CURRAGH RESOURCES INC.

FARO MINE

1988 ANNUAL REPORT
TO THE
YUKON TERRITORY WATER BOARD

LICENSE #Y-IN85-05AL

APRIL 1989

(FROM 1988 ANNUAL REPORT)

TABLE: 4 MILL FRESH WATER CONSUMPTION 1988

MONTH	WATER CONSUMPTION (CUM)	ORE FEED (TONNES)	WATER/ ORE FEED (CUM/TONNE) OF ORE	CYANIDE		COPPER SULPHATE	
				(KG)	(KG/TONNE) OF ORE	(KG)	(KG/TONNE) OF ORE
JAN	877890	380604	2.31	56603	0.15	195494	0.51
FEB	844230	360774	2.34	38168	0.11	147059	0.41
MAR	889080	362483	2.45	41497	0.11	147710	0.41
APR	798660	369024	2.16	38999	0.11	173875	0.47
MAY	877280	392373	2.24	36000	0.09	149881	0.38
JUN	567460	204362	2.78	43428	0.21	103870	0.51
JUL	745180	270054	2.76	24000	0.09	107210	0.40
AUG	935800	381057	2.46	58900	0.15	179590	0.47
SEP	924070	349165	2.65	38500	0.11	175740	0.50
OCT	894060	329439	2.71	46700	0.14	163120	0.50
NOV	942760	378417	2.49	38600	0.10	170202	0.45
DEC	934220	348836	2.68	50953	0.15	232450	0.67
TOTAL	10230690	4126588		512348		1946201	
DAILY AVERAGE	28029	11306	2.50	1404	0.13	5332	0.47

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1.0 SURFACE WATER QUALITY DATA

The 1988 water quality data is presented in Appendix 1. Summary statistics are presented for each sampling location in Appendix 1A. Monthly and yearly statistics are provided. The complete set of water quality data is presented in Appendix 1B.

1.1 Summary

Table 1 presents a summary of effluent water quality data along with effluent standards from Curragh Resources Inc.'s water licence. Site locations are shown on Figure 1. With a few exceptions effluent from the mine site was within water license limits

Concentrations of ammonia, zinc, lead, total cyanide and weak acid dissociable (WAD) cyanide in the Cross Valley Dam decant water exceeded effluent standards occasionally. Ammonia effluent standards were generally exceeded during mid-winter and spring periods. Zinc and lead excursions were associated with the Intermediate Dam raising construction period.

Cyanide in effluent continues to be elevated during winter months when natural degradation processes are impaired. Hydrogen peroxide treatment was initiated during the December 7, 1988 cyanide spill and treatment as required has been maintained since this time. A detailed report on the cyanide spill and the treatment process is provided in Appendix 2.

Concentrations of ammonia and total cyanide in the seepage from the Cross Valley Dam (X13) exceeded effluent standards on occasion. The interpretation of the high cyanide concentrations in these seepages continues to be a problem. There is no correlation between total and WAD cyanide data and bio-assay data do not support the high total cyanide assays. The WAD cyanide concentrations in the X13 seepage did not exceed 0.015 mg/L throughout the year and thus was consistently within effluent standards.

1.2 Monitoring Program and Activities

1.2.1 Licence Stipulated Monitoring

The surveillance Network Program (Schedule A) of Curragh Resources Inc.'s water licence (Y-IN85-05A) stipulates water quality sampling locations and the frequency of sampling. Part C of the water licence stipulates the "General Provisions for Reports, Sampling and Analysis".

In 1988, samples were collected and preserved for analysis in accordance to the terms and conditions stipulated in Curragh's water licence. Measurements of temperature and pH, and the preservation of samples were completed in the field. Samples were shipped immediately to commercial laboratories for analysis as follows:

. Eco-tech Laboratories (Kamloops, B.C.)	total cyanide, weak acid dissociable cyanide, ammonia.
. Bondar-Clegg and Co. Ltd. (Whitehorse, Y.T.)	copper, lead, zinc, manganese, iron, sodium, sulphate, suspended solids.

Results were reported monthly to the Yukon Territory Water Board. In addition, results which exceeded stipulated effluent standards were

FIGURE 1

CURRAGH RESOURCES INC.

SAMPLING POINT LOCATIONS

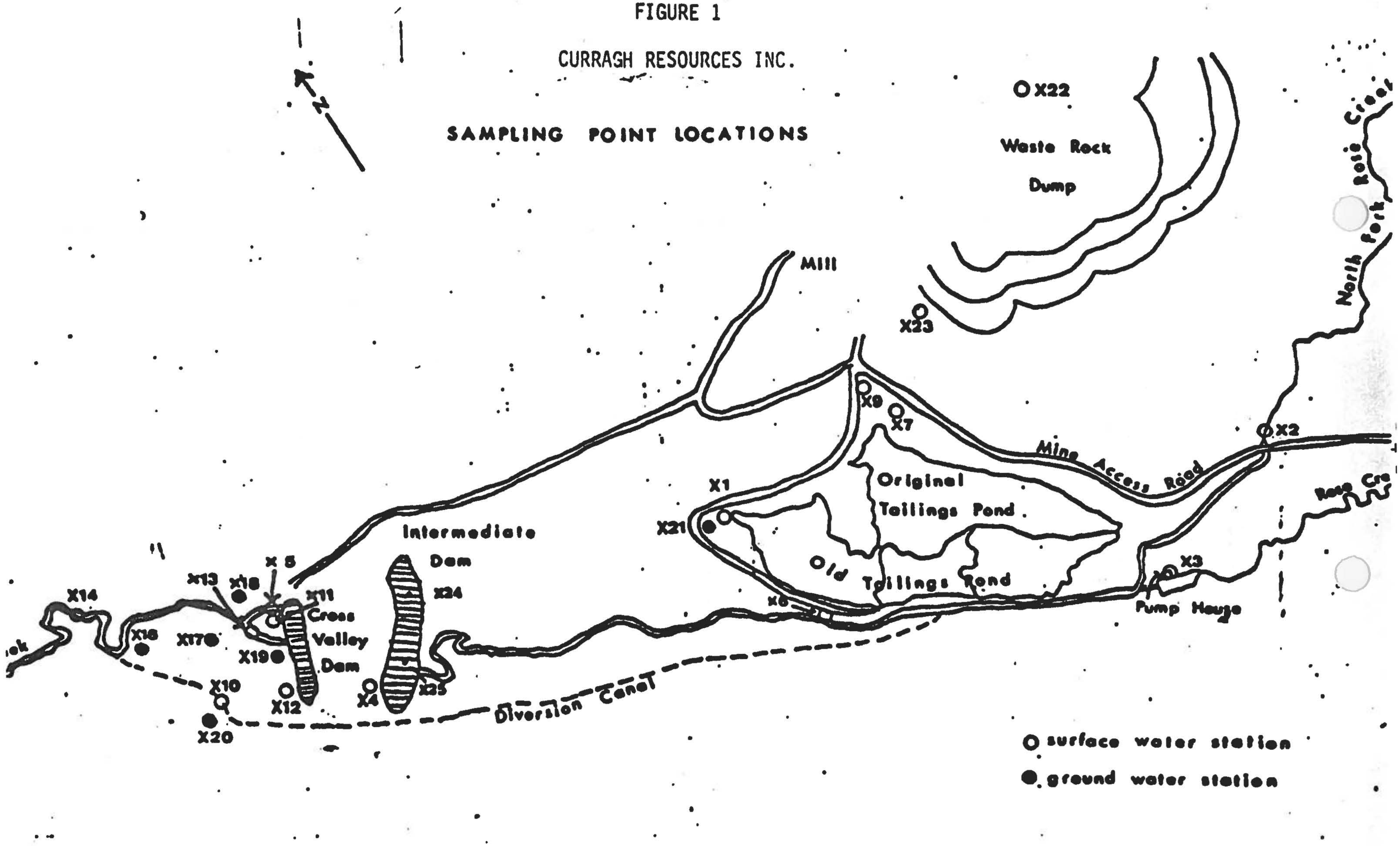


TABLE 1 : SUMMARY OF EFFLUENT WATER QUALITY   FARO MINESITE

A. Site X5: Decant from Cross Valley Dam

	AMMONIA (mg/L)	ZINC (mg/L)	LEAD (mg/L)	COPPER (mg/L)	TOTAL CYANIDE (mg/L)	WAD CYANIDE (mg/L)	SUSPENDED SOLIDS (mg/L)	pH
EFFLUENT STANDARD	1.00	0.500	0.200	0.200	0.050	0.050	15	> 6.5
YEARLY AVERAGE	0.90	0.246	0.140	0.025	0.064	0.026	3	7.9
STANDARD DEVIATION	0.20	0.202	0.045	0.022	0.042	0.025	1	0.2
NUMBER OF SAMPLES	51	52	52	52	90	53	51	50
RANGE: MINIMUM	0.28	0.044	0.080	0.008	0.005	0.005	1	7.1
MAXIMUM	1.75	0.755	0.300	0.110	0.220	0.149	20	8.5

A. Site X13: Seepage from Cross Valley Dam

	AMMONIA (mg/L)	ZINC (mg/L)	LEAD (mg/L)	COPPER (mg/L)	TOTAL CYANIDE (mg/L)	WAD CYANIDE (mg/L)	SUSPENDED SOLIDS (mg/L)	pH
EFFLUENT STANDARD	1.00	0.500	0.200	0.200	0.050	0.050	15	> 6.5
YEARLY AVERAGE	0.91	0.011	0.006	0.003	0.111	0.006	2	7.5
STANDARD DEVIATION	0.13	0.005	0.002	0.001	0.038	0.001	1	0.1
NUMBER OF SAMPLES	53	54	54	54	53	48	53	52
RANGE: MINIMUM	0.19	0.002	0.005	0.002	0.004	0.005	1	7.0
MAXIMUM	1.77	0.069	0.036	0.010	0.209	0.015	7	8.1

reported immediately to the Water Board and to the Water Resources branch of Indian and Northern Affairs Canada.

1.3 Flow Data

At the Faro minesite, effluent water is discharged into the Tailings impoundment area. The tailings area provides the retention time necessary for particle settlement and chemical degradation processes to occur prior to effluent water discharge to the environment.

The tailings impoundment area has three major inflow sources; the Faro concentrator discharge (X9), the open pit dewatering discharge (X22), and the waste rock dump seepage discharge which collects in the old Faro Creek channel (X23). The average 1988 monthly discharge rates from these sources, and the combined tailings impoundment inflow rate are shown on Figure 2. The 1988 yearly average total inflow to the tailings area was 394 L/s (6246 USGM).

Effluent water is discharged from the Tailings impoundment area through the decant structure of the Cross Valley Dam (X5). Water also discharges as groundwater seepage through the Cross Valley Dam. Flows of decant water (X5) were not recorded on a regular basis. However, weekly flow readings were taken at the weirs located at sites X11, X12, and X13. Weirs located at sites X11 and X12 record discharge seepage from the north and south abutments, respectively, of the Cross Valley Dam. The weir at site X13 records the total seepage through the Cross Valley Dam. Monthly averages of these seepage flows are shown on Figure 3. The 1988 yearly average seepage flow was 107 L/s (1696 USGM).

Inflow readings and estimates indicate that the greatest proportion of water flow to the system is from the tailings pipeline (X9). This flow is fairly constant, except during periods of concentrator shutdown.

Seepage discharge readings are also fairly constant; however there are higher rates during summer months. Abutment seepage (X11 and X12) comprise only a small proportion of the total seepage flow (X13) through the dam. Decant discharge (X5) although not measured, can be expected to parallel inflow discharge if adjustments are made for precipitation events and spring snow and ice melt. The estimated 1988 minimum yearly average flow through the Cross Valley Dam decant, therefore was 287 L/s (4550 USGM).

1.4 Suspended Solids

Suspended solids levels in the Cross Valley Dam decant (X5) were consistently low and well within the effluent standard of 15 mg/L. The yearly average level was 3 mg/L. The residence time available in the tailings impoundment area ensures adequate settling of solids.

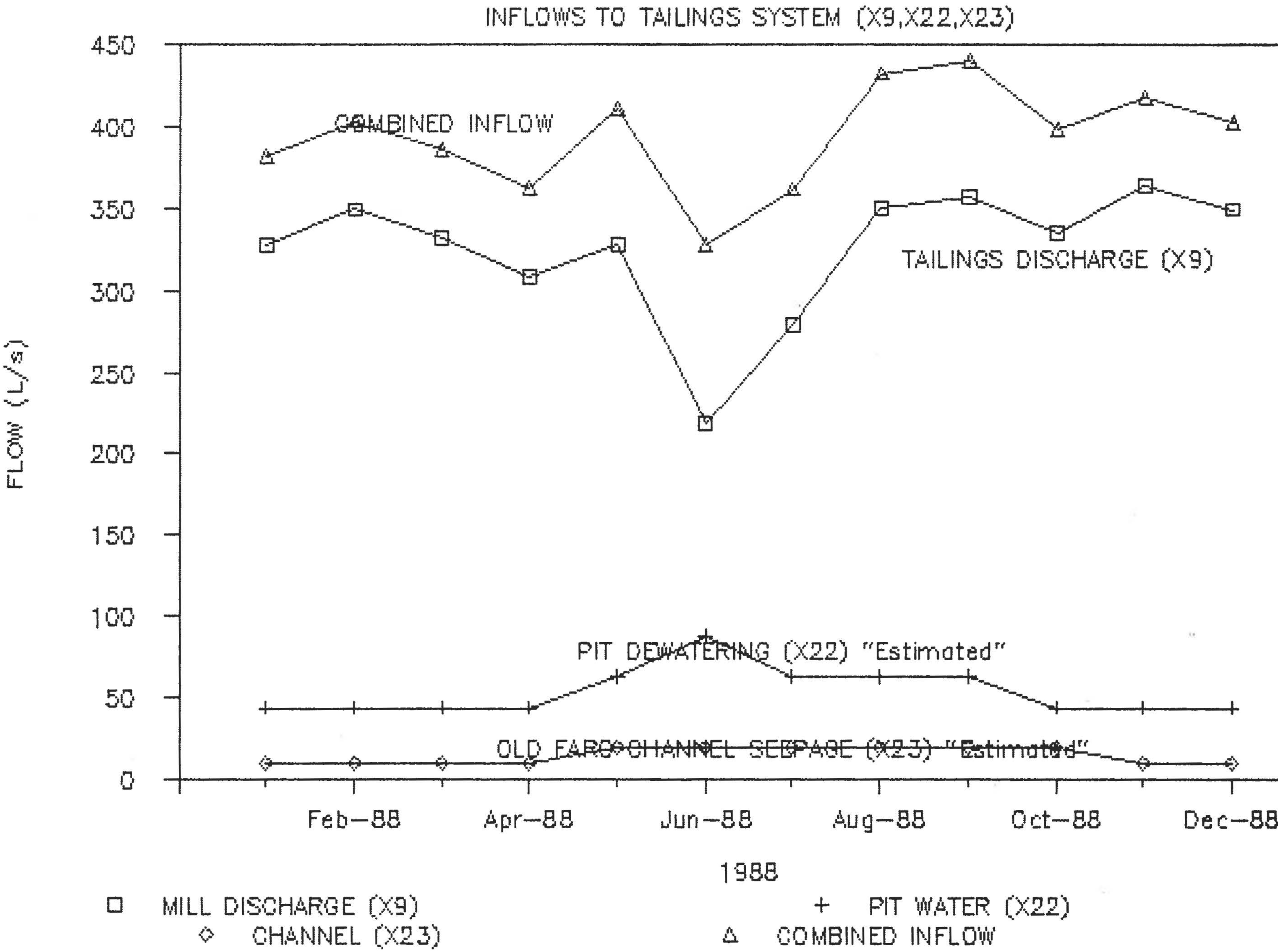
The average monthly suspended solids levels at various Rose Creek sites are shown in Figure 4. As illustrated, elevated levels of suspended solids occurred in Rose Creek upstream and downstream of the minesite during freshet. The creek was clear at all other times, with the exception of Rose Creek diversion (X10) during November. Increased suspended solids levels at this time are attributable to canal maintenance work.

1.5 pH

The pH of the Cross Valley Dam decant water (X5) was well above the minimum effluent standard of 6.5 pH units. The yearly average at the site was 7.90. The groundwater seepage through the Cross Valley Dam (X13) also was within the effluent standard for pH. The yearly average pH for this site was 7.47. The mine's receiving water, Rose Creek (X14) had an average pH of 7.67 in 1988 with a range from 7.49 to 8.01.

Infrequently, various inputs to the tailings impoundment area were less than 6.5 units. Pit dewatering discharge (X22/ JB) had pH values of less than 6.5 on eight occasions, with a low of 5.8 being recorded in July. The seep from the dump (X23) was less than 6.5 only once during the year. A pH of 5.8 was recorded in July. These inputs were neutralized before effluent could discharge to the environment through the Cross Valley Dam decant (X5).

FIGURE 2



INFLOWS TO TAILINGS SYSTEM (X9,X22,X23)
COMBINED INFLOW
TAILINGS DISCHARGE (X9)
PIT DEWATERING (X22) "Estimated"
OLD FARO CHANNEL SEEPAGE (X23) "Estimated"
FLOW (L/s)
450
400
350
300
250
200
150
100
50
0
Feb-88
Apr-88
Jun-88
Aug-88
Oct-88
Dec-88
1988
MILL DISCHARGE (X9)
PIT WATER (X22)
CHANNEL (X23)
COMBINED INFLOW

FIGURE 3

SEEPAGE FROM CROSS VALLEY DAM

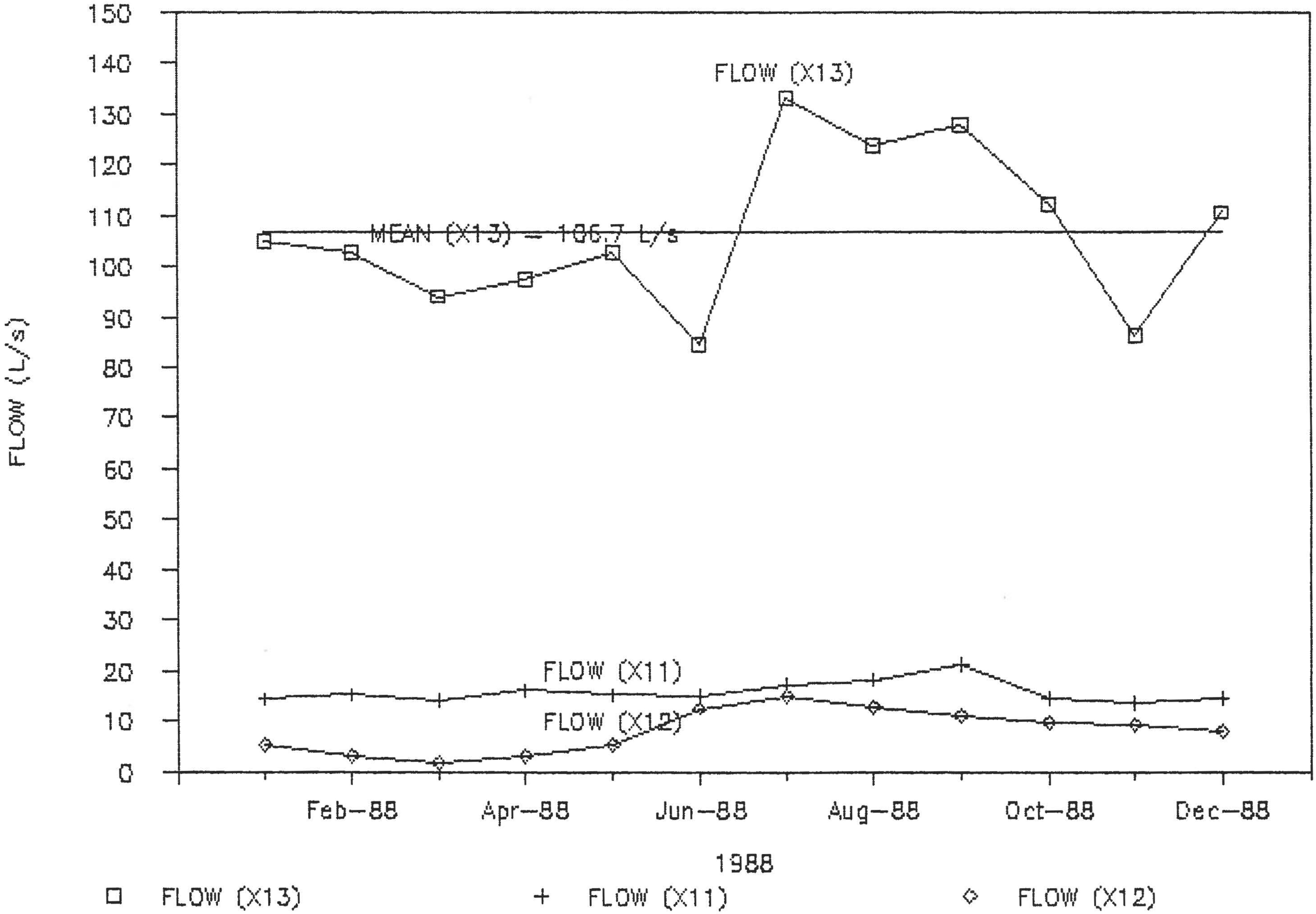
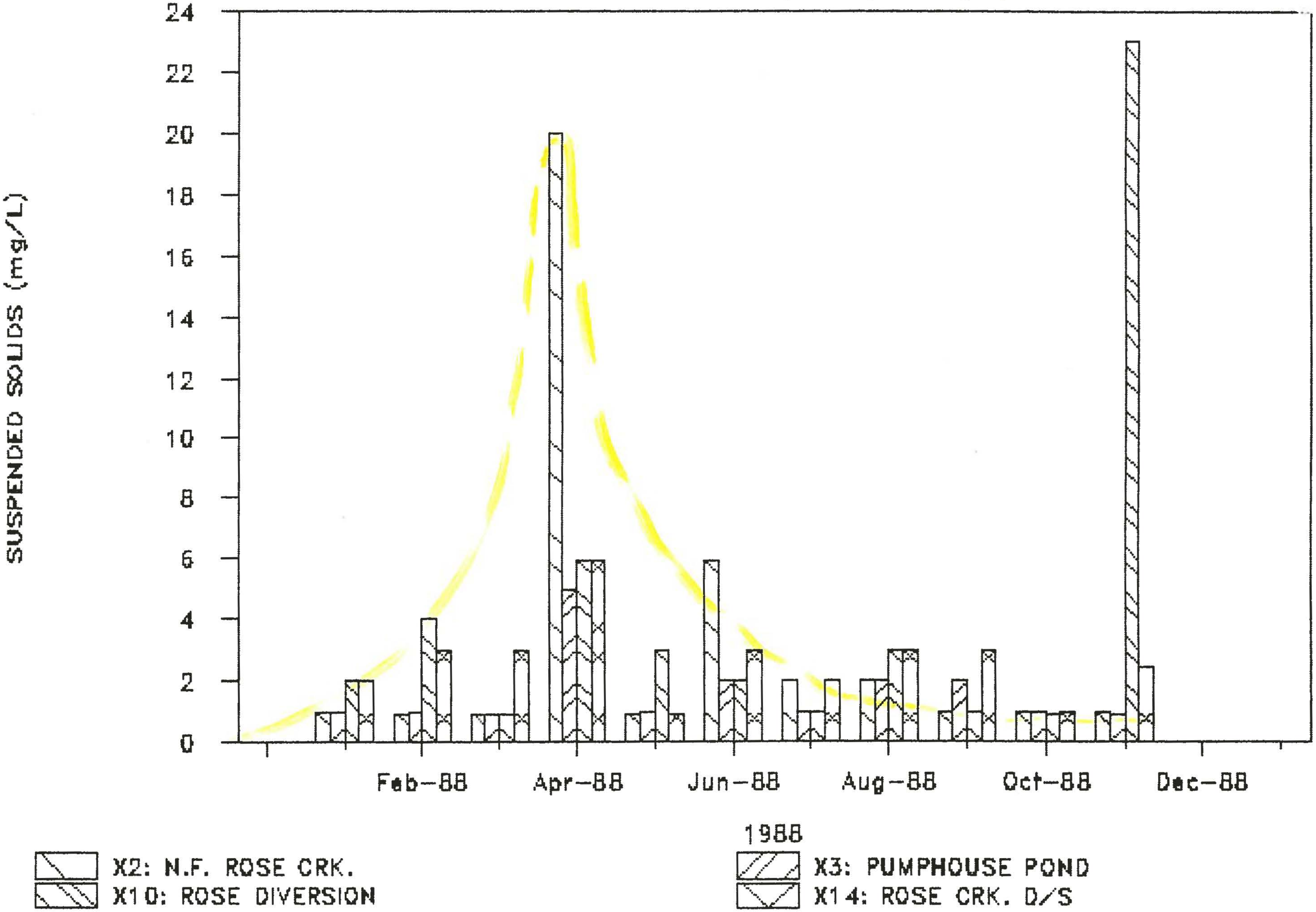


FIGURE 4 : SUSPENDED SOLIDS

ROSE CREEK SITES (Monthly Averages)



1.6 Chemical Quality

1.6.1 Ammonia

The average monthly ammonia concentrations of the decant discharge (X5), the Rose Creek diversion background water (X10) and Rose Creek water below the mine site (X14) are illustrated on Figure 5.

The yearly average ammonia concentration in the Cross Valley decant (X5) was 0.90 mg/L with a range of 0.28 to 1.75 mg/L. Fourteen of 51 samples taken throughout the year exceeded the effluent standard of 1.0 mg/L of ammonia. Cross Valley Dam seepage (X13) averaged 0.90 mg/l with a range of 0.19 to 1.77 mg/L of ammonia. In comparison, background concentrations as shown in the Rose Creek diversion water (X10) averaged 0.20 mg/L with a range of 0.01 to 0.57 mg/L.

1.6.1.1 Sources of Ammonia

Ammonia originates either from natural sources or from explosives residues in the open pit; ammonia is not used in the concentrator. Ammonia, therefore, entered the tailings impoundment system from the following sources:

- Pit water (X22) with an average yearly ammonia concentration of 1.64 mg/L and a range of 0.14 to 6.53 mg/L.
- Pit water (JB) with an average yearly ammonia concentration of 1.65 mg/L and a range of 0.82 to 2.43 mg/L.
- Dump seepage (X23) with an average yearly ammonia concentration of 0.76 mg/L and a range of 0.05 to 1.88 mg/L.

- Tailings line (X9) with an average yearly ammonia concentration of 0.81 mg/L and a range of 0.15 to 2.09 mg/L.

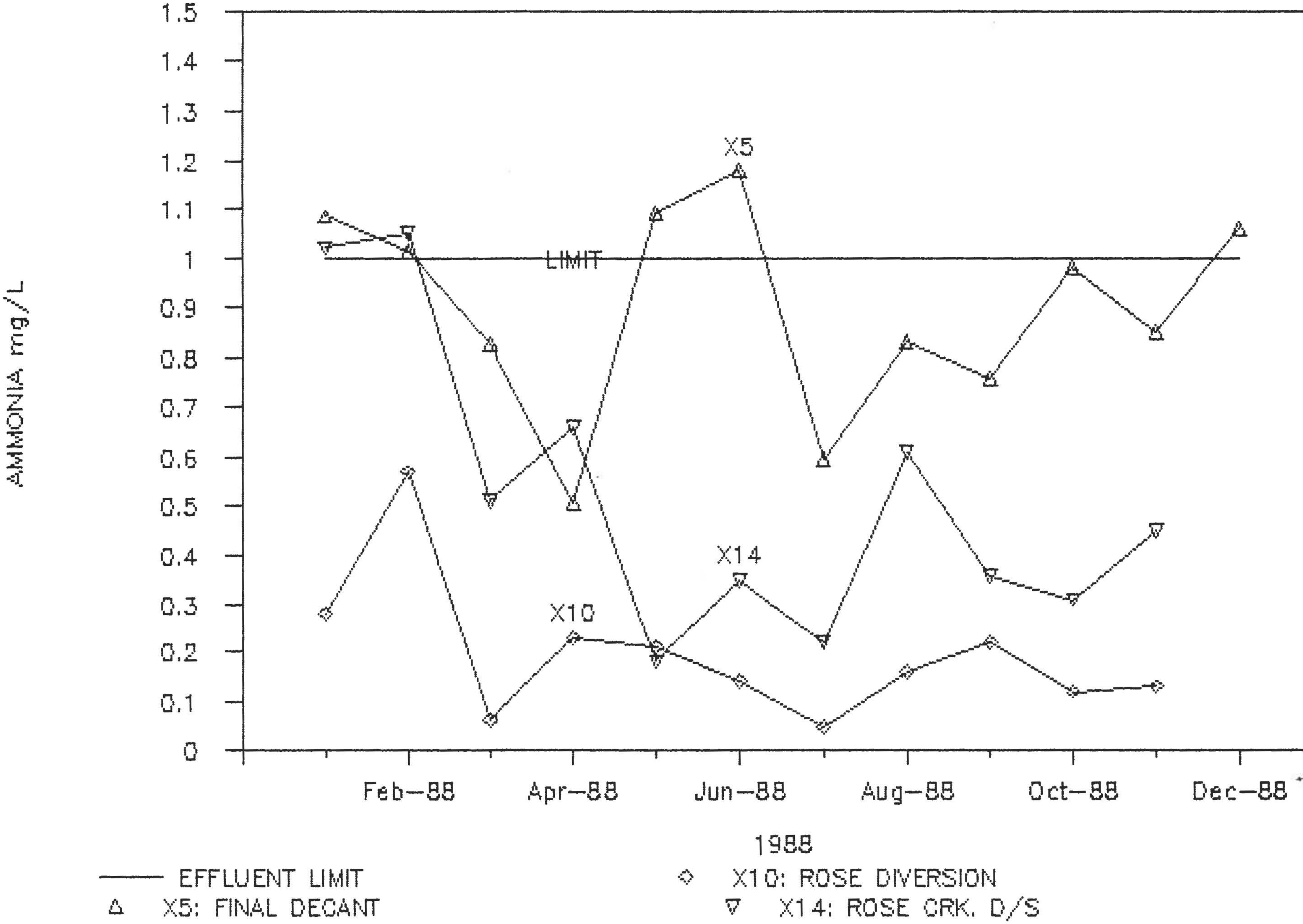
The Cross Valley dam decant (X5) reflects the ammonia inputs from the pit water and pit ore into the tailings system. As illustrated in Figure 5 the ammonia concentrations being discharged in the Cross Valley dam decant water were erratic, showing no seasonal trend.

1.6.1.2 Evaluation of Ammonia Data

Rose Creek downstream of the confluence between the Rose Creek diversion and the mine's effluent discharge (X5 & X13) is the mine's receiving water. Rose Creek (X14) had a 1988 average ammonia concentration of 0.52 mg/L and a range of 0.16 to 1.05 mg/L. Ammonia toxicity is not considered to be a problem in receiving water with pH below 8 and ammonia concentrations less than 1 mg/L. (Sawyer and McCarty 1978). As shown in section 1.5, the mine's receiving water, Rose Creek (X14) had an average pH of 7.67 in 1988, with a pH range from 7.49 to 8.01.

FIGURE 5 : AMMONIA

FARO MINESITE



1.6.2 Zinc

The average monthly zinc concentration of the final decant (X5), the Rose Creek diversion water (X10) and Rose Creek water downstream of the minesite (X14), are shown on Figure 6. Zinc averages for well water discharge (PW4), North Fork Rose Creek water (X2) and pumphouse pond water (X3) are shown on Figure 7.

The 1988 average zinc concentration in the Cross Valley decant was 0.246 mg/L with a range of 0.044 to 0.755 mg/L. Five of 52 samples exceeded the effluent standard of 0.50 mg/L. Zinc concentrations in the final decant (X5) exceeded effluent standards only during and immediately following the construction involved with raising the Intermediate Dam; this period extended from September to early November. Pumps were used to transfer water across the Intermediate Dam, and the high zinc values, most probably, resulted from the bottom sediment disturbance generated in the Intermediate Dam tailings pond by the pumping activity. Zinc concentrations in final decant water (X5) were well within the effluent standards for the remaining part of 1988.

The yearly average for well water discharge (PW4) was 1.161 mg/L with a range of 0.630 to 1.970 mg/L. Well water is required during the winter months (from December to April) to supplement concentrator water requirements. Two wells, PW4 and PW5, out of the four are located in the vicinity of the 'Old Tailings' impoundment area. The high zinc levels in the well water indicates that the wells utilize tailings area groundwater as part of their water reservoir.

Zinc concentrations in the pumphouse pond water (X3) increased during the well pumping period. The yearly average was 0.277 mg/L, but a maximum concentration of 1.220 mg/L was recorded in January when pumping was occurring.

1.6.2.1 Sources of Zinc

Sources of zinc to the tailings impoundment area were:

- Pit water (X22) with a 1988 yearly average zinc concentration of 47 mg/L and a range of 11 to 118 mg/L.
- Pit water (XA22) with a 1988 yearly average zinc concentration of 20 mg/L and a range of 6 to 86 mg/L.
- Pit water (JB) with a 1988 yearly average zinc concentration of 66 mg/L and a range of 16 to 118 g/L.
- Dump seepage (X23) with a 1988 yearly average zinc concentration of 21 mg/L and a range of 17 to 28 mg/L.
- Tailings line (X9) with a 1988 yearly average zinc concentration of 0.09 mg/L and a range of 0.003 to 2.75 mg/L.

The relative significance of the zinc sources is evident when concentrations are coupled with water discharge rates. Pit water discharge (X22, XA22, and JB) averaged 54 L/s in 1988; the dump seepage (X23) averaged 15 L/s and the Tailings pipeline (X9) averaged 325 L/s. In terms of yearly average zinc loading to the tailings area, pit water contributes 3600 mg/s, seepage contributes 320 mg/L and tailings contribute 30 mg/s. Thus, the tailings line (X9) was not a significant source of zinc to the Tailings impoundment area.

Actual zinc loadings from the pit water and the dump seepage are much higher than indicated with yearly averages. Peak zinc input occurs from April to June when maximum zinc concentrations are coupled with maximum water discharges. The mill discharge (X9) is sufficiently alkaline, however, to precipitate most of the zinc inputs to the tailings impoundment area. In 1988, the average pH for the mill discharge was 9.60.

1.6.2.2 Evaluation of Zinc Data

Zinc concentrations in Rose Creek downstream of the minesite (X14) ranged from 0.02 to 0.21 mg/L and during 1988, averaged 0.097 mg/L. These zinc levels in receiving water and illustrated in Figure 6, are not considered toxic; however, zinc toxicity to fish may begin at concentrations of 0.07 mg/L (Anon. 1987).

Zinc concentrations in the pumphouse pond (X3), as previously noted, were elevated during the January to April period of well operation. During most of this period water discharge does not occur from the pumphouse pond. Thus, downstream, at both the Rose Creek diversion (X10) and Rose Creek below the minesite (X14), increased zinc concentrations were not evident until April. The year maximum of 0.230 mg/L zinc at X10 and 0.210 mg/L zinc at X14 were recorded in April and these peaks are not exclusively a reflection of zinc loading from the well water discharge since Rose Creek at X2, above the pumphouse pond, also shows an increase in April Figure 7. This loading does not appear to be significant.

FIGURE 6 : ZINC

Average Monthly Concentrations

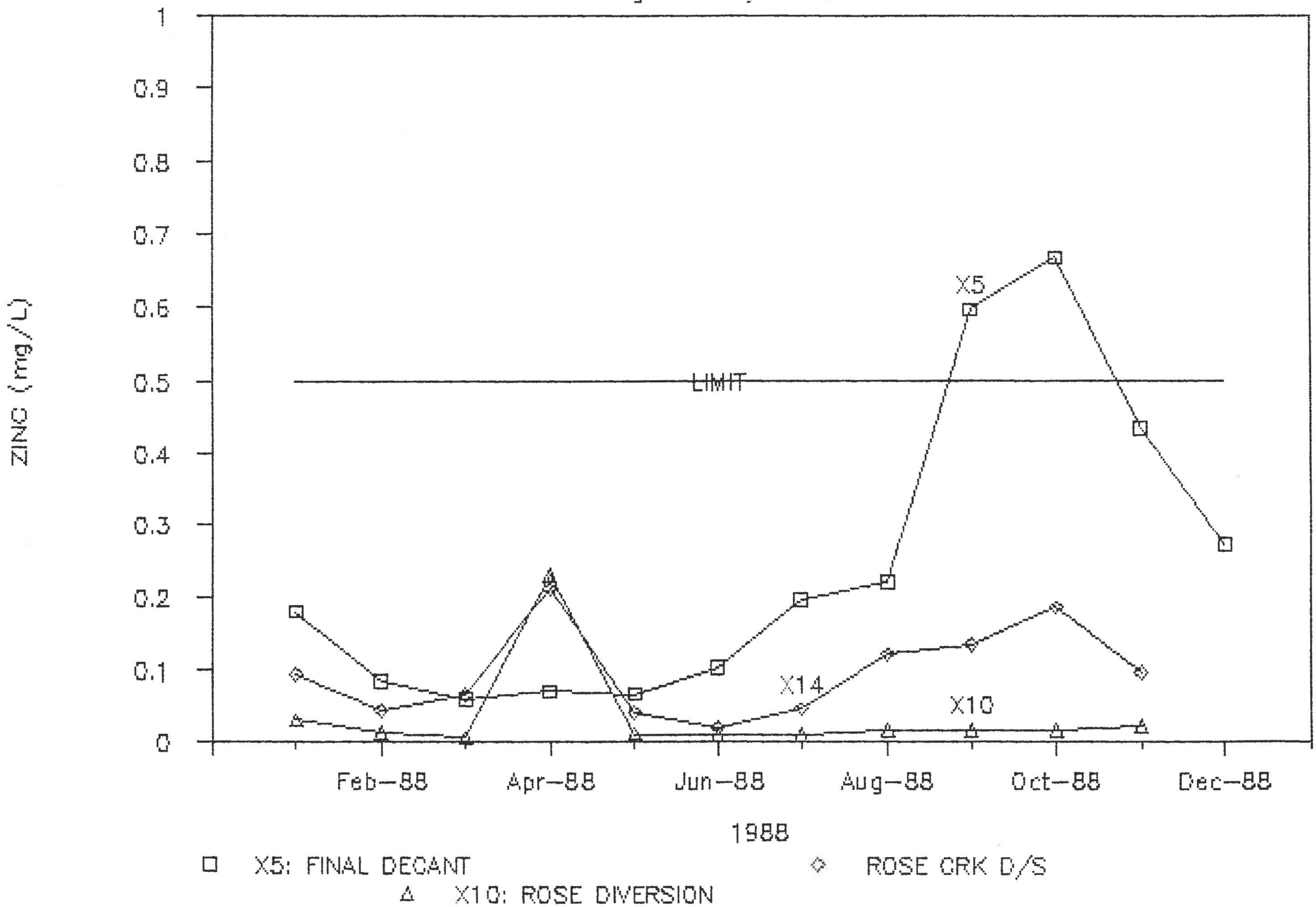
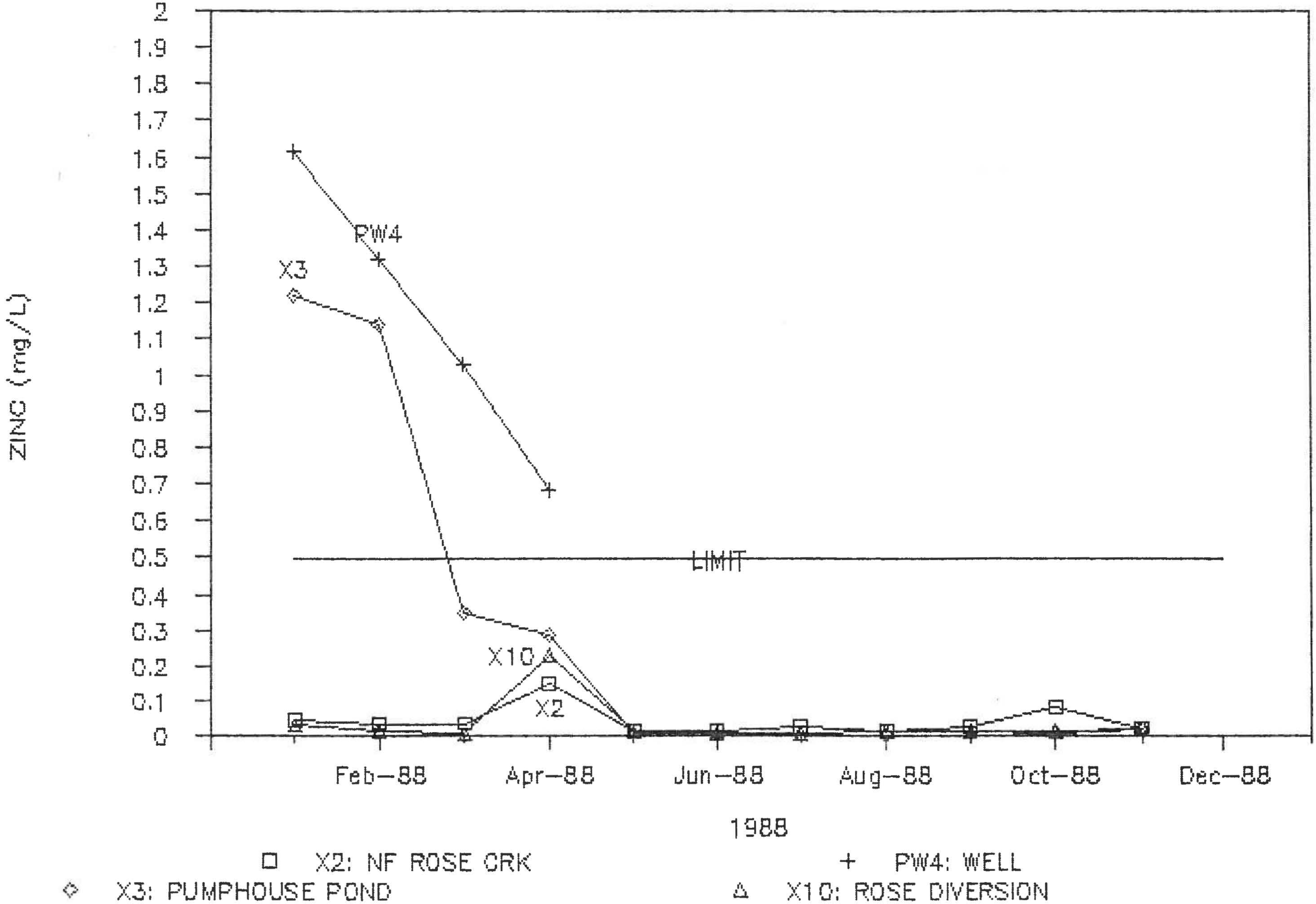


FIGURE 7 : ZINC

Average Monthly Concentrations



1.6.3 Lead

The 1988 monthly lead concentrations of the Cross Valley decant (X5), the Rose Creek background water (X10), and the Rose Creek water below the mine site (X14) are shown on Figure 8.

The yearly average lead concentration in the decant water (X5) was 0.140 mg/L with a range of 0.080 to 0.300 mg/L. Eight of 52 samples, taken from September to November, exceeded the effluent lead standard of 0.20 mg/L. The lead effluent standard was exceeded, as with zinc, during the construction period for raising the Intermediate tailings dam. Lead concentrations in the decant (X5) were within the effluent standards for the remainder of the year.

1.6.3.1 Sources of Lead

Lead entered the tailings impoundment area from the following sources:

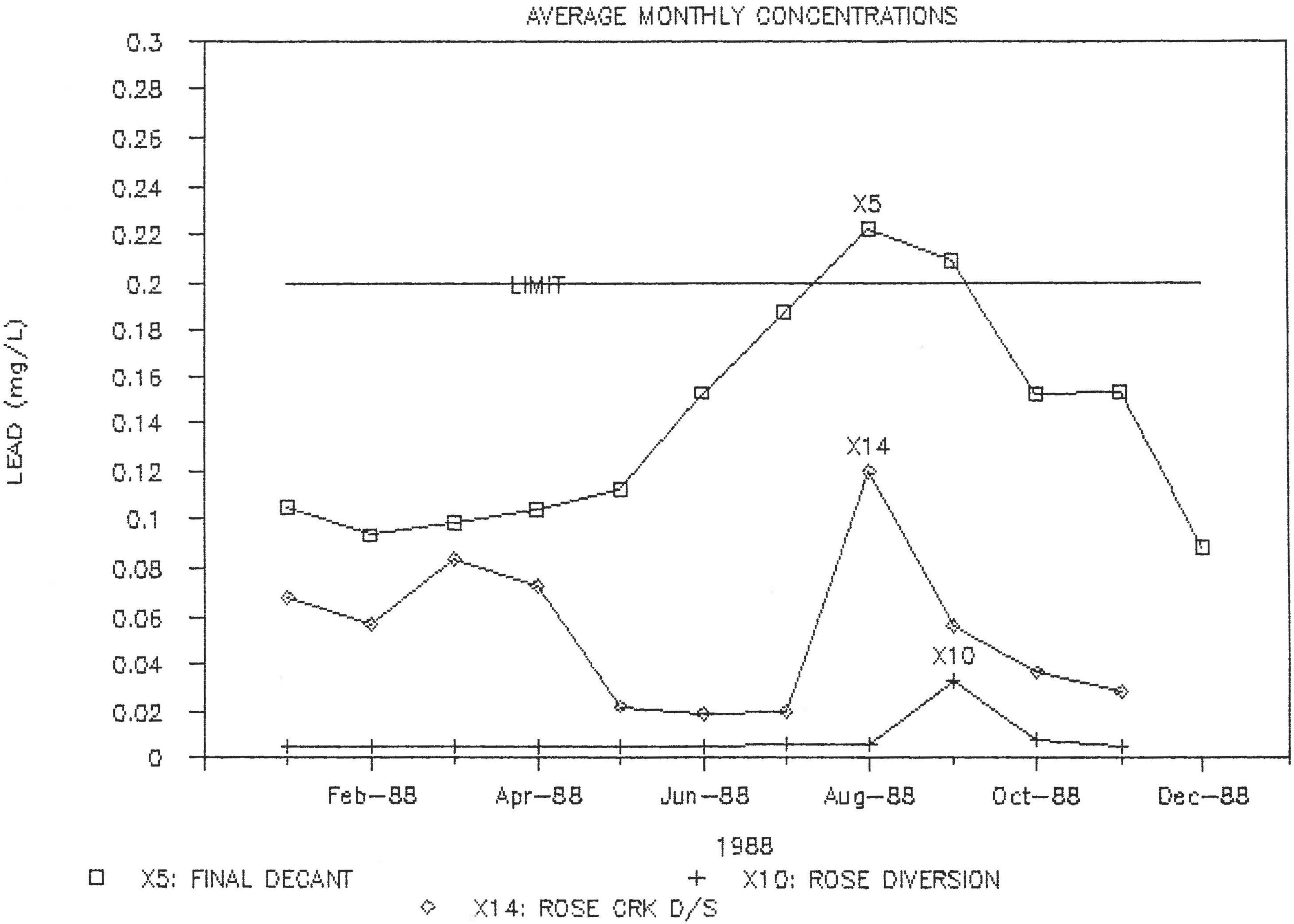
- Pit water (X22) with an average yearly lead concentration of 0.12 mg/L and a range of 0.005 to 0.92 mg/L.
- Pit water (JB) with an average yearly lead concentration of 0.11 mg/L and a range of 0.02 to 0.37 mg/L.
- Dump seepage (X23) with an average yearly lead concentration of 0.16 mg/L and a range of 0.01 to 3.72 mg/L.
- Tailings line (X9) with an average yearly lead concentration of 0.64 mg/L and a range of 0.006 to 23.2 mg/L.

High lead level inputs could not be identified with a specific period in 1988. The water retention time in the tailings impoundment area is responsible for the settling processes which decrease lead concentrations in the effluent. Lead in water is usually bound to particulates.

1.6.3.2 Evaluation of Lead Data

Rose Creek downstream of the mine (X14) had an average 1988 lead concentration of 0.053 mg/L and a range of 0.005 to 0.120 mg/L. As shown in Figure 8, lead levels in the Rose Creek receiving waters were fairly constant. The peak of 0.120 mg/L was recorded in August. Background lead levels are illustrated with lead levels in Rose Creek diversion water (X10). Lead levels, in conjunction with 1988 bioassay results, did not appear to produce chronic toxicity in Rose Creek.

FIGURE 8 : LEAD



1.6.4 Copper

Copper levels were well below the effluent standard of 0.20 mg/L. The yearly copper concentration average in the Cross Valley Dam decant was 0.025 mg/L with a range of 0.008 to 0.110 mg/L. Monthly averages for the decant (X5) and Rose Creek below the mine site (X14) are shown on Figure 9.

1.6.4.1 Sources of Copper

Copper is a component of the ore and is added in the concentrator process in the form of copper sulphate. Copper sulphate was added in the mill at an average rate of 0.5 kg per tonne of ore. Copper in the tailings discharge (X9) averaged 0.379 mg/L with a range of 0.005 to 5.950 mg/L. Copper was not found in appreciable quantities in other inflows to the tailings system.

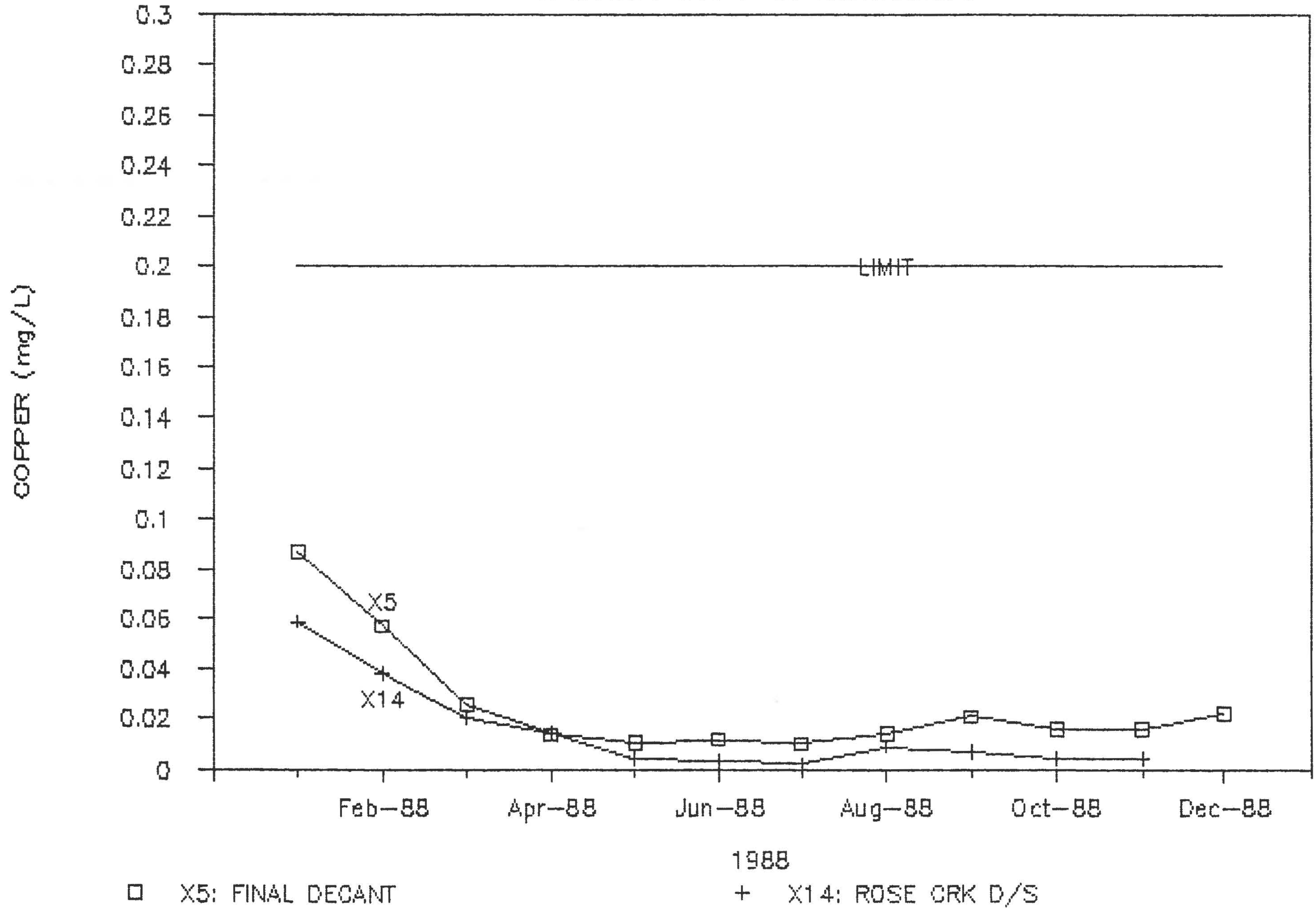
In the tailings, copper complexes with various compounds, including cyanide and ammonia. The retention time available in the tailings system was sufficient in 1988 to reduce copper levels in the effluent discharge to within effluent standards.

1.6.4.2 Evaluation of Copper Data

The 1988 average copper concentration in Rose Creek water below the mine site was 0.015 mg/L. These levels were below the 0.07 mg/L copper concentration considered toxic to juvenile fish (Anon. 1987).

FIGURE 9 : COPPER

AVERAGE MONTHLY CONCENTRATIONS



1.6.5 Cyanide

Total and weak acid dissociable (WAD) monthly average cyanide concentrations are shown for the Cross Valley decant (X5), the Cross Valley dam seepage (X13), the Rose Creek diversion water (X10), and the receiving water of Rose Creek below the mine site (X14) on Figure 10.

In 1988, total cyanide at the decant (X5) averaged 0.064 mg/L with a range of 0.005 to 0.220 mg/L. WAD cyanide at this location averaged 0.026 mg/L with a range of 0.005 to 0.149 mg/L.

In the Cross Valley dam seepage (X13), total cyanide averaged 0.111 mg/L with a range of 0.04 to 0.209 mg/L. WAD cyanide in the seepage averaged 0.006 with a range of 0.006 to 0.015 mg/L.

From January to April, 1988 cyanide concentrations in effluent discharge (X5 and X13) exceeded the effluent discharge standard of 0.05 mg/L. The lower cyanide consumption rates of ores being processed during this period, and a decrease in the natural cyanide degradation rate during the winter are considered the primary causes. Cyanide concentrations also increased in October for the same reasons.

In December, 1988 a cyanide spill occurred in the reagent building of Curragh Resources' concentrator. Cyanide effluent levels were reduced during this period through treatment using hydrogen peroxide. Peroxide addition is continuing, on a as required basis, to control cyanide levels in the effluent for the remainder of 1988/89 winter period.

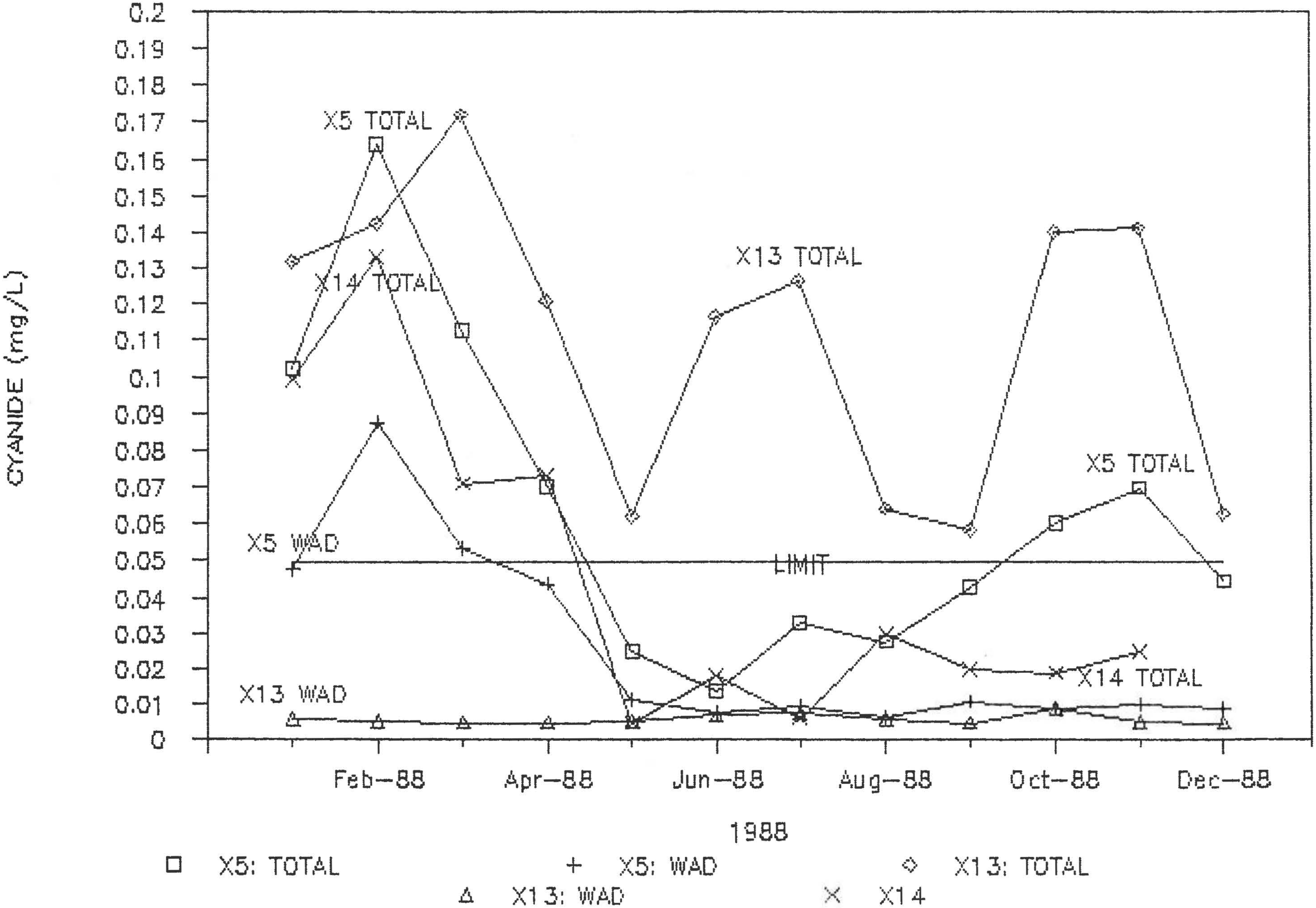
A detailed report entitled "Cyanide Treatment" is enclosed in Appendix 2. This report reviews the cyanide levels in the effluent discharge, details the events of the cyanide spill, provides details of the hydrogen peroxide treatment process and its effectiveness, and provides Curragh's cyanide treatment plan.

1.6.5.1 Evaluation of Cyanide Data

The 1988 average total cyanide concentration in Rose Creek downstream of the mine site was 0.045 mg/L with a range of 0.005 to 0.133 mg/L. Monthly results are plotted on Figure 10. The peak, as illustrated, occurred during February, 1988. Since April, both total and WAD cyanide levels in Rose Creek (X14) have been below 0.050 mg/L. As previously stated, a detailed analysis of cyanide, its potential problems and a plan to mitigate these problems in the future are provided in Appendix 2.

FIGURE 10 : CYANIDE

AVERAGE MONTHLY CONCENTRATIONS



1.7 Bioassays

Bioassay lab reports are presented in Appendix 3, and summarized in Table 2. Table 2 provides results only for bioassays in which the lethal concentration was not greater than 100 percent or in which mortalities occurred within a 96 hour period.

As shown, the bioassays for the Cross Valley decant (X5) for January, February and March reported mortalities within 96 hours. In February and March, the lethal concentration was also less than 100 percent. These bioassay results correspond to the high cyanide concentration results for the effluent discharge (X5) during this period.

In June, the bioassay for the Cross Valley decant (X5) also had mortalities within the last 24 hours of the test. There is no obvious reason for these mortalities. Ammonia levels were elevated in June, averaging 1.18 mg/L. The combination such as was recorded on June 23, in which the ammonia concentration was greater than 1.0 mg/L and the pH was greater than 8, could be responsible. However, this result has questionable applicability. The test was at 15 ° C whereas Rose Creek temperature does not exceed 8 ° C and the pH does not exceed 8, the toxicity of ammonia is less in these conditions. All other chemical concentrations in the final decant (X5) in June were within effluent standards.

The Cross Valley seepage (X13) had bioassay results during 1988 in which the lethal concentration was always greater than 100 percent.

However, mortalities were reported for the last 24 hours of the March bioassay. These mortalities are also probably a reflection of the high cyanide concentrations which were recorded in the seepage at this time.

TABLE 2: BIOASSAY RESULTS (X5 AND X13)   1988

MONTH	SITE	CONCENTRATION 96-h LC50	PERCENT SURVIVAL 24 h	48 h	72 h	96 h
JANUARY	X5	> 100 %	100	100	100	70
FEBRUARY	X5	< 100 %	100	100	40	0
MARCH	X5	< 100 %	100	90	80	30
MARCH	X13	> 100 %	100	100	90	90
JUNE	X5	> 100 %	100	100	100	80

NOTE: X5 = CROSS VALLEY DAM DECANT
X13 = CROSS VALLEY DAM SEEPAGE

2.0 GROUNDWATER DATA

Results from the groundwater monitoring are presented in Table 3. Licence groundwater sample sites are presented in Table 3A and additional sample sites are presented in Table 3B. Licence site locations are shown on Figure 1.

2.1 Groundwater Investigations

Groundwater sampling was undertaken in October, 1988. The pH and temperature of the groundwater samples were determined in the field. Sample stabilization was also done immediately at the site location. Samples were shipped to Bondar-Clegg and Co. Ltd. for the determination of concentrations of copper, lead, zinc, manganese, iron, sodium and sulphate.

2.2 Evaluation of Groundwater Data

The groundwater results indicate that the tailings impoundment area had little effect on downstream groundwater quality in 1988. Water quality in groundwater samples downstream of the Cross Valley Dam (X16, X17, and X18) remained good, with no discernable changes in quality from 1987. Metal levels were very low and the pH was greater than 7.

Groundwater quality at X21 by the old tailings decant was also comparable to 1987 quality. Zinc, manganese, sodium and sulphate levels decreased in the 10 and 40 meter samples, and increased slightly in the

27 meter sample. The metal levels, in general, are quite low. The pH remained basic at all depths.

Metal levels were also low and pH neutral to basic in groundwater samples from the Cross Valley and Intermediate Dams. Slight increases occurred in manganese, sodium and sulphate levels from 1987 levels.

TABLE 3A GROUNDWATER RESULTS

A: LICENCE GROUNDWATER SAMPLE SITES

SITE	LOCATION	DATE	pH	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	Mn (mg/L)	Fe (mg/L)	Na (mg/L)	SO4 (mg/L)
X16A	BY ROSE CREEK, DOWNSTREAM OF CROSS VALLEY DAM	12-Oct-88	7.8	0.005	-0.005	0.019	0.125	0.190	2.1	35
X16B	A - 5 M B - 30 M	12-Oct-88	8.0	0.002	-0.005	0.009	0.005	0.020	2.4	10
X17A	DOWNSTREAM OF CROSS VALLEY DAM	12-Oct-88	7.9	-0.002	-0.005	0.003	0.025	0.045	3.2	13
X17B	A - 5 M B - 20 M	12-Oct-88	7.8	-0.002	-0.005	0.005	0.160	0.070	3.1	16
X18B	NORTH OF CROSS VALLEY DAM B - 20 M	12-Oct-88	7.5	-0.002	-0.005	0.008	0.295	0.530	30.0	200
X21A	BY OLD TAILINGS POND DECANT	13-Oct-88	7.4	0.012	0.160	0.750	14.200	5.500	62.0	469
X21B	A - 10 M B - 27 M	13-Oct-88	7.6	0.003	0.026	0.150	2.080	0.015	23.5	212
X21C	C - 40 M	13-Oct-88	7.5	0.002	-0.005	0.084	3.800	0.710	19.0	173
X24A	INTERMEDIATE DAM: NORTH A - SHALLOW	13-Oct-88	7.7	0.003	-0.005	0.008	3.350	0.070	98.0	384
X24B	B - DEEP	13-Oct-88	7.9	0.002	-0.005	0.007	2.850	0.025	75.0	322
X25A	INTERMEDIATE DAM: SOUTH A - SHALLOW	13-Oct-88	7.5	0.002	-0.005	0.003	0.325	0.150	13.0	186
X25B	B - DEEP	13-Oct-88	7.8	-0.002	-0.005	0.003	0.345	0.030	4.8	67

NOTE: Less then = (-)

TABLE 3B GROUNDWATER RESULTS

B: ADDITIONAL GROUNDWATER SAMPLE SITES

SITE	LOCATION	DATE	pH	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	Mn (mg/L)	Fe (mg/L)	Na (mg/L)	SO4 (mg/L)
CVDC 4S	CROSS VALLEY DAM	12-Oct-88	7.6	0.004	0.005	0.023	2.500	0.120	64.0	387
	CREST NORTH									
CVDC 4D	S - SHALLOW D - DEEP	12-Oct-88	7.9							
CVDC 7S	CROSS VALLEY DAM	12-Oct-88	7.6	0.003	0.005	0.012	6.000	0.150	88.0	372
	CREST MID									
CVDC 7D	S - SHALLOW D - DEEP	12-Oct-88	7.6	0.002	0.013	0.017	4.250	0.005	84.0	428
CVDC 9S	CROSS VALLEY DAM	12-Oct-88	7.7	0.004	-0.005	0.021	0.025	0.035	14.5	127
	CREST SOUTH									
CVDC 9D	S - SHALLOW D - DEEP	12-Oct-88	7.8	0.002	-0.005	0.011	0.125	0.670	18.0	174
CVDT 1	CROSS VALLEY DAM	13-Oct-88	7.6	0.004	0.005	0.008	5.500	0.260	100.0	439
	TOE NORTH									
CVDT 2	CROSS VALLEY DAM	13-Oct-88	7.6	0.003	-0.005	0.003	2.800	0.025	80.0	428
	TOE SOUTH									
ID 4S	INTERMEDIATE DAM	13-Oct-88	7.2	0.004	-0.005	0.013	16.800	0.140	88.0	520
	MID									
ID 4D	S - SHALLOW D - DEEP	13-Oct-88	7.8	0.003	-0.005	0.007	0.590	0.330	72.0	433

3.0 BIOLOGICAL MONITORING PROGRAMS

In 1988, in compliance with Schedule B of Curragh's water licence Y-IN85-05A, a biological study of Rose Creek and Anvil Creek was conducted jointly by Environment Canada and Curragh Resources Inc. This report is presented in Appendix 4.

Curragh Resources Inc. also contracted P.A. Harder and Associates in 1988 to conduct a fisheries investigation for Rose Creek. This report is presented in Appendix 5.

3.1 The Biological Monitoring Program

The 1988 biological investigation of Rose Creek and Anvil Creek showed no apparent anomalies in the water quality for the dates sampled.

None of the benthic populations indicated stress (diversity less than 0.3) although the diversity indices decreased downstream of R2 at R3 and R4. Diversity recovered slightly at R5. Water quality data does not account for the diversity decrease.

Further, the total number of individuals at each site was significantly less than reported in previous studies. This decrease could be attributable to the high water flows experienced in the 1988 season.

3.2 The Rose Creek Fisheries Study

P.A. Harder and Associates established that a resident population of Arctic Grayling is present in the upper portions of North Fork Rose Creek.

Investigations in Rose Creek in the vicinity of the diversion channel, the pumphouse pond, the reservoir, and the headwaters of North Fork Rose Creek indicated that Arctic Grayling spawning was finished by the end of May.

An attempt to determine whether or not fish move up the diversion channel from lower Rose Creek was not successful. P.A. Harder and Associates did, however, establish that a large resident population of Arctic Grayling is present in the freshwater reservoir and the pumphouse pond. These populations were considered important in the maintenance of the Grayling population in Rose Creek. Efforts to stabilize and maintain the reservoir and the pumphouse pond, at the cessation of mining, is recommended.

4.0 PHYSICAL MONITORING

The physical monitoring program is detailed in "Schedule C" of Curragh Resources' water licence. Additional physical monitoring is detailed in this water licence in the "Summary Schedule" for Faro Mine Abandonment Plan Research and Monitoring.

4.1 Physical Monitoring: Down Valley Tailings Project

The report entitled 1988 Performance Monitoring and Additional Work on the Down Valley Tailings Project, Faro Mine, prepared by Golder Associates is included in Appendix 6.

This report presents and reviews data from the 1988 monitoring program as stipulated in Schedule C of the water licence. The data reviewed included observations of thermisters, slope indicators, piezometers on the dams, flow data and survey data of vertical and horizontal hub movements. A field inspection was made by H.G. Gilchrist of Golder Associates in September, 1988.

The report's conclusion is that "the project has performed generally as expected". The report contains recommendations for further monitoring, and recommendations on maintenance requirements.

4.2 Other Physical Investigations

In addition to the annual monitoring and review program, supplementary investigations were also carried out in 1988 in areas of particular concern. Some of these investigations are stipulated in the "Summary Schedule" of the water licence.

4.2.1 Fresh Water Supply Dam

Golder Associates was contracted in 1988 to perform a stability evaluation of this structure. Their findings are included as a supplement in the 1988 Performance Monitoring and Additional Work on the Down Valley Tailings Project, Faro Mine (Appendix 6).

Golder Associates has concluded that this structure has a static factor of safety against sliding of F.S.= 1.28 and F.S.= 1.02 under earthquake loading conditions.

Golder Associates, from their findings, recommend that the factor of safety for the dam should be increased to F.S.= 1.5. To accomplish this, the addition of a toe berm is recommended. The details of the required construction are presented in the Golder Report. Curragh Resources Inc., in 1989, will undertake to carry out the recommended construction and stabilization.

4.2.2 Diversion Canal Dyke From Stations 1+300 to 2+500

This investigation was undertaken by Golder Associates in 1988, and their findings are included as a supplement in the 1988 Performance Monitoring Report (Appendix 6).

This investigation was conducted in response to noted canal dyke crest cracking. New instrumentation was installed, and a monitoring program has been recommended. Specific dyke maintenance was also recommended. Curragh Resources Inc. is committed to performing this maintenance, and in 1988, began working on a recommended drainage ditch downslope of the dyke. This ditch, and dyke compaction and grading will be completed in 1989.

4.2.3 Cross Valley Dam

This investigation was conducted by Golder Associates in 1988; their results and recommendations are included as a supplement in the 1988 Performance Monitoring Report (Appendix 6).

This study was initiated to determine the cause and significance of dam crest cracking. New instrumentation was installed, and a monitoring program, including a crack survey, has been recommended. Curragh Resources Inc. will act upon these recommendations.

4.2.4 Waste Rock Dumps

The report entitled "Stability Assessment Waste Rock Dumps, Faro Mine, 1988, prepared by Golder Associates is included in Appendix 7.

A field assessment was conducted by D.B. Campbell of Golder Associates in May, 1988. Stability analysis was conducted on selected dump slopes.

The report concludes that "For the most part, the Faro Mine dumps exhibit sufficient static stability that in our (Golder Associates) opinion, flattening of dump faces is not required for geotechnical reasons." An exception was "the localized area on the eastern dump perimeter, immediately to the north of the junction of the upstream face of North Fork causeway" and the rock dump. A stabilizing toe berm is recommended.

4.2.5 North Fork Rock Drain

The report entitled "Performance of Rock Drain North Fork Rose Creek, 1988, prepared by Golder Associates is included in Appendix 8.

A field assessment was conducted by D.B. Campbell of Golder Associates in May, 1988. Specific concerns were addressed by Golder Associates. Golder Associates conclude that:

- "there is no possibility that the capacity of the rock drain could become impaired over time as a result of downward migration of fine particles within the body of the waste rock";

- and "the side slopes of the causeway fill can be expected to remain stable".

Curragh Resources will continue to monitor the causeway performance in accordance to the program stipulated in the "Summary Schedule" of the water licence.

4.2.6 Emergency Procedures for Down Valley Project

In the event of an emergency, with respect to suspected dam or dyke instability, Curragh Resources Inc. and Golder Associates have developed an Emergency Procedures Plan. This plan is included in Appendix 9.

5.0 FRESH WATER CONSUMPTION

Curragh Resources Inc. pumps fresh water from Rose Creek primarily to supply the requirements of its concentrator. Within the concentrator, principle water uses are for grinding and flotation. A detailed review of the fresh water supply and mine water consumption is included in Appendix 10.

5.1 Water Supply

Curragh's fresh water supply system consists of:

- a water supply reservoir
- a pumphouse pond and pumphouse
- groundwater wells (PW3, PW4, PW5, PW6)
- North Fork Rose Creek Diversion
- a supply line from the pumphouse to the mill.

The main source of fresh water is the water supply reservoir which supplies water to the pumphouse year round. Reservoir capacity is recharged from the Rose Creek drainage basin. The water supply is supplemented by the North Fork of Rose Creek and groundwater wells adjacent to the pumphouse pond during the winter months.

5.2 Water Consumption

Table 4 summarizes the fresh water consumption for the mill during 1988. The total water consumption is composed of a fixed component associated with the daily milling operation and a variable component dependent upon the volume of ore feed to the mill. Hence, the relationship between ore feed and water consumption is not linear.

The water licence, Part B.1, limits Curragh's water usage to 15.38 million Cubic Meters per year (CUM), with a maximum daily consumption rate not in excess of 42,900 CUM/day. The average daily water requirement for the mill during 1988 was 28,030 CUM/day. The total water usage for 1988 was 10.3 million CUM/year. Water consumption, based on mill water meter readings, were therefore within both the daily and yearly water licence limits for 1988.

TABLE: 4 MILL FRESH WATER CONSUMPTION 1988

MONTH	WATER CONSUMPTION (CUM)	ORE FEED (TONNES)	WATER/ ORE FEED (CUM/TONNE) OF ORE	CYANIDE		COPPER SULPHATE	
				(KG)	(KG/TONNE) OF ORE	(KG)	(KG/TONNE) OF ORE
JAN	877890	380604	2.31	56603	0.15	195494	0.51
FEB	844230	360774	2.34	38168	0.11	147059	0.41
MAR	889080	362483	2.45	41497	0.11	147710	0.41
APR	798660	369024	2.16	38999	0.11	173875	0.47
MAY	877280	392373	2.24	36000	0.09	149881	0.38
JUN	567460	204362	2.78	43428	0.21	103870	0.51
JUL	745180	270054	2.76	24000	0.09	107210	0.40
AUG	935800	381057	2.46	58900	0.15	179590	0.47
SEP	924070	349165	2.65	38500	0.11	175740	0.50
OCT	894060	329439	2.71	46700	0.14	163120	0.50
NOV	942760	378417	2.49	38600	0.10	170202	0.45
DEC	934220	348836	2.68	50953	0.15	232450	0.67
TOTAL	10230690	4126588		512348		1946201	
DAILY AVERAGE	28029	11306	2.50	1404	0.13	5332	0.47

6.0 PIT WATER PUMPING

During 1988, pit water pumping was carried out from Zone I, Zone II, and JB Phase (Zone III). The yearly average discharged was estimated at 0.054 CUMS, with a winter month average of 0.044 CUMS and a summer month average of 0.067 CUMS. Total pit water pumped for the year was 1,660,000 cubic meters. All pit water discharge was pumped to the tailings.

7.0 TAILINGS FACILITY WATER BALANCE

The total water discharged to the Tailings in 1988 was:

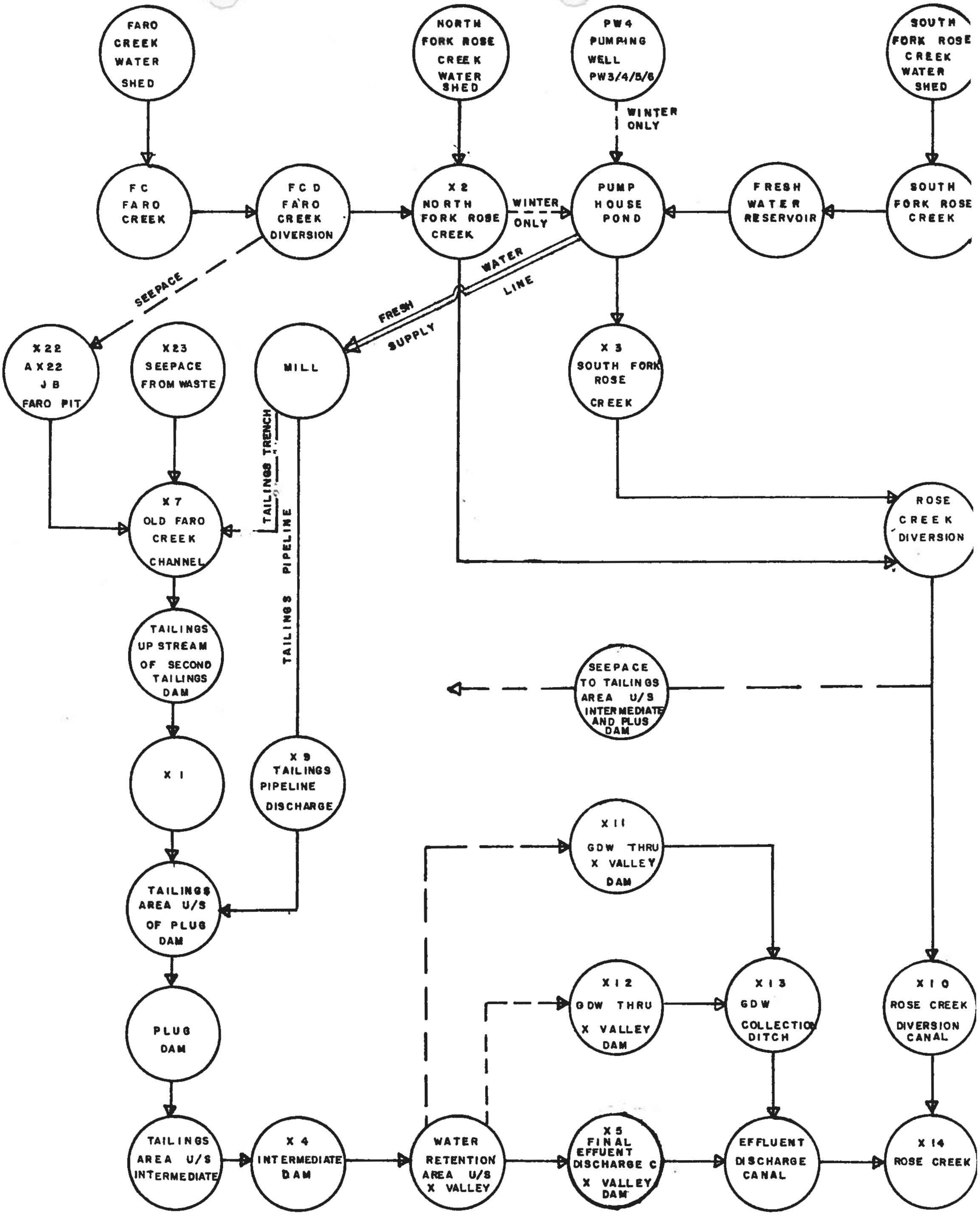
	Volume (CUM)
. Pit water pumped to tailings	1,660,000
. Mill tailings discharge	10,330,000
TOTAL INPUT	**11,960,000**

The total water discharged from the tailings impoundment area in 1988 was:

. Decant at Cross Valley Dam (X5)	9,050,000
. Cross Valley Dam seepage (13)	3,374,000
TOTAL OUTPUT	**12,424,000**

As indicated, the output discharge is greater than the input recharge. This difference is attributable to seepages into the tailings from Rose Creek Diversion, precipitation, and spring snow melt. Other sources, as estimated, are equivalent to yearly average inflow of 0.015 CUMS. Figure 11 illustrates schematically the Faro minesite flow regime.

FIGURE 11 SCHEMATIC OF FARO MINESITE FLOW REGIME AND WATER QUALITY SAMPLING SITES



8.0 MAINTENANCE WORK

The dam structures, diversion dykes, and the canal slopes require periodic maintenance. Yearly instrumentation monitoring is also required.

8.1 Jobs Completed In 1988

The major maintenance tasks completed in 1988 were:

- the diversion canal backslope thermal liner was repaired and graded to Golder design specifications and recommendations;
- the Rose Creek flow was re-directed into the 1974 channel routing upstream of the automatic gauging station;
- a seepage drainage ditch was installed downslope of the Rose Creek diversion dyke between stations between 1+300 and 2+500. Backfill of drainage rock remains to be placed;
- a crack survey strip chart was completed for Rose Creek diversion dyke between stations 1+300 and 2+500.
- a crack survey strip chart was completed for the fresh water supply dam and the Cross Valley dam;
- a deformation survey of the Down Valley Project was completed by Underhill & Underhill;
- Faro Creek diversion channel was relined to reduce seepage into the Faro pit;
- all instrumentation, including thermisters, inclinometers, and piezometers were monitored in 1988.

8.2 Jobs To Be Done In 1989

The major maintenance tasks for 1989, as recommended by Golder Associates (Appendix 6) are:

- repair the canal dyke section opposite the quarry location;
- install an additional one or two weirs at the outfall of the diversion canal;
- mantle a local area of sloughing in the wall of Borrow Pit "I" adjacent to the diversion canal at abut Station 1+300;
- raise the diversion dyke at the upstream end of the North Valley Wall Interceptor Ditch, and repair the small backslope slides some distance downstream from the point of diversion.

The crest of the dyke between stations 1+300 to 2+500 must be dressed and recompacted to close and reconsolidate cracked sections. A large vibratory peg-type drum packer should be used in conjunction with blading to effect this work.

In addition, the seepage drainage ditch below the canal dyke (from station 1+300 to 2+500) must be completed before spring thaw in 1989. The ditch must yet be backfilled with drain rock.

A major construction project to stabilize the fresh water reservoir dam will also be undertaken in 1989. This stabilization maintenance construction was recommended by Golder Associates. Detailed construction plans will be available for review before commencement of this project.

9.0 Waste Rock Deposition

Waste rock deposition, including the development of the Zone Two dump, the high sulphide waste dump, and the Vangorda haul road continued as planned. General details of the waste rock deposition plan were included in the "Faro Pit Abandonment" report (1988) and the "Development of the Zone Two Waste Dump" report (1987).

Major emphasis in 1988 was placed on developing the Vangorda haul road. Subsequently, approximately 8.5 million tonnes of non acid generating waste rock was deposited as road fill. The Zone Two dump functioned as a secondary dump site in 1988. Waste rock segregation continued throughout 1988, with potentially acid producing waste rock being deposited in the "high sulphide" dump.

10.0 Other Projects and Investigations

In 1988, Curragh Resources Inc. submitted the Faro Mine Abandonment Plan to the Yukon Territorial Water Board. This report identified areas in which further research was required, and outlined a projects and implementation schedule. Monitoring schedules, where appropriate, were also included. These projects and the implementation schedule are included in the "Summary Schedule" of Curragh' water licence.

10.1 Waste Rock Characterization

The sampling for the waste rock characterization began in February, 1989. Sampling procedures being used include:

- developing rock type cross-sections of the pit from available drill hole information;
- selecting representative samples of the rock types of the Faro deposit, including waste and country rock;
- having the samples analyzed by a commercial laboratory for acid\ base potential;
- subjecting selected samples to slake and freeze-thaw tests.

Sampling is expected to be completed in the Summer of 1989 when Curragh's exploration staff are on site. After the completion of chemical and physical analysis, the results will be correlated to estimated waste rock volumes. These volumes will be determined from the pit cross-sections. In this manner, the acid generating potential for the waste dumps can be approximated. A detailed report of results is expected to be available in 1989.

10.2 Groundwater Studies

In 1988, a groundwater monitoring network was installed immediately below the Zone Two open pit and waste dump. Water levels and water quality will be monitored in 1989.

The groundwater monitoring network downslope of the "high sulphide" waste dump was not completed in 1988. The drilling program was temporarily terminated because of equipment access problems encountered in the marshy ground. This program will be completed prior to spring thaw in 1989, and water levels and water quality will then be monitored.

An extensive drilling program was also conducted in the tailings impoundment area. The objective of this program was to determine, not only the chemical composition of various ages of tailings, but also to investigate groundwater quality and attenuation capacity of the hydrogeological regime beneath the tailings. The consultants, Steffen Robertson and Kirsten were contracted in September to complete the field investigations. Extensive chemical analysis of pore water and solids is presently being conducted by B.C. Research. Results should be available by early summer, 1989.

10.3 Loss of Flow in Faro Creek Diversion

The Faro Creek diversion was investigated in 1987, and results indicated that considerable flow loss occurred through its containment dyke. This leakage resulted in not only higher pit dewatering costs, but also resulted in larger contaminated water volumes being pumped to the tailings area.

During August and September, 1988, a stepped channel was constructed in the Faro Creek diversion and the channel bottom, for approximately 600 meters of its length, was double lined. These actions appear to significantly reduced flow loss from the diversion channel.

10.4 Hydrology

In 1988, the automatic flow recorder on Rose Creek diversion was operational and a continuous flow record was attained. Periodic determinations of the flow in Faro Creek, North Fork Rose Creek and Rose Creek downstream of the minesite were also made using a Marsh-McBirney velocity flow meter. Depth of impounded water immediately upstream of the North Fork Causeway were also periodically determined, with maximum effort occurring during spring freshet and other high discharge periods.

In 1988, an Isco, Model 2870 automatic flow recorder was purchased. This device will be installed on North Fork Rose Creek upstream of the confluence of Faro Creek Diversion and North Fork Rose Creek in 1989.

10.5 Seep Surveys: Faro Pit and Waste Dump Seeps

In September, 1987, seepage water quality and quantity surveys were initiated. In 1988, a further five seep surveys were conducted in April, May, June, August, and October. The seep surveys are designed to determine potential pit and dump seepage water quality at mine abandonment. Total metal loadings can presently be determined and seasonal variations can be identified. With water quality modelling, future metal loadings and their effects can be predicted. These seep surveys will be continued until abandonment; however, the frequency of sampling and the number of sample locations will be reduced. Two sampling events, during spring and fall, should now be sufficient

The chemical analysis results for samples from the 1987 and 1988 seep surveys are now available. A detailed analysis of the data, however, is not yet complete. A report on the seep surveys to date will follow under separate cover. This report should be available by the summer of 1989.

11.0 Impact Assessment

During 1988, Curragh Resources' effluent discharge occasionally exceeded effluent standards. Cyanide levels during the early part of 1988 exceeded standards, and lead and zinc concentrations were above licence limits for the period Intermediate Dam construction,

A cyanide treatment system, using hydrogen peroxide as the cyanide destruction chemical, has been instituted to reduce future cyanide impacts. Treatment results from December, 1988 indicate that this method can work to reduce effluent cyanide levels. Metal levels, excepting the construction period, were generally within accepted effluent standards.

Reviewing the chemical data for the effluent discharge in conjunction with results from the biological studies and bioassay results, an increased environmental impact on Rose Creek downstream of the minesite is not evident during 1988. The benthic survey indicates that, even with occasional periods of below standard discharge, the organisms in Rose Creek have not shown a systematic increase in stress, but are within the range experienced during the operation of the mine. The fisheries study indicates that Rose Creek continues to support a healthy Arctic Grayling fish population. Comparison to background water quality data being accumulated on Vangorda Creek shows that at site R5 the downstream impact of the mines operation does not result in water quality significantly worse than that experienced in Vangorda Creek, a stream not impacted by development but draining a naturally weathering ore deposit.

In conclusion, the Curragh Resources Inc. mine at Faro operated throughout 1988 and degradation of either water quality or of health of Rose Creeks biota were not evident.