

The Regional Municipality of Halton Burlington Landfill Site Application for Continued Use

VOLUME 3 of VOLUME 3

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Consulting Engineers & Planners

OUR FILE: 9319-02

YOUR FILE:

30 March 1984

M.M. Dillon Limited
47 Sheppard Avenue East
WILLOWDALE, Ontario
M2N 5X5

Attention: Mr. W.F. Wells, P.Eng.
Project Manager

Burlington Landfill Continued Use -
Application for a Certificate of
Approval

Dear Sirs:

We are pleased to present the report on Leachate Treatment contained as Appendix 'P' of the Technical Report filed in support of an Application for a Certificate of Approval for the continued use of the Burlington Landfill Site.

The writer will appear as a witness at the hearing before the Environmental Assessment Board on the basis of this report.

Yours truly,

M.M. DILLON LIMITED

T. A. Constantine

TAC:llly
Encl:

T.A. Constantine, P.Eng.
Chief Environmental Engineer

SECTION P
LEACHATE TREATMENT

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SECTION P LEACHATE TREATMENT

1. LEACHATE FLOWS

A review of the weekly flow charts for the period between 28 January 1983 to 27 May 1983 shows that daily leachate flows range from 2.27 to 12.1 L/s. Weekly averages over this same period ranged from 4.54 to 6.81 L/s as shown in Table 1. An overall average of 6.05 L/s can be taken as a valid representation of average daily flows from the presently drained landfill areas. This value is somewhat higher than that presented in the Gartner Lee report. Both Gartner Lee's report and Dillon's previous letter reports of 1983, however, cover a period up to February 1983 whereas the flow data analysis under this report covers the period from January to May 1983. During this latter period an additional segment of the leachate system became operational. The higher flow rate results from this.

In order to present a conservative future scenario, a further leachate flow rate of 7.1 L/min/ha over 10 ha of landfill area was allowed in addition to the present average flow of 6.05 L/s. This additional flow assumes Phases B, D and most of C are without final cover. Also, present trends towards increased precipitation rates have been accepted (see Section O - Hydrogeological Study). Once final cover is applied to these areas, infiltration or leachate generation rates will be substantially reduced.

This additional leachate flow results in a maximum (short term) average daily flow of 7.3 L/s. Hydraulically, this

22 but Feb. 25
indicates 1.5 l/sec.

any data
since May
83 22

Flow rate
contributed
by each
phase?
- to collection
system

- 7.3 l/sec with phases B, C & D in place
- with phase A in place, what would be flow rate be?
- how do you calculate this?

is this correct?
(with B, C & D in place)
part of C?

if same, then you are saying that leachate resulting from phase A will not be

TABLE 1
LEACHATE FLOW DATA

<u>Week of</u>	<u>Flow Range</u>		<u>Average Flow</u>
	<u>L/s</u>	<u>(igpm)</u>	<u>L/s (igpm)</u>
83-05-27	3.8 to 7.6	(50 to 100)	4.9 (65)
20	3.0 to 8.3	(40 to 110)	4.5 (60)
13	3.8 to 9.1	(50 to 120)	6.1 (80)
06	3.8 to 9.1	(50 to 120)	6.1 (80)
83-04-22	2.3 to 8.3	(30 to 110)	4.5 (60)
15	2.3 to 8.3	(30 to 110)	5.3 (70)
07	2.3 to 7.6	(30 to 100)	5.3 (70)
83-03-31	2.3 to 7.6	(30 to 100)	4.5 (60)
25	2.3 to 9.8	(30 to 130)	6.1 (80)
11	2.3 to 7.6	(30 to 100)	5.3 (70)
04	3.0 to 8.3	(40 to 110)	6.1 (80)
83-02-25	2.3 to 7.6	(30 to 100)	5.3 (70)
18	2.3 to 8.3	(30 to 110)	5.7 (75)
11	2.3 to 8.3	(30 to 110)	6.1 (80)
04	3.8 to 7.6	(50 to 100)	6.8 (90)
83-01-28	2.3 to 12.1	(30 to 160)	6.1 (80)

represents a dry weather flow (dwf) population equivalent of approximately 1,440 (hydraulic population equivalent based on a flow of 430 L/c/d). [This flow would have no measurable hydraulic effect on the present overall influent flow rates of approximately 1,021 L/s at the Burlington Skyway WPCP.]

2. LEACHATE CHARACTERISTICS

A review of five leachate samples collected during December 1983 and January 1984 as presented in Table 2, shows that with the exception of phenols and BOD₅, leachate effluent quality is well within the normally accepted sewage criteria. Furthermore a check of chlorinated organics shows the concentration to be well below any level of concern, and there was no trace whatsoever of pesticides.

Because of the higher than normal BOD₅ levels, the leachate flow rates will cause an increase in BOD₅ levels in the raw sewage of anywhere from 1 to 5 mg/L. Analysis of the operating data from January 1980 to December 1983 shows that the marginally increased organic load did not negatively affect plant operation. [The effluent quality throughout this period has remained relatively stable at approximately 10 mg/L.]

Regarding phenols which are noted to exceed the normally acceptable sewage limits of 100 mg/L, this compound can be generally oxidized without undue problems. With a flow dilution factor of approximately 170 to 1, phenol concentrations

TABLE 2

BURLINGTON LANDFILL - LEACHATE METALS ANALYSIS
(mg/L)

PQ-9 - Supp Samples Nov. 27/83

	<u>Zn</u>	<u>Cu</u>	<u>Ni</u>	<u>Pb</u>	<u>Cd</u>	<u>Cr</u>	<u>Mo</u>	<u>Co</u>	<u>Se</u>	<u>As</u>	<u>Hg</u>	<u>Fe</u>	<u>BOD₅</u>	<u>SS</u>	<u>P</u>	<u>pH</u>	<u>Phenol*</u>
Jan 9 1984	1.1	0.009	0.081	.060	.01	.075	-	-	.001	.001	.00029	33,000	594		2.0	7.05	680
Jan 5 1984	-	<.3	<.6	<1	<.1	<.6	-	<.5	-	-	-	83.3	370	218	0.2	6.8	-
Dec 22 1983	1.0	<.3	<.6	<1	<.1	.8	-	<.5	-	-	-	90	1 365	348	1.7	7.1	-
Dec 13 1983	0.5	<.3	<.6	<1	<.1	<.6	-	<.5	-	-	-	60.7	1 120	142	6.9	6.7	-
Dec 9 1983	0.6	<.3	<.6	<1	<.1	.7	-	<.5	-	-	-	7.3	1 150	244	1.8	6.7	-
Normal Sewerage Acceptable Levels	5	3	5	3	3	3	5	5	5	2	0.5	17	300	350		5.5-9.0	100

whose criteria

< Means less than.

* Phenols measured in ug/L.

in raw sewage will be increased by approximately 4.8 ug/L. Normal effluent quality criteria allows for maximum phenol concentrations of up to 20 ug/L. Therefore, unless there is a high phenol concentration in raw sewage prior to adding landfill leachate, dilution coupled with partial oxidation will provide an acceptable effluent quality - well within the allowable limits.

As noted, heavy metals concentration is well within the basic criteria for acceptance into the sanitary sewer system. These metals do, however, end up in the sludge which is presently disposed of by land spreading. This aspect will be further discussed in a later section. At this point it will suffice to say that heavy metal concentrations in the digested sludge are well within the "Guidelines for Sewage Sludge Utilization on Agricultural Lands" established by the Ontario Ministry of Agriculture and Food and the Ministry of the Environment.

3. RAW SEWAGE QUALITY

A review of the operating data between January 1980 to December 1983 (inclusive) shows that while seasonal fluctuations do occur in BOD₅ and Suspended Solids (SS) levels, the increase attributable to the addition of landfill leachate is minimal.

Because of the phasing by which leachate has been introduced into the sanitary collection system, in four stages between 1980 to 1983, it was possible to look at the raw sewage characteristics following each stage. The overall results

show that while BOD₅ values do increase for a short period following each staged connection of the leachate system into the sanitary collection system, the BOD₅ concentration subsequently stabilizes to within the normal range between 180 to 230 mg/L with no apparent upset to plant operation. Regarding Suspended Solids, the raw sewage concentration over this same four-year period does not show any abnormally high trends. Barring seasonal fluctuations, SS levels in raw sewage influent have remained considerably stable except for a short period around November of 1983. While this incident appears to have occurred simultaneously with the connection of the fourth leachate drain system, no similar fluctuations were noted during the previous three stages. Furthermore, leachate SS levels measured in the range of up to 350 mg/L, are estimated to contribute not more than 1 to 2 mg/L to the overall raw sewage influent. Consequently, the cause of higher SS levels during the latter part of 1983 in the raw sewage influent must be attributed to other factors.

4. EFFLUENT QUALITY

The effluent quality at the Burlington Skyway STP has remained considerably stable over the past four years and well within the normally established effluent guidelines. There have not been any abnormal concentrations of BOD₅, SS or pH during this period. Consequently plant operation has not been affected by the minute traces of chlorinated organics, high phenol concentrations or any other noted parameter contributed by the leachate from the Burlington Landfill. (It is expected that, even with the additional leachate flow from the continued use areas, the effluent quality will not be adversely affected.)

what
chlorinated
organics?

The plant has experienced an increase in the volume of air required to treat a given volume of waste water immediately following each new leachate drain connection stage. This increase can readily be explained by the need to oxidize the additional organic load contributed by the leachate. The volume of air required has, however, been generally decreasing over the past four years indicating tighter process control on the part of the operating staff while producing an excellent effluent.

5. DIGESTED SLUDGE QUALITY

In order to permit the application of sludge on agricultural lands, the sludge must meet specific criteria in terms of heavy metals concentration relative to the minimum ammonium plus nitrate nitrogen to metal ratios. These ratios established for 11 metals and listed under "Guidelines for Sewage Sludge Utilization on Agricultural Lands" are outlined under Tables 3 and 4 along with actual ratios calculated using digested sludge from the Skyway STP for 1982 and 1983.

As noted on Tables 3 and 4, only cadmium appears to exceed the maximum allowable ammonia to metal ratio for the application of sludge on agricultural land. It appears that the cadmium level is approximately two times greater than that allowed. Of this total cadmium concentration, mass balance calculations, the results of which are shown for all heavy

TABLE 3

METAL TO AMMONIUM + NITRATE NITROGEN RATIOS IN DIGESTED SLUDGE
(1982)

Metal	Maximum Allowable Ratio	Actual Ratios* (Ammonia/metal)											
		MONTH											
		J	F	M	A	M	J	J	A	S	O	N	D
Zinc	4	7.3	4.1	-	10.4	6.1	6.2	6.1	9.1	4.7	5.5	6.4	6.9
Copper	10	20	13	-	22.3	14.9	15.4	13.5	25	15	19.4	21.7	24.7
Nickel	40	1,508	995	-	91.7	654	1,140	885	1,077	560	760	927	1,069
Lead	15	73	44	-	63.5	44.7	51.4	42.5	81.4	42	61.8	63.6	53.4
Cadmium**	500	270	146	-	850	250	260	212	280	171	267	297	209
Chromium	6	79	44	-	17.6	53.1	51.4	47.2	72.2	35	45	56	74
Molybdenum	180	2,111	1,219	-	1,755	1,420	1,590	1,417	1,750	1,292	1,796	1,483	1,374
Cobalt	50	4,750	2,438	-	688	3,400	4,625	2,125	2,800	1,680	1,317	2,543	2,138
Selenium	500	3,167	975,000	-	13,750	28,300	4,625	4,474	1,795	3,231	6,175	6,846	10,688
Arsenic	100	633	315	-	2,120	401	514	607	824	350	494	556	687
Mercury	1,500	7,308	4,875	-	3,930	4,720	3,824	3,864	4,118	3,360	5,200	4,944	4,183

*Unacceptable ratios occur when ratio is shown as a number smaller than the maximum allowable ratio. Higher ratios indicate that metal content is lower than what is allowed.

**Cadmium concentrations exceeded the allowable level for sludge disposal on agricultural land. Source appears to be area metal plating industry.

TABLE 4

METAL TO AMMONIUM + NITRATE NITROGEN RATIOS IN DIGESTED SLUDGE
(1983)

Metal	Maximum Allowable Ratio	Actual Ratios* (Ammonia/metal)									
		MONTH									
		J	F	M	A	M	J	J	A	S	O
Zinc	4	6.1	7.2	9.3	7.6	9.2	6.5	4.7	4	3.9	4.5
Copper	10	22.7	24	24.7	24.7	34.3	23.1	18.8	12.2	11.6	12.1
Nickel	40	886	1,263	1,110	3,533	2,075	1,333	900	1,024	340	445
Lead	15	42.4	72.1	101	96	85	61	53	51	55	48
Cadmium**	500	221	184	198	120	7,857	69	82	57	85	121
Chromium	6	70	72	101	82	85	61	41	36	29	34
Molybdenum	180	1,500	3,367	2,775	1,828	2,750	2,080	1,698	1,609	195	1,295
Cobalt	50	2,167	3,607	4,440	5,300	4,400	4,160	3,913	2,252	27,250	2,543
Selenium	500	32,500	33,667	10,090	6,625	6,471	4,952	-	-	3,633	-
Arsenic	100	488	481	1,088	815	1,100	800	-	-	545	-
Mercury	1,500	3,362	3,483	7,400	10,600	6,875	5,474	-	-	3,028	-

*Unacceptable ratios occur when ratio is shown as a number smaller than the maximum allowable. Higher ratios indicate that metal content is lower than what is allowed.

**Cadmium concentrations exceeded the allowable level for sludge disposal on agricultural land. Source appears to be area metal plating industry.

metals in Table 5*, indicate that approximately 0.5% of the total cadmium concentration is contributed by the landfill leachate. The rest of the cadmium enters the sewer system from other sources. Apparently the Region has traced the source and has already concluded that the major cadmium contributor is a local metal plating operation.

As further noted on Table 5*, [with the exception of zinc, lead, copper and chromium, heavy metal contribution from landfill leachate is minimal and has no detrimental effect on overall sludge quality.] Regarding (zinc), which appears to be largely contributed by the leachate, the overall concentration is still well within the allowable ammonia to metal ratio.) Note, however, that the average ammonia to metal ratio for zinc and copper approaches 50% of the allowable limit. [Tighter sludge quality guidelines on the ammonia to copper and zinc concentration, leading to a higher ratio, or higher copper and zinc concentration in the leachate could result in producing a sludge which would be unacceptable for disposal on agricultural land.]

Two other metals, lead and chromium, although appearing to be responsible for 3 to 12% of the metal concentration in the sludge, are well below the allowable levels and pose no problems unless established metal ratios were to be increased by at least a factor of 3 for lead and 10 for chromium.

* Base data for Table 5 provided in Appendix P-1.

TABLE 5

**HEAVY METAL CONCENTRATION IN SLUDGE CONTRIBUTED
BY METAL CONCENTRATION IN LEACHATE**

Metal		A	B	C		D	E
		Maximum Metal Conc. in Leachate (mg/L)	Maximum Estimated Leachate Flow (L/s)	Metal Conc. in Sludge (mg/L)		Average Monthly Sludge Flow m ³	% Metal Contributed by Leachate
				Min.	Max.		
Zinc	(Zn)	<u>1.1</u>	7.26	4	64	5 023	6-100
Copper	(Cu)	<u>.3</u>	7.26	12	34	5 023	3.3-9.3
Nickel	(Ni)	<u>.6</u>	7.26	340	2 533	5 023	<0.6
Lead	(Pb)	<u>1.0</u>	7.26	51	101	5 023	3.7-7.3
Cadmium	(Cd)	<u>.1</u>	7.26	67	7 857	5 023	<0.5
Chromium	(Cr)	<u>.8</u>	7.26	26	101	5 023	3-11.5
Molybdenum	(Mo)	-	7.26	195	3 367	5 023	-
Cobalt	(Co)	<u>.5</u>	7.26	2 252	27 250	5 023	<0.1
Selenium	(Se)	<u>.001</u>	7.26	3 633	33 667	5 023	<0.1
Arsenic	(As)	<u>.001</u>	7.26	481	1 100	5 023	<0.1
Mercury	(Hg)	<u>.00029</u>	7.26	3 027	10 600	5 023	<0.1

NOTES:

A This is the maximum heavy metal concentration measured in leachate as noted in Table 2.

B This maximum flow calculated by taking present average daily flow of 6.05 L/s plus an allowance of 0.12 L/s/ha for 10 ha of projected additional landfill area.

C Minimum and maximum concentration of metals in digested sludge over 1983.

D Average monthly digested sludge volume (1983 value) - see Appendix P-1.

E % of total metal in sludge contributed by maximum metal concentration in leachate -

$$\frac{A \times B}{C \times D} \times 100\%$$

Therefore, although the level of heavy metals contributed by the landfill leachate appears to have no detrimental effect on the digested sludge quality, the zinc and copper concentrations in the leachate should be closely monitored through periodic leachate analysis. Investigations should also be undertaken to determine the major contributing sources of these heavy metals.

Rec'd

A P P E N D I X P-1

APPENDIX P-1

DIGESTED SLUDGE VOLUMES (m³)

	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
January	2 895.5	7 349	4 591	4 545.5
February	4 632	6 431	4 794	4 844
March	2 079	7 281	6 350	4 985
April	551.1	4 454.5	4 694	4 284
May	1 463	3 513	4 288	4 704
June	3 218.5	4 250	5 695	4 987
July	4 033	4 255	5 200	4 886.5
August	4 656.5	5 145	5 324.5	5 145.5
September	3 564.5	5 518	4 118	5 729
October	3 718	4 964	3 219	5 688.5
November	3 521.5	6 247	6 047.5	5 282
December	3 373	5 395	4 275	4 886
Annual Total (m ³)	37 640	64 801	58 597	60 282
Monthly Average (m ³)	3 136.7	5 400	4 883	5 023

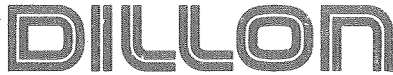
APPENDIX P-1

(continued)

METAL CONCENTRATION IN DIGESTED SLUDGE

<u>Metal</u>	<u>1980</u>		<u>1981</u>		<u>1982</u>		<u>1983</u>	
	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>
Zinc	5.1	2.0	5.0	2.8	6	5	64	4
Copper	13.85	5.9	14	9.1	19	15	34	12
Nickel	1 600	440	1 365	562	885	654	2 533	340
Lead	37.3	17.7	51	29	62	43	101	51
Cadmium	179.6	58	171	97	267	213	67	7 857
Chromium	46.1	21.4	44	28	45	53	101	26
Molybdenum	11 411	1 049	3 750	811	1 796	1 417	3 367	195
Cobalt	4 700	772	3 440	811	3 400	1 317	27 250	2 252
Selenium	2 412	1 254	13 928	4 867	28 333	1 800	33 667	3 633
Arsenic	1 196	173	375	317	824	401	1 100	481
Mercury	6 808	2 576	4 227	3 042	5 200	4 118	10 600	3 027





Consulting Engineers & Planners

OUR FILE: 9319-02

YOUR FILE:

30 March 1984

M.M. Dillon Limited
47 Sheppard Avenue East
WILLOWDALE, Ontario
M2N 5X5

Attention: Mr. W.F. Wells, P.Eng.
Project Manager

Burlington Landfill Continued Use -
Application for a Certificate of
Approval

Dear Sirs:

We are pleased to present the report on Water Quality Impacts contained as Appendix 'Q' of the Technical Report filed in support of an Application for a Certificate of Approval for the continued use of the Burlington Landfill Site.

The writer will appear as a witness at the hearing before the Environmental Assessment Board on the basis of this report.

Yours truly,

M.M. DILLON LIMITED

L.E. Johnston, Ph.D.
Associate

LEJ:11y
Encl:

SECTION Q
WATER QUALITY IMPACTS

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1. INTRODUCTION

This discussion on water quality extends the work done by Gartner Lee Associates Limited(1) by looking at the trace quantities of chemicals found in water associated with the Burlington landfill. The Hydrogeological Study (Section 0) discussed overall quantities and quality of surface and ground water associated with the landfill. This report assesses the potential impacts of the ground water on local populations down gradient of the landfill.

The approach taken is to assess the impacts of the largely synthetic organic chemicals found in the landfill leachate. The impacts are assessed in the context of a number of simplifying assumptions all of which conservatively overstate the real situation likely to be encountered. These simplifications are necessary in order to use the data in the complex relationship between leachate quality and impacts down gradient. The impacts will be shown to be slight under these assumptions.

The water quality data have been reported by Gartner Lee Associates Limited(1). These are data from surface and ground water samples collected by Gartner Lee and analyzed by the Ministry of the Environment (MOE). The data include routine water quality analyses results. These usually have values above a part per million. There are also water quality analyses for trace level contaminants, those with values below one part per million. The routine analyses

have been carried out at most sampling points for five years providing a historical database is available. The trace analyses were only done once for the Hydrogeological Study so an additional sampling event was undertaken. These samples (also taken by Gartner Lee) were analyzed by Wellington Environmental Consultants.

The human impacts are assessed under the hypothetical scenario that the contaminated ground water, typified by ground water found in boreholes down gradient of the landfill, is used for domestic purposes in a community further down gradient from the landfill. Furthermore, the impacts are those of the trace contaminants. [The background concentrations of naturally occurring mineralization of this water have been ignored.] (This mineralization would likely preclude use of this water for domestic consumption in the absence of the trace contamination.)

The aquatic impacts are also assessed. The effect of leachate treatment on the Burlington Skyway WPCP is discussed in Section P.

2. DATABASE

Two sources of data were used to assess the impacts:

- data from MOE laboratories;
- data from Wellington Environmental Consultants.

The MOE data on routine water quality parameters goes back five years and are collected in an Appendix to the Hydrogeological Study. The most recent sampling event (November 1983) for analysis by MOE included sampling for trace contaminants, in addition to the conventional parameters. These results are also appended to the Hydrogeological Study. Upon review of the MOE trace contamination data, an additional set of samples was taken to confirm the MOE analysis and to obtain data on additional trace contaminants. These results are appended to this report.

The analytical methodologies used by MOE have been published, reference(2). The samples analyzed by Wellington were analyzed using methods described in their report which is appended hereto.

The data are collected in this section. They have been organized in the subsections that follow along the lines found in dissertations on environmental contamination. Some chemical groups have been omitted since they were not detected at the present detection limits; reference is made to these under "Others" (Section 2.4) for completeness.

2.1 Volatile Organics

The data on volatile organic compounds are summarized in Table 1. Chemicals have been listed only when the lab detected the chemical. Note that the February 1984 sampling was much less extensive. Only those sample locations marked with an asterisk were sampled by Gartner Lee and analyzed by Wellington. The February results were, more often than not, lower than those obtained from the November samples. Also, many fewer compounds were detected. For reference, the detection limit of compounds not detected by Wellington is indicated for the Wellington analysis procedure.

Three chemicals have been definitely identified by both laboratories:

1,1,1-trichloroethane
trichloroethylene
1,1,2,2-tetrachloroethane

*note - assume
not borehole
17 shows
leachate.* { These chemicals are most frequently associated with leachate from the landfill (see data from boreholes 16 and 17 and from the leachate).

The rest of the data exemplifies the difficulty in obtaining meaningful results at these trace concentrations. Three comments are appropriate:

- i) Some chemicals are detected by MOE but not by Wellington in spite of adequate sensitivity of the Wellington techniques (methylene chloride, trans-1,2-dichloroethylene, 1,1-dichloroethane, chloroform, 1,2-dichloropropane, 1,2-dichlorobenzene). These are very volatile chemicals

TABLE 1
VOLATILE ORGANICS

COMPOUND	SAMPLE LOCATION ⁺																											Wellington Detection Limit
	1 I	II	III	7 I	III	12 I	II	13 I	14 II	15 I	16 I	II	III	IV	17 I	II	III	IV	22 I	III	18 I	II	III	SW 1 *	M H	SW 3 *		
MINISTRY OF ENVIRONMENT																												
methylene chloride				87		13	14		7										950			7			116		ND 10	
trans-1,2-dichloroethylene																									56.9		ND 5	
1,1,-dichloroethane							6						4	5											94.4		ND 20	
chloroform																			0.6					0.9			ND 0.1	
1,1,1-trichloroethane	5	1	2	-	-	2	4	2	-	2	6	7	7	2	9	4	4	2	5	1.1	400	40		-	-			
1,2-dichloroethane															11										2.7		ND 10	
1,2-dichloropropane																									3.5		ND 1.0	
trichloroethylene							4							7					10						0.7			
tetrachloroethylene													1		1												ND 0.1	
1,2-dichlorobenzene																									6.7		ND 1.0	
benzene																			0.2					0.2	4		ND 100	
toluene													6		7				0.7	75				0.5	>168		ND 100	
ethylbenzene																									15.1		ND 100	
m-xylene																			0.6	17				0.3	32.7		N/A	
ortho-and para-xylene																			0.7					0.7	28.1		N/A	
1,1,2,2-tetrachloroethane														2														
WELLINGTON ENVIRONMENTAL																												
1,1,1-trichloroethane															0.1	1.0								*	0.1	*		
trichloroethylene															4.9	0.5								0.7	1.3	0.6		
1,1,2,2-tetrachloroethane															0.6													

+ Sample locations from GLAL Designations, MH = leachate from toe-drain manhole. Sampled 83.11.22.
22-III, SW-1 and MH analyzed by GC/MS, all others by direct injection GC-ECD. All data in ug/L.

* Samples analyzed by Wellington, all GC-ECD/FD, sampled 84.02.07.
ND = not detected at ppb level indicated, N/A not analyzed.

page Q 6 quote

for drain
manhole

which are readily lost from an aqueous substrate. [That they were found by MOE and not by Wellington could be ascribed to different flow rates of leachate during sampling.]

- ii) Some chemicals are detected by MOE below Wellington's detection limit meaning the presence is suggested but not confirmed. These include benzene, ethylbenzene, toluene, 1,2-dichloroethane.
- iii) "Artifacts of well construction" was suggested by the MOE for the results from borehole 22 level III(3). This is a relatively new monitor located up gradient from the landfill. It also contained large quantities of tetrahydrofuran, a commonly used solvent for glues used in constructing these monitoring wells.

2.2 Inorganics

The inorganics analyzed at the trace level are metals and metalloids. The data for all analyses available are given in Table 2. These data exhibit similar inconsistencies between the laboratories as the volatile organics above.

Iron, chromium and zinc are consistently found in many samples. In addition, samples from borehole 16 and 17 show indications of cadmium and lead contamination in addition to chromium and zinc. The rest of the metals are quite low. The iron could come from natural sources in addition to the landfill activity. (The native red soil colour is due to an iron rich mineralization).

Sampled Nov. 22/83

TABLE 2
INORGANICS

CHEMICAL

MINISTRY OF THE ENVIRONMENT

Arsenic
Cadmium
Chromium
Copper
Iron
Lead
Mercury
Nickel
Selenium
Silver
Zinc

*why
N/A*

SAMPLE LOCATION					
1 I	16 IV	17 I	SW I mg/L	M H	SW 3
			.006	.001	
			<.005	<.01	
			.023	.075	
			.019	<.009	
			21	33	
			.03	<.06	
			.00002	.00029	
			.039	.081	
			<.001	<.001	
			NA	NA	
			.062	1.1	

WELLINGTON

Arsenic
Cadmium
Chromium
Copper
Iron
Lead
Mercury
Nickel
Selenium
Silver
Zinc

<.001					
<.005		.009	<.005		
<.05		.240	<.05	.150	<.05
<.02					
NA	NA	NA	NA	NA	NA
<.05		.056	<.05		
<.0002					
<.02					
<.001					
<.01					
.054	.084	.069	.029	.129	.031

NA = not analyzed

< = not detected at minimum detection limit

Samples analyzed by MOE sampled 83.11.22

Samples analyzed by Wellington sampled 84.02.07.

2.3 Other EPA 129 Priority Pollutants

The prime reason for having the monitors resampled by Garner Lee and analyzed by Wellington was the lack of any data on many compounds which the United States Environmental Protection Agency (EPA) lists on its Priority Pollutants List of 129 chemicals (EPA 129). It was anticipated for example that phthalate esters should show up in the leachate given their pervasive use and occurrence in other substrates. Analysis for the EPA 129 is widely accepted in North America as a suitable screening analysis to identify environmental contamination by chemicals.

Representatives from three classes of compounds were detected in the leachate sample taken on 84.02.07 from the manhole in the leachate transmission sewer. Except for phenols, they were not detected in other samples. The compounds belong to the classes:

- phthalate esters
- polynuclear aromatic hydrocarbons (PAH)
- phenols

The concentrations of the specific members are given in Table 3.

2.4 Others

Two other observations on the water quality data are important. Firstly, pesticides were not detected in any

TABLE 3
EPA 129 PRIORITY POLLUTANTS
NOT LISTED PREVIOUSLY

	Manhole* (ug/L)
Phthalate Esters	
Butylbenzyl phthalate	10
Dimethyl phthalate	131
Polynuclear Aromatic Hydrocarbons and Related Compounds	
Acenaphthene	69
Fluorene	139
Naphthalene	80
Penanthrene	222
Phenols	
p-chloro-m-cresol	3.0
2,4-dichlorophenol	5.9
2,4-dinitrophenol	Trace
pentachlorophenol	36
phenol	75
2,4,6-trichlorophenol	Trace

*200d
no test
240.*

is this not a pesticide? see P.Q-17

* Sampled 84.02.07

samples by either lab. Second, the leachate from the collection system shows a variety of short chain aliphatic hydrocarbons and simply substituted aromatics.

Both labs tested all samples for a wide range of pesticides commonly found in environmental samples. Included in these tests were tests for PCB and dioxin. None was detected at levels down to the parts per billion range.

The wide variety of these organic chemicals found in the leachate collection system are typical of what is expected in municipal solid waste. The compounds are found in three general classes:

- . aliphatic oxygenated compounds, ketones, ethers, acids and aldehydes
- . simply substituted aromatic compounds
- . organic sulfides

The oxygenated aliphatics could originate from partially oxidized organic matter in municipal waste or in some cases are commonly used polar solvents found in paint and printing ink. Similarly, the aromatics could arise from partial degradation of wood waste or from commonly used aromatic chemicals like phthalate esters. The presence of organic sulfides is typical of intermediate products of anaerobic degradation, a common process in landfills usually associated with methane generation.

3. SOURCES AND TOXICITY

Prior to a discussion on the impacts of the chemicals found in the Burlington landfill leachate, an understanding of these chemicals is developed. A discussion on the sources of these chemicals will provide information on how these chemicals could have come to be in the municipal waste and thus in the leachate. It is pointed out that these are chemicals that are in routine use or are present in everyday surroundings. This, in no way, is to suggest the chemicals are benign. A balancing submission of the toxicity of the chemicals is also given.

3.1 Sources

3.1.1 Volatile Organics

Trichloroethylene

Industrial Wastes

Trichloroethylene has historically been the most used metal degreasing solvent. As such, it will have been present in degreaser cleaning and maintenance wastes. Trichloroethylene has also been used as an extraction solvent, in the dyeing industry, for dry cleaning, as a fumigant, in refrigeration and heat exchange systems, in textile processing, as a chemical intermediate, and as a diluent in paints and adhesives. Waste materials from any of these industries could contain trichloroethylene. In addition, discarded containers of consumer products such as paint or adhesive that contain it would ultimately release it to the landfill environment.

1,1,1-trichloroethane (methylchloroform)

Ninety percent of the trichloroethane sold is used for cold cleaning of metals, that is, the metal object is sprayed, wiped or dipped in the solvent to clean it. Some trichloroethane is also used in vapour degreasing (for heat-sensitive parts), and in aerosol formulations. The vapour degreasing wastes would include degreaser cleaning and maintenance sludges and residues. Aerosol formulations include those using trichloroethane as a carrier for paint and those designed as spray-on cold cleaning solvent.

1,1,2,2-tetrachloroethane

undesired waste.
Tetrachloroethane is used as solvent, for metal cleaning and degreasing, in paint remover, varnishes and lacquers, in resin and wax manufacture, for extraction of oils and fats, in insecticides, herbicides, and as a fumigant.

Wastes which could be expected to contain 1,1,2,2-tetrachloroethane include degreaser sludges and residues, paint and varnish waste, residues from seed oil extraction, contaminated cleaning and manufacturing wastes, and discarded containers of consumer products such as insecticides.

3.1.2 Inorganics

Chromium

Chromium is a metal with a wide variety of industrial uses; it is present in metal alloys, used in pigments and paints, for metal cleaning and plating, tanning, textile processing, and dyeing, wood treatment, ceramics, brick manufacture and recording tapes. Products of these processes will contain chromium, in some cases available for release. It is likely that paint residues, leather, textile and wood residues would be significant sources of soluble chromium compounds.

Zinc

Zinc is a very common element in manufacturing. The most obvious use is in galvanized metal; when this is discarded, zinc is made available to leachate. Other discarded materials containing zinc in available form are automative parts, fuses, dry cell batteries, fungicides, roofing hardware, dyes, zinc-plated metals, rubber goods and plastic, cosmetics, paints, pesticides, and lubricants.

3.1.3 Phthalate Esters

Butylbenzyl phthalate

This phthalate ester is used as a specialty plasticizer, primarily for polyvinyl chloride (PVC) and cellulosic plastics. The total volumes of these plastics produced is immense, worldwide, in the order of a 500,000 tonnes per

year, much of it for consumer products so that large quantities will find their way into municipal landfills. Release of plasticisers from discarded PVC and cellulosic plastics in the landfill is the probable source of this material.

Dimethyl phthalate

Used as a plasticiser/processing aid in nitrocellulose and cellulose acetate plastics and rubber, and as an ingredient in lacquers, molding powders and consumer goods such as perfume and insect repellent, this chemical is likely to be present in a large variety of discarded consumer goods. It is a relatively easily leached from plastics and rubber over time and would therefore likely occur in leachate. Where it is used in lacquers and insect repellent or other consumable goods, residues in discarded containers would also be available for leaching.

3.1.4 Polynuclear Aromatic Hydrocarbons and Related Compounds

Several polynuclear aromatic hydrocarbons and related compounds have been found in leachate from the site, including acenaphthene, fluorene, naphthalene, and phenanthrene.

These materials are ubiquitous products of combustion and can be found in combustion residues - household wood and coal ashes, cigarette ends, etc. Coal tar pitch, used primarily for roofing but also for clay pigeons, sealants, and protective coatings contains very high levels of PAHs and

construction spoils including coal tar roofing would contribute to PAH in leachate. Asphalt contains much less PAH type compounds than coal tar, but still significant quantities. Asphalt too is present in construction spoils - paving, roofing, and shingles.

3.1.5 Phenols

p-chloro-m-cresol

The major uses for this chemical have been based on its toxicity to microorganisms. It has been used as a germicide and preservative for glues, paint, ink, textiles and leather. Occurrence in leachate is likely due to its release from consumer products of these classes discarded to municipal waste.

2,4-dichlorophenol

This chemical is used as an intermediate in chemical manufacture, principally "2,4-D" herbicides, and is also a product of the degradation of 2,4-D. Wastes from a herbicide manufacturer or formulator would probably be accompanied by other toxic species, so it is likely that this chemical occurs as a result of leaching and degradation of herbicide residues in discarded containers from agricultural consumer use.

2,4-dinitrophenol

There has been some use of 2,4-dinitrophenol in the dye, explosive, and photographic industries. It also has been used in the wood preserving industry. Major exposure to leaching would be in discarded (dyed) textiles (as a dye degradation product) and wood preserved with formulations containing it.

Pentachlorophenol

Pentachlorophenol is very widely used for its fungicidal, bactericidal, algicidal, and herbicidal properties. It is a major ingredient in wood preservatives. Presence in leachate is most likely due to leaching from construction wastes containing treated wood scrap.

Phenol

A major use of phenol has been in the manufacture of adhesives for plywood laminating. Wastes from plywood manufacture and fabrication, including scrap plywood, would contribute heavily to leachate phenol levels. Phenol is also available from many resins used for adhesive and bonding purposes. Many consumer products contain phenol as a preservative/germicide, and discarded containers of these will contribute to leachate.

2,4,6-trichlorophenol

This phenolic material is present in fungicides and herbicides. It is also a degradation product of phenoxy herbicides. Degradation of containers residues from consumer, and agricultural use is the most likely source of this chemical.

3.2 Toxicity

The toxicity of chemicals can be expressed in a variety of ways depending on:

- . the species affected - man, fish, other mammals, rodents, etc.;
- . the environmental medium through which the intoxicant acts-air, water, food;
- . quantitative relationships between amount ingested and body mass.

The impacts of the water quality were assessed on the basis of drinking the water, and thus the toxicity information is expressed in terms of drinking water criteria. These are not toxic concentrations of these chemicals but rather the criteria for safe drinking water based on toxicity studies. The Ontario drinking water quality objectives and the surface water quality criteria are appended for reference.

The criteria in terms of ingestion concentrations or amounts are summarized in Table 4 for the chemicals identified in Section 2 as those for which impacts should be assessed. These criteria will be used in developing the human impacts in Section 4. (Characteristically, the criteria do not all exist and the existing criteria from different sources are apparently contradictory.) In spite of these shortcomings this set of criteria will be useful provided they are used in full knowledge of their origins.

TABLE 4
CHEMICAL TOXICITY

<u>Chemical</u>	<u>Criterion</u>				<u>Other</u>
	ADI (mg/d)	Carcinogen Risk/10 ⁶ (ug/L)	Non-Carcinogen Acceptable (ug/L)	DW (ug/L)	
Volatile Organics		(ug/L)	(ug/L)	(ug/L)	
1,1,1-trichloroethane	38	-	-	-	-
trichloroethylene	1.7	2.7	-	-	LD ₅₀ 4.9 g/kg oral rat
1,1,2,2-tetrachloroethane	-	0.17	-	-	LD ₅₀ 3 g/kg i.p. mouse
Inorganics					
Chromium III	125	-	-	50	
Chromium VI	0.175	.0008	-	-	
Zinc	-	-	5,000	5,000	
Polynuclear Aromatic Hydrocarbons	-	.00028	-	-	
- Acenaphthene					
- Fluorene					
- Naphthalene					
- Phenanthrene					
Phthalate Esters					
Dimethylphthalate	700	-	160,000		
Butylbenzylphthalate	-	-	-		LD ₅₀ 3.2 g/kg i.p. mouse
Phenols				(2)	
Phenol	7.0	-	3,400		
Pentachlorophenol	2.1	-	140		
2,4-dichlorophenol	7.0	-	0.5		
p-chloro-m-cresol	-	-	-	-	LD ₅₀ 0.5 g/kg oral rat
2,4,6-trichlorophenol	-	-	1.2		
2,4-dinitrophenol	0.14	-	68.6		

ADI = Acceptable Daily Intakes from "Summary of Published Acceptable Daily Intakes (ADIs) for EPA's Priority Pollutants." prepared by Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency Cincinnati Ohio, 1983. 11.29.

TABLE 4
CHEMICAL TOXICITY
(concluded)

Carcinogen Risk: Drinking water concentration which if consumed daily would increase the cancer by one in 1,000,000. Reference: Criteria and Standards of Water Quality, Chapter 1 in Chemistry of Water Treatment, S.D. Faust and O.M. Aly, Ann Arbor Science (Butterworths) 1983.

Non-Carcinogenic Acceptable Concentration: for chemicals that are not carcinogens the acceptable Drinking water concentration. Relate to an LC_{50} by factors of 10,100 or 1000 depending on adequacy of data. Reference as above.

DW = Drinking water standards from National Health and Welfare Canada, "Guidelines for Canadian Drinking Water Quality, 1978 Supporting Documentation".

Other: Typical lowest lethal dose (LDL_0) and lethal dose for 50% of the test species (LD_{50}) from the Registry of Toxic Effects of Chemical Substances, NIOSH, 1979.

The ADI's are the most widely available for this group of chemicals. They refer to acceptable daily intakes from all sources, food, water, air and could simplistically be related to drinking water levels in consideration of the fact that the average human ingests 2 L of water/day.

For some chemicals the concentration causing one additional cancer per million people drinking water contaminated at that level is available. Other chemicals are found to be non-carcinogenic but other toxic effects impose acceptable levels on their concentrations. In general these are much higher concentrations and are one to three orders of magnitude below the lowest known acutely toxic effect.

For completeness the Canadian Drinking Water standards are included where available. Also for two compounds for which data were not given in the previous categories some animal test data are given. The comparable data for trichloroethylene are also given. This is not to imply any toxicological relationship but simply makes the comparison as a point of reference.

4. POSSIBLE IMPACTS

The quality of the ground and surface water associated with the Burlington landfill are considered from two points of view:

- . impact on human health from trace contaminants;
- . impact on aquatic organisms.

The possible human health impacts are considered from only one point of view, namely the potential for these waters to cause cancer. The possible surface water impacts on aquatic life are also discussed.

4.1 Possible Impact on Human Health

In order to evaluate possible chemical intoxication, the worst case scenario approach has been adopted. It involves assessing the impact of using leachate contaminated ground water as a domestic water source. The major impact assessed is the potential of the waterborne contaminants to cause cancer. This does not consider any of the sub-clinical impacts of using this water as a domestic source. The background mineralization of the ground water would likely also be a source of most of the sub-clinical impacts based on the background quality data.

again, assumes that borehole 17 shows leachate !! { The scenario envisions that leachate contaminated ground water, as typified by samples from boreholes 16 and 17, continues to flow down gradient over long periods of time

towards the Aldershot community with no attenuation or renovation. Further, the community is assumed to tap this leachate contaminated water for domestic use. The question is then asked, what would be the impact of the trace contaminants identified above on those using this water? This is a more conservative assumption than, for example, persons coming in contact with the water because our scenario is based on ingestion of the water.

An assessment of the possible impacts is summarized in Table 5. The chemicals listed were identified in Section 2. Two additions, namely 1,2-dichloroethane and cadmium are included. These chemicals were not positively identified as leachate components since they were not confirmed by both laboratories. They do, however, represent a possible health risk and are therefore included. Chromium is listed as a +3 oxidation state, the state likely to be found in ground water. Polynuclear aromatic hydrocarbons (PAH) and phthalate esters are not listed as they were found only in the leachate from the sewer manhole. PAH's are an interesting case in that they are highly carcinogenic (one in a million cancer risk concentration is .00028 ug/L) and pervasive (estimated almost 500×10^6 kg/annum produced worldwide), yet it seems many natural processes immobilize them. In this case they do not appear in any of the ground water samples in spite of their rather high concentration in leachate. Phenols have been listed although they were not confirmed by all leachate analysis.

The levels selected for comparison in Table 5 were the highest found from boreholes 16 and 17. Where the chemical is a non-carcinogen the levels found are compared to published acceptable levels. In some cases these levels were not available and values were inferred from acceptable daily

TABLE 5
 IMPACTS OF USE OF LEACHATE CONTAMINATED GROUND WATER
 AS DOMESTIC SOURCE

Chemical	Highest* Concentration	Carcinogen Risk Concentration for 1 in 10 ⁶	Non-Carcinogen Acceptable Concentration	Additional Cancer
----- ug/L -----				
1,1,1-trichlorethane	9	-	19,000	-
trichloroethylene	7	2.7	-	3
1,1,2,2-tetrachloroethane	2	0.17	-	12
1,2-dichloroethane	11	0.95	-	12
Chromium	240	-	62,000	-
Zinc	84	-	5,000	-
Cadmium	9	10	-	1
Phenol	75	-	3,400	-
Pentachlorophenol	36	-	140	-
1,2-dichlorophenol	6	-	0.5	-
TOTAL				28 in 10 ⁶

* Borehole 16 or 17.

trespass.

see pesticide cases.

intakes (Table 4). In all cases the levels encountered were less than the acceptable level except for 1,2-dichlorophenol. In this case the level of acceptability is based on taste rather than toxicity.

The additional cancer risk was estimated by straight extrapolation from the one in a million risk concentration. These chemicals under the scenario of using this water as a drinking water source would lead to 28 additional cancers in the lifetime of a million people.

In order to apply this statistic to the Burlington landfill it is necessary to consider the total amount of water available for domestic use. The Hydrogeological Study(1) (Section 0) estimates the leachate leakage at 800 m³/year. At an average consumption for drinking of 2 L/day this means approximately 1100 people could have their drinking requirements satisfied by leachate contaminated ground water. Using the additional cancer statistics of 28 cancers/million there would be only .03 additional cancers or one additional cancer in more than 2,000 years traceable to the landfill.

The risk would not be discernable from all other causes of premature death from other sources present in everyday life. Furthermore a series of conservative assumptions have been made in arriving at this risk including:

- . use of leachate contaminated ground water as a domestic water source;
- . all water used for drinking only, 2 L/day whereas per capita total domestic consumption is about 200 L/day;

- . no further hydrogeological attenuation of chemical contaminants in intervening ground between boreholes 16 and 17 and the community;
- . no dilution from uncontaminated ground water;
- . no loss of chemical content through chemical reaction (hydrolysis largely);
- . inclusion of chemicals not confirmed to be present in the leachate;
- . use of highest concentrations encountered.

4.2 Possible Aquatic Impacts

The major source of impacts to the aquatic environment from the landfill is leachate contamination of surface water. Leachate contamination might occur from inputs such as leachate springs or ground water seepage.

As indicated in previous sections, leachate seepage into the ground water is occurring on the existing landfill site.

Analysis of ground water from boreholes down gradient (#17) of the landfill site indicates the presence of some of the chemical constituents of the raw leachate collected in the toe drain system. Three volatile organic compounds were identified in water samples taken from boreholes downstream of the landfill site (Table 1). All of these compounds occur in concentrations well below the lethal limits determined for aquatic organisms.

again,
borehole 17
shows
leachate

Borehole water analysis indicates that some heavy metals appear to be transported in the ground water (Table 2). However, the concentrations of these metals in the ground water down gradient of the landfill that can be attributable to leachate contamination are not significant in terms of impacts upon the aquatic environment. The background water quality of the ground water is very poor as a result of high concentrations of iron, sulphate and calcium (Table 6).

NIB { *
Therefore, the impacts to the aquatic environment of seepage of ground water contaminated by leachate into Falcon or Indian Creeks would appear to be negligible. [There is a potential for sublethal, or chronic, effects to occur; however, it would be difficult to attribute these impacts to leachate contaminated ground water as the background water quality of the ground water is so poor.]

Leachate springs are another potential source of leachate contamination of surface water. Inputs of leachate into either Falcon Creek or Indian Creek are unlikely as a perimeter ditch (designed for the 1:50 year storm) collects runoff from the landfill site and directs it into a settling pond. The toe drain system and proposed underdrain system are designed to reduce mounding of leachate. Therefore, the likelihood of leachate springs occurring, particularly in the proposed extended use area, are reduced. Leachate springs have occurred on the existing landfill site and most likely will occur in the future. They have been and will continue to be corrected as soon as they appear. However, the impacts of leachate seepage to aquatic environment are not apparent. Analysis of surface water quality upstream ((SW1)) and downstream ((SW3)) of the landfill shows no significant difference in water quality (Table 6).

TABLE 6
COMPARISON OF WATER ANALYSIS RESULTS
FOR AQUATIC IMPACTS

		S A M P L I N G L O C A T I O N					
		Manhole April 1983	(Toe Drain) Nov. 1983	SW1 1982 Mean	SW3 1982 Mean	BH17-I Nov. 1983	BH22-III Nov. 1983
CONDUCTIVITY	μ MHOS/CM.	6,450	6,200	689	770	40,500	1,250
pH		7.2	7.1	8.4	8.4	6.9	7.41
HARDNESS	(CaCO ₃)	2,164	2,038	329	377	3,385	675.7
ALKALINITY	(CaCO ₃)	2,264	2,268	256	289	204	532.2
CHLORIDES	(Cl)	108	762	40	37	15,400	5.6
SULPHATES	(SO ₄)	280	13	98	76	1,490	155
PHOSPHOROUS	Total	.85	2.0	0.36	< .06	1.0	0.2
(ASP)	Soluble			0.03	0.03		
NITROGEN	Total Kjeldahl	129	150	0.48	0.3	18	1.0
(as N)	Ammonium	107	88	< .1	< .1	17.4	< 0.1
	Nitrite	.05	0.06	0.01	.02	0.02	0.02
	Nitrate	.2	0.2	1.7	1.3	0.1	< 0.1
Potassium	(K)	373	305	2.9	3.8	149	11.8
Magnesium	(Mg)	235	253			240	115
Calcium	(Ca)	480	400			960	81
Sodium	(Na)	85	445	22.2	26	6,000	35.2
Iron	(Fe)	.59	-	.34	0.36	42.5	5.4
Phenols	(ug/L)	880	680	2.4	< .1	4.0	5.0
BOD		2,260	594	<2.0	< .9	4.4	10.6
COD		3,010	3,580	24	23.5	778	182

NOTE: Concentrations in ppm unless otherwise noted. From Hydrogeological Study(1) (Section 0) by Gartner Lee Associates Limited.

Leachate might possibly be carried into the surface water as a result of contamination of soil caused by leachate springs. The potential impact on the aquatic environment is low as leachate contaminated sediments would be collected in perimeter ditches and diverted into sediment ponds for disposal in the landfill.

Existing impacts to the aquatic environment, as a result of leachate contamination from the landfill site, are not apparent. Future impacts directly attributable to the landfill site are also unlikely to occur. The continued urbanization of the watershed will have far greater impact on the aquatic environment than will the extended use of the landfill.

Site monitoring by biological staff is recommended to further reduce the possibility of impacts occurring. A program to investigate the sublethal effects of leachate contamination of surface water using biological indicators would be of great value in assessing potential effects on the aquatic environment.

REFERENCES

1. Hydrogeological Study. Burlington Landfill Site Continued Use, prepared for M.M. Dillon Limited by Gartner Lee Associates Limited, February 1984.
2. Outlines of Analytical Methods, Ontario Ministry of the Environment, Laboratory Services Branch, June 1981.
3. M.G. Foster, Laboratory Services and Applied Research Branch. Memorandum to K. Hogg, Central Region, 1984 01 10.

APPENDIX

**REPORT FROM WELLINGTON ENVIRONMENTAL
CONSULTANTS INCORPORATED**

**WATER ANALYSIS FOR SAMPLES TAKEN
FEBRUARY 1984**

WATER ANALYSES
EPA PRIORITY POLLUTANTS

For:

M.M. Dillon Ltd. and
Gartner-Lee Associates Ltd.

Wellington Environmental
Consultants Incorporated

February 1984



WATER ANALYSES
EPA PRIORITY POLLUTANTS

1.0 INTRODUCTION

Wellington Environmental Consultants Incorporated were instructed by M.M. Dillon Ltd. and Gartner-Lee Associates Ltd. to analyze six (6) water samples for the 129 EPA priority pollutants. The methods used and the results obtained are discussed in the following report.

2.0 METHODOLOGY

2.1 Sampling

Samples were collected by personnel of Gartner-Lee Associates Ltd. and delivered to our laboratory on Feb. 7, 1984 at ca. 1400 hrs. The samples were taken in 4L brown glass bottles with teflon lined caps (no headspace, no preservatives). The samples were stored at 4°C until processed, which was carried out on Feb. 9, 1984.

The samples as received are listed below together with the code numbers that they were given; code numbers will be referred to in the remainder of this report.

<u>Sample</u>	<u>Code</u>
Manhole	GL-MH
BH1-11	GL-B1
BH16-1111	GL-B16
BH17-1	GL-B17
SW-1	GL-SW1
SW-111	GL-SW3
Gas Station	GL-GS

2.2 Sample Preparation

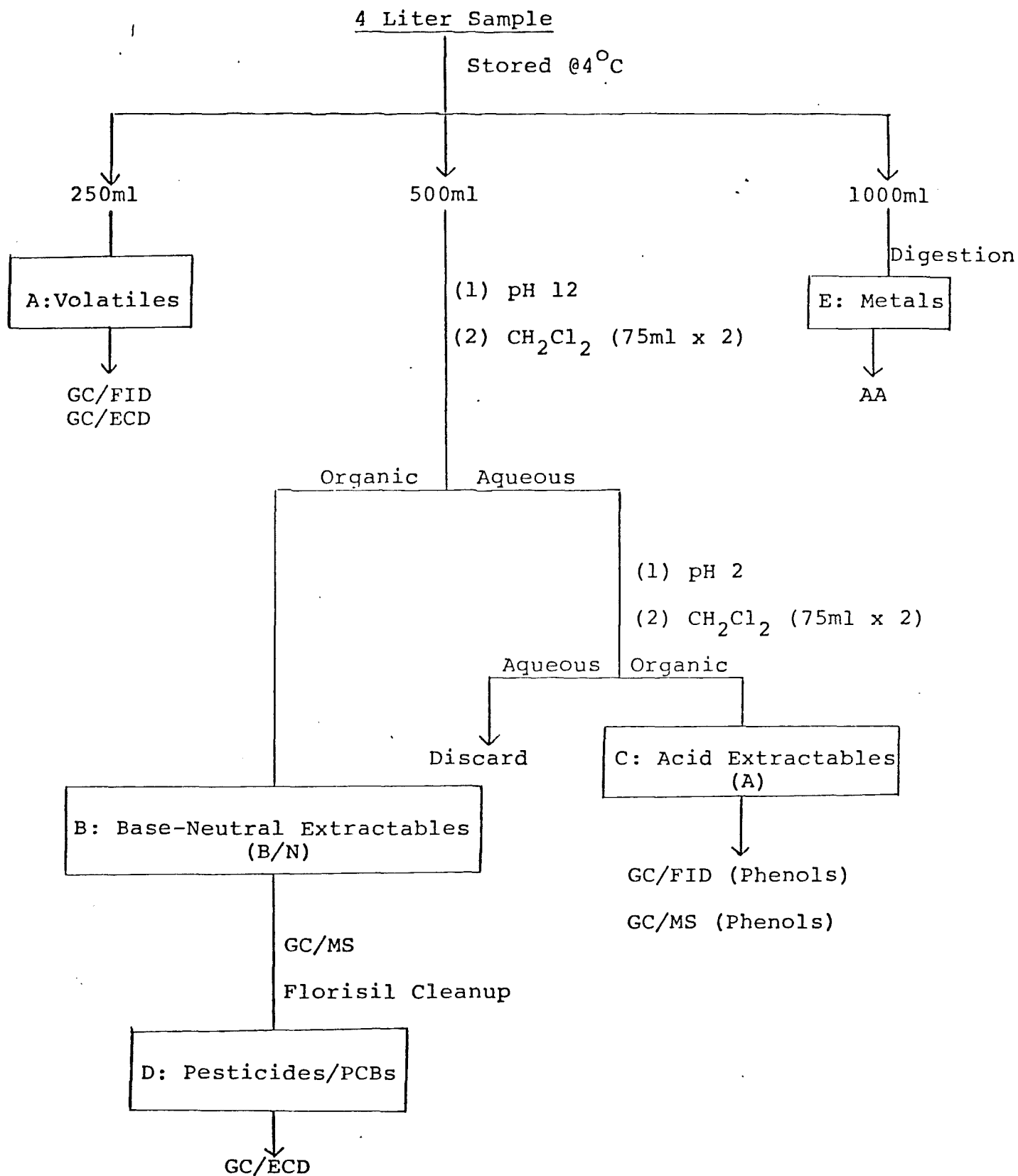
Each sample was subsampled and treated according to the methods prescribed by the U.S. EPA. The protocol used is given in Figure 1 and the final analysis procedures are described in section 2.3.

2.3 Analysis

A. Volatile Components

Volatile components in the water samples were concentrated using a modified headspace procedure. The halogenated aliphatic and aromatic hydrocarbons present were analyzed using gas-liquid chromatography with electron capture detection (GLC/ECD). Benzene and its alkyl derivatives were determined using GLC with a flame-ionization detector (GLC/FID).

Figure 1: Schematic for Trace Pollutant Analysis.



The equipment and conditions used for these analyses were as follows.

Equipment: Hewlett Packard 5880

Gas Liquid Chromatograph equipped with FID, ECD detectors, cool-on-column injection system and Level IV terminal/integrator.

Column: 2m 1% SP 1000 60/80 Carbopack B

<u>Condition:</u>	GC/FID	GC/ECD
Oven Temperature:Initial Value	30°C	30°C
Initial Hold	5 minutes	5 minutes
Program Rate	8°/minute	8°/minute
Final Value	200°C	200°C
Gases:Carrier	He @30ml/min	Argon methane @30ml/min
Air	200ml/min	
Hydrogen	30ml/min	

A standard mix of EPA volatile components, as listed in Table A.1 was used to identify and quantify these compounds in each sample.

B. Base-Neutral Extractables

The base-neutral extractable fractions (B/N Fraction) of the water samples were analyzed by GC/MS for the B/N EPA priority pollutants listed in Table B.1. One microliter of each B/N fraction (1ml total volume) was injected into the

GC/MS which scanned for compounds in the range of 40-500amu. The mass spectra of each of the components present were obtained and, their structure(s) were determined using computerized mass spectral data searches where possible.

Identification of the EPA B/N components was performed using a standard mix of these compounds as well as performing individual selected ion monitoring (SIM) on each sample, where necessary.

The GC/MS used and the operating conditions were as follows.

GC/MS: Mass Spectrometer - VG 12000 Quadrupole

Gas Liquid Chromatograph - Hewlett Packard 5792
equipped with cool-on-column injection system,
30m DB-5 capillary column

Data System- VG 11-250

Conditions:MS- EI/Positive Ion Mode

- Ionization Voltage 70eV
- Source Temperature 200°C

GLC - Oven Temperature

Initial Temperature - 100°C

Program Rate - 10°/minute

Final Temp. - 320°C

- Carrier Gas - He @15psi

C. Acid Extractables (Phenols)

The acid extractable fractions (A Fraction) of the water samples were initially analyzed by capillary GLC/FID for the EPA 'priority phenols' (listed in Table C.1). The chromatograph used and the conditions are as follows.

Hewlett Packard 5880 GLC-FID

30m SE54 capillary column (J&W)

Cool-on-column Injection

Level 4 Terminal/Integrator

Oven Temperature Profile:

Initial Temperature 50°C

Initial Time 1.00 min.

Program Rate 15°C/min.

Final Temperature 300°C

Final Time 20.00 min.

Carrier Gas: He @15psi

Aux Gas: He @30ml/min.

FID: Air @200ml/min.

H₂ @30ml/min.

One of these samples, GL-MH however, contained large amounts of interfering substances and was thus re-analyzed by capillary GC/MS. This analysis involved injection of 1ul of the A Fraction (1ml total volume) into the GC/MS and acquiring mass spectra of the compounds present in the range 50 to 450 amu. The mass spectra of each of the components present were obtained and, where possible, their structures

were determined using computerized and 'manual' mass spectral data searches.

In addition, specific ion chromatograms were then produced by computer searching of the mass spectra produced. The ions monitored were those characteristic of the EPA 'priority phenols'.

The GC/MS used and the operating conditions were as follows:

GC/MS

Mass Spectrometer - VG 12000 quadrupole

Gas-Liquid Chromatograph -

-HP 5792 with cool-on-column injection
system and equipped with a 30m DB-5
capillary column (J&W)

Data System - VG 11-250

GC/MS Interface - Direct.

CONDITIONS

MS - EI/Positive Ion Mode

- Ionization Voltage -70eV

-Source Temperature -200°C

GLC - Carrier Gas - He @15psi

- Oven Temperature Profile:

Initial Temp. 100°C

Program Rate - 15°C/min

Final Temp. -320°C

For both the GLC/FID and the GC/MS analyses a standard mixture

of the EPA priority phenols was injected separately for identification of these compounds and their quantitation by peak-area comparison.

D. Pesticides and PCBs

After GC/MS analyses, the base-neutral extracts of each sample were split and one half of the sample was subjected to florisil column clean-up procedures (as specified by the EPA). The pesticide/PCB fractions were subsequently analyzed by capillary gas chromatography with an electron capture detector (GLC/ECD) for those compounds listed in Table D.1.

Identification and quantitation of pesticides, PCBs and toxaphene was based on retention time and peak-area comparison to standard mixtures of these compounds.

The equipment and conditions used for these analyses were as follows.

Equipment - Hewlett Packard 5880 Gas Chromatograph equipped with an ECD Detector, cool-on-column injection system, 30m SE54 capillary column and level IV terminal/integrator.

Conditions- Oven Temperature Profile:

Initial Value - 90°C

Initial Time - 1 minute

Program Rate 1 - 10° /minute

Final Value - 150°C

Final Time - 0 minutes

Program Rate 2 - 1.5° /minute

Final Value - 300°C

Final Time - 90 minutes

E. Metals

One liter of each water sample was acidified to ca. pH 2 with HNO_3 and divided into three aliquots suitable for separate determinations of Mercury, Arsenic/selenium and other metals (200 ml, 400ml and 400 ml respectively). Mercury levels in each sample (100ml x 2) were determined by the cold vapour technique following

- digestion with H_2SO_4 and HNO_3
- oxidation with KMnO_4
- removal of excess KMnO_4 with hydroxylamine sulphate
- generation of elemental mercury following addition of stannous sulphate.

For arsenic and selenium, each sample was digested with HNO_3 and concentrated to 20.0ml. Levels of As and Se were then determined by atomic absorption spectroscopy (hydride generation technique).

Other metals listed in Table E.1 were determined by atomic

absorption (direct aspiration) following digestion of water samples with HNO_3 and concentration to 40.0 ml.

The equipment used for metal determination(s) was a Perkin Elmer Model 2380 Atomic Absorption Spectrophotometer.

2.4 Quality Assurance/Quality Control (QA/QC)

The following QA/QC procedures were carried out during the course of these analyses.

- All glassware used was rigorously cleaned and checked for cleanliness prior to processing the samples.
- All instruments (GLC, GC/MS, AA) used were calibrated daily and checked for linearity, sensitivity and reproducibility.
- Blank samples (glass distilled, deionized water) and 'spiked' samples were run concurrently with the samples analyzed.
- In addition to the 'spiked' samples, the extraction/concentration procedures were checked for recovery using the following surrogate spiking compounds which were added directly to the samples:

1-Bromo-2-chloropropaneVolatile Compounds

D₅ - phenolAcid Extractables

D₁₀- phenanthreneBase/Neutral Extractables.

3.0 RESULTS

A. Volatiles

The results of the GLC/ECD and GLC/FID analyses for the EPA volatiles in the water samples are summarized in Table A.1. All samples had low ppb levels of trichloroethylene and three samples B16, B17 and MH had, again, low ppb levels of 1,1,1-trichloroethane.

Only one sample, that from the manhole, had detectable levels of any chlorobenzenes. No benzene, toluene or ethylbenzene were detected in any of the samples at the detection limits given.

The recovery of the surrogate (internal standard) spike was greater than 80% for all samples.

B. Base Neutrals.

The results of the GC/MS analysis of samples B1 to MH are given in Table B.1. D₁₀Phenanthrene recoveries in all samples was greater than 90%.

Diethylphthalate was observed at low ppb levels in all samples but was also seen in the method blank. Sample MH was found to contain much higher levels of diethyl phthalate (ie. 131 ppb) compared to the low ppb levels attributed to the method.

No other EPA base-neutrals were observed in any samples except GL-MH. Other compounds identified in sample GL-MH at

ppb levels are given in Table B.1. Sample GL-MH was found to contain other compounds that interfered with the analysis. At this time these compounds are unidentified (not EPA base-neutrals) but their identities will be discussed in a report which will follow shortly.

C. Acid Fraction (Phenols)

Results of the analyses, GLC/FID and GC/MS, for the EPA phenols in the water samples are given in Table C.1.

Only one sample, that labelled 'manhole' (MH), had detectable levels of some of the EPA phenols. This sample contained large amounts of other acid extractable (eg. carboxylic acids) compounds and thus the phenols could only be detected by GC/MS.

All of the other samples, however, were quite clean with none of the EPA phenols, or significant amounts of any other coextractable compounds, detected. Recovery of the surrogate spike, D₅-phenol, was 70% or greater for all samples.

D. Pesticides/PCBs and Toxaphene

The results of the GLC/ECD analysis of the water samples are given in Table D.1. As shown in this table no halogenated pesticides, PCBs or toxaphene were detected in any of the samples.

E. Metals

The results of the metal analyses on samples SW1 to MH are given in Table E.1. All samples were found to contain low levels of zinc (ppb) and samples B17 and MH were found to contain other metals as indicated in Table E.1. No other metals as analyzed were found in the samples at the levels of detection indicated.

Table A.1 Volatiles

A	<u>VOLATILES</u> ^a	Detection Limit (ppb)	SW1	SW3	B1 (ppb)	B16	B17
	Acrolein	NA	NA	NA	NA	NA	NA
	Acrylonitrile	NA	NA	NA	NA	NA	NA
	Benzene	100	-	-	-	-	-
	Bis(chloromethyl)ether	5	-	-	-	-	-
	Bromodichloromethane	0.1	-	-	-	-	-
	Bromoform	0.1	-	-	-	-	-
	Bromomethane	NA	NA	NA	NA	NA	NA
	Carbon Tetrachloride	0.1	-	-	-	-	-
	Chlorobenzene	2	-	-	-	-	-
	Chloroethane	NA	NA	NA	NA	NA	NA
	2-Chloroethylvinyl ether	5	-	-	-	-	-
	Chloroform	0.1	-	-	-	-	-
	Chloromethane	NA	NA	NA	NA	NA	NA
	Dibromochloromethane	0.1	-	-	-	-	-
	Dichlorodifluoromethane	NA	NA	NA	NA	NA	NA
	1,1-Dichloroethane	20	-	-	-	-	-
	1,2-Dichloroethane	10	-	-	-	-	-
	1,1-Dichloroethylene	5	-	-	-	-	-
	trans-1,2-Dichloroethylene	5	-	-	-	-	-
	1,2-Dichloropropane	1.0	-	-	-	-	-
	cis-1,3-Dichloropropene	1.0	-	-	-	-	-
	trans-1,3-Dichloropropene	1.0	-	-	-	-	-
	Ethylbenzene	100	-	-	-	-	-
	Methylene Chloride	10	-	-	-	-	-
	1,1,2,2-Tetrachloroethane	0.1	-	-	-	-	-
	<u>1,1,2,2-Tetrachloroethene</u>	0.1	-	-	-	0.6	-
	Toluene	100	-	-	-	-	-
	<u>1,1,1-Trichloroethane</u>	0.1	-	-	-	0.1	1.0
	<u>1,1,2-Trichloroethane</u>	0.1	-	-	-	-	-
	<u>Trichloroethylene</u>	0.1	0.7	0.6	0.3	4.9	0.5
	Trichlorofluoromethane	NA	NA	NA	NA	NA	NA
	Vinyl chloride	NA	NA	NA	NA	NA	NA

a: none detected unless indicated

NA: not analyzed

Table A.1 Volatiles

A	<u>VOLATILES</u> ^a	Detection Limit (ppb)	MH (ppb)	GS
	Acrolein	NA	NA	NA
	Acrylonitrile	NA	NA	NA
	Benzene	100	-	-
	Bis(chloromethyl)ether	5	-	-
	<u>Bromodichloromethane</u>	0.1	-	0.9
	Bromoform	0.1	-	-
	Bromomethane	NA	NA	NA
	Carbon Tetrachloride	0.1	-	-
	Chlorobenzene	2	-	-
	Chloroethane	NA	NA	NA
	2-Chloroethylvinyl ether	5	-	-
	<u>Chloroform</u>	0.1	-	0.8
	Chloromethane	NA	NA	NA
	<u>Dibromochloromethane</u>	0.1	-	1.1
	Dichlorodifluoromethane	NA	NA	NA
	1,1-Dichloroethane	20	-	-
	1,2-Dichloroethane	10	-	-
	1,1-Dichloroethylene	5	-	-
	trans-1,2-Dichloroethylene	5	-	-
	1,2-Dichloropropane	1.0	-	-
	cis-1,3-Dichloropropene	1.0	-	-
	trans-1,3-Dichloropropene	1.0	-	-
	Ethylbenzene	100	-	-
	Methylene Chloride	10	-	-
	1,1,2,2-Tetrachloroethane	0.1	-	-
	1,1,2,2-Tetrachloroethene	0.1	-	-
	Toluene	100	-	-
	<u>1,1,1-Trichloroethane</u>	0.1	0.1	-
	<u>1,1,2-Trichloroethane</u>	0.1	-	-
	<u>Trichloroethylene</u>	0.1	1.3	1.5
	Trichlorofluoromethane	NA	NA	NA
	Vinyl chloride	NA	NA	NA

a: none detected unless indicated

NA: not analyzed

Table B.1: Base Neutral Extractables

<u>BASE-NEUTRAL EXTRACTABLES</u> ^a	Detection Limit (ppb)	SW1	SW3	B1	B16 (ppb)	B17	GS
Acenaphthene	5	-	-	-	-	-	-
Acenaphthylene	5	-	-	-	-	-	-
Anthracene	5	-	-	-	-	-	-
Benzidine	5	-	-	-	-	-	-
Benzo [a] anthracene	5	-	-	-	-	-	-
Benzo [b] fluoranthene	5	-	-	-	-	-	-
Benzo [k] fluoranthene	5	-	-	-	-	-	-
Benzo [ghi] perylene	10	-	-	-	-	-	-
Benzo [a] pyrene	10	-	-	-	-	-	-
Bis(2-chloroethoxy)methane	5	-	-	-	-	-	-
Bis(2-chloroethyl)ether	5	-	-	-	-	-	-
Bis(2-chloroisopropyl)ether	5	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	5	-	-	-	-	-	-
4-Bromophenyl phenyl ether	5	-	-	-	-	-	-
Butyl benzyl phthalate	5	-	-	-	-	-	-
2-Chloronaphthalene	5	-	-	-	-	-	-
4-Chlorophenyl phenyl ether	5	-	-	-	-	-	-
Chrysene	5	-	-	-	-	-	-
Dibenzo[a,h]anthracene	10	-	-	-	-	-	-
Di-n-butyl phthalate	5	-	-	-	-	-	-
1,2-Dichlorobenzene	1	-	-	-	-	-	-
1,3-Dichlorobenzene	1	-	-	-	-	-	-
1,4-Dichlorobenzene	1	-	-	-	-	-	-
3,3'-Dichlorobenzidine	5	-	-	-	-	-	-
Diethyl phthalate	5	-	-	-	-	-	-
Dimethyl phthalate	5	-	-	-	-	-	-
2,4-Dinitrotoluene	5	-	-	-	-	-	-
2,6-Dinitrotoluene	5	-	-	-	-	-	-
Di-n-octyl phthalate	5	-	-	-	-	-	-
1,2-Diphenylhydrazine	5	-	-	-	-	-	-
Fluoranthene	5	-	-	-	-	-	-
Fluorene	5	-	-	-	-	-	-
Hexachlorobenzene	5	-	-	-	-	-	-
Hexachlorobutadiene	5	-	-	-	-	-	-
(cont'd)							

Table B.1 continued.

BASE-NEUTRAL EXTRACTABLES ^a	Detection						
	Limit (ppb)	SW1	SW3	B1	B16 (ppb)	B17	GS
Hexachlorocyclopentadiene	5	-	-	-	-	-	-
Hexachloroethane	5	-	-	-	-	-	-
Indeno [1,2,3-cd]pyrene	10	-	-	-	-	-	-
Isophorone	5	-	-	-	-	-	-
Naphthalene	5	-	-	-	-	-	-
Nitrobenzene	5	-	-	-	-	-	-
N-Nitrosodimethylamine	5	-	-	-	-	-	-
N-Nitrosodiphenylamine	5	-	-	-	-	-	-
N-Nitroso-n-propylamine	5	-	-	-	-	-	-
Phenanthrene	5	-	-	-	-	-	-
Pyrene	5	-	-	-	-	-	-
2,3,7,8-TCDD	1	-	-	-	-	-	-
1,2,4-Trichlorobenzene	1	-	-	-	-	-	-

a: none detected unless indicated

Table B.1: Base Neutral Extractables

B	<u>BASE-NEUTRAL EXTRACTABLES</u> ^a	Detection Limit (ppb)*	MH (ppb)
	Acenaphthene	10	69
	Acenaphthylene	10	-
	Anthracene	10	-
	Benziidine	10	-
	Benzo [a] anthracene	10	-
	Benzo [b] fluoranthene	10	-
	Benzo [k] fluoranthene	10	-
	Benzo [ghi] perylene	10	-
	Benzo [a] pyrene	10	-
	Bis(2-chloroethoxy)methane	10	-
	Bis(2-chloroethyl)ether	10	-
	Bis(2-chloroisopropyl)ether	10	-
	Bis(2-ethylhexyl)phthalate	10	-
	4-Bromophenyl phenyl ether	10	-
	<u>Butyl benzyl phthalate</u>	10	10
	2-Chloronaphthalene	10	-
	4-Chlorophenyl phenyl ether	10	-
	Chrysene	10	-
	Dibenzo[a,h]anthracene	10	-
	Di-n-butyl phthalate	10	-
	1,2-Dichlorobenzene	10	-
	1,3-Dichlorobenzene	10	-
	1,4-Dichlorobenzene	10	-
	3,3'-Dichlorobenzidine	10	-
	Diethyl phthalate	10	-
	<u>Dimethyl phthalate</u>	10	131
	2,4-Dinitrotoluene	10	-
	2,6-Dinitrotoluene	10	-
	Di-n-octyl phthalate	10	-
	1,2-Diphenylhydrazine	10	-
	Fluoranthene	10	-
	<u>Fluorene</u>	10	139
	Hexachlorobenzene	10	-
	Hexachlorobutadiene	10	-
	(cont'd)		

Table B.1 continued.

<u>BASE-NEUTRAL EXTRACTABLES</u>	^a Detection Limit (ppb)	MH (ppb)
Hexachlorocyclopentadiene	10	-
Hexachloroethane	10	-
Indeno [1,2,3-cd]pyrene	10	-
Isophorone	10	-
<u>Naphthalene</u>	10	80
Nitrobenzene	10	-
N-Nitrosodimethylamine	10	-
N-Nitrosodiphenylamine	10	-
N-Nitroso-n-propylamine	10	-
<u>Phenanthrene</u>	10	222
Pyrene	10	-
2,3,7,8-TCDD	10	-
1,2,4-Trichlorobenzene	10	-

a: none detected unless indicated

*: Detection Limit of 10ppb due to interfering compounds.

Table C.1: Acid Extractables (Phenols)

C	<u>ACID EXTRACTABLES</u>	Detection ^a	SW1	SW3	B1	B16	B17
		Limit (ppb)					
	p-Chloro-m-cresol	2.0	-	-	-	-	-
	2-Chlorophenol	2.0	-	-	-	-	-
	2,4-Dichlorophenol	2.0	-	-	-	-	-
	2,4-Dimethylphenol	2.0	-	-	-	-	-
	4,6-Dinitro-o-cresol	2.0	-	-	-	-	-
	2,4-Dinitrophenol	2.0	-	-	-	-	-
	2-Nitrophenol	2.0	-	-	-	-	-
	4-Nitrophenol	2.0	-	-	-	-	-
	Pentachlorophenol	2.0	-	-	-	-	-
	Phenol	2.0	-	-	-	-	-
	2,4,6-Trichlorophenol	2.0	-	-	-	-	-

a: None detected (by GLC/FID and GC/MS) unless indicated.

Table C.1: Acid Extractables (Phenols)

C	<u>ACID EXTRACTABLES</u>	Detection ^a	GS	MH
		Limit (ppb)		
	<u>p-Chloro-m-cresol</u>	2.0	-	3.0
	<u>2-Chlorophenol</u>	2.0	-	-
	<u>2,4-Dichlorophenol</u>	2.0	-	5.9
	<u>2,4-Dimethylphenol</u>	2.0	-	-
	<u>4,6-Dinitro-o-cresol</u>	2.0	-	-
	<u>2,4-Dinitrophenol</u>	2.0	-	t
	<u>2-Nitrophenol</u>	2.0	-	-
	<u>4-Nitrophenol</u>	2.0	-	-
	<u>Pentachlorophenol</u>	2.0	-	36
	<u>Phenol</u>	2.0	-	75
	<u>2,4,6-Trichlorophenol</u>	2.0	-	t

a. None detected (by GLC/FID and GC/MS) unless indicated.

t: trace; ca. 1ppb

Table D.1 Continued.

D	PESTICIDES AND PCBs ^a	Detection Limit (ppb)	SW1	SW3	B1 (ppb)	B16	B17
	Aldrin	0.001	-	-	-	-	-
	α -BHC	0.001	-	-	-	-	-
	β -BHC	0.001	-	-	-	-	-
	γ -BHC	0.001	-	-	-	-	-
	δ -BHC	0.001	-	-	-	-	-
	Chlordane	0.001	-	-	-	-	-
	4,4'-DDD	0.005	-	-	-	-	-
	4,4'-DDE	0.005	-	-	-	-	-
	4,4'-DDT	0.005	-	-	-	-	-
	Dieldrin	0.001	-	-	-	-	-
	α -Endosulfan	0.001	-	-	-	-	-
	β -Endosulfan	0.001	-	-	-	-	-
	Endosulfan Sulphate	0.005	-	-	-	-	-
	Endrin	0.001	-	-	-	-	-
	Endrin Aldehyde	0.001	-	-	-	-	-
	Heptachlor	0.001	-	-	-	-	-
	Heptachlorepoxyde	0.001	-	-	-	-	-
	PCB 1016	0.02	-	-	-	-	-
	PCB 1221	0.02	-	-	-	-	-
	PCB 1232	0.02	-	-	-	-	-
	PCB 1242	0.02	-	-	-	-	-
	PCB 1248	0.02	-	-	-	-	-
	PCB 1254	0.02	-	-	-	-	-
	PCB 1260	0.02	-	-	-	-	-
	Toxaphene	0.40	-	-	-	-	-

a: none detected unless indicated.

Table D.1. Pesticides and PCBs

D <u>PESTICIDES AND PCBs</u> ^a	Detection Limit (ppb)	GS	MH
		(ppb)	
Aldrin	0.001	-	-
α -BHC	0.001	-	-
β -BHC	0.001	-	-
γ -BHC	0.001	-	-
δ -BHC	0.001	-	-
Chlordane	0.001	-	-
4,4'-DDD	0.005	-	-
4,4'-DDE	0.005	-	-
4,4'-DDT	0.005	-	-
Dieldrin	0.001	-	-
α -Endosulfan	0.001	-	-
β -Endosulfan	0.001	-	-
Endosulfan Sulphate	0.005	-	-
Endrin	0.001	-	-
Endrin Aldehyde	0.001	-	-
Heptachlor	0.001	-	-
Heptachlorepoxyde	0.001	-	-
PCB 1016	0.02	-	-
PCB 1221	0.02	-	-
PCB 1232	0.02	-	-
PCB 1242	0.02	-	-
PCB 1248	0.02	-	-
PCB 1254	0.02	-	-
PCB 1260	0.02	-	-
Toxaphene	0.40	-	-

a: none detected unless indicated

Table E.1 Inorganics.

E	<u>INORGANICS</u> ^a	Detection Limit (ppb)	SW1.	SW3	B1	B16 (ppb)	B17	MH
Antimony		NA	NA	NA	NA	NA	NA	NA
Arsenic		1	-	-	-	-	-	-
Asbestos		NA	NA	NA	NA	NA	NA	NA
Beryllium		NA	NA	NA	NA	NA	NA	NA
Cadmium		5	-	-	-	-	9	-
Chromium		50	-	-	-	-	240	150
Copper		20	-	-	-	-	-	-
Cyanide			NA	NA	NA	NA	NA	NA
Lead		50	-	-	-	-	56	-
Mercury		.2	-	-	-	-	-	-
Nickel		20	-	-	-	-	-	-
Selenium		1	-	-	-	-	-	-
Silver		10	-	-	-	-	-	-
Thallium		NA	NA	NA	NA	NA	NA	NA
Zinc		5	29	31	54	84	69	129

a: none detected unless indicated

NA: not analyzed for

ADDENDUM TO
REPORT

WATER ANALYSES
EPA PRIORITY POLLUTANTS

For:
M.M. Dillon Ltd.
Gartner-Lee Associates Ltd.

Wellington Environmental
Consultants Incorporated

February 1984



1.0 INTRODUCTION

The following report describes in more detail some of the GC/MS analyses carried out on extracts of water samples collected by personnel of Gartner-Lee Associates at a landfill site (reportedly in Burlington). In our previous report we gave the results of our analyses for the 'EPA 129' in these samples.

At that time we indicated that one sample, labelled 'manhole' (MH), contained large amounts of other compounds not prioritized by the EPA.

We have completed a more rigorous GC/MS analysis of both the acid (A) and base/neutral (B/N) extracts of this sample and the results obtained are described herein.

2.0 METHODOLOGY

As previously described, 1ul of the final extracts (A and B/N) were injected into the GC/MS and mass spectra recorded in the range 40-500 amu. Presence/absence of any of the EPA priority pollutants was then determined by obtaining selected ion chromatographs keying on ions that are characteristic of these compounds. (The results obtained were summarized in our previous report).

In only one sample, that from the manhole, were any of the EPA 129 detected.

This sample (MH) contained high levels of other compounds in both the A and B/N fractions. Therefore for both fractions the mass spectra of each component were printed and where possible their structures determined using 'manual' and computer-assisted mass spectral library (NBS) searches.

3.0 RESULTS AND DISCUSSION

A (Acid) Fraction

The GC/MS - Total Ion Chromatograph (TIC) of the acid extract from the sample taken from the manhole is shown in Figure 1a. The poor peak shape results from the polarity of the components present and also from overloading the column.

The TIC's of the other water samples were all quite similar; that for sample GL-SW1 is shown in Figure 1b. The major peaks present in all of these samples were identified as the d₅-phenol (internal standard; scan number ca. 55) and a phthalate (impurity in solvent; scan number ca. 365). In addition, all of the other peaks seen were also present in our solvent/equipment blank (distilled water). As an indication of the levels present or rather the sensitivity of the method, the d₅-phenol was added to each sample at a level of 20ppb.

In the TIC of the acid extract of GL-MH the d₅-phenol is 'buried' under the other components present; by generating selected ion chromatographs, however, it was found and its recovery determined to be ca. 70%.

From their mass spectra the compounds present in the acid extract of GL-MH were determined to be, for the most part, aliphatic and aromatic carboxylic acids as listed in Table 1. We have estimated that their levels are, conservatively, of the order of 0.1 to 0.5ppm.

B/N (Base/Neutral) Fraction

The TIC of the B/N fraction of sample GL-MH is shown in Figure 2a.

As with the acid extracts, the B/N extracts of the other samples were all quite similar. Again, for comparison purposes, the TIC of the B/N extract of GL-SW1 is shown in Figure 2b.

The major component present in all of the samples, excluding GL-MH, was d₁₀-phenanthrene (scan number ca. 580; internal standard) which was added to all samples at a level of 20ppb. Unlike the acid extract, the internal standard (d₁₀-phenanthrene) can be seen in the B/N extract of GL-MH. Its recovery was, in all samples, greater than 90%.

Most of the compounds present in the B/N extract of GL-MH were determined to be aliphatic (both linear and cyclic) aldehydes, ketones, ethers and alcohols. Aromatic alcohols (ie. phenyl ethanol; not phenols) and aldehydes also were detected. This data is summarized in Table 2.

The levels of these compounds were roughly estimated to range from 10 to 100 ppb.

4.0 SUMMARY

As noted in our previous report and accompanying letter all of the samples, except GL-MH, are quite free of contaminants at ppb levels and lower.

Both the A and B/N extracts of the 'manhole' sample contain complex mixtures of organic constituents.

To the best of our ability we have attempted to identify as many of these compounds as possible. The assignments listed in Tables 1 and 2 are for the most part likely correct, however, they can only be considered tentative until compared with standards.

In addition, it should also be noted that not all peaks are assigned structures or formula. This was due in most cases to mixtures of spectra.

Table 1: Sample GL-MH: GC/MS of Acid Extract

<u>Scan Number</u>	<u>Mass Spectral Assignment</u>
10	C ₆ or C ₇ aliphatic acid
19	"
78	"
114	"
127	"
141	C ₇ -C ₉ aliphatic acid
164	cyclohexane carboxylic acid
186	C ₈ or C ₉ aliphatic acid
219	phenyl acetic acid
223	C ₉ aliphatic acid
261	phenylpropanoic acid
354	C ₂ - phenylbutanoic acid
369	diethyl phthalate*
442	pentachlorophenol

* impurity in solvent

Table 2: Sample GL-MH: GC/MS of Base/Neutral Extract

<u>Scan Number</u>	<u>Mass Spectral Assignment</u>
9	C ₂ -benzene
17	C _{6,7} - aliphatic aldehyde
21	"
24	butoxy ethanol or propanol
26	C ₅ -C ₇ aliphatic ether
40	C ₈ -aliphatic aldehyde or ketone
64	"
69	C ₆ -alkoxy alcohol
78	C ₉ or C ₁₀ - aliphatic aldehyde
83	C ₉ -C ₁₂ alkane
86	"
93	C ₉ or C ₁₀ - aliphatic ketone
105	phenylethanol
109	aromatic aldehyde
111	"
159	C ₁₀ - aliphatic aldehyde
173	aromatic alcohol
175	"
188	"
195	C ₁₀ -aliphatic ketone (cyclic)
201	"
239	aliphatic ketone
256	aliphatic ether
298	C ₁ - pyrrolidinylpyridine (nicotine)
309	C ₁₂ - alkene
315	aliphatic aldehyde or ketone
326	C ₁ - indole
338	aliphatic alcohol or aldehyde
347	C ₁₂ - cyclic aliphatic amine

(cont'd)

Table 2: cont'd

<u>Scan Number</u>	<u>Mass Spectral Assignment</u>
417	poly ethoxylate or propoxylate
448	dihydromethylindolone
456	C ₁₂ -aromatic amides
464	C ₄ -phthalate
582	d ₅ -phenanthrene
596	C ₁₅ -alkene
605	phthalate
646	"
705	"
729	aliphatic aldehyde
738	S ₈
781	polyethoxylated or propoxylated alcohol (C ₁₉)

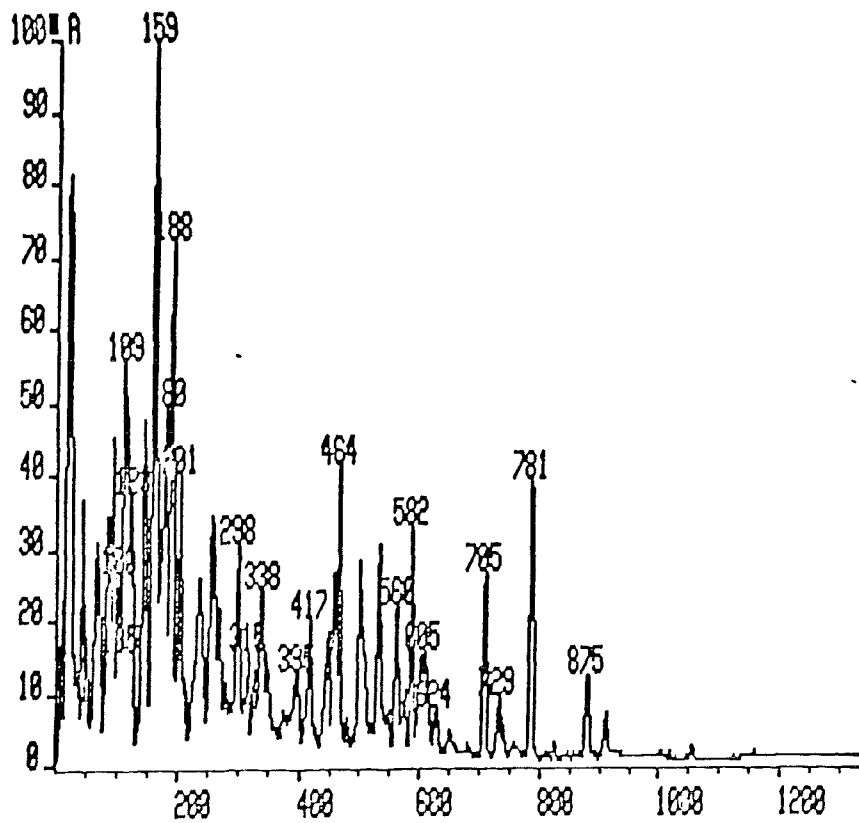


Figure 2a:
GC/MS (TIC) of
GL-MH B/N Extract

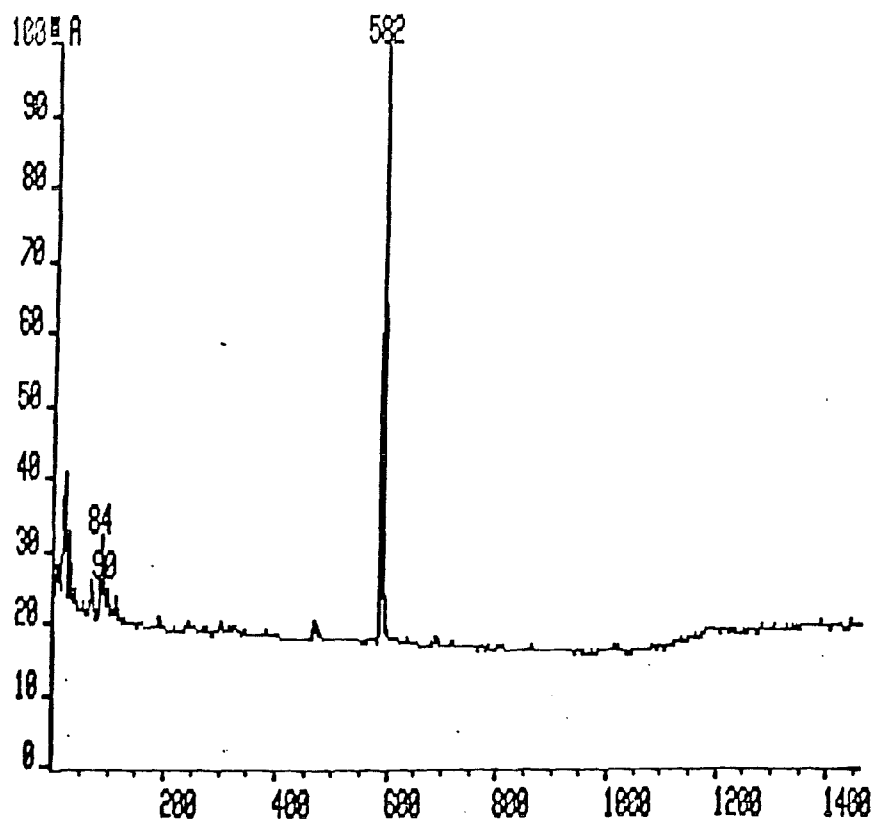


Figure 2b:
GC/MS (TIC) of
GL-SW1 B/N Extract

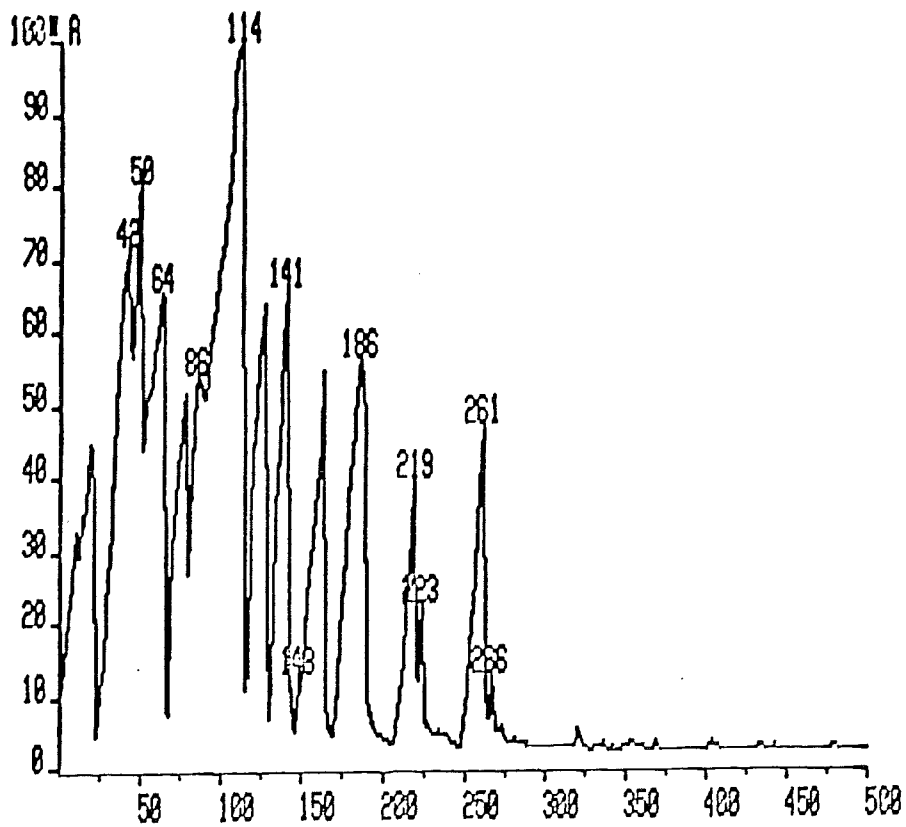


Figure 1a:
GC/MS (TIC) of
GL-MH Acid Extract

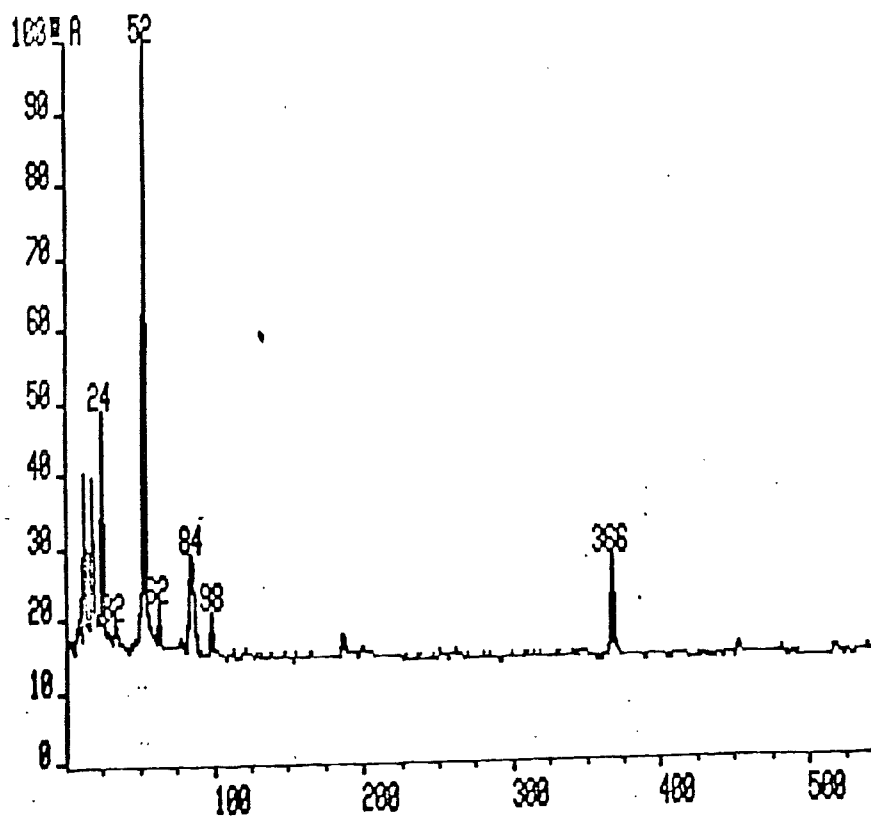


Figure 1b:
GC/MS (TIC) of
GL-SW1 Acid Extract

APPENDIX

**ONTARIO DRINKING WATER OBJECTIVES
AND
SURFACE WATER QUALITY OBJECTIVES**

ONTARIO DRINKING WATER OBJECTIVES

A PUBLICATION OF THE

ONTARIO
MINISTRY OF THE
ENVIRONMENT

Revised, 1983

1. INTRODUCTION

The primary purpose of drinking water objectives is for the protection of public health. Any water intended for human consumption should not contain any disease-causing organisms or hazardous concentrations of toxic chemicals or radioactive substances. Aesthetic considerations may also provide a basis for drinking water objectives since the water should be pleasant to drink. Temperature, taste, odour, turbidity and colour are all important in achieving waters which are aesthetically acceptable and pleasant to drink. Other aspects of water quality such as corrosiveness, tendency to form incrustations and excessive soap consumption should be controlled on the basis of economic considerations because of their effects on the distribution system and/or the intended domestic and industrial use of the water. The limits described in this document are considered to outline the minimum requirements necessary to fulfill the above objectives.

The document has been divided into a major section on health related water quality parameters and a section on characteristics related to aesthetic and other considerations. The final section deals with monitoring and surveillance for chemical, physical, bacteriological and radiological parameters. Tables 1, 1A, 2 and 3 list the limits for these parameters.

The appendices provide supporting documentation of the items listed in Tables 1, 1A, 2 and 3 in addition to providing information on other parameters which were studied and for which no specific limit could be established.

1.1 TYPES OF LIMITS

The following three types of limits shall be recognized:

Maximum Acceptable Concentration (MAC)

This term is used for limits applied to substances above which there are known or suspected adverse health effects. The presence in a drinking water of a substance at a level in excess of its maximum acceptable concentration shall be grounds for rejection of the water unless effective treatment is available. The length of time the maximum acceptable concentration can be exceeded without injury to health will depend on the nature and concentration of the contaminant; however, no drinking water can be permitted to exceed these limits continuously.

TABLE 1 Maximum Acceptable Concentrations Parameters Related to Health	
Parameter*	Concentration (mg/L)
Arsenic	0.05
Barium	1.0
Boron	5.0
Cadmium	0.005
Chromium	0.05
Cyanide (Free)	0.2
Fluoride	2.4
Lead	0.05
Mercury	0.001
Nitrate (as N)**	10.0
Nitrite (as N)	1.0
Nitrilotriacetic Acid (NTA)	0.05
Pesticides	
(Aldrin + Dieldrin	0.0007
(Carbaryl	0.07
(Chlordane	0.007
(DDT	0.03
(Diazinon	0.014
(Endrin	0.0002
*** (Heptachlor + Heptachlor Epoxide	0.003
(Lindane	0.004
(Methoxychlor	0.1
(Methyl Parathion	0.007
(Parathion	0.035
(Toxaphene	0.005
2,4-D	0.1
2,4,5-TP	0.01
Radionuclides****	—
Selenium	0.01
Silver	0.05
Trihalomethanes*****	0.35
Turbidity	1 FTU
<p>* Unless otherwise stated the limits for each substance refer to the sum of all forms present.</p> <p>** Where both nitrate and nitrite are present, the total nitrate plus nitrite-nitrogen should not exceed 10 mg/L.</p> <p>*** When more than one of these pesticides is present, the "total pesticides" shall not exceed the sum of their MAC's or 0.1 mg/L whichever is the lesser.</p> <p>**** Maximum acceptable concentrations and target concentrations for radionuclides can be found in Table 3, section 2.4.</p> <p>***** The term "trihalomethanes" comprises chloroform, bromodichloromethane, chlorodibromomethane, and bromoform, and their concentration as determined by the gas sparge or purge equivalent method (i.e. actual concentration) should not exceed 0.35 mg/L at any time.</p>	

Interim Maximum Acceptable Concentration (I.M.A.C.)

This term is used to describe limits for substances of current concern with known chronic effects in mammals and for which there are no established maximum acceptable concentrations. Although toxicological, epidemiological and health data are available for such substances the data are subject to public and scientific debate before agreement on a maximum acceptable concentration. The I.M.A.C. will generally be a conservative value subject to change as more precise information becomes available.

When a substance is detected at a concentration above its I.M.A.C., it will signal the need for more sampling and investigation. Requirements for corrective action will be on a case-by-case basis.

TABLE 1A Interim Maximum Acceptable Concentrations Parameters Related to Health	
Parameter	Concentration (mg/L)
Polychlorinated Biphenyls	0.003
Uranium	0.02

Maximum Desirable Concentration (MDC)

This term is used for limits on substances which, when present at concentrations above the limits, are either aesthetically objectionable to an appreciable number of consumers or may interfere with good water quality control practices. These limits should not be exceeded whenever a more suitable supply or treatment process is, or can be made available at a reasonable cost.

The chemical substances shown in Table 2 should not be present in a water supply in excess of the concentrations indicated where, in the judgement of the Ministry, other more suitable supplies are, or can be made available.

TABLE 2 Maximum Desirable Concentrations Parameters Related to Aesthetic Quality	
Parameter	Concentration*
Chloride	250
Colour	5 (TCU) **
Copper	1.0
Iron	0.3
Manganese	0.05
Methane	3 L/m ³
Odour	Inoffensive
Organic Nitrogen***	0.15
Phenols	0.002
Sulphate	500
Sulphide	Inoffensive
Taste	Inoffensive
Temperature	15° C
Total Dissolved Solids	500
Total Organic Carbon	5.0
Zinc	5.0
* Unless otherwise indicated, the maximum desirable concentrations are expressed in mg/L	
** True Colour Units.	
*** Total kjeldahl nitrogen minus ammonia nitrogen.	

The establishment of a limit should not be regarded as implying approval of the degradation of a high quality supply to the specified level. The limits described herein have been derived from the best information currently available; however, the development of drinking water objectives is an on-going process. Scientific knowledge of the complex inter-relationships that determine water quality continue to increase as does the understanding of the physiological effects of the substances present in water. Also, man continues to introduce new chemical substances into the environment, many of which may contaminate drinking water supplies. It, therefore, may be necessary to revise the established limits as new and more significant data become available.

1.2 APPLICATION OF LIMITS

A water supply system is defined as including the works and auxiliaries for collection, treatment, storage and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer.

The limits outlined in this document apply to all water supply systems which provide water for domestic purposes and serve more than five private residences or are capable of supplying water at a rate greater than 0.5 litres per second.* Although a water supply serving five or fewer private residences is excluded from the application of the limits, it is desirable that the quality of water from these supplies should not be inferior to that supplied to the public in general.

*OWR Act, R. S. O. 1980
Section 23, Subsection (9)

SURFACE WATER QUALITY OBJECTIVES

WATER MANAGEMENT

**– Goals, Policies, Objectives
and Implementation Procedures
of the Ministry of the Environment**

**Ontario Ministry
of the
Environment**

November, 1978

Provincial Water Quality Objectives

The Provincial Water Quality Objectives are a set of narrative and numerical criteria designed for the protection of aquatic life and recreation in and on the water. They represent a desirable level of water quality that the Ministry strives to maintain in surface waters of the Province. They are often the starting point in deriving waste effluent requirements. The Objectives are set out in Table 1.

The Objectives for protection of recreational water uses are based on public health and aesthetic considerations. With respect to aquatic life the Objectives are set at such values as to protect all forms of aquatic life and all aspects of the aquatic life cycles. The clear intention is to protect all life stages during indefinite exposure to the water. With the exception of dissolved oxygen, temperature classification of organisms is not considered relevant to the application of criteria. Numerous studies have found that the biological variation of response within species to a toxicant is as great or greater than the biological variation among species. Consequently, criteria will be applied equally to "warm water" species and "cold water aquatic organisms". This approach will also incorporate the variation of sensitivity occurring when "warm water" species are exposed to contaminants under low temperature conditions and when "cold water" species are exposed under high temperature conditions.

Ideally, water quality objectives should be established based on "no negative effect" data derived from chronic long-term tests on sensitive organisms. However, current understanding of chemical dynamics and effects on aquatic life are limited to a few species and contaminant levels that are lethal in short term tests. Therefore, the numerical Objectives in Table 1 are generally derived from short-term toxicity data and "application factors". Data from short-term toxicity tests are usually expressed as median lethal concentrations (LC50), indicating the concentration of test material that caused death to 50 per cent of the test organisms within a given period of time. An application factor can be defined as the ratio of the maximum concentration having no negative effect on the test organism to the 96 hour LC50 concentration. This approach to establishing water quality objectives is not ideal, but is a practical method of making an estimate of a safe concentration from limited toxicity data. The application factors commonly used are:

Concentrations of materials that are nonpersistent or have noncumulative effects should not exceed 0.1 of the 96-hour LC50 at any time or place after mixing with the receiving waters. The 24-hour average of the concentration of these materials should not exceed 0.05 of the 96-hour LC50 after mixing. For toxicants which are persistent or cumulative, the concentrations should not exceed 0.05 of the 96-hour LC50 at any time or place, nor should the 24-hour average concentration exceed 0.01 of the 96-hour LC50.

Objectives in Table 1 represent minimum water quality conditions and are based on data produced by exposing healthy stress-free organisms to one variable at a time. The Objectives do not account for additive effects of more than one chemical nor for additional environmental stress arising from temperature and predation factors. Consequently, water with a quality at or near the Objectives for several parameters may not protect aquatic life because of synergistic effects.

Each Objective has been set on the basis of a scientific rationale. Supporting discussions on establishing Objectives have been taken from several sources and are compiled into a single document, available from the Ministry of the Environment, entitled: "Rationale for the Establishment of Ontario's Provincial Water Quality Objectives". The scientific data base used for setting the Objectives is constantly changing and new information may result in modification to a stated Objective from time to time.

It is not practical to treat all effluents so they meet the Objective concentrations. Therefore, some volume of water must be provided for dilution or modification of the waste effluent before the Objectives can be met. Within the mixing zone, where the Objectives are not met, there will be some damage or loss to the aquatic environment. Nevertheless, at no point should conditions be immediately lethal so that swimming organisms cannot evade the area. The mixing zone mainly represents a loss of habitat, but it must not be allowed to become an area where aquatic life is killed or seriously damaged. Procedures have been established for managing the mixing zones.

In addition to the specific water quality Objectives listed in Table 1, there are five general conditions which should be met:

All waters shall be free from substances attributable to man-caused point source or non-point source discharges in concentrations that:

1. Settle to form objectionable deposits;
2. Float as debris, scum, oil or other matter to form nuisances;
3. Produce objectionable colour, odour, taste or turbidity;
4. Injure, are toxic to or produce adverse physiological or behaviour responses in humans, animals or plants; or
5. Produce undesirable aquatic life or result in the dominance of nuisance species.

Table 1
Provincial Water Quality Objectives

INORGANICS AND OTHER PARAMETERS

Alkalinity and pH Alkalinity should not be decreased by more than 25% of the natural concentrations. The pH should be maintained within the range 6.5-8.5.

***Ammonia** Concentrations of un-ionized ammonia should not exceed 0.02 mg/L for the protection of aquatic life.

The percentages of un-ionized ammonia in aqueous ammonia solution for different temperature and pH conditions are listed below:

		pH								
		6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
Temperature °C	5	0.013	0.040	0.13	0.39	1.2	3.8	11	28.	56.
	10	0.019	0.059	0.19	0.59	1.8	5.6	16.	37.	65.
	15	0.027	0.087	0.27	0.86	2.7	8.0	22.	46.	73.
	20	0.040	0.13	0.40	1.2	3.8	11.	28.	56.	80.
	25	0.057	0.18	0.57	1.8	5.4	15.	36.	64.	85.
	30	0.081	0.25	0.80	2.5	7.5	20.	45.	72.	89.

For example, at 20°C and pH 8.0, a total ammonia concentration of 0.5 mg/L would give an un-ionized concentration of $0.5 \times 3.8/100 = 0.019$ which is less than the un-ionized Objective of 0.02.

Chlorine Total residual chlorine, as measured by the amperometric (or equivalent) method, should not exceed 0.002 mg/L.

Cyanide Concentrations of free cyanide in unfiltered sample should not exceed 0.005 mg/L.

Dissolved Gases To protect aquatic organisms, the total dissolved gas concentrations in water should not exceed 110 percent of the saturation value for gases at the existing atmospheric and hydrostatic pressures.

*Under certain temperature and pH conditions, the total ammonia criterion for the protection of aquatic life may be less stringent than the criteria for other beneficial uses.

Dissolved Oxygen At no time should dissolved oxygen concentrations be less than the values specified below:

Temperature °C	Dissolved Oxygen Concentration			
	Cold Water		Warm Water	
	Biota		Biota	
	% Saturation	mg/L	% Saturation	mg/L
0	54	8	47	7
5	54	7	47	6
10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In situations where additional physical and/or chemical stresses are present these minimum levels may prove inadequate and more stringent Objectives may be necessary.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the above-specified concentrations. Such a condition should not be altered by adding oxygen demanding materials causing a depletion of dissolved oxygen.

Hydrogen Sulfide Concentration of undissociated hydrogen sulfide should not exceed 0.002 mg/L, at any time or place, to protect aquatic life.

Oil and Grease Oil or petrochemicals should not be present in concentrations that:

- can be detected as a visible film, sheen, or discolouration on the surface;
- can be detected by odour;
- can cause tainting of edible aquatic organisms;
- can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or are deleterious to resident aquatic organisms.

Phenols Concentrations of phenols should not exceed 1 µg/L to protect against tainting of edible fish flesh. *ppb*

Phosphorus, Total Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should only be considered as general guidelines which should be supplemented by site-specific studies:

To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L;

A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 $\mu\text{g/L}$ or less. This should apply to all lakes naturally below this value;

Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 $\mu\text{g/L}$.

Radionuclides

Radiation exposure should be kept as low as reasonably achievable, economic and social factors being taken into account.

Radioactive materials should not be present in receiving waters as a consequence of the failure of an installation to exercise practical and economic controls to minimize releases.

Regardless of economic factors, the dose equivalent to individuals consuming the waters must not exceed the limits recommended for the appropriate circumstances by the Atomic Energy Control Board.

Water quality objectives based on these considerations will ensure that fish and other aquatic life will not receive hazardous doses of radiation.

Present objectives are as follows:

Gross beta emitters	1000 pCi/L
Radium-226	3 pCi/L

Where other radioisotopes occur, their significance should be assessed for each situation with respect to the potential hazard to humans and to aquatic life.

Temperature

1) General

The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

2) Waste Heat Discharge

(a) Ambient Temperature Changes

The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10C° (18F°). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10C° (18F°). Potential dischargers are to apply to the Ministry of the Environment for guidance as to the allowable temperature rise for each thermal discharge.

This Ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis.

(b) Discharge Temperature Permitted

The maximum temperature of the receiving body of water, at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature at a representative control location plus 10°C (18°F) or the allowed temperature difference, whichever is the lesser temperature. These maximum temperatures are to be measured on a mean daily basis from continuous records.

(c) Taking and Discharging of Cooling Water

Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the Implementation Procedures for Policy 3 (page 15).

Total Dissolved Solids

Dissolved Solids must not be added to increase the ambient concentrations by more than 1/3 of the natural concentrations to protect aquatic life. The added solids should not significantly alter the overall ionic balance of the receiving waters.

Turbidity

Suspended matter should not be added to surface water in concentrations that will change the natural Secchi disc reading by more than 10 percent.

HEAVY METALS

The following metal Objectives (except for mercury) are based on the total concentration of an unfiltered water sample. It is recognized that metals may not be toxic in particulate or bound form. It is quite possible for the total concentration in a given surface water to exceed the Objective without damaging any aquatic life. However, in the absence of any standard technique to measure the toxic components, it is assumed that all of the metal is in a toxic form unless specific data show otherwise. Further, an asterisk is placed before three parameters, namely arsenic, chromium and selenium, which have Objectives for aquatic life protection that are less stringent than the criteria for other beneficial uses.

***Arsenic**

Concentrations of Arsenic in an unfiltered sample should not exceed 100 µg/L to protect aquatic life.

Beryllium

For the protection of aquatic life, concentrations of beryllium should not exceed 11 µg/L

in an unfiltered sample of hardness less than 75 mg/L of CaCO_3 and not exceed 1100 $\mu\text{g/L}$ in an unfiltered sample of hardness greater than 75 mg/L of CaCO_3 .

Cadmium Concentrations of cadmium in an unfiltered sample should not exceed 0.2 $\mu\text{g/L}$ to protect aquatic life.

***Chromium** Concentrations of chromium in an unfiltered sample should not exceed 100 $\mu\text{g/L}$ to protect aquatic life.

Copper Concentrations of copper in an unfiltered sample should not exceed 5 $\mu\text{g/L}$ to protect aquatic life.

Iron Concentration of iron in an unfiltered sample should not exceed 300 $\mu\text{g/L}$ to protect aquatic life.

Lead The toxicity of lead is highly dependent on the alkalinity of the water. The toxicity declines as the alkalinity increases. The total lead concentration should not exceed the values given below:

Alkalinity mg/L as CaCO_3	Maximum lead Concentration $\mu\text{g/L}$
Up to 20	5
20 to 40	10
40 to 80	20
greater than 80	25

Mercury Concentrations of total mercury in *filtered* water should not exceed 0.2 $\mu\text{g/L}$ nor should the concentrations of total mercury in whole fish exceed 0.5 $\mu\text{g/g}$ (See Table 2).

Nickel Concentrations of nickel in an unfiltered sample should not exceed 25 $\mu\text{g/L}$ to protect aquatic life.

***Selenium** Concentrations of Selenium in an unfiltered sample should not exceed 100 $\mu\text{g/L}$ to protect aquatic life.

Silver Concentrations of silver in an unfiltered sample should not exceed 0.1 $\mu\text{g/L}$ to protect aquatic life.

Zinc Concentrations of zinc in an unfiltered sample should not exceed 30 $\mu\text{g/L}$ to protect aquatic life.

Unspecified Non-Persistent Toxic Substances and Complex Effluents For non-persistent compounds or mixtures with no Objectives because of a lack of specific data, their concentration should not exceed 0.05 of the 96 hour LC_{50} value for any approved test species.

PESTICIDES

The wide-spread use of pesticides for the control of undesirable plant and animal life will continue for the foreseeable future. Ideally, application practices and pesticide formulations strive for maximum impact on the target organisms. However, strict adherence to sound application practices do not necessarily ensure an effective containment of the chemicals used. The physico-chemical properties of substances and environmental transport processes have introduced the pesticide chemicals into the aquatic environment, often with undesirable side-effects on non-target communities of the biota. The risks to aquatic ecosystems depend on the chemical and physical properties of the pesticides, type of formulations, method and rate of application and the nature of receiving waters. While acute toxicity data and usage characteristics are considerations in environmental assessments, organic compounds with bioaccumulative potential and resistance to degradation have so far presented the greatest hazard to human and aquatic life.

The following are Objectives for pesticides in widespread use in Ontario. Objectives for several other pesticides with sufficient data for establishing Objectives are also listed. Several pesticides commonly used in Ontario, which do not have criteria listed here due to lack of sufficient data, are listed in Table 3. Criteria will be established for these compounds upon collection and review of biological data but until that time objectives of generic compounds should be used as guidelines for acceptable concentrations.

Maximum Concentration in $\mu\text{g/L}$ (unfiltered sample)		Remark
Actively Used Herbicides in Ontario:		
Dicamba (Banvel)	200.0	
Diquat	0.5	
Diuron	1.6	
Dalapon	110.0	
Simazine	10.0	
2, 4-D (BEE)	4.0	
Actively Used Insecticides in Ontario:		
Chlordane	0.06	
Chlorpyrifos (Dursban)	0.001	
Diazinon	0.08	
Endosulphan	0.003	
Fenthion (Baytex)	0.006	
Guthion	0.005	
Malathion	0.1	
Methoxychlor	0.04	
Pyrethrum	0.01	

Maximum Concentration in $\mu\text{g/L}$ (unfiltered sample)		Remark
Other Pesticides Not Actively Used in Ontario:		
Aldrin/Dieldrin	0.001	a
DDT and Metabolites	0.003	b, See Table 2
Endrin	0.002	a
Heptachlor and Heptachlor epoxide	0.001	a
Lindane	0.01	a
Toxaphene	0.008	
Parathion	0.008	

- a: The edible portion of fish should not exceed $0.3 \mu\text{g/g}$ for the protection of human consumers of fish.
- b: The whole fish (wet weight basis) should not exceed $1 \mu\text{g/g}$ for the protection of fish consuming birds.

INDUSTRIAL ORGANICS

Thousands of synthetic organic chemicals are in daily use as raw materials, products and additives. The potential hazards posed by many industrial organics are poorly understood because many of these compounds are ill-defined, being by-products of a main reaction and of little commercial concern.

Unlike pesticides which are specifically designed to be toxic to some target organisms in the environment and whose environmental persistence and toxicity are documented and regulated under licencing laws, it is only in recent years that the significance of organic contaminants has become recognized. In general, they degrade slowly or not at all and are frequently bioaccumulative. Organisms such as fish can accumulate over a period of time, pollutant concentrations thousands or millions of times the minute pollutant level in water (usually as low as a few parts per trillion). This accumulation may have a long-term deleterious effect on aquatic species and on human health.

For the control of industrial organics and other toxic substances, the Ministry will make use of the Implementation Procedures outlined for the "Hazardous Substances" Policy (page 20-22).

The Objectives outlined below for a small number of industrial organics are based on current toxicity data. Adoption of these Objectives does not imply that more stringent criteria will not be necessary in the future if other deleterious effects are detected. Further, these Objectives are intended as guidance for dealing with past release or accidental losses, but not for new releases.

Concentration in $\mu\text{g/L}$ (unfiltered sample)		Remark
Dibutylphthalate	4.0	
Diethylhexylphthalate	0.6	
Other Phthalates	0.2	
Dechlorane (mirex)	0.001	See Table 2
Polychlorinated Biphenyl	0.001	See Table 2





Consulting Engineers & Planners

OUR FILE: 9319-02
YOUR FILE:

30 March 1984

M.M. Dillon Limited
47 Sheppard Avenue East
WILLOWDALE, Ontario
M2N 5X5

Attention: Mr. W.F. Wells, P.Eng.
Project Manager

Burlington Landfill Continued Use -
Application for a Certificate of
Approval

Dear Sirs:

We are pleased to present the report on Surface Drainage contained as Appendix 'R' of the Technical Report filed in support of an Application for a Certificate of Approval for the continued use of the Burlington Landfill Site.

The writer will appear as a witness at the hearing before the Environmental Assessment Board on the basis of this report.

Yours truly,

M.M. DILLON LIMITED

A.K. Mitchell

AKM:llly
Encl:

A.K. Mitchell, P.Eng.
Senior Associate

SECTION R
SURFACE DRAINAGE

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2. SITE DRAINAGE	R-3
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SECTION R SURFACE DRAINAGE

1. GENERAL

The present site is drained by three ditches (see Figure R-1). The west or roadside ditch flows through a sediment basin to Falcon Creek. The east ditch drains to an intermittant tributary of Falcon Creek. The ditch draining the northeast corner of the site drains into the Indian Creek watershed. The boundaries of the Falcon Creek and Indian Creek watersheds are shown on Figure R-2.)

The continued use of the landfill will result in additional developed lands contributing to run-off in both the Indian Creek and Falcon Creek watersheds. This run-off must be accommodated by existing or new site ditches and ultimately by off-site watercourses. The impact on the site drainage system and on the receiving watercourses is discussed below.

2. SITE DRAINAGE

i) West Ditch

The net effect of the proposed landfill changes is to increase the drainage area to the sediment basin from 11.5 ha to 13.4 ha, an increase of 17%. Certain upstream reaches of the ditch will experience greater relative increases in drainage area. The ditch will ultimately have to be extended about 200 m around the north limit of the landfill as illustrated on Figure R-1.

11/8/2003
= 11/8/2003

Ditch sizing criteria used in past design has been to carry the 50-year flow without exceeding a flow depth of 0.45 m (1.5 ft.) while limiting 5-year flow velocities to 1.8 m/s (6 ft./s) on grass lined reaches.

rec'm

The existing ditch design was checked for adequacy under the proposed conditions, and was found to meet the previously established criteria. However, as velocities will be only marginally lower than the established limit on some reaches, the "as-constructed" ditch should be checked by survey to confirm compliance with the design. Field observations note a number of areas where minor improvements to ditch depth would result in greater security against overtopping.

Although the ditch appears to be satisfactory, the increased flows will necessitate up-sizing of some culverts. These will be confirmed following survey check on the ditch.

ii) East Ditch

Because of contour changes in the southern portion of the site, the drainage area contributing to the east ditch will actually decrease from 8.6 ha to 7.7 ha. The existing ditch which is presently functioning satisfactorily will continue to do so under the conditions of the proposed plans for continued use.

iii) Northeast Ditch

The ditch that has been built parallel to the existing fence-line will cease to exist under presently proposed plans (see Figure R-1). This ditch will be relocated to intercept drainage from the new landfill slopes and direct it to the same gully on the Indian Creek watershed.

Rec'n
is it not possible to make the ass't at this time?

The tributary will drain only 3.0 ha of landfill, 0.2 ha less than before, but field observations suggest that erosion protection of the gully will be necessary. Rip-rap lining and/or drop structures may be required. This will be assessed during final design work.

iv) New Perimeter Ditch

- new ditch to Indian Creek

A new perimeter ditch (see Figure R-1), will have to be constructed along the eastern limits of Phase B. It will drain to another gully leading to Indian Creek. The contributing drainage area to the ditch is 3.8 ha.

Rec'n

Erosion is occurring in the gully even under the present undeveloped conditions because of steep grades. To prevent erosion under the increased run-off conditions, grades will be reduced by filling some of the existing gully and providing drop structures. Rip-rap lining of portions of the gully will probably still be necessary.

The same consideration for erosion prevention will be given to the perimeter ditch upstream of the gully.

* 3. OFF-SITE WATERCOURSES

i) Falcon Creek

The drainage area of Falcon Creek above the North Service Road to the base of the escarpment is approximately 220 ha. The proposed site changes will add about 0.8 ha to this watershed that originally contributed to the Indian Creek watershed. The impact of the additional run-off from this land will be insignificant.

ii) Indian Creek

Although the drainage area contributing to Indian Creek will be reduced by 0.8 ha, surface cover changes and grade increases to part of the drainage area result in increased run-off rates. This run-off is carried by a tributary of the creek, portions of which are intermittently dry. At the property boundary with the NSP lands, the increase in peak flow will be about 50%. This increase in peak flow will diminish to about 25% where the tributary meets the North Service Road. At this point, it is joined by another tributary which will further reduce the percentage increase in peak flow.

In summary, one tributary of Indian Creek crossing the NSP lands is expected to experience peak flow increases of between 25% to 50%. This will be reflected by somewhat greater flow depths and velocities. However, it is not expected that erosion protection will be required. If erosion does become a problem, the Region will implement measures to control and eliminate erosion.

Downstream of the North Service Road, the impacts will be negligible for practical purposes.

off site water courses, impacts will be negligible
→ assuming only surface H₂O in ditches + creeks
if leachate in ditches and creeks, impacts may not
be negligible?



OUR FILE: 9319-02
YOUR FILE:

30 March 1984

The Regional Municipality
of Halton
P.O. Box 7000
1151 Bronte Road
OAKVILLE, Ontario
L6J 6E1

Attention: Mr. R.W.J. Moore, P.Eng.
Director of Public Works

Burlington Landfill Continued Use -
Application for a Certificate of
Approval

Dear Sirs:

NE { We are pleased to present the Design and Operations Report contained as Appendix 'S' of the Technical Report filed in support of an Application for a Certificate of Approval for the continued use of the Burlington Landfill Site. This report incorporates the results of investigations by others, contained in Appendices G to R. The basis for development of the site by the Region of Halton is contained in Appendix 'T' - Basis for Approval.

The writer will appear as a witness at the hearing before the Environmental Assessment Board on the basis of this report.

Yours truly,

M.M. DILLON LIMITED

W. F. Wells

W.F. Wells, P.Eng.
Senior Associate

WFW:llly
Encl:

SECTION S
DESIGN AND OPERATIONS

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SECTION S

DESIGN AND OPERATIONS

1. SITE DESIGN

1.1 Design Approach

The basis of the design and operational planning is the development of a phased concept which would permit landfill closure prior to completion to final grades. By extending landfill operations in orderly phases it is possible to use only as much capacity as is required prior to a Regional waste management system being put in place.

Four phases for continued use; A, B, C, and D are proposed. Landfill operations in Phases A and C will be carried out above existing landfill grades while Phases B and D will extend the limits of fill into the existing buffer zone. Operational requirements consider the various design components to ensure that the phases are compatible with each other.

Site design considered the final and base contours as well as the design of surface drainage and leachate control works. The difference between the final and base contours establishes the volume available for landfiling. The difference between the base contours, which set the depth and grading of the excavations, and the existing contours gives the volume of earth to be excavated for cover material.

As part of the approval for the expansion in 1980 a contingency plan for the Falcon Creek valley was prepared and

approved in principle by Regional Council. The basis of the plan was the design of an interceptor system should the ground water monitoring program indicate that leachate was degrading Falcon Creek. The contingency plan, as part of this application, will be redesigned to ensure protection of Falcon Creek from the new portions of the landfill.

Design criteria established in the hydrogeological study were used to establish the base contours, the design of the leachate control works, and the development of the monitoring program.

1.2 Final Contour Design

The proposed final contours for each of the four phases of continued use are shown on Figures S-1, S-2, S-3, and S-4. The maximum proposed elevation, which would occur with the development of Phase D, is 10 m higher than presently approved final contours.

Landfill slopes will be finished to a maximum grade of 4:1 and a minimum grade of 5%. These grades, consistent with the present design, will promote surface drainage off the fill area without causing excessive erosion. The toe of slope coincides with the limit of landfilling and will be setback a minimum of 10 m from the brow of ravine slopes to allow sufficient area for the construction of drainage works (see Section R).

Should landfill operations be scheduled for termination prior to the completion of any one Phase, landfilling will continue at least until final grades fall within the criteria set above.

1.3 Base Contour Design

The proposed base contours for Phases B and D are illustrated on Figure S-5. Landfilling operations for Phases A and C will continue on from existing grades once final cover has been removed.

The Hydrogeological Study recommends that future excavations should extend to at least the limit of the till's upper fracture zone to minimize leachate exfiltration through the landfill's base. The fractured zone is approximately 6.5 m below ground surface at the north end and gradually decreases to 2.5 m below ground at the south end of Phase B. In areas where this amount of excavation is not possible, Gartner Lee recommends that the base contours be over excavated by 0.6 m. The excavated soil would be replaced in 0.2 m lifts and compacted to 95% standard Proctor. The cell floor would then be inspected to ensure that no fracturing exists.

The Hydrogeological Study also recommends that a minimum of 1.5 m of glacial till separate the waste from the bedrock.

Taking the above into account, base contour plans were developed so as to maximize site capacity while providing sufficient earth cover for the landfill's operational requirements. Other design parameters allow for the installation of leachate collectors at a minimum grade of 1%. In order to facilitate surface drainage and minimize ponding, a minimum base slope of 2% was also set. Both parameters are consistent with the present site design.

The resultant depths of excavation generally vary from 7 m (not including the removal of cover material stockpiles) to no excavation at all. In order to achieve the proper base grades and slopes of leachate collector piping, the southern portion of Phase B must actually be filled over the present ground elevations.

Excavation side slopes are 2:1 maximum. These slopes should be inspected for sand seams to determine the need for special treatment prior to landfilling. Where excavation depths are less than 2 m, berming will be added to provide a total side slope height of 2 m. These berms will be constructed with the clay till excavated on site properly compacted in 0.2 m lifts. Berming will be required around Phase B's southern limit of fill.

1.4 Site Quantities

A summary of site quantities, broken down to the proposed phases, is provided on Table 1. As indicated, an average gross refuse density of 700 kg/m^3 was used to estimate available waste capacities. Previous site capacity updates support this figure.

In estimating cover material quantities, an allowance of 0.6 m is made for final cover and a 4:1 refuse to cover ratio was used to calculate daily and intermediate cover requirements. Depending on the phases completed, sufficient cover material may be provided by the on-site excavations. Cover material will also continue to be obtained, in all likelihood, from off-site sources. Any excess fill from the excavations or off-site sources will be stockpiled for later use, possibly to supplement the in-place final cover.

TABLE 1
SITE QUANTITIES

	<u>PHASE A</u>	<u>PHASE B</u>	<u>PHASE C</u>	<u>PHASE D</u>
LANDFILL VOLUME AVAILABLE				
Total Volume	159,600 m ³	152,800 m ³	454,000 m ³	181,300 m ³
Final Cover (0.6 m depth)	-	25,100 m ³	-	9,200 m ³
Daily and Intermediate Cover (@ 4:1 refuse to cover ratio)	31,900 m ³	25,500 m ³	90,800 m ³	34,400 m ³
LANDFILL CAPACITY				
Refuse Volume	127,700 m ³	102,200 m ³	363,200 m ³	137,700 m ³
Refuse Weight (@ 700 kg/m ³)	89,400 tonnes	71,500 tonnes	254,200 tonnes	96,400 tonnes
Estimated Life of Phase	6.1 months	4.7 months	16.5 months	6.1 months
Interim Closure Date*	Feb 1985	June 1985	Nov 1986	May 1987
EXCAVATION AND COVER MATERIAL				
Volume of Earth Excavated (allowing 15% bulking)	-	132,800 m ³	-	115,800 m ³
Final Cover Required	2,900 m ³ **	25,100 m ³	7,300 m ³ **	9,200 m ³
Daily and Intermediate Cover	31,900 m ³	25,500 m ³	90,800 m ³	34,400 m ³
Non-Operational Requirements (berms etc.)	-	6,500 m ³	-	-
Net Surplus (Deficit)	34,800 m ³	75,700 m ³	98,100 m ³	72,200 m ³
Cummulative Surplus (Deficit)	(34,800 m ³)	40,900 m ³	(57,200 m ³)	15,000 m ³

* Assuming landfilling commences 1 August 1984 in Phase A.

** Assuming in-place final cover excavated and re-used with 10% loss

An allowance (15%) has been made for bulking of excavated fill quantities.

The final cover requirements and the net surplus/deficit figures shown on Table 1 are premised on landfill closure after completion of the phase in question. The cumulative surplus/deficit quantities assume all phases are completed and that excavations in one phase will be undertaken concurrently with landfilling in others. This will allow landfilling operations to continue, uninterrupted, from one phase to another.

1.5 Leachate Collection

 The existing Burlington landfill is equipped, to varying degrees, with leachate control facilities. A retrofitted toe-drain system is now in operation to reduce leachate mounding and to control leachate springs around the periphery of the southern portion of the landfill. The Phase II expansion area, approved in 1980, was designed with a full under-drain and toe drain system for the control and collection of leachate. Collected leachate from the two systems is routed through a common transmission sewer to the existing sanitary sewer opposite the Tridon plant on the North Service Road. From here, flows are directed through the sewer system to the Burlington Skyway Water Pollution Control Plant (leachate treatment at this plant is discussed in Section P). { A flow metering station has been installed to record flows discharging from the landfill site. }

The engineered leachate control system in the Phase II area will be extended to the north and east to service the proposed continued use areas. The system extensions are illustrated on Figure S-6.

The toe drain, which will be installed around the perimeter of the new excavation, helps prevent leachate breakout on the landfill's side slopes. Rubble or porous material is used to ensure a hydraulic connection up the wall of the excavation redirecting any horizontal leachate movement downward, to the toe drain. Leachate collected by the underdrain system is also routed through the toe drain to eventually be directed to the off-site transmission sewer.

The underdrain system comprises parallel runs of 150 mm diameter perforated pipes spaced at maximum intervals of 40 m (as recommended in the Hydrogeological Study).

All collector piping will be installed a minimum of 0.3 m below base contours. At least 0.5 m of graded granular material will then be placed over the piping to protect it from damage by on-site vehicles and to ensure that silting of the pipes does not occur. Around the perimeter of the landfill, at both ends of each section of the collector piping, manholes will be installed for inspection, maintenance and monitoring.

It is estimated by Gartner Lee Associates Limited that leachate generation rates of 5.7 L/min/ha can be expected during site operation. Leachate volumes will reduce to 3.4 L/min/ha once final cover has been placed. It is further calculated that the engineered leachate control system will collect 90% of all leachate produced in the underdrained areas.

1.6 Leachate Contingency Program

Preliminary design work for a leachate contingency system to serve the existing site is presented in two earlier reports; Burlington Landfill Site - Leachate Contingency System, M.M. Dillon Limited, 28 September 1981 and Hydrogeological-Geotechnical Study Report - Contingency Leachate Collection System, Gartner Lee Associates Limited, 14 August 1980.

A ground water interceptor system, installed below the water table in the area between Falcon Creek and the landfill, was proposed in these reports. This system would create a localized ground water drawdown and thus intercept leachate flow from the landfill to the Creek. This system is to be implemented should ground and/or surface water monitoring establish a leachate contamination problem at Falcon Creek.

Should such a problem appear to be occurring, the source and cause of contamination will initially be identified. If the situation can be satisfactorily corrected (i.e. by eliminating a leachate spring or by repairing a failed section of leachate collector piping) appropriate measures will be undertaken immediately. The contingency system will be employed should remedial measures either not be possible or fail to prove effective and contamination problems persist.

The continued use of the Burlington site necessitates the northerly and easterly extension of the contingency system along Falcon Creek to the site's property boundary. The proposed collector alignment is shown, along with that previously envisaged, on Figure S-6.

The contingency system's design is consistent with that presented in the earlier reports. Generally, a perforated

drain pipe would be bedded in a trench located along the south side of the Creek. The base of the interceptor trench would be below the Creek's bottom likely at depths of 3 m or less. The side of the trench closest to Falcon Creek would be lined with clay or an artificial membrane to prevent the inflow of uncontaminated Creek water. Once backfilled with stone, the top of the trench would be similarly sealed to reduce surface water infiltration.

The total length of the collector trench could conceivably reach 1,700 m. The actual length constructed would depend on where the leachate problems were occurring. Using a previously estimated capture rate of 0.2 L/min/m of trench length, as much as 340 L/min of ground water could be collected.

Two options are available for the off-site transmission of the collected groundwater for treatment at the Burlington WPCP. These are:

- i) Direct Discharge to Leachate Transmission Sewer - Collected water would flow, by gravity, along a southerly extension of the collection trench to the existing leachate transmission sewer on the North Service Road.
- ii) Discharge to the Leachate Collection System - Here, the interceptor trench would discharge to a pumping station which would direct the captured water, via a forcemain, to the existing on-site collection system. From this point, flows would combine with the leachate collected on-site and be directed, through the existing system, to the transmission sewer along the North Service Road.

The potential discharge rates of the contingency system should not pose a significant hydraulic or biological impact to the Burlington Skyway WPCP.

Should implementation of the leachate contingency plan proceed, a detailed geotechnical investigation would be required to support the final design process.

1.7 Site Access

The existing site entrance located on the North Service Road will continue to be used for site access.

Internal access roads will be constructed as necessary to the landfill's working face. Where site drainage routes cross these access roads, ditching and culverts will be installed to keep the road from becoming saturated during wet weather.

2. SITE OPERATION AND DEVELOPMENT OF PHASES

2.1 Staging of Operations

As previously discussed, the proposed continued use of the Burlington landfill will be undertaken in four phases: A, B, C, and D. Each phase will be completed to its proposed final contours before landfilling commences on the next. Site preparation work, however, may occur in one phase concurrently with landfilling in another. For example, excavation, base preparation and the installation of leachate collectors

would be commenced in Phase B while Phase A is being landfilled. This process allows a smooth transition between phases and provides an uninterrupted source of refuse capacity.

Once the new Regional landfill site has been developed and is ready to receive refuse, the Burlington landfill will be closed in a manner consistent with its site design standards.

2.2 Operational Development

Site operations discussed herein are grouped in accordance to the time in which they would occur. The preparation of excavations and the installation of leachate collection system components will be carried out as discussed in Sections 1.3 and 1.5, respectively.

Prior to landfilling in Phase A, the following activities must be undertaken (see Figure S-7):

- i) Extend the perimeter access road to this area.
- ii) Raise the Bell Canada telephone line.
- iii) Remove the in-place final cover to a sufficient extent to permit the initial landfilling operations. Stockpile cover in areas shown. (Final cover must be removed completely to avoid future problems with perched leachate springs.)

2.2.1 Phase A Landfilling

Phase A should provide sufficient refuse capacity to support landfilling for approximately 6.1 months. Assuming operations commence here at the start of August 1984, the Phase's projected completion would therefore be in February 1985. The following site activities, illustrated on Figure S-7, will be undertaken concurrently with the development of Phase A:

- i) Commence landfilling in the area initially stripped of final cover. Continue in ordered lifts stripping and stockpiling in-place final cover as required.
- ii) Use cover material stockpiles to supply daily and intermediate cover requirements.
- iii) Progressively replace final cover as new final contours are reached.
- iv) Construct an access road to Phase B.
- v) Commence excavations in Phase B and continue from south to north. Stockpile excavated material in area shown at north end of site. Supplement, as needed, the cover material stockpiles in Phase A.
- vi) Close off any wells, boreholes or other possible ground water conduits in the Phase B area. Inspect base of excavation and side slopes for fractures and sand seams.

- vii) Infill the southern section of Phase B to the proposed base contours and construct the perimeter toe berm (discussed in Section 1.3). Earth fill used on the base and in the berms will be placed in 0.2 m lifts under proper moisture conditions and compacted to 95% standard Proctor.
- viii) Install perimeter fencing and ditching to service Phase B.
- ix) Begin installing Phase B's leachate collection system from south to north.

2.2.2 Phase B Landfilling

Assuming landfilling operations in Phase A are finished in February 1985, the refuse capacity provided by Phase B should last until June 1985 (approximately 4.7 months). The following site activities, illustrated on Figure S-8, will be undertaken concurrently with landfilling in Phase B:

- i) Commence landfilling in the southern section of Phase B and proceed northerly in ordered lifts.
- ii) Finish placing final cover on Phase A area. Rehabilitate slopes as soon as climatic conditions permit.
- iii) Complete excavation work in Phase B to northern limit of fill. Excavated material will be used to supply daily and intermediate cover requirements as well as for final cover on Phase A, if needed. Excess fill to be stockpiled in area shown.

- iv) Complete construction of Phase B's leachate collection system.
- v) Place intermediate cover only on Phase B's completed slopes. Cover depth will be increased to final cover specifications should Phase C not proceed.
- vi) Extend access road to Phase C's initial working area.
- vii) Begin stripping final and intermediate cover on the existing site's northern slopes in preparation for landfilling in Phase C

2.2.3 Phase C Landfilling

Approximately 16.5 months of waste capacity is provided by Phase C. Assuming landfilling finishes in June 1985 for Phase B, Phase C's landfill operations should last until November 1986. Figure S-9 illustrates site operations undertaken during this period.

- i) Begin landfilling on the northern section of Phase C and proceed south. Extend, as necessary, the height of leachate collection manholes along the western boundary of Phase B to accommodate the higher refuse lifts.
- ii) Progressively strip in-place final and intermediate cover prior to landfilling. This material, to be stockpiled in conveniently located areas, will be used to supply daily and intermediate cover requirements.

- iii) As Phase C's proposed final contours are reached, final cover will be placed with the exception of areas affected by the development of Phase D where only intermediate cover will be placed. Slopes receiving final cover are to be rehabilitated as soon as climatic conditions permit.
- iv) Construct a site access road to Phase D's initial working area.
- v) Commence excavations for Phase D proceeding from east to west. Excavations will expose the existing northern limit of refuse to ensure a hydraulic connection with previously developed areas.
- vi) Close off any wells, boreholes or other possible ground water conduits in the Phase D area. The base of excavation and side slopes will be inspected for fractures and sand seams.
- vii) Construct perimeter ditches surrounding Phase D.
- viii) Begin installing Phase D's leachate collection system from east to west.

2.2.4 Phase D Landfilling

Phase D should provide 6.1 months of waste capacity for an ultimate site closure date of May 1987. The following site activities, shown on Figure S-10, will be undertaken as Phase D is landfilled:

- i) Commence landfilling and proceed in ordered lifts from east to west.
- ii) Finish final cover on southern sections of Phase C area. Rehabilitate these slopes as climatic conditions permit.
- iii) Complete excavation work in Phase D to western limit of fill. Excavated material will be used to supply daily and intermediate cover requirements as well as for final cover on Phase C. Excess fill to be stockpiled in area shown.
- iv) Complete construction of Phase D's leachate collection system.
- v) Progressively place final cover on Phase D area as the final contours are achieved.

2.2.5 Site Closure

Once landfilling operations cease on the Burlington site, any cover material remaining in stockpiles may be used to supplement the in-place final cover. Site rehabilitation measures, commenced as individual areas of the site were finished, will then be completed.

Depending on the site's ultimate after-use plan, certain buildings and facilities may be removed upon closure. The weigh scales will be relocated to the new Regional landfill site.

2.3 Daily Operations

In 1984, incoming waste quantities are anticipated to average 610 tonnes/day (based on a 5-1/2 day operating week). This daily average is expected to rise to 660 tonnes/day in 1987.

Based on the above, on a normal working day, a single working face having a dumping width of 30 m to 50 m will be adequate. The size of the working face may vary beyond this range to accommodate higher rates of landfilling and an increased number of incoming vehicles. Every effort will be made, however, to keep the working face size to a workable minimum. Compaction efficiencies, vector control, the use of cover material, etc. are all improved on smaller working faces.

A ramped method of landfilling will be employed. This involves the dumping of refuse at the base of a sloped working face where it will be spread up the slope into 0.3 m to 0.6 m layers. Refuse compaction will then be carried out by landfill compactors making a minimum of three passes. The maximum slope of the working face will be 3:1 while the depth of each refuse lift will be limited to 2.5 m. These operating procedures have been shown to yield refuse densities at the Burlington landfill in the order of 700 kg/m³.

The following is the schedule for cover material application.

- i) Daily Cover - at the end of each working day 150 mm of earth cover will be placed over all exposed refuse.
- ii) Intermediate Cover - in areas where landfilling will not be carried out for extended periods, at least 250 mm of

earth cover will be applied to facilitate the movement of equipment and to prevent the erosion of earth cover and exposure of refuse.

- iii) Final Cover - completed landfill areas will receive a minimum of 600 mm of earth cover. This cover will be vegetated as soon as climatic conditions permit.

Daily and intermediate cover applications will either be broken up or removed prior to adding subsequent lifts of refuse. In this way perched leachate springs (caused when these layers of cover material impede the natural downward movement of infiltrating water) will be eliminated.

2.4 Surface Drainage Control

As landfill operations progress, site contours and drainage patterns alter frequently. Surface water control will be exercised both within and outside of the working area to move surface drainage away from site operations. Interior, temporary drainage systems will therefore be continually constructed. These systems include:

- i) Temporary ditches constructed around proposed excavations. These ditches will discharge to the permanent perimeter ditches.
- ii) Ongoing grading during landfiling to minimize surface ponding. Minimum working grades to be 2%.
- iii) The use of portable pumps to drain ponded areas.

Access roads, scale approaches and dumping areas will be adequately crowned so that vehicle access is not hindered during wet site conditions.

2.5 Site Maintenance

The various facilities, buildings and site works will be maintained in a clean, tidy condition and in good working order through the following routine conditions:

1. Areas where landfilling will not be carried out for extended periods and where erosion and/or refuse exposure has resulted, will be regraded and, if required, additional earth cover placed.
2. Finished areas will be routinely checked for erosion and regraded and vegetated, as required.
3. All ditches and swales will be re-excavated and graded as needed to keep them clear of silt, debris and weeds.
4. Entrance areas will be maintained in a tidy condition with grasses cut and maintained. Entrance gates, signs and roadways will also be kept in good repair.
5. Leachate collector manholes will be inspected periodically and sumps cleaned as necessary.
6. All buildings will be kept in a clean, tidy appearance and repaired and painted as required.
7. Internal access roads will be regarded periodically and additional granular material applied as required.

2.6 Access Control

The existing site is fenced with a lockable entrance gate. Site access by the public will be restricted to normal operating hours during which the gate will be open and vehicular entry is controlled by the site scaleman. At other times the gate will be closed and locked.

Perimeter fencing, already in place, will be extended as necessary to deter unauthorized entry.

2.7 Litter Control

A regular program for litter control has been undertaken for the existing operations and will be maintained for the continued operations. This program comprises the following:

1. The daily pick-up of litter on and adjacent to the landfill property by a groundkeeper. Additional staff are brought in as necessary on a part-time basis.
2. Portable litter fences installed at the working face to control the on-site spread of litter. These fences are positioned in accordance with the advance of the working face and the daily prevailing wind direction.
3. Perimeter fencing, already in place, will be extended as necessary to surround new landfiling areas and assist in litter control.

4. During seasonally windy periods, efforts will be made to establish the working face in sheltered areas and to keep its size to a minimum. Furthermore, during these periods, wastes will be compacted as soon as practical.

2.8 Dust Control

Dust control measures will be undertaken during dry weather conditions and will comprise the application of water or calcium chloride to non-paved roads. Waste oils will not be used for dust control.

Calcium chloride will not be used for applications within 10 m from the brow of the Falcon Creek ravine slopes.

2.9 Site Equipment

At present, the following equipment is employed on-site:

- two landfill compactors
- two bulldozers
- one track-type loader
- elevating scrapers (number will vary with need)
- one grader

The landfill compactors are assigned to the working face for the spreading and compacting of refuse. The track-type loader is primarily used for the handling and spreading of cover material and for site maintenance. Elevating scrapers, assisted as necessary by a bulldozer, are used to excavate, transport and stockpile cover material. The grader is used for road maintenance.

Additional equipment may also be used occasionally on a part-time basis to assist in site works.

2.10 Operating Hours

Site operating hours will remain the same as those presently in force. The site is open Monday to Saturday from 8:00 a.m. to 5:30 p.m. with the exception of the period from 1 October to 30 April when the site will close at 4:00 p.m. on Saturdays and holidays. The site is closed Sundays, Christmas Day and New Year's Day.

3. SITE RECORDS AND OPERATIONS MONITORING

3.1 Waste Quantities and Site Updates

Daily records will be kept of the following information:

- i) number and type (by category) and approximate time of arrival of incoming vehicles;
- ii) weights of refuse received;
- iii) weights (or volumes) of clean fill imported to the site;
- iv) ultimate use made of imported and excavated fill (e.g. cover for landfill, berm or access road construction, etc.);
- v) revenues collected.

Records will also be kept of the progress of excavations and of the placement of intermediate or final cover. These records will be kept as frequently as site conditions change.

Landfill development will be monitored semi-annually through the use of aerial photography. Contour mapping will be derived from this photography and using computer-assisted volume calculations, site capacity updates will be carried out. Checks will be made at these times to monitor the use of cover material and to ensure sufficient final cover material is available.

In addition to the above, inspection records will be kept on the installation of site works, in particular the installation of leachate collector systems. Notes will be made on the type of materials encountered during excavation, ground water conditions, any problems encountered during construction, construction materials used and installation procedures.

3.2 Water Quality Monitoring

A ground and surface water monitoring program is currently in-place for the Burlington landfill. This program will be maintained with modifications, as needed, to monitor the Phase B and D areas. Continued attempts will also be made to further define the existing leachate plume.

Details of the water monitoring programs are provided in the Hydrogeological Study (Section 0). Program specifics will be finalized in consultation with the Ministry of the Environment based on the approved plan for landfilling. An annual review and assessment of the monitoring programs will be prepared for submission to the Ministry.

3.3 Gas Monitoring

As discussed in the Hydrogeological Study (Section 0), any gas produced at the site will naturally tend to vent by upward movement. Once vented to the atmosphere, these gases (primarily methane and carbon dioxide) will disperse with no adverse public health effects.

If, in the future, development encroaches the landfill site, the need for gas monitoring must be re-assessed.



SECTION T
BASIS FOR APPROVAL

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BASIS FOR APPROVAL

The Burlington landfill site's existing Conditions of Approval (discussed in Section F) were reviewed for applicability to the Region's continued use proposals. Of the Conditions still appropriate to this Application, suggested wordings are presented below:

- i) Liquid industrial and toxic waste including pathological waste, industrial, chemical and sewage sludges, hazardous waste, septic tank pumpings, radioactive waste and processed organic waste will not be accepted for disposal at the landfill site.
- ii) The Regional Municipality of Halton will carry out the predictive monitoring programs including the submissions to the Ministry of the Environment of annual monitoring data as required by the Director of the Environmental Approvals Branch of the Ministry of the Environment.
- iii) Regular progress reports on landfilling operations including the following information:
 - a) results of an interpretive analysis of all monitoring programs for gas and leachate;
 - b) yearly summary of volumes and weights of waste handled at the site;

- c) environmental and operational problems encountered during the operation and mitigating actions taken;
- d) quality and quantity of leachate discharged into the sanitary sewer system;
- e) assessment of the operation and performance of all gas and leachate control facilities.

are to be submitted to the Director of the Environmental Approvals Branch, Ministry of the Environment.

- iv) Prior to landfilling in the Phase B, C and D areas, details of the surface drainage works and sediment control measures are to be submitted by the Regional Municipality of Halton and approved by the Director of the Environmental Approvals Branch, Ministry of the Environment.
- v) Prior to landfilling in Phases B and D, final plans, specifications and an engineer's report on the toe-drain and under-drain leachate collector system are to be submitted to and approved by the Director of the Environmental Approvals Branch, Ministry of the Environment.
- vi) No landfilling shall take place in Phases B and D until all boreholes, any gas or water wells, and any other conduits for possible leachate movement within the actual landfill area are identified and properly sealed to the satisfaction of the Director of the Environmental Approvals Branch, Ministry of the Environment.
- vii) Prior to landfilling in Phases B and D, the Municipality shall certify that the site preparation work has been completed in accordance with the plans and specifications approved by the Director of the Environmental Approvals Branch of the Ministry of the Environment.

viii) Within four months prior to the closure of the site, a complete closure plan pertaining to the termination of landfilling operations at the site, together with a schedule of dates and details as to the following stages:

- a) planning of the work required to restrict access to and landscape the closing site;
- b) information to and education of the public of the closure plan;
- c) implementation of the site rehabilitation procedures;
- d) maintenance of the closed site by periodic inspections to ensure the control of erosion and the integrity of the revegetated cover;
- e) the long-term care and maintenance of gas and leachate monitoring and control facilities;

is to be submitted for approval to the Director of the Environmental Approvals Branch, Ministry of the Environment.

ix) Within six months following the termination of landfilling operations at the site, two copies of as constructed site plans, including details of the final development contours, fill line, buffer zones, site boundaries, location of works, easements, monitoring stations and pollution control facilities are to be submitted to the Director of the Environmental Approvals Branch, Ministry of the Environment.

x) No part of the landfilling site shall be conveyed prior to or after closing of the site to any person by the applicant or any transferee from the applicant except to a Federal or Provincial Government, or any agency thereof without the prior approval of the Director of the Environmental Approvals Branch, Ministry of the Environment.

- xi) No operation shall be carried out at the site after one hundred and twenty days from these conditions becoming enforceable unless this Certificate including the reasons for these conditions has been registered by the applicant as an instrument in the appropriate Land Registry Office against title of the site and the duplicate registered copy thereof has been returned by the applicant to the Director of the Environmental Approvals Branch, Ministry of the Environment.

This Application also commits Halton Region to certain actions in support of continued landfilling at the Burlington site. These actions, formed mostly in the recommendations presented in the various technical sections, do not necessarily translate directly into future Conditions of Approval. They are summarized herein, however, simply to confirm the Region's responsibilities and its commitment to a safe and well engineered waste disposal system.

Therefore, the Region shall:

- terminate landfill operations at this site, consistent with the plans developed herein, once the new Regional waste disposal site is ready to accept refuse;
- carry out the preparation of excavations, installation of leachate control systems, operational development, cover material application and surface drainage control all in accordance with the recommendations set out herein;
- maintain adequate on-site drainage while ensuring erosion does not occur in off-site drainage courses as a result of the landfill operations. Erosion protection measures will be implemented as required;

- maintain the various site facilities and site works in an acceptable state consistent with this report's recommendations;
- continue litter and dust control programs;
- require adequately muffled construction and operating equipment to be used on-site. Deny reasonable access to vehicles in poor repair;
- continue the water, leachate and operational development monitoring programs (with modifications to include the Phase B and D areas) as recommended in Sections O, P and S, and as may be modified by the Ministry of the Environment from time-to-time;
- construct a right-turn lane on the North Service Road at the site entrance for vehicles approaching from the east;
- progressively rehabilitate site areas as final contours are achieved. The rehabilitation program will attempt to provide the best possible screening of site views from adjacent properties. Site after-use and rehabilitation to be complementary to the goals and objectives of the Parkway Belt West Plan;
- continue to rehabilitate the eroded Falcon Creek slopes;
- employ the leachate contingency plan should the monitoring programs establish continual contamination problems at Falcon Creek and should remedial measures either not be possible or fail to prove effective;
- continue to inform and involve the public in decisions affecting management of this site.