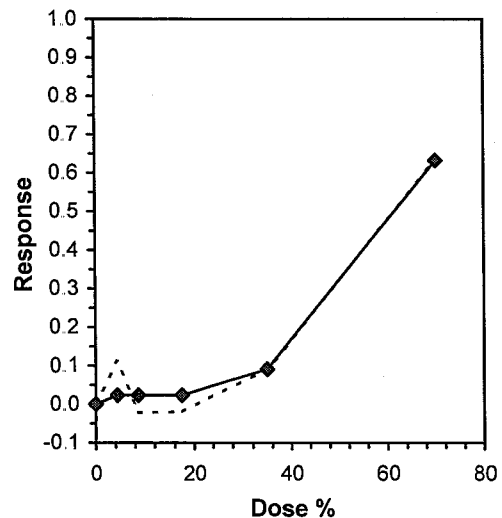
Conc-%	Mean	N-Mean	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%	N				Mean	N-Mean
Pooled	90.867	1.0000	90.867	74.200	104.000	14.348	6				90.867	1.0000
4.38	80.800	0.8892	80.800	70.000	89.800	12.403	3	1.401	2.602	18.693	88.778	0.9770
8.75	92.867	1.0220	92.867	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	35	70	49.4975	2.85714	18.6933	0.20572	1647.03	103.188	1.5E-05	5, 15
Treatments vs Pooled Controls										

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



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0747



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三

Attn. Max W. Lloyd

Attn: Mary Moody

Shipping Date 12/10/00[illegible]

the sample collection date/time is the end of the compositing period.

1 For composite effluent of water samples, the sample collection date/time is the one of the sampling period.

[illegible]

3 Collapsible Carboy (CC); glass jar (GJ); glass jar (GJ); jelly jar (JJ); plastic jar (PJ);

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September 2005

LABORATORY REPORT

Azimuth Consulting Group
POLARIS MINE
ENVIRONMENTAL EFFECTS
MONITORING PROGRAM
August 6, 2005 Sample

PREPARED FOR:

PREPARED BY:

Azimuth Consulting Group
Vancouver, BC



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
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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 LC ₅₀ 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 LC ₅₀). (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 <i>Artemia</i> 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 $\pm$ SD)	GROWTH (DRY WEIGHT MG) (MEAN $\pm$ SD)
Negative Control	92.0 $\pm$ 11.0	0.81 $\pm$ 0.24
Brine Control	88.0 $\pm$ 17.9	0.91 $\pm$ 0.12
Pooled Controls	90.0 $\pm$ 11.0	0.86 $\pm$ 0.18
4.2	88.0 $\pm$ 11.0	0.86 $\pm$ 0.18
8.4	96.0 $\pm$ 8.9	0.90 $\pm$ 0.13
16.9	80.0 $\pm$ 14.1	0.76 $\pm$ 0.17
33.7	92.0 $\pm$ 11.0	0.75 $\pm$ 0.13
67.4	80.0 $\pm$ 14.1	0.81 $\pm$ 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 $\pm$ SD)
Negative Control	85.0 $\pm$ 2.9
Brine Control	87.2 $\pm$ 2.6
Pooled Controls	86.1 $\pm$ 2.8
4.5	79.8 $\pm$ 1.7*
8.9	76.5 $\pm$ 0.6*
17.8	61.8 $\pm$ 2.2*
35.6	52.8 $\pm$ 1.9*
71.3	37.2 $\pm$ 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 Sx B Txs RSO
 Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	Garraw Creek	Garraw Creek	Garraw 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 [Ⓢ] → 8.3	7.8 [Ⓢ] → 8.4	7.9 [Ⓢ] → 8.4
DO (mg/L)	9.8 [Ⓢ] → 7.6	10.0 [Ⓢ] → 7.6	10.5 [Ⓢ] → 7.6
Conductivity (μmhos/cm)	-	-	-
Salinity (ppt)	1.0 [Ⓢ] → 30.0	1.0 [Ⓢ] → 30.0	1.0 [Ⓢ] → 30.0
Ammonia (mg/L N)	-	-	-
Chlorine (mg/L Cl)	-	-	-
Other	Ⓢ After salinity adjustment	Ⓢ After salinity adjustment	Ⓢ 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 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 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) ~~103 (88-124)~~ μg/L Cu
 7-d growth IC50 95 (75-125) (76-127) μg/L Cu

Reference Toxicant Warning Limits (mean ± 2SD) and CV

7-d survival LC50 132 ± 40 μg/L Cu CV=15%
 7-d growth IC50 133 ± 40 μg/L Cu CV=15%

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	<u>1/10</u>	<u>67.4</u>	<u>>67.4</u>	<u>>67.4</u>		
Growth		<u>67.4</u>	<u>>67.4</u>		<u>>67.4</u>	<u>>67.4</u>

Other -

Data Verified By Chalpi

Date Verified Sept 1/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azinuth

Sample ID G. Creek (Garra Creek)

EVS Project No. 04-1A24-044

Test Initiation Date/Time 9 Aug 05 / 1500h

EVS Work Order No. 0500327

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	ML	ML	SXB	SR	SXB	SXB	SXB	SXB	ML	ML	ML

Concentration % (v/v)	pH													
	0	old 1 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	~~8.0~~ 8.0	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	~~8.0~~ 8.0	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	ML	ML	SXB	SR	SXB	SXB	SXB	SXB	ML	ML	ML

WQ Instruments Used: Temp. Calibrated Hg Thermometer pH 030302

Comments _____

Test Set Up By SXB Data Verified By Qualif Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA

Client Azinuth

Sample ID C. Creek C. Creek

EVS Project No. 04-1424-044

Test Initiation Date/Time 9 Aug 05 / 1500

EVS Work Order No. 0500327

Source/Date Received ABS Inc. / 9 Aug 05

Concentration (%)	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	MSG	MSG	SXB	SXB	SXB	SXB	SXB	SXB	SXB	MSG	MSG

Concentration (%)	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	MSG	MSG	SXB	SXB	SXB	SXB	SXB	SXB	SXB	MSG	MSG

WQ Instruments Used: Salinity AS3 HANNA HC3

DO II-A-20

Comments used II-A-20306

Test Set Up By SXB

Data Verified By MSG

Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azineth
 EVS Project No. 04-1424-054
 EVS Work Order No. 0500327

Sample ID G - Creek (Zorro Creek)
 Test Species/Batch *Atherinops affinis*, 9 Aug 05
 Test Initiation Date/Time 9 Aug 05 1500
 No. of Organisms/Volume 5 / 200ml

Concentration <i>Y(VI)</i>	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
0 CTL	A	1 T	5	5	5	5	5	5	5	
	B	2 T	5	5	5	5	5	5	4	
	C	3 T	5	5	5	5	5	5	5	
	D	4 T	5	5	5	5	5	5	5	
	E	5 T	5	5	5	5	5	5	4	
B-CTL	A	6 T	5	5	5	5	5	5	5	
	B	7 T	5	5	5	5	5	5	5	
	C	8 T	5	5	5	5	5	5	5	
	D	9 T	5	5	5	5	5	5	4	
	E	10 T	5	5	4 ^①	4	4	4	3	
4.2	A	11 T	5	4	5 ^② 4	4	4	4	4	
	B	12 T	5	5	5	5	5	5	5	
	C	13 T	5	5	5	5	5	5	5	
	D	14 T	5	4	5 ^③ 4	4	4	4	4	
	E	15 T	5	4 ^④	4 ^⑤ 5	4	4	4	4	2 no body
8.4	A	16 T	5	5	5	5	5	5	5	
	B	17 T	5	5	5	5	5	5	5	
	C	18 T	5	5	5	5	5	5	4	
	D	19 T	5	5	5	5	5	5	5	
	E	20 T	5	5	5	5	5	5	5	
Technician Initials		SXB	SXB	ML	SXB	SXB	SXB	77	SXB	

Sample Description light brown, no smell

Data Verified By Gulfi

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 Garraw Creek
 Test Species/Batch *Atherinops affinis*
 Test Initiation Date/Time 9 Aug 05 / 1500
 No. of Organisms/Volume 5/200ml

Concentration <u>Y(100)</u>	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
16.9	A	21 T	5	5	5	5	5	5	5	① No dead body - ~~Technical~~ ^{5/2}
	B	22	5	5	4	4	4	4	4	
	C	23	5	5	5	5	5	5	4	
	D	24	5	5	④ 4	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	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	5 3	
	D	34	5	5	5	5	5	5	4	
	E	35	5 4 5	5	5	5	5	5	4	
	A									
	B									
	C									
	D									
	E									
Technician Initials		SXB	SXB	ML	SXB	SXB	SXB	TM	SXB	

Sample Description clear - colourless
 Data Verified By Galjit 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: 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.

Galfin
Aug. 31/05

Test: LF-Larval Fish Growth and Survival Test

Test ID: 0500327

Species: AA-Atherinops affinis

Protocol: EPAW 95-EPA West Coast

Sample ID: Garrow_Creek

Sample Type: EFF2-Industrial

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	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

Galfi
Ana 31/05

Larval Fish Growth and Survival Test-7-d survival

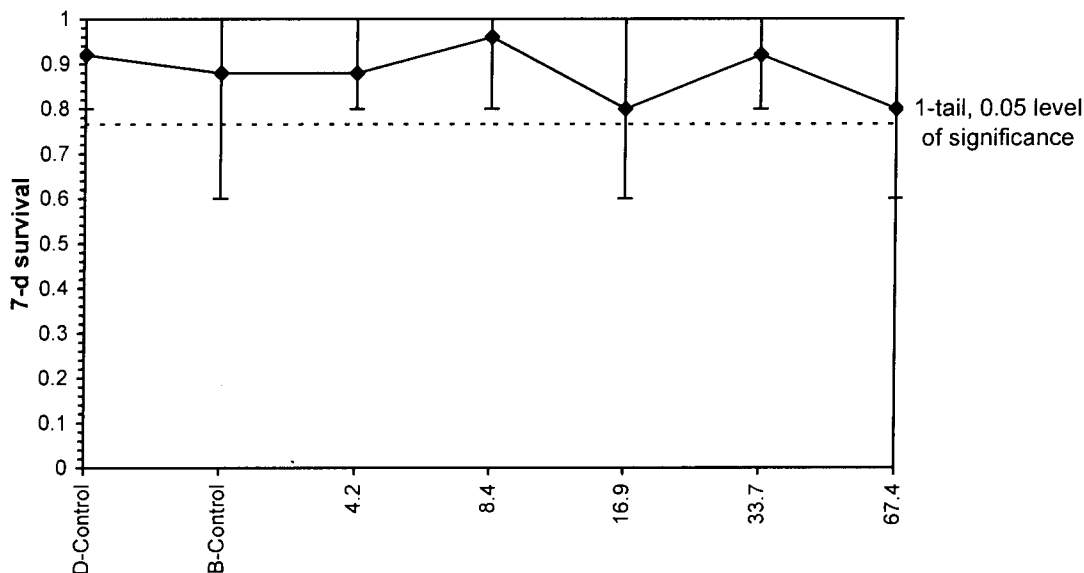
Start Date: 8/9/2005	Test ID: 500327	Sample ID: Garrow_Creek
End Date: 8/16/2005	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth - Polaris 04-1424-044		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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.

Larval Fish Growth and Survival Test-7-d survival

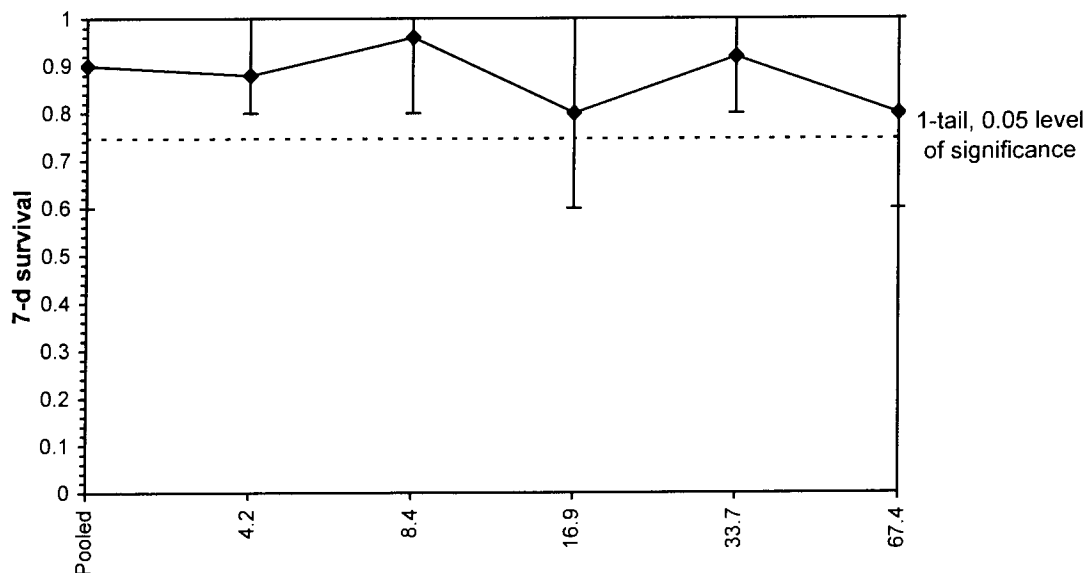
Start Date: 8/9/2005	Test ID: 500327	Sample ID: Garrow_Creek
End Date: 8/16/2005	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth - Polaris 04-1424-044		

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

Conc-%	Mean	SD	Transform: Arcsin Square Root					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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.

Larval Fish Growth and Survival Test-7 Day Growth (CND)

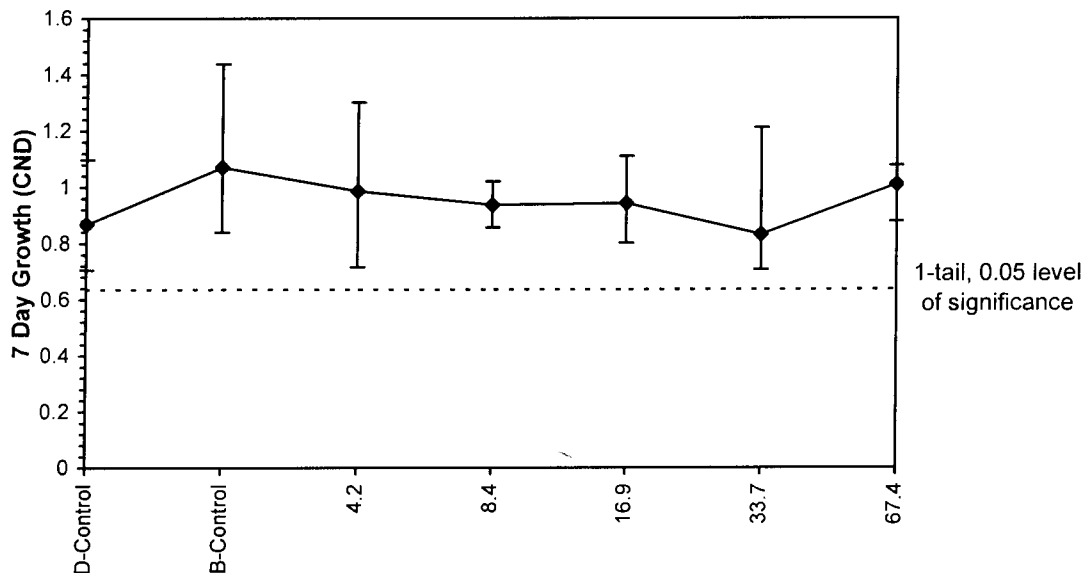
Start Date: 8/9/2005	Test ID: 500327	Sample ID: GARROW_CREEK
End Date: 8/16/2005	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth - Polaris 04-1424-044		

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

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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 w negative control using Canadian method to assess test validity criteria.

Galfr
Aug. 31/05

Larval Fish Growth and Survival Test-7 Day Growth (US)

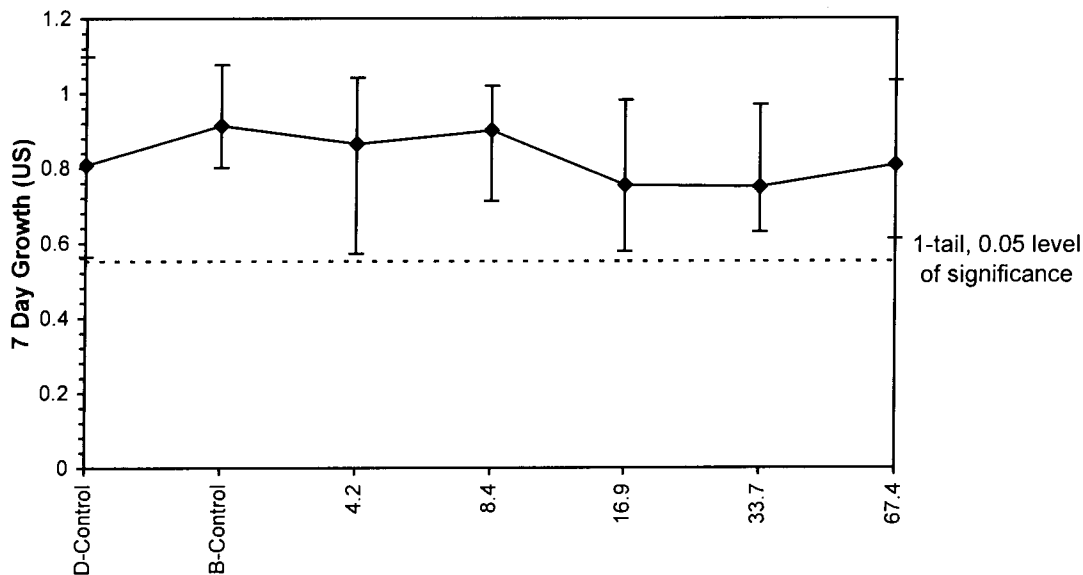
Start Date: 8/9/2005	Test ID: 500327	Sample ID: GARROW_CRE
End Date: 8/16/2005	Lab ID: BCEVS-EVS Environment Cc	Sample Type: EFF2-Industrial
Sample Date:	Protocol: EPAW 95-EPA West Coast	Test Species: AA-Atherinops affinis
Comments: Azimuth - Polaris 04-1424-044		

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

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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

Galjit
Sept. 11/05

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				

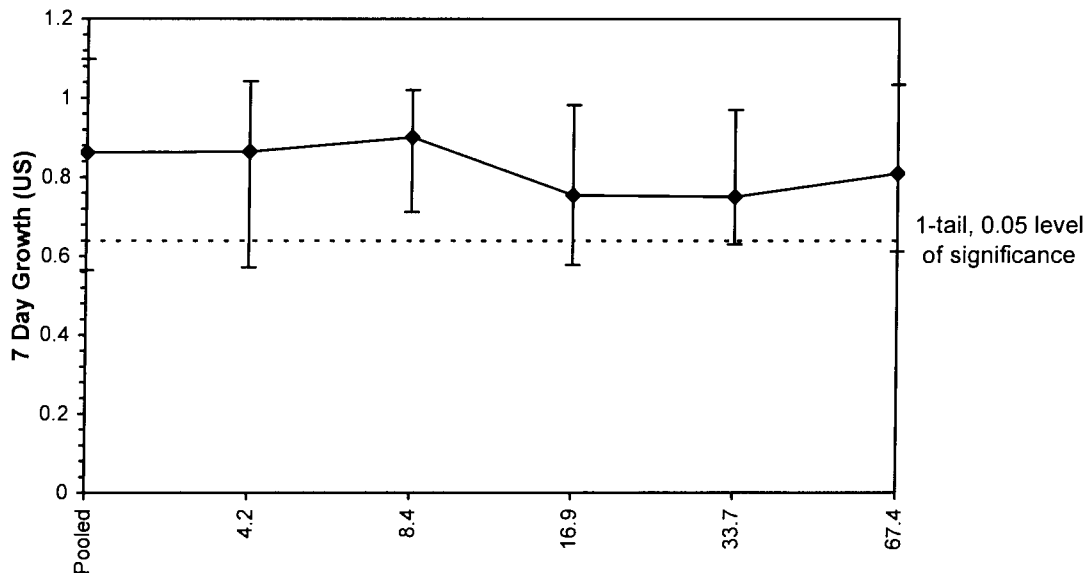
Conc-%	1	2	3	4	5
D-Control	1.0000	0.6080	1.0980	0.7760	0.5640
B-Control	0.8380	1.0760	0.9920	0.8020	0.8620
4.2	0.8120	0.9280	0.9700	1.0420	0.5720
8.4	0.8980	0.8560	0.7120	1.0200	1.0200
16.9	0.9820	0.8880	0.6860	0.5780	0.6420
33.7	0.7260	0.9700	0.7060	0.6300	0.7240
67.4	1.0340	0.8380	0.6120	0.8640	0.7040

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed Critical	MSD
			Mean	Min	Max	CV%	N			
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.

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 MJC JXS RSJ
 Test Initiation Date 9 Aug 05

Sample	Initial Sample	Refresh Samples	
	Day 0	Day 2	Day 4
Identification	100mg/L Cu Stock (0500001)		
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 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 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) µg/L Cu
 7-d growth IC50 95 (78-127) µg/L Cu

Reference Toxicant Warning Limits (mean ± 2SD) and CV

7-d survival LC50 132 ± 40 µg/L Cu CV=15%
 7-d growth IC50 133 ± 40 µg/L Cu CV=15%

TEST RESULTS

Endpoint	Conc. Units	NOEC	LOEC	LC50 (95% CL)	IC50 (95% CL)	IC25 (95% CL)
Survival	µg/L	56	100	103 (91-118)		
Growth	µg/L Cu	32 (25-56)	32 (100)	95 (78-127)	95 (78-127)	64 (47-91)

Other _____

Data Verified By Gail H

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 Ref tox

EVS Project No. 09-1424-044

Test Initiation Date/Time 9 Aug 05 1500

EVS Work Order No. C500327

Source/Date Received ABS Inc. 19 Aug 05

Concentration <i>Mg/L Cu</i>	Temperature (°C)													
	0	old 1 New		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	17L	17L	SRS	SRS	SXB	SXB	SXB	SXB	17	17	17

Concentration <i>Mg/L Cu</i>	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	8.0	8.0
56	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
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	7.8	7.9	7.8	8.0	7.9	7.9			
320	7.9	7.9	8.0	7.9	7.9									
				17L										
Tech. Initials	SXB	SXB	SXB	17L	17L	SRS	SXB	SXB	SXB	SXB	SXB	17	17	17

WQ Instruments Used: Temp. Calibrated by Thermometer pH 030302

Comments _____

Test Set Up By SXB Data Verified By Chalpit Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS

7-d *Atherinops affinis* SURVIVAL AND GROWTH TEST – WATER QUALITY DATA (EEM)

Client Azinoth

Sample ID Cu Reftox

EVS Project No. 04-1424-044

Test Initiation Date/Time 9 Aug 05/1500

EVS Work Order No. 0500327

Source/Date Received ABS In H Aug 05

Concentration µg/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	M/L	M/L	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

Concentration µg/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	7.5	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									
Tech. Initials	SXB	SXB	SXB	M/L	M/L	SRS	SRS	SXB	SXB	SXB	SXB	TH	TH	TH

WQ Instruments Used: Salinity II-C-3

DO II-A-20

Comments Dosed II-A-05306

Test Set Up By SXB Data Verified By Qualifit Date Verified Aug 2/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimoth
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500327

Sample ID cu. left tox
 Test Species/Batch *Atherinops affinis*
 Test Initiation Date/Time 9 Aug 05 1500
 No. of Organisms/Volume 5/200ml

Concentration <i>Mg/L Cu</i>	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	D one fish died on wall while feeding – technician error.
	B	42	5	5	5	5	5	5	4	
	C	43	5	5	4	4	4	4	4	
	D	44	5	5	④4	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 ⁴⁷	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	MLL	SXB	SXB	SXB	Tm	SXB	

Sample Description clear colourless

Data Verified By Gallik

Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
7-d *Atherinops affinis* TOXICITY TEST – DAILY SURVIVAL DATA

Client Azimoth
 EVS Project No. 041424049
 EVS Work Order No. 0500327

Sample ID Cu Ref tox
 Test Species/Batch *Atherinops affinis*
 Test Initiation Date/Time 9 Aug 05 / 1500
 No. of Organisms/Volume 5 / 200ml

Concentration <i>Mg/L Cu</i>	Rep.	Pan No.	Number of Survivors – Day of Test							Comments
			1	2	3	4	5	6	7	
180	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					
320	A		^{SXB} 80	0	0					
	B		2	0	0					
	C		^{SXB} 80	0	0					
	D		^{SXB} 80	0	0					
	E		1	0	0					
	A									
	B									
	C									
	D									
	E									
	A									
	B									
	C									
	D									
	E									
Technician Initials			SXB	SXB	M/L	SXB	SXB	SXB	rm	SXB

Sample Description clear - colourless
 Data Verified By Galfi 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: Satorius 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: *Galp*
 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

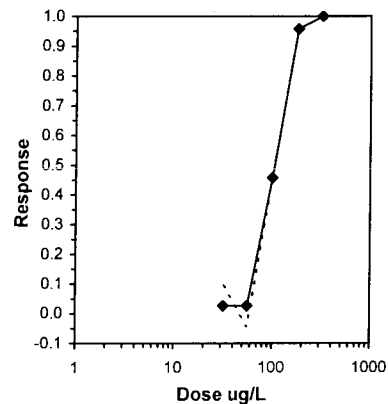
Larval Fish Growth and Survival Test-7-d survival					
Start Date:	8/9/2005	Test ID:	rtacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - Polaris 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

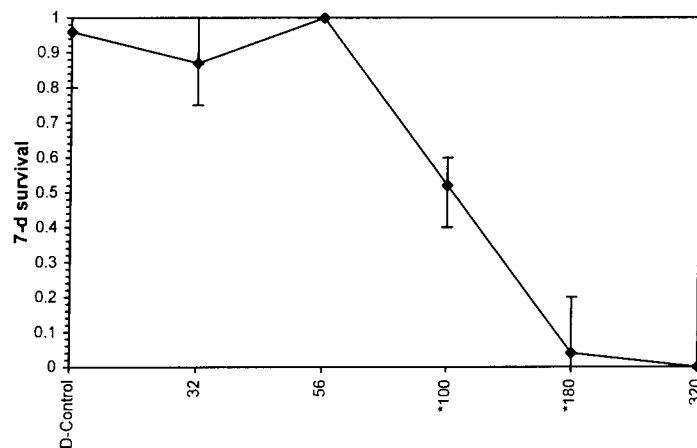
Transform: Arcsin Square Root							Rank Sum	1-Tailed Critical	Number Resp	Total Number
Conc-ug/L	Mean	SD	Mean	Min	Max	CV%				
D-Control	0.9600	0.0894	1.2977	1.1071	1.3453	8.207	5		1	25
32	0.8700	0.1204	1.1850	1.0472	1.3453	11.519	5	20.00	3	23
56	1.0000	0.0000	1.3453	1.3453	1.3453	0.000	5	30.00	0	25
*100	0.5200	0.1095	0.8055	0.6847	0.8861	13.691	5	15.00	12	25
*180	0.0400	0.0894	0.2731	0.2255	0.4636	38.990	5	15.00	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-Kärber				
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



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Aug-31/05

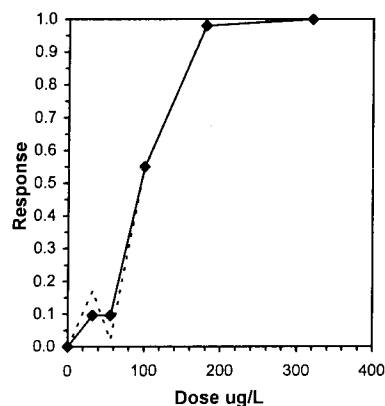
Larval Fish Growth and Survival Test-7 Day Growth (US)					
Start Date:	8/9/2005	Test ID:	rtaacu46	Sample ID:	REF-Ref Toxicant
End Date:	8/16/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	CU-Copper
Sample Date:		Protocol:	EPAW 95-EPA West Coast	Test Species:	AA-Atherinops affinis
Comments:	Azimuth - 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

Conc-ug/L	Mean	SD	Transform: Untransformed				N	Rank Sum	1-Tailed Critical	Isotonic	
			Mean	Min	Max	CV%				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

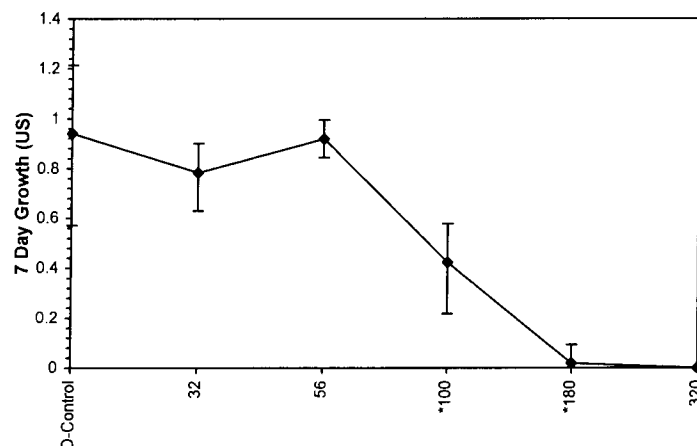
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.96904	0.888	-0.5637	1.29994
Bartlett's Test indicates unequal variances ($p = 8.40E-03$)	13.6784	13.2767		
Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	56	100	74.8331	

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

* indicates IC estimate less than the lowest concentration



Dose-Response Plot



Galka
Aug. 31/05

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. 04-1424-844
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) 16.0 → 15
pH 7.3 → 8.3
Dissolved Oxygen (mg/L) 10.0 → 8.5
Conductivity (µmhos/cm) 2700
Salinity (ppt) 1.0 → 29.0
Ammonia (mg/L N) —
Chlorine (mg/L Cl) —
Other —

0 Brine Adjustment

TEST SPECIES

Organism Dendrosten excentricus
Source Westwind Seabab
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 → 8.4 → 8.5
Dissolved Oxygen Range (mg/L) 7.8 → 8.5
Salinity Range (ppt) 29 7.8
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

Galpik

Date Verified

Aug. 31/05

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY**

Client Azimuth Consulting (Polina Mine)
 EVS Project No. 04-1424-044
 EVS Work Order No. 0500328
 Logbook Echinoid #13 Pages 71-74

Test Initiation Date/Time 9 Aug 05 / 1723
 Test Species Dendroseta excentricus
 Source/Date Received Westward Seals 19 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 Hygrometer pH II-A-53 Salinity II-A-030303 DO II-A-20
 Sample Description Clean with no odor
 Data Verified By Galphin Date Verified Aug - 31 / 05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimuth Consulting (Polaris Marine)
 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 Dendaster excentricus
 Source/Date Received Westward 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 Gulph

Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNT (SAMPLES)

Client Azimutk Consulting (Polina's Wharf)

Test Initiation Date/Time 09 Aug 05 / 1723

EVS Project No. 04-1424-044

Test Species Dendroica eximiosa

EVS Work Order No. 0500328

Source/Date Received Western Scale / 09 Aug 05

Logbook Echinoid Pages 71-74

Test Duration 10:10

Sperm:Egg Ratio 2000:1

Sample ID <i>Y-010</i> <i>Sagehen Creek</i>	Replicate	Number of Fertilized Eggs	Number of Unfertilized Eggs	Comments	Tech. Initials
<i>Max</i> <i>71.3%</i>	A	<i>37</i>	<i>63</i>		<i>SRS</i> ↓
	B	<i>40</i>	<i>60</i>		
	C	<i>37</i>	<i>63</i>		
	D	<i>35</i>	<i>63</i>		
<i>35.6</i> <i>36%</i>	A	<i>50</i>	<i>50</i>		
	B	<i>54</i>	<i>46</i>		
	C	<i>54</i>	<i>46</i>		
	D	<i>53</i>	<i>47</i>		
<i>17.8</i> <i>18%</i> <i>no</i>	A	<i>64</i>	<i>36</i>		
	B	<i>59</i>	<i>41</i>		
	C	<i>63</i>	<i>37</i>		
	D	<i>61</i>	<i>39</i>		
<i>8.9%</i>	A	<i>76</i>	<i>24</i>		
	B	<i>77</i>	<i>23</i>		
	C	<i>77</i>	<i>23</i>		
	D	<i>76</i>	<i>24</i>		
<i>4.5%</i>	A	<i>82</i>	<i>18</i>		
	B	<i>80</i>	<i>20</i>		
	C	<i>79</i>	<i>21</i>		
	D	<i>78</i>	<i>22</i>		
	A				
	B				
	C				
	D				

Data Verified By *Galich*

Date Verified *Aug 31 / 05*

Test: SC-Sperm Cell Fertilization test

Test ID: 0500328

Species: DE-Dendraster excentricus

Protocol: EPS1/RM/27-EC 92 (Sperm Cell)

Sample ID: Garrow Creek

Sample Type: ~~GW-groundwater~~ Effluent

Start Date: 8/9/2004 10:10

End Date: 8/9/2004

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)

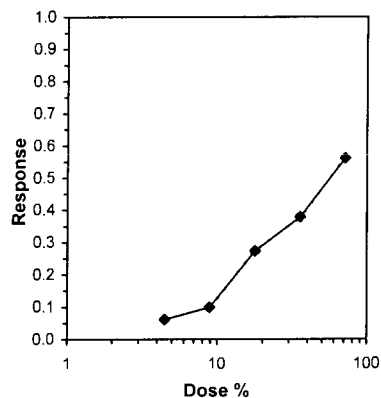
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	8/9/2004 10:10	Test ID:	500328	Sample ID:	Garrow Creek
End Date:	8/9/2004	Lab ID:	BCEVS-EVS Environment C	Sample Type:	GW-groundwater Effluent
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm)	Test Species:	DE-Dendroaster excentricus
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	

Conc-%	Mean	SD	Transform: Untransformed					t-Stat	1-Tailed		Isotonic	
			Mean	Min	Max	CV%	N		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

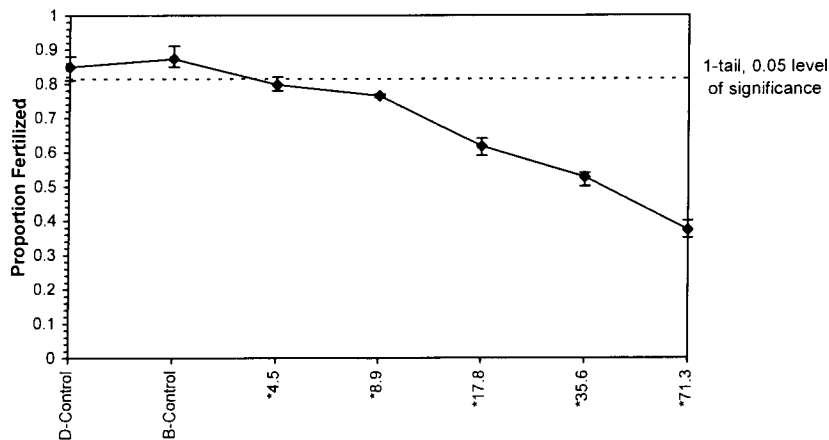
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.96944	0.884	-0.376	-0.1401		
Bartlett's Test indicates equal variances (p = 0.37)					5.40444	15.0863				
The control means are not significantly different (p = 0.30)					1.13994	2.44691				
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 deletion control

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 Cr	Sample Type:	GW-groundwater <i>Effluent</i>
Sample Date:	8/6/2004	Protocol:	EPS1/RM/27-EC 92 (Sperm)	Test Species:	DE-Dendroaster excentricus
Comments:	Azimuth Consulting Group (Polaris Mine) 04-1424-044 (0500328)				

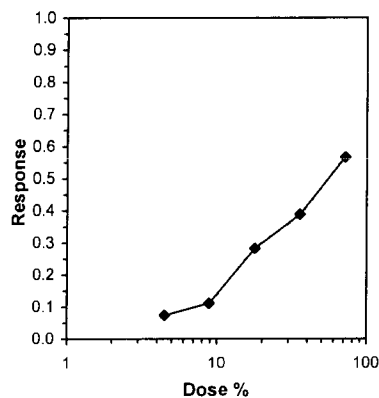
Conc-%	1	2	3	4
D-Control	0.8800	0.8100	0.8500	0.8600
B-Control	0.9100	0.8600	0.8500	0.8700
4.5	0.7800	0.7900	0.8000	0.8200
8.9	0.7600	0.7700	0.7700	0.7600
17.8	0.6100	0.6300	0.5900	0.6400
35.6	0.5300	0.5400	0.5400	0.5000
71.3	0.3500	0.3700	0.4000	0.3700

Conc-%	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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

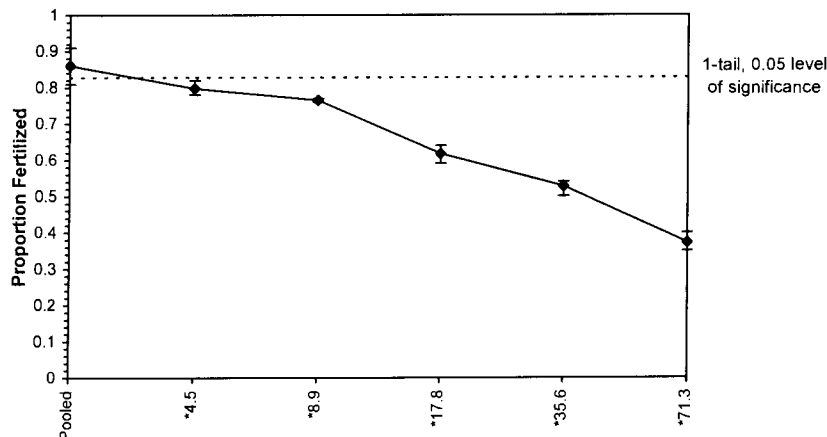
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)					0.97972	0.896	-0.1255	1.3485		
Bartlett's Test indicates equal variances (p = 0.30)					6.1116	15.0863				
The control means are not significantly different (p = 0.30)					1.13994	2.44691				
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

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST DATA SUMMARY**

Client Azimuth Consulting (Pleiku 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 Reflex Sol'n #05-S-009
Amount Received 1L
Date Collected 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 Dendrosten 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 Gail K

Date Verified Aug 31/05

**EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST INITIAL WATER QUALITY**

Client Azimuth Consulting (Polaris Marine)
 EVS Project No. 04-1424-8044
 EVS Work Order No. 0500328
 Logbook Calvin #13 Pages 71-74

Test Initiation Date/Time 9 Aug 05 / 1723
 Test Species Dendrosten excentricus
 Source/Date Received Westward Seabird 9 Aug 05
 Test Duration 10:10

Reflex

Sample ID SDS (mg/L)	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)	Comments
Ctrl	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 Hy-Thermometer pH II-A-51 Salinity II-A-0303 DO II-A-20

Sample Description _____

Data Verified By Gail K Date Verified Aug 31/05

EVS ENVIRONMENT CONSULTANTS
ECHINOID FERTILIZATION TOXICITY TEST – EGG COUNTS (CONTROLS)

Client Azimuth Consulting (Polaris Hw) Test Initiation Date/Time 09/11/05 1123
 EVS Project No. 04-1424-044 Test Species Dendrochorda excentricus
 EVS Work Order No. 0500328 Test Duration 10:10
 Logbook Echinoid Pages 71-74 Sperm:Egg Ratio 2000:1

Reflex

Concentration SDS (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~~ 73	27		
	C	~~72~~ 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					
Ctrl	A	88	12		SRS
	B	81	19		
	C	85	15		
	D	86	14		

Data Verified By Gail H

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)

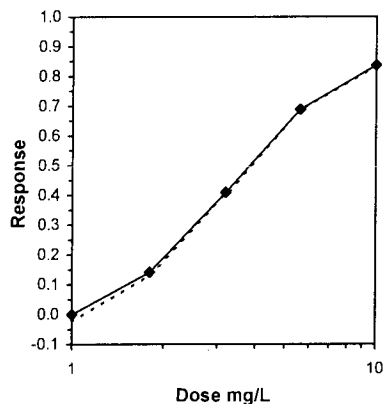
Sperm Cell Fertilization test-Proportion Fertilized					
Start Date:	8/9/2005 10:10	Test ID:	rtdesds052	Sample ID:	REF-Ref Toxicant
End Date:	8/9/2005	Lab ID:	BCEVS-EVS Environment C	Sample Type:	SDS-Sodium dodecyl sulfate
Sample Date:		Protocol:	EPS1/RM/27-EC 92 (Sperm	Test Species:	DE-Dendroaster excentricus
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	

Conc-mg/L	Mean	SD	Transform: Untransformed				N	t-Stat	1-Tailed Critical	MSD	Isotonic	
			Mean	Min	Max	CV%					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

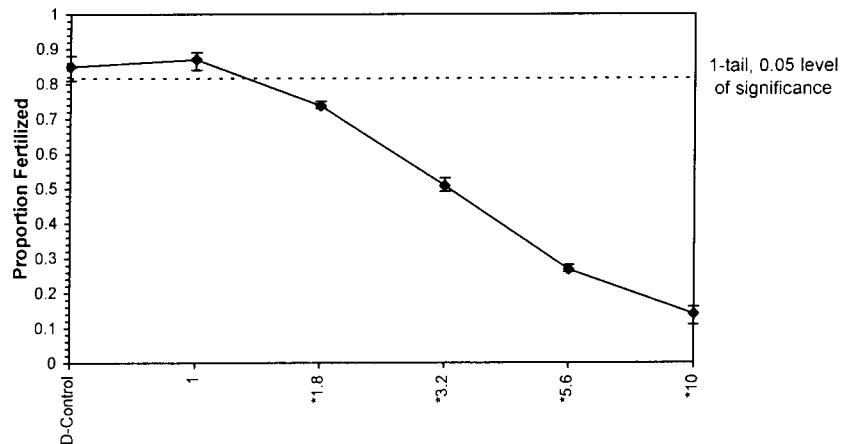
Auxiliary Tests					Statistic	Critical	Skew	Kurt		
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)					0.95791	0.884	-0.5718	-0.0762		
Bartlett's Test indicates equal variances ($p = 0.43$)					4.8475	15.0863				
Hypothesis Test (1-tail, 0.05)					MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test					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



Dose-Response Plot



Galpif
Aug 31, 2005

APPENDIX III

Chain-of-Custody Form

0743



195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date Aug 6/06

0743

Client Name Teck Cominco
Address Box 2000
Kimberly DC
VIA 3E1

Client Contact Bruce Donald
Phone 250-427-8405
Fax 250-427-8461
Sampled by B. Bolton

Ship to _____
Attn. Edward Casanova

[illegible]

- 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
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White — returned to consignor by consignee

Please see instructions for completion on back of form

0742



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Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

Shipping Date Aug 6 08

Client Name Jack Camacho Client Contact Bruce Donald Ship to _____
Address Ban 2000 Phone 250-427-8405 _____
Kimberly BC Fax 250-427-8451 _____
VIA 3E1 Sampled by B Bolton Attn. Edmund Canario

[illegible]

- 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:

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0741



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Fax: 604-662-8548
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Shipping Date Aug 6/05

195 Pemberton Avenue
North Vancouver, B.C.
Canada V7P 2R4
Tel: 604-986-4331
Fax: 604-662-8548
www.golder.com

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

Client Name Jack Cominos Ship to _____
 Address Box 2000 _____
Kivikilly, BC _____
V1A 3E1 _____
 Client Contact Bruce Donald _____
 Phone 250-427-8405 _____
 Fax 250-427-8451 _____
 Sampled by: B Bolton _____
 Attn: Edmund Canario

[illegible]

- 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

APPENDIX I

Polaris 2005 Sampling Event Chronology

Appendix I - Polaris 2005 Sampling and Event Chronology

Because 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 3rd 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



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



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
Kimberley BC
V1A 3E1

May 2005



Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC
V6K 2G8

Project No
TC-03-03

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ACKNOWLEDGEMENTS

We would like to acknowledge the support of Teck Cominco Polaris staff for their assistance and logistical support while on site. Bruce Donald, Teck Cominco is especially thanked for his support of the study and providing latitude to conduct an independent investigation of Garrow Lake. Bruce Donald and Walter Kuit (Teck Cominco) are also thanked for providing historical insight about Garrow Lake and for their review of this report.

Applied Technical Services, Victoria BC is thanked for their careful taxonomic identification of benthic invertebrates. ALS Vancouver is acknowledged for their care in chemical analysis of water, sediment and fish samples.

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/m³ 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./m²) or volume (#/m³).
- 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 $\mu\text{g/g}$.

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 km², 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 monimolimnion. 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 km², 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 an 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 m³/s and 0.55 m³/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 m³/sec) before rapidly diminishing to relatively low discharge volume (0.1 m³/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 HydrolabTM 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 m² 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/m³). 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 m²) 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 m²) to determine density of organisms (#/m²).

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 ($K = \text{length}^3/\text{weight} \times 10^5$), 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 ($\sim 0^{\circ}\text{C}$), 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}C 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 monimolimnion. 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 monimolimnion 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 Platford (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 Mm³ 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 μ m) was too large; Fallis et al. (1987) used a 73 μ m 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 μ m 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 μ m) 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.

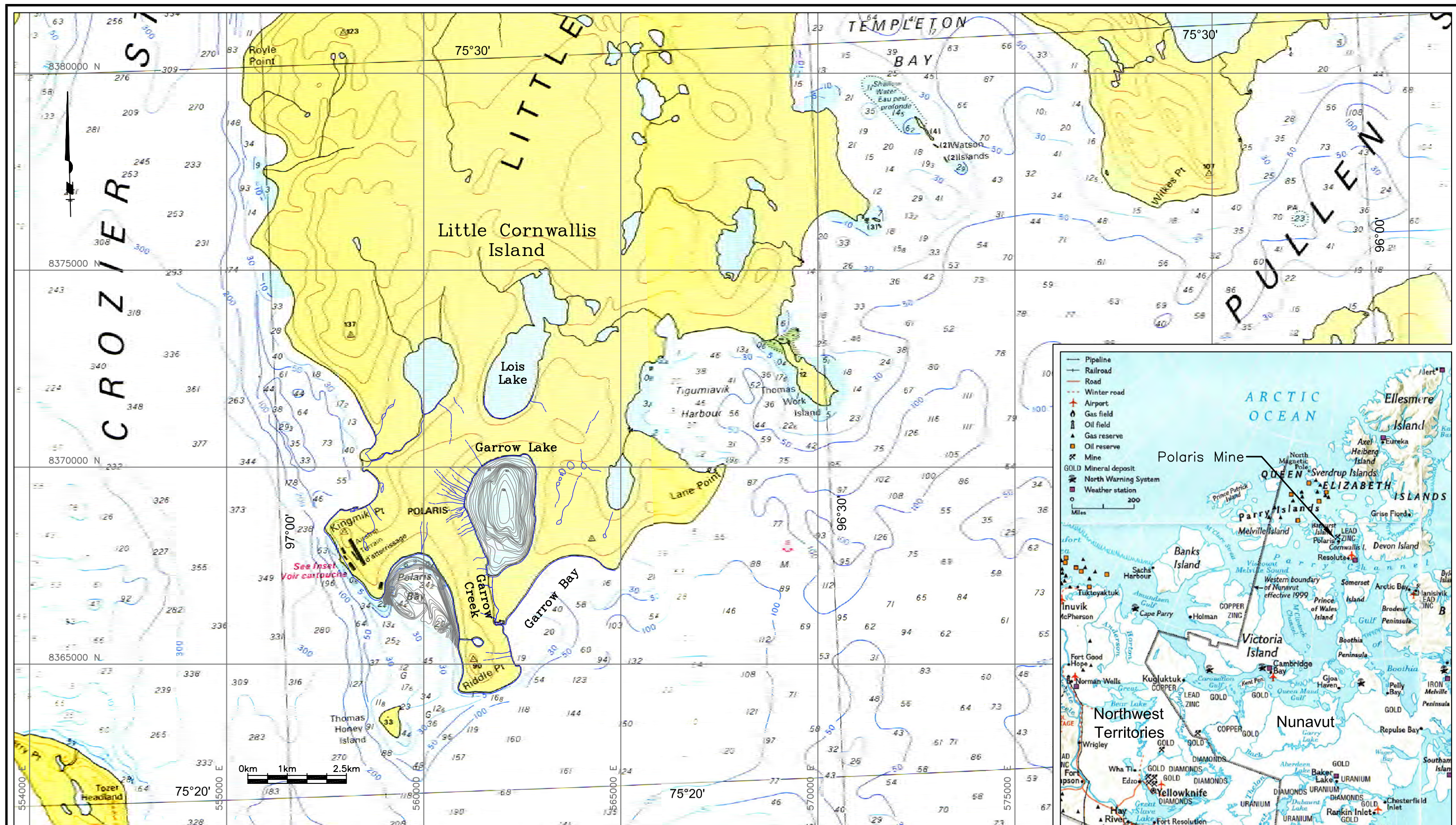
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FIGURES





Garrow 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



Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver BC, V6K 2G8

DRAWN BY:	BT	CHK. BY:	RB	PROJECT No:	TC-03-03
SCALE:		DATE:	6/10/2003 2:52 PM		

PROJECT: Polaris	
TITLE: Polaris Mine Study Area	
CLIENT: Teck Cominco	Figure 1-1



TECK COMINCO	LOCATION OF LITTORAL ZONE SEDIMENT / BIOTA STATIONS AND WATER QUALITY PROFILE STATION - GARROW LAKE, AUGUST 2003		REVISIONS <table border="1"> <tr> <th>NO.</th> <th>DATE</th> <th>BY</th> <th>DESCRIPTION</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>		NO.	DATE	BY	DESCRIPTION													PROJECT: POLARIS	
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APPROVED BY: RB SCALE: 1:25,000 Charone www.charone.ca	TC-03-03 11-22-2004 CCL		002																			

Figure 3a. Temperature (C) depth profile in Garrow Lake, 2003.

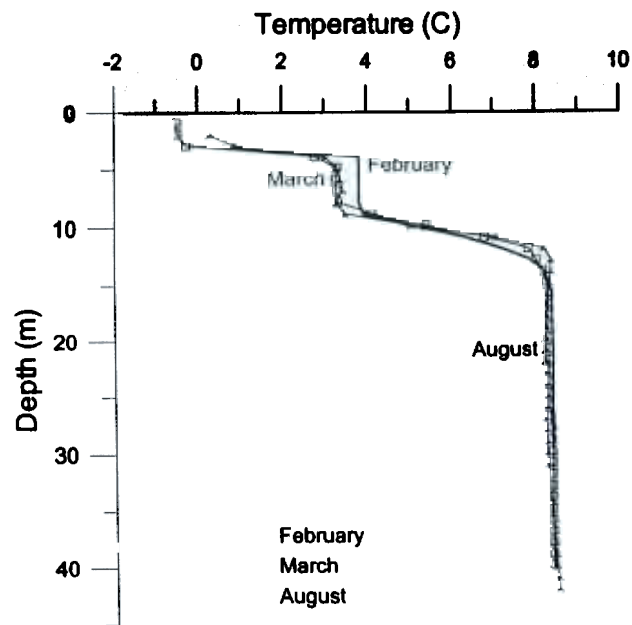


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 2003.

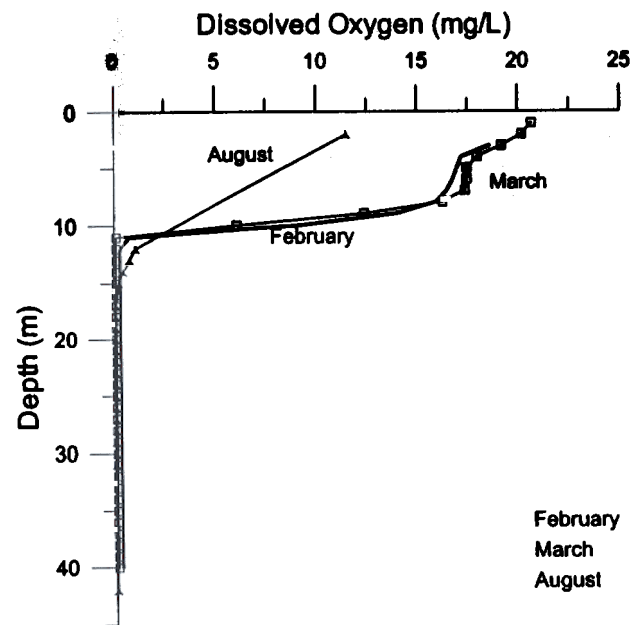


Figure 3a. Temperature (C) depth profile in Garrow Lake, 1976.

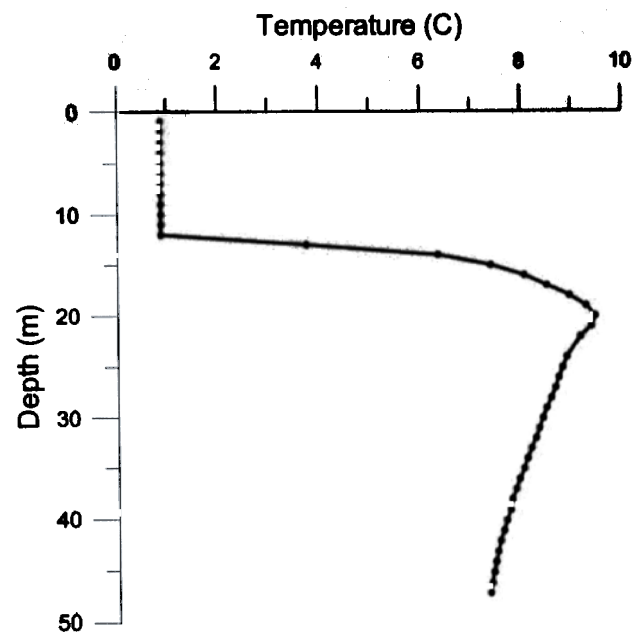
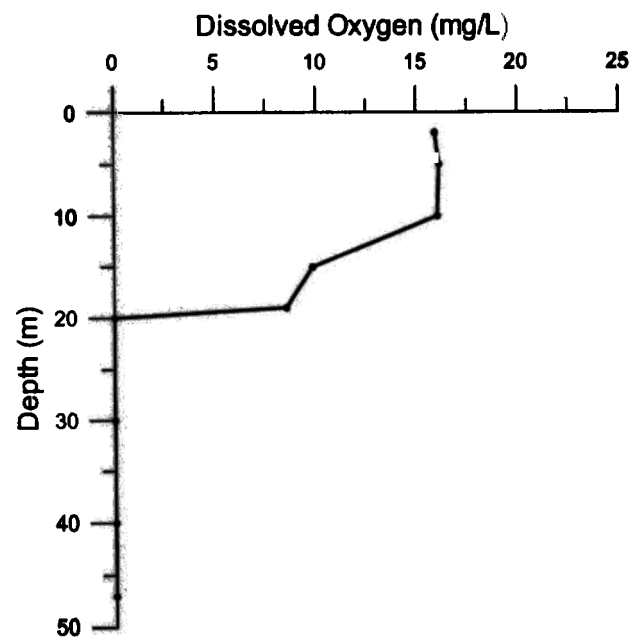


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 1976.



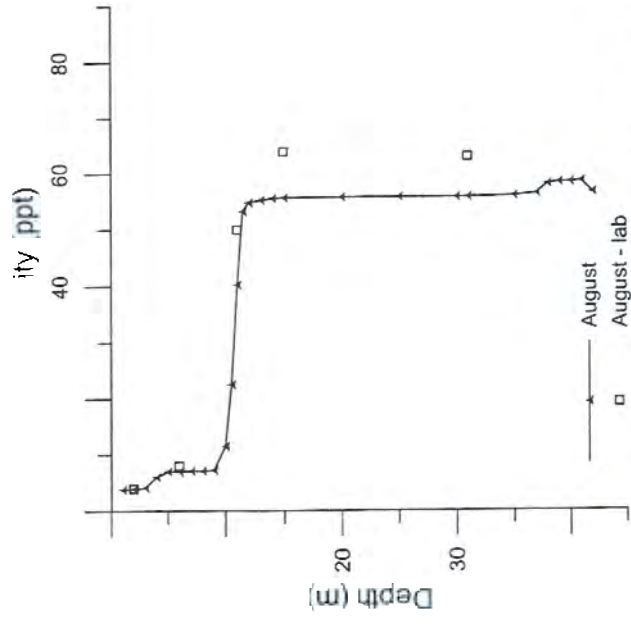


Figure 3c. Salinity (ppt) depth profile in Garrow Lake.

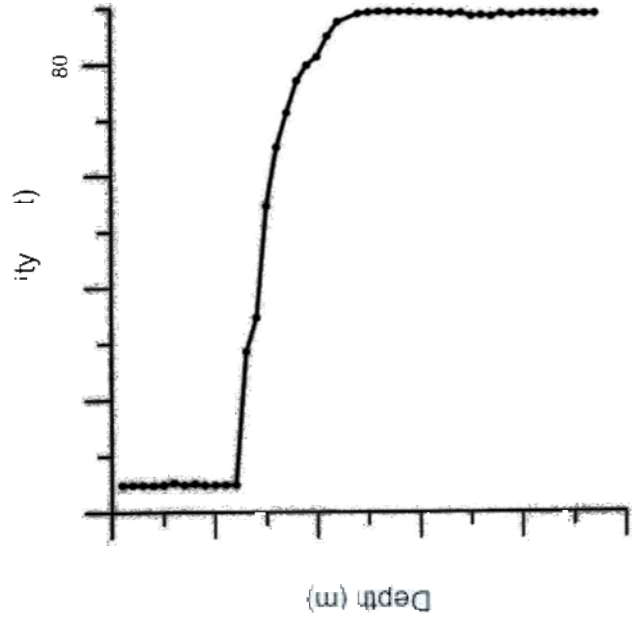
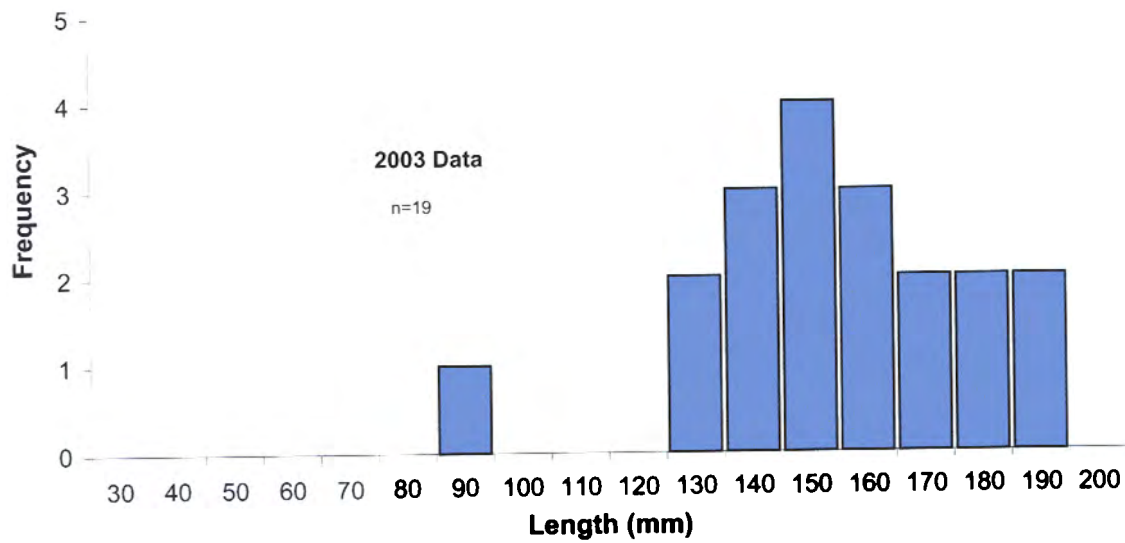
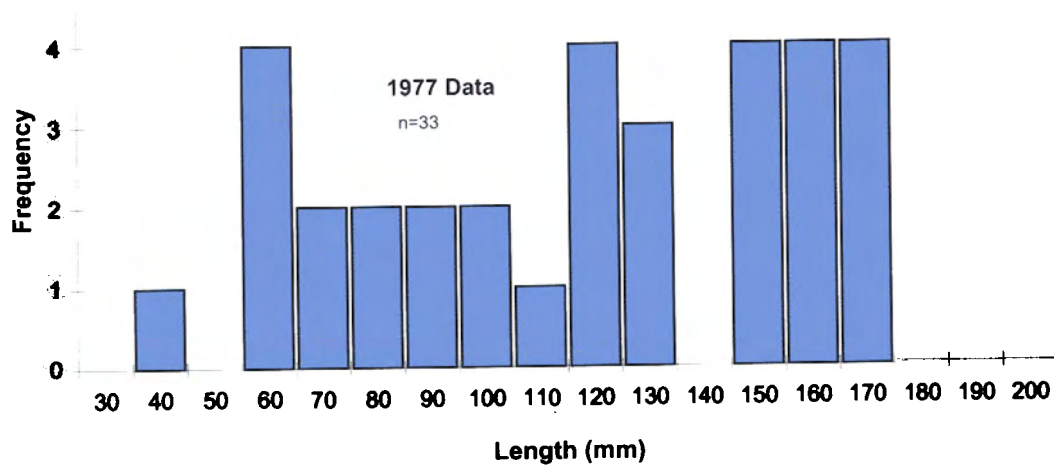
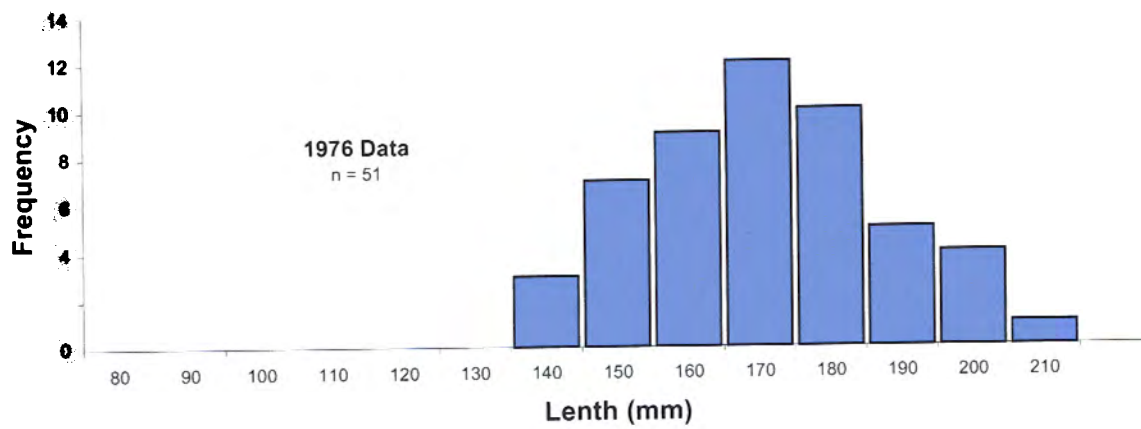


Figure 4. Comparison of length - frequency distribution of fourhorn sculpin from 1976 (Fallis et al., 1987) 1977 (BC Research (1978) and 2003.



TABLES



Table 1. Details of sediment, water and biota collections from Garrow Lake, August 8 – 10, 2003.

Station	UTM		Depth (m)	Parameter				Observations
	N	E		Water	Benthos	Zooplankton	Sediment	
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
GL-S-SED			8				X	flocculent sediment throughout grab with black sticky varves.
GL-1-WQ	8369695	0561130	0 – 42	X				



Table 2. Summary of Garrow Lake water column metals concentration (mean, range; ug/L), 1976 - present.

		n	Arsenic		Cadmium		Copper		Lead		Nickel		Zinc	
			mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
June 1976 ^{AB} (Fallis et al., 1987)	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
	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 (BC Research 1978)	Mixolimnion	12	<1		0.2	<0.1 - 0.6	10	1 - 60	5	<1 - 16			24	6 - 100
	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 (BC Research 1981)	Mixolimnion	14	<1		>0.5		19	6 - 32	<1				49	20 - 95
	Pycnocline	24	<1		>0.5		23	13 - 36	<5				46	28 - 85
	Monimolimnion	16	8	3.4 - 13	>0.5		16	3 - 50	<10				48	15 - 113
August 1981 (Ouellet & Dickman 87)	Mixolimnion	2			>0.5		1.0		<10		7		10	9 - 12
	Pycnocline	1			1.0		>1		<10		10		9	
	Monimolimnion	7			<1.2		<2.4		<24		11		16	7 - 34
October 1981 (Fallis et al. 1987)	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
	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 (BC Research, 1988)	Mixolimnion	1							5				20	
	Pycnocline	1							5				40	
	Monimolimnion	1							14				30	
September 1987 (BC Research, 1988)	Mixolimnion	1							7				230	
	Pycnocline	1							5				220	
	Monimolimnion	2							25				45	
May 1990 (BC Research, 1988)	Mixolimnion	1							10				410	
	Pycnocline	1							21				1,820	
August 1998 (Teck Cominco)	Mixolimnion	4	<1		1.0	<1 - 1	1.0	<1 - 1	2	<1 - 5	<2		198	150 - 320
August 1999 (Teck Cominco)	Mixolimnion	4	<1		1.0		2.3	<1 - 4	15.3	13 - 22	5	4 - 5	233	220 - 270
August 2001 (Teck Cominco)	Mixolimnion	4	<1		<2		1.5	<1 - 2	1.8	<1 - 3	4	3 - 5	223	180 - 330
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 ‰	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.

Total Metals	Fallis et al. (1987) June 1976 (n=9)		BC Research (1978) August 1977 (n=2)		BC Research (1981) May and August 1980 (n=19)	
	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	Mean	GL-N North	GL-S South	Fallis et al. 1987
Depth (m)	7.5	6.5 - 8.5	6 - 8	2 - 7		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
<u>Enchytraidae</u>		471	10	418	390	1470	550
COPEPODA							
Cyclopoida	juv*						
EPHEMEROPTERA							
<u>Baetidae</u>							
<i>Baetis bicaudatus</i>	N	2					
DIPTERA							
<u>Chironomidae</u>	P	1					
Tanypodinae							
<i>Procladius</i>	L	1					
<u>Orthocladiinae</u>							
<i>Eukiefferiella</i>	L	1					
<i>Orthocladius</i>	L						
<u>Diamesinae</u>							
<i>Diamesa</i>	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 identified 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	-	-	-	-	-

¹K = Condition Factor = (body weight x 10⁵) / total length³

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

¹K = Condition Factor = (body weight x 10⁵) / total length³

[^] 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	$\text{Log}_{10}(\text{weight}) = 2.82 * \text{Log}_{10}(\text{length}) - 4.78$	0.99 ^A
1977	33	$\text{Log}_{10}(\text{weight}) = 2.40 * \text{Log}_{10}(\text{length}) - 3.98$	0.97
2003	19	$\text{Log}_{10}(\text{weight}) = 2.96 * \text{Log}_{10}(\text{length}) - 5.06$	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





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



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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 m² 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.



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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 m² 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.



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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.



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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. Donald

Copy signed by TCL received by DFO

Signature:

Stephannie Critch

Date:

July 23, 2003

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.

Depth (m)	Pre-Mine Profile			Post-Mine Profile							
	June 1976 (Fallis et al. 1987)			Winter 2003 (Teck Cominco)			August 2003				
	Temperature (°C)	Salinity ppt	D.O. mg/L	Temperature (°C)	Conductivity (mS)	D.O. mg/L	Temperature (°C)	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	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
Total Metals (mg/kg ww)														
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	0.067	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	0.63	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	78.8	120	86.5	54.3	50.4	85.1	78	57.3	72.3	20.6	50.4 - 120