PRINCE RUPERT LANDFILL LEACHATE: IMPACT ON HAYS CREEK

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Introduction

Leachate from the landfill site at Prince Rupert has been identified as a serious pollutant in Hays Creek. This problem was documented by Ableson (1976) and has existed to the present date. This report is to document the more recent leachate and creek water chemistry findings and remove all doubt that the creek is adversely affected. A summary of this type is required to help properly focus the efforts of the permittee to improve the landfill site. In addition, recommendations for future monitoring are derived from data reviews of this type.

Background

File letters from the Federal Department of Fisheries and Oceans and from the Provincial Fish and Wildlife Branch suggest Hays Creek once supported runs of cutthroat and steelhead trout as well as chum, pinks and coho salmon. Both species and numbers have declined so that now only a small number of pairs of coho spawn in the creek. Leachate from the dump has been identified as a leading cause of this decline.

Sampling sites were established in 1975 to collect samples upstream and downstream from the leachate sources in order to assess the magnitude of the problem. The sites are shown in Figure 1. Analysis of water in the creek downstream from the dump show significant elevations in certain priority contaminants when compared to water upstream (control samples). Analyses of the actual leachate show very high concentrations of priority contaminants compared to control samples. The conclusion has been therefore that the creek is polluted. This has led to negotiations between the Waste Management Branch and the City of Prince Rupert to agree on a strategy for

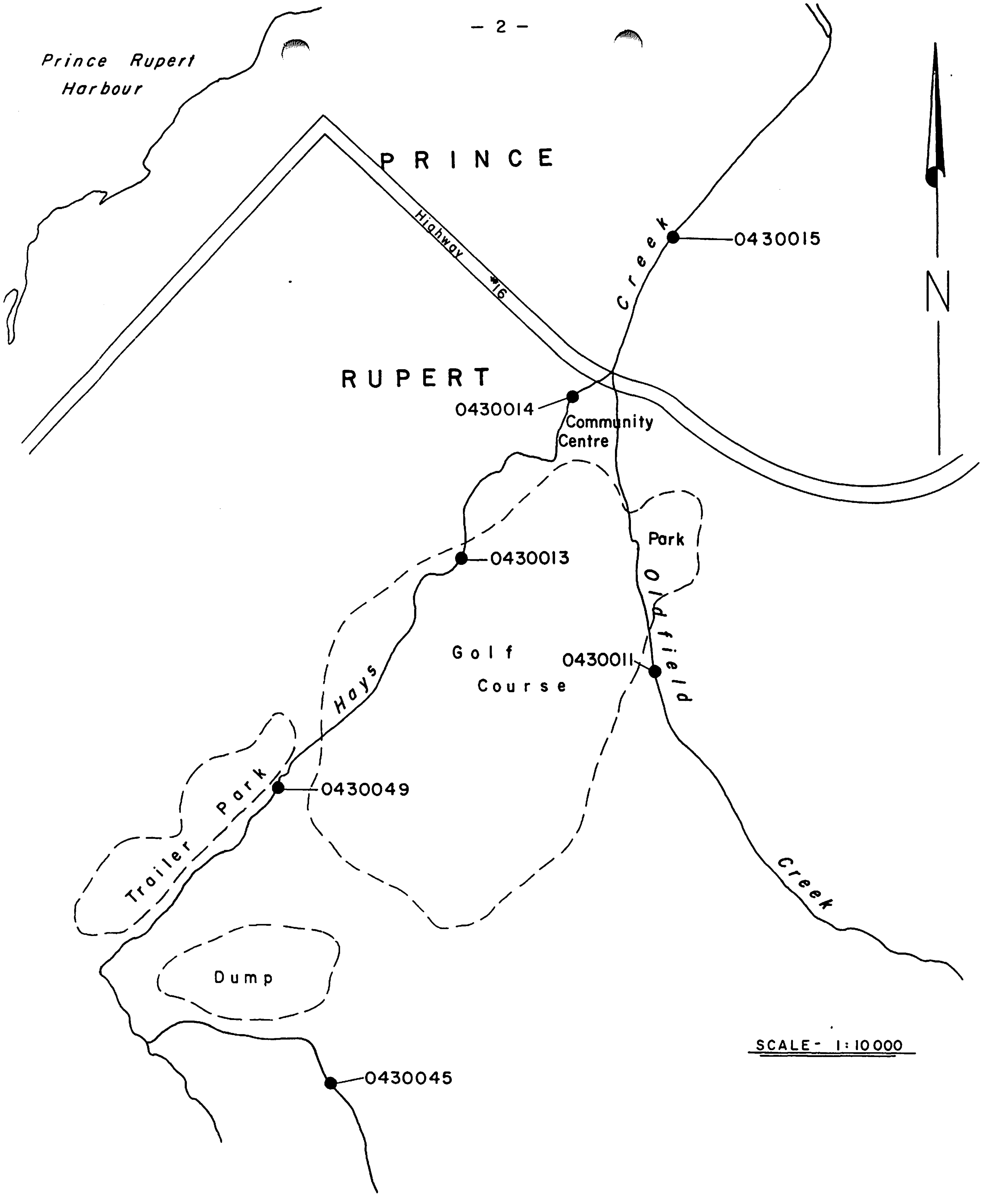

Fig. I. Sampling site locations on Hays Creek solving the leachate pollution problem. It was identified that no recent compilation or interpretation of field data was available to help focus the discussion. This report, therefore, is aimed at filling the gap.

In the next sections, the specific priority contaminants of concern in the creek are discussed and compared to published criteria for protecting aquatic life. Drinking water quality is not at issue here as there are no domestic licences on the creek. Next, the levels of these contaminants in control samples are shown, and finally the downstream water quality is illustrated.

Priority Contaminants

Leachate from municipal landfill sites contains certain chemical characteristics such as high suspended solids, large amounts of ammonia, dissolved substances which create a high conductance and dark colour, as well as reactive organic or chemical substances which consume dissolved oxygen in receiving waters. Of these, some are poisonous to aquatic life at very low concentrations. Others, such as chloride, sulphate, sodium and potassium are much less toxic although their presence serves as a good indicator that a leachate problem is present. Indeed, these are variables which can be used to confirm that a substance is municipal landfill leachate (Murray, et al 1981).

The variables of interest here are those which are known to have detrimental effects on aquatic life at low concentrations. They are ammonia, nitrate, iron, chemical oxygen demand, phosphorus and suspended solids. While not overtly detrimental, colour and conductance will also be discussed as these indicate the presence of dissolved organic and inorganic substances in the water.

Water Quality Criteria

Published criteria for the priority contaminants, if any, are listed below (Table 1). These are generally acknowledged concentrations in water below which aquatic life is protected.

TABLE 1 Criteria for selected variables

Variables	Criterion	Reference
Ammonia (unionized)	.02 mg/L	USEPA 1976
COD*		
Colour	negligible increase	WMB 1977
Conductance	no criterion	
Iron (Total)	1.0 mg/L	USEPA 1976
Nitrate	.3 mg/L**	Min. Env. 1982
Phosphorus	no increase**	Min. Env. 1982
Suspended Solids	increase < 10 over background	Singleton 1983

* No applicable criterion. A maximum dissolved oxygen decrease of 10% in receiving waters is specified by the Waste Management Branch.

** Any increase in N or P can cause algae problems in streams. Waste Management Branch (1979) guideline is no increase in algal growth downstream.

Control Sites

Bearing these numbers in mind, water quality data is summarized below for the two upstream or control sample points, site 0430045 and site 0430011 (Table 2).

TABLE 2 Water Quality at Control Sites

Sample date Jan. 18/84	H_2O Criteria	0430045 Upper Hays Ck.	0430011 Upper Oldfield Cr.
Ammonia mg/L	.02 mg/l	.009	not sampled
COD mg/L		<10.0	
colour TAC		8.0	
Conductance umho/cm		53.0	
Iron (total) mg/L	1.0 mg/l	.03	
Nitrate mg/L	0.3 mg/l	not sampled	
Phosphorus mg/L		.027	
Suspended Solids mg/L		6.0	

Data summarized 1975-1984 (average value + S.D.)

	0430045	0430011
Ammonia mg/L	.007 ± .001	.02 ± .02
COD mg/L	11.9 ± 2.3	14.2 ± 2.1
Colour TAC	18 ± 9	30 ± 18
Conductance umho/cm	48 ± 7	57 ± 12
Iron total mg/L	.22 ± .2	.61 ± 48
Nitrate mg/L	.056 ± .04	.032 ± .008
Phosphorus mg/L	.004	.019 ± .009
Suspended Solids mg/L	1.5 ± .3	7.7 ± 5.7

From Table 2, it is evident that both stations show water quality which is below criteria, and which serves as an adequate baseline.

Leachate Quality

Now it is necessary to compare these data with the actual characteristics of the leachate. Only one recent analysis of the leachate is available, it was not sampled at all by WMB until January, 1984. The chemical characteristics of the leachate are as follows (Table 3):

TABLE 3 Chemical Characteristics of Prince Rupert Landfill Leachate 18 January, 1984

	Leachate	Upstream Avg. (2 control sites)
Ammonia (Total) mg/L	47.2	.013
COD mg/L	244	13.05
Colour TAC	46	24
Conductance umho/cm	1690	52.5
Iron (Total) mg/L	102	0.41
Nitrate mg/L	not measured	0.044
Phosphorus mg/L	.199	.011
Suspended Solids mg/L	368	4.45

Table 3 clearly shows that the leachate itself contains quantities of ammonia lethal to fish, COD shows an 18 fold increase, colour is twice as dark, iron is 248 times higher in the leachate. The discharge of this material to a small water course like Hays Creek would constitute a serious hazard to aquatic life.

Downstream Impact

As a drinking water source, Hays Creek is not acceptable below the landfill site. Bacteriological counts show elevations of faecal coliforms downstream when compared to control sites. Table 4 summarizes these data. Refer to Fig. 1 for site locations.

TABLE 4 Faecal Coliform in Hays Creek (MPN/100 ml)

	Control 0430045	Trlr Park 0430049	Golf Course 0430013	Comcenter 0430014	Park N & H 16 0430015
Sampling Period	1978-84	1978-81	1975-84	1975-78	1975-78
No. of Samples	6	3	11	6	6
Average	10	253	107	116	91
Maximum Value	33	540	350	350	170
Minimum Value	<.2	110	5	8	8

The creek is not used as a source of drinking water but it is used to a limited extent for recreation. The recommended maximum for water contact recreation is 200 MPN/100 ml. Faecal coliform levels in the creek are high enough that residents at Comox Trailer Park should keep their children from playing in the water.

As the leachate mixes with the creek it becomes more dilute. Depending on the ratio of one to the other, it is possible to have widely varying concentrations in creek water downstream. As a general rule, it would be expected that dilution increases with distance from the source. Ths trend is apparent with the coliform data, and in the tables which follow.

Tables 5 to 12, showing downstream concentrations are found in Appendix 1. The data are arranged by site in a downstream progression, with the upstream control site appearing first. The first row in each table shows the period of years for which there are records. The second shows how many samples have been taken over that period. The average values obtained followed by the maximum and minimum are shown next. Averages are used in the following discussion.

Discussion

Ammonia increases in concentration by 257 times (1.8 ÷ .007) at the Comox Trailer Park site. Below the highway the concentration has diluted to 95 times the control concentration. Note that data overlaps only for 1978 and 1979. Except for site 0430013, we do not have a continuous record at all sites. There do not appear to be other sources of ammonia to the creek below the dump.

Chemical oxygen demand takes a significant jump below the dump and remains high downstream. The one sample at 0430049 is not representative. With COD so high it would be expected that dissolved oxygen would be consumed and be held at depressed levels in the creek. The data shows this does happen. On July 2, 1975 COD at the civic centre (0430014) was 82 mg/L with a corresponding dissolved oxygen at 2.4 mg/L. On the same day, the site below the highway (0430015) showed a COD of 63 and a DO of 5 mg/L. Unfortunately there are no corresponding values for the control site on this date.

Colour increases below the dump site but also below site 0430049. It is possible that a coloured leachate is entering at other locations. The small sample size at the trailer park may be biasing the averages downward. The pure leachate was 46 on 18 January/84. More sampling is necessary for this variable.

Conductance at site 0430013 was about 10% of the conductance of the leachate on the same date, 18 Jan/84. This suggests a dilution factor of about 10 to 1 at the time of sampling. More direct measures of the leachate itself are required to gain a general sense of dilution in the creek. Conductance downstream averages 3-4 times the upstream concentration.

Total iron levels in Hays Creek downstream are six times higher than the published Criterion to protect aquatic life. Concentrations at the control site are less than the published criterion.

Nitrate and phosphorus will be considered together. Nitrate appears to be relatively unaffected in Hays Creek. Phosphorus however is sharply elevated below the dumpsite. Where phosphorus increases in the presence of nitrogen, large algal masses can form on rocks in the stream. These tend to reduce the habitat suitable for fish and important insect larvae. No observations are available on whether this effect takes place.

Suspended solids obviously enter the creek via the leachate. Here again it is apparent that more sediment reaches the stream between sites 0430013 and 0430014. This sediment source should be investigated.

The basic findings are that the leachate causes increases in concentration in Hays Creek of ammonia, COD, colour, conductance, Iron, phosphorus and suspended solids.

Published criteria to protect aquatic life are exceeded downstream, with some qualifiers. For example, the effect of COD in depressing dissolved oxygen is indicated but not proved; conductance has no criterion; and there is no criterion for nutrient increases, only the guideline in the Pollution Control Objectives of this Ministry (1979).

The City of Prince Rupert had a permit to dump refuse at the site under specified conditions. The permit expired in 1983. The permit did not consent to the release of leachate into nearby surface waters. In fact the permit specified that surface water diversionary works, as required, would be provided. Based on the data included here, such diversions are necessary to protect water quality in Hays Creek.

Ambient Objectives & Monitoring

In addition to the ambient objectives found in the Pollution Control Objectives, 1979, it is necessary to set specific water quality objectives for selected variables and then ensure compliance with a monitoring program. To date, monitoring Hays Creek has been carried out by WMB on a spotty basis; the useful control site has not been sampled for as long a period as the impact sites; the sampling frequency is too low, and the timing of sampling needs to be considered. In addition, responsibility for monitoring the creek needs to be turned over to the permittee.

To arrive at ambient water quality objectives for Hays Creek it is necessary to examine background levels of the priority contaminants, and compare these with published criteria for protecting specified water uses. Fish and aquatic life are the obvious priority uses of Hays Creek, since creek water is not used for domestic purposes. The criteria to use will be those which protect aquatic life. Since published criteria are few for the priority contaminants in dump leachate, and since the baseline data set for Hays Creek is weak, it is proposed that only interim objectives can be set. With a more complete record of water and leachate quality, flows and dilutions, permanent objectives for Hays Creek can be promulgated.

A specific monitoring program is subject to discussion with the permittee before it is finalized. Interim water quality objectives are still being discussed within the Waste Management Branch. Therefore it is premature to include these proposals in the present report.

LITERATURE CITED

Ableson, D. 1976 Death of a Watershed: The Physical and Chemical Limnology of Hays Creek. Pollution Control Branch, Prince George

B.C. Ministry of Environment 1982 Preliminary Working Criteria for Water Quality. Draft

Murray, J.P., Rouse, J.V., and Carpenter, A.B., 1981 Groundwater Contamination by Sanitary Landfill Leachate and Domestic Wastewater in Carbonate Terrain. Water Res. 15:745-575

Singleton, H.J. 1983 Water Quality Criteria for Particulate Matter, Water Management Branch, Victoria. Draft

U.S. Environmental Protection Agency 1976 Quality Criteria for Water. Washington EPA-440/9-76-023

Waste Management Branch, Ministry of Environment 1977 Pollution Control Objectives for the Forest Industry. Victoria, Queen's Printer

Waste Management Branch, Ministry of Environment 1979 Pollution Control Objectives for Municipal Type Waste Discharges. Victoria, Queen's Printer

APPENDIX 1

TABLE 5 Ammonia in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	75-84	75-79	75-79
No. of samples	7	3	12	9	10
Average value	.007	1.8	1.1	.99	.67
Maximum value	.013	1.86	1.9	1.86	1.14
Minimum value	L.005	1.72	.4	.4	.35

TABLE 6 Chemical Oxygen Demand in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	1979	75-84	75-79	75-79
No. of samples	5	1	9	8	8
Average value	11.9	16.1	37.7	36.4	38.9
Maximum value	15.7		84.8	83	67.2
Minimum value	L10		16	L10	L10

TABLE 7 Colour in Hays Creek (T.A.C.)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	78-84	75-79	75-79
No. of samples	7	3	10	8	9
Average value	18	31	70	66	60
Maximum value	31	38	80	78	72
Minimum value	3	18	50	44	41

TABLE 8 Specific Conductance in Hays Creek (umho/cm)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	not sampled	75-84	75-79	75-79
No. of samples	7		18	15	15
Average value	48		161	161	149
Maximum value	58		257	261	212
Minimum value	39		56	96	87

TABLE 9 Total Iron in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	75-84	75-79	75-79
No. of samples	7	3	14	11	11
Average value	.22	6.8	6.3	6.6	5.7
Maximum value	.8	17.5	12.9	14.1	12.8
Minimum value	.03	1.2	3.4	3.1	2.3

TABLE 10 Nitrate in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	78-84	75-79	75-78
No. of samples	5	2	8	7	8
Average value	.056	.05	.08	.07	.088
Maximum value	.13	.06	.13	.11	.14
Minimum value	.02	.04	.05	.04	

TABLE 11 Phosphorus in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	78-84	75-79	75-79
No. of samples	6	2	17	15	19
Average value	.004	.025	.087	.1	.067
Maximum value	.005	.027	.229	.25	.19
Minimum value	.003	.024	.03	.03	.022

TABLE 12 Suspended Solids in Hays Creek (mg/L)

	Control Site 0430045	0430049	0430013	0430014	0430015
Sampling period	78-84	78-81	78-84	75-79	75-79
No. of samples	6	2	15	14	14
Average value	1.5	7	26.5	30	24
Maximum value	2		48	113	51
Minimum value	L1		6	6	3