Ex860

The Corporation of the
City of Burlington

EVALUATION OF HALTON REGION LANDFILL TECHNICAL STUDIES

Site D - Milton

DESIGN AND OPERATIONS REPORT

- Part A - Landfill Design Criteria
- Part B - Critique of Trow Technical Studies
- Part C - Recommended Design Amendments

February 1988
Ref. No. 1354-10

CONESTOGA-ROVERS & ASSOCIATES

CRA
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March 1, 1988

Reference No. 1354-10

Mr. Mike McQuaid
Weir and Foulds
Barristers and Solicitors
Suite 1600, Exchange Tower
P.O. Box 480, 2 First Canadian Place
Toronto, Ontario
M5X 1J5

Dear Mike:

Re: Site D - Design and Operations Report
Halton Environmental Assessment

Enclosed is our report entitled "Evaluation of Halton Region Landfill Technical Studies, Site D - Milton, Design and Operations Report".

This report was prepared on behalf of the City of Burlington as part of the on-going Environmental Assessment process for the establishment of a new landfill site in the Region of Halton.

Should you have any questions, please do not hesitate to contact out office.

Yours very truly,

CONESTOGA-ROVERS & ASSOCIATES

Anthony J. Crutcher, P.Eng.

AJC/dvs

Encl.

EXECUTIVE SUMMARY

As part of the ongoing Environmental Assessment (EA) process to obtain a new landfill site, the Regional Municipality of Halton (Halton) retained the services of Trow Hydrology Consultants Ltd (Trow) to provide design and operations reports for the two candidate landfill sites; Site D in Milton (Exhibit H-41) and Site F in Burlington (Exhibit H-42). The intent was that the reports would form the basis for an application under the Environmental Protection Act (EPA) for the operation of a sanitary landfill site.

Subsequent to the release by Halton of the Trow design reports, the City of Burlington (City) directed Conestoga-Rovers & Associates (CRA) to review and comment on the Trow design reports. As a consequence of this review, and in light of the recommended expanded site capacity requirement detailed in the CRA report entitled, "Evaluation of Halton Region's Waste Quantity Projections", March 1988, (CRA Waste Quantity Report), Burlington also requested CRA to evaluate the feasibility of expanding the landfills to accommodate the expanded site capacity requirements.

The report presented herein was written to document all of the above noted work undertaken by CRA for Site D. Comments on Site F are incorporated under a separate report. This report is structured as follows:

Part A - Landfill Design Criteria

Part B - Critique of Trow Technical Studies

Part C - Recommended Design Amendments

Part A, "Landfill Design Criteria", provides the philosophy and design criteria which provide the guidelines for landfilling at Site D. Included is information pertaining to landfilling in general, and pertaining to Site D specifically. Part B, "Critique of Trow Technical Studies", assesses the design provided by Trow in their report entitled, "Design and Operations Report - Site D". The focus of the review is the conceptual design provided by Trow; however, the review also includes an assessment of the degree of adherence to established design criteria, a discussion of the level of detail provided, and a review of the cost estimate. Part C, "Recommended Design Amendments", provides details of design changes which would enhance the suitability of Site D for landfilling.

Based on the design criteria provided in Part A of this report, CRA identified a number of areas that required further evaluation. With regard to the hydrogeologic criteria of maintaining the hydraulic trap and maximizing the thickness of the upper till unit CRA noted the following:

3. The criteria employed for determining the extent of paved roads was not clearly defined; however, based on the criteria detailed in Part A of the report presented herein, some additional paving would be beneficial.

4. The design layout and cost estimate were premised on the assumption that leachate would be hauled rather than conveyed from the site via a sewer or forcemain. Considering long term economic considerations and practicality, a dedicated leachate forcemain would be the preferable approach.

Part C of this report, "Recommended Design Amendments", provides an alternative design which addresses each of the identified comments. The alternative design specifically addresses the base contours, design and maintenance of the leachate collection system, and the layout of the site facilities. The general layout of the landfill site, the operation of site, the placement of berms, and the end use have not been substantially altered from the design provided by Trow. The proposed design changes would decrease the capital cost (including leachate disposal) of Site D from $14.9 million to $14.5 million.

Part C also addresses the need for establishing a site with a capacity of 6.6 million tonnes. This value, as calculated in the CRA Waste Quantity Report, is approximately 75 percent greater than the 3.8 million tonne capacity assumed in the Trow design. Based on the expanded site capacity requirement, the feasibility of expanding Site D is evaluated based on criteria such as hydrogeologic suitability, cost efficiency and practicality. As demonstrated in Part C, the site can be expanded to the east by approximately 1.9 million tonnes within the existing site berms and without increasing the height of the landfill site. Additional capacity of 0.9 million tonnes, for a total of 6.6 million tonnes, could be achieved by raising the height of the landfill an additional 2.5 metres. It could also be achieved by extending the property boundaries.

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PART A - LANDFILL DESIGN CRITERIA

A.1.0 INTRODUCTION

The purpose of a municipal landfill site is to provide an environmentally safe and efficient disposal site for the disposal of non-hazardous ~~solid domest~~ic, commercial and industrially generated waste. To assist with landfill design, the Ministry of the Environment (MOE) publishes guidelines entitled, "Guidelines for the Establishment, Operation, Management, Maintenance and Closure of Landfilling Sites in Ontario", (Guidelines). Adherence to the principles of the Guidelines is necessary before receiving a Certificate of Approval under Part V of the Environmental Protection Act (EPA).

As outlined in the Guidelines, the design of a landfill site will be constrained by physical considerations such as size requirement, land availability and site topography; by the need to mitigate potential off-site impacts such as groundwater contamination, visual impact and land use compatibility; and by specified engineering design criteria.

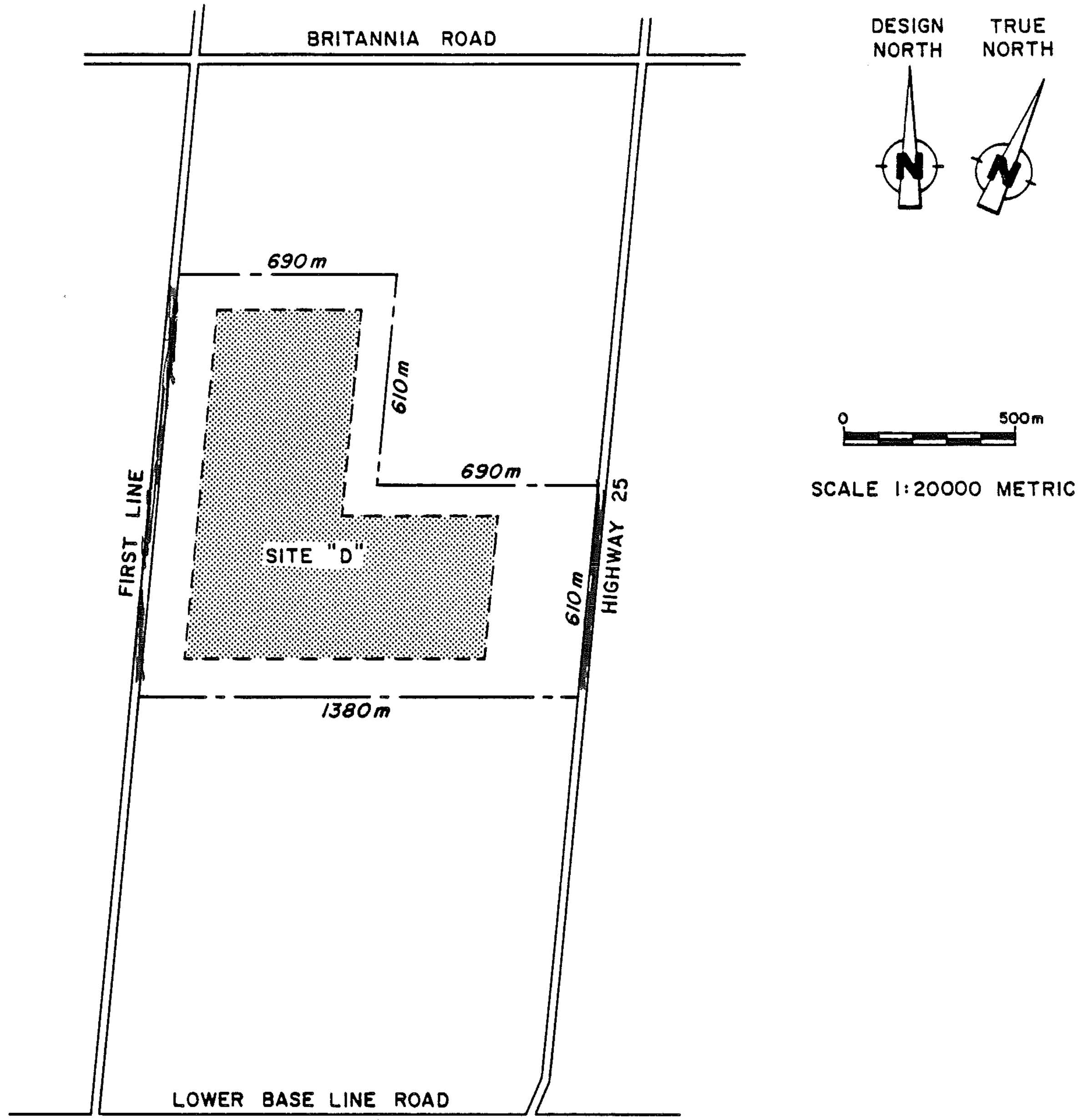
Each of these three types of constraints will be discussed separately in the following sections. Because each site has its own constraints and because the rigors of landfill design are in a state of flux, the constraints presented herein have various sources. Some are based on the findings presented in the completed Halton EA submission and Technical Studies, some are based on standard engineering practice, while others are based on CRA's experience with landfills elsewhere.

A.2.0 PHYSICAL CONSTRAINTS

A.2.1 SITE DESCRIPTION

Site D is illustrated in Figure A2.1, (page 4). The site is situated in the Town of Milton on parts of Lots 3 and 4 of Concession II in the geographic Township of Trafalgar. It is bound on the east by Highway 25 and on the west of First Line. In total, the Site contains approximately 126 ha of land, with approximately 42 ha in each of the north, southwest, and east sections. Allowing for a minimum 100 m buffer around the perimeter of the site, approximately 78 ha is potentially available for landfilling, although approximately 8 ha would be required for site services. Therefore, the net available lands for landfilling is approximately 70 ha.

The site is moderately flat, peaking in the middle and draining to Sixteen Mile Creek in the east and to Bronte Creek in the west. No major water courses traverse the site, although a small tributary of Bronte Creek traverses the northwest corner. Low permeability tills mantle the site, while surface elevations range from a low of approximately 181 m in the west to a high of approximately 186 m in the southeast. The existing land use is predominantly agricultural with four residences located within the site boundaries.



NOTE: DIMENSIONS ARE APPROXIMATE.

figure A2.1

LOCATION MAP
SITE "D" – DESIGN AND OPERATION
City of Burlington

CRA

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A.2.2 SITE CAPACITY

The site capacity requirement was initially calculated as 3.8 million tonnes in the report entitled "EPA Review of Waste Quantities Projection (Exhibit H-15)". This report was prepared in February 1986 by C.N. Watson and Associates Ltd. for the Region of Halton. The capacity requirement translates to a site volume requirement of approximately 8.0 million cubic metres. The volume calculation is based on a waste cover soil ratio of 4:1 and a refuse density of 600 kg/m^3.

In the CRA report entitled, "Evaluation of Halton's Waste Quantity Projections" March 1988, the recommended site capacity requirement was increased to 6.6 million tonnes. However, for the purposes of the review presented in Part B of this report, the site capacity of 3.8 million tonnes was accepted as a given design criteria. Part C of this report includes the feasibility of expanding the site to accommodate additional capacity.

A.3.0 OFF-SITE IMPACT CONSTRAINTS

A.3.1 GENERAL

A wide spectrum of environmental, physical and social factors must be considered during development of a landfill site in the conceptual and final design stages. The design factors range from the environmental aspects of biophysical, agricultural, wind and air quality, to the physical aspects of site capacity, hydrogeology, and stormwater control, to the social aspects of noise, archaeology, heritage, visual and after-use planning.

Each of the above listed aspects were studied by various members of the Halton E.A. Team. The individual conclusions and recommendations were then forwarded to Trow for consideration in completing their landfill design. For reference purposes, each of the above listed aspects are summarized in the following sub-sections. It should be noted that each set of recommendations represents an independent assessment of a specific aspect, and that any landfill design would have to "trade off" conflicting recommendations.

From the perspective of landfill design, hydrogeology provides the most significant set of design constraints. This is because the fundamental design aspects (lateral extent, depth of excavation, base contours, and leachate collection system) form an integral part of the hydrogeologic assessment of the potential for leachate migration.

The initial hydrogeologic assessment was undertaken by Trow Hydrology Consultants (Trow) on behalf of the Region of Halton. Thereafter, CRA completed an independent evaluation on behalf of the City of Burlington. Recommendations from both of these studies are summarized in the design constraints presented herein. This is because the Trow hydrogeologic recommendations provided the basis for the Trow Site D landfill design; whereas, the CRA hydrogeologic recommendations provide the basis for review of the Trow landfill design presented in Part B of this report, and provide the basis for the CRA recommended alternative design presented in Part C of this report.

A.3.2 HYDROGEOLOGY

Trow conducted an hydrogeological investigation of the proposed Site D landfill area. The major findings of the Trow hydrogeological study formed the basis of the Trow Site D design and as summarized in the "Trow Design and Operations Report", September 1986, (Exhibit H-41) are as follows:

1. The landfill site is founded on slowly permeable clayey glacial till with a low horizontal groundwater gradient.

2. Recharge conditions exist at the site in sufficient quantities to require a leachate collection system to control leachate mounding and off-site migration.

3. A hydraulic containment concept (i.e. a hydraulic trap) is feasible wherein the hydraulic head of the landfill is kept less than the surrounding environment. This will result in creating a discharge condition in the landfill area which will prevent off-site migration of leachate.

4. The base excavation depths will be designed to ensure the hydraulic trap in all the proposed cells of the site.

5. Collector pipe spacing was recommended to be 30.5 m which allowed mounding between the pipes to a maximum of 1.5 m.

6. A gas control system will not be required.

7. Natural attenuation would serve as contingency control at the site.

8. Further contingency systems consisting of perimeter leachate tile drain pipes and purge wells will provide additional opportunity to prevent off-site leachate migration.

9. Monitoring would be required to establish the effectiveness of the control systems for leachate, gas and storm water.

Points 2. to 5. of the Trow summary relate to the need to maintain leachate levels below the surrounding groundwater levels, in order to maintain the hydraulic trap concept. To this end, Trow selected a design leachate mound elevation of 0.4 m below the lowest piezometric elevation recorded on April 15, 1986. The various monitoring wells were used to specify design piezometric heads for various areas of the site.

Points 1. and 7. make reference to the clayey Upper Till unit, which underlies the site. The ability of the unit to contain and attenuate leachate complements the concept of the hydraulic trap in that it provides a contingency control should the trap fail to operate as designed.

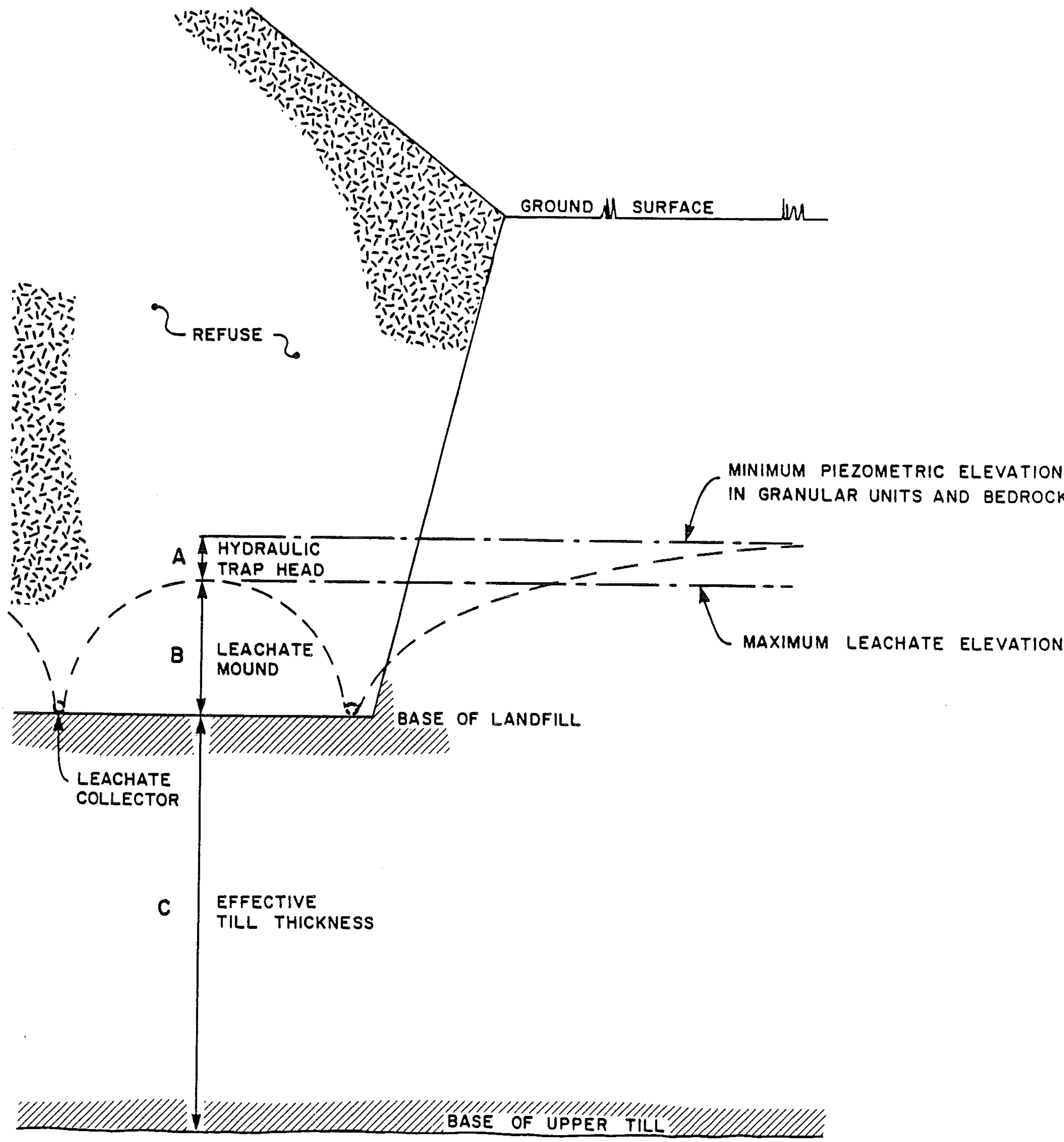
As discussed, CRA also conducted a hydrogeologic evaluation of Site D. This evaluation provides a basis for review of the Trow landfill design presented in Part B of this report, and provides a basis for the Alternative design presented in Part C of this report. The major findings and recommendations of CRA, as they relate to landfilling are summarized as follows:

1. Maintain a maximum leachate level of 0.4 m below April 1986 piezometric elevations for the underlying granular units and bedrock to provide for the hydraulic trap.

2. Maintain a maximum thickness of the unweathered Upper Till underlying the base of the landfill.

3. Ensure that the leachate collection system is effective in minimizing mounding.

These hydrogeologic considerations are illustrated in the schematic landfill of Figure A3.1 (page 11). The letter "A" (0.4 metres) denotes the inward gradient which provides the hydraulic trap, the letter "B" denotes the leachate mound, and the letter "C" denotes the thickness of the Upper Till unit remaining below the base of the site. At any given location, the total of A, B and C represents a fixed sum. The specific values of A, B and C, are influenced by the hydrogeologic objectives and engineering design constraints; although the design can be



NOT TO SCALE

figure A3.1

HYDROGEOLOGIC DESIGN CRITERIA
SITE "D" - DESIGN AND OPERATION
City of Burlington

CRA

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directed to balancing conflicting objectives such as maximizing the head on the hydraulic trap (A), maximizing the thickness of the remaining Upper Till unit (B), and balancing the site soil requirements.

A.3.3 TRANSPORTATION

In their report entitled "Transportation Analysis - Site D", August 1986 (Exhibit H-32), Giffels and Associates Limited analyzed and reported on the impacts of transportation around Site D during landfill operation. With respect to site design, the report recommended that the site entrance should be located 150 m North of the south property boundary.

A.3.4 BIOPHYSICAL

The biophysical aspects of the landfill site were analyzed and summarized by Bird and Hale Limited in their report entitled "Biophysical Analysis Report - Site D" August 1986 (Exhibit H-17). In summary, they concluded that "from a biophysical perspective Site D exhibited only minor constraints to the development of a municipal landfill site" (page i). More specifically, the two small forested areas lost to the proposed landfill would not be significant, although the landfill would result in the loss of significant floral species. Animal and bird life would not be seriously affected due to their mobility, vermin problems should not be serious if standard landfill practices are followed, and potential problems with the Burlington Airpark could be mitigated with appropriate landfill management techniques.

A.3.5 AFTER-USE

In their report entitled "Agricultural Impact and Rehabilitation Report" (Exhibit H-20), Ecological Services for Planning Ltd. (ESP) analyzed the possibility of using the landfill site as an agricultural zone after closure. The study concluded that the site could be rehabilitated to a viable agriculture area if the topsoil was stripped separately from the subsoil, and that the final cover consists of approximately 0.2 m of topsoil overlying 0.8 m of a mixture of B & C Horizon, and a 0.5 m clay cover (see Figure 1 of ESP report). To minimize erosion and allow drainage runoff, slopes in the middle of the site should not exceed five percent.

A.3.6 VISUAL IMPACT

The visual impact analysis was presented by the Landplan Collaborative Ltd. in their report entitled "Visual Analysis - Site D", August 1986 (Exhibit H-23). The report recommended that the final landfill contours be limited to 15 m above the existing elevations, screening be constructed along Highway 25 and First Line Road, the landfill side slopes be reduced to 8:1 along the southern part of the western edge and 5:1 along the north edge, progressive site rehabilitation be implemented, dense tree cover be planted along the north and west sides of the site, the location of services away from Highway 25 and the area be screened, as well as varying the topography along the top of the landfill.

A.3.7 WIND IMPACT

The analysis of the wind impact on the landfill design and operation was studied by F.H. Theakston and Associates and included in their report entitled "Wind Analysis Report", September 1986. As summarized in the Trow Design and Operations Report, the wind analysis concluded that the buildings around the landfill would not be adversely affected by the change in wind patterns and that leeward slopes should be limited to a maximum of 3:1 to reduce particulate movement. The wind analysis report recommended that landfilling should proceed in a west to east direction, that progressive rehabilitation should occur during operation, that all landfill slopes should be limited to a maximum of 3:1 and that litter fences and vegetative planting should be used to reduce the impact of air movement.

A.3.8 AIR QUALITY

Senes Consultants Limited studied the impact of the proposed landfill operations on the air quality surrounding the site (Exhibits H-29 and H-29A). The report concluded that the landfill site operation will not cause off-site dust and odour problems, except during berm construction. The report recommended that where possible, paved roads should be used and that non-paved roads be watered during dry periods.

A.3.9 NOISE IMPACT

Barman Coulter Swallow Associates analyzed the noise component of the landfill operation on the surrounding environment (Exhibit H-35). The report concluded that the west berms should mitigate the noise problems and that the additional truck traffic should not pose significant noise problems if the site entrance is on Highway 25.

A.3.10 ARCHAEOLOGY

The Museum of Archaeology (London) performed a preliminary archaeological study of the landfill site. The study determined that 12 prehistoric and archaeological finds were located on and around the landfill site area. The report recommended that if landfill is to occur at this site, further investigation is required to determine the significance of these finds. Where necessary, the identified areas should be avoided or mitigative steps taken.

A.3.11 HERITAGE FEATURES

The Landplan Collaborative Ltd. conducted a heritage feature assessment of the landfill site property (Exhibit H-26). The report concluded that no provincially or regionally significant features are located at the site, however, three local heritage features exist on the site property. The three local features include a farm residence, remnant plantings and orchard, and outbuildings. The Landplan report recommended that these heritage features should be preserved.

A.4.0 ENGINEERING DESIGN CRITERIA

Engineering design criteria, as presented in this report fall in one of three categories: general design parameters which are independent of site location; design factors which represent a synthesis of the recommendations detailed in Section A.3.0; and site specific design and operation considerations. Each set of criteria is discussed separately, below.

A.4.1 GENERAL DESIGN PARAMETERS

The design parameters employed by Trow in completing site design, are summarized as follows:

1. A minimum 100 m buffer zone around the site,

2. Excavation slopes of 1:1, landfill side slopes of 4:1 except where visual concerns govern, and a top slope ranging from 1 to 5 percent to facilitate an agricultural end use,

3. A waste to cover ratio of 4:1,

4. A compaction density of 600 kg/m^3,

5. A site volume capacity of 3.8 million tonnes ($8.2\ Mm^3$),

6. A leachate generation rate of 0.45 m/yr during site operation and 0.30 m/yr after site closure,

7. a leachate collection system,

8. A minimum 1.0 metre clay cap.

The above listed parameters are consistent with industry-wide accepted values.

A.4.2 <u>OFF-SITE IMPACT CONSIDERATIONS</u>

Based on the recommendation of the team of consultants whose site evaluations were summarized in Section A.3.0, Trow incorporated the following:

1. Prepare the base contours and install the leachate collection system such that the hydraulic trap will be maintained,

2. Along the southern half of the western edge of the site, maintain a maximum slope of 8:1,

3. Along the western section of the northern edge of the site, maintain a maximum slope of 5:1,

4. Construct a berm along the western edge of the property, with a height of seven to nine metres,

5. Landfill from west to east, and from north to south,

6. To the extent which is possible, maintain a maximum landfill height of 15 m above existing grades.

A.4.3 SITE SPECIFIC CONSIDERATIONS

The components of a landfill design can be grouped as follows:

- base contours, soil balance and leachate collection,
- final contours,
- leachate disposal,
- site service facilities and site servicing requirements,
- access and service roads,
- stormwater collection and control,
- site closure details,
- contingency plans,

- site development plans including soil storage requirements,
- operation and maintenance of the site,
- ability to expand site,
- cost estimate.

Requirements for each of these groups is provided in the following sub-sections.

A.4.3.1 Base Contours, Soil Balance, Leachate Collection System

Establishment of base contours is influenced by both hydrogeologic and engineering design considerations. As discussed in Section A.3.2, the hydrogeological considerations are:

- maintenance of the hydraulic trap,
- maximization of remaining Upper Till under the site,
- placement and maintenance of an effective leachate collection system.

Engineering considerations for each of these hydrogeologic considerations can be considered separately. Related to maintenance of the hydraulic trap, the following should be considered:

1. The elevation of the base contours and the width of the drain spacing for the leachate collectors, should be such that the head elevation of the leachate mound between adjacent collectors does not exceed the maximum design leachate mound elevation.

Related to maximization of the remaining Upper Till under the site, the following should be considered:

1. The height of the leachate mound should be kept to a minimum to allow for the highest feasible base elevation,

2. The depth of excavation for the leachate collection system should be minimized by reducing leachate travel distances and by placing collectors on the floor of the landfill rather than in collection trenches; thereby maintaining the maximum thickness of the Upper Till.

Related to placement and maintenance of an effective leachate collection system, the following should be considered (Bass, 1986).

1. The collection pipes should be adequately sized to ensure free drainage from the landfill.

2. The strength of the collection pipes should be selected to minimize the likelihood of collapse.

3. Manholes and clean-outs should be sufficiently spaced to ensure access for regular cleaning.

4. The drainage layer and pipe network should be designed to minimize the impact on leachate mounding caused by localized clogging of the collection system.

5. The drainage and filter layers of the collection system should be designed to minimize the likelihood of clogging.

6. Where practical, the slope of the collection system should be set to 2.0 percent.

A.4.3.2 Final Contours

Final contours will be influenced by the area of the site, the capacity of the site, and the elevation of the base contours. Beyond these considerations, landfill contours should be influenced by general design parameters listed in Section A.4.1 and off-site impact considerations listed in Section A.4.2.

A.4.3.3 Waste Types

The Environmental Protection Act, and Regulation 309 specifically, provides a tool for grouping wastes. In general, four categories exist: inert waste, non-hazardous industrial waste, municipal refuse, and hazardous industrial waste. The landfill design requirement will vary depending on the type of wastes accepted. For example, minimal engineering is required for an inert waste site while more sophisticated engineering is required for a hazardous industrial waste site.

A.4.3.4 Leachate Disposal

Ultimately, all collected leachate must be treated. Alternatives include an on-site treatment facility, construction of a sewer/forcemain to transport leachate to an existing secondary (biological) treatment facility, or haulage of leachate to an existing secondary treatment facility. Regardless of the method selected, a common collection point and a leachate pumping station will be required.

Each of these options for leachate treatment and disposal have to be determined to be acceptable from an environmental impact perspective. Based on information presented in the Guidelines, it is not expected that design details are required as part of the EA submission, although conceptual layouts and costs comparisons should be included.

A.4.3.5 Site Servicing

Site servicing requirements include potable water, sufficient storage or flow rate capacity for fire protection, and electricity.

Potable water requirements will be minimal and can be provided by an on-site well or a municipal watermain. Sufficient water for fire protection can be provided by on-site storage ponds, or by a municipal watermain. The storage pond could be incorporated with the required stormwater retention ponds.

Electricity will be required for the service buildings and to operate the leachate pumping station(s).

A.4.3.6 Site Service Facilities

As summarized in the Trow Design and Operations Report - Site D, required site service facilities include:

- weigh scale and scale house
- maintenance building
- site office
- staff and visitors parking
- bulk bin pick-up area

The site plans should accommodate space for the above facilities, although based on the Guidelines specific designs are not required. In locating these facilities, the following should be considered:

- all facilities should be placed to make efficient use of existing space,
- the maintenance building should be located as near as possible to the landfilling area,

- the bulk bin pick-up area should be accessible to casual users.

A.4.3.7 <u>Access and Service Roads</u>

The access road, from the main road to the weigh scales, will be in use for the entire life of the site. Virtually all traffic entering or leaving the site will use this road. Therefore, the access road should be paved and designed to carry heavy truck traffic. The road should be sufficiently long to accommodate an incoming truck queue, without backing onto the main road.

The approach roads to the maintenance building and the bulk bin pick-up area will also be heavily used, and required for the entire life of the site.

For emergency purposes, an alternative entrance to the site is desirable. This entrance will receive minimal use and could be a single lane gravel top road.

Secondary service roads are required to deliver the waste trucks from the weigh scales to the active site area. Since the active site area will constantly change over the life of the site, the specific requirements for service roads will also change.

Since some service roads may only be in use for several months while others may be used for several years or more, the need for paving these roads will vary. A suggested criteria would be to pave all roads which will be in active use for four years or more. This criteria is based on CRA experience.

The designs provided for the EA should illustrate the location of all roads, the extent of paving and should provide typical cross-sections. Additional details can be provided in the final design.

A.4.3.8 Stormwater Collection and Central Management

As a consequence of landfilling, site drainage patterns, particularly during storms, will be substantially different than would occur during existing site conditions. As well, the construction of a landfill on Site D will necessitate relocation of the tributary of Bronte Creek which traverses the northwest corner of the site.

Given the above, the Halton Region Conservation Authority (HRCA) provided the following list of conditions (Exhibit H-238):

1. The Bronte tributary diversion be sized to convey the Regional Storm flow and designed such that existing state/storage, stage/discharge relationships are maintained for a variety of storm flows up to and including the Regional Storm event.

2. The Bronte tributary diversion contain a low flow channel lining to prevent erosion.

3. The perimeter ditches be designed to convey as a minimum, the 50 year storm with erosion control protection up to the 5 year storm conditions.

4. The storm water management system be designed such that there are no increases in post development flow rates over predevelopment flow rates for a range of storms up to and including the 1:100 year storm.

5. The storm water management system be designed to prevent any potential increase in erosion along the Bronte and Sixteen Mile Creek tributaries should any change in the flows result in the final design.

Furthermore, the HRCA specified that in the final design stage the above calculations should be carried out with the "appropriate" hydrologic and hydraulic computer modeling methods, as specified in:

(a) Flood Plain Management in Ontario, Technical Guidelines, Ministry of Natural Resources, and

(b) Storm Water Management Guidelines, Central Region, Ministry of Natural Resources.

A.4.3.9 Monitoring and Contingency Plans

The hydrogeologic and landfill engineering design criteria assume that the system will operate as designed. Margins of safety are built in to allow for some variability; however, the possibility remains that the system will fail to operate as designed. In the case of Site D, failure specifically refers to failure of the hydraulic trap. Given the possibility of failure, monitoring of leachate mounding is required to track the possible egress of leachate from the site. Should monitoring identify a failure in the system, then a contingency (back-up) system may be required if the failure cannot be remediated.

The EA submission and Technical Studies should provide a conceptual contingency plan, although specific details are not required.

A.4.3.10 Landfill Construction and Operation Costs

The guidelines indicate that based on the level of detail in the design, cost estimates should be provided for each component. This cost estimate will allow a comparison of design options and will enable a complete economic and financial assessment of waste disposal alternatives.

A.4.3.11 Site Development Plans

Site development from the initial site clearing to placement of final cover, requires integration of all on-site activities. For example, the sequence in which the site is filled, berm construction, soil stockpiling, stormwater management, base excavation, placement of the leachate collection system, road construction, and placement of the final cover, are all interrelated activities. Therefore, sequential site development plans are required to illustrate the integration and balancing of the above activities.

A.4.3.12 Landfill Operation

The day to day operation of a landfill will vary as the site develops and with changing weather conditions. Correspondingly, the operation of a landfill requires specific machinery and staff.

As described in the Guidelines, the submission should address the day to day operation of the site; specifically the method of waste placement, compaction and covering. The submission should also address equipment and staffing needs.

PART B - CRITIQUE OF TROW TECHNICAL STUDIES

B.1.0 INTRODUCTION

In September 1986, the Regional Municipality of Halton (Halton) released the technical reports for the proposed Halton Regional Landfill Site. These reports were prepared as part of the ongoing Environmental Assessment (EA) process. Included was the "Design and Operations Report" prepared by Trow Hydrology Consultants (Trow) completed for Site D in Milton (Exhibit H-41).

Part B of the report presented herein, represents a review of the Trow Design and Operations Report for Site D. Specifically, CRA reviewed:

1. base excavation, leachate collection system, leachate disposal,
2. final contour plan, soil balance,
3. waste types,
4. site servicing, site service facilities,
5. access and service roads,
6. stormwater collection and control,
7. landfill construction and operation costs,
8. site development plans, and
9. landfill operation.

For each of the design components in the above list, CRA reviewed the adherence to the design criteria, the practicality and completeness of the design and undertook an independent check of all material quantities.

With regards to each of the nine landfill aspects listed on the previous page, CRA comments can be listed in one of three categories: substantial comments leading to the recommendation of an alternative design; minor comments leading to the recommendations of minor design changes; and agreement with the existing design concept and design detail.

Based on a review of the base excavation, leachate collection system and leachate disposal plan, as well as a comparison to the design criteria established in Part A of this report, CRA has identified a number of pertinent comments and has identified the need to provide a revised design for the base contours, the leachate collection system and the leachate disposal plan.

Details of the Review are included in Section B.2.0, while Part C of this report provides the revised design.

Based on a review of the final contour plan and soil balance, site services, site service facilities, access and service needs, and stormwater collection and control, minor comments are provided. Details of these comments are included in Section B.3.0, and are incorporated in the recommended design amendments presented in Part C of this report.

With regard to the waste types, the site development plans and the site operation, CRA is in agreement with the presented design and has no further comment.

With the exception of leachate sewer/forcemain costs, CRA was also in general agreement with the landfill cost estimate provided by Trow. The overall cost estimate is discussed in Section B.4.0. The primary purpose of this discussion is to provide a basis for comparing the revised cost estimate resulting from the proposed design changes.

B.2.0 REVIEW OF BASE CONTOURS, LEACHATE COLLECTION, LEACHATE DISPOSAL

B.2.1 BASE CONTOURS

The base contours and the leachate collection system, as illustrated on Drawing 2 of the Trow Design and Operations Report (Exhibit H-41), are reproduced on Plan 1 of this report. As the plan illustrates, the site has been divided into five cells; each approximately 200 m wide by 500 m long.

The specifics of the base design criteria were provided in Part A of this report. In general, the design objectives were to maintain a hydraulic trap and maximize the thickness of Upper Till underlying the site. Based on these two objectives, the review of the Trow base contours entailed:

1. plotting existing monitoring well locations on Plan 1,

2. for each monitoring well listed on Plan 1, noting the minimum April 1986 piezometric water level and the elevation of the base of the Upper Till unit,

3. for each cell, selecting a representative minimum April 1986 piezometric water level and a representative elevation of the bottom of the Upper Till Unit.

The above calculations, along with the Trow-specified leachate mound, are summarized in Table B.2.1, page 37. The maximum leachate mound is calculated as 1.5 metres on page 125 of the "Trow Site D Hydrogeologic Report", September 1986 (Exhibit H-39).

The information presented in Table B.2.1. (page 37), along with all elevation information taken from Plan 1, allow an assessment of the Trow design's adherence to the two design objectives of maximizing the till thickness and maintaining a 0.4 m differential between the maximum leachate elevations and the minimum April 1986 piezometric elevation. This assessment is summarized in Table B.2.2 (page 38). To assist in understanding the table, Figure B.2.1 (page 39) provides a cross-sectional illustration of Cell No. 5.

As Table B.2.2 illustrates, the design does not meet the 0.4 m hydraulic trap criteria in Cells 1 and 5. It should be noted, however, that this deficiency is marginal.

With regard to remaining till thickness, Table B.2.2 (page 38) illustrates that the minimum Upper Till thickness underlying the site will range from 2.6 m in Cell 2 to 3.6 m in Cell 5.

TABLE B2.1

SUMMARY OF TROW HYDROGEOLOGIC DESIGN CONSTRAINTS

Cell No.	Maximum Elevation of Base of Upper Till (m)	April 1986 Minimum Piezometric Elevation (m)	Maximum Leachate Mound (m)
1	176.0	181.2	1.5
2	175.9	181.5	1.5
3	175.2	181.5	1.5
4	175.5	181.2	1.5
5	175.4	180.8	1.5

Notes:

(1) "Maximum Elevation of Base of Upper Till" calculated from existing borehole logs. See Plan 1 and Exhibit H-39A.

(2) "April 1986 Minimum Piezometric Elevation" derived from records of existing boreholes. See Plan 1 and Exhibit H-39A.

TABLE B2.2

COMPARISON OF HYDROGEOLOGIC DESIGN CONSTRAINTS TO TROW BASE ELEVATION DESIGN

Cell No.	Maximum Base of Upper Till (m)	Base of Landfill (m)	Maximum Leachate Level	Design Piezometric Elevation (m)	Minimum Upper Till Thickness (m)	Minimum Hydraulic Trap Head (m)
1	176.0	179.5	181.0	181.2	3.5	0.2
2	175.9	178.5 - 179.5	181.0	181.5	2.6	0.5
3	175.2	178.0 - 179.5	181.0	181.5	2.8	0.5
4	175.5	178.5 - 179.1	180.6	181.2	3.0	0.6
5	175.4	179.0	180.5	180.8	3.6	0.3

Notes:

1) "Maximum Base of Upper Till" (see Table B2.1, page 37).

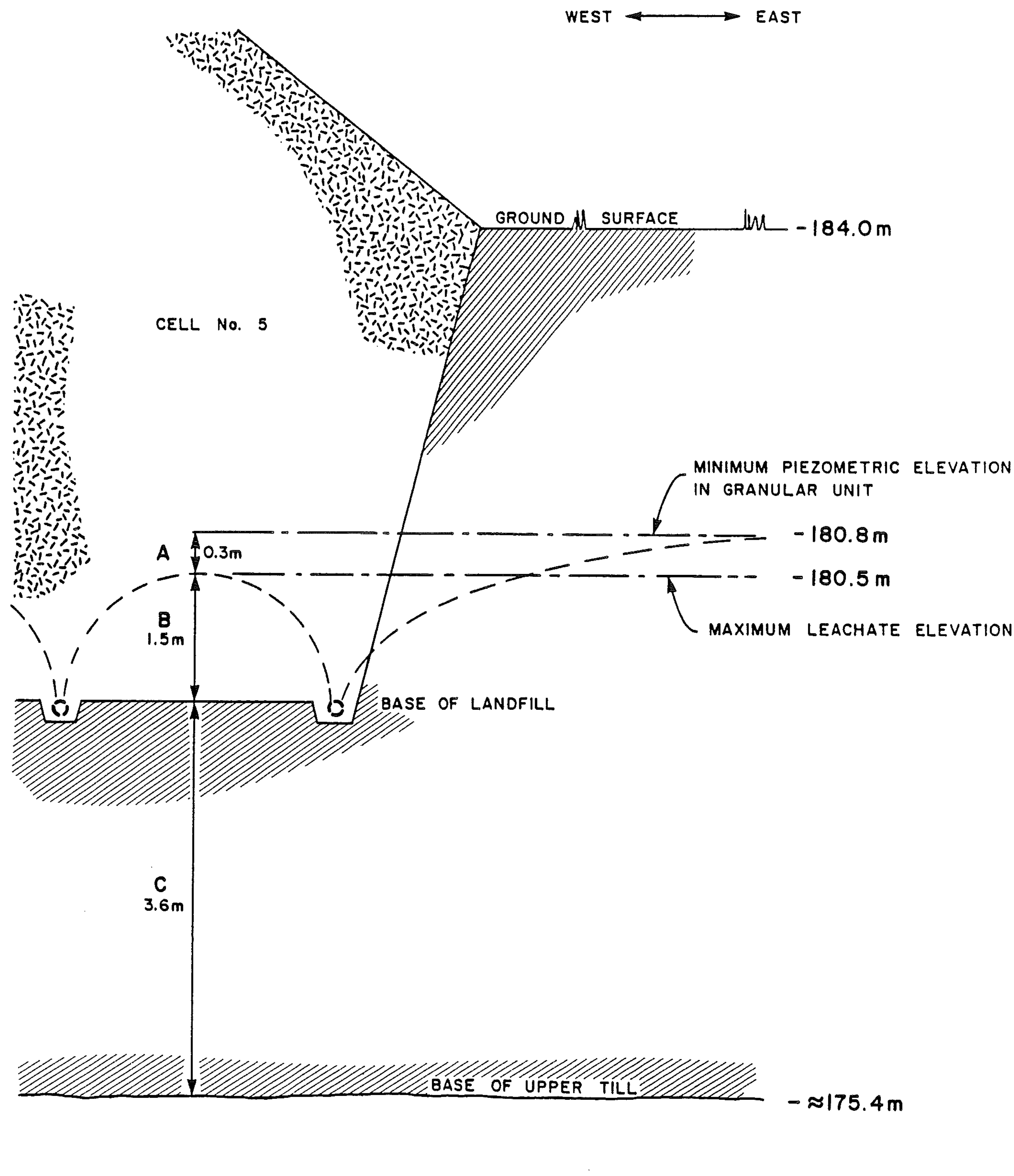
2) "Base of Landfill from Trow Drawing No.2, Exhibit H-41.

3) "Maximum Leachate Level" is highest elevation of base of landfill plus leachate mound of 1.5 m.

4) "Design Piezometric Elevation" is equal to the lowest measured piezometric elevation in strata below the upper till, as measured in April 1986 (see Table B2.1, page 37).

5) "Minimum Upper Till Thickness" is the difference between the maximum base of the Upper Till and the minimum base of the landfill.

6) "Minimum Hydraulic Trap Head" is determined by subtracting the "Maximum Leachate Level" from the "Design Piezometric Elevation". A value less than 0.4 m under "Minimum Hydraulic Trap Head" implies that the trap design criteria has not been met.



NOT TO SCALE

figure B2.1

TROW - HYDROGEOLOGIC DESIGN CRITERIA
SITE "D" - DESIGN AND OPERATION
City of Burlington

CRA

1354-10-30/11/87-33-D-0

Based on this review, and irrespective of concerns regarding the leachate collection system, it can be concluded that the base contours generally achieve the objectives of base contour design criteria. However, it is recommended that consideration be given to design improvements which would increase the hydraulic trap head and increase the thickness of the Upper Till remaining under the landfill site.

B.2.2 LEACHATE COLLECTION SYSTEM

B.2.2.1 Leachate Generation Rates

For the purposes of design, Trow assumed a leachate generation rate of 0.45 m/yr while the site was active and 0.30 m/yr after site closure. These rates represent guideline values provided by the MOE and are therefore, acceptable for design purposes. In practice, these values represent the upper range of expected generation rates.

B.2.2.2 Leachate Collection System

The leachate collection system (LCS) is illustrated in Trow Drawing No. 2 (Exhibit H-41) and in CRA Plan No. 1. The system consists of the following:

1. In the odd numbered cells, perforated collectors flowing from north to south and connecting into a perforated sub-header system,

2. In the even numbered cells, perforated collectors flowing from south to north and connecting into a perforated collector,

3. Within each cell, a single perforated sub-header draining from west to east and connecting to a solid header system,

4. A solid header system, extending on a north-south line, immediately to the east of the landfill area, and draining to a common leachate collection point,

5. Perforated perimeter collectors installed adjacent to the outer limit of each cell, and connecting to the sub-header system, and

6. At the common collection point, an oversized manhole with sufficient size to contain the equivalent of the capacity of a leachate haulage vehicle.

Details regarding each of the system components (perforated collectors, perforated subheaders, solid header system) are as follows:

1) Perforated Collection Pipes:

- diameter of 0.15 metres
- spacing of 30.5 metres
- minimum slope of 0.25 percent
- pipes placed in stone-filled trenches cut below the base of the landfill, with trenches extending from 0.5 to approximately one metre below the base of the landfill
- approximately 25 percent of collectors accessible for maintenance

2) Perforated Subheaders:

- diameter of 0.2 metres
- one sub-header draining from east to west, along either the northern or the southern limit of each cell
- slopes ranging from 0.25 to 0.50 percent
- pipes placed in stone-filled trenches cut below the base of the landfill, with trenches extending from 0.5 to approximately two metres below the base of the landfill
- manholes placed every 100 m, except where depth of waste is in excess of 16 m

3) Solid Header System:

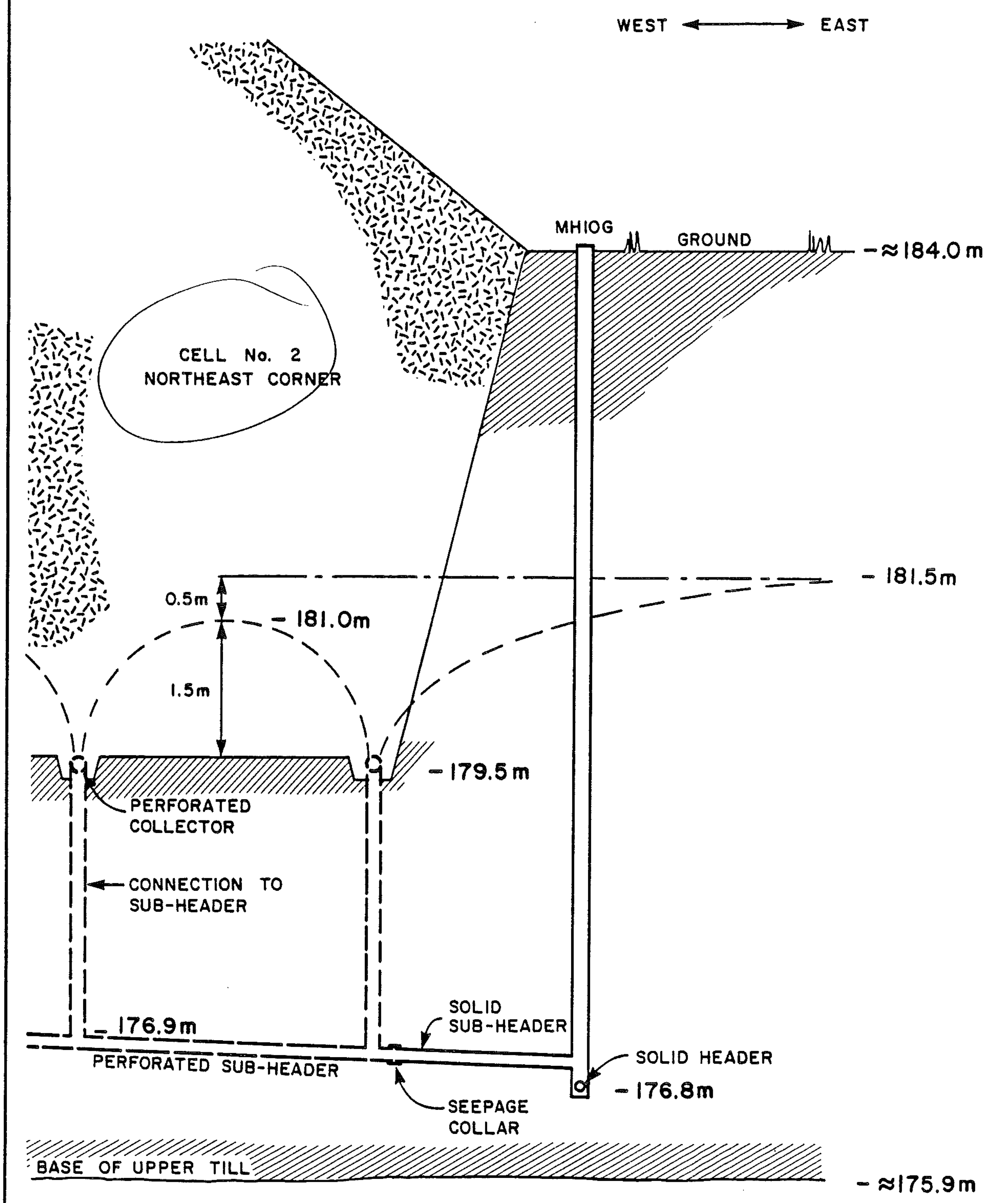
- diameter of 0.30 metres
- system extends in a north-south direction immediately to the east of the landfilling area

- from Cell 1 to Cell 3, pipe slopes in southerly direction with the invert elevation varying from 177.6 m in the north to 175.5 m in the south
- from Cell 4 and Cell 5, pipe slopes in a northerly direction with the invert elevation varying from 176.0 m in the south to 174.6 m in the north
- two header sections meet at a common manhole, labelled as No.20 in Trow Drawing 2 and Plan 1 attached hereto
- header system accessible for maintenance by manholes placed every 100 m

To assist in the review, Figure B.2.2 (page 44) was developed to provide a typical cross-sectional view of the leachate collection system. In addition, the base elevation of each subheader and header manhole are plotted on Plan 1.

Based on the leachate collection system design criteria and the design illustrated in Plan 1 and Figure B.2.2 (page 44), the following were noted:

1. In all cases the perforated leachate collectors cut below the base of the landfill, from a minimum cut of 0.6 m at the upgradient end of each line to 1.1 m where the collectors connect to the subheaders.



NOT TO SCALE

figure B2.2

TROW – LEACHATE COLLECTION CROSS-SECTION
SITE "D" – DESIGN AND OPERATION
City of Burlington

CRA

1354-10-30/11/87-33-D-0

2. In all cases the perforated subheaders cut below the base of the landfill, from a minimum cut of 0.75 m to a maximum cut of 2.5 m.

3. In the worst case, the thickness of the Upper Till Unit below the leachate collection pipe will be reduced to a minimum of approximately 1.0 m.

4. The solid header system will cut into the Lower Till Unit while the proposed pumping station (elevation 169.7 m) will extend below the Upper Till Unit.

5. The slope of all perforated collectors is 0.25 percent, while the slope of the headers and subheaders ranges from 0.3 to 0.5 percent.

6. Sections of the leachate collection systems in cells 2, 3 and 4 are poorly accessible for maintenance.

In light of the above information, it can be concluded that the leachate collection system as it is presently conceptualized requires further evaluation to meet the design criteria.

B.2.3 LEACHATE DISPOSAL

The Trow Design and Operations Report provided for the hauling of leachate from the site, commencing in year 3 and continuing over the life of the site. Reference is made in the report to the possibility of connecting to a future trunk sewer or the possibility of constructing a dedicated sewer/forcemain to connect to an existing sanitary sewer. However, for the purpose of the Trow design (and cost estimates) these were discounted because of uncertainties in scheduling future facilities and sewer lines.

In the report, Trow also provided a cost estimate for hauling of leachate. This ranged from a low of $164,000 in year 3 to a high of $854,000 in year 19. Costs were not included beyond year 20 although haulage would be required for many years after site closure.

Subsequently, as part of the Consolidated Board Hearings, Trow provided a conceptual design for a leachate sewer/forcemain connecting to an existing Highway 25 sanitary sewer which presently terminates several hundred meters south of Upper Middle Road in the Town of Oakville. Details of the sewer/forcemain were as follows:

1. It would extend from Manhole 20 at Site D, along the Highway 25 right-of-way, to an existing sanitary sewer 2670 metres south of Highway 5.

2. The total distance would be approximately 9600 meters; consisting of 8700 metres of 300 mm gravity sewer and 900 meters of 100 mm forcemain.

3. The gravity sewer would include 84 manholes spaced approximately every 100 metres.

4. The sewer/forcemain would include four pumping stations.

5. The sewer would be placed adjacent to Highway 25; therefore, road restoration and resurfacing would be required.

A complete review of the design was limited by the lack of design details, such as the location of the forcemain section(s), the depth of excavation, and the location of the pumping station. However, based on a review of available information, the following were noted:

1. Since the sewer/forcemain will be "dedicated" with no intermediate inflow, more extensive use could be made of the less expensive forcemain.

2. Since the sewer/forcemain will be "dedicated", a manhole spacing of 100 metres for the sewer sections is somewhat excessive.

3. The width of the Highway 25 right-of-way is typically in excess of 35 m, therefore, consideration should be given to installing the sewer/forcemain at a distance from the highway, such that minimal resurfacing will be required.

In light of the cost of long term hauling and the concerns with the provided sewer/forcemain design, it is recommended that the feasibility of the sewer/forcemain be evaluated in some detail, and the economics of the sewer/forcemain be compared to the economics of long term hauling.

B.3.0 REVIEW OF ADDITIONAL DESIGN COMPONENTS

At the outset of Part B of this report, it was noted that CRA was in general agreement with a number of design components, although minor variances from the design objectives were noted. These components included the final contour plan and soil balance, the site services and site service facilities, the access and service roads, and the stormwater collection and control plans. Each of these components is discussed in the following sub-sections. Where applicable, design amendments are recommended.

B.3.1 FINAL CONTOURS AND SOIL BALANCE

Recalculation of the site volume confirms that the site was adequately sized for the 3.8 million tonne capacity identified by the Region; and, the design would result in excess excavation of approximately 453,000 cubic metres of clay till. At the outset, the Trow report listed the recommendations of the end-use consultant who identified the need for additional final cover soil to facilitate agriculture as an end-use. However, in calculating the final contours and the soil quantities, explicit reference was not made to using a part of this excess to increase the cover soil depth on the top of the landfill to the thickness recommended by the agricultural consultant.

B.3.2 SITE SERVICES AND SITE SERVICE FACILITIES

The Trow design provided sufficient pond capacity for fire prevention purposes and assumed that potable water would be supplied by an on-site well. **As an option, it is recommended that consideration be given to constructing a watermain to the site from either Milton or from Oakville.** This watermain would supply water for fire prevention and would also provide a contingency water supply for adjacent properties that may potentially be affected by leachate egress from the site should the hydraulic trap fail.

An overview of the site service facilities did not identify any concerns; however, the overall facility layout makes ineffective use of site lands. As illustrated in Trow Drawing 3, the facilities are distributed across the eastern third of the site, an area in excess of 30 ha. **The provided layout of site service facilities would effectively inhibit possible easterly expansion of the site and therefore should be amended to accommodate this future/contingency expansion possibility.**

B.3.3 ACCESS AND SERVICE ROAD

The provided access and service road layout and design adhered to virtually all of the design criteria listed in Part A of this report. The only exception was the section of service road leading from the maintenance building to Cells 1 and 2. **It is recommended that this section of the service road be paved since it will be in use for at least four years.**

B.3.4 STORMWATER COLLECTION AND CONTROL

The provided stormwater collection plan failed to achieve all of the design considerations provided by the Halton Region Conservation Authority (HRCA). However, by way of Council Resolution, the Region of Halton has agreed that detailed stormwater management calculations will be carried out as part of the final site design.

It is expected that, in the worst case, detailed calculations would recommend larger stormwater management ponds. Given the Council resolution and given that larger ponds could be readily accommodated on the site, the Trow design is considered acceptable at this time.

B.4.0 <u>REVIEW OF TROW COST ESTIMATE</u>

To undertake a review of the Trow cost estimate, CRA completed independent calculations of all material quantities, researched unit prices for system components, and ultimately tallied an independent assessment of capital and operation costs.

Although the cost of individual items varied, the overall landfill cost estimate calculated by CRA was close to the Trow landfill cost estimate. Therefore, the Trow cost estimate was accepted. For information purposes, a summary of the Trow landfill costs is attached as Table B.4.1 (page 53). The information presented in this table will be used in developing costs for the recommended design amendments provided in Part C of this report.

A summary of costs for leachate hauling and the leachate sewer/forcemain are included in Table B4.2 (page 54). A review of the cost of the leachate sewer/forcemain suggested that, because of the provided conceptual design, the overall estimate may be high. **Therefore, it is recommended that this cost estimate be reviewed as part of the recommended evaluation of the feasibility of the leachate sewer/forcemain.**

TABLE B4.1

TROW - CAPITAL COST SUMMARY

A)	Clearing, Grubbing and Cell Excavation	$ 1,525,000
B)	Leachate Collection System	1,443,000
C)	Access Roads	860,000
D)	Site Services	968,000
E)	Stormwater Management	129,000
F)	Site Closure	3,250,000
	Subtotal	$ 8,175,000
	Contingency (15%)	1,226,250
	Subtotal	$ 9,401,250
	Engineering (15%)	1,410,190
	GRAND TOTAL	$10,811,440

TABLE B4.2

TROW - LEACHATE SEWER/FORCEMAIN

Lift Stations (4)	$ 200,000
Forcemain (900 m of 100 mm dia)	90,000
Gravity Sewer (8700 m of 300 mm dia)	1,087,500
Manholes - 84	588,000
Road Resurfacing (9600 m)	960,000
Subtotal	$2,925,500
Contingency (15%)	438,830
Subtotal	$3,364,330
Engineering (15%)	504,650
GRAND TOTAL	$3,868,980

B.5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the critique of the Trow design for Site D, it was concluded that the design demonstrates that it is feasible to construct a landfill which will adhere to the prescribed design criteria. It was also concluded that the provided site design could be optimized to enhance Site D's feasibility as a landfill site.

Based on the review of the Trow design for Site D, and in light of the above conclusions, the following are recommended:

1. An alternative design be provided for the base contours and leachate collection system, which more closely adheres to the hydrogeologic design criteria.

2. A more detailed analysis be completed of the feasibility of providing a dedicated leachate sewer/forcemain to convey the landfill leachate to the nearest sanitary sewer connection.

3. The layout of the site service facilities be amended to accommodate future expansion to the east.

4. The section of service road leading from the maintenance building to Cell No. 1 and No. 2 be paved.

5. Consideration be given to the feasibility of constructing a watermain from Milton or Oakville to the site, to supply potable water to the site and as an alternative water supply contingency plan.

6. Analysis be completed of the feasibility of expanding the site capacity from 3.8 million tonnes to as much as 6.6 million tonnes, as recommended in the CRA report entitled, "Evaluation of Halton Region's Waste Quantity Projections", March 1988.

PART C - RECOMMENDED DESIGN AMENDMENTS

C.1.0 DESIGN OBJECTIVE

Part B of this report presented a review of the "Site D Design and Operations Report" (Exhibit H-41) prepared by Trow Hydrology Consultants (Trow), and submitted as part of the Region of Halton's (Halton) submission.

In conclusion, the review identified that the Trow conceptual design, while demonstrating the site was technically acceptable, could be optimized. In particular, the design did not totally achieve the hydrogeologic design objectives of minimizing the excavation of the Upper Till unit, and providing a leachate collection system which in the long term will effectively collect leachate and maintain the hydraulic trap.

In addition to concerns with the landfill base and leachate collection system, a number of recommended design amendments were identified to be considered at the pre-design level which would provide an improvement of the overall design of a landfill at Site D.

In light of these noted comments by CRA, the report (Part C) presented herein, provides an alternative design for the Site D landfill base and leachate collection system. Although the alternative design focuses on the base contours and leachate collection system, revisions are also provided for the final contour plan and layout of the site facilities. Changes to the final contour plan are a direct result of the alternative base contours and leachate collection system, rather than any concern with the Trow design. Changes to the layout of the site facilities are provided to make more efficient use of site lands and to accommodate future/contingency landfill expansion.

Apart from comments on the Trow landfill design, Part B of this report also identified the need to address:

1. The feasibility of constructing a dedicated leachate sewer/forcemain as an alternative to long term leachate haulage,

2. The need to assess the feasibility of constructing a watermain from Oakville or Milton, and

3. The need to address the feasibility of expanding the site capacity from 3.8 million tonnes to as much as 6.6 million tonnes as recommended in the CRA report entitled, "Evaluation of Halton Region's Waste Quantity Projections", March 1988.

The feasibility of each of these considerations is also presented in Part C of this report.

C.2.0 DESIGN CRITERIA

The design criteria for landfilling at Site D were discussed extensively in Part A of this report. As presented, design considerations were grouped as either "Physical Constraints", "Off-Site Impact Constraints" or "Engineering Design Criteria". Physical constraints referred to the availability and character of the subject lands. Off-site impact constraints referred to the wide spectrum of environmental, physical and social factors which must be considered in a landfill design. Engineering design criteria refer to the synthesis of physical and impact constraints with engineering design objectives.

These design criteria, as presented in Part A, formed the basis of the alternative design presented in this Part of the Report. As indicated earlier, this alternative design specifically addressed the base contours and the leachate collection system, therefore, the dominant design criteria are the hydrogeologic design objectives discussed in Section A.3.2, as well as the base contour and leachate collection system design criteria discussed in Section A.4.3.1.

C.3.0 SITE DESIGN

C.3.1 BASE CONTOURS AND LEACHATE COLLECTION SYSTEM

C.3.1.1 Design Details

The proposed base contours and leachate collection system are presented in Plan 2, while Figure C3.1 (page 61), provides conceptualized cross-sectional views of the system.

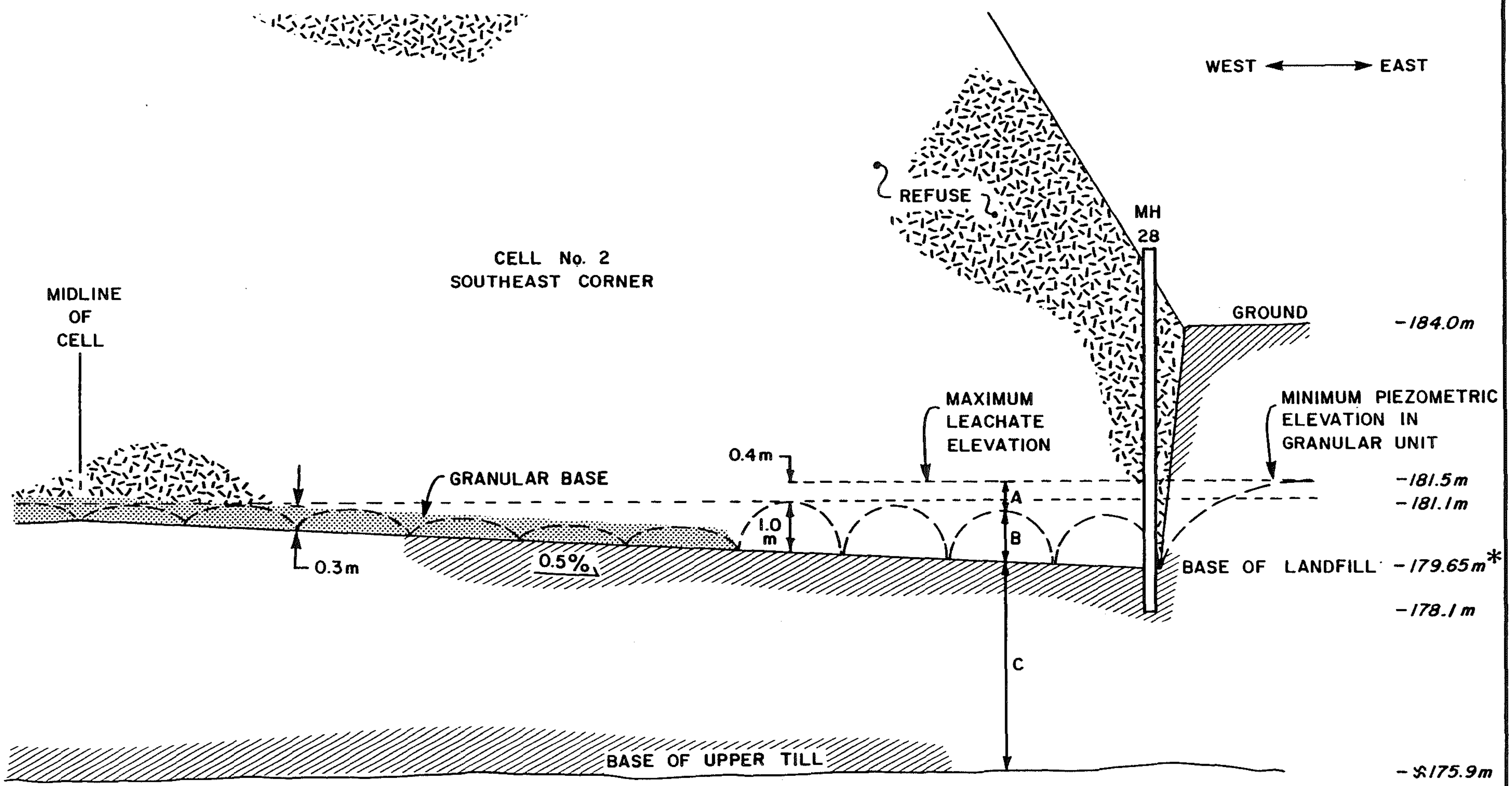
Characteristics of the system are as follows:

1. Each cell is peaked in the middle along the north-south axis for Cells No. 1 and No. 2, and the east-west axis for Cell No.3.

2. From the cell middle, leachate drainage is to the east and to the west for Cells No. 1 and No. 2, and to the north and to the south for Cell No. 3.

3. Perforated sub-header pipes are spaced approximately every 100 m and extend the full length of each cell.

4. The sub-headers are peaked in the middle and slope to the east and west (Cells No. 1 and No. 2) at a slope of 0.5 percent.



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(H) 1:1250
(V) 1:125

*REFERS TO BASE OF LANDFILL
MIDWAY BETWEEN ADJACENT SUB-HEADERS

CRA

figure C3.1

CRA - HYDROGEOLOGIC DESIGN CRITERIA
SITE "D" - DESIGN AND OPERATION
City of Burlington

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5. Where possible, each end of the sub-header terminates in a manhole to facilitate long term maintenance of the collection system.

6. Because of the depth of refuse, manholes are not feasible along the northern limit of Cell 3, therefore, in these locations "clean-outs" are provided.

7. The sub-headers are enclosed in a bed of clear stone to enhance drainage and to provide an alternative flow route in case of pipe failure or pipe clogging.

8. French drains, oriented along a north-south plane for Cells No.1 and No.3, and oriented along an east-west plane for Cell No.3 drain to the sub-headers.

9. The french drains are placed directly on the landfill base, rather than in a trench, have a minimum slope of 0.5 percent, and are spaced every 20 metres.

10. The manholes located at the end of each sub-header are connected by a solid header pipe. The slope of the header pipe is a minimum of 0.4 percent.

11. The solid header system cuts a maximum of 1.4 m below the base of the landfill. To minimize excavation into the Upper Till unit, headers terminate in one of four

leachate booster stations located about the perimeter of the landfill.

12. From the booster stations, leachate is conveyed via forcemain to a single leachate pumping station.

13. The bottom of each booster station and the bottom of the main leachate pumping station are placed no deeper than 177.0 m.

14. For monitoring purposes, each station is underlain by a granular leak detection pad.

C.3.1.2 Hydrogeologic Design Objectives

Figure C3.1 (page 61) illustrates a typical cross-section of the landfill design. Denoted in the Figure are the letters A, B and C. As described in Section A.3.2, the letter "A" denotes the inward gradient which provides the hydraulic trap, the letter "B" denotes the leachate mound, and the letter "C" denotes the thickness of the Upper Till unit remaining below the base of the site. At any given location, the total of A, B and C represents a fixed sum. Within any of the three cells, the magnitude of A, B and C can be adjusted to optimize conflicting design and balance objectives such as maximizing the hydraulic trap head (A), maximizing the thickness of the upper till unit (C), and balancing the site soil requirements.

To select "optimum" base contour elevations, it is first necessary to define the hydrogeologic design contraints for each cell; specifically, the maximum elevation of the base of the Upper Till unit and the "maximum" leachate mound elevation. This information is summarized in Table C3.1, page 65. The maximum elevation of the base of the Upper Till unit was derived from the borehole information plotted on Plan 1. As described with the hydrogeologic design criteria, the leachate mound elevation was selected as 0.4 m below the lowest piezometric elevation recorded on April 15, 1986. This information is also plotted on Plan 1.

Maximum flexibility can be achieved by minimizing the leachate mound. It is for this reason that a drain spacing of 20 m is proposed. Furthermore, it is proposed that a 0.3 m granular blanket (with a minimum hydraulic conductivity of 1×10^{-3} cm/s) be placed over the middle half of each cell, where the base elevations are the highest. By following this approach, the leachate mound can be kept to 0.3 m where the granular blanket is present and to 1.0 m where the mound will be in the refuse (hydraulic conductivity of 1×10^{-4} cm/s). To assist in understanding the design approach refer to Figure C3.1 (page 61) and Figure C3.2 (page 66).

TABLE C3.1

SUMMARY OF HYDROGEOLOGIC DESIGN CONSTRAINTS

Cell No.	Maximum Elevation of Base of Upper Till (m)	April 1986 Minimum Piezometric Elevation (m)	Maximum Leachate Mound Elevation (m)
1	175.9	181.2	180.8
2	175.9	181.5	181.1
3	175.5	180.8	180.4

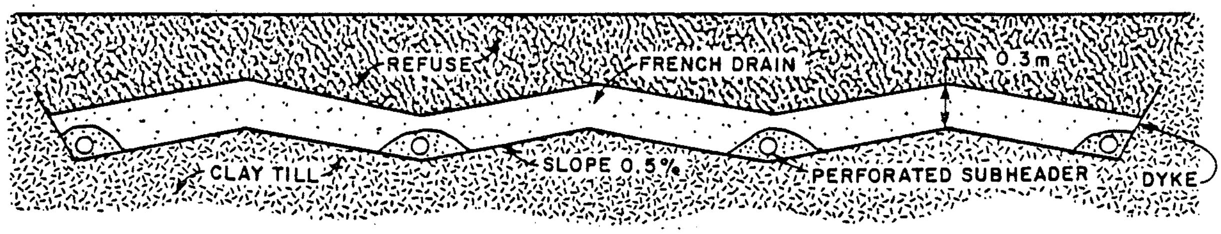
Notes:

1) "Maximum Elevation of Base of Upper Till" derived from existing borehole logs (See Plan 1 and Exhibit H-39A).

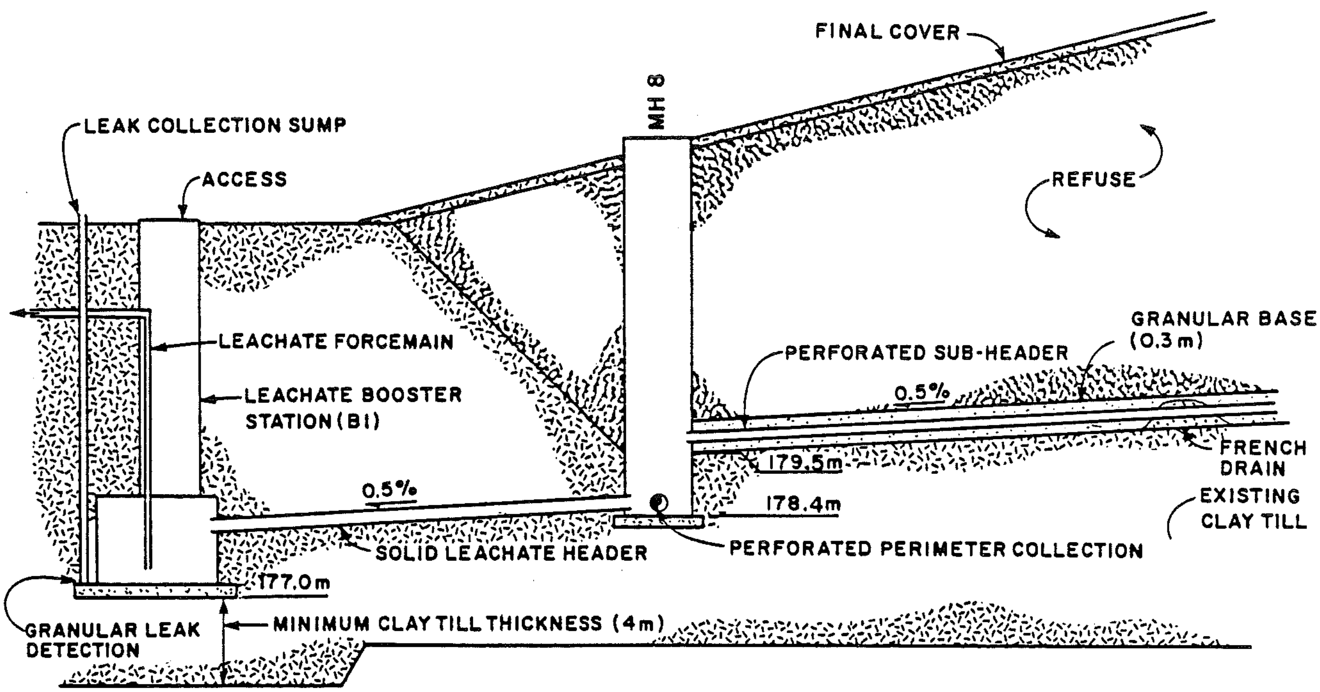
2) "April 1986 Minimum Piezometric Elevation" derived from records of existing borehole (See Plan 1 and Exhibit H-39A).

3) "Maximum Leachate Mound Elevation" refers to the maximum leachate design level. It is 0.4 meters below the April 1986 minimum piezometric elevation.

CROSS-SECTION 'A-A'



CROSS-SECTION 'B-B'



NOT TO SCALE

figure C3.2

CROSS-SECTIONS OF ALTERNATIVE DESIGN
SITE "D" - DESIGN AND OPERATION
City of Burlington

CRA

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Since the proposed design minimizes the leachate mound buildup and minimizes trench excavation below the base of the site, maximum flexibility remains for balancing the advantages of maximizing the hydraulic trap head, the thickness of the Upper Till Unit, and the overall site soil balance.

C.3.1.3 Alternative Design Scenarios

Based on the prescribed concept, five alternative design scenarios were developed. These are summarized in Table C3.2, page 68. The objective of the five design scenarios were as follows:

Design Scenario	Objective
1	Depth of excavation selected to balance soils, assuming a final cover of 1.0 metres
2	Depth of excavation selected to balance soils, assuming a final cover sufficient for an agricultural end use
3	Depth of excavation selected to ensure that a hydraulic trap design head of 0.4 meters is always maintained
4	Depth of excavation selected to provide an additional 0.3 m "Safety Factor" for the hydraulic trap
5	Depth of excavation selected to ensure a minimum of 4.0 m of upper till below the base of each cell

TABLE C3.2

ALTERNATIVE DESIGN SCENARIOS

Design Scenario	Cell No.	Maximum Base of Upper Till (m)	Minimum Base of Landfill (m)	Maximum Leachate Level (m)	Design Piezometric Elevation (m)	Minimum Upper Till Thickness (m)	Minimum Hydraulic Trap Head (m)	Total Soil Surplus (Mm^3) 1.0 m Cap	1.4 m Cap
1	1	175.9	179.3	181.0	181.2	3.4	0.2	0.0	-0.21
	2	175.9	179.6	181.3	181.5	3.7	0.2		
	3	175.5	179.1	180.6	180.8	3.6	0.2		
2	1	175.9	178.9	180.6	181.2	3.0	0.6	+0.21	0.0
	2	175.9	179.2	180.9	181.5	3.3	0.6		
	3	175.5	178.7	180.2	180.8	3.2	0.6		
3 (as per plans)	1	175.9	179.1	180.8	181.2	3.2	0.4	+0.10	-.11
	2	175.9	179.4	181.1	181.5	3.5	0.4		
	3	175.5	178.9	180.4	180.8	3.4	0.4		
4	1	175.9	178.8	180.5	181.2	2.9	0.7	+0.26	+0.05
	2	175.9	179.1	180.8	181.5	3.2	0.7		
	3	175.5	178.6	180.1	180.8	3.1	0.7		
5	1	175.9	179.9	181.6	181.2	4.0	-0.4	-.22	-.43
	2	175.9	179.9	181.6	181.5	4.0	-0.1		
	3	175.5	179.5	181.0	180.8	4.0	-0.2		

Design Scenarios

1. Depth of excavation selected to balance soil - 1.0 m final cap
2. Depth of excavation selected to balance soil - average 1.4 m final cap
3. Depth of excavation selected to maintain minimum hydraulic trap of 0.4 m
4. Depth of excavation selected to maintain minimum hydraulic trap of 0.7 m
5. Depth of excavation selected to ensure minimum of 4.0 m of upper till

As Table C3.2 (page 68) illustrates, Scenario 1 would maintain a minimum till thickness of 3.4 m but would result in failure of the hydraulic trap criteria of a 0.4 m differential. Scenario 2 would maintain a minimum till thickness of 3.0 m and would provide a 0.2 m margin of safety for the hydraulic trap.

Scenario 3 would maintain a minimum till thickness of 3.2 m and would result in the minimum excavation necessary to maintain the hydraulic trap to the specified criteria. As well, Scenario 3 would result in a virtual soil balance regardless of final cover thickness.

Scenario 4 would provide a 0.3 m margin of safety for the hydraulic trap, but would result in a soil surplus and would maintain a minimum upper till thickness of 2.9 m.

Scenario 5 would maintain a minimum upper till thickness of 4.0 m but would result in a failure of the hydraulic trap concept and a site soil defficiency of at least 0.22 Mm^3.

In comparing the alternative scenarios, it is evident that the third alternative provides the optimum scenario given the prescribed hydrogeologic design criteria; however, the second scenario which balances the site soil requirement and provides a 0.2 m margin of safety for the hydraulic trap, is also an acceptable alternative.

Specific attributes of the selected Scenario 3 are as follows:

1. The hydrogeologic criterion of maintaining at least 0.4 m between the maximum leachate elevation and the lowest April 1986 piezometric elevation is achieved.

2. Minimum Upper Till Thickness will be 3.2 m (along the eastern limit of Cell 1). This is the maximum possible given the hydraulic trap criteria. Over the entire site, the average Upper Till Thickness would be in the order of 4.5 metres.

C.3.2 FINAL CONTOURS

Plan 3 provides a plan of the final contours, given the third design scenario. As with the Trow design, the final contour plan adheres to the criteria listed in Section A4.2. The maximum elevation has been maintained at the same maximum elevation of 202 metres as provided in the Trow design.

As required, the site capacity remains in the order of 3.8 million tonnes.

The placement of manholes in the Trow design resulted in a trisecting of the top of the landfill usable for agriculture. Because of changes in the manhole placement, the recommended design alternative provides a larger area usable for agriculture, while at the same time, maintaining minimum and maximum slope criteria.

C.3.3 GENERAL LAYOUT

The general layout of the site facilities is also illustrated on Plan 3. The types of facilities, the general layout characteristics, extent of paved roads, is in accordance with the design criteria detailed in Section A.4.0. Most of the facilities have been placed toward the eastern limit of the site, in order to facilitate future/contingency site expansion to the east.

C.4.0 LEACHATE SEWER/FORCEMAIN

The purpose of this section of the report is to provide an assessment of the feasibility of constructing a dedicated leachate sewer/forcemain (leachate line) from Site D to the existing Highway 25 sanitary sewer which presently terminates several hundred meters to the south of Upper Middle Road, and then to compare this design to the one provided by Trow as described in Part B of this report. A cost comparison between the two designs and hauling is included in the revised cost estimate of Section C.5.0.

At the outset of this assessment, CRA completed a field reconnaissance:

- to identify a preferred route,
- to assess whether sufficient lands existed in the Highway 25 right-of-way to enable minimal disruption of the travelled portion of the highway,
- to note any significant valley crossings.

As well, CRA reviewed a 1:25000 topographic map to determine where gravity sewers could be placed and where pumping stations and forcemains would be required. Figure C4.1 (page 73) provides a schematic plan view of the proposed route, including the placement of a pumping station.

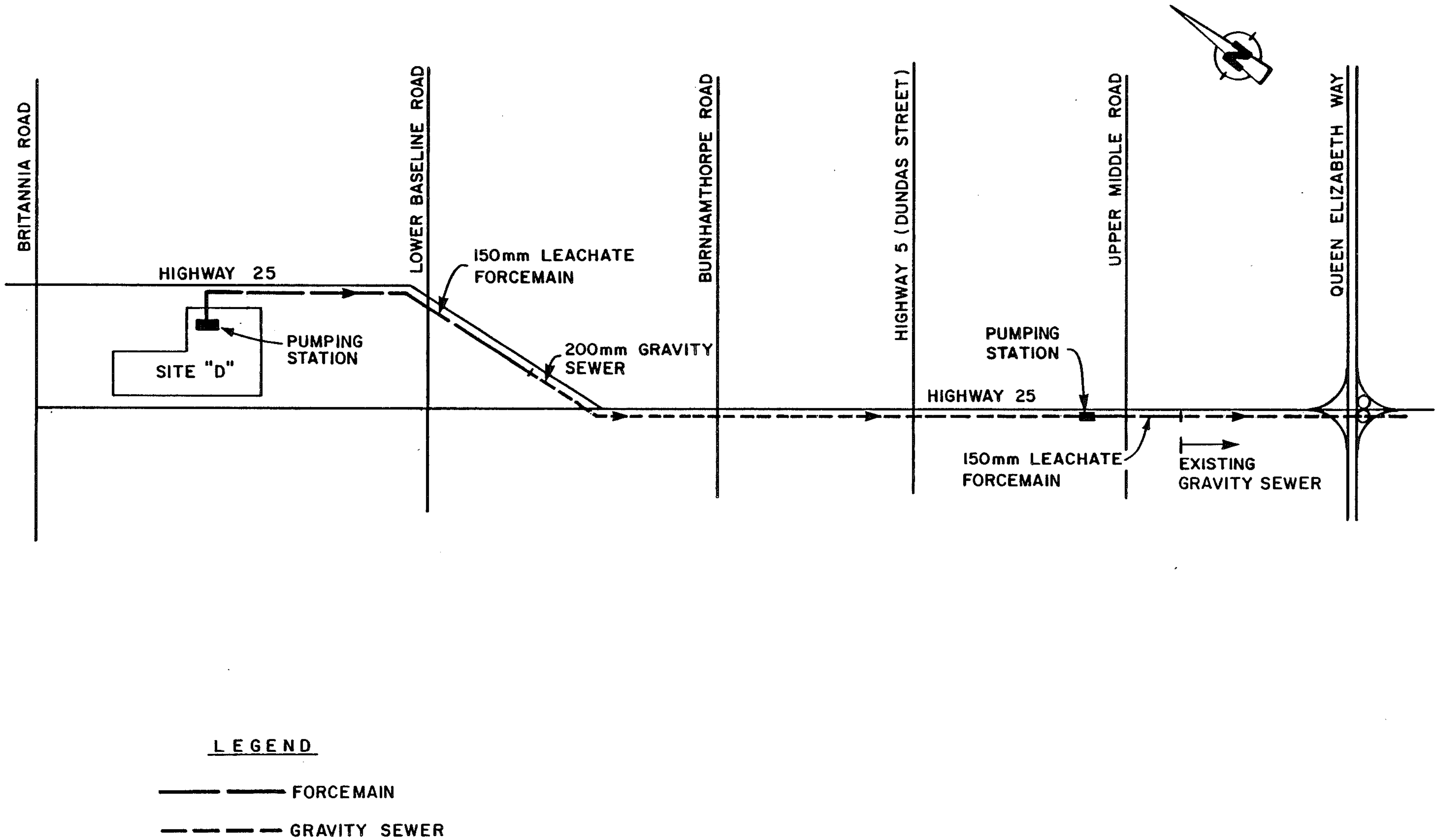

figure C4.1

PROPOSED LEACHATE FORCEMAIN / SEWER
SITE "D" – DESIGN AND OPERATION
City of Burlington

CRA

1354-10 – 30/11/87 – 33 – D – 0

As illustrated in Figure C4.1, it is proposed to construct a 150 mm forcemain from Site D to a high point of land approximately one kilometre south of Lower Baseline Road.

From Lower Baseline Road, the land slopes gradually to the south, therefore, a 200 mm gravity sewer is proposed from the terminous of the forcemain to a point approximately 200 metres to the north of Upper Middle Road. For the gravity sewer, manhole spacings of 120 m are proposed. This spacing is greater than existing Halton design standards, but is well within acceptable limits for cleaning and maintenance.

The gravity sewer will terminate at a pumping station which will pump the leachate via 150 mm forcemain, the final distance to the existing sanitary sewer.

Between Site D in the north and the QEW in the south, the Highway 25 right-of-way is in excess of 35 metres in width. This is sufficiently wide to enable construction of the leachate line without interfering with the highway traffic. At some locations, such as the intersection with Highway 5, the right-of-way narrows and the excavation will likely extend into the highway asphalt. The placement of a sewer/forcemain within the right-of-way requires approval by the Ministry of Transportation and Communications (MTC), although sewer installations in Highway right-of-ways are acceptable.

A comparison between the Trow leachate sewer/forcemain design and the alternative presented herein, are as follows:

1. The Trow design is predominantly a gravity sewer, while the alternative design is evenly divided between a forcemain and a gravity sewer.

2. The Trow design assumes that restoration will be required over the full length of Highway 25, while the alternative design assumes that minimal restoration will be required since the line would be in the Highway 25 right-of-way.

3. The Trow design provides for a manhole spacing of 100 metres for the gravity sewer, while the alternative design provides for a spacing of 120 metres.

This section has addressed the feasibility of a dedicated leachate line. It should be noted that this design should be viewed in the context of future development along Highway 25, since future sanitary sewers may make a dedicated line redundent.

C.5.0 SITE WATERMAIN

The purpose of this section of the report is to provide an assessment of the feasibility of constructing a Site watermain from either Milton or Oakville, to Site D and as a contingency to homes located within 1.0 km of the site. The watermain would provide a supply of potable water to the site, as well as fire protection water and would provide an alternative water supply to residences potentially impacted by leachate egress from the site.

Although the watermain would not be required at the outset of landfilling, the feasibility requires assessment as a contingency plan.

Water supply to Site D can be provided from Oakville or from Milton. As illustrated in Figure C5.1 (page 77), from Oakville, the watermain would connect to the existing grid along Highway 25 south of Upper Middle Road. From there, it would parallel the proposed leachate sewer/forcemain to Site D; a distance of approximately nine kilometers.

From Milton, the watermain would connect to the existing grid near the corner of Derry Road and Highway 25. From there, it would parallel Highway 25 south to Site D; a distance of approximately four kilometers.

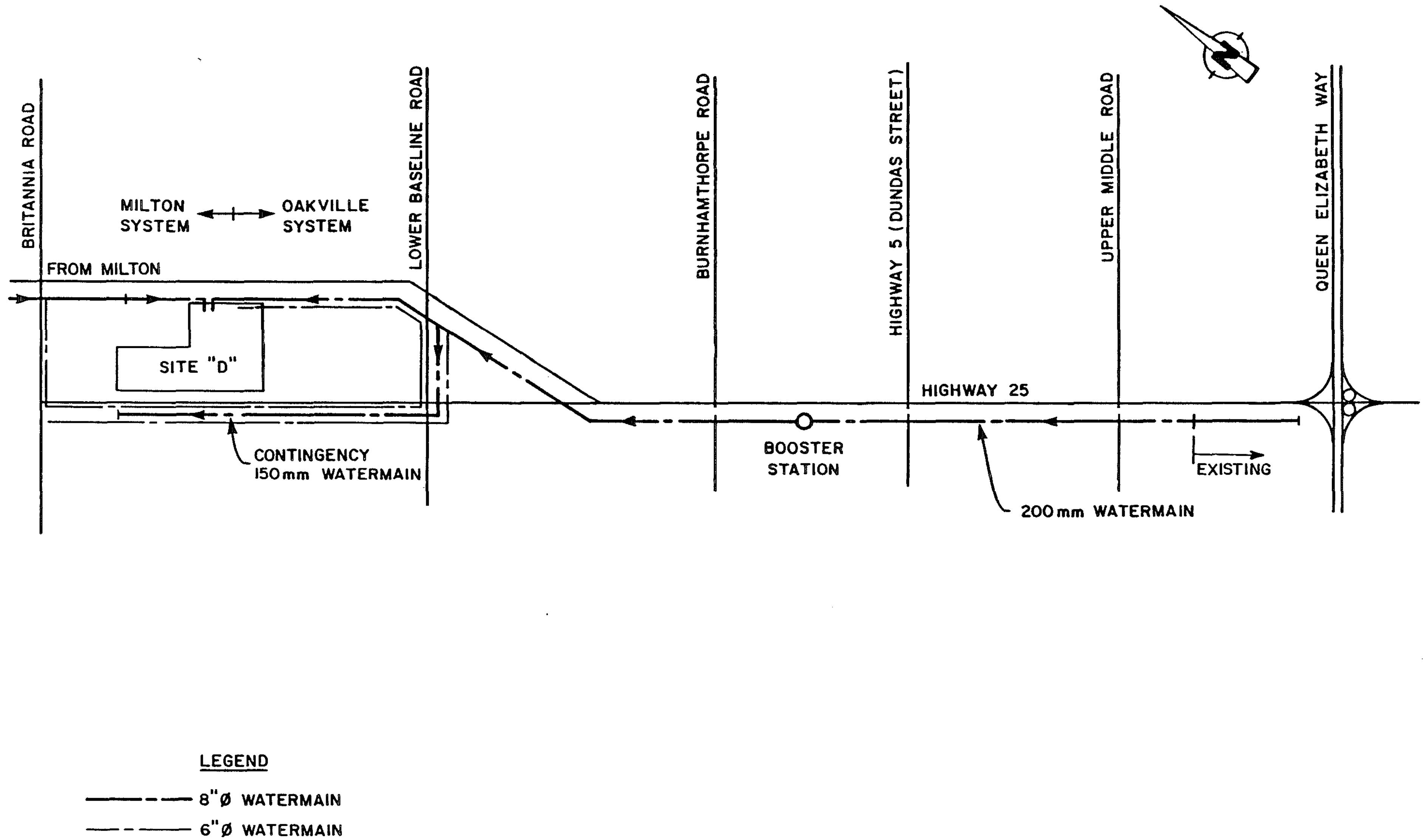

figure C5.1

PROPOSED WATERMAIN SERVICING SYSTEM
SITE "D" - DESIGN AND OPERATION
City of Burlington

CRA

1354-10-30/11/87-33-D-0

The watermain would be 200 mm in diameter. This is sufficient to supply fire protection at Site D and to provide an alternative water supply to adjacent properties.

C.6.0 REVISED COST ESTIMATE

As discussed in Section B.4.0, with the exception of the leachate sewer/forcemain, CRA was generally in agreement with the Trow cost estimate. However, given the proposed design changes, a cost update is required.

Table C6.1 (page 80) provides a comparison of the cost estimate for the Trow leachate collection system to the cost estimate for the recommended design amendment. To maintain consistency, CRA typically employed the unit prices provided by Trow and included in Schedule K. As the table indicates, exclusive of contingency and engineering, the leachate collection system for the recommended design will be approximately $2.79 million as compared to $1.44 million for the Trow design for a difference of $1.35 million.

The Trow design resulted in an excess soil excavation of 453,600 cubic metres. As summarized in Table C6.2 (page 81), the five alternative scenaros would reduce the excess excavation by 0.19 to 0.67 Mm^3 corresponding to a cost savings of up to $2.01 million. Additional savings of up to $0.60 million would be realized by reducing the amount of regrading required at site closure. In particular, the recommended Design Scenario 3 would result in a combined savings of $1.51 million. This would generally compensate for the additional cost of the leachate collection system.

C.6.0 <u>REVISED COST ESTIMATE</u>

As discussed in Section B.4.0, with the exception of the leachate sewer/forcemain, CRA was generally in agreement with the Trow cost estimate. However, given the proposed design changes, a cost update is required.

Table C6.1 (page 80) provides a comparison of the cost estimate for the Trow leachate collection system to the cost estimate for the recommended design amendment. To maintain consistency, CRA typically employed the unit prices provided by Trow and included in Schedule K. As the table indicates, exclusive of contingency and engineering, the leachate collection system for the recommended design will be approximately $3.76 million as compared to $1.44 million for the Trow design for a difference of $2.32 million.

The Trow design resulted in an excess soil excavation of 453,600 cubic metres. As summarized in Table C6.2 (page 81), the five alternative scenarios would reduce the excess excavation by 0.19 to 0.67 Mm^3 million metres cubed corresponding to a cost savings of up to $2.01 million. Additional savings of up to $0.60 million would be realized by reducing the amount of regrading required at site closure. In particular, the recommended Design Scenario 3 would result in a combined savings of $1.51 million. This would generally compensate for the additional cost of the leachate collection system.

TABLE C6.1R

COST COMPARISON - LEACHATE COLLECTION SYSTEM

Component System	Trow Design	Alternative Design
Perforated Leachate Collection Pipe	$ 680,000	$ 224,000
Perforated Sub Headers	216,000	92,800
Perimeter Leachate Forcemain	0	316,100
Solid Headers	140,000	87,500
French Drains	0	667,500
Manholes	357,000	115,200
Leachate Lift Stations	0	100,000
Main Leachate Pumping Station	50,000	200,000
Hydro Service to Lift Stations	0	199,500
Granular Base Material	0	1,755,000
Subtotal	$1,443,000	$3,757,600
Contingency (15%)	216,450	563,640
Subtotal	$1,659,450	$4,321,240
Engineering (15%)	248,920	648,186
GRAND TOTAL	$1,908,370	$4,969,426

Notes:

1) Where costs for certain components were not available in the Trow cost estimate, CRA costs were applied.

TABLE C6.1

COST COMPARISON - LEACHATE COLLECTION SYSTEM

Component System	Trow Design	Alternative Design
Perforated Leachate Collection Pipe	$ 680,000	$ 224,000
Perforated Sub Headers	216,000	92,800
Perimeter Leachate Forcemain	0	316,100
Solid Headers	140,000	0
French Drains	0	667,500
Manholes	357,000	115,200
Leachate Lift Stations	0	100,000
Main Leachate Pumping Station	50,000	200,000
Hydro Service to Lift Stations	0	199,500
Granular Base Material	0	877,500
Subtotal	$1,443,000	$2,792,600
Contingency (15%)	216,450	418,890
Subtotal	$1,659,450	$3,211,490
Engineering (15%)	248,920	481,720
GRAND TOTAL	$1,908,370	$3,693,210

Notes:

1) Where costs for certain components were not available in the Trow cost estimate, CRA costs were applied.

TABLE C6.2

COST ADJUSTMENTS FOR ALTERNATIVE EXCAVATION DEPTHS

Design Scenario	Change in Excavation (Mm^3)	Change in[1] Total Excavation Cost ($ million)	Change in[2] Closure Cost ($ million)
1	-0.45	-1.35	-0.60
2	-0.24	-0.72	-0.32
3	-0.35	-1.05	-0.46
4	-0.19	-0.57	-0.25
5	-0.67	-2.01	-0.60

Notes:

1) Based on excavation cost of $3.00/m^3 exclusive of 15% contingency and 15% engineering

2) Cost prorated based on Trow's $600,000 allowance for mass grading.

Table C6.3 (page 83) provides a cost summary of the Leachate Sewer/Forcemain as outlined in Section C.4.0. The total capital cost is estimated at $1.8 million exclusive of contingency and engineering. Annual maintenance costs are estimated to be in the order of $5,000 to $10,000 per year. The cost estimate excludes approval costs, but since the capital worth of the leachate line would exempt it from the EA process, substantial approval costs are not anticipated.

Table C6.4 (page 84) provides a comparison of the leachate sewer/forcemain cost estimate as provided by Trow and by CRA. As discussed in Section C.4.0, the primary cost difference results from differences in the use of forcemains, the number and cost of manholes, and the extent of asphalt restoration required.

As documented in Schedule K, the annual cost of leachate haulage is expected to commence in Year 3 at $164,250, increase to $492,750 in year 10, and level off at $854,100 in year 19. Over the life of the site, the haulage costs translate to a present value of $4.1 million. Haulage costs after site closure would be in addition to this amount.

TABLE C6.3

COST SUMMARY - LEACHATE SEWER/FORCEMAIN

Lift Stations (2)	$ 400,000
Forcemain (4,400 m)	
Pipe	139,000
Installation	222,000
Gravity Sewer (5,000 m)	
Pipe	107,000
Installation	393,000
Manholes (50)	125,000
Boring/Casing	45,000
Restoration	387,000
Sub-Total	$1,818,000
Contingency (15%)	272,700
Sub-Total	$2,090,700
Engineering (15%)	313,600
TOTAL	$2,404,300

TABLE C6.4

COST COMPARISON - LEACHATE SEWER/FORCEMAIN

	Trow Design		Alternative Design	
	Quantity	Cost	Quantity	Cost
Lift Stations	4	$ 200,000	2	$ 400,000
Forcemain	900	90,000	4,800	361,000
Gravity Sewer	8,700	1,087,500	5,700	500,000
Manholes	84	588,000	50	125,000
Boring/Casing	--	--	--	45,000
Restoration	--	960,000	--	387,000
Sub-Total		$2,925,500		$1,818,000
Contingency (15%)		438,830		272,700
Subtotal		$3,364,330		$2,090,700
Engineering (15%)		504,650		313,600
GRAND TOTAL		$3,868,980		$2,404,300

Table C6.5 (page 86) provides a cost summary of the Site D contingency watermain. From Oakville, the watermain is expected to cost $1.0 million exclusive of contingency and engineering, while from Milton the watermain cost would be reduced since the travel distance would be less. An additional $0.5 million would be required to provide a perimeter watermain to distribute water to surrounding properties. This latter cost is exclusive of individual hookups.

Table C6.6 (page 87) contains a summary of the Trow cost estimate, the value of the design changes and a cost estimate for the revised design. As the Grand Total indicates the net savings of the recommended design would be approximately $1.7 million. These costs exclude the watermain since this is a contingency item only. The cost estimate for the Trow Design includes the value of leachate hauling rather than the Trow cost for the leachate sewer/forcemain, since hauling had been assumed in the economic analysis.

Table C6.5 (page 86) provides a cost summary of the Site D contingency watermain. From Oakville, the watermain is expected to cost $1.0 million exclusive of contingency and engineering, while from Milton the watermain cost would be reduced since the travel distance would be less. An additional $0.5 million would be required to provide a perimeter watermain to distribute water to surrounding properties. This latter cost is exclusive of individual hookups.

Table C6.6 (page 87) contains a summary of the Trow cost estimate, the value of the design changes and a cost estimate for the revised design. As the Grand Total indicates the net savings of the recommended design would be approximately $0.45 million. These costs exclude the watermain since this is a contingency item only. The cost estimate for the Trow Design includes the value of leachate hauling rather than the Trow cost for the leachate sewer/forcemain, since hauling had been assumed in the economic analysis.

TABLE C6.5

CONTINGENCY WATERMAIN COSTS

WATERMAIN TO SITE D FROM OAKVILLE

Booster Station	$	225,000
Trunk Main		
Pipe (200 mm) 9406m		414,000
Installation		244,000
Valves 13 x $800 each		10,400
Air Release and Drain Chambers (5) $3650 each		18,250
Boring/Casing Hy 5 + 25		30,000
Restoration – if w.main + sewer forcemain if later $\boxed{\$387,000}$		20,000
Sub-Total	$	961,650
Contingency (15%)		144,250
Sub-Total	$	1,105,900
Engineering (15%)		165,900
TOTAL	$\boxed{\$}$	$\boxed{1,271,800}$

SITE PERIMETER WATERMAIN

Trunk Main (5,~~750~~ m) OK [redacted]		
Pipe 5750m 150mm pipe $57.80/m	$	55,800
Installation		276,550
Valves 7 valves x $600 each		4,200
Restoration [illegible]		161,000
Sub-Total	$	497,550
Contingency (15%)		74,650
Sub-Total	$	572,200
Engineering (15%)		85,800
TOTAL	$	658,000

TABLE C6.6

REVISED CAPITAL COST SUMMARY

		Trow Design	Cost Adjustment	Revised Design
A1)	Clearing, Grubbing and Cell 1 Excavation	$ 1,525,000		$ 1,525,000
A2)	Reduction in Overall Excavation		-1,050,000	-1,050,000
B)	Leachate Collection System	1,443,000	1,350,000	2,793,000
C)	Service and Access Roads	860,000	48,000	910,000
D)	Site Services	968,000		968,000
E)	Stormwater Management	129,000		129,000
F)	Site Closure	3,250,000	-460,000	2,790,000
G)	Leachate Forcemain			1,818,000
	Subtotal	$ 8,175,000		$ 9,883,000
	15% Contingency	1,226,250		1,482,450
	Subtotal	$ 9,401,250		$11,365,450
	15% Engineering	1,410,190		1,704,820
		$10,811,440		$13,070,270
	Present Value of Leachate Hauling or Forcemain operation	4,100,000	4,100,000	120,000
	GRAND TOTAL	$14,911,440		$13,190,270

TABLE C6.6R

REVISED CAPITAL COST SUMMARY

		Trow Design	Cost Adjustment	Revised Design
A1)	Clearing, Grubbing and Cell 1 Excavation	$ 1,525,000		$ 1,525,000
A2)	Reduction in Overall Excavation		$-1,050,000	-1,050,000
B)	Leachate Collection System	1,443,000	2,314,600	3,757,600
C)	Service and Access Roads	860,000	48,000	910,000
D)	Site Services	968,000		968,000
E)	Stormwater Management	129,000		129,000
F)	Site Closure	3,250,000	-460,000	2,790,000
G)	Leachate Forcemain			1,818,000
	Subtotal	$ 8,175,000		$10,847,600
	15% Contingency	1,226,250		1,627,140
	Subtotal	$ 9,401,250		$12,474,740
	15% Engineering	1,410,190		1,871,211
		$10,811,440		$14,345,951
	Present Value of Leachate Hauling or Forcemain operation	4,100,000	4,100,000	120,000
	GRAND TOTAL	$14,911,440		$14,465,951

C.7.0 FEASIBILITY OF EXPANSION

C.7.1 DESIGN OBJECTIVE

In the Conclusions of the Report entitled "Evaluation of Halton Region's Waste Quantity Projections", March 1988, CRA recommended that the capacity of the proposed Halton Landfill Site be increased from 3.8 million tonnes to 6.6 million tonnes. The reasons for the recommended increase in site capacity are well documented in the above noted Report. Briefly, they are as follows:

- The planning period for the proposed landfill site would extend 20 years, from September 1988 to August 2008.

- The annual waste generation rate would initially be 0.82 tonnes/capita (0.9 tons/capita), increasing by 0.01 tons/capita/yr for the first ten years, and by 0.75 percent per year for each year of the planning period.

- Source separation is projected to increase to 12 percent in 1989 and remain at 12 percent until the end of the planning period.

- The capacity would be based on the worst case scenario where no EFW plant would be constructed during the planning period.

- A contingency of 5 percent should be included to allow for higher than expected waste generation.

The objective of this section of the Report is to address the feasibility of expanding Site D, from 3.8 million tonnes to as closed to 6.6 million tonnes as is practical. In this context feasibility is defined as the ability to provide the additional capacity within the limits of the landfill design criteria defined in Part A of this report.

To address this feasibility, a discussion is provided of the design considerations specific to expansion, the design is presented, and conclusions are provided regarding the expansion feasibility.

C.7.2 DESIGN CONSIDERATIONS

C.7.2.1 Physical Constraints

The layout of the site facilities provided in Plan 2 illustrated that approximately 17 ha is available for extending the landfill to the east. At all other boundaries the landfill is confined by site property limits and the need to maintain a 100 m buffer between the landfill area and the neighbouring property. Consideration could also be given to increasing the height of the landfill.

At this time consideration was not given to expansion beyond the defined property limits since this would affect the scope of the Environmental Assessment completed to date.

C.7.2.2 Off-Site Impact Constraints

The need to assess a wide spectrum of environmental, physical and social factors were addressed in Section A.3.0 of this report. The site expansion will be constrained to the existing property boundaries. Therefore, since site operation would not be altered, only the hydrogeologic and visual design aspects require consideration in providing expansion plans.

With regard to hydrogeology, the design criteria were three-fold: to provide for the hydraulic trap by maintaining leachate levels 0.4 m below April 1986 piezometric elevations; to maximize the thickness of the unweathered Upper Till Unit underlying the site; and to provide an effective leachate collection system to ensure maximum flexibility in providing for the hydraulic trap and maximizing Upper Till thickness.

With regard to visual impact, expansion to the east would not substantially affect the visual impact of the site. However, raising the site would increase the site visual impact.

C.7.2.3 Site Specific Considerations

The expansion of the landfill would directly affect the base contours, leachate collection system, site soil balance, final contours, and stormwater management. Therefore, in addressing the feasibility of expansion the design for each of the above must be considered.

C.7.3 SITE DESIGN

C.7.3.1 Base Contours and Leachate Collection System

The proposed base contours and leachate collection system are presented in Plan 4. Characteristics of the expansion area are identical to those provided for in Section C.3.1 for Cell 3.

To select "optimum" base contour elevations, it is first necessary to define the hydrogeologic design constraints for each cell. This information is summarized in Table C7.1 (page 92). Note that data denoted as Cell 4 refers to the expansion area, whereas data denoted as

TABLE C7.1

SUMMARY OF HYDROGEOLOGIC DESIGN CONSTRAINTS - EXPANDED SITE

Cell No.	Maximum Elevation of Base of Upper Till (m)	April 86 Minimum Piezometric Head (m)	Design Leachate Mound Elevation (m)
1	175.9	181.2	180.8
2	175.9	181.5	181.1
3	175.5	180.8	180.4
4 (1)	174.4	181.1	180.7
4ne (2)	174.7	179.2	178.8

NOTES:

(1) Cell No. 4 refers to the expansion area

(2) 4ne refers to the northeast corner of Cell No. 4

Cell 1, 2 and 3 refers to the revised design presented earlier in this part of the report. Also note that Table C.7.1 provides separate constraints for the northeast corner of the expansion area where measured piezometric heads are lower than the rest of the landfill site (see Plan 1).

In providing expansion plans, it was assumed that Design Scenario 3 would apply; i.e. that the depth of excavation would be the minimum necessary to maintain the hydraulic trap. To achieve this design objective the revised design had called for a 0.3 m granular blanket to be placed over the middle half of each cell, where the base elevations are highest. This approach would keep the leachate mound to 0.3 m where the granular blanket is present and to 1.0 m where the mound will be in the refuse. For the expansion area, the granular blanket will also be required in the northeast quadrant, given the relatively low leachate mound elevation applicable to this area. (The piezometric elevation should be verified for final design).

Details of the base elevation and the hydrogeologic design constraints are summarized in Table C.7.2, page 94. As the table illustrates, the depth of excavation for Cell 4 will be constrained by the need to maintain the hydraulic trap in the northeast corner. This will result in a hydraulic trap margin of safety of 0.7 m for the remainder of the cell. It will also result in an overall

TABLE C7.2

EXPANDED SITE DESIGN SCENARIO

Cell No.	Maximum Base of Upper Till (m)	Minimum Base of Landfill (m)	Maximum Leachate Level (m)	Design Piezometric Elevation (m)	Minimum Upper Till Thickness (m)	Minimum Hydraulic Trap Head (m)	Total Soil Surplus (Mm^3)	
							1.0 m Cap	1.4 m Cap
1	175.9	179.1	180.8	181.2	3.2	0.4	+0.32	-0.03
2	175.9	179.4	181.1	181.5	3.5	0.4		
3	175.5	178.9	180.4	180.8	3.4	0.4		
4	174.4	178.5	180.0	181.1	4.1	1.1		
4ne	174.7	178.5	178.8	179.2	3.8	0.4		

Notes:

(1) 4ne refers to the northeast corner of Cell No. 4

soil surplus of approximately 320,000 cubic meters if the site is not capped to facilitate agricultural end-use.

C.7.3.2 Final Contours

Plan 5 provides a plan of the final contours for the expanded site. The contours on the western two-thirds of the site are identical to those provided in the alternative design. The maximum elevation in the expanded area has been set at the same level as the remainder of the site.

Given the recommended base and final contours, the expansion area will be sufficient to accommodate an additional 1.9 million tonnes of waste, bringing the total site capacity to 5.7 million tonnes. Based on the site capacity projection of 6.6 million tonnes presented in the CRA report entitled "Evaluation of Halton Region's Waste Quantities Projections", March 1988, a 5.7 million tonne site would have a site life of approximately 18 years. By increasing the height of the landfill by an additional 2.5 meters the capacity would be increased to 6.6 million tonnes.

C.7.3.3 General Layout

The general layout of the site facilities are also illustrated on Plan 5. With the exception of the leachate pumping station and the placement of the east stormwater retention pond, this layout is identical to the one provided in Plan 3 for the revised site plan.

C.7.3.4 Stormwater Collection and Control

Expansion of the site will result in increased site runoff during storm conditions. This will necessitate an additional stormwater retention pond at the east end of the site. The anticipated location of this pond is illustrated on Plan 5. Detailed calculations of the pond size should be carried out as part of the final design.

C.7.4 COST OF EXPANSION

The capital expenditure of site expansion will be limited to the leachate collection system, stormwater collection system and site closure. All additional cost will be incurred as part of the on-going site operation. By pro-rating based on site area, expected capital expenditures resulting from site expansion, including 15 percent contingency and 15 percent engineering, are as follows:

Leachate Collection System	$1,170,000
Stormwater Management	85,000
Site Closure	1,170,000
Total	$2,425,000

This additional capital expenditure of $2.419 million provides an additional site capacity of 1.9 million tonnes. This corresponds to $1.28/tonne. By comparison the capital expenditure for providing the site with a capacity of 3.8 million tonnes is $13.2 million, or $3.47/tonne. Therefore from a cost perspective site expansion is cost effective.

C.7.5 CONCLUSION

Based on the provided analysis the following conclusions can be made:

1. Site expansion from 3.8 million tonnes to 5.7 million tonnes is feasible from an environmental, engineering and economic perspective.

2. The additional capacity can be achieved by expanding to the 17 ha to the east of the originally proposed site. Vertical expansion will not be required.

3. By increasing the height of the landfill by 2.5 m, the capacity would be increased to 6.6 million tonnes.

All of which is respectfully submitted,

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