BURLINGTON LANDFILL SITE

Design and Operations Report

REGIONAL MUNICIPALITY OF HALTON

DILLON
Consulting Engineers & Planners

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OUR FILE: 8376-01
YOUR FILE:

30 January 1980

Regional Municipality of Halton
1151 Bronte Road
Oakville, Ontario L6J 6E1

Attention: Mr. D.J. Corbett, P.Eng.
Manager of Construction

Burlington Landfill Site
Design and Operations
Draft Report

Dear Sirs:

We are pleased to submit the Design and Operations Report for the Phase II expansion of the Burlington Landfill Site. This report along with the Hydrogeological Study prepared by Gartner Lee Associates Limited will form the basis for an application to the Ministry of the Environment for a hearing before the Environmental Assessment Board and a Certificate of Approval.

Quantities in this report are given in metric units with imperial units given in parentheses. For clarity the presentation of detailed tabular data is made in metric units in the body of the report and in imperial units in Appendix 1.

Yours truly,

M. M. DILLON LIMITED

W. F. Wells

WFW:gg
Encl..

W.F. Wells, P.Eng.
Project Manager

REGIONAL MUNICIPALITY OF HALTON
BURLINGTON LANDFILL SITE
DESIGN AND OPERATIONS REPORT

M. M. DILLON LIMITED
CONSULTING ENGINEERS AND PLANNERS

8376-01

JANUARY 1980

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1. INTRODUCTION

1.1 Purpose and Scope

This report provides the basis for the design, construction and operation of the proposed expansion of Burlington Landfill Site and additional capacity on the existing site. The design integrates the expanded operation with that of the existing site.

The design of the site works and facilities is based on the recommendations of the Hydrogeological Study prepared by Gartner Lee Associates Limited.

An environmental analysis was undertaken by Dillon staff. This report contained in Appendix A was prepared to meet the intent of the Regional Official Plan respecting environmentally sensitive areas and policies of the Parkway Belt West Plan.

The recommendations of both these reports were considered and incorporated as required into the design and operating plans for the Burlington Site. The plan also meets the intent of the Ministry of the Environment guidelines and regulations respecting landfills.

1.2 Background

On 5 July 1978, Regional Council authorized M.M. Dillon Limited to prepare a study to recommend the best strategy for the provision of landfill capacity until such time as

major new Regional facilities for waste disposal and/or processing could be approved and developed.

Based on the investigations and recommendations of that study, Council adopted a plan for the development of additional capacity to include:

1. Expansion of the Oakville Landfill Site comprising the development of lands to the east of the present site.

2. Modification of final contours to the existing Burlington Landfill Site. Referred to as Phase I of the Burlington Landfill expansion, this phase comprises the provision of additional depth of landfilling on the north portion of the existing site.

3. Expansion of the existing Burlington Landfill Site onto adjacent property. Referred to as Phase II of the Burlington Landfill Site expansion, this phase comprises the acquisition of lands to the north of the present site and the development of additional landfill capacity on the existing area and the expanded landfill area.

This report is prepared as the basis for the application for the Phase II expansion onto lands adjacent to the site and a regrading of the area known as Phase I.

2. WASTE QUANTITIES AND CHARACTERISTICS

2.1 Rates of Refuse Generation

Based on the data presented in the Review of Waste Quantities and Characteristics prepared by M.M. Dillon Limited in February 1979, and on a review of recent landfill weight records, the following projections have been derived for rates of refuse generation in the Region and for the City of Burlington.

TABLE 1A*
PROJECTED RATES OF REFUSE GENERATION

ESTIMATED ANNUAL TONNAGES

Year	Burlington (tonnes)	Regional Total (tonnes)
1980	87,000	188,000
1981	89,000	193,000
1982	91,000	200,000
1983	94,000	208,000

* See Appendix A - Table 1B for quantities in imperial units.

These estimates were based on recent population forecasts and on records of the weighed refuse at the Region's existing sites.

2.2 Remaining System Capacity and Estimated Site Closure Dates

On 4 May 1979, aerial photography was taken of the Region's three remaining landfill sites. Contour mapping was generated for these sites and computer assisted volume calculations carried out. A field survey was carried out at the Georgetown Site on 14 July 1979 to update mapping derived from the aerial photographs. Based on these surveys it is estimated that the remaining capacity is:

TABLE 2A*
REMAINING LANDFILL CAPACITY

Site	Date of Estimate	Capacity Remaining (m^3)
Georgetown Landfill	14 July 1979	27000
Oakville Landfill	4 May 1979	184000
Burlington Landfill	4 May 1979	333000

* See Appendix 1 - Table 2B for quantities in imperial units.

These volumes represent the volume between the existing contours and approved final contours. At the Burlington Site, current operations include excavations for cover material supply and for landfilling capacity. The volume of proposed excavations has been included in the calculations.

Using remaining site capacities, and rates of landfilling, the following site closure dates have been estimated.

TABLE 3
ESTIMATED SITE CLOSURE DATES

Site	Estimated Closure Dates
Georgetown Landfill*	October 1979
Oakville Landfill	April 1980
Burlington Landfill	July 1980

* now closed

Landfilling operations at the Georgetown Landfill were discontinued on 31 October 1979 and replaced by a container system available for public use. Wastes formerly accepted from commercial and municipal haulers have been diverted to the Oakville Site.

2.3 Site Capacity and Operating Life

Based on the designs of the proposed expansions, and rates of landfilling, the operating life for each expansion and for the combined expansions are given in Table 4.

The rates used in the calculations for waste generation are averaged over the estimates of operating life.

Existing approved capacity in Halton will be fully utilized by July 1980. If the Burlington landfill is the only site then available for Regional wastes the Phase I expansion will provide capacity for an additional eight months, that is until the Spring of 1981 and the Phase II expansion, a further 18 months, that is until the Fall of 1982.

TABLE 4A*

SITE OPERATING LIFE

PHASE I AND PHASE II EXPANSIONS (TONNES)

	Phase I only	Phase II only	Phase I & II combined
Site Capacity	129,000 tonnes	295,000 tonnes	424,000 tonnes
Site Operating Life - Burlington Wastes Only			
1) assumed average waste generation rate	88,000 tonnes/yr	92,000 tonnes/yr	91,000 tonnes/yr
2) estimated operating life at the stated rate of waste generation	18 months	38 months	56 months
Site Operating Life - Total Region Wastes			
1) assumed average waste generation rate	190,000 tonnes/yr	197,000 tonnes/yr	194,000 tonnes/yr
2) estimated operating life at the stated rate of waste generation	8 months	18 months	26 months

* See Appendix 1- Table 4B for quantities in imperial units.

The Region also proposes to expand the Oakville Landfill. Capacities provided in Oakville will increase the operating life at the Burlington Site. Estimates made in the Interim Waste Disposal Feasibility Study prepared by M.M. Dillon Limited in September 1978 indicate that expansions to both the Burlington and Oakville Site would extend landfilling operations at the Burlington Site until September 1983.

2.4 Waste Characteristics

The site will be available to municipal and private haulers collecting wastes within the Region. Wastes generated from locations outside the regional boundaries will not be accepted.

Wastes that will be accepted at the site include domestic and household wastes, commercial, institutional and industrial wastes and construction and demolition debris. Wastes from street cleaning and public utilities works will also be accepted.

Certain types of wastes will be specifically excluded. These include:

- pathological wastes
- industrial chemicals and sludges
- liquid industrial wastes
- hazardous and toxic wastes
- septic tank pumpings
- radioactive wastes
- sewage sludge

The control of wastes to the site will be the responsibility of the Region. The site scaleman will be authorized by the Region to reject any loads containing any restricted wastes.

3. SITE DEVELOPMENT CONSIDERATIONS

3.1 Site Description

The lands proposed for site expansion are situated north of the existing site, and are bounded to the west and north by Falcon Creek, to the south by landfilling on the existing site and to the east by agricultural lands (Class 1 - 60%, Class 3 - 40%). Falcon Creek is situated in a 25 m deep (82 ft) ravine with ravine slopes ranging between 15% and 50% and creek bed elevations from 130 m-ASL (426 ft-ASL) to 163 m-ASL (535 ft-ASL). The lands proposed for landfilling slope generally to the southeast with slopes ranging between 3% and 12% and elevations between 165 m-ASL (541 ft-ASL) to 184 m-ASL (604 ft-ASL). The existing landfill slopes generally do not exceed 20% and the maximum height of landfilling is 171 m-ASL (561 ft-ASL).

The total property requirements for the expansion are estimated at 23 ha (58 ac) of which 7 ha (17 ac) will be used for landfilling. These are located on parts of Lots 3 and 4, Concession 2, Township of East Flamborough (now The City of Burlington). The site location is shown on Drawing 1, and site boundaries and ownership of the existing site and adjacent properties on Drawing 2.

A hedgerow to the east of the proposed expansion, heavily wooded areas to the west and north; and the present landfill to the south, surround the lands planned for site expansion.

3.2 Property Ownership and Zoning

A title search was carried out in June 1979 on the lands proposed for expansion and adjacent properties. The results of the search are shown on Drawing 2. The Region's property extends, as shown, to the North Service Road. These lands as well as those identified for expansion, on Drawing 2, will constitute the lands included in the Region's application for a Certificate of Approval for the operation of the expanded site.

The lands proposed for the expansion are in the Parkway Belt West Plan and are in the "general complementary use area". A regulatory exemption was granted to the Region in April 1979 for the proposed landfill expansion.

3.3 Traffic Projections

A one week survey of vehicles using Halton landfills was carried out by the Region during the period Monday, 26 February 1979 to Saturday, 3 March 1979. The hour of arrival for vehicles was recorded for vehilces classified according to the following categories:

Type A - Cars and station wagons
Type B - Cars and station wagons with trailers
Type C - Pickup trucks and small vans
Type D - Large trucks and other vehicles

The results of the survey are shown in the following tables.

TABLE 5

BURLINGTON LANDFILL SITE - VEHICLE TRAFFIC

DISTRIBUTION OF VEHICLE ARRIVAL TIMES

MONDAY TO FRIDAY AVERAGE

(26 February 1979 to 2 March 1979)

	NUMBER OF VEHICLES				
Time	Type A	Type B	Type C	Type D	Total
8 - 9 am	1	1	4	7	13
9 - 10	2	1	5	12	20
10 - 11	1	0	5	8	14
11 - 12	2	0	5	13	20
12 - 1 pm	2	1	4	8	14
1 - 2	1	0	5	7	13
2 - 3	1	0	4	6	11
3 - 4	1	0	4	8	13
4 - 5	1	0	3	5	9
5 - 6	0	0	0	1	1
TOTAL	12	3	39	75	128

TABLE 6

BURLINGTON LANDFILL SITE - VEHICLE TRAFFIC

DISTRIBUTION OF VEHICLE ARRIVAL TIMES

SATURDAY

(3 March 1979)

Time	NUMBER OF VEHICLES				
	Type A	Type B	Type C	Type D	Total
8 - 9 am	4	3	4	3	14
9 - 10	5	2	7	6	20
10 - 11	11	3	15	1	30
11 - 12	18	1	11	6	36
12 - 1 pm	15	1	10	2	28
1 - 2	9	1	12	0	22
2 - 3	7	1	10	2	20
3 - 4	11	2	10	3	25
4 - 5	-	-	-	-	-
5 - 6	-	-	-	-	-
TOTAL	80	14	79	23	195

TABLE 7

HALTON LANDFILLS - VEHICLE TRAFFIC

(TOTAL FOR BURLINGTON, OAKVILLE AND GEORGETOWN SITES)

DISTRIBUTION OF VEHICLE ARRIVAL TIMES

MONDAY TO FRIDAY AVERAGE

(26 February 1979 to 2 March 1979)

	NUMBER OF VEHICLES				
Time	Type A	Type B	Type C	Type D	Total*
8 - 9 am	1	<1	6	14	22
9 - 10	5	1	13	26	46
10 - 11	4	<1	13	30	47
11 - 12	6	<1	10	28	44
12 - 1 pm	4	1	9	24	37
1 - 2	4	<1	12	20	37
2 - 3	2	<1	9	18	30
3 - 4	2	<1	10	18	31
4 - 5	2	<1	6	8	17
5 - 6	<1	-	<1	1	2
TOTAL	30	5	88	189	313

* Does not total exactly because of roundings.

TABLE 8

HALTON LANDFILLS - VEHICLE TRAFFIC

(TOTAL FOR BURLINGTON, OAKVILLE AND GEORGETOWN SITES)

DISTRIBUTION OF VEHICLE ARRIVAL TIMES

SATURDAY

(3 March 1979)

	NUMBER OF VEHICLES				
Time	Type A	Type B	Type C	Type D	Total
8 - 9 am	7	6	9	7	29
9 - 10	22	3	25	9	59
10 - 11	34	11	35	7	87
11 - 12	51	8	40	11	110
12 - 1 pm	36	5	33	4	78
1 - 2	32	1	26	4	63
2 - 3	21	5	29	4	59
3 - 4	25	3	19	4	-
4 - 55	-	-	-	-	-
5 - 6	-	-	-	-	-
TOTAL	228	42	216	50	536

4. SITE DESIGN

4.1 Design Approach

The design of the proposed expansion is in accordance with the intent of the Ontario Ministry of the Environment regulations and guidelines. In addition, the findings and recommendations of the hydrogeological study, the environmental analysis and site specific requirements and constraints have been taken into account.

The site design includes the preparation of a final contour plan. It is intended that the landform proposed be compatible with the surrounding topography; be integrated to contours on the existing landfill; and take into account the site's proposed end use. Natural site features - vegetative cover and relief - are considered to minimize the landform's visibility from adjacent properties. The final contour design also incorporates a surface drainage concept which minimizes erosion and maintenance. Site drainage works to control runoff and divert it to existing natural drainage features are incorporated.

The design of the site includes the preparation of a base contour plan which establishes the depth and grading of excavations. This design is based on the findings and recommendations of the hydrogeological study and on operational requirements - in particular the supply of a sufficient volume of earth cover to support landfilling operations. A conceptual design for leachate control based on the recommendations of the hydrogeological study has been prepared and integrated to the base contour design.

The final contour plan and the base contour plan establish the volume available for landfilling. Base contours, when compared to existing contours establish the total volume of cover material available.

The operational requirements of the site are reflected in the various components of the design so that drainage, access, site facilities and services are maintained during all stages of operation and so that landfilling activities, construction of site works, supply of cover and earth works can be undertaken in phases which are compatible with one another.

4.2 Site After-Use

The site is or will be in the ownership of the Region of Halton. The Region upon termination of landfilling will cover the entire site with a minimum of 2 ft. of final cover material and will vegetate the area likely by applying a mulch for seeding. The Region will repair any problem areas resulting from erosion or differential settlement.

The Region will continue to operate and maintain the leachate system and will continue site ground and surface water monitoring.

The City of Burlington has expressed an interest in converting the site into parkland. The Region would be prepared to provide the lands to the City for the development of a park. The landform developed was reviewed with City staff prior to finalization. Certain park uses could be accommodated at the site.

The final contour plan and the base contour plan establish the volume available for landfilling. Base contours, when compared to existing contours establish the total volume of cover material available.

The operational requirements of the site are reflected in the various components of the design so that drainage, access, site facilities and services are maintained during all stages of operation and so that landfilling activities, construction of site works, supply of cover and earth works can be undertaken in phases which are compatible with one another.

4.3 Site Design Capacity

This expansion (Phase II) has been designed to provide capacity for the landfilling of 295,000 tonnes (325,000 tons) of refuse while the Phase I expansion capacity will allow the landfilling of 129,000 tonnes (142,000 tons). The volume available for landfilling has been calculated using the difference between base contours and final contours. The total capacity of the Phase I and II expansion is 424,000 tonnes (467,000 tons).

4.4 Final Contour Design

The proposed final contours are shown on Drawing 3.

The landform described in the final contour design consists of a plateau sloping gently (approximately 1.5%) from existing contours in the north part of the site to contours in the Phase I expansion area of the existing site. From this plateau, downward slopes, facing east and west toward the ravines; and south, toward the existing landfill will be graded at a maximum grade of 4:1. The landform in the existing site will obstruct the visibility of the expansion area operations from the south that is from Highway 403. From the west, a heavily wooded area; and from the east, a hedgerow, provide vegetative screening. Viewed from the north, there will be little perceptible change in site topography.

Landfilling operations in the south part of the site will be carried out generally above existing grades, while in the north will be carried out primarily in deep excavations.

The toe of the landfill slopes will coincide with the limit of landfilling and will be set back a minimum of 10 m (33 ft) from the brow of the ravine slopes to allow sufficient area for the construction of ditches and swales.

Final contours have been designed to minimum grades of 2% to promote drainage and to maximum grades of 4:1 to minimize erosion and facilitate maintenance.

4.5 Base Contour Design

Proposed base contours are shown on Drawing 4. These contours have been designed taking into account the findings and recommendations of the Hydrogeological Study. Thus, the following recommendations have been considered:

1. Establish base contours which will allow for the installation of leachate collectors at minimum grades of 1.0%.

2. Establish base contours which will permit a minimum of 1.5 m (5 ft) of clay till overburden to be retained between the Queenston Shale and the refuse.

3. Establish base gradients which will promote the flow of leachate to the leachate collector piping.

The following design criteria have been established:

1. Maximize site capacity by providing landfill volume in site excavations.

2. Provide sufficient earth cover from site excavations to supply an adequate amount of earth cover to support landfilling and site rehabilitation operations.

3. Provide proper drainage of the base of the excavation during all phases of operation.

Based on the above requirements, the base contours have been designed to provide 232,000 m^3 (303,000 cu.yd.) volume of excavation. Minimum base slopes are 2% to facilitate drainage. The average depth of excavation is 3 m (10 ft) while the maximum depth is 7 m (23 ft).

Excavation side slopes are 2:1 maximum and shall have a minimum height of 2 m (7 ft). Where excavation depths are less than 2 m (7 ft), berming will be added to provide a total side slope height of 2 m (7 ft). These berms will be constructed with clay till excavated on site and compacted in 0.2 m (8 in) lifts.

4.6 Site Quantities

It is anticipated that landfilling operations at the Burlington Site, will continue, uninterrupted, from the existing landfill area to the Phase I expansion area and then onto the lands of the Phase II expansion area. Thus, in the planning of site operations, in particular, for cover material requirements, it is assumed that part or all of the Phase II expansion will be undertaken concurrently with the Phase I expansion.

Due to the short supply of on-site cover material at the existing site, excavations in the Phase II expansion have been designed to supply a sufficient volume of cover material to support both the Phase I and Phase II expansions. Should the cover material from the proposed excavation in Phase II not be available during the operation of Phase I, cover material will be obtained from off-site sources.

In estimating cover material requirements an allowance of 0.6 m (2 ft) has been made for final cover and a 4 to 1 refuse to cover ratio for estimating daily and intermediate cover requirements. It is estimated that an average refuse density of 600 kg/m^3 (1,010 lb/cu. yd) will be achieved in the operations.

Based on the above assumptions a summary of site quantities is shown in Table 6.

4.7 Surface Drainage Concept

Discussions regarding surface drainage are presented in the Environmental Analysis prepared by M. M. Dillon Limited and appended in this report. The report has noted that runoff draining over the Falcon Creek ravine slopes has eroded the clay till overburden and has exposed the Queenston Shale. The exposed shale is susceptible to rapid weathering and erosion and thus deep gullies have been formed.

The surface drainage concept for the site comprises the construction of perimeter ditches or swales as shown on Drawing 3. These will be constructed between the toe of the landfill slopes and the brow of the ravine and will discharge to natural site surface drainage features.

The swale to the west of the operation will discharge to Falcon Creek immediately north of the North Service Road while the swale to the east of the operation will drain to an intermittent stream.

TABLE 6A*

SITE QUANTITIES

PHASE I AND PHASE II EXPANSIONS

Site Capacity	Phase I Expansion	Phase II Expansion	Total
1) Refuse Weight	129,000	295,000	424,000
Volume Utilization			
1) Refuse Volume	214,000 m^3	123,000 m^3	177,000 m^3
2) Daily and intermediate cover (@ 4:1 refuse to cover ratio)	54,000 m^3	123,000 m^3	177,000 m^3
3) Final cover (@ 0.6 m depth of application)	46,000 m^3	45,000 m^3	91,000 m^3
TOTAL VOLUME UTILIZED	314,000 m^3	660,000 m^3	974,000 m^3
Excavation and Cover Material Balancing			
1) Volume of excavation	-	233,000 m^3	233,000 m^3
2) Allow 15% for bulking of excavated earth fill	-	35,000 m^3	35,000 m^3
TOTAL AVAILABLE COVER MATERIAL	-	268,000 m^3	268,000 m^3
1) Daily and intermediate cover requirements (as above)	54,000 m^3	123,000 m^3	177,000 m^3
2) Final cover (as above)	46,000 m^3	45,000 m^3	91,000 m^3
TOTAL COVER REQUIREMENTS	100,000 m^3	168,000 m^3	268,000 m^3
Net Deficiency or Surplus	100,000 m^3 deficiency	100,000 m^3 surplus	NIL

* See Appendix 1- Table 6 B for quantities in imperial units.

The ditches and swales will be designed to minimize silting and where necessary, measures will be taken for protection against erosion.

4.8 Leachate Collection and Disposal System

A toe drain leachate collector system has been designed for the existing Burlington Landfill Site and is now being constructed. This system comprises the installation of 1,100 m (3,610 ft) of leachate collector piping discharging through 830 m (2,720 ft) of transmission sewer to an existing sanitary sewer opposite the Tridon plant on the North Service Road. This sewer is part of the Burlington Skyway Water Pollution Control Plant sanitary sewer system. A flow metering station is being installed to record flows discharging to the sanitary sewer.

The system will control the surface discharge of leachate from landfill slopes. Comprising perforated pipes installed in a granular bedding at the toe of landfill slopes, the collectors lower the level of leachate below the surface of these slopes and prevent breakout through the layer of cover material.

The results of the Hydrogeological Study indicate that in addition to the small portion of leachate discharging as springs to surface waters, that leachate produced at the existing site infiltrates into the underlying shale. Based on these results and on analyses carried out for the proposed expansion, it has been recommended that an underdrain leachate collector system be installed for the expansion area.

The proposed system is shown on Drawing 4. It comprises parallel runs of 150 mm (6 in) perforated pipes installed in granular bedding with runs spaced at maximum intervals of 45 m (148 ft).

At both ends of each section of collector piping, manholes will be installed for inspection, maintenance and monitoring. Each collector will drain to a header pipe which will be connected to the leachate collector system on the existing site.

The collector piping will be installed a minimum of 0.30 m (12 in) below the base contours of the site. A minimum of 0.50 m (18 in) of graded granular material will be placed over the collector piping upon completion of its installation to protect it from damage by site equipment and vehicles using the site and to ensure that leachate will flow freely to the pipes and will not be hindered by silting in the pipes.

The underdrain leachate collector system will be a gravity system and will discharge continuously to the sanitary sewer system. The system will be operated such that leachate levels will not build-up within the landfill site.

4.9 Access Roads

Access to the site will be via the existing access from the North Service Road. Access to the fill area will be via the route for a proposed access road shown on Drawings 5 and 7.

The road base will be constructed of waste materials consisting primarily of a mixture of broken concrete, asphalt and bricks followed by granular materials. The road will be crowned to a minimum crossfall grade of 2% and the maximum profile gradient will be 8%. Where site drainage crosses the access road, ditching and culverts will be installed to keep the road from becoming saturated during wet weather.

4.10 Access Control

The existing site is fenced with a farm type fence and lockable gate. The gate is open during site operating hours and during that time entry is controlled by the site scaleman. At other times the gate will be closed and locked.

A 1.2 m (4 ft) farm type fence will be installed along the site boundary to deter unauthorized entry. Illegal entry signs will be posted at locations along the fence.

4.11 Site Buildings and Facilities

The present site includes an 18.3 m by 8.2 m (60 ft by 27 ft) concrete block building which includes a 3.8 m by 4.3 m (12.5 ft by 14 ft) office and scalehouse. The building is serviced by potable water cistern and septic tank. A 9,100 ℓ (2,000 gallon) fuel tank is used for diesel fuel storage.

Because of the remoteness of the proposed landfill expansion from the present facilities, a portable equipment storage and maintenance building will be erected at the location shown on Drawing 5. The building will be heated and insulated and equipped with a washroom and a work area. Services will include a potable water cistern, a sewage holding tank and a fuel storage tank. A pole line will be constructed from the existing equipment maintenance facility and will carry power and telephone lines.

Following the closure of the Burlington Landfill Site and the opening of the proposed new regional facilities the building will be dismantled, transported and reassembled at the new site.

4.12 Scales and Scale House

The existing scale is an Eastern Scale Model 3025 DSR with a 27,727 kg (61,000 lb) capacity and a 7.3 m by 3 m (24 ft by 10 ft) scale deck. The scaleman's station and office is 3.8 m by 4.3 m (12.5 ft by 14.0 ft) and is housed within the existing maintenance building.

Based on the anticipated landfill traffic projections made in Section 3.3 - Traffic Projections, it is estimated that the number of weekday vehicles will increase by 8% during the period 1980 to 1983, however will increase by 143% following the closure of the Oakville Site and the diversion of refuse vehicles to the Burlington Site.

To accommodate this increase, a new electronic scale will be installed adjacent to the existing beam scale. This scale will be "legal for trade", will have a capacity of 70 tonnes (77 tons), and will be an electronic load cell type with electronic digital display. (It is intended that following the closure of the Burlington Site that this scale will be transported to a new regional landfill site). The existing scale will be converted to give an electronic digital readout. A new scale house will be provided and thus two scaleman's stations will be provided. Each station will have digital displays for both scales so that they may be operated independently or as "in" and "out" scales with either one or two scalemen.

4.13 Public Container System

Because of the long distance from the site entrance to the expansion area, automobiles will not be allowed to the working face. A public container system will be provided inside the site entrance in an area visible from the scaleman's station and will only be available for use during site operating hours.

The container compound will be designed to facilitate the flow of traffic and minimize queuing. The proposed layout will accommodate three roll-off type containers of up to 31 m^3 (40 cu. yds) capacity. Ramps and retaining walls will be constructed to facilitate dumping. Berming and landscaping will be carried out to minimize visual impact. Fences will be installed to control the spread of litter.

The area will be kept in a clean and tidy appearance. The area will be paved to facilitate clean up and litter will be picked up daily.

5. SITE OPERATIONS

5.1 Staging of Operations

Landfilling and site works for the expansion to the Burlington Site will be staged. It is proposed as shown on the Site Operations Plan - Drawing 5, that two operating areas be identified - Area A and Area B. The excavation of Area A will provide cover material for the operation of the Phase I expansion of the Burlington Site while the excavation of Area B will provide cover material to support landfilling operations in Area A. Locations are identified for a stockpile of cover material for landfilling in Area B and for a topsoil stockpile for rehabilitation of the entire expansion area.

The installation of the leachate collector piping will be carried out following the completion of excavations for cover material.

5.2 Initial Site Preparation

Before commencing landfilling operations on the expansion area, the following works will be constructed:

i) Install 1.2 m (4 ft) farm type fence along the site boundary.

ii) Install 2 m (6.5 ft) high fencing along the perimeter of the landfilling area as shown on Drawing 5. The fence is required to protect adjacent woodlots from the spread of litter and to prevent accidental damage to trees by site equipment. The fence will remain in place during the entire operating life of the expansion.

iii) Strip 0.2 m topsoil from Area A and establish a topsoil stockpile.

iv) Construct swales or ditches as shown on Drawing 3.

v) Extend the access road to the base of the Area A excavation as shown on Drawing 5.

vi) Erect the new equipment storage building at the location indicated on Drawing 5.

vii) Install site services - power, telephone, potable water cistern, sewage holding tank and fuel storage tank.

viii) Excavate and transport cover material as required to the Phase I landfilling operations on the existing site.

5.3 Site Operations - Area A

Following completion of the initial site preparation works and substantial completion of the landfilling of the Phase I operations on the existing site, the following activities will be undertaken for landfilling of Area A:

i) On completion of the Area A excavation, install the underdrain leachate collector system. Leachate collector pipes will be isolated from the header piping by capping the pipes at their discharge to the leader pipe manholes. Upon completion of landfilling over the entire base area of the site, the caps will be removed to allow leachate to drain through the leachate collector system.

ii) Extend the access road to the start of landfilling operations.

iii) Begin landfilling operations in accordance with the sequence shown on Drawing 5.

iv) Begin excavation of Area B to provide cover material to support landfilling operations in Area A.

v) Stockpile excess cover material on the area designated on Drawing 5 to allow for landfilling in Area B.

vi) Begin and continue progressive rehabilitation in Area A using material from the topsoil stockpile.

5.4 Site Operations - Area B

At this stage landfilling in Area A will be nearing completion as will be the excavation of Area B. A cover material stockpile will have been established for the final stages of operation. The following activities will be undertaken:

i) Complete the installation of the leachate collector system in Area B, and connect leachate collectors in Area A to the leachate collection system.

ii) Begin landfilling in the Area B excavation using fill from the cover material stockpile.

iii) Continue site rehabilitation in Area A as final contours are achieved.

iv) Upon completion of landfilling operation, dismantle the equipment storage and maintenance building and scales for transport to a new regional landfill.

v) Complete site rehabilitation, remove litter fencing and facilities not required for the site after use.

5.5 Daily Operations

The 1980 estimated average daily quantity (based on 311 operating days per year) of solid waste landfilled at the Burlington Landfill, is in the order of 280 tonnes (308 tons) per day while the Regional total is 605 tonnes (666 tons) per day. The projected daily rate for 1983 is estimated at 300 tonnes (331 tons) per day for Burlington wastes while the Region total is estimated at 670 tonnes (739 tons) per day.

The present operations comprise the landfilling of wastes in a single working face. Landfilling at the higher rate, that is when all of the Region's wastes are landfilled at the Burlington Site, will be accommodated by increasing the size of the working face to allow for the increased number of vehicles. A working face 30 m to 50 m (100 ft to 160 ft) in width is currently required at the existing site while a working face 50 m to 70 m (160 ft to 230 ft) in width will be required at the higher rate. The size of the working face may vary beyond this range to accommodate variations in daily and seasonal quantities and to accommodate specific constraints of operations, however, the recommended ranges will generally be adequate.

A ramped method of landfilling will be employed, comprising the deposition of refuse at the base of the working face, its spreading into 0.3 m to 0.6 m (12 in to 24 in) layers and its compaction by landfill equipment with a minimum of three passes. A maximum of 3:1 slope is allowed at the working face while the height of lift is generally limited to 2.5 m (8 ft).

It is anticipated that using this method of operation, a refuse density of 600 kg/m^3 (1010 lbs/cu. yd.) will be achieved.

Assuming an average working face length of 40 m (130 ft) with the Oakville Site open and 60 m (200 ft) with the Oakville Site closed, the rate of advance of the working face is 4 m/day (13 ft/day) and 7 m/day (23 ft/day) respectively.

At the end of each working day, all wastes will be covered with earth fill.

The schedule for the application of daily cover material will be as follows:

1. Daily Cover: At the end of each working day 150 mm (6 in) will be placed on all exposed refuse at the working face.

2. Intermediate Cover: In areas where landfilling will not be carried out for extended periods, a minimum depth 250 mm (10 in) of cover will be applied to facilitate the movement of equipment and to prevent the erosion of earth cover and exposure of refuse.

3. Final Cover: Areas where landfilling has been completed will receive a minimum of 600 mm (2 ft) of earth cover.

5.6 Surface Drainage during Operations

During the progress of landfilling operations, site contours and hence drainage patterns, will be altered frequently.

Perimeter ditches or swales will be constructed before landfilling begins. Also, additional temporary measures will be required during landfilling operations, and comprise the following:

i) Temporary ditching will be constructed so that surface runoff is not allowed to flow into site excavations.

ii) Grading during and after landfilling will be such that ponding does not occur and as a result, the rate of infiltration and hence, leachate production increases. All temporary and final grading will be a 2% minimum grade.

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

The control of surface drainage during the initial stages of site operations will be achieved by constructing temporary ditches as required around the proposed landfill excavations. These will discharge to the permanent ditches and swales. The excavation will drain by gravity to the southwest area of the expansion. A temporary trench will be constructed to allow for drainage from the excavation to the permanent drainage works.

The base of the excavation will be graded to a minimum grade of 2% to facilitate drainage.

Should drainage in the excavations be temporarily impeded during the construction of the first lift of refuse, portable pumps will be used to drain ponded areas.

5.7 Site Maintenance

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

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. All ditches and swales will be re-excavated and graded, as required to keep them clear of silt, debris and weeds.

3. Entrance areas and rehabilitated areas will be routinely cleared of weeds; and grassed areas cut and maintained. The reapplication of topsoil and reseeding will be carried out as required.

4. Leachate collector manholes will be inspected periodically and sumps cleaned as required.

5. All buildings will be kept in a clean, tidy appearance and repaired and painted as required.

6. Access roads will be regraded periodically and additional granular material applied as required.

7. Dust control measures will be undertaken during dry conditions. Water or calcium chloride will be used, however, calcium chloride will not be used within 10 m (33 ft) from the brow of the Falcon Creek ravine. Waste oils will not be used for dust control.

5.8 Litter Control

A regular program for litter control has been undertaken by the Region for the existing operations and will be maintained for the expanded operations. The program will be expanded and will comprise the following:

1. The daily pickup of wind blown paper on the landfill property and adjacent properties will be carried out, as required. Normally one labourer will be available for litter control on a daily basis, however, during windy periods and following snow melt periods when snow buried litter is exposed, additional staff will be brought in to carry out clean up operations as expeditiously as possible.

2. Portable litter fences at the working face to control the on-site spread of litter will be installed. These fences are positioned in accordance with the advance of the working face and the daily prevailing wind direction.

3. Prior to commencing operations in the expansion area a 4 m (13 ft) litter control fence will be installed as shown on Drawing 5.

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

5.9 Site Equipment

Should both the Burlington and Oakville Sites be available for landfilling concurrently, it is anticipated that the quantity of wastes landfilled at the Burlington Site will not increase significantly (in the order of 3% per year), thus the present equipment complement would be adequate:

i) 1 landfill compactor
ii) 1 track type loader
iii) 2 elevating scrapers (part-time).

The landfill compactor is assigned to the working face for the spreading and compaction of refuse; while the track type loader is used primarily for the handling and spreading of cover material and for site maintenance. Elevating scrapers will be used from time to time to excavate, transport, stockpile, and spread cover material. Under normal circumstances, one elevating scraper would be sufficient to handle cover material however, a second scraper may be required for initial excavations and for establishing large stockpiles.

Following the closure of the Oakville Landfill Site, it is expected that the quantities of wastes taken to the Burlington Landfill Site will increase by approximately 120%. At that time the equipment complement would be as follows:

i) 2 landfill compactors
ii) 1 track type loader
iii) 2 elevating scrapers (1 full time, 1 part-time).

From time to time additional equipment will be used on a part-time basis to carry out site rehabilitation work, construct and maintain access roads, construct site facilities and buildings, and for general site earth works.

5.10 Site Operating Hours

The present site operating hours are as follows:

Monday to Friday	8:00 A.M. to 5:30 P.M.
Saturday	8:00 A.M. to 4:00 P.M.

The site is closed Sundays, Christmas Day and New Year's Day. Operations will continue on the above schedule however, following the closure of the Oakville Landfill Site, these hours will be expanded to the following schedule:

Monday to Friday	7:30 A.M. to 6:00 P.M.
Saturday	8:00 A.M. to 4:00 P.M.

These hours will allow for the additional travel time incurred by vehicles originating from Oakville, Milton and Halton Hills.

5.11 Site Records and Operations Monitoring

The planning of landfilling operations, the design of site works and facilities, and the preparation of quantity schedules and budgets is largely dependent on data accumulated during past operations. During the landfilling operations for the proposed expansion the Region or its Contractor will keep the following records:

i) Number, type (by category) and approximate time of arrival of vehicles using the site.

ii) Weights of refuse landfilled.

iii) Amounts of revenues collected.

iv) Volumes (and/or weights) of clean fill brought to the site from off-site sources.

v) Volumes of excavations.

vi) Volumes of earth cover stockpiles.

vii) Volumes of topsoil stockpiles.

viii) Estimates of quantities of daily, intermediate and final cover material used.

The progress of landfilling operations will be monitored at least twice yearly through the use of aerial photography. Contour mapping will be derived from this photography and using computer assisted volume calculations, the volume of landfill used during periods between flight dates will be estimated. Through the analysis of this data and site records, the performance of the landfill operation will be monitored and controlled. Interpretation of the photography will provide data for the planning and implementation of site restoration programs, for the planning, design, and construction of surface drainage works, and to provide a record landfilling activities.

In addition to the recording of quantities for site operations, inspection records will be kept on the installation of all 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.

5.12 Water Quality Monitoring Program

The Hydrogeological Study has presented data and analyses on the production and migration of leachate from the existing site and presented predictions on the production and migration on leachate from the expanded site. The Region proposes to continue their present monitoring programs and expand these as required for the Phase II expansion.

The following program for ground water monitoring will be undertaken is currently proposed:

1. Six boreholes installed during the hydrogeological study will be selected as monitoring stations.

2. Ground water levels will be recorded monthly for one year.

3. Ground water samples will be taken every 3 months and tested for conductivity pH and phenols.

4. Records will be kept of readings taken on the leachate flow metering station in the leachate collection system.

5. Data will be reviewed annually and the monitoring program reassessed.

A water quality monitoring program will be implemented and will be based on the following recommended guidelines:

i) Three surface water quality monitoring stations will be established on Falcon Creek.

ii) A V-notch weir flow monitoring station will be installed on Falcon Creek.

iii) Surface water quality will be sampled and tested at each station every three months.

iv) All data will be reviewed annually and the program re-assessed.

Details of the program will be developed in consultation with the Ministry of the Environment based on the final approved program for the landfill.

6. SITE REHABILITATION AND AFTER USE

6.1 Site Rehabilitation

A program for landfill rehabilitation is currently being implemented at the existing site. Following the application of 0.6 m (2 ft) of earth cover on completed areas, 100 mm (4 in) of topsoil will be applied and hydroseeding carried out. The work will be scheduled during periods when vegetative cover will be quickly achieved, in order to minimize erosion.

A program of grass maintenance will be implemented on revegetated areas. Re-seeding and re-application of topsoil will be carried out as required.

6.2 After Use

It is intended to return the site to passive use, through a site rehabilitation program. Preliminary discussions have been held between Region of Halton staff and City of Burlington staff regarding possible recreational uses for the site, however to date no committments have been made.

APPENDIX 1

TABLE 1B

PROJECTED RATES OF REFUSE GENERATION

ESTIMATED ANNUAL TONNAGES (TONS)

Year	Burlington	Regional Total
1980	96,000 tons	207,000 tons
1981	98,000 tons	213,000 tons
1982	101,000 tons	221,000 tons
1983	104,000 tons	229,000 tons

TABLE 2B

REMAINING LANDFILL CAPACITY

Site	Date of Estimate	Capacity Remaining (cu.yd.)
Georgetown Landfill	14 July 1979	35,000
Oakville Landfill	4 May 1979	241,000
Burlington Landfill	4 May 1979	435,000

TABLE 4B

SITE OPERATING LIFE

PHASE I AND PHASE II EXPANSIONS (TONS)

	Phase I only	Phase II only	Phase I & II combined
Site Capacity	142,000 tons	325,000 tons	467,000 tons
Site Operating Life - Burlington Wastes Only			
1) assumed average waste generation rate	97,000 tons/yr	101,000 tons/yr	100,000 tons/yr
2) estimated lifetime	18 months	38 months	56 months
Site Operating Life - Total Region Wastes			
1) assumed average waste generation rate	209,000 tons/yr	212,000 tons/yr	213,000 tons/yr
2) estimated lifetime	8 months	18 months	26 months

TABLE 6B

SITE QUANTITIES

PHASE I AND PHASE II EXPANSIONS

	Phase I Expansion	Phase II Expansion	Total
Site Capacity			
1) in tons (imperial)	142,000	325,000	467,000
Volume Utilization			
1) Refuse	280,000 cu.yd	643,000 cu.yd	923,000 cu.yd
2) Daily and intermediate cover (@ 4:1 refuse to cover ratio)	70,000 cu.yd	161,000 cu.yd	231,000 cu.yd
3) Final cover (@ 0.6 m depth of application)	60,000 cu.yd	59,000 cu.yd	119,000 cu.yd
4) Total volume utilized	410,000 cu.yd	863,000 cu.yd	1,273,000 cu.yd
Excavation and Cover Material Balancing			
1) Volume of excavation	-	305,000 cu.yd	305,000 cu.yd
Add 15% bulking factor			
2) Allowance for bulking	-	46,000 cu.yd	46,000 cu.yd
3) Total Available Cover Material		350,000 cu.yd	350,000 cu.yd
Deduct			
4) Daily and intermediate cover requirements	71,000 cu.yd	161,000 cu.yd	231,000 cu.yd
5) Final cover requirements	60,000 cu.yd	59,000 cu.yd	119,000 cu.yd
6) Cover Material Deficiency or Surplus	131,000 cu.yd deficiency	131,000 cu.yd surplus	NIL

APPENDIX A

BURLINGTON LANDFILL SITE EXPANSION
ENVIRONMENTAL ANALYSIS

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1. INTRODUCTION

1.1 Background

In July 1978, the Council of the Regional Municipality of Halton authorized M.M. Dillon Limited to study and recommend the best strategy for the provision of landfill capacity until a major new Regional facility for waste disposal and processing could be approved and developed.

The study, The Interim Waste Disposal Feasibility Study, was prepared by M.M. Dillon Limited in September 1978. It assessed the potential for the development of landfill capacity at four locations which included the extension of the Burlington site. Based on recommendations of that study, Council adopted a plan for the development of additional landfilling on the existing Burlington Site as well as onto lands north of the site.

A preliminary environmental analysis was prepared as part of that study. A further detailed analysis was recommended to be part of the submission of reports required for application for the approval of the proposed expansion of the Burlington site.

This appendix has also been prepared to satisfy the requirements of the Environmentally Sensitive Areas Policy of the Official Plan of the Regional Municipality of Halton.

The Falcon Creek ravine immediately west of the existing site and its proposed expansion is designated as an Environmentally Sensitive Area (ESA) referred to as "Sassafras Woods" in the Official Plan.

An ESA is defined as a land or water area "containing natural features or ecological functions of such significance as to warrant their protection in the best long-term interests of the people and environment of Halton Region."[1]

The Policy states that an Environmental Impact Assessment (EIA) is required where the physical and/or biological features of an ESA may become altered. Included in this report is an assessment of the impact of landfill operations adajcent to Sassafras Woods.

This appendix was also prepared to reflect the concerns expressed by Halton Region's Environmental and Ecological Advisory Committee (EEAC). EEAC is primarily concerned about the impact of landfilling on 3 areas:

i) Sassafras Woods;
ii) the eroded slopes[2] along the west boundary of the existing site;
iii) water quality of Falcon Creek.

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1 *Regional Municipality of Halton, Ecological and Environmental Advisory Committee, Environmentally Sensitive Area Study, Planning Department, 1978.*

2 *Slope is within the boundaries of the Environmentally Sensitive Area.*

1.2 Purpose and Scope

This appendix has been prepared to:

i) address concerns identified in the preliminary environmental analysis contained in The Interim Waste Disposal Feasibility Study;

ii) satisfy the requirements of the Environmentally Sensitive Areas Policy of the Official Plan;

iii) address concerns expressed by EEAC.

The primary objectives of the study were to:

i) survey existing environmental conditions of the site extension;

ii) assess the environmental effects of existing and proposed landfill operations;

iii) recommend measures to minimize adverse environmental effects.

The study area is outlined on Drawing 1.

1.3 Method

This study was carried out in 3 stages. The first stage involved a review of secondary sources, contacting relevant agencies and interpretation of air photos.

A field investigation was conducted in the second stage of the study in June 1979. Additional field work was undertaken in August and September. Terrain, surface drainage characteristics, vegetation and fish and wildlife habitat were surveyed. Air quality, with respect to the potential for dust in dry weather, and potential visibility of landfill operations on the site extension were investigated.

The third stage of the study identified the environmental effects of landfilling and recommended measures to minimize potential effects.

2. EXISTING SITE CONDITIONS

2.1 Physiography and Soils

The site is located on a clay plain underlain by Queenston shale.[1] Two ravine systems form the site boundaries: a ravine extending along the western and northern edge, identified as high hazard land slopes by Ontario Land Inventory and, a ravine extending along the eastern edge, identified as high hazard lands because of soil erosion potential.[2]

The site occurs as a plateau between the ravine systems, and slopes irregularly to the south. The southerly sloping topography has been altered on the adjoining lands by land-fill operations, resulting in raised, hummocky terrain.

The western and eastern ravines are overlain with deep red clay.[3] Shale occurs close to the surface on the western and eastern slopes where ground cover has been removed and surficial materials have been eroded.

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1 *Caley, J.F., Paleozoic Geology of the Toronto-Hamilton Area, Ontario, Geological Survey of Canada, 1961.*

2 *Ministry of Natural Resources, Ontario Land Inventory, Hazard Lands, Hamilton-Burlington Area (no date).*

3 *Regional Municipality of Halton, Ecological and Environmental Advisory Committee, Environmentally Sensitive Area Study, Planning Department, September 1978.*

Soil on the proposed site extension is composed of well drained Oneida loam.[1] The agricultural capability of the site is rated as 60% Class 1 and 40% Class 3. Topography causes the major limitation to agricutural activity in the area.[2]

2.2 Site Drainage

The proposed site extension includes two drainage basins: one draining to Falcon Creek in the ravine to the west and north; and one draining to Indian Creek in the ravine to the east. A small intermittent tributary of Falcon Creek is located in the northwest corner of the site extension. Most of the site extension presently drains to Falcon Creek. Only the eastern-most portion of the site drains into Indian Creek.

Surface runoff from the completed landfilling area is presently collected in drainage ditches along the eastern and northern site boundaries. Runoff is then diverted directly over the steep red shale slopes of the western ravine to Falcon Creek (see Drawing A), and to swales entering Indian Creek southeast of the site.

Collector ditches are not seeded or mulched. The seeding of these pitches was postponed when consideration was given to expanding landfill operations. This has resulted in the

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1 *Gillespie, J.E., and R.E. Wicklund, The Soils of Halton County, 1971.*

2 *ARDA, Soil Capability for Agriculture, 1968.*

severe erosion of the ravine slopes and sedimentation in drainage swales. As a result of the erosion of the ravine slopes, runoff from the site over the western slope has removed vegetation and formed many deep gullies.

2.2.1 Surface Water Quality

Gartner Lee Associates Limited undertook a water quality survey in the spring and summer of 1979.[1] Water quality was tested on samples taken at a station on Falcon Creek downstream of the landfill near Highway 403. Results are presented in Table 1.

The results of testing did not indicate a significant impact on water quality from landfill operations.

Concentrations of phenols recorded a maximum of 1 ppb in one sample at one location only. This is the Ontario Ministry of the Environment's drinking water quality guideline for phenols. This is the only water quality parameter that suggests leachate may have entered Falcon Creek and been detectable. Values for alkalinity, hardness, sulphates, chlorides and iron are somewhat high. However, levels of these chemical parameters are not unusually high for a creek flowing through an area of Queenston shale bedrock.[2] When compared to results from the ground water quality sampling, the measurements recorded for Falcon Creek are considerably lower. The results from two of the boreholes that were drilled to test ground water are also presented in Table 1.

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1 *Results presented in Hydrogeological Study Final Report Proposed Burlington Landfill Site, September 1979.*

2 *Gartner Lee Associates Ltd., Hydrogeologic Study Final Report Proposed Burlington Landfill Site Extension, September 1979.*

TABLE 1

WATER QUALITY - FALCON CREEK

SAMPLE LOCATIONS:

1. Falcon Creek Water Quality near Highway 403
2. Leachate characteristics (Borehole #8 through landfill)
3. Background Water Quality (Borehole #1 located in the north corner of the site extension).

	4 April 1979			2 May 1979			4 June 1979		
	1	2	3	1	2	3	1	2	3
CONDUCTIVITY µMHOS/CM.	540	-	880	630	13,850	3,260	690	15,600	5,400
pH	7.9	-	7.5	8.0	5.5	7.2	8.4	5.7	7.5
HARDNESS ($Ca\ CO_3$)	254	-	238	314	8,000	1,110	351	10,100	1,804
ALKALINITY ($Ca\ CO_3$)	185	-	204	245	6,890	163	-	-	-
CHLORIDES (Cl)	35	-	47	35	1,190	136	28	13,000	203
SULPHATES (SO_4)	53	-	203	-	-	-	61	750	2,950
PHOSPHOROUS AS P TOTAL									
PHOSPHOROUS AS P Soluble									
NITROGEN Total Kjeldahl	0.6	-	1.6	-	-	-	0.4	720	5.4
NITROGEN Free Ammonia	-	-	-	-	-	-	-	-	-
NITROGEN Nitrite	-	-	-	-	-	-	-	-	-
NITROGEN Nitrate	-	-	-	-	-	-	-	-	-
METALS Potassium (K)	-	-	-	-	-	-	3.3	570	44
METALS Magnesium (Mg)	-	-	-	-	-	-	-	-	-
METALS Calcium (Ca)	-	-	-	-	-	-	-	-	-
METALS Sodium (Na)	18	-	105	-	-	-	23	930	800
METALS Iron (Fe)	.95	-	15	.40	800	6.0	.27	970	3.1
B.O.D.	0.6	-	135	-	-	-	1.40	26,000	28
PHENOL (ppb)	<1	-	<1	1.1	-	-	-	-	-
C.O.D.									
COLOUR									

Note: Concentrations in ppm unless otherwise noted.

Leachate is seeping from springs along the toe of the landfill. From the toe it appears to be seasonally entering the stream by overland flow. Ground water discharge does not appear to be a major source of leachate contamination to the stream. Ground water flows to depth and moves in a southerly direction.

A more detailed one year water monitoring program is currently being undertaken by Gartner Lee Associates Ltd.

2.3 Vegetation

Vegetation was examined during field surveys in the spring, summer and fall of 1979. Vegetation is described for the ravine forest edge, hedgerows, the eroded western shale/clay slope, fields and stream banks.

2.3.1 Ravine Forest Edge

Mixed ravine forest communities occur along the western, northern and eastern site boundaries (Drawing A). The forest structure is primarily secondary growth, with more mature trees established in the lower ravine areas. The forest presently supports rich canopy and understorey flora which has high ecological value, and very high functional value in controlling slope erosion.

The ravine forest bordering the west and north limits of the proposed site extension, "Sassafras Woods", meets two of the nine criteria for establishing an Environmentally Sensitive Area:[1]

i) the area is a habitat with limited representation in the Region, Ontario or Canada, or a small remnant of particular habitats which have virtually disappeared within the Region;

ii) the area provides habitat for rare or endangered species that are endangered regionally, provincially or nationally.

Sassafras Woods is distinguished for:

i) the provision of habitat for Carolinian species at the northern limit of their range in Ontario;

ii) the presence of nationally, provincially and regionally rare tree and ground flora species; and

iii) the size, location and linkage value of the woods in the context of remaining escarpment forest.[2]

Sassafras Woods is approximately 100 hectares (247 ac) in size. Sugar maple is the dominant species in association with shagbark hickory, witch hazel, ironwood and red oak.

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1 *Regional Municipality of Halton, Ecological and Environmental Advisory Committee, Environmentally Sensitive Area Study, Planning Department, September 1978, (see excerpt in Appendix 2).*

2 *Ibid.*

The western and northern edges of Sassafras Woods abutting the site extension were examined. Table 2 summarizes species information. No rare plants were observed along the ravine forest edge.

The Indian Creek ravine borders part of the eastern property boundary of the existing landfilling area and the proposed site extension. Trees are generally young to semi-mature with a few scattered mature specimens of red and white oak. Table 3 summarizes species information in that area.

Vegetation near the drainage outlet to Indian Creek is dominated by young to semi-mature trembling aspen trees.

Vegetation near the drainage outlet to Falcon Creek largely consists of forbs, grasses and shrubs. Species include:[1]

- goldenrod
- asters
- field horsetail
- wild carrot
- grasses
- clovers
- thistles
- willow shrubs
- red maple and white ash saplings
- ferns

The drainage ditch discharges into Falcon Creek in an area where there are very few mature trees.

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[1] *All scientific names are included in Appendix A1.*

TABLE 2

VEGETATION ALONG WESTERN AND NORTHERN EDGE OF SASSAFRAS WOODS

Area (Refer to Base Map)	Dominant Trees	Size Age	Shrubs	Herbaceous Plants	Comments
A	. red oak . shagbark hickory . large-tooth aspen . hawthorn . ironwood . white ash . witchhazel	• young to semi-mature • 20-cm dbh • 3-6m in height	. hawthorn . choke cherry . honeysuckle . serviceberry . sumac . saplings of dominant trees	. sweet brier . false solomon's seal . solomon's seal . common buttercup . sharplobed hepatica . common cinquefoil . common strawberry . thimbleweed . wild grape	. red maple (10-20 cm dbh) . sweetcherry (20-25 cm dbh) in association with the dominants along ravine crest . red oak, sugar maple and white pine (40-50 cm dbh) in depressional areas
B	. white oak . red oak . trembling aspen . white ash . sumac . hawthorn	• mature • 20-55 cm dbh	. same species as in Area A	. same species as in Area A	. sugar maple, black maple, shagbark hickory, white pine in association with dominant trees
C	. white oak . red oak . sugar maple . white maple . white ash . black cherry . witch hazel	• 10-45 cm dbh	. honeysuckle . hawthorn . chokecherry . saplings of dominant trees	. solomon's seal . false solomon's seal . trillium . roundlobed hepatica . thimbleweed . jewelweed . wild lily-of-the-valley . white baneberry . common strawberry . common cinquefoil	. ironwood, sweet cherry, red maple (10-30 cm dbh) in association with dominants

TABLE 3

VEGETATION ALONG EDGE OF INDIAN CREEK RAVINE

Area (Refer to Base Map)	Dominant Trees	Size Age	Shrubs	Herbaceous Plants	Comments
D	. sugar maple . white ash . ironwood . shagbark hickory . red oak . white oak	• less than 30 cm dbh	. hawthorn	. false solomon's seal . common strawberry . common cinquefoil	
E	. large tooth aspen . hawthorn . white oak . red oak . shagbark hickory	• 10-20 cm dbh • several red and white oaks are 40-55 cm dbh	. very few shrubs open understory		. open structure

2.3.2 Hedgerows

Hedgerows form the southern and eastern boundaries of the site extension. The predominantly shrubby structure of these hedgerows distinguishes them from adjoining ravine forest communities.

The hedgerow forming the eastern site extension boundary (Hedgerow 1) is composed of hawthorn and honeysuckle, intermixed with mature white oak, red oak and shagbark hickory. The oaks range in size between 40-65 cm (16-26 in) dbh. Shagbark hickory trees are estimated at up to 25 cm (10 in) dbh. Also present in the hedgerow are mature sugar maple, and white ash and nannyberry estimated at less than 20 cm (8 in) dbh.

The hedgerow along the southern site boundary (Hedgerow 2) is largely comprised of hawthorn and honeysuckle shrubs, with a sparse representation of:

- shagbark hickory
- red oak
- white ash
- american elm
- black maple[1]

With the exception of the elm, the hedgerow trees are generally young to semi-mature, averaging 10-20 cm (4-8 in) dbh. The mature elm tree is approximately 35 cm (14 in) dbh.

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[1] *Black maple is regionally uncommon.*

The hedgerow located along the east side of the existing landfill site entrance road (Hedgerow 3) is composed of bur oak ranging between 10-50 cm (4 in-20 in) dbh and scattered young shagbark hickory. A clump of semi-mature eastern cottonwood forms the northernmost portion of the hedgerow.

2.3.3 Eroded Western Clay/Shale Slope

Young trees, shrubs and herbaceous plants have colonized the more stable crest and toe areas of the actively eroding slope. Vegetation has been displaced from most of the steep west-facing slope.

On stable slope areas, several trees and shrubs (less than 15 cm (6in) dbh) were noted during field investigations:

- red oak
- white oak
- shagbark hickory
- white ash
- large-tooth aspen
- trembling aspen
- sumac
- hawthorn
- choke cherry
- currant
- poison ivy
- honeysuckle

Several species of herbaceous flora were also observed along stable areas of the slope, including:

2.3.4 Fields

The area proposed for the site extension is a typical old field ecosystem composed of timothy grass, asters, goldenrod, cow vetch, thistles, red clover and common buttercup.

The completed landfill site is sparsely covered with herbaceous species similar to those colonizing the eroded clay slopes (see Section 2.3.3). Yellow and white sweet clover, chickory, shepherd's purse, and ox-eye daisy are the most abundant.

2.3.5 Stream Banks

Trees and shrubs noted along the banks of Falcon Creek include:

- american elm
- black willow
- witch hazel
- eastern cottonwood
- ironwood
- white ash
- wild grape
- virginia creeper
- honeysuckle

Two provincially and regionally rare herbaceous plants[1] were noted in the Falcon Creek stream valley: large-bracted tick trefoil (Desmodium cuspidatum) and three-leaved false solomon's seal (Smilacina trifolia). The persistence of these plants will not be affected.

Downstream of the drainage outlet to Falcon Creek, vegetation is dominated by dogwood shrubs, brambles, virginia creeper, sumac and young white elm, cottonwood and shagbark hickory saplings. There are few mature trees in that area.

Along the banks of Indian Creek, these trees and shrubs were noted:

- shagbark hickory
- black willow
- large-tooth aspen
- white ash
- sumac
- honeysuckle

2.4 Fish and Wildlife

2.4.1 Regional

The study area is included in an area rated by Canada Land Inventory as Class 2 (out of 7 classes)[2] for the production

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1 *Regional Municipality of Halton, Ecological and Environmental Advisory Committee, Environmentally Sensitive Area Study, Planning Department, September 1978.*

2 *Class 1 - high; Class 7 - low.*

of deer.[1] Optimum plant growth for forage and cover is limited by a poor soil nutrient content and soil moisture. Canada Land Inventory rates the area as Class 7 for the production of waterfowl.[2]

Ontario Land Inventory rates the capability of the area for the production of seven wildlife species: white-tailed deer, ruffed grouse, hungarian partridge, ring-necked pheasants, european hare, migrant geese and ducks.[3] Table 4 summarizes the rating.

2.4.2 Local

During the site field survey, several birds were observed: red-tailed hawk, turkey vulture, ruffed grouse, herring gull, kildeer, catbird, song sparrow (and nest), bobolink and red-winged blackbird. Other birds such as whip-poor-will, golden-crowned kinglet and the ruby-crowned kinglet have been sighted in Sassafras Woods.[4]

Considerable deer activity has been noted along Falcon Creek. Since deer are usually found only in relatively undisturbed natural areas, Sassafras Woods is generally considered to be a significant local habitat and corridor for many wildlife species.[5]

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1 *Canada Land Inventory, Land Capability for Wildlife - Ungulates, 1971.*

2 *Ibid, Waterfowl, 1971.*

3 *Ontario Land Inventory, Land Capability Classification for Wildlife, 1976.*

4 *Regional Municipality of Halton, Ecological and Environmental Advisory Committee, Environmentally Sensitive Area Study, Planning Department, September 1978.*

5 *Armour, L., Royal Botanical Gardens, Hamilton. Personal communication, 28 June 1979.*

TABLE 4

LAND CAPABILITY CLASSIFICATION FOR WILDLIFE

SPECIES	CLASS (1-high; 7-low)	LIMITATIONS[1]
White-tailed deer	2	deficient soil moisture
Ruffed grouse	2	deficient soil moisture
Hungarian partridge	2	deficient soil moisture
Ring-necked pheasants	3	climate; deficient soil moisture
European hare	2	deficient soil moisture
Migrant geese	2	deficient soil moisture
Puddle ducks; wood ducks, duck hunting	7	lack of free-flowing water; excessively flat or rolling topography restricting water impoundment; unfavourable landform pattern.

1 *Characteristics that limit the production of suitable food and cover for wildlife or have an adverse effect on the species.*

The Ministry of Natural Resources has described the potential of Falcon and Indian Creeks to support fish as limited. These intermittent creeks are assumed to contain minnows and perhaps suckers in the summer. The potential of the Creeks to support fish is limited by their physical parameters, such as low flow, low velocity and relatively high water temperature.[1]

2.5 Air Quality

During field surveys (undertaken in dry weather conditions) dust resulting from vehicular traffic along the site access was observed. Dust was controlled by applying waste oil along the access road. Oil was observed in the drainage swales.

The impact of blowing dust and particulate matter on air quality is local to the site and not of major environmental significance. Of greater significance is the detrimental effect of waste oil that is washed by overland flow into drainage swales.

Observations of air quality consisted of a visual assessment of existing conditions, no quantitiative measures were taken.

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1 *Gingrich, M., Ministry of Natural Resources, Cambridge, Personal communication, 4 and 5 July 1979.*

3. EFFECTS OF LANDFILLING

An analysis was made of the potential for adverse effects on:

- erodible western clay/shale slope
- stream water quality
- vegetation
- fish and wildlife
- air quality

The visibility of proposed landfill operations is also examined.

A description of some of the effects of current landfill operations are included to predict effects of the proposed site expansion.

The potential environmental effects of proposed landfilling operations are summarized as follows:

- surface runoff causing continued erosion along the west clay/shale slope.

- increased sediment loading and turbidity in Falcon and Indian Creeks as a result of soil erosion during initial site preparation and operation. Water quality could be significantly impaired because of low flow and low velocity of the creeks.

- leachate may enter surface water.

- loss of vegetation in Sassafras Woods as a result of gully erosion.

- removal of, or damage to plants in Sassafras Woods and in the Indian Creek ravine during site preparation, drainage ditch construction and site operation.

- removal of a hedgerow along southern site extension boundary.

- the imposition of landfill activity and noise on the local wildlife habitat.

- reduction in creek water quality and effect on aquatic habitat.

- excessive dust produced by vehicular traffic on site access road.

- impact on water quality as a result of using waste oil for dust control.

- visibility of landfill operations on the site extension from residences and roads.

4. RECOMMENDATIONS

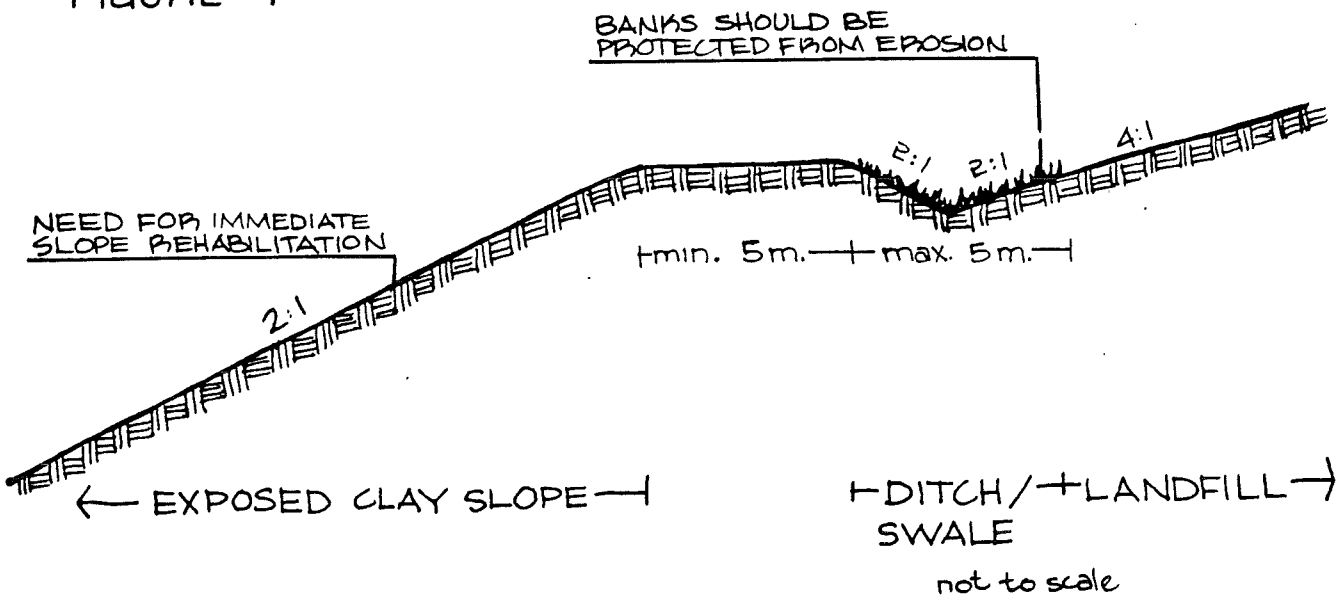
Based on the impact of current landfilling operations, recommendations are made to minimize impact as a result of operations on the proposed site extension. Detailed construction guidelines should be developed for the initial site preparation. Recommendations are described according to environmental features listed in the beginning of Chapter 3.

4.1 Erodible Western Clay/Shale Slope

Surface runoff from past landfill operations was collected in peripheral ditches, and directed to Indian Creek and Falcon Creek. As described in Section 2.1, surface water diverted to the west was routed directly over the steep ravine slope. Runoff has eroded the clay till overburden and has exposed the Queenston shale which is very susceptible to rapid weathering and erosion. The proposed drainage scheme for the site extension will direct runoff from the eastern portion of the site in existing ditches to Indian Creek. Most of the surface runoff will be directed along the western site boundary to outlet into Falcon Creek near Highway 403. At this location, the creek valley is gently sloping and shallow.

The new drainage scheme is designed to ensure that runoff will not be directed over the eroded clay/shale slopes. The proposed ditch will have a large width and depth capacity and a berm along the western ditch wall cut into overburden. The walls of the ditch should be protected to prevent slope back-cutting and channel bed erosion (see Figure 1).

FIGURE 1



Appropriate measures will be identified during design of the drainage works and included in the Design and Operations Final Report.

Temporary erosion control measures should be implemented during construction of the drainage outlet to Falcon Creek. The period and extent of construction activity along this area of the ravine slope should be minimized to avoid unnecessary disturbance to soils and vegetation. Site preparation should be undertaken outside of the heavy rainfall season. This clay/shale slope is very susceptible to erosion and measures must be implemented to ensure that it will be checked. Section 4.2 presents general recommendations for protection of vegetation and subsequent revegetation of the slope in the vicinity of drainage outlet construction.

It is recommended that remedial measures immediately be undertaken to rehabilitate the eroded western slope abutting the existing site. The suitability and feasibility of various erosion control measures should be analyzed to assess the best method of slope stabilization on this very sensitive and significant area.

All-terrain vehicles are causing and aggravating severe degradation of the erodible slopes and the valley bottoms. If erosion control measures are to be successful, all-terrain vehicles must be prohibited from entering the area.

4.2 Surface Water Quality

The site is overlain by clays which contribute to high levels of mineral colloids and surface water turbidity. As clay particles are very difficult to settle out of suspension in water, erosion should be controlled at the source. The Region will undertake a program of progressive site rehabilitation. Areas of completed landfilling will be graded, topsoil will be applied and areas will be hydroseeded.

As described in Section 4.1, erosion control measures for ditches will be identified during design of drainage works. Specific methods to control ditch channel and slope erosion will be selected according to expected runoff intensity. If feasible, sediment barriers (e.g. silt fence, straw bale, sandbags) should be installed in drainage ditches to filter sediment laden runoff before entering Falcon or Indian Creek. During construction of the drainage outlets, a

temporary sediment barrier, or similar protection measure, should be installed downstream in the creeks to filter or trap sediment. The creek banks should be protected from erosion during construction. Permanent erosion control measures should be implemented as soon as construction is complete.

The hydrologic characteristics of the site should be understood to ensure that leachate does not migrate to watercourses.

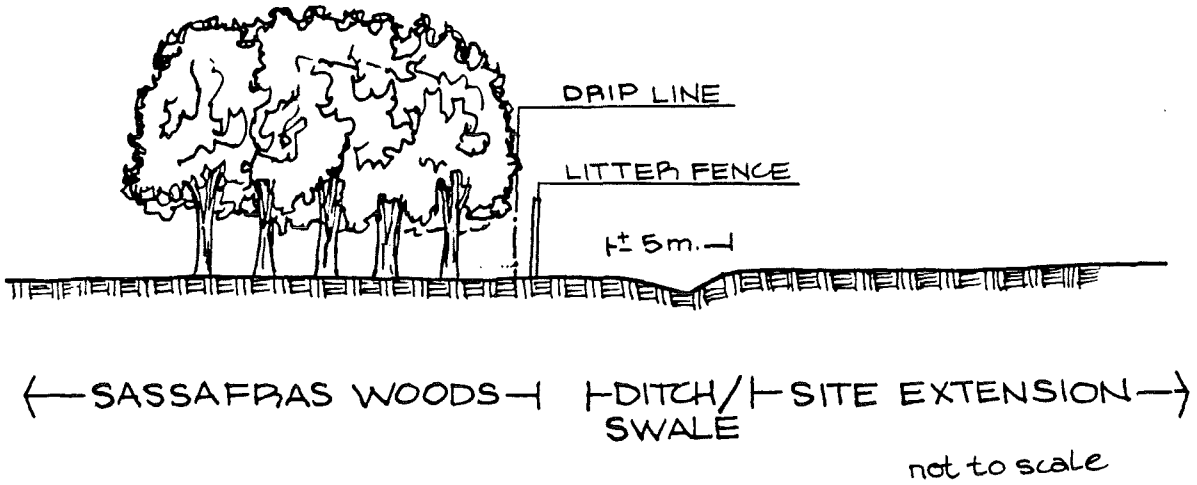
4.3 Vegetation

4.3.1 Sassafras Woods

Surface runoff from the landfill site will be directed to an outlet entering Falcon Creek south of current landfill operations (see Section 4.2). Both the routing of runoff and the capacity of the diversion ditch should protect the slopes of Sassafras Woods Sensitive Area from the initiation of gully erosion along the wooded edge and exposure to potential surface runoff contaminants.

In the initial construction phase, a wire mesh fence should be erected along the edge of Sassafras Woods on the site extension. The fence should be erected outside the drip line zone of the edge trees (set at approximately 5 metres). This fence will serve as a barrier to machinery movement during drainage ditch construction and site preparation, and should prevent serious root, branch or stem damage to trees, shrubs and herbaceous plants (see Figure 2). The fence

FIGURE 2



not to scale

should remain after initial site preparation is completed to intercept litter blowing from the landfill site. No vegetation should be removed.

The drainage ditch will outlet into Falcon Creek near Highway 403. South of Sassafras Woods the ditch will follow along the top of bank and join Falcon Creek where there are the least topographic and vegetation limitations. There will be very little vegetation removal and the alignment of the ditch will ensure that any large specimen trees are avoided.

A large clearing, dominated by herbaceous vegetation, exists where the ditch will discharge into Falcon Creek. A temporary fence should be installed around the perimeter of the forest edge abutting the clearance to protect plants against damage during construction of the drainage outlet. The slope should then be immediately revegetated to ensure that soil erosion is controlled.

4.3.2 Eastern Ravine Woods and Hedgerows

Site preparation and drainage ditch construction should not require the removal of vegetation from the hedgerow along the east boundary of the proposed site extension or from the edge of the eastern ravine woods (see Drawing A). A wire mesh litter fence (see Section 4.3.1) should be erected along the edge of the hedgerow and the eastern ravine woods to protect vegetation from damage during initial site preparation. The fence set-back specification outlined in Section 4.3.1 should be followed.

Construction of the drainage outlet to Indian Creek will require the removal of some trees along the ravine edge. Young and semi-mature large-tooth aspen and cottonwood trees will be removed. These species are very common in the area.

The hedgerow along the southern site extension boundary will be removed. This hedgerow is presently composed of hawthorn and honeysuckle shrubs, interspersed with young and semi-mature ash, oaks, hickory and a mature elm (see Section 4.3.2). With the exception of the black maple, trees, shrubs and ground flora to be removed in this hedgerow occur throughout the study area.

4.4 Fish and Wildlife

The presence of heavy equipment, dust and noise during the construction and operation phases of landfill development, will create less hospitable habitat conditions for local wildlife. Dust should be controlled by methods outlined in

Section 4.5. Confinement of landfill activity within the site boundaries (see Section 4.3) should prevent any reduction of edge vegetation density or continuity. The present edge structure of the ravine woods provides an advantageous buffer, and its maintenance is critical to continued wildlife activity in the ravine woods.

The drainage ditch outlet to Falcon Creek is located downstream of the Environmentally Sensitive Area and therefore should not affect its fish or wildlife habitat. Downstream of the outlet, Falcon Creek flows through urban areas where there is little aquatic habitat.

The aquatic habitat of Indian Creek should be protected by implementing the erosion control measures suggested in Section 4.1 and 4.2.

4.5 Air Quality

Dust produced by operations on the site extension should be controlled by applying water or calcium chloride to site access roads. Calcium chloride, however, should not be used within 10m from the brow of the Falcon Creek ravine. Waste oil should not be used for dust control because of the risk of contamination of the creeks.

4.6 Landfill Visibility

Most vegetation surrounding the site will be maintained for its value as a visual buffer. Forest vegetation and the ravines west, north and east of the site effectively screen the view from most of the residences along peripheral roads.

Air photo interpretation, land contour analysis and field surveys, revealed that certain stages of landfill operations may be visible from one residence located northwest of the site. Ravine vegetation partially obstructs the view from the residence.

Final landfill contours are designed in such a way that when viewed from areas outside the site, there will be little perceptible change in topography. In addition, the Region will progressively rehabilitate completed landfill areas to help minimize any visual effects of the operations.

Landfill operations on the site extension will not be visible from Highway 403. The existing landfill site will screen proposed operations from Highway 403. There will be a view of the site extension from King Road. The hedgerow along the east site extension boundary will be maintained to help screen operations.

5. SUMMARY

5.1 Conclusions

- Continued erosion along the west clay slope should be prevented by surface drainage design and remedial measures for slope rehabilitation.

- No impairment of surface water quality, as a result of leachate, is anticipated.

- Erosion and sedimentation measures should reduce sediment loading and turbidity in Indian and Falcon Creeks.

- Little impact on Sassafras Woods is anticipated. No vegetation will be removed and perimeter fences will protect plants from damage during initial site preparation and site operation.

- Surface drainage design will protect the ravine slopes of Sassafras Woods from erosion as a result of runoff.

- Litte impact on fish and wildlife habitat is anticipated.

- There will be little perceptible change in topography when the landfill is viewed from areas outside of the property.

- The Region's plan for progressive site rehabilitation will minimize visual effects of site operations.

5.2 Recommendations

1. For protection of erodible clay/shale slope:

   - Prevent runoff flow over slope.
   - Implement erosion control measures in drainage ditches.
   - Implement temporary erosion control measures on banks of Falcon Creek during construction of drainage ditch and outlet.
   - Minimize period and extent of construction activity near Falcon Creek.
   - Undertake site preparation outside of the heavy rainfall period.
   - Minimize vegetation removal and revegetate the valley slope after construction of the drainage outlet.
   - Rehabilitate the eroded slope.
   - Prohibit all-terrain vehicles on the slope.

2. For protection of surface water quality:

   - Erosion control measures in all drainage ditches will reduce sediment input to runoff.

- If feasible, install sediment barriers in drainage ditches to filter runoff before discharging into Falcon or Indian Creek.

- Prohibit migration of leachate into water-courses.

- Install temporary sediment barrier (or similar measure) downstream of construction activity for drainage outlets to Falcon and Indian Creeks.

- Protect creek banks from soil erosion during construction of drainage outlets.

- Implement permanent erosion control measures in valleys as soon as construction is completed.

3. For protection of vegetation:

   - Erect a wire mesh fence along the hedgerow and ravine woods edge on the boundaries of the site extension.

   - Erect a temporary fence around the perimeter of the forest abutting the clearance near the drainage outlet to Falcon Creek.

4. For protection of fish and wildlife habitat:

   - Control dust.

   - Confine landfill operations within fenced boundaries.

   - Protect aquatic habitat with erosion and sedimentation control measures on site, in drainage ditches and in Falcon and Indian Creeks.

5. For protection of air quality:

   - Apply water and/or calcium chloride to site access roads for dust control during dry conditions.

   - Calcium chloride should not be used to control dust within 10 m of the brow of the Falcon Creek ravine.

   - Waste oil should not be used for dust control.

SCIENTIFIC NAMES

a) Trees:

Common Name	Scientific Name
ash, white	*Fraxinus americana*
aspen, large-tooth	*Populus grandidentata*
aspen, trembling	*Populus tremuloides*
cherry, black	*Prunus serotina*
cherry, sweet	*Prunus avium*
cottonwood, eastern	*Populus deltoides*
elm, american	*Ulmus americana*
hawthorn	*Crataegus* sp.
hickory, shagbark	*Carya ovata*
ironwood	*Ostrya virginiana*
maple, black	*Acer nigrum*
maple, red	*Acer rubrum*
maple, sugar	*Acer saccharum*
nannyberry	*Viburnum lentago*
oak, bur	*Quercus macrocarpa*
oak, red	*Quercus rubra*
oak, white	*Quercus alba*
pine, white	*Pinus strobus*
sumac	*Rhus typhina*
willow, black	*Salix nigra*
witch hazel	*Hamamelis virginiana*

b) Shrubs:

Common Name	Scientific Name
choke cherry	Prunus virginiana
currant	Ribes sp.
hawthorn	Crataegus sp.
honeysuckle	Lonicera sp.
serviceberry	Amelanchier sp.
sumac	Rhus typhina

c) Herbaceous Plants:

sweet brier	Rosa eglanteria
false solomon's seal	Smilacina racemosa
solomons seal	Polygonatum p. pubescens
common buttercup	Ranunculus acris
sharp-lobed hepatica	Hepatica acutiloba
common cinquefoil	Potentilla simplex
common strawberry	Fragaria virginiana
thimbleweed	Anemone virginiana
wild grape	Vitis sp.
trillium	Trillium sp.
round lobed hepatica	Hepatica americana
jewelweed	Impatiens sp.
wild lily-of-the-valley	Maianthemum canadense
white baneberry	Actaea pachypoda

Herbaceous Plants (continued)

Common Name	Scientific Name
poison ivy	*Rhus radicans*
white sweet clover	*Melilotus alba*
yellow sweet clover	*Melilotus officinalis*
red clover	*Trifolium pratense*
nightshade	*Solanum dulcamara*
nipplewort	*Lapsana communis*
pasture rose	*Rosa carolina*
common milkweed	*Asclepias syriaca*
wild carrot	*Daucus carota*
yarrow	*Achillea millefolium*
cow vetch	*Vicia cracca*
common mullein	*Verbascum thapsus*
shepherd's purse	*Capsella bursa-pastoris*
ox-eye daisy	*Chrysanthemum leucanthemum*
field horsetail	*Equisetum arvense*
goldenrod	*Solidago* sp.
common chickory	*Cichorium intybus*
welted thistle	*Cardus crispus*
winter cress	*Barbarea vulgaris*
great burdock	*Arctium lappa*
virginia creeper	*Parthenocissus quinquefolia*
timothy grass	*Phleum pratense*
asters	*Aster* sp.

APPENDIX A2

Sassafras Woods Excerpt

from: Regional Municipality of Halton and Ecological and Environmental Advisory Committee. Environmentally Sensitive Area Study. Planning Department. September 1978.