FRANK.RV4
W9412

AN OVERVIEW OF WATER QUALITY IN FRANK LAKE 1990-1993

Prepared by:

Al Sosiak, M.Sc.

Surface Water Assessment Branch
Technical Services and Monitoring Division
Alberta Environmental Protection

July 1994

INTRODUCTION

Frank Lake is a restored lake and wetland area east of High River, Alberta. It was designed to treat wastewaters from the High River Wastewater Treatment Plant (WWTP) and the Cargill Foods Limited meat packing plant, and to provide habitat for waterfowl production. It also provides an alternative to municipal wastewater discharge to the Highwood River. Prior to the restoration of Frank Lake in 1989, High River WWTP effluent was discharged directly to the river, and prolific weed growth and fish kills had occurred (summarized in Alberta Environment 1990).

The Frank Lake restoration project was initiated by Ducks Unlimited Canada, which built storage works in 1989 to stabilize the lake level. The existing Frank Lake basin was thereby divided into three main basins. Ducks Unlimited was also licensed to divert Highwood River water to Frank Lake to compensate for evaporation. At the same time, the Municipal District of Foothills was licensed to construct works and divert High River WWTP and Cargill effluent to Frank Lake.

Alberta Environmental Protection (AEP) began a water quality monitoring program at Frank Lake in 1990. This program was designed to provide a very basic characterization of the combined effluents and treatment efficiency in the first basin. At the time of implementation, water quality data were available for the individual High River WWTP and Cargill effluents, but not for their combined discharge into Frank Lake.

METHODS

The Frank Lake water quality program consisted of grab sampling of the combined Cargill and High River WWTP effluents (hereafter referred to as the "influent") in the channel to Frank Lake, and the outfall from basin 1 (Figure 1). The period of sampling extended from October 23, 1990 to January 14, 1993, and occurred at a frequency of four times per year (once each season).

The first basin was shallow and too difficult to access with a boat in 1990. Therefore, the decision was made to sample the outfall from this basin, instead of collecting a euphotic zone composite sample, which is the standard lake sampling procedure employed by AEP. The sampling design for this program also specified that each basin outfall should be sampled as the three basins filled. However, no flow was observed at either the basin 2 or 3 control structures (Figure 1) during this survey.

The variable list for this monitoring program included all the licensed variables for the High River WWTP and Cargill plant. Samples were also analyzed for organic compounds at the Alberta Environmental Centre (extractable and volatile priority pollutants and PCBs). Chlorine, dissolved oxygen, pH, conductivity and temperature were measured on site.

RESULTS AND DISCUSSION

Results for inorganic and biological variables are in Appendix I. Organic compounds occurring over the method detection limit are in Appendix II. The basin 1 outfall was not flowing on three of the

10 routine sampling dates. A limited range of variables was sampled on August 24, 1990 at the influent channel only. Medians in Appendix I were calculated using only those dates when there was flow at both the sites.

The key findings were as follows:

(1) The concentrations of all variables in the combined influent which were specified on the Cargill and High River WWTP plant licences were at or below the maximum daily limits for each licence, on all the sampling days except August 24, 1990. On that date total suspended solids (TSS) was 265 mg/L, compared to 25 mg/L on the Cargill license. This high influent TSS may have been caused by algal biomass in the High River WWTP effluent, which does not have a TSS limit in summer.

The influent to Frank Lake had very high levels of dissolved phosphorus, nitrite/nitrate and ammonia. With such high nutrient levels, one would expect a very high level of aquatic plant biomass to result. Maximum summer chlorophyll *a* at the basin 1 outfall was indeed in the hyper-eutrophic range of productivity (OECD 1982) in 1991 and 1992, indicating extremely high levels of phytoplankton biomass. There was also relatively high chlorophyll *a* in the influent on some dates, which suggests algal growth in the treatment system. Perhaps as a result of the high algal biomass in basin 1, there were also higher levels of dissolved organic carbon and turbidity at the basin 1 outfall than in the influent (Appendix I).

(2) Basin 1 provided treatment for some of the phosphorus and nitrogen in the influent, but nitrite and ammonia levels at the basin 1 outfall were still usually over the guidelines for the protection of aquatic life. Of variables specified on the Cargill licence, ammonia, pH and total residual chlorine (TRC) (licensed as free residual chlorine) regularly exceeded one of the Canadian Water Quality Guidelines (CWQG) in the basin 1 outfall (CCME 1994)(Appendix I).

Influent total ammonia and TRC were usually within the acutely toxic range of concentration for invertebrate and fish species, as defined in CCME (1994). At least the mixing zone in Frank Lake would likely be toxic to sensitive aquatic invertebrate and fish species.

Chloride exceeded the CWQG guideline for irrigation of sensitive crops (100 mg/L), in both the influent and the basin 1 outfall.

(3) Certain constituents were apparently retained by basin 1. Calcium and zinc were lower at the basin 1 outfall than in the influent. The decrease in calcium may have been caused by aquatic plant uptake of carbon dioxide, and precipitation of calcium carbonate.

Mercury, which is rarely detected in surface water, occasionally exceeded the CWQG guideline in the basin 1 outfall.

There was surprisingly little settling of suspended sediment, and fixed nonfilterable residue (ashed suspended sediment) was similar in the basin 1 outfall and influent. A mass balance analysis could be used to provide an estimate of the proportion of each constituent retained in basin 1, but would likely be relatively crude given the frequency of measurement in this study.

(4) Frank Lake apparently acts as an evaporative basin and concentrates various other constituents. Alkalinity, dissolved solids, pH, sodium, sulphate and dissolved arsenic were higher at the outfall than in the influent. As a result, the sodium absorption ratio (SAR) of the basin 1 outfall was higher than in the influent and both exhibited a slight restriction for irrigation based on the CWQG. SAR is a measure of the effects of excess sodium on soil structure and water movement. It is expressed as a ratio of the concentration of sodium, calcium and magnesium ions.

(5) Chlorine was used in the Cargill plant as an anti-fouling agent. Early in the program high levels of total residual chlorine were detected in the influent and the plant was asked to adjust their treatment rates (D. Spink, personal communication). The chlorine levels maintained in the influent were apparently high enough to eliminate most fecal coliform bacteria, which were only detected in the influent on one sampling date (2 per 100 mL on July 6, 1992). Fecal coliform counts were higher in the basin 1 outfall than in the influent on four dates. This small increase in coliforms at the outfall could be caused by warm blooded animals in or near Frank Lake, for example waterfowl or livestock.

Note: although chlorine levels exceeded the CWQG guideline for the protection of aquatic life (0.002 mg/L TRC) at the basin 1 outfall (Appendix I), this guideline specifies use of ampirometric titration or its equivalent. A less precise Hach kit was used in the Frank Lake study.

(6) Trace and low levels of some chlorinated organic compounds were detected in both the influent and basin 1 outfall (Appendix II). Various other organic compounds were also detected, including some unusual (tentatively identified) compounds such as caffeine, which was detected in each of the three winter samples from the influent. Appendix II contains all results over the method detection limits, plus compounds less than the detection limit but present at trace levels. All positively identified organic compounds were at levels lower than the available CCME and USEPA (USEPA 1986) guidelines. The environmental significance of the tentatively identified compounds is unknown. The other 80 compounds included in each scan and PCBs were not detected in the basin 1 outfall.

SUMMARY

Except for total suspended solids on one occasion, all the variables in the combined effluent were at or below the maximum daily limits specified for the High River WWTP and Cargill plant licences. The influent to Frank Lake had very high levels of aquatic plant nutrients, and the lake itself was in the hyper-eutrophic category based on phytoplankton chlorophyll *a*.

Frank Lake and the associated wetland area provide good treatment for most of the variables included in this sampling program. However, nitrite, ammonia and total residual chlorine often exceeded the Canadian Water Quality Guidelines for the protection of aquatic life in the basin 1 outfall. Although generally less than the detection limit, mercury was sometimes detected in the outfall effluent. The source of mercury should be ascertained, and residues in aquatic organisms should be determined in future sampling programs.

Frank Lake acts as an evaporative basin and concentrates various salts. As a result, the sodium absorption ratio of the basin 1 outfall exceeded the slight restriction guideline for irrigation in the Canadian Water Quality Guidelines. Chloride also exceeded the guideline for the irrigation of sensitive crops, in both the influent and basin 1 outfall.

FUTURE SAMPLING

This sampling program was designed to provide basic characterization of combined influent quality and treatment in basin 1. Sampling was infrequent and only two sites were sampled. Future sampling should document spatial variation and better define temporal trends in water quality. More frequent sampling would allow a better resolution of mass flux through the system and allow more insight into processes. It would appear important to quantify the true assimilative capacity of Frank Lake, so that the effects of additional municipal wastewater or industrial effluents can be determined.

The following issues should be addressed by future sampling programs at Frank Lake:

(a) Ammonia and TRC were at levels that are likely toxic to aquatic invertebrates, at least in the mixing zone. Since this could affect the food supply of some waterfowl, invertebrate monitoring would be useful;

(b) Low levels of mercury were sometimes found in the influent and basin 1 outfall. Since mercury can readily enter the food chain and bio-concentrate, sediment and animal mercury residues should be measured, and the source of the mercury in the influent should be determined;

(c) Mixing patterns in Frank Lake are not documented. Some constituents may be at high, potentially toxic levels in the mixing zone for the influent but acceptable in other areas.

If higher lake levels cause significant discharge from basin 3 to the Little Bow River, each of the three basin outfalls should be sampled to assess their respective treatment effects. Downstream impacts on water quality should also be assessed, in particular the following:

(a) The effects of SAR in Frank Lake on the suitability of the Little Bow River for irrigation use;

(b) The effects of dissolved phosphorus and nitrogen loading from Frank Lake on primary production in the Little Bow River.

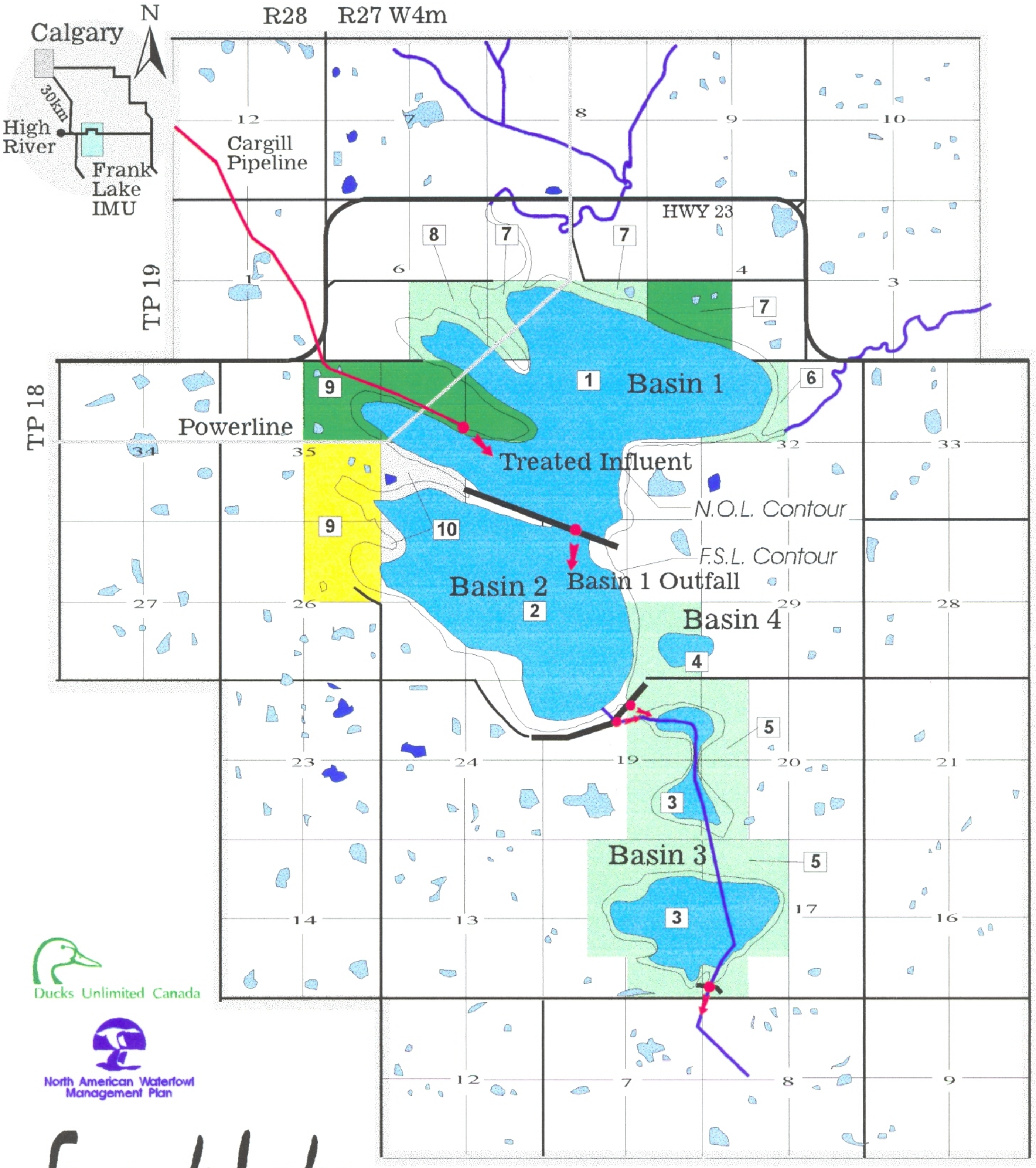
LITERATURE CITED

Alberta Environment. 1990. Highwood River instream flow needs. Compendium of background information. Planning Division, Calgary.

Canadian Council of Ministers of the Environment. 1994. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines, Ottawa.

OECD (Organisation for Economic Co-operation and Development). 1982. Eutrophication of waters. Monitoring, assessment and control. Final Report. OECD Cooperative Programme on Monitoring of Inland Waters (Eutrophication Control), Environment Directorate, OECD, Paris. 154 p.

United States Environmental Protection Agency. 1986. Quality criteria for water. Office of Water Regulations and Standards, EPA 440/5-86-001.



Frank Lake

Figure 1. IMU Segment Plan

3	Segment No.	Light green	MD of Foothill Purchase 780ha (1928ac)
Black line	Dam/Dyke	Dark green	NAWMP Purchase 178ha (439ac)
Red arrow and dot	Control	Yellow	Horrell Purchase 125ha (310ac)
Purple line	Ditch/Canal		

fr-imu-2.cdr

Appendix I. Grab sample results for influent entering Frank Lake and basin 1 outfall, 1990-93. Outfall values over CCME guidelines are marked as follows: (1) Protection of Aquatic Life (bold italics); (2) Irrigation (dashed outlines); (3) Contact Recreation (shaded). Inorganic variables analyzed at Chemex Labs Alberta Inc., except for August 24, 1990 when they were done by the Alberta Environmental Centre. Coliform counts were made at the Provincial Laboratory of Public Health for Southern Alberta and chlorophyll *a* was analyzed at the Surface Water Monitoring Branch laboratory.

STATION	DAY	MON.	YR.	COLOUR TRUE REL UN 02021L	COND US/CM 02041L	COND US/CM 02041F	TEMP DEG.C 02061F	TEMP AIR DEG.C 02066F	TURB NTU 02074L	CARBON DISS ORG 06104L	CARBON DISS INORG 06152L	HCO3 LAB CALCD 06202L	CO3 LAB CALCD 06302L	OIL AND GREASE 065**L	TOTAL PHENOLS MG/L 06537L	CHLORO PHYLL a MG/M3 06715L	N TKN MG/L 070**L	NO2/NO3 DISS MG/L 07110L
TREATED INFLUENT	24	8	90		1590					MG/L	MG/L	650	MG/L	MG/L			84.5	
TREATED INFLUENT	23	10	90	10	1357	1562	5.5	4	7.1	17.5	52.2	335.2	L0.5	0.4	L0.001	0.4	38	28.4
TREATED INFLUENT	15	1	91	30	1283	1310	3.9	6	6.2	20	58.5	258.4	L0.5	0.5	0.009	3.1	23.2	19.6
TREATED INFLUENT	16	4	91	20	801	850	5.2	9	13	7.7	34.2	190.2	L0.5	L0.2	L0.001	11	5.6	18.2
TREATED INFLUENT	18	7	91	50	1540	1600	20.7	19	17	27.1	42	263.3	L0.5	0.9	0.006	5.1	20.4	61.5
TREATED INFLUENT	17	10	91	20	1080	1141	10.2	-3	5	11.3	57.2	299.9	L0.5	0.3	L0.001	7.6	6.4	3.1
TREATED INFLUENT	20	1	92	40	1380	1437	6	8	1.9	16.7	47.5	249.9	L0.5	1.4	L0.001	21.6	12	42
TREATED INFLUENT	22	4	92	50	1240	1189	11.4	16	7	11.7	53	293.8	L0.5	0.5	L0.001	48.9	8.12	21.4
TREATED INFLUENT	6	7	92	40	1010	1031	16	16	157	12.1	31.2	193.8	L0.5	L0.2	L0.001	1.6	5.44	33.7
TREATED INFLUENT	7	10	92	40	1950	1940	14.4	10	2.3	12.8	29	192.6	L0.5	0.8	L0.001	0.8	9.8	77.5
TREATED INFLUENT	14	1	93	80	2120	2070	3.6	-20	7.3	18	79.5	441.3	L0.5	L0.2	0.002	8	43.5	57
INFLUENT DUPLICATE	14	1	93	80	2110				7.5	18.1	79.5	443.7	L0.5	L0.2	L0.001		39.5	56.5
MEDIAN(90-92), outfall flowing				40	1240	1189	10.2	9	7.1	12.1	47.5	263.3	L0.5	0.4	L0.001	7.6	8.12	28.4
BASIN 1 OUTFALL	23	10	90	30	1697	1850	1.4	4	30	36.1	104	477.4	54.8	L0.2	L0.001	10.7	10.4	6.6
BASIN 1 OUTFALL	16	4	91	60	955	919	9.3	5	80	19.3	34	173.6	20.8	L0.2	***0.002***	119.2	5.2	3.6
BASIN 1 OUTFALL	18	7	91	30	759	791	18.4	20	10	17.9	27.5	91.7	94.7	0.6	***0.007***	1.7	2.6	0.134
BASIN 1 OUTFALL	17	10	91	30	1060	1093	5.3	-3	15	27.5	34	171.6	57.7	0.3	L0.001	11.4	3.76	0.535
BASIN 1 OUTFALL	20	1	92	30	1620	1831	3	8	2	15	61.5	396.2	L0.5	L0.2	L0.001	103.5	12	34.8
BASIN 1 OUTFALL	22	4	92	100	1350	1227	12.8	16	65	20.9	84	275.7	43.7	0.6	L0.001	345.1	3.6	0.013
BASIN 1 OUTFALL	6	7	92	30	1030	895	18.2	17	8.4	17.2	40.8	121.7	90.7	L0.2	L0.001	2.7	5.84	1.99
MEDIAN(90-92)				30	1060	1093	9.3	8	15	19.3	40.8	173.6	54.8	L0.2	L0.001	11.4	5.2	1.99

STATION	DAY	MON.	YR.	BOD 5 DAY MG/L 08202L	COD TOTAL MG/L 08301L	F DISS MG/L 091**L	ALK TOTAL CaCO3 101**L	PPALK MG/L CaCO3 10151L	PH 10301L	PH 10301F	NFR MG/L 10401L	FILT RES MG/L 104**L	NFR FIXED MG/L 10501L	HARDNESS TOTAL CaCO3 10605L	SURFACT-ANTS 10701L	Na DISS MG/L 11103L	Mg DISS MG/L 121**L	SILICA REACT SIO2 141**L
TREATED INFLUENT	24	8	90			0.29	533		7.78		265	1026		312	MG/L	125	31	
TREATED INFLUENT	23	10	90	0.3	49	0.31	275	L0.1	8.08	8.1	17	722	9.4	302.2	0.75	132	30.9	11.2
TREATED INFLUENT	15	1	91	4.5	29	0.27	212	L0.1	7.25	6.8	18.2	623	5.4	316.4	0.57	108	29.8	12.2
TREATED INFLUENT	16	4	91	1.9	25	0.21	156	L0.1	8.04	7.4	14	358	8.6	210.7	1.05	63	19	5.3
TREATED INFLUENT	18	7	91	9.7	120	0.27	216	L0.1	7.58	7.6	26	701	6	322.1	2.3	170	33	13.3
TREATED INFLUENT	17	10	91	7.4	40	0.25	246	L0.1	7.51	7.1	6.8	600	3.6	277.4	0.47	105	27	9.65
TREATED INFLUENT	20	1	92	3.6	40	0.25	205	L0.1	7.75	7.6	17	660	2.4	314.8	1.81	155	28.5	10.9
TREATED INFLUENT	22	4	92	6.8	40	0.21	241	L0.1	7.99	8.1	11	632	3.2	269.7	0.4	133	22.4	10.4
TREATED INFLUENT	6	7	92	40	30	0.21	159	L0.1	7.16	7.6	28	502	22	259.7	0.55	94.3	21.8	10
TREATED INFLUENT	7	10	92	13.4	40	0.23	158	L0.1	6.91	7	2.8	874	0.8	390.3	1.38	184	38.2	13.7
TREATED INFLUENT	14	1	93	3.7	40	0.23	362	L0.1	7.88	7.6	11	1095	1.3	407.4	1.6	228	38.1	12.2
INFLUENT DUPLICATE	14	1	93	3	50	0.23	364	L0.1	7.88		10	1101	L0.4	404.8	1.4	228	38.7	12.75
MEDIAN(90-92), outfall flowing				6.8	40	0.25	216	L0.1	7.75	7.6	17	632	6	277.4	0.75	132	27	10.4
BASIN 1 OUTFALL	23	10	90	11.9	88	0.33	483	45.7	8.64	7.9	48.5	1072	9	456.5	0.4	176	52	16.2
BASIN 1 OUTFALL	16	4	91	21.1	95	0.21	177	17.3	8.81	***9***	59	535	38	247.7	0.6	87	28	11.6
BASIN 1 OUTFALL	18	7	91	2	55	0.2	233	78.9	9.84	***10***	7.6	473	6.8	182.9	0.17	93	20.2	13
BASIN 1 OUTFALL	17	10	91	4.3	80	0.22	237	48.1	9.35	***10.2***	8.8	642	6.8	171.5	0.33	159	21.5	7.25
BASIN 1 OUTFALL	20	1	92	6.2	60	0.28	325	L0.1	8.05	8.5	19	836	5.6	376.5	1.26	174	36.5	14.7
BASIN 1 OUTFALL	22	4	92	42.6	110	0.27	299	36.4	9.07	***9.1***	135	783	72	298.1	0.22	152	34.9	2.39
BASIN 1 OUTFALL	6	7	92	1	10	0.21	251	75.6	9.65	***9.8***	10	599	6.8	221	0.28	129	28.8	1.23
MEDIAN(90-92)				6.2	80	0.22	251	45.7	9.07	9.1	19	642	6.8	247.7	0.33	152	28.8	11.6

Appendix I. Continued.

STATION	DAY	MON.	YR.	NITRITE DISS MG/L 072**L	AMMONIA TOTAL NH3 07505L	N TOTAL CALCD 07602L	OXYGEN METER O2 081**F	Ca DISS MG/L 20103L	COLI TOTAL NO/DL 36002L	COLI FECAL NO/DL 36012L	B DISS MG/L 05107L	Al EXT MG/L 13303L	Al EXTRB MG/L 13311L	Mn EXT MG/L 253**L	Fe EXT MG/L 263**L	Ni EXT MG/L 28302L	Cu EXT MG/L 29305L	Zn EXT MG/L 30305L
TREATED INFLUENT	24	8	90	0.006	MG/L	84.5	MG/L											
TREATED INFLUENT	23	10	90	3.7	21	66.4	10.4	70	L10.	L10.	0.16	L0.01		0.086	0.21	0.002	0.003	0.012
TREATED INFLUENT	15	1	91	0.6	12	42.8	11.7	77.5	L10.	L10.	0.15	L.01		0.067	0.17	0.003	0.006	0.026
TREATED INFLUENT	16	4	91	0.05	4	23.8	13.8	53	L10.	L10.	0.05	0.04		0.034	0.21	0.002	0.002	0.026
TREATED INFLUENT	18	7	91	0.4	17.8	81.9	7.3	74.5	200	L10.	0.14	0.07		0.098	0.27	0.002	0.005	0.108
TREATED INFLUENT	17	10	91	2.9	5.04	9.5	4.5	66.5	L10.	L10.	0.07	L0.01		0.06	0.22	L0.001	L0.001	0.006
TREATED INFLUENT	20	1	92	0.059	7.01	54	10.8	79	L2.	L1.	0.1	0.05		0.093	0.25	0.002	0.005	0.09
TREATED INFLUENT	22	4	92	14	6.7	29.52	9.6	71	4	L1.	0.09	L0.01		0.04	0.1	0.002	0.003	0.015
TREATED INFLUENT	6	7	92	10.2	5.36	39.14	3.5	68	500	2	0.08		0.22	0.061	0.5	0.004	0.004	0.015
TREATED INFLUENT	7	10	92	13	9.67	87.3	3.5	95		L1.0	0.1		L0.01	0.64	0.09	L0.001	0.003	0.022
TREATED INFLUENT	14	1	93	18.5	39	100.5	10.9	102	182	L2.	0.13		0.01	0.13	0.14	L0.001	0.004	0.022
INFLUENT DUPLICATE	14	1	93	19	36.8	96		100			0.13		L0.01	0.13	0.14	L0.001	0.003	0.052
MEDIAN(90-92), outfall flowing				2.9	6.7	39.14	9.6	70	L10.	L10.	0.09	0	0	0.061	0.22	0.002	0.003	0.015
BASIN 1 OUTFALL	23	10	90	***1.4***	***5***	17	9.9	97	36	30	0.08	***0.3***		0.19	***0.75***	0.003	0.003	0.004
BASIN 1 OUTFALL	16	4	91	***0.48***	***0.35***	8.8	15.9	53	10	L10.	0.08	L0.01		0.94	***0.41***	0.005	0.004	0.007
BASIN 1 OUTFALL	18	7	91	0.03	***0.17***	2.734	10.4	39.9	100	77	0.06	0.07		0.02	0.16	0.004	0.003	L0.001
BASIN 1 OUTFALL	17	10	91	***0.068***	***0.27***	4.295	11.3	33.2	26	L4.	0.04	0.07		0.044	0.07	0.003	0.003	0.006
BASIN 1 OUTFALL	20	1	92	***0.4***	***6.97***	46.8	7.1	90.5	200	2	0.1	0.08		0.085	0.18	0.003	***0.006***	***0.079***
BASIN 1 OUTFALL	22	4	92	L0.003	L0.01	3.613	7.2	61.8	10	L1.	0.05	***0.31***		0.25	***0.45***	0.005	0.003	0.007
BASIN 1 OUTFALL	6	7	92	***0.47***	0.1	7.83	7.6	41	34	28	0.06		0.1	0.016	0.15	0.006	0.004	0.006
MEDIAN(90-92)				0.4	0.27	7.83	9.9	53	34	2	0.06	0.075	0.1	0.085	0.18	0.004	0.003	0.006

STATION	DAY	MON.	YR.	P DISS MG/L 151**L	P TOTAL MG/L 15406L	SULPHIDE DISS MG/L 16101L	SULPHIDE DISS MG/L 16200L	SO4 DISS MG/L 16306L	Cl DISS MG/L 17206L	SODIUM ABSORP-TION RATIO	As DISS MG/L 331**L	Se TOTAL MG/L 34011L	Mo TOTAL MG/L 42009L	Ba EXTRB MG/L 56311L	Hg TOTAL UG/L 80011L	Pb EXT MG/L 82302L	CHLORINE FREE MG/L 17102F	CHLORINE TOTAL MG/L 17103F
TREATED INFLUENT	24	8	90					127	106.5	4.81		0.0001	0.002			0.004	Hach kit	Hach kit
TREATED INFLUENT	23	10	90	7.1	7.2		L0.1	162	124	3.31	0.0014				L0.05	L0.002	0.4	3.4
TREATED INFLUENT	15	1	91	5.5	7.5		L.02	149	101	2.64	0.0006				0.13	0.004	0.1	1
TREATED INFLUENT	16	4	91	2.74	2.98		L0.02	75	42.2	1.89	0.0004				L0.05	L0.002	0.2	0.8
TREATED INFLUENT	18	7	91	10.7	11.4		L0.02	142	112	4.12	0.001				L0.05	0.004	0.1	0.5
TREATED INFLUENT	17	10	91	3.05	3.4		L0.02	136	99	2.74	0.0012				L0.05	L0.002	0.2	0.2
TREATED INFLUENT	20	1	92	7.58	8.3		L0.02	123	124	3.80	0.0005				0.38	L0.002	0.1	0.6
TREATED INFLUENT	22	4	92	7.85	8.15		L0.02	90.6	144	3.53	0.0003				L0.05	L0.002	0.1	0.4
TREATED INFLUENT	6	7	92	4	4.2	0.12		95.8	80.8	2.55	0.0006			0.1	0.14	0.003	0.06	0.06
TREATED INFLUENT	7	10	92	11.4	12.4	L0.01		184	176	4.03	0.0005			0.1	L0.05	L0.002	0.1	0.4
TREATED INFLUENT	14	1	93	9.4	9.8	L0.01		182	243	4.89	0.0003			0.1	L0.05	L0.002	0.03	0.18
INFLUENT DUPLICATE	14	1	93	9.6	9.8	L0.01		188	244	4.91	0.0004			0.1	L0.05	L0.002		
MEDIAN(90-92), outfall flowing				7.1	7.2	0	L.02	123	112	3.31	0.0006			0	L0.05	L0.002	0.1	0.5
BASIN 1 OUTFALL	23	10	90	2.05	2.4		L0.1	244	159	3.59	0.018				L0.05	L0.002	0.2	***0.2***
BASIN 1 OUTFALL	16	4	91	1.21	1.66		L0.02	175	55.8	2.41	0.014				L0.05	L0.002	0.1	***0.1***
BASIN 1 OUTFALL	18	7	91	0.467	0.537		L0.02	104	55.5	2.99	0.015				L0.05	L0.002	0.1	***0.2***
BASIN 1 OUTFALL	17	10	91	0.7	0.8		L0.02	149	112	5.28	0.011				L0.05	L0.002	0.1	***0.1***
BASIN 1 OUTFALL	20	1	92	6.95	7.4		L0.02	166	141	3.90	0.0055				***0.17***	L0.002	L0.1	***0.1***
BASIN 1 OUTFALL	22	4	92	0.58	1.56		L0.02	197	122	3.83	0.013				L0.05	L0.002	0.09	***0.2***
BASIN 1 OUTFALL	6	7	92	0.5	0.52	L0.01		122	100	3.78	0.0077			0.03	***0.13***	L0.002	0	***0.02***
MEDIAN(90-92)				0.7	1.56	0	L0.02	166	112	3.78	0.013			0.03	L0.05	L0.002	0.1	0.1

Appendix II. Extractable and volatile priority pollutants at trace levels (in some cases with trace levels estimated) or over the method detection limit (all compounds reported as µg/L). All organic analyses were done at the Alberta Environmental Centre.

STATION	DAY	MON	YR	TOLUENE 95226L	CHLOROFORM 95208L	BUTYLBENZYL-PHTHALATE 95050L	DIETHYL-PHTHALATE 95052L
TREATED INFLUENT	1	11	90			L1.	L1.
TREATED INFLUENT	15	1	91	L1.	TRACE	TRACE	L1.
TREATED INFLUENT	16	4	91	L1.	L1.	L10.	L10.
TREATED INFLUENT	18	7	91	L1.	L1.	L10.	L10.
TREATED INFLUENT	20	1	92	L1.	TRACE	L10.	L10.
TREATED INFLUENT	22	4	92			L10.	L10.
TREATED INFLUENT	6	7	92	L1.	L1.	L1.	L1.
TREATED INFLUENT	7	10	92	L1.	2	L10.	L10.
TREATED INFLUENT	14	1	93	L1.	1	L10.	1
BASIN 1 OUTFALL	1	11	90			L1.	L1.
BASIN 1 OUTFALL	16	4	91	L1.	L1.	L10.	L10.
BASIN 1 OUTFALL	18	7	91	L1.	L1.	L1.	L1.
BASIN 1 OUTFALL	20	1	92	L1.	1	L10.	L10.
BASIN 1 OUTFALL	22	4	92			L10.	L10.
BASIN 1 OUTFALL	6	7	92	TRACE	L1.	L1.	L1.

STATION	DAY	MON	YR	CARBON TETRA-CHLORIDE 95204L	O-XYLENE 95233L	M,P-XYLENE 95234L	ETHYL-BENZENE 95221L	HEXADEC-ANOIC ACID 95007L
TREATED INFLUENT	1	11	90					1
TREATED INFLUENT	15	1	91	L1.	L1.	L1.	L1.	
TREATED INFLUENT	16	4	91	L1.	L1.	L1.	L1.	L30.
TREATED INFLUENT	18	7	91	L1.	TRACE	TRACE	TRACE	L30.
TREATED INFLUENT	20	1	92	L1.	L1.	L1.	L1.	10
TREATED INFLUENT	22	4	92					9
TREATED INFLUENT	6	7	92	L1.	L1.	L1.	L1.	L3.
TREATED INFLUENT	7	10	92	L1.	L1.	L1.	L1.	L30.
TREATED INFLUENT	14	1	93	L1.	L1.	L1.	L1.	L30.
BASIN 1 OUTFALL	1	11	90					L3.
BASIN 1 OUTFALL	16	4	91	1	L1.	L1.	L1.	L30.
BASIN 1 OUTFALL	18	7	91	L1.	TRACE	L1.	L1.	L3.
BASIN 1 OUTFALL	20	1	92	L1.	L1.	L1.	L1.	12
BASIN 1 OUTFALL	22	4	92					5
BASIN 1 OUTFALL	6	7	92	L1.	L1.	L1.	L1.	L3.

STATION	DAY	MON	YR	CAFFEINE	SULPHUR (S8)	ALIPHATIC ALCOHOLS	STEARIC ACID	OLEIC ACID
TREATED INFLUENT	1	11	90				1	
	15	1	91	5			5	10
	20	1	92	10				
	14	1	93	7	5			
BASIN 1 OUTFALL	22	4	92			80		