

C. GARRETT

A SUMMARY OF  
AQUATIC ENVIRONMENTAL INFORMATION  
RELATING TO  
SILVANA MINES INC.  
SILMONAC MINE  
CARPENTER CREEK, NEW DENVER, B.C.

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MEMORANDUM

NOTE DE SERVICE

TO  
A

B.W. Kelso,  
Environmental Protection Biologist,

FROM  
DE

R.L. Hallam,  
Project Biologist

|   |
|---|
| SECURITY - CLASSIFICATION - DE SECURITE       |
| OUR FILE - N/REFERENCE<br><b>4780-37/K116</b> |
| YOUR FILE - V/REFERENCE                       |
| DATE<br><b>Oct 14, 1980</b>                   |

SUBJECT  
OBJET

SILVANA MINES INC., SILMONAC MINE, CARPENTER CREEK, NEW DENVER, B.C.

Attached for your information is a copy of my "Summary of Aquatic Environmental Information Relating To Silvana Mines Inc., Silmonac Mine, Carpenter Creek, New Denver, B.C.". Please note that this is an internal working document put together by myself outside of working hours for this Department's reference only and special note should be made of the provisions on the title page limiting its use. Please advise if you wish copies forwarded to such agencies as the B.C. Fish and Wildlife Branch.

*Robert Hallam*

R. Hallam

Attach.



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BVAEP

A SUMMARY OF  
AQUATIC ENVIRONMENTAL INFORMATION  
RELATING TO  
SILVANA MINES INC.  
SILMONAC MINE  
CARPENTER CREEK, NEW DENVER, B.C.

by

Robert L. Hallam

July 1980

This summary of aquatic environmental information is intended as a succinct review of readily available data for the Department of the Environment's internal reference only. All conclusions and recommendations are offered as guidance by the author and do not necessarily reflect the opinion or policy of the Department of the Environment. No part of this document may be used, reprinted or quoted without the permission of the Department of Environment, Environmental Protection Service, Kapilano 100, Park Royal, West Vancouver, B.C. V7T 1A2.

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A SUMMARY OF AQUATIC ENVIRONMENTAL INFORMATION RELATING TO  
SILVANA MINES INC., SILMONAC MINE, CARPENTER CREEK, NEW DENVER, B.C.

1 INTRODUCTION

Silvana Mines Inc., originally known as Kam-Kotia Mines Ltd., operate the former silver-lead-zinc properties of Silmonac Mines Ltd., New Denver, B.C. Production commenced in August of 1970 following extensive underground exploration in 1969 by a joint venture between Kam-Kotia Mines Ltd., and Burkam Mines Ltd. The ore is shipped to the nearby 150 ton/day mill of Carnegie Mining Co. Ltd. (acquired by Silvana Mines Inc. in 1977) located adjacent to Carpenter Creek near Sandon, B.C. (figure 1).

The reference mine production rate based on the 1971 operating year was established at 135 tons/day (Villamere et al., 1978). Estimated probable ore reserves as of December 31, 1977, were 48 855 tons averaging 16.43 oz/ton silver, 5.8% lead and 5.9 % zinc. Possible reserves are estimated at 506 000 tons (Canadian Mines Handbook, 1979).

The mill was initially operated at approximately 70 tons/day but since 1978 it has operated at approximately 100 tons/day. Average process water consumption is 60 000 IGPD (B.C. Ministry of Environment, EQUIS Data File). The mill produces separate lead and zinc concentrates by differential flotation using methylisobutylcarbinol(MIBC), xanthates, sodium cyanide, and copper sulphate with silver values reporting to both the lead and zinc concentrates. The overall milling grade during 1977 was 19.4 oz/ton silver, 7.41 % lead and 6.13 % zinc (Canadian Mines Handbook, 1979). There is no in-plant process for cyanide destruction prior to effluent discharge. A description of the milling process can be found in Villamere et al. (1978).

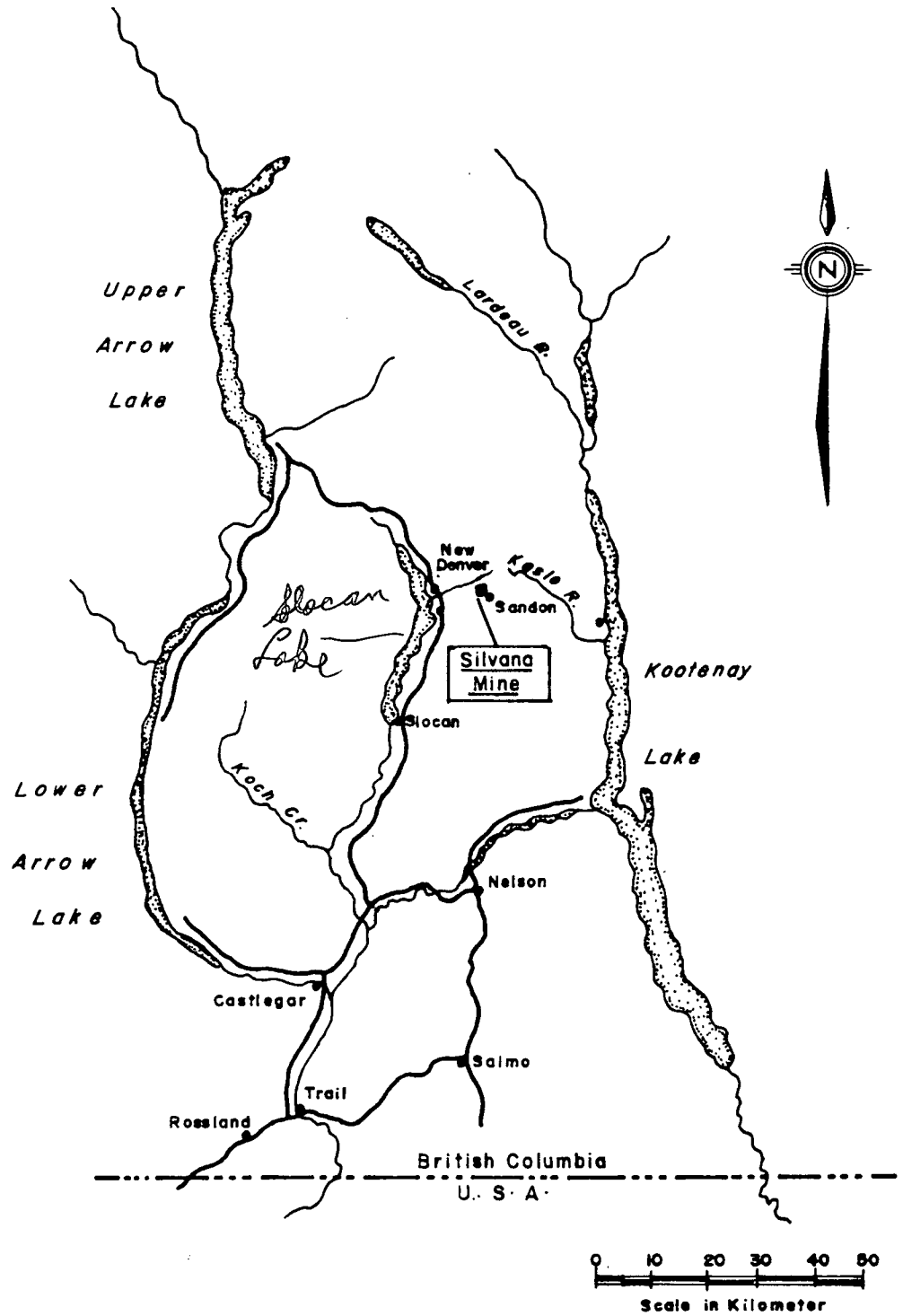


FIGURE 1 LOCATION OF SILVANA MINE SITE

2 EFFLUENT DESCRIPTION AND POLLUTION CONTROL

The mill effluent is discharged to a 6-acre, two-stage tailings impoundment system separated from Carpenter Creek by a road berm. Supernatant is decanted from the primary impoundment to a polishing pond from which a final effluent is exfiltrated and occasionally decanted to Carpenter Creek (figure 2).

The original Pollution Control Permit PE-1203, covering the above, was issued November 16, 1972, in the name of Kam-Kotia Mines Ltd. and Burkam Mines Ltd., authorizing the discharge of a maximum 90 000 IGPD effluent supernatant and prescribing limits (table 1) on its quality with respect to total solids; suspended solids; pH; dissolved lead, zinc and copper; and total cyanide. A review of effluent data to March 1979 (at which time the permit was amended), submitted by the company pursuant to the original permit requirements, is presented in table 1 and compared with data obtained by the Environmental Protection Service in June of 1977 (Villamere et al., 1978) and the British Columbia Waste Management Branch (B.C. Ministry of Environment, EQUIS Data File) between January 1, 1976, and January 23, 1980,

The above comparison shows that the effluent quality was highly variable, marginally within the Permit requirements and exceeded the requirements of the National Metal Mining Liquid Effluent Guidelines (shown in table 1) with regard to suspended solids, total lead and total zinc.

A composite sample of the final effluent decant was found to be non-toxic to rainbow trout in 1977 (Villamere et al., 1978) but tailings supernatant during shutdown in 1973 was found to be acutely toxic, having a 96-hour LT<sub>50</sub> of 34 hours (Hoos et al., 1973).

On January 27, 1978, Silvana Mines Inc. made application to the British Columbia Waste Management Branch to amend the Pollution Control Permit to reflect expected increases in mill production. The Department of Fisheries and Oceans and the Department of the Environment took the opportunity to provide comment and recommendations on the need to upgrade the entire disposal system (Heskin, 1978). An amended Pollution Control Permit was issued April 10, 1979, which:



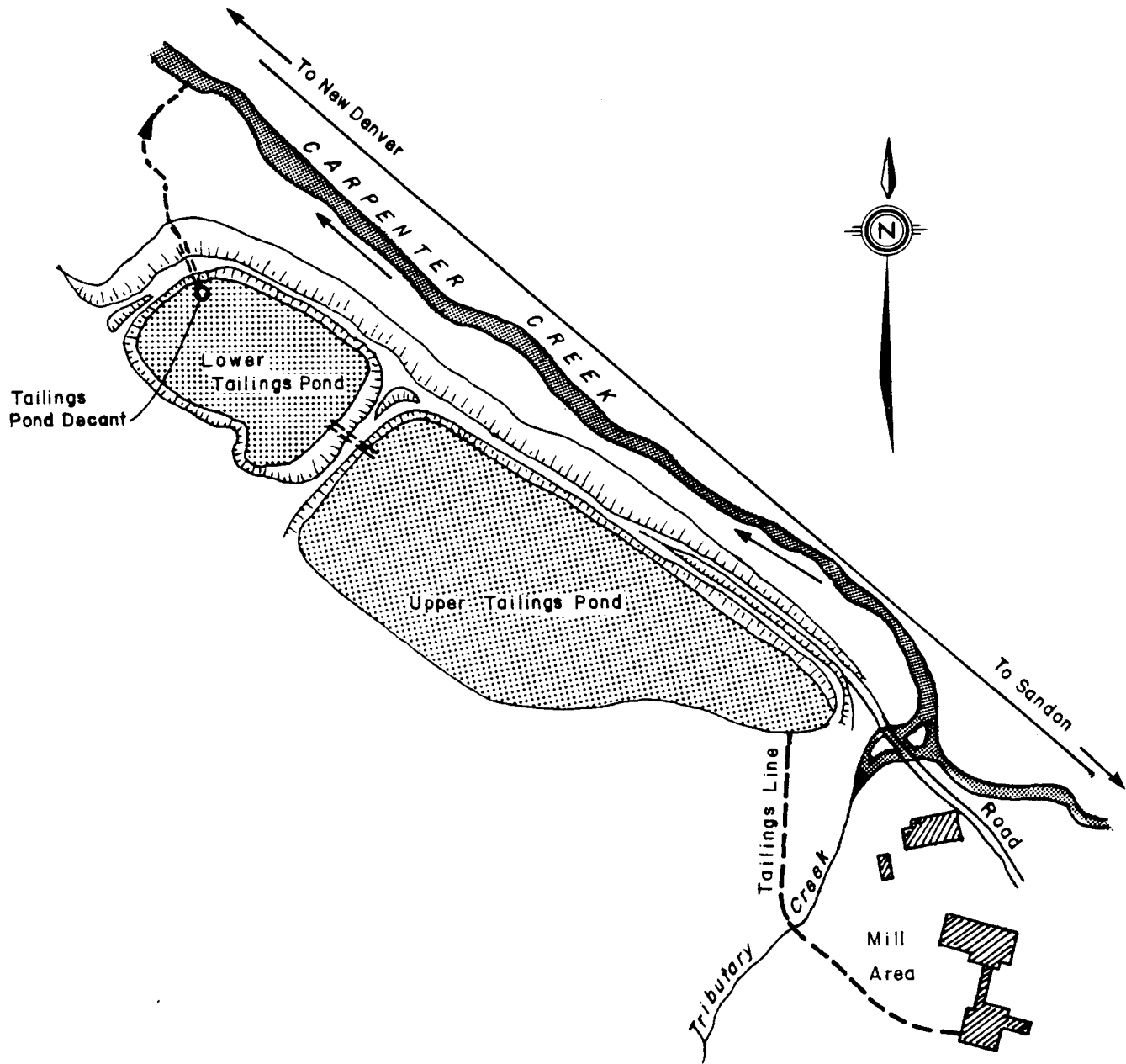


FIGURE 2 SILVANA MINES INCORPORATED

TABLE 1 EFFLUENT SUMMARY TO MARCH 1979, SILVANA MINES INC.

|                                       | pH       | COMPONENT (ppm) |      |      |       |       |       |       |       |      |      |        |       |       | DZn   | DNI   |   |
|---------------------------------------|----------|-----------------|------|------|-------|-------|-------|-------|-------|------|------|--------|-------|-------|-------|-------|---|
|                                       |          | TS              | SS   | SO4  | TCN   | TAS   | TCu   | TPb   | TZn   | TNi  | DCu  | DPb    | DCu   | DZn   |       |       |   |
| Provincial*<br>Permit<br>Requirements | 8.0-9.0  | 450             | 50   | -    | L0.04 | -     | -     | -     | -     | -    | -    | -      | -     | L0.04 | L0.03 | L0.04 | - |
| Federal**<br>Guidelines               | 5.5 min. | -               | 37.5 | -    | -     | 0.75  | 0.45  | 0.30  | 0.75  | -    | -    | -      | -     | -     | -     | -     | - |
| Mar. 04/77                            | 8.5      | 957             | 575  | 205  | L0.01 | -     | 0.89  | 0.002 | 2.6   | -    | 0.53 | L0.001 | 0.010 | -     | -     | -     | - |
| Apr. 23/77                            | 8.6      | 238             | 80   | 113  | 0.01  | -     | 0.10  | 0.016 | 0.25  | -    | 0.07 | 0.001  | 0.015 | -     | -     | -     | - |
| Jun. 08/77                            | 7.6      | 371             | 169  | 100  | 0.01  | -     | 0.12  | 0.43  | 0.65  | -    | 0.01 | 0.004  | 0.04  | -     | -     | -     | - |
| Jun. 21/77**                          | 6.7      | 430             | 190  | -    | -     | 0.018 | 0.10  | 0.50  | 0.81  | 0.05 | 0.01 | 0.02   | 0.08  | 0.05  | -     | -     | - |
| Jun. 22/77**                          | 6.9      | 490             | 250  | -    | -     | 0.033 | 0.10  | 0.70  | 0.82  | 0.05 | 0.01 | 0.02   | 0.14  | 0.05  | -     | -     | - |
| Jun. 23/77**                          | 7.1      | 510             | 280  | -    | -     | 0.023 | 0.10  | 0.78  | 0.81  | 0.05 | 0.01 | 0.02   | 0.21  | 0.05  | -     | -     | - |
| Aug. 25/77                            | 6.8      | 337             | 81   | 170  | L0.01 | -     | 0.39  | 0.295 | 0.38  | -    | 0.02 | 0.008  | 0.10  | -     | -     | -     | - |
| Sep. 29/77                            | 6.6      | 188             | 12   | 102  | L0.01 | -     | 0.20  | 0.011 | 0.13  | -    | 0.06 | 0.011  | 0.06  | -     | -     | -     | - |
| Nov. 28/77                            | 6.9      | 251             | 1    | 74   | L0.01 | -     | 0.007 | 0.008 | 0.74  | -    | 0.01 | 0.004  | 0.61  | -     | -     | -     | - |
| Dec. 22/77                            | 7.1      | 439             | 28.4 | 152  | L0.01 | -     | 1.28  | 0.005 | 0.31  | -    | 0.80 | 0.004  | 0.27  | -     | -     | -     | - |
| Feb. 07/78                            | 8.45     | 468             | 190  | 128  | 0.5   | -     | 1.32  | 0.92  | 0.60  | -    | 1.03 | L0.001 | 0.05  | -     | -     | -     | - |
| Mar. 30/78                            | 8.4      | 313.2           | 93.2 | 59.2 | 0.26  | -     | 0.89  | 0.49  | 0.64  | -    | 0.69 | 0.001  | 0.013 | -     | -     | -     | - |
| Feb. 02/79                            | 6.95     | 1247            | 7    | 591  | 5.2   | -     | 2.43  | 0.019 | 0.19  | -    | 2.40 | 0.005  | 0.25  | -     | -     | -     | - |
| Mar. 23/79                            | 8.2      | 216             | 8    | 82   | 0.4   | -     | 0.76  | 0.06  | 0.082 | -    | 0.56 | 0.002  | 0.77  | -     | -     | -     | - |
| Jan. 01/77 to***                      | 7.9      | 389             | 118  | 149  | 0.37  | -     | 1.14  | 0.85  | 1.63  | -    | 0.65 | 0.014  | 0.17  | -     | -     | -     | - |
| Jan. 23/80                            | (35)     | (28)            | (29) | (22) | (29)  | -     | (21)  | (28)  | (21)  | -    | (28) | (27)   | (28)  | -     | -     | -     | - |

L = less than

\* Pollution Control Permit PE-1203 issued November 16, 1972.

\*\* For eight-hour composite samples (Willanere et al., 1978).

\*\*\* EQIS data summary (B.C. Ministry of Environment), all other data from Silvana Mines Inc. quarterly reports.

( ) indicate the number of samples upon which average has been based.

- (a) reduced the required monitoring frequency of the effluent from semi-quarterly to quarterly;
- (b) imposed less stringent requirements on the maximum limits for TCN, dissolved copper and dissolved zinc contained in the effluent;
- (c) removed the limit on total solids and dissolved lead contained in the effluent;
- (d) removed the requirement to monitor total copper, lead and zinc; dissolved lead and total solids at all sample locations; and
- (e) eliminated the requirement to monitor Carpenter Creek upstream and downstream of the tailings decant.

However, the "Letter of Transmittal" required that the operator submits a report, by October 31, 1979, on measures taken to reduce the quantities of cyanide, copper and zinc reagents used in the mill and retain a qualified geotechnical engineer to assess the stability and integrity of the tailings dams. At the time of writing neither report had been submitted to the Waste Management Branch for review although it was reported that Golder and Associates had been retained to complete the latter.

A summary of effluent data from March 31, 1979, to March 3, 1980, pursuant to the amended Pollution Control Permit PE-1203 is provided in table 2. Since the majority of effluent is disposed of by exfiltration, which reappears as a seepage spring, it is included here as effluent and is recognized as the main point of discharge. These data indicate that the tailings supernatant decant and seepage are high in total cyanide, dissolved copper and dissolved zinc in particular; and either one can periodically exceed the permit limits in pH, suspended solids, total cyanide, dissolved copper or dissolved zinc.

*the present problem?*

It is reported that a mine water stream drains into a tributary of Carpenter Creek at the Silvana Mines Inc. site, however, there are no available data on its quantity or quality (Villamere et al., 1978) or record of a Pollution Control Permit covering such a discharge.

TABLE 2 EFFLUENT SUMMARY FROM MARCH 31, 1979 TO MARCH 3, 1980, PURSUANT TO POLLUTION CONTROL PERMIT PE-1203 (AS AMENDED APRIL 1979), SILVANA MINES INC.

| DATE                            | Component (ppm) |      |       |     |       |       |        |        |        |        |       |       |       |      |                  |      |
|---------------------------------|-----------------|------|-------|-----|-------|-------|--------|--------|--------|--------|-------|-------|-------|------|------------------|------|
|                                 | pH              |      | SS    |     | TCN   |       | DCd    |        | DCu    |        | DFe   |       | DZn   |      | DSO <sub>4</sub> |      |
|                                 | TPD             | SWS  | TPD   | SWS | TPD   | SWS   | TPD    | SWS    | TPD    | SWS    | TPD   | SWS   | TPD   | SWS  | TPD              | SWS  |
| Provincial Permit Requirements* | 6.5 to 8.5      |      | L50.0 |     | L0.10 |       | --     |        | L0.05  |        | --    |       | L0.50 |      | --               |      |
| May. 13/79                      | 6.75            | 6.90 | 76.8  | 9.6 | L0.01 | L0.01 | L0.001 | L0.001 | L0.001 | L0.001 | L0.03 | L0.03 | 0.010 | 1.00 | 68.2             | 56.2 |
| Oct. 12/79                      | 7.60            | 7.50 | 6.5   | 6.0 | L0.01 | L0.01 | L0.001 | L0.001 | 0.011  | L0.001 | L0.03 | L0.03 | 0.260 | 0.85 | 88.5             | 52.0 |
| Dec. 20/79                      | 9.30            | 7.10 | 71.0  | 6.0 | 0.01  | 0.01  | L0.001 | 0.003  | 0.130  | 0.013  | L0.03 | L0.03 | 0.007 | 1.06 | 77.0             | 70.0 |
| Mar. 03/80                      | 9.10            | 7.35 | 28.5  | 9.0 | 3.64  | 0.06  | L0.001 | 0.002  | 0.48   | 0.002  | L0.03 | L0.03 | 0.002 | 1.24 | 100.0            | 61.0 |

L = less than  
 \* PE-1203 as amended April 10, 1979  
 TPD Tailings Pond Decant  
 SWS Seepage Water Spring

3 DESCRIPTION OF RECEIVING WATERS AND AQUATIC RESOURCES

Carpenter Creek flows westerly from the town of Sandon for approximately 10 km before discharging to Slocan Lake near the town of New Denver, B.C. Flows at Sandon (drainage area 19.3 sq. miles) are reported to range from a low of 16 cfs in January to a high of 369 cfs in June with a yearly mean of 85.2 cfs. Flows at the mouth, near New Denver (drainage area 65 sq. miles), range between a low of 38 cfs in February to a high of 828 cfs in June with a yearly mean of 192 cfs (Department of Environment, 1977). Slocan Lake is a moderately large lake being approximately 35 km long and 2 km wide at its widest point.

There are no quantitative data on the fishery resource of Carpenter Creek, however, B.C. Fish and Wildlife files indicate resident species include rainbow trout and probably dolly varden in the upper reaches. The lower reaches provide spawning habitat for migrant species of "Slocan fish" (Andrusack, personal communication, 1978).

4 REVIEW OF RECEIVING WATER QUALITY AND ENVIRONMENTAL  
IMPACT ASSESSMENTS

To the knowledge of the author, no receiving environment impact assessments of the watershed relative to Silvan Mines Ltd. have been conducted, although it has been long known that the water quality of the system is poor as a result of the combined seepages from old mine shafts and tailings dumps left from earlier mining activity. During World War II, for example, interned Japanese Canadians were advised against drinking local surface water and swimming in Slocan Lake.

Pollution Control Permit PE-1203 required the monitoring of Carpenter Creek at a site upstream and 1000 feet downstream of the tailings decant on a frequency of six-week intervals until this requirement was deleted when the permit was amended April 10, 1979. The available results of the company monitoring pursuant to the above from February 4, 1977, to March 23, 1979, are provided in table 3. The decant has an immediate impact on Carpenter Creek water quality and the most significant effects are seen in the increases in total solids (166.3 to 207.2 mg/l), suspended solids (7.7 to 15.5 mg/l), sulphates (37.6 to 51.1 mg/l), total lead (0.014 to 0.033 mg/l), total zinc (0.33 to 0.48 gm/l), and dissolved zinc (0.24 to 0.38 mg/l).

The averaged values from the above monitoring are compared with additional unrelated monitoring data for the Carpenter Creek drainage system in table 4 (B.C. Ministry of Environment, EQUIS Data File). As indicated, the watershed reflects abnormally high total and dissolved zinc and generally higher than normal levels of total iron and lead above and below the Silvana Mines Inc. operation. The immediate impact of the Silvana tailings supernatant discharge noted above is difficult to determine in downstream water quality data but there appears to be a slight overall increase in suspended solids, specific conductance, alkalinity, and hardness with distance downstream. Heavy metal loadings appear to be attenuated to some extent by the influences of the relatively uncontaminated tributaries of Kane and Tributary Creeks.

TABLE 3 MONITORING RESULTS FOR CARPENTER CREEK UPSTREAM AND DOWNSTREAM OF THE SILVANA MINES INC. TAILINGS DECANT FROM FEBRUARY 4, 1977 TO MARCH 23, 1979, PURSUANT TO POLLUTION CONTROL PERMIT PE-1203

|            | Parameter (ppm) |       |              |       |                  |       |                 |       |       |       |        |        |       |       |        |       |        |        |        |        |       |       |  |  |
|------------|-----------------|-------|--------------|-------|------------------|-------|-----------------|-------|-------|-------|--------|--------|-------|-------|--------|-------|--------|--------|--------|--------|-------|-------|--|--|
|            | pH              |       | Total Solids |       | Suspended Solids |       | SO <sub>4</sub> |       | TCN   |       | TCu    |        | TPb   |       | TZn    |       | DCu    |        | DPb    |        | DZn   |       |  |  |
|            | Above           | Below | Above        | Below | Above            | Below | Above           | Below | Above | Below | Above  | Below  | Above | Below | Above  | Below | Above  | Below  | Above  | Below  | Above | Below |  |  |
| Feb. 04/77 | 7.9             | 7.9   | 192          | 241   | 0.2              | 0.6   | 13.2            | 62.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.001 | 0.001 | L0.290 | 0.42  | L0.001 | L0.001 | L0.001 | 0.001  | 0.29  | 0.42  |  |  |
| Mar. 23/77 | 7.7             | 7.8   | 157          | 138   | 3.4              | 8.2   | 30.0            | 56.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.004 | 0.009 | L0.036 | 0.50  | L0.001 | L0.001 | 0.004  | 0.004  | 0.035 | 0.47  |  |  |
| Jun. 08/77 | 7.7             | 7.2   | 107          | 144   | 51.3             | 80.0  | L2.0            | L2.0  | L0.01 | L0.01 | 0.008  | 0.013  | 0.075 | 0.153 | 0.24   | 0.43  | 0.008  | 0.003  | 0.003  | 0.004  | 0.065 | 0.08  |  |  |
| Aug. 25/77 | 7.3             | 7.3   | 112          | 98    | 2.0              | 1.6   | 63.0            | 79.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.026 | 0.057 | 0.16   | 0.27  | L0.001 | L0.001 | 0.005  | 0.017  | 0.14  | 0.24  |  |  |
| Sep. 29/77 | 6.6             | 6.8   | 71           | 76    | 1.6              | 0.4   | 40.0            | 50.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.009 | 0.006 | 0.21   | 0.34  | L0.001 | L0.001 | 0.005  | 0.005  | 0.18  | 0.27  |  |  |
| Nov. 28/77 | 7.6             | 6.9   | 195          | 457   | 0.7              | 24.0  | 36.6            | 166.0 | L0.01 | 0.4   | L0.001 | 0.86   | 0.007 | 0.210 | 0.52   | 0.28  | L0.001 | 0.42   | 0.003  | 0.006  | 0.24  | 0.24  |  |  |
| Dec. 22/77 | 7.9             | 8.0   | 219          | 267   | 16.4             | 13.0  | 61.2            | 86.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.008 | 0.002 | 0.40   | 0.55  | L0.001 | L0.001 | 0.005  | 0.001  | 0.36  | 0.48  |  |  |
| Feb. 07/78 | 7.7             | 8.0   | 120          | 183   | 6.0              | 35.0  | 59.6            | 46.8  | L0.01 | 0.01  | 0.002  | L0.001 | 0.004 | 0.006 | 0.35   | 0.50  | L0.001 | L0.001 | 0.002  | 0.002  | 0.19  | 0.31  |  |  |
| Mar. 30/78 | 7.9             | 7.9   | 217.8        | 212.6 | 0.8              | 5.6   | 41.3            | 42.1  | L0.01 | L0.01 | L0.001 | L0.001 | 0.008 | 0.006 | 0.71   | 0.98  | L0.001 | L0.001 | 0.002  | L0.001 | 0.55  | 0.86  |  |  |
| Feb. 02/79 | 7.85            | 7.45  | 207.7        | 204.0 | 1.7              | 2.0   | 33.0            | 31.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.001 | 0.007 | 0.34   | 0.53  | L0.001 | L0.001 | L0.001 | 0.004  | 0.27  | 0.45  |  |  |
| Mar. 23/79 | 7.6             | 7.7   | 230.8        | 258.4 | 0.8              | 0.4   | 33.5            | 41.0  | L0.01 | L0.01 | L0.001 | L0.001 | 0.005 | 0.010 | 0.36   | 0.52  | L0.001 | L0.001 | L0.001 | 0.001  | 0.27  | 0.40  |  |  |
| Average    | 7.6             | 7.54  | 166.3        | 207.2 | 7.7              | 15.5  | 37.6            | 51.1  | L0.01 | L0.04 | L0.001 | L0.074 | 0.014 | 0.033 | 0.033  | 0.48  | L0.001 | L0.038 | 0.004  | 0.004  | 0.24  | 0.38  |  |  |

L = less than

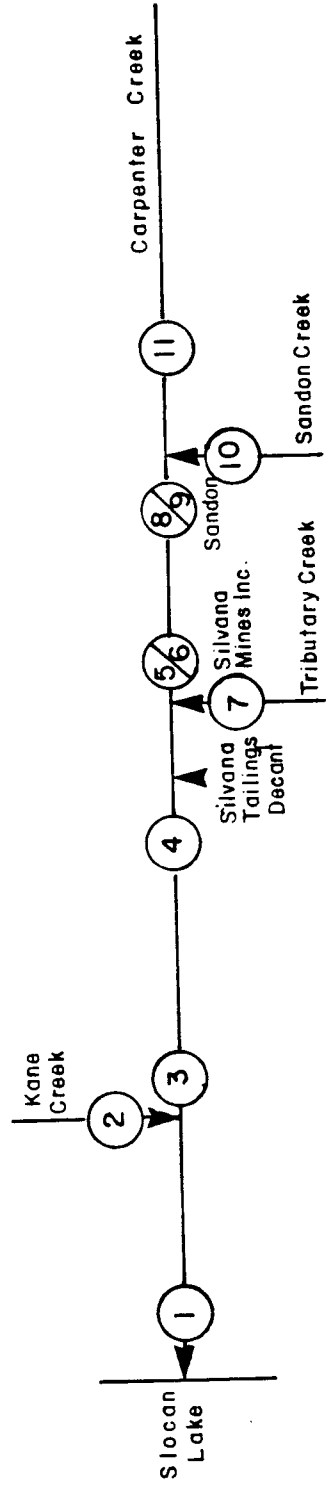
TABLE 4 SUMMARY OF CARPENTER CREEK DRAINAGE WATER QUALITY TO JANUARY 23, 1980,  
B.C. MINISTRY OF ENVIRONMENT, EQUIS DATA FILE

| Location # | pH       | T.S.      | S.S.     | Spec. Cond. | T°C    | DO <sub>2</sub> | Alk      | TCN       |
|------------|----------|-----------|----------|-------------|--------|-----------------|----------|-----------|
| 1          | 8.06(18) | 120.0(7)  | 76.0(1)  | 169.6(13)   | 5.4(9) | 11.0(4)         | 67.4(10) | L0.01(8)  |
| 2          | 8.03(7)  | 95.0(2)   | -        | 134.8(6)    | 5.1(4) | 10.9(1)         | 67.8(4)  | L0.01(2)  |
| 3          | 7.9(7)   | 123.0(2)  | -        | 170.5(6)    | 5.1(4) | 11.0(1)         | 64.1(4)  | L0.01(3)  |
| 4          | 7.54(11) | 207.2(11) | 15.5(11) | -           | -      | -               | -        | L0.04(11) |
| 5          | 7.6(11)  | 166.3(11) | 7.7(11)  | -           | -      | -               | -        | L0.01(11) |
| 6          | 7.75(37) | 150.4(29) | 5.6(24)  | 151.6(11)   | 4.6(7) | 11.0(3)         | 48.1(9)  | L0.02(31) |
| 7          | 7.9(8)   | 111.0(2)  | -        | 141.3(6)    | 4.5(4) | 10.9(1)         | 56.2(5)  | L0.01(2)  |
| 8          | 7.9(7)   | 138.0(1)  | 19.0(1)  | 129.4(7)    | 3.5(3) | 10.8(1)         | 49.9(3)  | L0.01(3)  |
| 9          | 7.7(32)  | 155.0(29) | 9.4(24)  | 159.0(7)    | 6.7(5) | 10.9(3)         | 54.6(5)  | L0.02(29) |
| 10         | 7.8(9)   | 118.0(2)  | -        | 152.8(7)    | 4.0(4) | 11.1(1)         | 47.3(5)  | L0.01(2)  |
| 11         | 7.9(8)   | 71.0(2)   | -        | 112.0(6)    | 5.2(4) | 11.0(2)         | 45.9(5)  | L0.01(2)  |

continued...

L = less than

( ) indicate the number of samples upon which average has been based.



SCHEMATIC OF SAMPLE SITE LOCATIONS



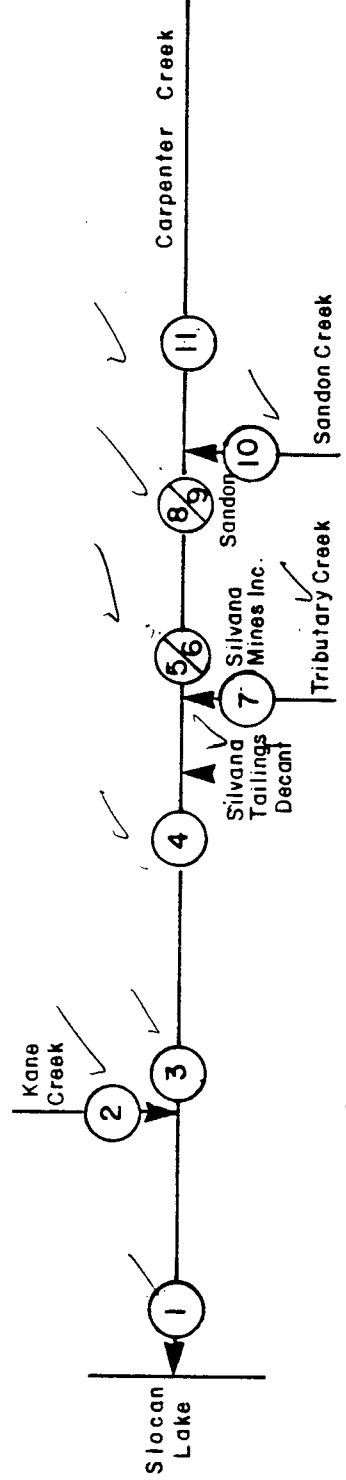
TABLE 4 SUMMARY OF CARPENTER CREEK DRAINAGE WATER QUALITY TO JANUARY 23, 1980,  
(continued) B.C. MINISTRY OF ENVIRONMENT, EQUIS DATA FILE

| Location # | Hard.    | SO <sub>4</sub> | TAS       | DCd        | TCd        | DCa      | DCu        | TCu        |
|------------|----------|-----------------|-----------|------------|------------|----------|------------|------------|
| 1          | 85.7(10) | 22.8(8)         | L0.005(6) | 0.001 (8)  | 0.002 (8)  | 25.2(10) | L0.001(3)  | 0.001(6)   |
| 2          | 73.2(4)  | 12.8(4)         | L0.005(1) | L0.005 (3) | L0.0005(2) | 20.7(4)  | L0.001(2)  | 0.001(2)   |
| 3          | 87.3(4)  | 33.0(4)         | L0.005(1) | 0.0019(2)  | 0.005 (2)  | 26.6(4)  | L0.001(2)  | L0.001(2)  |
| 4          | -        | 51.1(11)        | -         | -          | -          | -        | L0.038(11) | L0.074(11) |
| 5          | -        | 37.6(11)        | -         | -          | -          | -        | L0.001(11) | L0.001(11) |
| 6          | 74.1(9)  | 30.2(31)        | L0.005(5) | 0.001 (2)  | 0.003 (2)  | 22.7(9)  | 0.003(24)  | 0.004(29)  |
| 7          | 70.1(4)  | 22.1(4)         | L0.005(2) | L0.0005(2) | L0.0005(1) | 24.3(4)  | L0.001(2)  | L0.001(2)  |
| 8          | 67.3(4)  | 21.9(2)         | -         | 0.0013(3)  | 0.003 (1)  | 20.7(4)  | L0.001(3)  | -          |
| 9          | 71.4(7)  | 36.5(29)        | L0.005(4) | -          | 0.003 (1)  | 22.3(7)  | 0.003(24)  | 0.004(31)  |
| 10         | 73.9(5)  | 37.7(4)         | L0.005(2) | 0.002 (3)  | 0.005 (2)  | 25.1(5)  | L0.001(2)  | L0.001(2)  |
| 11         | 59.4(4)  | 17.5(4)         | L0.005(2) | L0.0005(3) | 0.0013(1)  | 18.0(4)  | L0.001(2)  | L0.001(2)  |

L = less than

continued...

( ) indicate the number of samples upon which average has been based.



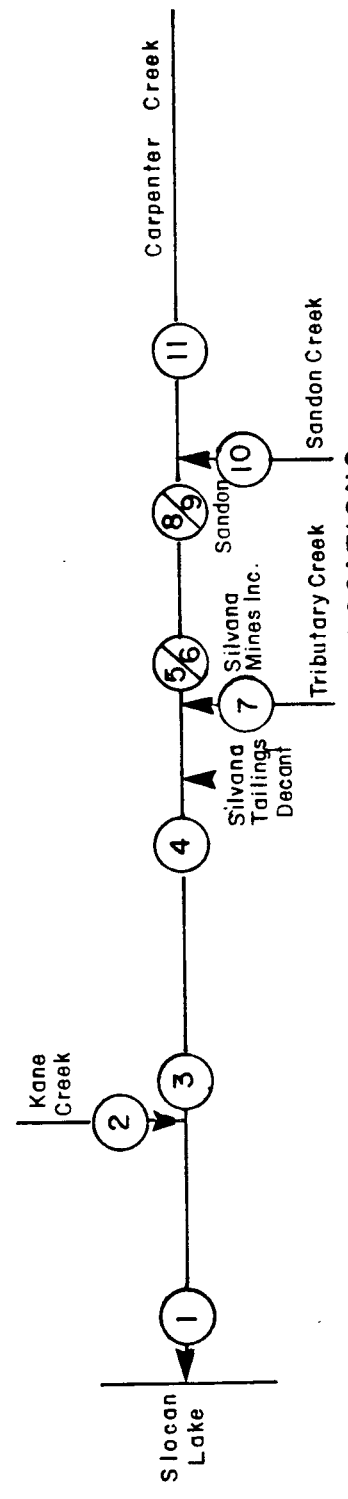
SCHEMATIC OF SAMPLE SITE LOCATIONS

TABLE 4 SUMMARY OF CARPENTER CREEK DRAINAGE WATER QUALITY TO JANUARY 23, 1980,  
(continued) B.C. MINISTRY OF ENVIRONMENT, EQUIS DATA FILE

| Location # | DFe     | TFe     | DPb       | TPb       | DHg<br><i>µg/L</i> | THg      | DZn        | TZn        |
|------------|---------|---------|-----------|-----------|--------------------|----------|------------|------------|
| 1          | L0.1(3) | 0.18(6) | L0.001(3) | L0.001(6) | 5.5(10)            | L0.05(2) | 0.19 (4)   | 0.24 (7)   |
| 2          | L0.1(2) | 0.2(2)  | L0.001(2) | L0.001(3) | 5.2(4)             | L0.05(2) | L0.0005(3) | 0.0005(3)  |
| 3          | L0.1(2) | 0.35(2) | L0.001(2) | 0.006(2)  | 5.1(4)             | L0.05(1) | 0.26 (3)   | 0.49 (3)   |
| 4          | -       | -       | 0.004(11) | 0.033(11) | -                  | -        | 0.38 (11)  | 0.48 (11)  |
| 5          | -       | -       | 0.004(11) | 0.014(11) | -                  | -        | 0.24 (11)  | 0.033(11)  |
| 6          | L0.1(2) | 0.14(5) | 0.003(24) | 0.009(29) | 4.2(9)             | L0.05(2) | 0.23 (25)  | 0.32 (29)  |
| 7          | L0.1(2) | L0.1(2) | L0.001(2) | L0.001(2) | 2.3(4)             | -        | L0.0005(2) | L0.0005(2) |
| 8          | L0.1(3) | -       | 0.002(3)  | -         | 3.8(4)             | -        | 0.18 (4)   | 0.44 (1)   |
| 9          | -       | 0.12(5) | 0.003(24) | 0.017(31) | 3.8(7)             | L0.05(1) | 0.39 (24)  | 0.46 (31)  |
| 10         | L0.1(2) | L0.1(2) | 0.006(2)  | 0.004(2)  | 2.7(5)             | -        | 0.29 (3)   | 0.46 (3)   |
| 11         | L0.1(2) | 0.15(2) | L0.001(2) | L0.001(2) | 3.5(4)             | -        | 0.05 (3)   | 0.13 (3)   |

L = less than

( ) indicate the number of samples upon which the average value was based.



SCHEMATIC OF SAMPLE SITE LOCATIONS

5 SUMMARY AND CONCLUSIONS

Silvana Mines Inc. is a small operation (maximum 150 tons/day) producing separate lead and zinc concentrates. There is no in-plant destruction of cyanide, which is used in the process, and the resultant tailings effluent is consequently very high in total cyanide, dissolved copper and, particularly, dissolved zinc. Final effluent is either exfiltrated or decanted but not recycled.

The effluent periodically exceeds specified permit limits and has a significant impact on the water quality of Carpenter Creek immediately downstream but monitoring of the receiving water pursuant to the original Pollution Control Permit has been significantly curtailed by amendments to the permit dated April 10, 1979.

A definitive environmental impact assessment of the effluent on the downstream ecology has not been conducted and there is virtually no information of the systems fishery resource. Therefore it is recommended that:

- (a) the Department of Environment obtain and review the reports on tailings dam integrity and in-plant cyanide use, required of the permittee by amendments to the Pollution Control Permit PE-1203 issued April 10, 1979;
- (b) an investigation be conducted to determine the feasibility of employing chlor-alkali destruction of cyanide prior to effluent discharge or alternately employing effluent recycle;
- (c) an environmental impact assessment be conducted of the Carpenter Creek system relative to the Silvana Mines Ltd. discharge; and
- (d) the need to bring the mine water discharge under Pollution Control Permit be investigated.

6 REFERENCES

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