

ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF ENFORCEMENT

EPA-330/2-75-006

*EVALUATION OF PROPOSED
NPDES PERMIT LIMITATIONS
FOR
HOMESTAKE MINING COMPANY*

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

DENVER, COLORADO

AUGUST 1975



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I. INTRODUCTION

The Administrator of EPA Region VIII on 21 November 1974 asked the National Enforcement Investigations Center (NEIC) to evaluate wastewater discharges from the Homestake Mining Company in Lead, South Dakota. The evaluation was to verify the adequacy of proposed effluent limitations in the Homestake Mining Company NPDES* permit No. SD-0000043.

NEIC studies began in January 1975; the findings of a portion of the work were published in the February 1975 report, *Evaluation of Proposed NPDES Limitations for Homestake Mining Company and Lead-Deadwood Sanitary District No. 1*.¹

Subsequent to the February report, the Administrator of EPA Region VIII requested that NEIC conduct continuous-flow acute bioassays on nine metals for which effluent limitations had been proposed in the Homestake Mining Company NPDES permit. This report contains results of studies conducted from 1 May to 7 June 1975 and recommended effluent limitations for the Homestake Mining Company.

* *National Pollutant Discharge Elimination System, Federal Water Pollution Control Act Amendments of 1972.*

II. CONCLUSIONS

Bioassays of nine metals anticipated in the wastewater from the Homestake Mining Company demonstrated the need to revise the limitations presented in NPDES permit No. SD-0000043.

From the series of bioassays performed with cadmium (Cd), copper (Cu) and zinc (Zn), the 96-hour median effective concentrations (96-hour EC50) were calculated to be 6.6, 253 and 550 $\mu\text{g}/\text{l}$, respectively. These concentrations become 0.07 $\mu\text{g Cd}/\text{l}$, 2.5 $\mu\text{g Cu}/\text{l}$ and 5.5 $\mu\text{g Zn}/\text{l}$ after adjusting the EC50 values downward by a factor of 0.01, as required by the South Dakota Water Quality Standards. These concentrations are permitted by South Dakota in wastewater discharges, and they are lower than the NPDES permit recommended values of 3 $\mu\text{g Cd}/\text{l}$, 20 $\mu\text{g Cu}/\text{l}$ and 40 $\mu\text{g Zn}/\text{l}$.

Another series of bioassays was performed and adjusted EC50 values were obtained for chromium, mercury, lead, nickel and silver. The concentrations specified in the NPDES permit for these elements were found to be more stringent than required to: 1) meet South Dakota Water Quality Standards, and 2) to protect a proposed coldwater fishery in Whitewood Creek, downstream from the Homestake Mining Company effluent.

The arsenic concentration of 100 $\mu\text{g}/\text{l}$ specified in permit No. SD-0000043 complies with South Dakota Water Quality Standards. Furthermore, the toxicity tests performed with arsenic showed that 100 $\mu\text{g As}/\text{l}$ would not deter survival and propagation of coldwater fishes in Whitewood Creek.

III. RECOMMENDATIONS

The following recommendations are made in accordance with South Dakota Water Quality Standards for the discharge of residual and accumulative substances, and to assure the protection of a coldwater fishery in Whitewood Creek.

Heavy metal effluent limitations in Homestake Mining Company permit No. SD-0000043 should be revised to read:

1. Total cadmium concentrations shall not exceed 0.07 $\mu\text{g}/\text{l}$ (1/100 EC50).
2. Total copper concentrations shall not exceed 2.5 $\mu\text{g}/\text{l}$ (1/100 EC50).
3. Total zinc concentrations shall not exceed 5.5 $\mu\text{g}/\text{l}$ (1/100 EC50).
4. Total chromium concentrations shall not exceed 240 $\mu\text{g}/\text{l}$ (1/100 EC50).
5. Total lead concentrations shall not exceed 80 $\mu\text{g}/\text{l}$ (1/100 EC50).
6. Total mercury concentrations shall not exceed 0.3 $\mu\text{g}/\text{l}$ (1/100 EC50).
7. Total nickel concentrations shall not exceed 350 $\mu\text{g}/\text{l}$ (1/100 EC50).
8. Total silver concentrations shall not exceed 0.3 $\mu\text{g}/\text{l}$ (1/100 EC50).

The effluent limitation of 100 $\mu\text{g}/\text{l}$ for arsenic is adequate as listed in NPDES permit No. SD-0000043.

IV. RESULTS AND DISCUSSION

The toxicity of arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc to 2-month-old rainbow trout in Whitewood Creek water was tested in continuous flow, 96-hour bioassays. The results of these bioassays are summarized in Table 1, and they are compared with effluent limitations proposed for the Homestake Mining Company NPDES permit No. SD-0G00043. Recommended effluent limitations are proposed by NEIC, assuming that Whitewood Creek during low flow will provide little or no dilution and that the Homestake Mining Company will continue to discharge wastewaters into Gold Run.

The effluent permit limitation proposed for arsenic was adequate. Proposed limitations for cadmium (3 $\mu\text{g}/\text{l}$), copper (20 $\mu\text{g}/\text{l}$), and zinc (40 $\mu\text{g}/\text{l}$) are not sufficiently stringent to comply with South Dakota Water Quality Standards and to assure the establishment of a coldwater fishery in Whitewood Creek downstream from the Homestake Mining Company effluent. To meet the standards and to establish a coldwater fishery in the affected reach of Whitewood Creek, cadmium concentrations should be limited to 0.07 $\mu\text{g}/\text{l}$, copper to 2.5 $\mu\text{g}/\text{l}$, and zinc to 5.5 $\mu\text{g}/\text{l}$. Effluent limitations proposed in the permit for chromium, lead, mercury, nickel and silver are more stringent than required to comply with state standards designed to protect a coldwater fishery in Whitewood Creek.

ARSENIC (As)

The toxicity of arsenic was tested using solutions of sodium arsenite (NaAsO_2) in Whitewood Creek water. Concentrations of arsenic used in the bioassay ranged from 2.31 to 37 mg As/l (2,310 to 37,000 $\mu\text{g}/\text{l}$). During the 96-hour bioassay, fish mortalities ranged from 100% in

Table 1
SUMMARY OF 96-HOUR BIOASSAY RESULTS
COMPARED WITH EFFLUENT LIMITATIONS PROPOSED FOR
NPDES PERMIT NO. SD-000043[†]

| Toxicant | Compound Tested | Test Concentration Range | EC50 | Effluent Limitations | | Adequacy of Limitation in Permit No. SD-000043 |
|----------|---|--------------------------|--------|---------------------------|----------------------|--|
| | | | | EC50 x 0.01 ^{††} | Permit No. SD-000043 | |
| As | sodium arsenite NaAsO ₂ | 2,310-37,000 | 10,800 | 108 | 100 | Adequate |
| Cd | cadmium nitrate Cd(NO ₃) ₂ ·4H ₂ O | 1.8-28 | 6.6 | 0.07 | 3.0 | Lentent |
| Cr | chromium nitrate Cr(NO ₃) ₃ ·9H ₂ O | 4,020-64,250 | 24,090 | 241 | 50 | Stringent |
| Cu | cupric nitrate Cu(NO ₃) ₂ | 78-1,250 | 253 | 2.5 | 20 | Lentent |
| Pb | lead nitrate Pb(NO ₃) ₂ | 875-14,000 | 8,000 | 80 | 50 | Stringent |
| Hg | mercurous nitrate Hg(NO ₃) ₂ ·H ₂ O | 22.9-367 | 33 | 0.3 | 0.2 | Stringent |
| Ni | nickel nitrate Ni(NO ₃) ₂ ·6H ₂ O | 6,110-97,750 | 35,500 | 355 | 200 | Stringent |
| Ag | silver nitrate AgNO ₃ | 5-80 | 28.8 | 0.3 | 0.2 | Stringent |
| Zn | zinc acetate Zn(C ₂ H ₃ O ₂) ₂ ·2H ₂ O | 66-1,053 | 550 | 5.5 | 40 | Lentent |

[†] Concentrations in µg/L of the element.

^{††} South Dakota Water Quality Standards prohibit the discharge of any material which produces concentrations of chemicals greater than 0.1 times the median tolerance limit (96-hr) for short residual compounds, and 0.01 times the median tolerance limit for accumulative substances or substances with residual life greater than 30 days in the receiving water. Because the toxicants tested are either accumulative or would have residual lives greater than 30 days, an application factor of 0.01 was used for calculation of effluent limitations.

concentrations as low as 18.5 mg As/l, to 65% at 9.25 mg As/l. No mortality occurred in the lower concentrations of 4.62 to 2.31 mg As/l (App. B, Table B-1). The 96-hour EC50* for 2-month-old rainbow trout was calculated to be 10.8 mg As/l (10,800 μ g/l). To establish a cold-water fishery in the affected reach of Whitewood Creek downstream from Gold Run and to comply with South Dakota Water Quality Standards, arsenic concentrations in the Homestake Mining Company effluent should be limited to less than 108 μ g/l.

The results of the arsenic bioassay compare closely with those of other investigators using salmonid fish. Holland² determined the 96-hour TL₅₀ of arsenic to pink salmon to be 11.0 mg/l, and in another investigation³, the 48-hour TL_m to chum salmon fry was 11.0 mg/l.

CADMIUM (Cd)

A solution of cadmium nitrate ($\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$) in Whitewood Creek water was used to test the toxicity of cadmium to rainbow trout. Cadmium concentrations in the bioassay test ranged from 1.8 to 28 μ g Cd/l. During the first 24 hours of the bioassay, all fish exposed to 28 and 21 μ g Cd/l died [Table B-2]. At the end of 48 hours, mortality was 100% in 14 μ g/l and 55% in 7 μ g/l; whereas, all fish in a 3.5 μ g/l concentration of cadmium survived. No additional mortalities occurred during the 96-hour bioassay. Using 2-month-old rainbow trout, the EC50 for cadmium was 6.6 μ g/l. To establish a trout fishery in Whitewood Creek and to comply with South Dakota Water Quality Standards, cadmium concentrations in the Homestake Mining Company discharge should not exceed 0.07 μ g/l.

* EC50 indicates the effective concentration (actual or interpolated) at which 50% of the experimental animals survived. Some literature sources in this report use LC50 and TL₅₀, which for the purpose of this report indicate values equivalent to EC50.

Cadmium was found to be more toxic in Whitewood Creek than has been reported from laboratory studies by other investigators using salmonid species.^{4,5} It is assumed that dilution waters used in these other bioassays did not contain heavy metal contaminants. Conversely, the Whitewood Creek dilution water used in the bioassays conducted by NEIC contained relatively high concentrations of other heavy metals, notably mercury and zinc. These metals are known to be synergistic with cadmium; therefore, it can be expected that cadmium would be more toxic in Whitewood Creek than has been reported by laboratory investigators.

CHROMIUM (Cr)

Bioassay tests to determine the toxicity of chromium to rainbow trout were conducted using 4.02 to 64.25 mg/l (as Cr) solutions of chromium nitrate ($\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$) in Whitewood Creek water. During the first 24 hours of the bioassay, all fish died in the highest chromium concentrations (64.25, 48.19 and 32.125 mg/l) and all fish survived in 16.06 mg Cr/l [Table B-3]. No additional mortalities occurred during the 96-hour test. Using 2-month-old rainbow trout, the 96-hour EC50 for chromium was 24.09 mg/l (24,090 $\mu\text{g/l}$), and the safe level was determined as 241 $\mu\text{g/l}$. Therefore, the 50 $\mu\text{g/l}$ chromium limitation recommended in NPDES permit No. SD-0000043 is more stringent than needed for the establishment of a trout fishery in Whitewood Creek downstream from the Homestake Mining Company effluent.

The 24.09 mg/l EC50 established for chromium toward Whitewood Creek rainbow trout compares closely with the results of other bioassays. Pickering⁶ determined the 96-hour LC50 of chromium toward other test fish in hard water to be 27 mg/l.

COPPER (Cu)

Solutions of cupric nitrate ($\text{Cu}(\text{NO}_3)_2$) were used to test the toxicity of copper toward rainbow trout. Copper concentrations ranged from 0.078 to 1.25 mg/l (78 to 1,250 $\mu\text{g}/\text{l}$) in the bioassays. Although most of the mortalities in this bioassay occurred by the end of 48 hours' exposure (mortality was 100% in 1.25 and 0.938 mg/l), deaths continued to occur at lower concentrations for the duration of the tests [Table B-4].

The 96-hour EC50 for copper against rainbow trout was calculated to be 253 $\mu\text{g}/\text{l}$ (0.253 mg/l). Using the application factor of 0.01 required by South Dakota Water Quality Standards to assure the establishment of a coldwater fishery, the copper concentrations in the Homestake Mining Company effluent must be limited to 2.5 $\mu\text{g}/\text{l}$. Thus, the 20 $\mu\text{g}/\text{l}$ copper limitation recommended in permit No. SD-0000043 does not satisfy the South Dakota regulations.

The EC50 value for copper of 253 $\mu\text{g}/\text{l}$ determined for Whitewood Creek compares closely with the results of other rainbow trout bioassays. Davies and Goettl⁷ reported a 7-day LC50 of 250 $\mu\text{g}/\text{l}$ for copper against rainbow trout. Chapman,⁸ using steelhead trout, reported 96-hour LC50 values as low as 18 $\mu\text{g}/\text{l}$.

LEAD (Pb)

The toxicity of lead to rainbow trout was tested using solutions of lead nitrate ($\text{Pb}(\text{NO}_3)_2$) in Whitewood Creek water. Concentrations of the test solutions ranged from 0.875 to 14.0 mg/l (875 to 14,000 $\mu\text{g}/\text{l}$). Mortalities occurred throughout the 96-hour bioassay, indicating that lead is an accumulative poison [Table B-5].

The 96-hour EC50 value determined for lead against 2-month-old rainbow trout was 8.0 mg/l (8,000 µg/l), and the safe concentration for establishing a trout fishery in Whitewood Creek downstream from Gold Run is 80 µg/l. Thus, the 50 µg/l lead limitation recommended in NPDES permit No. SD-0000043 is more stringent than needed.

The EC50 value of 8.0 mg/l measured for rainbow trout in Whitewood Creek water is near the values reported by other investigators for other test species. Henderson⁹ reported 96-hour LC50 values for another salmonid species, brook trout, ranging from 4 to 5 mg Pb/l. In soft water, the 96-hour LC50 for rainbow trout reported by Brown¹⁰ was 1 mg Pb/l.

MERCURY (Hg)

Toxicity of mercury to rainbow trout was determined through bioassay tests using solutions of mercurous nitrate ($\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$) in Whitewood Creek water. Concentrations of mercury tested ranged from 22.92 to 366.66 µg/l. Within 48 hours, all test fish died in the mercury concentrations of 183.33 µg/l and higher [Table B-6]. Within 96 hours, at least 90% of the test fish were dead in concentrations of 45.83 µg/l or higher. Using 2-month-old rainbow trout, the 96-hour EC50 value was calculated to be 33 µg Hg/l.

The mercury concentration of 0.2 µg/l recommended in the Homestake NPDES permit is more stringent than needed to protect a coldwater fishery in Whitewood Creek. Furthermore, it is more stringent than required to comply with the South Dakota Water Quality Standards, prohibiting the discharge into receiving water of accumulative and residual chemical concentrations greater than 0.01 times the EC50 value.

NICKEL (Ni)

Toxicity of nickel to rainbow trout was tested using solutions of nickel nitrate ($\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$) in Whitewood Creek water. Test fish were exposed to nickel concentrations ranging from 6.11 to 97.75 mg/l (6,110 to 97,750 $\mu\text{g}/\text{l}$). Within 24 hours, substantial numbers of test fish died in nickel concentrations of 73.31 mg/l (73,310 $\mu\text{g}/\text{l}$) and higher [Table B-7]. At the completion of the 96-hour bioassay, duplicate concentrations of 48.88 mg Ni/l (48,880 $\mu\text{g}/\text{l}$) caused 80% and 100% fish mortalities. No mortalities were recorded in the 24.44 mg Ni/l (24,440 $\mu\text{g}/\text{l}$) concentrations and the 96-hour EC50 was calculated to be 35.5 mg Ni/l (35,500 $\mu\text{g}/\text{l}$).

The toxicity values calculated from the bioassay results presented in Table B-7 are similar to values reported in the literature.¹¹ The nickel concentration of 200 $\mu\text{g}/\text{l}$ recommended in Homestake permit No. SD-0000043 is more stringent than needed to comply with South Dakota Water Quality Standards for toxic substances (0.01 EC50 or less) and to protect a coldwater fishery in the affected reach of Whitewood Creek.

SILVER (Ag)

Toxicity of silver was determined by exposing 2-month-old rainbow trout to varying concentrations of silver nitrate (AgNO_3) in Whitewood Creek water. Test concentrations of silver ranged from 5 to 80 $\mu\text{g}/\text{l}$. All the test fish died in the concentrations of 80 $\mu\text{g}/\text{l}$ after 24 hours and in 60 $\mu\text{g}/\text{l}$ in 96 hours. A 95% mortality occurred in the 40 $\mu\text{g}/\text{l}$ concentration during the bioassay; no other fish mortalities occurred [Table B-8].

The calculated 96-hour EC50 of 28.8 $\mu\text{g}/\text{l}$ is similar to values reported by other investigators.^{12,7} Furthermore, the recommended

0.2 µg Ag/l in Homestake Mining Company wastewater discharge is more stringent than needed to meet South Dakota Standards (0.01 EC50 or less) and to protect a coldwater fishery in Whitewood Creek.

ZINC (Zn)

To determine the toxicity of zinc to rainbow trout, a series of bioassays was conducted using a solution of zinc acetate ($\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$) in Whitewood Creek water. Test concentrations of zinc ranged from 0.066 to 1.053 mg/l (66 to 1,053 µg/l). When the 96-hour bioassay was complete, fish mortalities of 90% were recorded in the 1.053 mg Zn/l concentration, while 85% and 45% mortalities were found in the 0.79 and 0.526 mg Zn/l concentrations, respectively [Table B-9]. Using 2-month-old rainbow trout, the 96-hour EC50 was calculated to be 0.55 mg Zn/l (550 µg/l).

Toxicity of zinc established by these bioassays (EC50 value of 550 µg/l) was somewhat less than reported in the literature. For example, in separate studies with rainbow trout Davies and Goettl⁷ reported a 96-hour TL₅₀ value of 240 µg Zn/l, and Chapman⁸ reported 136 µg Zn/l. Nevertheless, the limitation specified for zinc in wastewater from Homestake Mining Company must reflect the environmental conditions (i.e., hardness, dissolved oxygen, temperature and synergistic-antagonistic characteristics) of Whitewood Creek. To comply with South Dakota Water Quality Standards, and to establish and maintain a coldwater fishery in the downstream affected reach of Whitewood Creek, zinc concentrations in the Mining Company wastewaters should be limited to less than 5.5 µg/l (1/100 EC50).

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APPENDIX A
BIOASSAY METHODS

BIOASSAY METHODS

All 96-hour bioassays were done according to standardized methods¹³ using a continuous flow proportional diluter, providing a series of six dilutions of toxicant and a dilution water control.

Dilution water (receiving water) for all bioassays was obtained from Whitewood Creek 0.5 km (0.3 mi) upstream from the Homestake Mining Company effluent. The chemical quality of Whitewood Creek is shown in Appendix B Tables, B-1 through B-9.

Test water for each of the bioassays was prepared by adding a stock concentrate of reagent grade chemical to Whitewood Creek water. The chemicals used were sodium arsenate (NaAsO_2), cadmium nitrate [$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$], chromium nitrate [$\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$], cupric nitrate [$\text{Cu}(\text{NO}_3)_2$], mercurous nitrate ($\text{HgNO}_3 \cdot \text{H}_2\text{O}$), lead nitrate [$\text{Pb}(\text{NO}_3)_2$], nickel nitrate [$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$], silver nitrate (AgNO_3) and zinc acetate [$\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$].

The test organisms used in all bioassays were young-of-the-year (2-month-old) rainbow trout obtained from the McNenny National Fish Hatchery, Spearfish, South Dakota. The total length of these fish ranged from 51 to 76 mm (2 to 3 in).

Test chambers were made of glass and had 8-liter capacities. Bioassay exposures were in duplicate at each test concentration with ten fish in each chamber. The minimum volumetric turnover for any chamber was 6-1/2 times in 24 hours.

Test water was monitored daily for pH, temperature, dissolved oxygen and total alkalinity. A sample of the 100% concentration was collected daily for metals analysis. One test chamber in each series was continuously monitored for temperature fluctuation with a recording thermocouple.

Fish mortalities were recorded at 24-hour intervals. EC50 values were estimated using straight-line graphic interpolation.

APPENDIX B
ANALYTICAL RESULTS

Table B-1
ACUTE TOXICITY OF ARSENIC AND ASSOCIATED CHEMICAL DATA
 1-5 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | | |
|----------------------|--------------------------------------|-----------------|-------|-------|------|------|------|------|-------|------|-------|------|------------------------------|-----------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | Control (Receiving water) | |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (7.7-8.5)(7.7-8.5) | | - | - | - | - | - | - | - | - | - | - | (6.4-7.8) | (6.4-7.8) |
| Dissolved Oxygen | 8.0 | 7.9 | 7.8 | 7.2 | 7.4 | 7.3 | 7.2 | 7.3 | 7.1 | 6.9 | 7.2 | 6.9 | 6.7 | 6.8 |
| Temperature (°C) | 13.5 | 13.2 | 13.3 | 14.3 | 13.9 | 14.3 | 14.0 | 14.1 | 14.3 | 14.3 | 14.3 | 14.4 | 15.2 | 15.2 |
| Total Alkalinity | 126 | 126 | - | - | - | - | - | - | - | - | - | - | 95 | 95 |
| Total Arsenic | 37 | 37 | 27.75 | 27.75 | 18.5 | 18.5 | 9.25 | 9.25 | 4.62 | 4.62 | 2.31 | 2.31 | <0.01 | <0.01 |
| Total Cadmium | <0.002 | <0.002 | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (µg/l) | 0.88 | 0.88 | - | - | - | - | - | - | - | - | - | - | 1.45 | 1.45 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | 0.036 | 0.036 | - | - | - | - | - | - | - | - | - | - | 0.028 | 0.028 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 80 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 10 | 20 | 40 | 60 | 80 | 50 | 100 | 90 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 20 | 20 | 30 | 100 | 90 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 50 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 37 mg/l arsenic in solution of sodium arsenite; average values in mg/l, range in parentheses
 †† Letters A and B signify duplicate bioassay tests

Table B-2
ACUTE TOXICITY OF CADMIUM AND ASSOCIATED CHEMICAL DATA
 2-6 June 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|-------|-------|-------|-------|-----------|-----------|-----------|-----------|-----------|-----------|------------------------------|-----------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (7.8-8.3) | (7.8-8.3) | - | - | - | - | (8.1-8.2) | (8.0-8.2) | (8.1-8.2) | (8.1-8.3) | (8.0-8.2) | (8.1-8.2) | (7.6-8.3) | (7.6-8.3) |
| Dissolved Oxygen | 7.8 | 8.0 | 7.9 | 7.9 | 7.7 | 7.8 | 7.0 | 7.0 | 7.0 | 6.9 | 7.0 | 6.8 | 6.9 | 6.9 |
| Temperature (°C) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 16.4 | 16.4 | 16.6 | 16.4 | 16.5 | 16.4 | 16.6 | 16.4 |
| Total Alkalinity | 133 | 133 | - | - | - | - | - | - | - | - | - | - | 132 | 132 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | 0.028 | 0.028 | 0.021 | 0.021 | 0.014 | 0.014 | 0.007 | 0.007 | 0.0035 | 0.0035 | 0.0018 | 0.0018 | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (ug/l) | 0.25 | 0.25 | - | - | - | - | - | - | - | - | - | - | 1.1 | 1.1 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 0 | 0 | 0 | 0 | 10 | 10 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 40 | 100 | 100 | 100 | 100 | 100 | 100 |
| 74 hr | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 40 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 40 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 0.028 mg/l cadmium in a solution of cadmium nitrate; average values in mg/l, range in parentheses

†† Letters A and B signify duplicate bioassay tests

Table B-3
ACUTE TOXICITY OF CHROMIUM AND ASSOCIATED CHEMICAL DATA
 3-7 June 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------------------------|-----------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (4.6-5.0) | (4.6-5.0) | (5.4-5.4) | (5.5-5.5) | (6.3-6.3) | (6.2-6.2) | (6.5-6.7) | (6.4-6.7) | (6.9-7.5) | (6.9-7.2) | (7.0-7.2) | (6.9-7.3) | (8.2-8.3) | (8.1-8.3) |
| Dissolved Oxygen | 7.8 | 7.7 | 7.2 | 7.8 | 7.8 | 7.8 | 6.8 | 6.8 | 6.7 | 6.8 | 6.8 | 6.8 | 6.7 | 6.7 |
| Temperature (°C) | 17.5 | 17.5 | 17.0 | 17.0 | 17.0 | 17.0 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.5 | 17.5 |
| Total Alkalinity | 7.5 | 7.5 | - | - | - | - | - | - | - | - | - | - | 131.5 | 131.5 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | (<0.002-0.007) | | (<0.002-0.007) | | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | 64.25 | 64.25 | 48.19 | 48.19 | 32.125 | 32.125 | 16.06 | 16.06 | 8.03 | 8.03 | 4.02 | 4.02 | <0.01 | <0.01 |
| Trivalent Chromium | 64.25 | 64.25 | 48.19 | 48.19 | 32.125 | 32.125 | 16.06 | 16.06 | 8.03 | 8.03 | 4.02 | 4.02 | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | (<0.05-0.08) | | (<0.05-0.08) | | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (ug/l) | 0.21 | 0.21 | - | - | - | - | - | - | - | - | - | - | 1.2 | 1.2 |
| Total Nickel | 0.015 | 0.015 | - | - | - | - | - | - | - | - | - | - | >0.01 | >0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | >0.01 | >0.01 |
| Total Zinc | 0.011 | 0.011 | - | - | - | - | - | - | - | - | - | - | 0.010 | 0.010 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 64.25 mg/l chromium in a solution of chromium nitrate; average values in mg/l, range in parentheses
 †† Letters A and B signify duplicate bioassay tests

Table B-4
ACUTE TOXICITY OF COPPER AND ASSOCIATED CHEMICAL DATA
 3-7 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------------|-------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (6.2-6.5)(6.2-6.5) | | - | - | - | - | - | - | - | - | - | - | (6.4-6.7)(6.4-6.7) | |
| Dissolved Oxygen | 7.1 | 6.8 | 6.5 | 6.5 | 6.7 | 7.1 | 6.7 | 6.6 | 6.3 | 6.5 | 6.4 | 6.3 | 6.4 | 6.3 |
| Temperature (°C) | 15.1 | 15.1 | 15.3 | 15.1 | 14.9 | 14.6 | 14.3 | 14.5 | 14.6 | 14.8 | 14.6 | 14.7 | 15.1 | 15.1 |
| Total Alkalinity | 88 | 88 | - | - | - | - | - | - | - | - | - | - | 87 | 87 |
| Total Arsenic | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| Total Cadmium | 0.002 | 0.002 | - | - | - | - | - | - | - | - | - | - | 0.002 | 0.002 |
| Total Chromium | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| Trivalent Chromium | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| Hexavalent Chromium | 0.005 | 0.005 | - | - | - | - | - | - | - | - | - | - | 0.005 | 0.005 |
| Total Copper | 1.25 | 1.25 | 0.938 | 0.938 | 0.625 | 0.625 | 0.312 | 0.312 | 0.156 | 0.156 | 0.078 | 0.078 | 0.03 | 0.03 |
| Total Lead | 0.05 | 0.05 | - | - | - | - | - | - | - | - | - | - | 0.05 | 0.05 |
| Total Mercury (µg/l) | 1.20 | 1.20 | - | - | - | - | - | - | - | - | - | - | 1.20 | 1.20 |
| Total Nickel | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| Total Silver | 0.01 | 0.01 | - | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| Total Zinc | 0.022 | 0.022 | - | - | - | - | - | - | - | - | - | - | 0.022 | 0.022 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 20 | 40 | 70 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 0 | 40 | 20 | 70 | 50 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 20 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 10 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 1.25 mg/l copper in a solution of cupric nitrate; average values in mg/l, range in parentheses
 †† Letters A and B signify duplicate bioassay tests

Table B-5
ACUTE TOXICITY OF LEAD AND ASSOCIATED CHEMICAL DATA
10-14 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | | |
|----------------------|--------------------------------------|-----------------|------|------|------|------|------|------|-------|------|-------|-------|------------------------------|--------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | Control (Receiving water) | |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (6.8-7.0)(6.8-7.0) | | - | - | - | - | - | - | - | - | - | - | (7.1-7.7)(7.1-7.7) | |
| Dissolved Oxygen | 8.1 | 8.2 | 7.6 | 7.5 | 7.5 | 7.5 | 7.5 | 7.4 | 7.4 | 7.5 | 7.6 | 7.5 | 7.5 | 7.4 |
| Temperature (°C) | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.7 | 12.8 | 12.7 | 12.9 | 13.0 | 13.5 | 13.5 |
| Total Alkalinity | 76 | 76 | - | - | - | - | - | - | - | - | - | - | 82 | 82 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | <0.002 | <0.002 | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | 14.0 | 14.0 | 10.5 | 10.5 | 7.0 | 7.0 | 3.5 | 3.5 | 1.75 | 1.75 | 0.875 | 0.875 | <0.05 | <0.05 |
| Total Mercury (µg/l) | 1.32 | 1.32 | - | - | - | - | - | - | - | - | - | - | 1.00 | 1.00 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | 0.022 | 0.022 | - | - | - | - | - | - | - | - | - | - | 0.020 | 0.020 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 80 | 70 | 90 | 80 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 40 | 50 | 70 | 70 | 70 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 10 | 50 | 50 | 60 | 60 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 14.0 mg/l lead in a solution of lead nitrate; average values in mg/l, range in parentheses

†† Letters A and B signify duplicate bioassay tests

Table B-6
ACUTE TOXICITY OF MERCURY AND ASSOCIATED CHEMICAL DATA
 16-20 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|--------|--------|--------|--------|-----------|-----------|-------|-------|-------|-------|------------------------------|-----------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (8.0-8.1) | (8.0-8.1) | - | - | - | - | (8.0-8.0) | (8.0-8.0) | - | - | - | - | (8.1-8.1) | (8.1-8.1) |
| Dissolved Oxygen | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 | 6.3 | 6.8 | 6.6 | 6.4 | 6.6 | 6.3 | 6.3 | 6.3 | 6.1 |
| Temperature (°C) | 17.2 | 17.3 | 17.0 | 17.0 | 17.3 | 16.8 | 16.3 | 16.6 | 16.7 | 16.7 | 16.7 | 16.6 | 16.8 | 16.8 |
| Total Alkalinity | 89 | 89 | - | - | - | - | 182 | 182 | - | - | - | - | 91 | 91 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | <0.002 | <0.002 | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (µg/l) | 366.66 | 366.66 | 275.00 | 275.00 | 183.33 | 183.33 | 91.66 | 91.66 | 45.83 | 45.83 | 22.92 | 22.92 | 0.63 | 0.63 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | 0.015 | 0.015 | - | - | - | - | - | - | - | - | - | - | 0.015 | 0.015 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 30 | 60 | 20 | 60 | 90 | 70 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 90 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 70 | 80 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 80 | 100 | 100 | 100 | 100 | 100 |

[†] Percent of 366.66 µg/l mercury in a solution of mercurous nitrate; average values in mg/l, range in parentheses

^{††} Letters A and B signify duplicate bioassay tests

Table B-7
ACUTE TOXICITY OF NICKEL AND ASSOCIATED CHEMICAL DATA
24-28 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------------------------------|--------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (8.0-8.0)(8.0-8.0) | | - | - | - | - | - | - | - | - | - | - | (8.2-8.3)(8.2-8.3) | |
| Dissolved Oxygen | 7.3 | 7.6 | 7.0 | 7.1 | 6.9 | 6.9 | 6.9 | 6.8 | 6.9 | 6.9 | 6.8 | 6.8 | 6.8 | 6.8 |
| Temperature (°C) | 12.8 | 13.2 | 12.6 | 12.5 | 12.8 | 12.9 | 12.9 | 13.1 | 13.0 | 13.0 | 13.0 | 13.0 | 13.4 | 13.4 |
| Total Alkalinity | 112 | 112 | - | - | - | - | - | - | - | - | - | - | 115 | 115 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | (<0.002-0.005)(<0.002-0.005) | | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (µg/l) | 0.24 | 0.24 | - | - | - | - | - | - | - | - | - | - | 1.03 | 1.03 |
| Total Nickel | 97.75 | 97.75 | 73.31 | 73.31 | 48.88 | 48.88 | 24.44 | 24.44 | 12.22 | 12.22 | 6.11 | 6.11 | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | <0.008 | 0.008 | - | - | - | - | - | - | - | - | - | - | 0.011 | 0.011 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 0 | 0 | 50 | 80 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 0 | 70 | 80 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 0 | 10 | 60 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 0 | 20 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 97.75 mg/l nickel in a solution of nickel nitrate; average values in mg/l, range in parentheses

†† Letters A and B signify duplicate bioassay tests

Table B-8
ACUTE TOXICITY OF SILVER AND ASSOCIATED CHEMICAL DATA
 19-23 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|------|------|------|------|------|------|-------|------|-------|-------|------------------------------|-----------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (8.0-8.2) | (8.0-8.2) | - | - | - | - | - | - | - | - | - | - | (8.0-8.2) | (8.0-8.2) |
| Dissolved Oxygen | 7.7 | 7.6 | 7.1 | 7.9 | 7.6 | 7.8 | 7.4 | 7.4 | 7.4 | 7.4 | 7.0 | 7.1 | 6.8 | 6.8 |
| Temperature (°C) | 15.5 | 15.5 | 17.0 | 14.3 | 14.2 | 14.6 | 14.3 | 14.3 | 14.5 | 14.3 | 14.4 | 14.3 | 14.2 | 14.5 |
| Total Alkalinity | 102 | 102 | - | - | - | - | - | - | - | - | - | - | 108 | 108 |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | <0.002 | <0.002 | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (µg/l) | 0.45 | 0.45 | - | - | - | - | - | - | - | - | - | - | 1.3 | 1.3 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | 0.08 | 0.08 | 0.06 | 0.06 | 0.04 | 0.04 | 0.02 | 0.02 | 0.01 | 0.01 | 0.005 | 0.005 | <0.01 | <0.01 |
| Total Zinc | 0.021 | 0.021 | - | - | - | - | - | - | - | - | - | - | 0.015 | 0.015 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 0 | 0 | 0 | 10 | 90 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 0 | 0 | 0 | 10 | 40 | 20 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 0 | 0 | 0 | 10 | 30 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 0 | 0 | 0 | 0 | 10 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 0.08 mg/l silver in a solution of silver nitrate; average values in mg/l, range in parentheses

†† Letters A and B signify duplicate bioassay tests

Table B-9
ACUTE TOXICITY OF ZINC AND ASSOCIATED CHEMICAL DATA
9-13 May 1975

| Parameter | Bioassay Concentrations [†] | | | | | | | | | | | | Control (Receiving water) | |
|----------------------|--------------------------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------------|--------|
| | 100% | | 75% | | 50% | | 25% | | 12.5% | | 6.25% | | A | B |
| | A | B ^{††} | A | B | A | B | A | B | A | B | A | B | A | B |
| pH (units) | (6.9-7.3)(6.9-7.3) | | - | - | - | - | - | - | - | - | - | - | (7.1-7.7)(7.1-7.7) | |
| Dissolved Oxygen | 8.1 | 8.2 | 7.8 | 7.6 | 7.3 | 7.0 | 7.6 | 7.2 | 7.5 | 7.6 | 7.5 | 7.6 | 7.4 | 7.1 |
| Temperature (°C) | 12.6 | 12.6 | 12.6 | 12.7 | 12.6 | 12.6 | 12.5 | 12.5 | 12.6 | 12.8 | 13.6 | 12.9 | 13.0 | 13.1 |
| Total Alkalinity | 76 | 76 | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Arsenic | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Cadmium | <0.002 | <0.002 | - | - | - | - | - | - | - | - | - | - | <0.002 | <0.002 |
| Total Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Trivalent Chromium | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Hexavalent Chromium | <0.005 | <0.005 | - | - | - | - | - | - | - | - | - | - | <0.005 | <0.005 |
| Total Copper | <0.03 | <0.03 | - | - | - | - | - | - | - | - | - | - | <0.03 | <0.03 |
| Total Lead | <0.05 | <0.05 | - | - | - | - | - | - | - | - | - | - | <0.05 | <0.05 |
| Total Mercury (µg/l) | 0.66 | 0.66 | - | - | - | - | - | - | - | - | - | - | 0.98 | 0.98 |
| Total Nickel | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Silver | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 |
| Total Zinc | 1.053 | 1.053 | 0.790 | 0.790 | 0.526 | 0.526 | 0.263 | 0.263 | 0.132 | 0.132 | 0.066 | 0.066 | 0.027 | 0.027 |
| % Survival at | | | | | | | | | | | | | | |
| 24 hr | 80 | 80 | 90 | 100 | 100 | 80 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 48 hr | 10 | 10 | 30 | 30 | 70 | 40 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 72 hr | 10 | 10 | 10 | 20 | 70 | 40 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 96 hr | 10 | 10 | 10 | 20 | 70 | 40 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

† Percent of 1.053 mg/l zinc in a solution of zinc acetate; average values in mg/l, range in parentheses

†† Letters A and B signify duplicate bioassay tests