Court File Nos.661/89
773/89
811/89

SUPREME COURT OF ONTARIO
(DIVISIONAL COURT)

B E T W E E N:

NSP INVESTMENTS LIMITED, THE CORPORATION OF THE TOWN OF MILTON, THE MILTON AREA CITIZENS COALITION, THE HALTON FEDERATION OF AGRICULTURE, WATKIN AND DOREEN MARTIN, WALTER TOMOSKY, THOMAS AND MARY-JEAN MARTIN, MICHAEL AND CYNTHIA REED, GRAHAM AND EVELYN GILLIES, SALLY VIRTULA, RAY AND ANNETTE WINTER, KIP AND ANNE CHAPUT, WILFRED AND FREDA LAWRENCE, BILL AND BEVERLY KETELAARS, JOHN VITETTA, STEVE AND SHIRLEY DOLBY, KEN WETTLAUFER, HOWARD GOWLAND, MR. AND MRS. PIETRO MOSCATO, MR. AND MRS. L. CIACCO, RICK AND COLLEEN SIMMONS, MR. AND MRS. ALBERTA SILVA

Applicants

\- and -

THE JOINT BOARD (ESTABLISHED UNDER SECTION 4 OF CONSOLIDATED HEARINGS ACT, 1981, S.O. 1981, C.20, AS AMENDED), THE REGIONAL MUNICIPALITY OF HALTON, THE CORPORATION OF THE CITY OF BURLINGTON, THE WEST BURLINGTON CITIZENS' GROUP, AND THE HONOURABLE JAMES BRADLEY, IN HIS CAPACITY AS THE MINISTER OF THE ENVIRONMENT

Respondents

APPLICATION RECORD OF THE RESPONDENT WEST BURLINGTON CITIZENS' GROUP

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45	October 20, 1987
51	October 29, 1987
66	November 30, 1987
92	February 16, 1988
168	August 24, 1988
174	September 14, 1988
179	October 17, 1988

Q. If we look at Figure 6, we have a map of the areas hydrogeologically favourable and I believe his evidence was that Site F would have been cut out on these factors?

A. From the standpoint of these areas which were deemed by him to be low impacts were the elements that were assessed there.

Q. All right. Then, Site F entered into it when you began to look at quarries?

A. The pits and quarries entered into it when we started to look at quarries, yes, and Site F came out of the process of looking a quarries.

Q. My understanding from the screening process is set out at page 51, and here we have again the Ministry's position is stated out that the screening process should establish a minimum criteria for hydrogeological and geological factors, and again this would eliminate the potential for a very poorly located site from becoming a high scoring site?

A. Yes. Where are you reading from?

Q. The bottom of page 51.

A. Yes?

Q. I guess my point is that would you agree that Site F would not have been chosen unless the pits and quarries were considered?

A. The possibility is that it would not have re-entered the screening process except for the determination to look at pits and quarries as alternatives for the natural attenuation type of facilities. Remember that this was not a guarantee because this was at a regional level of screening and if some other determination came up for any site in the Region, something that came up that would require a look at it at a more detailed level, then we would have to assess whether reiteration was necessary to see whether the validity of looking at all of those types of sites was valid or not before we proceeded to the next section.

Q. Mr. Walker, I am not sure if there is a blow-up of this map, but this is a map from Mr. Hiraishi's report, H-42, the site features and land use map, and I would like you if you could to put this up?

A. I can unfold it.

Q. This is land use and site features?

A. Just a moment. This is a map entitled Hydrology Consultants authorship for Halton, "Halton Environmental Protection Act Study, Site F, Burlington, Site Features and Land Use, March, 1987" the study. This eliminates it as a soil site but it didn't eliminate it as a quarry site.

Q. Certainly this is not any, if you, in the areas consider it hydrogeologically favourable based on the soil attentuation, over-burden thickness, Niagara Escarpment face, slope, drainage, infiltration, aquifers and buried aquifers. That is from the sources and information in that mapping. If you see the fine print on that.

A. That's right, but on figure 7 the following figure, the candidate areas, they are clearly outlined as including the major quarries.

Q. That is quarries candidate areas?

A. It contains both sets of information.

Q. You would agree though that site F would not have been chosen unless pits and quarries had been considered?

A. Yes, that is right.

Q. Again, at this point in time, just going back to page 11 in this report, we have seen, this is under the final evaluation factors that the selection ...

DR. KINGHAM: What page are you on?

H-59

[illegible] Associates Limited
Hydrology Consultants
Pollutech Limited
Richardson and
Associates Ltd.

Submissions, Evaluation Factors

Phase 2, Stage 2B Selection of Candidate Sites

Environmental Assessment of the Landfill Component of Halton's Solid Waste Management System

January 1984

MINISTRY OF THE ENVIRONMENT
REVIEW CRITERIA ("GREEN HAT")
ENVIRONMENTAL ASSESSMENTS ON WASTE MANAGEMENT

The attached schedule lists the type of information which should be incorporated into an environmental assessment dealing with waste management. The specific details to be provided depend upon the specific situation being evaluated and to some degree on the potential environmental significance of the undertaking. Qualified personnel should be engaged by the proponent to develop and carry out the environmental assessment for each specific situation.

The type of information which has been listed in the attached schedule has been developed mainly from the perspective of protecting the natural environment of land, air and water. Under the Environmental Assessment Act however, consideration must also be given to the effects of proposed undertakings on the man-made environment. As a result, proponents should also consult the Environmental Assessment Branch of the Ministry of the Environment, the other review agencies and the public throughout the environmental assessment process for their guidance and input.

Schedule
Information to be Included in an Environmental Assessment Involving Waste Management

An environmental assessment can be considered to be a planning process in which an issue is identified (such as the management of a municipality's waste) and a search for alternatives begins to respond to it. Reasonable alternatives are then identified and evaluated and a preferred alternative (the undertaking) is selected from amongst them. The information included in an environmental assessment should be presented in a manner which demonstrates that a systematic approach has been taken to respond to the particular waste management issue. The undertaking should be clearly defined and once a number of alternative solutions have been identified, the advantages, disadvantages and mitigation measures for each alternative as it affects both the natural and man-made environments (refer to the definition of environment in the Environmental Assessment Act) should be evaluated and a preferred alternative chosen.

The following summarizes the basic information which should be contained in an environmental assessment involving waste management to address the Ministry's land, air and water concerns:

1.0 The Issue

a) define clearly and describe objectives

b) list and describe:
- types and quantities of waste
- population served
- municipalities served
- design capacity and life
- major industries

c) project changes in population served, municipalities served, types and quantities of waste, etc.

d) existing conditions including existing waste management facilities, transportation network, land use and population distribution.

2.0 Waste Management Options

a) describe the various alternative types of waste management facilities including:
- incineration (plus energy from waste)
- landfill
- transfer stations
- waste reduction and recycling

b) evaluate the potential for combining the waste management plan with other municipalities including:
- types and quantity of imported/exported waste
- current practices
- contingency plan in the event waste can no longer be imported/exported
- confirmation that the site accepting exported waste is approved to accept it

c) public or private control of waste management

d) relationship with previous waste management studies.

3.0 Evaluation of the Waste Management Options

a) compare the advantages, disadvantages and mitigation (of disadvantages) of each waste management alternative using evaluation criteria and appropriate legislation such as the Environmental Protection Act and the Ontario Water Resources Act. This comparison should be carried out in conjunction with Section 4.0 (e.g., to locate a transfer station, the location of the landfilling site or EFW served by the transfer station should be known).

b) the evaluation criteria for alternative types of waste management facilities can include:
   - design life and capacity
   - cost (for option feasibility and general comparison)
   - land availability and use
   - population served and distribution
   - impacts on the natural environment including noise, odour, air and water impact
   - existing and potential market availability for waste reduction and recycling
   - transportation network
   - waste quantities and types

c) assess the relative importance of the evaluation criteria

d) assess the effects of projected changes throughout the design horizon including the effects of new technology

e) chose preferred option or combination of options

4.0 Selection of Potential Site Locations

1. Landfilling

a) select potential site locations based on the following criteria:
- water well records
- topographic maps
- soil/geologic maps
- land use maps
- groundwater maps
- zoning designations
- aerial photographs
- official plans and policy statements
- location of airports

2. Other Types of Waste Management Facilities (Transfer Stations, Incinerators, E.F.W. etc.)

a) Select the potential site locations. As opposed to the option of landfilling, where general hydrogeologic conditions can be used as a guide in selecting potential site locations there is no comparable dominant location criteria for the other waste management options. However, potential site locations can be selected on the basis of factors such as the following:

- centroid of waste production
- location of potential or existing energy user (for locating an E.F.W.)
- location of landfilling site or incinerator or E.F.W. (for locating a transfer station)
- land use (including distance to residences)
- site access (utilize major roadways)

5.0 Evaluation of Potential Site Locations

1. Landfilling

a) compare the advantages, disadvantages and mitigation (of disadvantages) of each potential site location with the evaluation criteria and appropriate legislation (Regulation 309 and E.P. Act)

b) the evaluation criteria can include the following:
- size of site
- cost of land aquisition and site development (for option feasibility and general comparison)
- adjacent land uses
- site access
- other potential uses of the site (such as agriculture)
- distance to residences
- buffer zone
- site screening
- cover soil availability
- location of the centroid of waste production
- environmentally sensitive areas
- hydrogeologic conditions including:
  - depth of water table below ground surface (from water well records)
  - flow direction of groundwater
  - type of soil/geology (from soil/geology maps)
  - nearby groundwater and surface water use and potential use (such as drinking water)
  - distance of surface water bodies

- feasibility of contingency systems for leachate control (including system design and installation and leachate handling)
- recharge or discharge area

c) assess the relative importance of the evaluation criteria

d) establish a minimum requirement for acceptability of hydrogeologic conditions to prevent the assessed relative importance of the other evaluation criteria from overwhelming the hydrogeologic conditions (i.e., a site which is not acceptable hydrogeologically, should not be selected as the preferred alternative)

e) chose a reasonable number of the better alternative sites for more detailed evaluation
   - a conceptual site plan for each site
   - a few boreholes may be necessary to confirm hydrogeologic conditions

f) chose the preferred alternative (site location) and rank the other locations in order of preference

2. <u>Other Types of Waste Management Facilities</u> (Transfer Stations, Incinerators, E.F.W., etc.)

   a) compare the advantages, disadvantages and mitigation (of disadvantages) of each potential site location with the evaluation criteria and appropriate government legislation (Regulation 308, 309 and E.P. Act)

b) the evaluation criteria can include the following:

- centroid of waste production
- location of potential or existing energy user (for locating an E.F.W.)
- location of landfilling site or incinerator or E.F.W. (for locating a transfer station)
- size of site
- adjacent land uses (including distance to residences)
- site access
- cost of land aquisition and site development (for option feasibility and general comparison)
- other potential uses of the site (such as agriculture)
- buffer zone
- site screening
- noise and odour control
- quantity of waste handled
- dimensioned site plan of property showing details including building locations, on-site vehicle routing and queuing areas, fencing etc.
- contingency plans (for waste handling and fire)
- where air emissions are involved, identify the type of waste incinerated, expected air contaminants, plume dispersion and mitigation measures
- potential to enlarge the facility
- potential to convert the facility to other waste management uses (such as upgrading an incinerator to an E.F.W.)

c) assess the relative importance of the evaluation criteria

d) chose the preferred alternative (site location) and rank the other locations in order of preference

6.0 Preferred Site Location (Undertaking)

a) present a conceptual plan for the design, operation, development and closure of the site.

Once the requirements of the Environmental Assessment Act have been met, approval is then required for the chosen site under Part V of the Environmental Protection Act. A detailed hydrogeologic report and a detailed operating and development report is required for Part V approval of a landfilling site and a Ministry guideline is available to assist in the preparation of these reports. In the case of types of waste management facilities other than landfilling sites, operating and development reports are required for Part V approval but, the information developed for the facility during the environmental assessment process would normally be sufficient to address most of the Part V requirements. Where air emissions are involved however, precise details of the equipment and pollution control devices are required for approval under Section 8 of the Environmental Protection Act.

Ex. WB-906

Terraprobe Limited

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WITNESS STATEMENT AND REPORT
EVALUATION OF HYDROGEOLOGIC SUITABILITY
HALTON REGION PROPOSED LANDFILL
SITES D AND F

Prepared for: West Burlington Citizens Group
c/o Canadian Environmental Law Association
Toronto, Ontario

Our File No. 85236

July, 1988

Distribution of Report

20 copies	Canadian Environmental Law Association (For distribution as required)
1 copy	Terraprobe Limited

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WITNESS STATEMENT OF PAUL W. BOWEN, P.ENG.

1 QUALIFICATIONS

I am a registered professional engineer in the Province of Ontario, and practice exclusively in the areas of hydrogeology and geotechnical engineering. I am a designated Consulting Engineer, and a founding principal in the firm of Terraprobe Limited.

I obtained a Bachelor of Applied Science in Geological Engineering from the University of Toronto in 1977. After several years of practice I returned to university, and in 1984 obtained a Master of Applied Science in Civil Engineering from the University of Waterloo. The majority of my course work at Waterloo was in the Earth Sciences Department, in the area of hydrogeology.

Specific information regarding my education and professional experience is presented on the curriculum vitae in Appendix A. In summary, I have been involved in hydrogeologic and geologic investigations for environmental, mining, and civil engineering projects since 1977. I have been involved in the hydrogeologic assessment of existing and proposed municipal and industrial landfills in numerous areas of southern Ontario, including the Regions of Peel and Durham, County of Essex, and Towns of Thorold and Beamsville.

2 INVOLVEMENT WITH HALTON REGION LANDFILL ENVIRONMENTAL ASSESSMENT

The West Burlington Citizen's Group sought to obtain independent hydrogeologic consulting services, as the result of their concerns regarding the suitability of Site F for use as a municipal landfill. Terraprobe Limited has been retained by the West Burlington Citizen's Group since September 1985, in providing hydrogeologic consulting services regarding the Halton Region Landfill Environmental Assessment. This has included critical review of most of the documents and reports regarding the hydrogeologic aspects of the environmental assessment, including;

- review of hydrogeologic criteria and ranking process used during Stage 2A through 2C site selection,
- review of hydrogeologic and landfill design and operation reports prepared by various parties leading up to the hearing in May 1987,
- attendance at the hearing and/or review of transcripts regarding hydrogeologic evidence presented at the hearing.

A list of the principal documents which have been reviewed in providing advice to the West Burlington Citizen's Group, and in the preparation of this report, are presented in Appendix B.

I also undertook inspections of Site D and Site F in October 1985, January 1987, June 1987, and July 1988.

The following report presents my professional opinion with regard to the hydrogeologic aspects of the site selection process; the hydrogeologic and geologic conditions at Sites D and F; and the expected hydrogeologic impact as a result of construction of a municipal sanitary landfill at Sites D and F.

3 SITE SELECTION

During the initial stages of site selection, (Stage 2A) several criteria were identified by the Region's investigators for screening and selection of candidate sites. The Stage 2A documents indicate that the criteria of primary importance was public health and safety and that the hydrogeologic factors, ie. the potential for ground and surface water contamination, were considered as the most critical.

The site selection and consolidation report in Stage 2B (Exhibit H-11), indicated that sites with the following characteristics were to be specifically avoided:

- areas where soil thickness was not sufficient
- areas of low soil attenuation capability
- areas with steeply sloping land.

Therefore 'traditional' sites with a thick cover of low permeability soil were considered as most suitable for landfilling.

An overlay constraint mapping technique was used to produce a map of areas which were considered hydrogeologically favorable for landfilling. This map was presented as Figure 6, in Exhibit H10 (Stage 2A, Final Report and General Overview Analysis October 1983). On this map, Site F was not included in the areas which were selected as hydrogeologically suited for landfilling, as a result of the thin overburden cover, and steeply sloping ground.

However, Site F was included in the selection process when a number of pits and quarry sites were considered " - as an alternative to the use of good farm land in Halton for landfill." The use of pits and quarry sites on this basis seemed to be inconsistent with the categories originally chosen to assess the candidate areas.

These categories included public health and safety, which was based on ground and surface water impact and traffic; natural environment; social environment; cultural environment; costs; and engineering and operations. Public health and safety was considered the most important, followed by natural and social environment, which were considered to be equal to each other, but less important than safety; cultural environment, which was of less importance than natural and social environment, and finally by costs and engineering which were of least importance (Exhibit H-11).

Use of farmland for landfill was considered to be an impact on the natural environment. Therefore, it appeared that the selection of pits and quarry sites was based on placing the natural environment category ahead of the public health and safety category. This would appear to be inconsistent with the site selection criteria, which considered public health and safety to be the most important category.

At this stage, it was recognized "..pits and quarries candidate areas may present rather distinct hydrogeological and operating characteristics for sanitary landfilling which must be considered on their own merits." It was suggested that additional attention would have to be paid to the hydrogeology of these sites, and to the engineering and management of leachate. Three constraint categories were included for the pits and quarry site only, and these included leachate generation, leachate collection and leachate treatment. It would seem that this was based on the consideration that escape of leachate from the quarry site may be of greater concern, since they are less suitable for landfill than candidate non-quarry sites.

At the stage 2B level, the leachate collection and generation criteria seemed to be based mainly on the concept of drawing the water table down around the quarry to provide a trap and prevent off site flow. The ability of the geologic environment to provide a hydraulic trap at the candidate sites was based only on limited hydrogeologic data, including a discussion with site operators regarding the volume of water pumped from the quarries. It is noted that at this stage most of the site F area was undisturbed land and had not been developed as an active quarry, although portions of it were licensed as such.

At the Stage 2C site selection level, Site F had been included in the selection process along with five non-quarry sites. With respect to hydrogeologic assessment criteria, site F appeared to fare worse than site D, in all aspects except for current use of the groundwater resource:

Criteria and Judgement	Site D	Site F	Comment
Attenuation capability (soil better than rock)	thick soil	rock	F worse
Geologic Complexity (simple better than complex)	uniform till with sand layers	fractured rock	F worse
Overburden thickness (thick overburden better than rock or thin overburden	Thick overburden	rock/thin overburden	F worse
Complexity of flow system (simple better than complex)	recharge	recharge and discharge	F worse
Type and distribution of aquifers (no use of aquifer or poor aquifer best)	resource poor, some use	resource poor, serviced with municipal piped water	F better

Despite site F faring worse in each category except for type and distribution of aquifers, it was considered to be better suited for landfilling from a hydrogeologic viewpoint than Site D.

In summary, there appears to be a number of inconsistencies with regard to the selection of Site F based on hydrogeologic criteria. Based on the hydrogeologic date which was available at the stage 2A through 2C selection process, and the prevailing state of knowledge regarding contaminant transport in fractured rock systems at the time of site selection, it is our opinion that Site F should not have been selected as a more suitable candidate site than Site D.

4 DISCUSSION OF SITE F

4.1 Geologic and Hydrogeologic Conditions

There have been a large number of hydrogeologic assessments conducted for Site F and the adjacent Bayview and Burlington Landfill sites. This includes studies presented by Cherry and Lush, Morrison Beatty, Hewetson, Gartner Lee, and Trow Hydrology Consultants Ltd.

As is noted on Page 7 of exhibit H40, all of the investigators present somewhat different views regarding the hydrogeologic conditions in the vicinity of Site F. It is our opinion that the Trow Hydrology Consultants Limited (THCL) investigation of the Site F area, as presented in exhibit H40, represents the most comprehensive study of the area. Specifically, it is based on a larger data base (larger number of sampled borings, in situ tests of permeability, and extensive sampling of groundwater quality), when compared to previous investigations by others.

We undertook a detailed review of the factual data, including plotting of all of the permeability, fracture, RQD and tritium data to compare with the THCL interpretation. Upon detailed examination, it became apparent that we could not support the THCL interpretation due to inconsistencies between the factual data and the interpretation.

During cross-examination, Mr. Sobanski and Mr. Beechinor presented a working drawing (exhibit H-220) which was considerably different than the idealized interpretations presented in the THCL report. This working drawing contained factual data from the study (rock fracture logs, tritium, permeability testing and the like), and presented as THCL's hydrogstratigraphic interpretation of the site. It is our opinion that exhibit H-220 was not consistent with the geologic or hydrogeologic data presented in the THCL report.

Subsequent presentations made by Conestoga Rovers Associates (CRA) in exhibit B-617 (Figures B-3.3 and Figure B-3.6) also indicated that there is poor correlation between the THCL interpretation of the site and the available borehole logs and results of in situ testing.

Thus, based on a detailed review of the factual information, we could not support the stratigraphic and hydrostratigraphic interpretation presented by THCL on Figures 2, 4, and 6 of exhibit H-40, and exhibit H-220.

Computer modelling of the flow system was conducted by THCL, using the FLONET model presented in exhibit H-40, and the subsequent 'better fit' model presented in exhibit H-221. These models were used to provide a 'better understanding of the existing groundwater flow system...., flow paths, infiltration/discharge occurrences and rates, and potential contaminant migration paths[1]. We note that the calibration of these models is based on providing a reasonable fit to the hydraulic head data (water levels) for the site. The models represent a non-unique solution to the data, meaning that many different interpretations of stratigraphy and permeability can be used to provide a similar fit to the data. Since we do not agree with the stratigraphic interpretation provided by THCL, it is our opinion that the flow system and flow paths represented by the models must be viewed with caution. In particular, the delineation of the extent and location of discharge zones and the possible contaminant flow paths may be subject to considerable error. This is illustrated in the FLONET modelling conducted by CRA and presented on Figure C.4.2 of exhibit B-617, which illustrates a much larger zone of discharge, while maintaining a reasonable fit to the head data.

Dr. Charlesworth (exhibit M-471) suggested that while the geology of the site was complex in detail, it was reasonably simple on a regional scale. His report suggested that the flow system consisted of an upper active zone, where groundwater movement was rapid and flow paths relatively short; and a deeper inactive or sluggish zone, where groundwater flow was very slow and flow paths were much greater in length.

Mr. Hodgson presented a similar concept during his cross-examination of Mr. Petrie. These discussions were presented in Volume 117 of the transcripts and on exhibits H-653, H-663, H-664 and M-677. In summary, it was suggested that two distinct flow systems could be described within the shale bedrock beneath the site. The first consisted of an upper active zone, which was characterized by low to moderate chloride levels, and high tritium levels. The existence of this zone was also inferred at the adjacent landfills, where the presence of leachate was implied based on relatively low levels of various organic parameters, including chlorobenzene.

The second system comprised a lower sluggish flow system that was characterized on the basis of saline groundwater (high chloride), and low tritium values.

It is our opinion that this latter concept of an active and sluggish flow system is a better representation of the site conditions. We note that the most compelling evidence of this flow system is the groundwater quality data. Based on this data, it would appear that the upper active zone may be on the order of 15 to 20 m of thickness, although it may be quite variable.

However, the results of in situ testing of the hydraulic properties of the rock, including the packer, Hvorslev and pump tests, do not provide an interpretation which is consistent with the groundwater quality data. Therefore, the hydrogeologic and hydrostratigraphic characterization of the site is based primarily on indirect evidence, ie. results of the water quality testing. This is contrary to the method generally used to characterize site conditions, whereby the geologic data gained from borings and in situ testing are used to provide an understanding of site hydrostratigraphy.

It is our opinion that the difficulty in characterizing Site F by conventional means is the result of several factors;

- Site Lithology. The geologic material beneath the site consists predominantly of shale. Flow through the shale is primarily through fractures. On the basis of visual examination it is very difficult to assess the hydraulic properties and groundwater flow which may occur through the fractures, since the fracture aperture and condition (ie. clay filling) is disturbed during the drilling process. Conversely, at a conventional site in porous media, the lithology is much more readily characterized. Areas of significant groundwater transmission (such as sand and gravel) can easily be visually identified from areas of low groundwater transmission (clays and glacial tills)

Interpretation of Hydraulic Properties of Fractured Rock. The nature of groundwater flow systems through fractured rock (groundwater flow directions and velocities) are very difficult to determine except on a large scale. This is largely due to the difficulty in determining the hydraulic properties (permeability) of the fracture system, as well as the extent, orientation and aperture of the fractures. Interpretation of these properties is exacerbated by the lack of analytical methods to assess these hydraulic properties. The analytical methods which have been developed to assess the results of Hvorslev tests, packer tests and pumping tests are generally based on analysis which are intended for porous media. Therefore, these analyses may not be directly applicable to fractured rock, and may lead to difficulties in the interpretation and calculation of hydraulic parameters. The interpretation is most tenuous when the scale of the testing is small, and does not affect a large mass of the rock. As noted by Blackport et al (ex. WB-226) the direction and velocity of groundwater flow in fractured rock is difficult to assess and may not fully correspond with the direction indicated by gradients and head data.

4.2 Contaminant Transport and Groundwater Flow Paths

As noted previously, the characterization of the groundwater flow system at the site is based largely on the results of groundwater quality analysis. It is our opinion that such an interpretation does not provide as complete or direct an understanding of the flow paths and the hydrostratigraphy of the site, as would be obtained if the site could be characterized by separate strata, each with individual hydraulic properties and groundwater flow systems.

For example, if the hydrostratigraphic interpretation presented by THCL in exhibit H-40 could be supported by the available data, then a reasonable basis could be provided for assessing the location and extent of any impact resulting from the site. However, a characterization which is based on indirect evidence, such as groundwater quality, may not permit this type of interpretation. Therefore, it is difficult to provide a clear assessment of the location and nature of any impact from the site.

It is our opinion that leachate which escapes the site will enter the shallow active groundwater zone, which has been described previously. Within this zone, it is expected that groundwater discharge within hundreds of metres of the site, into adjacent creek valleys and surface water courses in the immediate vicinity of the site, as well as to the marsh noted to the south of Highway 403. We note that the creeks in the area ultimately flow through the Aldershot residential community. The precise size of the discharge zone cannot

No attn

be determined with certainty from the existing data.

Groundwater modelling presented by Dr. Rowe in exhibit M-440 showed the significance of diffusion to the matrix as an attenuation mechanism in the shale bedrock. The model also indicated that significant attenuation would occur for a relatively wide range of aperture widths and spacings, hence, attenuation was not sensitive to these parameters.

However, as identified in exhibit M-440, the model is generic in nature and does not specifically account for the geology of the site. Rather, it provides a general interpretation, as it is based on a uniform condition of fracture spacing and orientation. The modelling also indicates that for widely spaced fractures there is little opportunity for diffusion, and contaminant velocities may be relatively high. Therefore, it is important to identify if such fracture systems are present ~~in the vicinity~~ of the site, as they convey small though significant volumes of unattenuated leachate rapidly from the site (Case 1, Figure 4, exhibit M-440).

There has been considerable discussion regarding the infiltration rate beneath Site F. THCL presented a range of approximately 12.7 to 22.5 mm per year in exhibit H-40 (Page 74) for existing site conditions, without the landfill in place. Infiltration rates when the landfill was in place, with a mound of a 10 m height, were calculated as 22.6 mm per year. CRA, based on a conceptualization of the site presented in exhibit B617, estimated that the infiltration of the site may be in the order of 50 to 100 mm per year.

It is our opinion that the infiltration at the site under current conditions is likely on the order of 10 to 20 mm per year, which is similar to the value predicted by THCL. This value is supported by a river basin study for the Oakville and Sixteen Mile Creeks (Appendix C); and the extent of the leachate plume which is currently observed at the adjacent Burlington Landfill site.

The results of the river basin study are based on a review of well data and an interpretation of the hydraulic properties and gradients within the shale bedrock. It is recognized that the river basin study includes areas which are underlain by a different geologic materials, primarily the Halton till. Nonetheless, it is our opinion that the results of the study are a reasonable estimate of the existing groundwater recharge in the vicinity of Site F.

As presented by Mr. Hodgson in cross-examination of Mr. Petrie (Volume 113) the use of recharge values in excess of 10 to 20 mm per year would lead to the expectation that a leachate plume could be found for a considerable distance beyond the existing Burlington site. This has not been observed.

THCL calculate a net discharge of approximately 10,000 cu.m. per year of leachate from the proposed Site F (exhibit H-40). This represents the volume of leachate which will escape the site and underdrain system. It is based on the infiltration rates calculated using the original FLONET model (approximately 22.6 mm per year with the landfill in place).

While we are not in agree with the method used to arrive at this infiltration rate, we are in agreement that the numerical value of infiltration is about 10 to 20 mm per year. Accordingly, it is our opinion that the leachate escape from the site will be on the order of 10,000 cu.m. per year.

We note that this escape of leachate will occur under the design and operating conditions proposed by THCL, which includes installation of perimeter and underdrain systems. In the event of plugging or failure of either system, then additional leachate escape will occur unless remedial work is undertaken. This suggests that the underdrain system is an essential part of the landfill design, which must be maintained and operated for the contaminating lifespan of the landfill.

4.3 Groundwater Resources in Aldershot Area

A survey of existing private wells in the Aldershot area was conducted in conjunction with the West Burlington Citizen's Group. The purpose of this survey was to determine the location of existing wells in the area and to collect water samples for water quality analysis.

The results of our well survey indicate that there is some existing use of groundwater resource in this area. The wells appear to be shallow and draw water from sand strata or sand lenses within the overburden material. The location of the wells, and results of water quality analysis with respect to chloride and sulphate are summarized on the accompanying Table 1 and Figure 1. It is noted that these have been presented as exhibit WB227 during the course of the hearing. At several locations, including 729 and 1047 Plains Rd., and 1067 King Road, the well is the only source of water supply and the residents indicate they have not connected to the municipal supply.

In contrast to the groundwater in the immediate vicinity of Site F, the chloride levels are relatively low, ranging from about 9 to 100 mg. They generally meet the Ministry of Environment drinking water guidelines with respect to this parameter. These wells indicate the presence of a limited but good quality groundwater resource in the Aldershot area.

4.4 Impact of Leachate

Most of the leachate which escapes the collection system is expected to discharge within hundreds of metres of the site, to the ground surface and the surface water system. A small percentage of the leachate will travel downward and enter the deep flow system and ultimately discharge at a much greater distance from the site, in the vicinity of Lake Ontario. It is very difficult to precisely quantify the amount of leachate which may enter the deep flow system. However, based on the very sluggish nature of this flow system, as evidenced by the low tritium and high chloride values, it is expected that the volume leachate entering this system will be much smaller, and perhaps less than 10 percent of total leachate discharge from the site.

Since most leachate will travel within the upper active flow system, it is considered important to more precisely delineate the depth and extent of this system in the vicinity of the site. This is important since any perimeter collection drain ~~which may be~~ constructed must effectively penetrate the full depth of the active flow zone in order to intercept most of the leachate flow.

It is not expected that the leachate discharge from the site will cause a measurable effect on water quality in private wells located down gradient of the site, in the Aldershot area. This is the result of several factors including:

- the relatively low salinity of water in this area, as compared to the underlying high salinity of water in the shale. This suggests that there is relatively little mixing of the deep and shallow flow systems. This is likely the result of the different densities of low and high salinity waters which causes the low salinity of water to 'float' on top of the high salinity water. This equilibrium is maintained by infiltration by fresh rain water.

- the very long flow path and ~~significant attenu~~ation which is expected to occur between the site and the nearest well.

While leachate egress from the site may not pose an immediate health and safety concern, there are several other concerns which must be considered. Firstly, the predictability of the site, with respect to the location and extent of contamination, is expected to be poor. This is the result of the poor definition of the flow paths and geology on a small scale, ie. within the immediate vicinity of the site. 2 Secondly, it appears that the monitoring of leachate egress from the site must be based on organic parameters, as a result of the high salinity and poor ambient groundwater quality. This type of monitoring program is not conventional, and requires more stringent analytical procedures and data interpretation.

Nonetheless, it is emphasized that there will be a definite off site impact, as there will be an escape of leachate from the site. While this impact may not affect the existing groundwater resource it may have some measurable affect on surface water courses in the area which subsequently flow through the Aldershot area. Further, it will represent an uncontrolled source of contaminant loading to the environment.

The current philosophy of waste management, such as presented by the Ministry of Environment in the MISA program, is to apply the best available technology to reduce contaminant discharge from all sources to the lowest possible level. This consideration is not based on strict public health and safety considerations in the immediate vicinity of a source, but rather is based on the reduction of the overall loading of contaminants to the environment as a whole. The best available technology for reduction of contamination at Site F, would include:

- the installation of a low permeability liner which may reduce the amount of leachate discharge 50 percent, based on THCL calculations in exhibit H-40, and,

- an extensive perimeter collection system, to cut off seepage through the upper active flow zone. We note that it will be difficult to assess the effectiveness of such a system unless the thickness of the upper zone is determined, or

- the installation of purge wells as part of the operating and design of the site, to ensure containment of groundwater flow through the active upper zone.

It is our opinion that incorporation of the above measures in the design is appropriate, based on minimizing the contaminant loadings to the environment. The need for this reduction of contaminant loading is also supported by the lack of predictability of the site, as well as the unconventional methods required for the monitoring of the site.

5 DISCUSSION OF SITE D

5.1 Geologic and Hydrogeologic Conditions

All investigators (THCL, Conestoga Rovers & Associates, and Dr. Charlesworth) are in agreement with the general stratigraphic characterization of the site, as presented by THCL. In summary, this interpretation includes delineation of the following zones;

- weathered upper till
- unweathered upper till
- lower till
- upper granular unit
- lower granular unit
- shale bedrock
- thin silt bed

The broad agreement concerning site lithology occurs since Site D consists largely of soil materials which can be readily identified on a visual basis.

There is some disagreement with respect to the horizontal continuity of the granular units, the permeability of the various strata, and the groundwater gradients. It is noted that these disagreements are generally more a matter of degree than concept at this site. It is our opinion that this again emphasizes that the stratigraphy at Site D is much more readily characterized than that of Site F, and suggests that additional investigation can be conducted to characterize site stratigraphy to the satisfaction of all parties.

5.2 Contaminant Transport

Firstly, it is important to recognize that the hydraulic trap concept proposed by THCL will prevent the off site migration of contaminants. While there is a large degree of discussion regarding the engineering details and long term operating characteristics of the proposed hydraulic trap system, it is recognized by all parties that a properly functioning hydraulic trap would effectively prevent off site migration of contamination.

It is also important to note that all investigators identify the same critical contaminant pathway for the site. This pathway consists of downward migration through the upper and lower till units, followed by lateral migration, through the upper granular unit. This understanding and characterization of the critical flow path suggests that differences of opinion regarding the continuity and permeability of the various strata are of less importance than at Site F, since a more assured monitoring and contingency plan can be implemented.

The results of a coupled modelling exercise, as presented by THCL, suggest that contamination would first appear approximately 60 years following failure of the hydraulic trap (Figure 19 of exhibit H-39).

Dr. Rowe (exhibit M-442, pg 6) indicated that off site migration through the upper granular unit may occur in a much shorter time frame, ranging from about 6 to 58 years, depending on the failure scenario which is considered. It is our opinion that cases 6 to 10 (pg. 27, exhibit M-442), which suggest off site migration after 6 to 21 years, are based on parameters which are overly conservative. Specifically, they consider a total failure of the collection tiles, with subsequent mounding to elevations of about 4.8 to 15 m above the existing water table. It is our opinion that the combination of these two events would be readily apparent to the landfill operators, and that suitable contingencies could be implemented to lower the mound and/or collect leachate from the upper granular unit.

Neglecting these cases, a range of 20 to 58 years is calculated for off site impact. Most of the remaining cases are based on assumptions of partial failure of the system. Again, it is our opinion that these time frames are ample to identify a partial failure of the trap, and implement suitable contingencies.

Nonetheless, the modelling presented by Dr. Rowe suggests the importance of maintaining and monitoring the efficiency of the collection system, in order to ensure that the trap functions as designed.

CRA presented several modifications to the THCL design to address these concerns (exhibit B-618). This included changes to the layout of the underdrain system, and installation of a granular drainage layer beneath the landfill. It is our opinion that these design modifications are appropriate to facilitate long term operation of the trap.

It is our opinion that in the event of failure of the hydraulic trap, leachate migration from the site can be much more readily predicted than that of Site F. This is the result of several factors including;

- better definition of site geology and therefore of the contaminant pathway,
- a higher degree of predictability of contaminant transport within porous media, as compared to fractured media,
- the relatively slow (period of tens of years) rate at which contaminant migration will occur, which will ensure that adequate time is available to effect appropriate contingency measures
- better ambient groundwater quality which would permit use of conventional monitoring parameters.

In the event of failure of the trap, it is our opinion that several different types of contingency measures could be implemented at the site in order to ensure complete containment of leachate. These would include:

- purge wells within the upper granular, and/or

- large diameter pumping wells installed within the waste in order to lower the leachate levels and maintain the trap or reduce the rate of leachate egress.

Evidence was presented that some contaminant egress may occur as a result of diffusion from the base of the landfill, even with the hydraulic trap operating and in place. We are in agreement with the evidence presented by Mr. Petrie on exhibits B-642 to B-644, which indicate diffusion profiles beneath the landfill. These indicate that a very long period of time is required (approximately 140 to 170 years) to achieve breakthrough from the till into the upper granular unit. These calculations are based on the very conservative assumption that the input of contaminant will not decline with time. We are in agreement Mr. Petrie and Mr. Sobanski that there will be reduction of contaminant concentration with time. Therefore, diffusion will occur back into, or toward the landfill as a result of reducing concentrations at the source. Thus, diffusion outward from the landfill is not considered to be a significant contaminant pathway at this site.

Finally, it is noted that the primary contaminant pathway considered for the site (ie. the upper granular unit) may not be continuous off site, and may not provide direct connection to neighboring water wells. The extent and continuity of this unit can be readily explored by additional test drilling and pump testing.

In conclusion, it is considered that with appropriate monitoring operating contingency plans complete containment of contaminants within the Site D boundaries can be assured.

6 CONCLUSIONS

The following conclusions are based on our review of the data and evidence presented with regard to Sites D and F.

Stratigraphic conditions at Site D have been adequately characterized and the contaminant flow path has been identified. Using the hydraulic trap concept, the landfill can be designed so that no off site migration of contaminants will occur. In the event of failure of the trap, or other unforeseen circumstances, then off site migration of contamination is expected to be slow and predictable. Migration and contaminants can be detected by conventional monitoring methods using inorganic indicator parameters such as chloride.

In the event of failure of the hydraulic trap, there is ample time to institute proper remedial control measures. The proposed remedial measures, consisting of purge wells in the upper granular unit, are considered to be a proven and suitable method to prevent off site migration.

Stratigraphic conditions at the Site F are not as well characterized as those at Site D. This is the result of lithology of the site (fractured shale bedrock) and the inherent difficulty in predicting the direction and velocity of groundwater flow on a small scale basis in a fractured media.

It is our opinion that there will be off site migration of leachate from Site F, using the site design proposed by THCL. The volume of leachate escaping from the site will likely be in the order of 10,000 cu.m. per annum. The pathway for leachate escape from the site is known only in a very general sense. It is expected that most of this leachate will discharge to the ground surface and surface water courses within hundreds of metres of the site. These water courses subsequently flow through the Aldershot residential community. This leachate discharge would represent an intentional, uncontrolled source of contaminant loading to the environment. The design of the site could be altered to reduce this discharge by installation of a low permeability liner, and a purge well system or extensive perimeter collection system.

In conclusion, it is our opinion that Site D presents a more suitable and predictable hydrogeologic environment for landfilling than Site F.

Respectfully Submitted,
TERRAPROBE LIMITED

Paul Bowen

Paul W. Bowen, P.Eng.

opinion of the suitability of Sites D and F for landfilling today? Start with a general overview and then go into a detailed analysis?

A. Okay.

Again, I feel that Site D is a containment site. It is one which is predictable in a hydrogeologic sense and I feel that it is, for that reason, better suited to landfilling than is Site F. Site F is not a containment site, it is one which, according to the present design, allows for offsite migration or escape of leachate and my primary concern at this time is the location and the nature of that extent, where it occurs and how long it will take to occur and the volume of leachate that will escape the site is not well understood.

Q. Can you go through the details of your analysis, if you would like to start with Site F first?

A. Mr. Chairman, I will be going through the information that I gathered or that I prepared in order to reach my conclusion about the geology of Sites D and F.

In many ways this is a summary of information that has been presented by previous investigators, the other people who have testified at overall loading of contaminants from a wide number of sources to the environment.

In my view, the best technology for reducing contamination at Site F could consist of many items. One would be the installation of a low permeability liner as discussed by Trow in Exhibit H-40. This would result in a reduction of the amount of leachate discharge by greater than 50 per cent. In addition to that, of course, there would still be leachate discharge even though the liner would reduce the volume of that discharge.

To collect that leachate discharge, I feel it would be necessary to either install an extensive perimeter system or a deep drainage system to collect that discharge or a purge well system.

MS VIGOD: Subject to any final comments you have, those will be my questions.

MR. LANCASTER: Thank you, Ms Vigod.

CROSS-EXAMINATION BY MR. TZEKAS:

Q. Mr. Bowen, may I deal first with the infiltration rates that you have assumed for Site F? I gather from the tests that you refer to that there was really no direct way for you to know or estimate that infiltration rate.

Q. Now, I would like to turn to the area of site engineering if I may. You have indicated, you have set out in the report, some of the controls that you propose at Site F and some of the systems that you feel would be necessary to create a suitable site.

First of all, can you tell me what the estimate of a 50 per cent reduction in exfiltration with a liner is based on?

A. Again, that was obtained from Exhibit H-40. It is Trow's estimate, and I believe it was somewhat greater than 50 per cent, as I recall. It was based on an assumed permeability and thickness for the liner beneath the landfill and based on that assumed permeability and thickness of the liner, there was a corresponding reduction in the amount of leachate that would leak through it.

Q. I take it there is some concept of the liner that allows that figure to be used.

A. Yes.

Q. Did you do any independent work on that, Mr. Bowen, or are you adopting Trow's number on that?

A. I am simply adopting Trow's number on that.

Q. Would the existence of a liner at

Site F allow one to measure or monitor the performance or the levels of exfiltration in a more specific way?

A. Yes, if there were an engineered liner placed beneath the site that would permit, at least in a much more definite sense, within a much smaller order of variability it would permit one to calculate how much leachate leaves or leaks out the bottom of the site because what we would be doing is placing an engineered containment layer whose properties we know fairly well between the refuse and the geologic environment. The shale bedrock. Because we know its properties fairly well and have some idea of how much mounding we can expect within the garbage we can then calculate how much would leak out the bottom of that liner.

So, in short, it would provide us with a high level of confidence as to ultimately how much will leak out the bottom of the site.

Q. Moving then to the perimeter drain system, can you indicate to me or give me an estimate of how effective you think that drain system might be in picking up the leachate which does get through the liner.

A. I think it would have limited effectiveness because, as I have illustrated on Exhibit

WB-907, that in order to pick up the leachate which would leak through the liner, through the bottom of the site if it weren't lined, in order to pick up that leachate before it flowed out and through the active zone, that drain would have to penetrate pretty well the full extent of that active zone. It is my recollection the existing toe-drain does not do that.

Q. By "the existing toe-drain" you mean the toe-drain suggested by Trow?

A. You are right, I shouldn't use the word existing -- proposed toe-drain as proposed by Trow.

Q. In order to create any kind of effectivness with respect to the perimeter drain system that you are suggesting, what work would need to be done in order to, prior to the installation such as this?

A. In order to allow for its proper design?

Q. Yes, sir.

A. I think it would be necessary first to determine exactly how thick this upper active flow zone is. If indeed it is of some thickness, perhaps 10 or 15 metres or more, it would become rather an expensive proposition to cut a toe-drain or excavate

A. It would be, I suspect, more permeable and potentially more problematic. It certainly would not be my preference.

However, keeping in mind still that we do have a level of protection below that, that is the essence of the lower collection system.

Q. I would like to, I will just touch on the design for the drains at both sites. Can you verify that really no matter how closely you space the drains at the proposed Site F, that there will always be an escape of leachate because of the downward gradient and in fact, that is really, as we have heard many times, you cannot create a hydraulic trap at Site F.

A. That is correct.

Q. At Site D, am I correct in saying that drains can be spaced or can be designed so that all the leachate can be collected?

A. At Site D the inference is that whatever the drain spacing, which really only results in the height of mounding that would occur, the hydraulic trap ensures that we collect all of the leachate that is generated at Site D and as well, increase that quantity by the intrusion of the groundwater into the site.

attenuation sites but certainly for major and larger municipalities that the direction is towards containment and control of the leachate.

Q. That was my next question to you. So, as a landfill engineer, would you agree that a landfill design is preferable that has no off-site migration versus a design that permits off-site migration so it is back if you like to the analogy of a box without a bottom versus a box with a leaky bottom.

A. That ~~would certainly be~~ my preference, yes.

Q. I would like to clarify one matter that Ms Cronk raised with you about purge wells at Site D.

A. Yes.

Q. I believe she referred you to page 94 of your Site D report. I don't know if you need to go there, but let me see if I can summarize my understanding and then you can tell me if I am correct.

Am I correct that purge wells that you propose as contingency at Site D can collect all the leachate in the event of a hydraulic trap failure, but that there will be just a five per cent increase little bit.

The way I formulated it myself this morning is that there are basically three scenarios, one scenario being where the primary engineered feature of each of the two sites are in operation and continue to be in operation and in the case of Site D, that is the hydraulic trap and the leachate collection system and at Site F simply the underdrain.

MS. VIGOD: Q. That's right.

A. I will discuss those scenarios and list each condition.

The next scenario is where there is a failure of the primary engineered system, either the underdrain at Site F or the hydraulic trap at Site D, and no contingencies measures are implemented.

Q. Okay.

A. The third scenario would be as with No. 2, the failure of the engineered systems, the primary systems, with the implementation of effective contingencies.

For Site D when everything is operating as planned, there is no leachate movement into the underlying granular units and there is contaminant migration through the upper unweathered till by diffusion, but our estimation is that those contaminants will not reach the upper granular units -- reach the granular units, be they upper or the lower, depending upon which one exists at which particular point in space.

As a result of this, I categorically state that there should be no impact at Site D,

At Site F, however, the underdrain system is going to collect a significant proportion of the leachate, but some of the leachate is going to bypass the underdrain and this movement will occur into the underlying shale bedrock and it is my estimation that there should still be no significant impact as a result of this migration which will occur over a period of tens of years.

DR. KINGHAM: How do you define "significant" in each of these cases?

THE WITNESS: Significant mainly being in terms of the impact on groundwater by chemicals which would exceed drinking water standards. In the second scenario, the failure of the engineered systems with no implementation of contingency measures; in this case there would be a movement of leachate downward through the unweathered upper till, the lower part of the lower till, at Site D, into the granular units and movement toward the site boundary.

B-617

PART A: DEFINITION OF SITE HYDROGEOLOGIC SUITABILITY FOR LANDFILLING

A.1.0 INTRODUCTION

In order to conduct an assessment of the hydrogeologic suitability of a site for landfilling the following items must be addressed:

1) The hydrogeologic setting.

2) The level of engineering necessary to provide effective primary protection.

3) The boundary impacts for landfill design option considered.

4) A monitoring program to monitor both the natural hydrogeologic setting as well as the engineering landfill system.

5) A contingency plan in the event that the system, natural or engineered, does not perform as expected.

The hydrogeologic setting is defined initially as this provides the basis upon which to develop the required engineering design. The final three of the above points are addressed following the definition of the hydrogeologic system and the conceptual engineering design.

From this assessment a hydrogeologically acceptable landfill site must meet the following minimum criteria:

1) Migration of contaminants from the landfill must be predictable and the impact from this migration must be determined to be acceptable.

2) The site must be able to be adequately monitored in order to verify the predictions on the behavior of the contaminant migration.

3) Feasible contingency plans must be developed such that if unacceptable contaminant migration results, as determined from the monitoring, this migration can be mitigated.

The following sections provide a discussion of these items.

The tendency is to put as much information as can be humanly gathered before the Board and then say "See, it is acceptable." We would like to suggest that there is in fact an objective way of looking at this which applies across the board and it applies beyond Sites D and F and we would like to propose that in fact there are three criteria against which you should evaluate both Sites D and F. The three criteria are set out in paragraph 19 and they are:

> "(1) It should be demonstrated that any predicted leachate migration from the landfill will not impair the reasonable use of ground water on adjacent property.
>
> (2) It should be demonstrated that a monitoring program can be developed which will be capable of identifying any movement of landfill-derived contaminants."
>
> (3) It should be demonstrated that feasible contingency measures will be available to mitigate any impact on adjacent property that is identified by the monitoring program."

I put those three criteria or fairly close versions of them as they have been cleaned up a little first to Mr. Sobanski at Volume 22 of the transcript, pages 5006 to 5008. I think it's best to simply refer you to those pages and ask you to read them. What I draw from them is that Mr. Sobanski generally agreed with the criteria and I gave him the opportunity to expand on them which he did, but I'm not sure he did it in such a way that you could add a criteria or anything like that from what he said. That's Volume 22, pages 5006 to '8. I also put the three criteria to Dr. Charlesworth at Volume 84, starting at page 20040 and Dr. Charlesworth also agreed with the criteria. He did, however, want to add another criterion and I think I can quote, he thinks the criterion should be that you understand the flow system. I have some comments on that but I think I can pick it up in what I want to say about what Conestoga-Rovers had to say about criteria because I think it's much the same point and I think the point is that understanding the flow system is essential to criterion (1), or some understanding and I think to say there is some absolute level of understanding is misleading.

MR. ESTRIN: What was the volume number?

MR. TIDBALL: Volume 84. When Conestoga-Rovers came along later in the hearing, to the practicalities in a site-specific way, you can carry it to the absurd because a trivial amount of contaminants would be enough to breach the standard when in fact you could have evidence that there will be no impact of a negative kind at all even by a trivial loading of contaminants. In my respectful submission on the evidence before you that is the appropriate amendment to be made to the criterion and we have outlined it in the typewritten version we have given to you.

Mr. Chairman and Dr. Kingham, the next portion of our submissions relates to planning and I would ask that you entertain those submissions from Mr. Griffiths. I wonder if it would be appropriate to take a break firstly.

MR. LANCASTER: It is.

MR. GRIFFITHS: I will add I will be making reference to just a few volumes of the transcript and you might want to look up four volumes, 63, 64, 102 and 103. Those will be the only transcripts to which I will be making extensive references.

MR. LANCASTER: Thank you. We will break for ten or 15 minutes and get those.

--- Recess

SUGGESTED CRITERIA FOR ACCEPTANCE OF LANDFILLING

MOE

Groundwater

1. It should be demonstrated that any predicted leachate migration from the landfill will not impair the reasonable use of groundwater on adjacent property.
2. It should be demonstrated that a monitoring program can be developed which will be capable of identifying any movement of landfill-derived contaminants.
3. It should be demonstrated that feasible contingency measures will be available to mitigate any impact on adjacent property that is identified by the monitoring program.

Surface Water

1. It should be demonstrated that predicted leachate migration from the site will have no impact on surface water.

ESTRIN

1. It should be demonstrated by the proponent both through hydrogeological and conceptual design evidence called at the Hearing that any predicted leachate migration from the landfill will not impair the reasonable use of groundwater on adjacent property for the contaminating lifespan of the site.

CRONK

1. It should be demonstrated that predicted leachate migration from the site will have no significant adverse impact on surface water.

CRA

1. Migration of contaminants from the landfill must be predictable and the impact from this migration must be determined to be acceptable.
2. The site must be able to be adequately monitored in order to verify the predictions on the behaviour of the contaminant migration.
3. Feasible contingency plans must be developed such that if unacceptable contaminant migration results, as determined from the monitoring, this migration can be mitigated.

southwest.

A. That refers to the area of discharge from groundwater in the shallow aquifer system.

Q. If we could make a third item, perimeter drains and I believe your evidence was that you would place them four metres into the shale?

A. I believe I said four to five metres.

Q. If we could enter that?

A. Again that is a typical depth. In some areas, like along the southern boundary in the vicinity of HC-8 upon, upon additional information that is going to be derived from developing the groundwater program you might find that there is virtually no need for a very deep perimeter drain along the southern boundary or much of the southern boundary.

Q. But right now the evidence we have is that this active zone I think goes anywhere from 0 to 20 metres in depth?

A. Along the southern boundary we have evidence that it ranges from 0 to 11.

Q. To 11. Again, as we have discussed many times, there is only that one borehole directly south?

A. That is correct.

Q. Just so that we have it clear, Trow's earlier design was three metres into the till, that is your evidence?

A. Yes, that is correct.

Q. Would you agree that part of the Trow design arose because they didn't have this, if you like, theory of the active and deep system of flow. In other words, they hadn't defined an active flow system perhaps in the 0 to 20 range?

A. Not based on the chloride concentration predominantly, no. The Trow hydrostratigraphy as outlined in Exhibit H-220 is basically limited to information along the cross-section going from HC-4 to HC-5, to HC-8 to HC-14. Along those particular boreholes the physical evidence in terms of the nature of the shale, responses during pumping tests and the like, would suggest that at the southern portion of the site there is a zone of basically no active flow. Any lateral flow through the weathered moderately fractured shale in the upper part of the bedrock would discharge on-site.

What the Trow conceptualization of the hydrostratigraphy doesn't take into account is lateral variation in the nature of materials.

If I can just continue for a few more moments. Basically Trow did not have boring, boreholes of the detailed type that they installed on-site to the east and the west in the appropriate locations to define the zone of moderately fractured shale in those areas, in the manner that they defined it at HC-4, HC-5, HC-8 and HC-14. What I have presented in attachment 4 in my witness statement is an evaluation of the thickness of the zone of active flow which, you know, compared to the zone of moderately fractured shale from the Trow interpretation and extrapolated or interpolated that the thickness of that zone both to the west, south of the Burlington site and to the east south of the Bayview site; that is the additional information we have now, and it really isn't incorporated into the Trow hydrostratigraphy and consequently the evaluation of that shallow flow pathway.

Q. In summary do I have it that the Trow cross-section was not an appropriate one to design the site in terms of a perimeter drain?

A. In terms of a perimeter drain I think I could concur with that.

Q. Now, the final item on the chart is item 4, the total exfiltration and I believe your

Consequently one has to go across quite a number, quite a vertical thickness of shale zones which may have a significant or a substantially lower vertical hydraulic conductivity.

Q. That is again --

A. I have to make one more statement. South of the site, obviously we have most of the information from on the site itself based on Trow's investigation and information from the investigations of the Bayview site and the Burlington site. South of the site we have far less data and really no clear way to correlate this particular fracture zone that we are considering, the deep pathway, with pathways a kilometre or more to the south other than the fact that there are still strong downward gradients in the lower portions of the bedrock on-site further suggesting that there are indeed lower vertical hydraulic conductivity zones even below this zone here, this zone being elevation 100 to 110 on the site.

Q. As we have discussed, what I am trying to get at is, you have discussed the Trow model. Of course you have to relate that to the real data, and as you said the discharge zone in that respect may extend further south.

Just turning back to their definition we now -- isn't it fair to say -- have a different definition of an active zone on this site as a result of the chlorides?

A. We have a different definition, that is correct, for the shallow zone, not the deep pathway and the discharge zone that we have been discussing on page 57.

Q. In other words, what I am trying to get at again is that that modeling of where the discharge would be from what Trow called the moderate zone is different from what we are talking now and that resulted in a change in design, or a proposed change. You are proposing a different design at this point before the Board?

A. For the perimeter drain for the southern portion of Site F, that is correct.

Q. Again, just to pursue this active zone a bit further. I believe your evidence was that the zone, as we have said, might extend from 0 to 20 metres and again it might average 5 to 10; is that fair?

A. The active flow zone?

Q. Yes.

A. That is the typical range I gave I think, yes.

Q. Wouldn't you agree that an average approach is not the best way to necessarily address a contaminant migration problem?

A. In terms of the design of the perimeter drain, certainly not. I didn't actually mean to suggest that a perimeter drain would be 4 or 5 metres into the shale at every single location. As I indicated, during the course of the development and testing of the monitoring well system around southwest, southern and southeast portions of Site F, we are going to gain a better insight of what the thickness of what the active flow zone truly is at the locations in which we are interested in intercepting it.

It would certainly be my expectation in most areas it would be in the range of five metres or so. In some areas south of the site it is my expectation at least across some of the southern site boundary it would be zero, and as I indicated yesterday to Mr. McQuaid, I would certainly use the information or recommend that the information from the development of the groundwater monitoring program be used for the detailed design of the perimeter drain system.

Q. Are you finished?

A. I am not finished yet.

As I described in my witness statement,

when I discussed the capture of off-site contaminants through the active flow zone, I mentioned not only a perimeter drain but the possibility of a shallow purge well system. It would be, not my expectation, but it would certainly be a recommendation in the areas where the active flow zone is thicker than either expected or thicker than could feasibly be captured with a perimeter drain system given the various construction constraints.

If it was felt necessary to capture that active zone which I believe in most cases it would be, that one could effect that capture with a shallow purge well system being different from a purge well system for Site F that I think has largely been discussed with respect to the deeper contaminant pathways.

Q. Again that would be something that I believe Mr. Bowen made reference to the fact that if the active zone, the greater thickness, you might have to, from an engineering standpoint, put in purge wells?

A. I recall from Mr. Bowen's witness statement that he did discuss purge wells. It is with specific reference to the upper active flow zone on page 9, that is correct; yes.

Q. I guess, would you agree though that the details of where the placement of these perimeter drains is an important design perimeter that will have implications both as to certainly the cost of the excavation and may have some engineering implications as to whether it is feasible to have an excavation of a certain depth or whether, as you are saying, you might want to have purge wells, what in fact the design implications are of what you are proposing?

A. The design implications are important and the information on the thickness of the active flow zone would obviously have to be derived before the detail design of cell No. 2 at the south end of Site F; that is correct.

MS. VIGOD: Mr. Chairman, perhaps we would like to -- I have at least up to a half hour more.

MR. LANCASTER: I think now we will break now until -- and try to get back at a quarter to two.

MR. HODGSON: Can I have an indicator -- will the Board have questions for this witness?

MR. LANCASTER: Yes.

MR. HODGSON: With respect, can we have some estimate of the time?

DR. KINGHAM: Probably around an hour.

Q. But Mr. Feenstra, my question is how, given the downward gradients at these wells, that they be located in the discharge zone and does this cause a problem?

A. Obviously at those specific locations the groundwater discharge gradients are not upward, and so at that location it would suggest that groundwater discharge is not taking place at these specific zones. The downward gradients though are considerably different in magnitude, being much reduced from the hydraulic gradients measured on-site in here and if you continue looking at Appendix 5 you will see there are in fact upward gradients that HC10, HC11 and HC12, somewhat south of the CNR tracks.

Q. I guess my question is that we really don't have any wells in the discharge zone as illustrated in the interrogatories by Mr. Beechinor and, in fact, we may see as you have discussed some upward gradients further south of that area.

A. That is correct, and for the discharge zone as drawn on Figure 1 of H-85, HC9 exists within that zone but the gradients are still slightly downward.

Q. That's right.

A. The downward gradients being approximately .06 compared to gradients of .5 or greater on-site.

Q. Would you predict then that the discharge zone could in fact be -- could perhaps start further south of HC9 and continue further south and would that be a reasonable assumption?

A. That would be a reasonable assumption, yes, given the upward hydraulic gradients shown at HC10, HC11 and HC12.

Q. Could you just perhaps describe the location of HC10, 11 and 12.

A. HC10 ...

Q. The distance from the landfill.

A. Distance from the landfill? Approximately a kilometre from the southernmost boundary of the property. Excuse me, actually from the landfill itself, and this is part of the property, but I understand landfilling won't take place in this area, so approximately a kilometre and a half.

Q. Would it be fair to say that those wells are located in basically a residential area?

A. That is correct, yes.

Q. Now, turning back to HC9 for a moment, if we would like to see Appendix 5; the well monitored for volatiles as I understand it was OW3 and I believe we could confirm that by looking at Appendix 12 in H-40-A, HC9, piezometer 3. If you want to look at Appendix 12.

A. Yes.

Q. It is towards the end of that appendix. I believe you will see there is a notation of 9-85 and then a small 3.

A. Yes.

Q. That would refer to OW3, I take it?

A. That is correct.

Q. If we look ...

A. I believe that that is piezometer number 3 which is located at approximately the same depth as one of the Morrison Beatty wells in which a variety of chemicals were detected in the UW study.

Q. If we look back at Appendix 5 just to clarify this, we can see -- Appendix 5 in H-40.

A. Piezometer 3 is at a depth of

there?

A. Oh, yes, there is a connection at a distance of eight metres.

Q. Dr. Charlesworth, we have had some discussion on the pumping well tests and packer and Hvorslev tests and is it fair to say that pumping tests are generally better indications of the permeability of the large massive rock because you are seeing an influence on a much greater degree of rock than you do in a Hvorslev or a packer test?

A. Yes, although I still put the qualifier I had before that there are difficulties in interpreting pump test data, particularly the kind of data that has come out of this test. I think there is a great danger as in so many aspects of hydrogeology that we tend to run these tests and draw the initial conclusions and to be sure of the value you are getting out of it you need to analyze it in a very rigorous manner, but certainly it indicates connectivity.

Q. I guess my point is that we can agree to differ on the exact permeability number for these fractures, but I think you have just said that there is certainly evidence that there are these highly-fractured zones capable of transmitting water.

A. Yes, and I would say there is some

evidence from PW-1 of a finite extent to that zone.

Q. Dr. Charlesworth, we have seen it extends ...

A. We see it extends to MB ...

Q. Over 200 metres to the north?

A. Yes.

Q. There is evidence of certainly a response to both the east and west?

A. It is a distorted response. The cone does not extend so far to the west as to the east and possibly it doesn't extend as far to the south as the north.

Q. If we are talking about the affected area of rock we are talking about quite a large area?

A. Yes. The test has demonstrated connection within the zone as outlined in red on M-437-D1.

Q. Especially if we compare that to the packer and Hvorslev tests because we are really talking about an order of magnitude difference response in between a metre or so of rock in up to 150 metres?

A. In terms of the piece of rock you are testing, yes.

Q. Isn't it true that in fact

wherever Trow did their pumping test, they did find evidence of some highly permeable zones?

A. They found -- there was evidence of higher permeability zones at those locations, yes, although the exact value we could argue about, what it meant in absolute terms.

Q. Some investigators such as Morrison Beatty in the past have suggested there is a marked decrease of permeability with depth. Would you agree the pumping test data shows that in fact there are some higher permeability zones that go to the full depth and extend out the boreholes that may be at least as deep as 30 metres?

A. I had difficulty with both the pump test and the packer test in identifying that decrease with depth. Where it is there it is sort of tenuous and there are cases where it is less near the surface and we have very low permeability in some cases near the surface, so both the packer and the pump test show that while one might assume that over a depth greater than they tested here you might expect that, it is difficult to clearly show that within that 30-metre zone.

Q. It is fair to say there is really quite a large variation of permeabilities and at least as we are talking about that zone there is not that evidence of a decrease?

A. There is variability of permeability within that zone, yes.

Q. When we are talking about contaminant migration, shouldn't we be concerned about the zones of higher permeability as they will be the ones that govern the first arrival of contaminants?

A. Yes. You have got to define how large those zones are in terms of how much contaminant they will transport. That is a critical factor.

Q. We have heard a lot of talk about this word "conservative", but would you agree it is not conservative to take an average value for permeability?

A. You have to look at ~~this in~~ context. There was a model proposed by Trow which I had some difficulty in fitting all the data into, but they had done their modelling on that basis. Given that one might argue as to whether that was accurate or not, it seems to me from discussing modelling with Dr. Rowe, that an alternative approach was rather than consider that highly-fractured zone, there is quite a spread of data and I don't think you should ignore the Hvorslev values and there is quite a bit of variability even within individual boreholes, and I had difficulty prior to it being drilled and sampled, how much disturbance of the core has ocurred during drilling? On the other hand, if we look at a site such as Site D which is in soil materials, it is much easier to categorize these various strata based on visual examination. One can easily tell the difference between a clay or silt till and a sand or sand and gravel material, so one can also easily begin to understand which zones may be capable of transmitting leachate or groundwater from the site.

The second concern I had was just with respect to the interpretation of hydraulic properties in bedrock material. It is very difficult, in my experience, to understand groundwater flow through a fractured bedrock material except on a very large scale.

When I say the nature of flow, I mean flow directions and flow velocities.

DR. KINGHAM: You have just added the word "very" to your sentence there, "... except on a large scale" and it may be useful up front for you to tell us what you mean by small scale, large scale and very large scale.

THE WITNESS: Okay. By "large scale" I mean, perhaps I should put it in terms of my opinion in the context of Site F. I think within several hundreds of metres it is difficult to understand the flow system. Beyond the range of several hundred metres, the flow system becomes easier to understand.

DR. KINGHAM: So, except on a large scale means except on a scale more than a few hundreds of metres.

THE WITNESS: That is correct.

DR. KINGHAM: In two dimensions.

THE WITNESS: In addition to that, it is difficult to interpret or to analyze what the hydraulic properties of a fractured rock are. There are several reasons for that. One is that one must be lucky enough during drilling to intercept or find a representative number of fractures when you do your testing.

Secondly, and perhaps more importantly, most of the testing that has been developed to understand the permeability or the hydraulic properties of media are based on analysis of porous media. Soil materials, sand and gravel, clays et cetera. They are not really based on fractured material. It is very difficult to get the information one would need to make a precise interpretation of flow and fractures. That sort of information would be the type and distribution and that is for the packer tests undertaken at HC4. The packer tests undertaken at HC4 also generated a hydraulic conductivity value of 10^{-4}, and I don't have the specific number, but again from that packer test, and packer tests conducted at HC3 where 10^{-4} values were appropriate, and HC3 is immediately proximate to PW2 and so I was indicating that that was just one area.

With respect to exfiltration from a landfill into the rock at Site F, we suggested numbers that may range from 50 millimetres per annum to 100 millimetres per annum. Since being on the stand and learning more about this site I believe the 100 millimetres per annum is high. I believe the 50 millimetres per annum is a good number and it may be conservative.

MR. McQUAID: Q. What does that mean in the terminology we have been using so the Board is clear?

MR. PETRIE: A. It is my opinion that the exfiltration from the landfill at Site F to the rock is not likely to exceed 50 millimetres per annum and it may be less, but for the purposes of design considerations I believe a conservative number or good number, i.e., 50 millimetres per annum is an appropriate number to use.

DR. KINGHAM: Is that number the number with the landfill in situ?

MR. PETRIE: I use the word exfiltration with a landfill in situ, yes. We have undertaken additional simulations of Site F from using the Trow model since we have been on the stand and my initial conclusions respecting the modelling exercise still stand. The modelling is based on a hydrostratigraphic interpretation with which I cannot agree and therefore I cannot place much credence on the modelling results. Additional simulations do not provide me with any additional understanding of the site and in my opinion the site is a complex site and I believe it cannot be reasonably modelled by the Flonet model as applied and I cannot place any interpretive weight on the results generated from that model.

The contingency options proposed for Site F are purge wells and the pump testing done by Trow indicates that, yes, you can pump water from the rock at this site. However the variety of response recorded from the wells leads to a measure of uncertainty as to just how many wells one would need or the purging required or the depth or spacing of those wells. Water can be pumped from the rock so I would imagine that with additional testing one could consider purge wells as a feasible contingency option but at this point in time I still have a measure of uncertainty respecting that.

My interpretation of the site we provided, or our interpretation we provided in B-617 and it indicates that the upper 15 metres of the rock can be considered as the more hydraulically active rock and within that zone there are components of downward flow and I would expect much of the water to move with the downward component of flow but sub-horizontally. Within that zone I cannot define specific flowpaths. I do not know or do not have a good handle on where the more permeable fractures are and I cannot predict where they would be. Below that 15-metre zone I expect the rock to be tighter or lower permeable and the gradients within that lower zone tend to be a little more steeply directed downward. Within that lower zone I expect some fractures to be in existence, and they have the capacity to transmit water; however, from the chloride data we have, those chloride levels are high suggesting that it is not modern water and maybe that zone is unlikely to be impacted by landfilling.

DR. KINGHAM: Which zone?

MR. PETRIE: Below 15 metres.

DR. KINGHAM: Can we understand that in terms of the chloride profiles here that below the red line is essentially old water geologically?

MR. PETRIE: We can understand that.

DR. KINGHAM: Above the blue line is relatively fresh water?

MR. PETRIE: Recognizing that as water exfiltrates from a landfill at the site and moves generally downslope, it is going to pick up more mineralizations as it flows and the chloride levels would increase from left to right and the water would still be modern in the general sense.

In consideration of all I have learned from the new data provided since I have been here and the additional interpretations considered, in my mind the site is poorly defined and I feel it cannot be easily monitored and I cannot make predictions regarding the rate and patterns of contaminant migration that may occur at this site and with respect to the criteria we developed on hydrogeologic suitability, I believe Site F is not hydrogeologically suitable.

Now, we considered an alternative landfill design of a clay liner and that clay liner would consist of a lower sand blanket, a clay liner itself and then a sand blanket and leachate collection system on the upper side of the liner and the refuse would be deposited above that again. We believe that that liner is a feasible alternative in order to make the site environmentally sound. It does in our mind give us greater confidence with respect to prediction and we have a greater capacity to monitor. We can monitor the sand blanket directly beneath the liner for a compacted, installed clay liner and we would have an understanding of its properties, its porosity and hydraulic conductivity, and would be able to make predictions regarding the rate of diffusion or the rate of contaminant transport through that liner and have a reasonable handle on the capacity for that liner to provide attenuation. Given that we can monitor the base of the liner, it provides us the capacity to monitor the site. Two questions or two points were raised during cross-examination regarding the liner and these we feel are design issues. One relates to the position of the water table vis-a-vis the liner and if the liner is at -- if the water table is at the base of the liner we have calculated one hydraulic gradient across that liner and if the water table is at the top of the liner we have a different hydraulic gradient across that liner. Thus the position of the water table with respect to the top of the liner is yet to be evaluated and we feel is a design issue respecting the design of a liner.

The second issue raised is the geotechnical considerations with respect to installing a compacted clay liner on one part on rock, and that would be the portion of the rock which would be removed so you would be dealing with a more fresh rock surface and, secondly, the clay liner to be installed on infilled material, infilled into the stream fillings so you would have two base materials on which the liner would be constructed. Those are geotechnical considerations and again can be addressed in a design aspect of that liner. We feel the liner does provide a feasible alternative to make the site environmentally sound.

DR. KINGHAM: Do you know of any case where an attempt has been made to put a liner on an incline on two different base materials and the liner has survived?

MR. PETRIE: I do not and could not speak to that.

MR. CRUTCHER: If I may add, I hope to be able to address that a bit more in the operations portion.

MR. PETRIE: To sum up again, the tritium and chloride data can be viewed as providing a measure of those portions of the rock which are more hydraulically active and ignoring some of the tritium data and it may be appropriate to do that and indeed it could be verified by additional tritium sampling and it would make it a less complicated picture or more consistent picture vis-a-vis the chloride and tritium for the more hydraulically active portions of the rock. We feel exfiltration from the landfill or -- 50 millimetres per annum is a good number, but in consideration of all of that I still feel there is difficulty in predicting the performance of the site and being able to monitor the site and there is some measure of uncertainty as to how effective purge wells would be to control contaminant migration should it occur and the liner alternative, and there are some design issues which must still be evaluated at greater depth, but we feel the liner provides us with the capacity to predict and monitor the site and, in that sense we believe the liner would make the site environmentally secure and more safe.

MR. McQUAID: Thank you, Mr. Petrie. Those are all my questions. Thank you, Mr. Chairman.

MR. LANCASTER: Thank you, Mr. McQuaid,

feel this is an inherent difficulty because of the lithology or the type of geologic materials that make up the site. Being fractured bedrock materials, again it is very difficult to characterize the extent and nature of fracturing. For that reason it is difficult to identify the groundwater flow paths and the properties of the rock, the hydraulic properties of the rock.

An important point to notice about Site F is that as it is designed there will be an off-site migration of leachate and the volume of this leachate may be in the order of 10,000 cubic metres per year or about 6,000 gallons per day. The pathway for the escape of this leachate from the site is known only in what I would call a general sense. That is, it is flowing downhill and away from the site. It will likely, most of this leachate, most of this 10,000 cubic metres will likely discharge within several hundreds of metres of the site. It will discharge to the ground surface and to surface watercourses in the area. Some of these subsequently flow through residential areas in Burlington.

It is my opinion that this leachate discharge represents an uncontrolled source or release of contamination to the environment. That when in comparison with Site F?

A. Perhaps before we continue with that there was one other point that I did wish to make, Mr. Chairman. That is presented on page 9 of my report. Having just said that I recognize there won't be an impact on the water quality in these wells as a result of Site F, I nonetheless want to emphasize that there will be an off-site impact. By that I mean that leachate will escape the site and again we can talk about a volume of about 10,000 cubic metres per year.

In my opinion that represents an uncontrolled source of contaminant loading or leachate loading to the environment. Irrespective of whether it causes impact on the drinking water wells I believe, particularly when it is compared to Site D that it makes Site F a poorer choice for a landfill than Site D.

At Site D we have containment of leachate and essentially there will be no off-site impact.

Q. So, could you turn to Site D and do you want to give your conclusions? First of all, comment on the geologic and hydrogeologic conditions?

A. Perhaps in beginning our discussion of Site D I think it is important to notice

Ex. B - 930

MUNICIPAL—INDUSTRIAL STRATEGY FOR ABATEMENT

(MISA)

A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters

June 1986

Ontario

Ministry of the Environment

Hon. Jim Bradley
Minister

Rod McLeod
Deputy Minister

STRENGTHENING OUR POLLUTION CONTROL SYSTEM

The Toxics Issue

Like many industrialized areas, Ontario is faced with the challenge of dealing effectively with the increasing presence of toxic contaminants in the lakes, rivers and streams of its aquatic environment.

High mercury levels in fish, dioxin in the Niagara River, the perchloroethylene spill in the St. Clair River -- all have focussed attention over the past decade on toxic contaminants and the potential risks they pose to aquatic life, public health and drinking water quality. The problems of toxic contaminants are of particular public concern in the Great Lakes System, where 800 different chemical compounds have been found.

Water pollution control efforts in Ontario have been hampered by outdated control concepts.

Until now, controls were aimed at the conventional pollutants such as biodegradable wastes, suspended solids, ammonia, phosphorus, some metals, oils, grease and phenols.

The newer, more complex pollutants have escaped specific control and present a threat to our drinking water, fisheries, and wild life.

There are two main groups of toxic contaminants of concern: toxic metals, such as mercury, lead and arsenic; and toxic organics (carbon-based compounds), such as dioxins, PCBs and chlorinated benzenes.

These toxic contaminants differ from conventional pollutants in one or more of the following ways: They pose a risk to fish, plants, wild life and human beings, even at low concentrations. They are persistent and either never break down or do so only very slowly. They accumulate in the environment. They are passed up the food chain in increasing amounts. This process, biomagnification, can result in thousands-fold increases in the concentrations of toxic contaminants from the levels present in the ambient water to those found in large fish.

Toxic contaminants will almost certainly have serious adverse effects over the long term. These effects have been demonstrated in the environment as indicated by the lowered reproduction rates of certain species of birds due to food chain effects.

New Initiatives

MISA will establish an abatement program for all the major specific toxic pollutants. The waste streams for each discharger will be analyzed. Hazardous pollutants will be identified, and discharge standards will be set using as a criterion the best available technology that is economically achievable (BAT).

To cope with the enormous diversity of chemicals found in the environment, target compounds are being selected for monitoring and control. This selection is based on:

- known use of compounds and their release to the environment;

- known toxic effects on plants, aquatic biota, animal life and human health;

- known presence in Ontario's environment.

These target compounds will be used to focus our control programs in a manageable and effective manner. **Toxic contaminants must be reduced, at source, before they escape into the environment.**

This will be achieved by establishing regulations for each industrial sector and the municipal sector. First, a monitoring regulation will be established requiring each company to monitor its effluent for a wide range of contaminants. The self-monitoring program will be policed by the Ministry taking samples from time to time on unannounced visits. As well, all samples taken by the companies will be duplicated, with the duplicate sample being available for the Ministry.

The MISA program will cover all major toxic polluters of waterways within three years as it encompasses eight industrial sectors, including (in alphabetical order):

- electric power generation
- industrial minerals
- inorganic chemicals
- iron and steel
- metal mining and refining
- organic chemicals
- petroleum refining
- pulp and paper

These sectors comprise some 200 of Ontario's 300 direct dischargers. Most of the remaining direct dischargers will be covered as other minor sectors are brought under the program. The municipal sector, consisting of 400 sewage treatment plants taking waste water from some 12,000 industries, will also be covered. The first two sectors to

Integrated Ecosystem Approach

The toxic contaminants problem is not unique to water. Toxic contaminants also pose a threat to air quality and form toxic rain. Leachates from landfill sites can potentially contaminate ground-water and surface-water supplies. All of these circumstances are interrelated aspects of an overall problem of environmental degradation, since toxic contaminants can be transferred from one medium to another.

To provide an effective solution to the management of toxic contaminants, Ontario has introduced an integrated and comprehensive strategy for attacking all sources of these contaminants in the ecosystem as a whole. In this respect, all the air, water and land regulatory components will be made compatible and complementary.

to do it at the time and I don't know why she failed to do it.

MS. VIGOD: First of all, if we go back in the transcripts I did question Mr. Beechinor on this very issue, but Mr. Feenstra is here to deal with contaminant migration and the impacts of these various thicknesses, and that is where my questions are going on this point, and I believe he has already stated that a thinner unit would result in travel times...

MR. LANCASTER: The Board will allow the questions on that basis.

MS. VIGOD: Q. Now, in relation -- we have had a discussion about the interpretation of the geological and hydrostratigraphic units at Site F. Would it be fair to say that it's more difficult to delineate the boundaries in a unit or in a material that is the same lithology, in other words shale rather than distinguishing between till and granular units.

A. In this case yes there is a considerable difference between the hydrostratigraphic units developed for Site F and for Site D. At Site D the differences in the hydrostratigraphic units are largely expressed by the actual difference in texture of the soils going from sands to silty clays or clayey silts. At this particular point the lithology or the nature of the shale bedrock is reasonably similar. What distinguishes one zone from the other is the hydraulic properties, hydraulic properties being influenced by secondary features such as fracture zones or other discontinuities as described by Mr. Beechinor, and so there is a fundamental difference between the two sites, correct.

Q. Just to sum up this point, as we have seen, the entire unit 3 used in your model, or unit 3 as found at H-220 is thinner in many places than the number used in the model and would it have been more prudent in the contaminant migration unit to have used a number less than 15 metres?

A. In terms of conditions for the overall site, I am not really sure what led Mr. Beechinor to the interpretation of that unit, being unit 3, the weakly fractured shale, was thinner at the north end of the site so I can't really comment on that, but the use of a thinner zone or a thinner unit 3 to some degree might be considered to be conservative because it would tend to give one

Site F.

MR. SOBANSKI: We certainly are unable to say that we have picked up every fracture or anything of that nature. We believe that we have given a reasonable, plausible description for the mechanism by which groundwater moves at the site. The fracturing obviously is a complexity that has a greater degree of complexity at Site F than it does at Site D. I don't believe that we have missed anything major. If we have, the implications of having missed it at this site are very -- the implications are not all that great if something has been missed because of the various factors that we have discussed throughout the hearing.

DR. KINGHAM: Let us go through the same kind of water balance we went through in terms of Site D. This site is about the same surficial area more or less than Site D is.

MR. SOBANSKI: I believe it is just a little smaller.

DR. KINGHAM: Therefore, it would have about the same amount of rain falling on it, I guess.

MR. SOBANSKI: Yes.

wouldn't want to lump all that data together?

A. I'm saying and what I said this morning was that we have clearly-defined zones there and it's a lot easier to depict those zones and they are more clearly defined. I believe as you go down the profiles of these boreholes there is more variability than a cross-section with those lines drawn on implies. They are two different scenes. If you did that you would come up with a more conservative answer than either Dr. Trow -- Dr. Trow, he got in again -- Dr. Rowe or Trow have modelled at Site D.

Q. You would agree those clearly defined zones you have talked about at Site D are clearly definable because they are visually definable and we can tell a granular unit from a till unit?

A. Yes.

Q. At Site F you would agree it is more difficult to identify those various fracture zones on a visual basis?

A. Yes. In a way there is less variability. Geologically there is less variability at Site F.

Q. But it is important you monitor them even though it is harder to identify them at Site F?

shale at the Bayview site, and I believe it varied over a fairly small range in the three samples that were tested.

Q. So, in summary on the input parameters, would it be fair to say that first of all it appears that the groundwater velocity taking into account the permeability, thickness and the dispersivity,are all perhaps more easily measured or determined at Site D than F?

A. The groundwater velocity?

Q. Yes, taking into account the components.

A. ~~Yes, I believe~~ that that would be relatively fair. At Site D in particular I don't think there is the same concern about anisotropy, the vertical hydraulic conductivity of the upper unweathereed till and the lower till being significantly different from the hydraulic conductivity that was actually measured in the field and interpreted from tritium data,mainly because we don't really expect there to be significant directional difference, and just because of the way the till was deposited and being sort of plumped down by a glacier rather than being laid down as a shale deposit in horizontal layers, thin horizontal layers.

Q. Also would agree there is now greater experience with contaminant transport modelling through a porous medium such as till than in a fractured medium such as shale?

A. There certainly is, and as we discussed on a number of occasions, the difficulty in modelling contaminant migration through a fractured porous medium like a shale is quantifying the effect of matrix diffusion.

Q. In this regard I would like -- I'm not sure of what I can read you,but perhaps I could have you read -- have you Dr. Cherry's book here?

A. Yes, I do.

Q. This is an underground best seller as they call it. Could you turn to page 409.

A. I'll have to tell John that I had to read from his book. He will be impressed.

Q. If we look at the second paragraph, the one starting with "It was indicated" and down towards the bottom.

A. Yes.

Q. If you go about three sentences into that paragraph it says "Fractured geological materials" and do you see that?

A. Yes, in the middle of the paragraph.

Q. Could you read the next three sentences please?

A. "Fractured geological materials however are notoriously anisotropic with respect to the orientation and frequency of fractures. It can be expected that dispersion of solutes during transport in many types of fractured rocks could not be described by an equation developed for homogenous granular materials. Little is known about dispersion of fractured medium."

That is three sentences, and then it goes on to describe common approaches, and then the evaluation of contaminant migration.

Q. The next sentence:
"The scale at which this approach becomes valid."

A. "The scale at which this approach bcomes valid in the analysis of field situations is not known."

The implication being that the larger the scale you evaluate contaminant migration over, the more representative, the more representative your evaluation becomes and more closely it might be related to effective -- what they call the equivalent porous media approach, and if you view fractured rock that is a network of discreet fractures on a large enough scale, it begins to look like a porous medium because the actual discontinuities become very small relative to the large scale you are observing the effects.

Q. Would you agree that looking at the contaminant migration to the property boundary at Site F would not be a large scale?

A. I don't think I would agree it would not be a large scale. It would certainly be getting up at the scale where the consideration of the fractured zones as an equivalent porous media might start to be appropriate.

Q. Okay. Could I refer you to N-249 for a minute. This is the article by Pankow, the cartridge method.

A. N-249?

Q. Yes.

A. That distance from the landfill to the discharge zone at Site F was 1400 metres.

Q. I mean to the site boundary.

A. To the site boundary, excuse me. Because -- I guess we actually considered the evaluation to the site boundary and we did model that case, but in our view the important area was the discharge zones.

Q. That would only be 50 metres?

A. Pardon me?

Q. That would only be 50 metres.

A. 50 metres from the edge of the landfill to the site boundary? I can't recall whether it's 100 or 50 metres, but that is a much smaller scale, and over that scale it probably is not representative to consider a fractured media as an equivalent porous media.

Q. Could we just refer to the Pankow article, page 332. Do you have that? The first paragraph about halfway down that paragraph states:

> "Furthermore, compared to porous media where much information exists on the theory of contaminant migration ... and on such behaviour

at field sites... contaminant
migration in fractured systems
is poorly understood."

Would you agree with that statement?

A. In comparison to porous media, yes, I would.

Q. Okay, the third point in summary would be would you agree that of the two parameters used at Site F with regard to thickness and velocity, they were not conservative based on the data that we have. For example, we have discussed thickness based on the actual field data showing the unit to be thinner than 15 metres, and in regard to the velocity the permeability field data and the tritium testing which may indicate somewhat higher permeability.

A. The actual values that were used for the hydraulic conductivity and the thickness were not, certainly not the most conservative values which could have been applied. As shown on Exhibit -- I have lost it -- Exhibit H-220, there are certainly areas where the thickness of the weakly fractured shale in zone 3 is less than 15 metres and it would be typically approximately 10 metres over most of the zone and, likewise --

provided to me."

Recalling that the context of this answer is a discussion during the cross-examination of Mr. Petrie of the fracturing of the unweathered upper till at Site D, do you recall that that was the context?

A. I recall that.

Q. Can you comment on that answer of Mr. Petrie's?

A. With regard to the response of Mr. Petrie, I would agree that there is not any direct evidence of fracturing in the unweathered upper till at Site D. However, during the course of cross-examination of Mr. Petrie by Mr. Estrin, there were a number of other sites and case histories brought before the Board which suggested that fracturing may occur in similar type till units at other localities.

In addition, since the cross-examination of Mr. Petrie by Mr. Estrin, it has come to my attention of some recent research conducted by the University of Waterloo in the Sarnia area, which I think is directly relevant to a consideration of the possibility of fracturing in the unweathered upper till at Site D.

Q. Before we get into that research,

Q. Certainly, there is nothing in Mr. Ruland's report on this?

A. No, there is not.

Q. Do I understand that prior to your giving evidence, you had not examined these core logs, any core log information, including the Rodvang thesis, to see if there were core logs in any detail reported in that thesis?

A. That is correct.

Q. So, what is the basis then for your comment on page 42080 that there was continuous core sampling?

A. The basis for that was the report on page 1 of the Ruland project referencing the work done by Rodvang in 1987.

Q. That is all?

A. That is correct.

Q. Now, do you know whether Mr. Ruland installed the Shelby-tubes that he is discussing in his project thesis?

A. Whether he was personally involved in all of them? I can't say.

Q. Do you know if he was involved in any of them?

A. I believe he was, yes.

Q. The reason I ask these questions, Mr. Feenstra, among others, which I will be getting to, you recall when you examined the Hewetson thesis, you went back to, I think it was Dr. Pankow, and you asked for as much of the basic data that you could get hold of in order to investigate the Hewetson thesis, whether tritium had got into the wells and so on.

A. That is correct. I wouldn't consider what I requested as basic data. It was data which considered, which included much of the data that Ms Hewetson reported.

It also had information on some other chemical parameters which were considered by Dr. Pankow at the time as being either extraneous contaminants due to the sampling methodology, or naturally occurring compounds. It was really that additional information that wasn't reported initially that I requested.

Q. You were looking for additional background data in any event.

A. Additional results to those reported initially, yes.

Q. In this case, am I correct that you have not really gone back and looked for additional background data on the core logs that are referred to?

Certainly not in Table 2.

A. I don't think they are exactly comparable.

Q. That really wasn't my question.

MR. HODGSON: I think the witness is answering whatever question he understood.

THE WITNESS: I think in the case of the data from the Bayview chemical monitoring, I was informed there was additional data available which was not reported and I requested to see it.

In this particular case, I have examined Mr. Ruland's project, the information from the test pits were synthesized in a written description in the text and in several figures showing fracture frequency and a variation of fracture frequency with depth.

I did not personally ask to examine the borehole logs or test pit logs. In fact, following your request, Mr. McQuaid, a few weeks ago, I spoke to Mr. Ruland and there are not test pit logs per se.

Mr. Ruland's observations and measurements of the test pits were integrated into the figures which I have noted in his report, his written descriptions in the text and this conceptual diagram showing a typical test pit cross-section as shown on page 32, I believe, of his project.

conductivity. We are talking about a hydraulic conductivity or a leakage rate of that same magnitude in this particular case.

Q. Not with fractures.

A. But not with fractures. The flow rate, the impact is going to be the same. What the fractures do is, they get you the contaminants there faster and that is the only difference.

Q. Let me ask you, hav you discussed this Ruland thesis or hypothesis with Trow, Mr. Sobanski?

A. Yes, I have.

Q. Does he agree or disagree with you?

A. I would believe he disagrees with me based on my most recent conversation.

Q. Are there any physical evidence that we have been discussing upon which he relays to you why deep fracturing is not a problem?

A. No. Mr. Sobanski did not present to my any physical evidence to support that opinion.

Q. Would I understand that you put the Ruland hypothesis to him, you explained it to him, the results of this project thesis?

slightly revised version.

Q. Revised by whom?

A. By the authors.

Q. After this date on the exhibit, the exhibit we have, states final copy, February 1988.

A. That was, as submitted to the journal, that is correct.

Q. And your copy is?

A. As accepted, which I just received this week dated September, 1988.

MR. HODGSON: I will undertake to provide everyone with a copy, Mr. Chairman.

MS. VIGOD: Q. Mr. Feenstra, I will read it, but I don't think the part I am reading will reflect on that:

"At the Lambton site, Desaulniers (1986) and others installed the total of 83 piezometers. 46 of these were installed in the upper 6 metres of the till with the rest installed between 6 and 47 metres depth."

If we stop there we see that Desaulniers in '86 at least had installed 83 piezometers?

A. That is correct.

Q. Then we go on: "Ross (1986)..."

and I take it Ross is another student?

A. I can check that for you if you like.

Q. Certainly he is not Mr. Ruland or Ms. Rodvang.

A. I can't comment on the exact identity of L. Ross, but that was a University of Waterloo project.

Q. "... installed nests of 10 piezometers at each of the 10 minor sites in Lambton county with 6 piezometers at each nest about 6 metres depth and the remainder installed to a maximum depth of 15 metres."

So we have Desaulniers in 1986 and then Ross installing a further nest of 10 piezometers, do you have that?

A. Yes.

Q. If we just turn the page, we can see that in the summer of 1986 a total of 85 piezometers was installed at the Tricil site and there is a discussion in relation to that site. So, would it be fair to say that these are the previous investigators who had installed piezometers in the area, later investigated by Mr. Ruland?

A. They were certainly the authors who

reported those investigations, correct. Without being specific I don't know precisely who installed those piezometers.

Q. They were reported earlier than Mr. Ruland and were obviously installed prior to his work?

A. It would appear to be, yes.

Q. Finally, if we turn to page 7 of the Rodvang thesis and if we see the first paragraph:

"All of the piezometer nests were installed by previous investigators..."

and then there is a reference to Desaulniers who we just talked about, 1986 installed piezometers between 1 and 30 metres depth, et cetera. Harding, 1986 installed four detailed piezometer nests between 1 and 10 metres depth at the LGS site, that is Lambton generating station site in 1984?

A. That appears to be correct, yes.

Q. Then we have the last reference to Ross et al, 1986, installed nests between 1 and 16 metres depth at 10 locations elsewhere in Lambton county. Would you say that that is in part confirmatory of what we have seen in H-88?

A. It would appear to be consistent, yes.

Q. Then it appears that for the

purposes of Ms. Rodvang's thesis, she says all of the piezometer nests were installed by previous investigators to her?

A. To her, that is correct.

Q. So, is it fair to say that those installations, by the time Mr. Ruland got to them, would have been, if you like, three investigators removed?

A. I am not precisely sure. Mr. Ruland has been around the University of Waterloo for several years and has been involved in a variety of projects. I haven't questioned him specifically on what his role in the various aspects has been, given the way investigations have been done in Lambton county, I think simply because statements such as occur on page 7:

"All the piezometer nests were installed by previous investigators."

And this thesis, excuse me, this thesis predates Mr. Rodvang's final work for completion of his degree, I am not sure whether that specifically means Mr. Ruland was not involved.

Q. But the authors referenced by Ms. Rodvang and also in the H-88 authors, we have seen the names of Ross, Harding, we don't see Mr. Ruland's name?

A. Obviously Mr. Ruland had not completed his project at the time these projects were compiled and prepared.

Q. To use an expression, I guess, from your counsel earlier in the hearing, isn't it important in understanding the hydrogeology of the site to get dirty in the data?

A. Excuse me, could you repeat that?

Q. You have heard it before. Isn't it important to understand the hydrogeology of the situation to get dirty in the data, to borrow a phrase from your counsel?

A. It is certainly a very useful exercise, yes.

Q. You have already said you didn't yourself investigate who had done the drilling, what techniques we used, what QA, QC was undertaken?

A. That is correct. Not in detail.

Q. I think you said the other day that you relied in part on the fact that students at Waterloo did good work and were conscientious?

A. That has to enter into an evaluation of the data used.

Q. You would agree that students may

be conscientious and also may be inexperienced?

A. That is a possibility, yes.

Q. As far as the logs, we have heard that you yourself didn't look in the logs and in fact students don't necessarily do detailed field logs, but I think you said they made observations at the site and then would come back and have their notes typed up?

A. That was the situation with respect to the descriptions of the test pits provided in Mr. Ruland's project, yes.

Q. We might agree that this might be fine in an academic setting, and I believe you commented yourself on the different standard of the students practice in logging and that of a consulting engineer or a consulting hydrogeologist?

A. There would certainly be differences, that is correct.

Q. For example, you would agree that if any of the hydrogeologists that have appeared before this Board or any other Board, in fact, was not able to produce field notes or logs, they would come under some criticism?

A. Depending on the nature of the information there would certainly be some questions, yes. I guess that would be an expectation for the work

Q. Again that wasn't, because that really wasn't related to his particular focus, that may be one explanation why he didn't?

A. That is correct, yes.

Q. You would agree though that it is important to understand the depositional history of the till that you are looking at, certainly in relation to both your fracture theory and in relation to certainly various aspects of comparison between tills?

A. Certainly in terms of the development of fracturing. The age of the deposit, well actually to some degree it depends largely on what one's hypothesis is for the mechanism that caused the development of these types of fractures. Certainly the depositional environment, the age, the length of weathering at the ground surface, the climate during the period in which the surface of the deposits were exposed; yes, these are all factors you need to consider.

Q. In fairness, I believe in the first paragraph in your witness statement, you make a reference to the fact that, for example, the Vandalia till is over 225,000 years old compared to the Halton till which is less than 50,000 years and as you stated, likely not comparable in the nature of organic fractures.

A. It would certainly be my expectation giving my limited understanding of pleistocene history in the Illinois area, that the Vandalia till would have been subjected to a much longer period of weathering for those portions exposed than the tills exposed at the surface in Southwestern Ontario, South Central and Southwestern Ontario. Consequently in that particular interest the depth of weathering and depth of fractures and those types of features might be quite different. The depth below the original ground surface.

Q. Again, also in relation to whether there are fractures or not, certainly the depositional history is a factor that should be taken into account?

A. I am not clear what you mean by depositional history, in terms of formation of fractures in clay materials, particularly if the fractures in fracturing -- excuse me -- the fracturing is due to climatic fracturing, the drying and desiccation of the upper part of the clay, perhaps the development of deeply rooted trees on the strata, I am not sure that the actual depositional history of the material itself has that great a bearing on it. In other words, the difference between a lacustrian clay and a clay glacial till may not be significant.

Q. Let me pursue this a little bit further and I think there is a reference in the Ruland paper that Sarnia is in the geographic area of the St. Clair clay plain. Would it be fair to say that the tills that are found in this area are rather unique in that they are believed to have been deposited in a lacustrian environment. In other words, put down in water?

A. That is one of the theories, yes.

Q. In contrast, the Halton till is what is called a lodgement till which was deposited in front of the advancing glaciers and were deposited in a different manner?

A. That is also correct.

Q. Again I would like to refer you back to the Exhibit 254 -- N-254 the Quigley and somebody with an unpronounceable names paper, on till geology, mineralogy and geotechnical behaviour?

A. Yes. I have that exhibit, N-254.

Q. Mr. Feenstra, I would ask you to turn to page 337 of that document?

A. Yes.

Q. And we see Figure 1 there?

A. Yes.

Q. Could you confirm that -- I am looking at the properties of the clay till, that the range of clay is between 20 to 50 per cent but generally in the range of 40 per cent, would that be fair?

A. That is correct, yes.

Q. This is described as a silty clay till, clay being a predominant component?

A. That is correct. As differing from Site D which is clay silt till with a slightly lower clay content.

Q. If we look at, we have grain size results for Site D found in Appendix 3 of Exhibit H-39A and if you could turn to that Appendix 3 I am looking at, first of all, borehole HC-1-85 at a depth of about, this is the first page in Appendix 3, depth of about 5 metres; do you see that?

A. Yes.

Q. Would you confirm that the clay content there is only approximately 17 per cent?

A. That would be a good interpretation I think from that figure, yes.

Q. If we turn through the pages to HC-3-85, again, HC-2-85, again at a depth of about 4 to 4.5 metres, the fourth page in, do you have that?

A. Yes.

Q. Again we see it is about 17 per cent clay?

A. For that particular sample, yes.

Q. If we turn another three pages in to HC-3-85 and again at a depth of approximately 5 metres, would you agree it is somewhere around 21 per cent?

A. Twenty-one per cent, yes.

Q. HC-4, if we follow along two pages further, again a depth of just over 4 metres, again 21 per cent?

A. Something in that range, yes, 21, 22.

Q. Again if we continue on to HC-5, again at a depth of 5.2 metres, again another three pages over again, we are seeing a clay content of about 23 per cent?

A. Yes.

Q. Finally, HC-6-85, again if we flip over three pages again at a depth of about 5 metres, it would be approximately 19 per cent?

A. Yes.

Q. So those numbers are all fairly uniform in the range of, if you want, 18 to 23 per cent, and we see that the Sarnia till is in a range greater than 40 per cent?

A. I believe all the clay content data that was available for the unweathered upper till at Site D had been summarized at another location on page 24 of Exhibit B-618.

Q. That confirms what we have just ...

A. The range is about 17.5 per cent to 23.5 per cent.

Q. Right. As we have just discussed, the clay fracture in the Sarnia till is in the range of ...

A. Excuse me, if I might clarify. Those are from the boreholes directly on the site. Some additional boreholes off-site are close to the site, some of them had slightly higher clay contents up to 35.5 per cent for HC-7-84 which ...

Q. That is at a depth of 1.6?

A. One-point-seven metres, yes. HC-7-84 is over on the eastern side of Site D. So, off the landfill area itself, but on the property.

Q. That is a somewhat lesser depth than some of these other samples?

A. It is in the unweathered or in the

weathered upper till.

Q. Now, in terms of the Sarnia till, can we agree that it was called a normal consolidated soil in that it never had the weight of an ice sheet on top of it to compact it?

A. I am not sure that I can comment on that. I am not precisely aware of those properties.

Q. Are you are aware that the Halton till or can you agree that the Halton till is heavily over-consolidated as it did have the weight of the glacier above it which then receded; are you aware of ...

A. I would have had that expectation given the nature of the deposition in Halton, but I haven't seen the data to confirm, geotechnical data to confirm that the Halton till is in fact over-consolidated. That really falls into the area of geotechnical engineering and I can't really comment.

Q. So you are saying really you can't help us on those distinctions?

A. No.

Q. Are you aware this is something you would have looked at, the shear strength of the Halton till is higher than that of the Sarnia till?

A. I am not aware, certainly I don't

believe there have been any shear strength determinations on the Halton Site D. In general I can't comment on that.

Q. We have some -- again some information on the plasticity of the Sarnia and Halton tills. First of all have you taken a look at that?

A. No, I have not examined that.

Q. Would you be aware that the Halton till would have a lower plasticity, likely as a result of lower clay content?

A. I am afraid I can't comment on that.

Q. You are aware, I believe you mentioned the other day the Atterburg limits that described how plastic a material is?

A. I don't believe I would have described that.

Q. But you are aware of that concept, plasticity?

A. It is not a consideration or a property of the clay that I would consider myself expert on to be able to make any comment on. I don't believe I had discussed it in previous evidence.

Q. Perhaps, Mr. Feenstra, you could look at Exhibit H-618, it is Table 1, Appendix 2, it is the Golder tests done at Site D.

A. That would be the third page into the Appendix?

Q. Yes.

DR. KINGHAM: Which? I see, at the back under the Tab, Appendix B is Appendix 2, the third page.

MS. VIGOD: Q. You see there we do have a statement of the liquid limit and the plasticity index?

A. Yes.

Q. You will see the liquid 25.9 per cent and plasticity 8.9. Again, Mr. Feenstra, I am not sure whether you would be aware of this, these factors wouldn't be affected whether the sample was dried or in a wet state?

A. I couldn't comment on that, no.

Q. If we look at, just to turn back to Exhibit N-254 ...

A. May I just make one other point with respect to Table 2. We might note that the clay content of several -- those additional samples -- are as high as 26 per cent.

Q. Again, that follows 18 to 23 and we have seen some in the 20 to 26 per cent range?

A. I would have characterized the general range at Site D as being between 20 and 30. Some are lower than 20. I believe the lowest number we have is 17 up to 26.

Q. If we look back at N-254 and page 338, we see a description at the bottom of that page that the liquid limit is fairly constant with depth varying from about 35 to 40 per cent with the higher values in the lower till?

A. Are you referring to a graph?

Q. No, 338, the text.

A. Which paragraph?

Q. That last paragraph.

A. Okay.

Q. We see there the liquid limit is fairly constant with depth varying from about 35 to 40 per cent with higher values in the lower till where the clay size fraction is also higher, 50 per cent, approximately 50 per cent compared with approximately 40 per cent?

A. I see that.

Q. Again we have a difference in the liquid limits between the two tills?

A. Yes. I can't really comment on the significance of these differences.

Q. But certainly these factors, certainly in relation to, I think you have already said, the clay content could be a factor that should be looked at?

A. The clay content is certainly going to be a factor that relates, which affects the ability, the nature of the clay. When a geological material of a reasonably high clay content is dried or weathered, obviously in a material with very little clay and silt, when drying occurs, the material is going to disaggregate into a loose granular material. The clay material when it is dried or weathered will tend to crack along very distinct surfaces or planes just as I think we have all seen in the bottom of mud puddles in clay fields.

Q. I believe when you were being cross-examined by Mr. Tidball he asked you whether there was any consequence if the lower till was fractured and you said, no, you didn't think, there would be little opportunity for fracturing because of the lower clay content. Do you recall that?

A. That would be one of the factors that one would need to take into account, yes.

Q. Wouldn't the same thing apply as between the Sarnia till and the upper till at Site D, in other words, there is less clay content and less opportunity for fracturing?

A. To a certain degree it depends on the actual proportion of clay present. Certainly in the sandy, silty sands, sandy silt till that I observed in cores at Site D, just from my visual observation it would seem to me that if that material was dried, it would not lead to significant cracking. In other words, when the sample of material from the lower till dried out they just crumbled. However, the samples of the upper till which were dried out and these were cores that were taken three years ago when I saw them, were very distinctly cracked and very, very hard.

Q. Mr. Feenstra, in general, wouldn't you agree that the mechanical properties of these two tills are important and this is something you really didn't examine in any detail?

A. The mechanical properties would certainly be important if the mechanism for the fracture formation is fracturing due to stress relief with respect to glacial rebound, glacial uplift ... With respect to the formation of cracks due to weathering and desiccation from deeply rooted trees, I am not sure that the physical properties, the geotechnical properties would have much bearing.

Q. Really, is this getting, I think you would assess these various possibilities for explaining fractures in stress relief, but wouldn't you agree that the effect of these would depend on the properties of the till, certainly to some degree?

A. Well, as I indicated, it will certainly depend on the clay content. Basically if the clay content isn't sufficiently high or the clay silt content isn't sufficiently high when desiccation and drying occurs, the material will crumble instead of crack. The actual geotechnical properties in terms of shear strength and plasticity, I am not altogether sure that those would have much bearing at all with respect to drying and desiccation.

Q. Wouldn't it be related as to the time or the method by which these fractures might occur?

A. I am not quite sure what you mean by time.

Q. Perhaps it would require more desiccation to have these cracks occur given the different properties of these materials?

A. That may certainly be. The clay content in particular and to some degree the strength of the material might certainly have a bearing on, for example, how deep the tree roots would actually be able to penetrate.

Q. If we are talking about the same sort of climatic region there may be differences as to how far the depth of these fractures, depending on some of these characteristics we have been talking about?

A. They certainly may have some bearing, that is correct. Certainly, once you start getting very deep into the clay like down in the vicinity of 8 or 9 or 10 or deeper metres, and the actual, I guess the long-term, the ability of the clay and the ability of the fractures to stay open in the long-term may in fact be due to, may to some extent be controlled by the geotechnical properties per se. Especially in terms of the horizontal and vertical stresses which exist in different directions and at different localities.

Q. If you just look back at the Quigley paper, Exhibit N-254 on page 337, again he is -- that he describes the Sarnia till as constituting an unusual deposit. Do you see that on page 337?

A. What paragraph is that?

Q. The second paragraph he says:

"Since most tills are understood by engineers to have been heavily premigration models are. If the unit is not continuous, then the off-site wells located in the upper granular unit will be even more protected. This also has important implications for what has become known as the shadow effect as stated by Mr. Feenstra.

If the unit is continuous, it will be my submission that any cutting off of recharge under the landfill site, would be offset by water flowing into the unit from off site and what would be created would, in fact, be a regional hydraulic trap. If the unit is not continuous, then again there would be no danger of off-site migration.

We will be asking the Board to reject the fracture theory as set forth by Mr. Feenstra in reply. At that time, Mr. Feenstra brought forward three new theories. In my submission really, three trial balloons. The first and most important is the fracture theory. The second is the shadow theory and the third is the excavation or heave theory.

Under cross-examination and even in examination-in-chief, I think it is fair to say that Mr. Feenstra played down the significance of the latter two hypotheses. In regard to the excavation or heave theory, he agreed he was not a geotechnical engineer and that that was beyond his expertise. The Region chose not to put any questions about whether such a theory might apply at Site D to Mr. Bowen who is a geotechnical engineer. We questioned Mr. Feenstra about the fact that the removal of the glacier from Site D would have been the removal of a far greater weight than the excavation of four metres of till from the site. Again, I refer the Board to pages 43665, Volume 175, where in response to a question by Dr. Kingham about this excavation theory, in light of the evidence of unlikelihood of liner fracturing under a considerable height of refuse and water Mr. Feenstra said:

> "I don't believe and I certainly didn't intend to pass judgment on the hypothesis of how possible heaving and stress relieving at the base of the landfill at Site D."

Mr. Chairman, this trial balloon has fallen rather flat in my submission.

In regard to the shadow theory, I adopt Mr. McQuaid's submissions made yesterday. As well, the submissions I earlier made on the relationship of whether the UGU was continuous or not, that leaves the fracture theory. In our opinion the Board should reject the fracture theory.

First, as Mr. Feenstra said clearly on numerous occasions, there is no direct data on Site D that would lead one to a conclusion that the till was fractured. Data gathered did include tritium tests, permeability tests, pumping tests, et cetera, and no conclusion that the till is fractured.

Secondly, we must look at the context in which Mr. Feenstra developed his theory and where it came from. First of all, all hydrogeologists until Mr. Feenstra in reply, took it for granted that the unweathered upper till was not fractured. Trow set it out in their report and on the basis of the evidence before the Board, I believe generally stated, it has been the opinion of hydrogeologists in Ontario that unweathered tills do not have fractures of concern. The only debate at this hearing had been on the hydraulic conductivity to be assigned for this unit.

If we recall this debate over whether Mr. Sobanski's $8x10^{-8}$ was a reasonable number raged for days. However, in my submission, it was a debate about a half order of magnitude, it was exactly that, half an order of magnitude question. In my submission, the Board doesn't even have to necessarily come up with a number, but can state a range and within that range we are sure that any off-site impacts in the case of the failure of the landfill will be minimal.

This kind of debate was also raised by Milton in regard to the permeability of garbage. Again, from the total weight of evidence, I would submit that Mr. Sobanski's 10^{-4} is a conservative enough number and again, we also have the evidence that this quibble is just a quibble. I would contrast these kinds of so-called uncertainties to the dramatic shift in evidence we have had at Site F where a highly fractured drain discharging into a neatly defined discharge area has long ago bit the dust.

Turning back to the fracture theory, where did this come from? Mr. Feenstra testified he was relying almost entirely on Mr. Ruland's Master's project. The first key point is that Mr. Ruland's work and conclusions were in relation to the Sarnia tills. Mr. Feenstra was the one who took these conclusions and extrapolated them to the Halton till at Site D many kilometres away. We must remember the debate that took place in relation to CRA's sampling of the till on the highway outside Site D. That was attacked as not being representative of the actual site. Here we have Mr. Feenstra extrapolating circumstances at the Sarnia till many kilometres away. As well, in cross-examination, it became clear that Mr. Feenstra had not seen any of the raw data used by Mr. Ruland and that in some circumstances there might not even be any as students have different practices than consulting hydrogeologists in doing borehole logs.

As well, it was clear in Mr. Ruland's project, that he had relied on the Rodvang thesis which Mr. Feenstra admitted he had not read until the City of Burlington provided him with a copy during these proceedings. In turn the Rodvang thesis refers to other earlier testing that was done by other investigators. Mr. Feenstra agreed that Mr. Ruland, because of the nature of his work, did not go into many details about the physical characteristics of the Sarnia till. It is our submission that the evidence shows that there are important physical differences between these two tills and Mr. Feenstra did not look into these differences before transferring the Ruland thesis to Site D. Again, I took him through a comparison of some of the grain size analysis done at Site D in relation to the Sarnia tills which are considerably more clayey.

Again, and I put this strongly before the Board, Mr. Hodgson had the opportunity to raise those matters with Mr. Bowen but chose not to. In that regard, the transcript, there may be an inference from, I guess, some of the material that has come out in this hearing as to the timing of various events. It appears the Region may have still been seeking instructions as to what to do with the Feenstra thesis when Mr. Bowen was on the stand. There is an examination of some of these dates in the transcript, but in any event, there was an opportunity to raise these matters and the Region chose not to.

Again, I refer the Board to a general discussion I had with Mr. Feenstra in Volume 175 about the issue of scientific uncertainty. That is found at page 43627. Again, there I went through a discussion with Mr. Feenstra, it starts at 43622, about the issue of scientific truth and uncertainty in the context of a Board with a decision to make.

Mr. Feenstra first agreed that there certainly were uncertainties involving the siting of a landfill when we don't know exactly what is going on below the earth and that we also had degrees of confidence in various hypotheses or conclusions that are made about a particular site. We discussed a continuum of, I guess, the remotely possible at one end to the, if you like, 95 per cent confidence level. Mr. Feenstra readily agreed that hydrogeology 95 per cent confidence would certainly be a high level. I guess -- we went on to discuss that between these extremes would be the probable hypothesis and various remotely possible or less probable hypotheses. it would be my submission that these hypotheses or trial balloons that have been brought to this hearing by Mr. Feenstra are at that one end of the continuum, near the remotely possible and for that reason, this Board should reject these hypotheses of being again in the realm of research and academia.

I would like to now turn to a discussion in part of Mr. Bowen's evidence. I wonder, Mr. Chairman, I think I am running out of breath, whether we might break now.

MR. LANCASTER: I was going to suggest we do. We will return at 1:45.

DR. KINGHAM: I would remind everyone that we did get some comments on this locational map. if there are any other comments, please let us know before the end of the day, so that we can return them to Ms Henderson.

--- Luncheon recess at 12:10 p.m.

--- Upon resuming at 1:48 p.m.

MR. LANCASTER: Please be seated.

MS VIGOD: Mr. Chairman, I would like to turn to a discussion of Mr. Bowen's evidence.

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based solely on piezometer response and triaxial testing results would be overly optimistic'

I would suggest that would be a very apt statement?

A. I also note you would find statements like that in Dr. Cherry's textbook and I am not the first one to make those statements and I would be most surprised if I were.

Q. You agree we could do that and apply that to Site D?

A. Those are your words. I have not been provided with evidence of fracturing at Site D in any way, shape or form. Obviously if evidence were provided by yourself or the proponent, one would have to consider that fracturing with respect to assessing Site suitability, but I am only going on the data that has been provided to me.

Q. Let's read your next sentence on page 36:

"The Maryhill Till was not previously recognized as a fractured medium."

You are telling us at Site 2 the unweathered upper till has not been recognized to this point in time as a fractured medium?

A. That is my understanding of it.

MR. LANCASTER: Any further comment? Mr. Tidball, have you any concerns?

MR. TIDBALL: I assume at this point we are dealing with Ms Cronk's motion and I have no submissions on that.

DR. KINGHAM: Mr. Garrod, did you know about the test pit?

MR. GARROD: Yes, sir, I did. It is done on my client's property and we were approached by the Town of Milton to ask permission to grant permission for that. I discussed it with my client and he granted that permission. Neither my clients nor myself actually viewed the test pit.

DR. KINGHAM: That would have been before April 6th and 7th, on or before?

MR. GARROD: Just prior to it being dug, we were asked permission. As you know, we have had no hydrogeological expert in this hearing and no expert, nor my clients nor myself actually viewed the test pit.

DR. KINGHAM: Mr. Hodgson, did you or your client know about the test pit?

MR. HODGSON: No, Mr. Chairman. I learned about it by telephone, I think it was a week ago, the Tuesday morning after you last sat. Mr. Leitch phoned me and told me as a matter of courtesy he to?

A. Mr. Sobanski and Dr. Gill.

Q. Do you know anything about the qualifications of Dr. Gill?

A. I understand he is a geotechnical engineer.

Q. With respect to Mr. Sobanski and Dr. Gill was there one conversation or more than one?

A. There was more than one.

Q. Can you name any other persons with qualifications with whom you discussed the contents of this witness statement at any time prior to the commencement of your cross-examination on Monday?

A. Dr. Quigley from the University of Western Ontario.

Q. Anyone else?

A. I discussed aspects of it with Dr. Rowe from the University of Western Ontario.

Q. In those conversations were you interested in gaining their insights into the work you had done?

A. Yes, I was.

Q. Now, finally, the last little group of questions and that is Mr. McQuaid asked you whether or not you had described to me a testing program and impact on the private wells.

Another possible contingency would be to actually construct a liner at Site D of recompacted native clay material and to take the bottom metre or metre and a half or something of that order of the base of the landfill and excavate it and recompact it to actually or basically cut off the fractures from hydraulic connection from leachate within the landfill. These aren't the only alternatives that are possible, but those I guess are three alternatives that I would like to suggest.

Q. You have prepared a decision tree, which has been incorporated as Attachment 5 in the copy of the witness statements the Board has marked as H-936 this morning, and I think this was sent by Fax to everyone else in the hearing on Friday. Have we any extra copies of it first of all, Mr. Feenstra?

A. No. I have one.

Q. It's the last page in H-936, Mr. Chairman. Could I ask you to take the Board through this -- is it fair to call it a decision tree?

A. I think that that is reasonable.

Q. I take it, leading you slightly, but you start out with a hypothesis that significant fracturing exists in the unweathered upper till at

Site D. Now, you haven't put it any higher or lower and you hold this hypothesis. Holding this hypothesis, what is your view as to how this hypothesis could be approached from the point of view of a hydrogeologist?

A. I think with respect to any hypothesis such as this, there are three alternatives that one could take. One is to simply accept the hypothesis as being likely, the likely situation, and then dealing with the implications and the consequences of that hypothesis with the various alternatives I have described: detailed monitoring with purge wells installed beforehand; the piped water and purge wells or to line Site D with a recompacted clay liner.

Q. Stopping you there, what would be involved in lining Site D and what would your recommendation be as to how it would be done?

Liner

A. It would be using the native till material on site and so it would be a matter of probably over-excavating the base of the landfill and replacing the material and compacting it. So it is basically re-working and cutting off the fractures that exist at the base of the landfill.

Another alternative approach to deal with this hypothesis is to simply reject the hypothesis as being either improbable or very unlikely. In that

DR. KINGHAM: I can help perhaps, page 12, the second last paragraph, last sentence.

MS. VIGOD: Thank you.

Q. Again, we have the area of land must be defined and depth. Now, Dr. Hughes, you did mention yesterday that you did have involvement in an earlier policy on advice to applicants and consultants in preparing hydrogeological reports for proposed landfill sites?

A. That is correct.

Q. I guess if we turn to the back we see the initials GH and have I caught you out here?

A. Again I was -- what would you call it -- the Recording Chairman on this committee and I might even have been Chairman on that committee, I don't know. I am Chairman of the working group now, but I don't recall where in the process of developing these things I became Chairman.

Q. But you are familiar with this policy and you had involvement in that?

A. That is correct.

MR. LANCASTER: This will be WB-931.

---EXHIBIT NO. WB-931: Advice to Applicants and to Consultants in Preparing Hydrogeologic Reports for Proposed Landfill Sites

MS. VIGOD: Q. Before getting into

this, you have stated that this policy is a groundwater policy and it doesn't deal with -- the reasonable use policy does not deal with surface water?

A. The reasonable use policy does not deal with surface water except -- I don't know if it even mentions surface water and I think I could say it doesn't deal with surface water in there.

Q. Let me ask if you would agree that obviously there is a link between groundwater and surface water and that groundwater can often discharge to surface water?

A. Certainly.

Q. And again if we look -- if we turn to page 3 of Exhibit WB-931, you will see a section on surface water there?

A. Yes.

Q. And again there is a requirement:

> "The quality, amount and existing and potential uses of surface waters..."

It should be addressed in terms of impact that may occur as a result of impacts on groundwater?

A. That is correct.

Q. Again, we really can't divorce the two in terms of looking at potential impact?

A. I don't suppose you can and if I

understand you correctly, you are right.

Q. And if we just look at page 4, the first part of E-154, the first part, the policy manual part?

A. That's the policy that goes with the blue book.

Q. Right. If we look at page 4 of that, we see under the groundwater quality management, under policies, and it is numbered 1, we see "As a general policy, water quality degradation will be controlled in order to protect reasonable uses existing or proposed of both ground and surface waters?"

A. I don't see where you are reading, but it sounds familiar.

Q. Page 4 under Policies. Do you see that?

A. Yes.

Q. Regulated sources of contamination?

A. Yes.

Q. Second sentence starting with "As general policy..."?

A. I see it.

Q. So again this policy makes that link between ground and surface waters?

A. That's right. Yes, it makes that

link.

Q. You would agree it would be important to have an understanding of the streams and their locations in the vicinity of any proposed landfill?

A. Well, in all probability, yes. In practice what we in the groundwater area would do, would be, and that is what the other policy statement says, the advice to consultants is more or less slough off the considerations of surface water onto the Water Resources Branch and the people who are concerned with surface water control.

Q. But somebody ...

A. Somebody will worry about it certainly.

Q. Somebody will worry about it and it is just a division in the Ministry as to who looks after what?

A. That's right.

Q. Dr. Hughes, you mentioned you had reviewed landfills until about five years ago, and is that your evidence?

A. Yes, I guess about five years ago or somewhere around there. I did review reports, submissions on landfills.

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Order in Council

Ontario
Executive Council

On the recommendation of the undersigned, the Lieutenant Governor, by and with the advice and concurrence of the Executive Council, orders that

WHEREAS the Joint Board (hereinafter referred to as the Board) under the provisions of the Consolidated Hearings Act, 1981, made a decision dated February 24, 1989, concerning a regional sanitary landfill site and ancillary uses for the Regional Municipality of Halton; an addendum to the decision was released on March 2, 1989; the Board (in summary form);

1. Accepted the environmental assessment as amended;

2. Refused approval to proceed with landfilling at site F in the City of Burlington but granted approval to proceed with landfilling at site D in the Town of Milton subject to certain conditions set out in the Board's decision. The Board directed the Approvals Director to issue a certificate of approval in accordance with those conditions;

3. Approved (under the provisions of the Planning Act, 1983) site plans and drawings as set out in Exhibit H-41, as amended by conditions of approval set out in the Board's decision;

4. Amended the official plan of the Town of Milton redesignating a parcel of land comprising Lot 3 and part of Lot 4, Concession 2 N.S., in the Town of Milton from "Agriculture" and "Conservation and Hazard Lands" to permit the construction, operation, and maintenance of a landfill site;

5. Further amended the official plan for the Town of Milton to provide to the extent possible for the agricultural after-use of the site (set out in Schedule A of the conditions forming part of the decision);

6. Amended By-law 61-85 of the Town of Milton to rezone the lands being Lot 3 and part of Lot 4, Concession 2 N.S., in the Town of Milton from "Agriculture" to permit a regional sanitary landfill site and ancillary uses as set out in Schedule B to the conditions forming part of the Board's decision;

7. Approved the application of the Regional Municipality of Halton (under the provisions of the Ontario Municipal Board Act) for:

   (a) the acquisition of land for the construction, operation and maintenance of a sanitary landfill site to contain 7.96 million cubic meters of waste, at an estimated cost of $12,775,000.00 (and the borrowing by way of temporary advances); and

   (b) the issuance of debentures to a maximum of $12,775,000.00 for a term not to exceed fifteen years.

8. Under the provisions of the Municipal Act, the Expropriations Act, and the Regional Municipality of Halton Act, as amended, approved the acquisition of the lands as set out in Schedule C of the Board's decision for constructing, operating and maintaining a landfill to contain 7.96 million cubic meters of waste in the Regional Municipality of Halton.

9. Under the provisions of the Conservation Authorities Act, and Regulations, permission and consent was given for the diverting and rerouting of a small stream traversing site D.

AND WHEREAS the Corporation of the Town of Milton filed an application to the Lieutenant Governor in Council asking that the Board's decision be rescinded with respect to the approval of site D and, in addition, that a new public hearing be required to be held to consider certain matters concerning site D summarized as follows:

1. the matter of fractures in the unweathered upper till;

2. the method of construction and placement of monitoring wells for short-term pumping tests and long-term monitoring of groundwater quality;

3. the correlation between the results of short-term pumping tests and a permeability calculation for the unweathered upper till;

4. the method of construction of a liner at site D;

5. a groundwater monitoring program for the movement of contaminants at site D;

6. the likelihood of inducing fractures in the unweathered upper till by excavating for landfill.

AND WHEREAS an application was filed by the Milton Area Citizens' Coalition, the Halton Federation of Agriculture, Watkin and Doreen Martin, Walter Tomosky, Thomas and Mary-Jean Martin and Michael and Cynthia Reed asking for relief summarized as follows:

1. Rescinding the decision of the Board with regard to site D and substituting a decision that granted all necessary approvals for site F, subject to the conditions of approval proposed at the hearing by the Ministry of the Environment of Ontario (hereinafter referred to as the Ministry); or, in the alternative;

2. (a) varying or rescinding those parts of the decision of the Joint Board which make the following findings:

   (i) that site F is hydrogeologically unsuitable if designed as proposed by the Region of Halton and supported by the Ministry;

   (ii) that site F was hydrogeologically unsuitable for landfill, even if designed with a liner in addition to the design proposed by the Region of Halton and supported by the Ministry;

(iii) that there would be essentially equal social impacts at both sites F and D;

(iv) that approval would be granted pursuant to the Expropriations Act, to acquire the lands and residences at site D;

(v) that the Government of Ontario Foodland Guidelines had not yet become official provincial government policy.

(b) The Applicants requested the following substituted findings:

(i) that site F was hydrogeologically suitable if designed as proposed by the Region of Halton and if made subject to the conditions of approval proposed by the Ministry;

(ii) that, in any event, site F would be hydrogeologically suitable for landfilling, if designed with a liner;

(iii) that, pursuant to the Expropriations Act, it was not fair, sound or reasonably necessary to expropriate the land and residences of Martin, Tomosky, Martin and Reed at site D;

(iv) that it was not reasonable to equate the "diffuse" and "less serious" social impacts that would result at site F with the "severe" social impacts that would result at site D;

(v) that the Foodland Guidelines, 1978 were official provincial government policy.

AND WHEREAS an application to the Lieutenant Governor in Council was filed by NSP Investments Limited (NSP) asking that -

1. the decision of the Board, dated February 24, 1989, together with addendum dated March 2, 1989 be rescinded and a decision be substituted therefor that authorizes the Region to proceed with landfilling at site F in accordance with the design proposed by the Region and subject to the conditions of approval

2. in the alternative, the Board's Order be varied and rescinded so that the following findings of the Board are rescinded:

(i) the findings that site F is hydrogeologically "unsuitable" and "unacceptable" for landfilling without a liner;

(ii) the finding that site F is hydrogeologically "unsuitable" and "unacceptable" for landfilling with a liner;

AND to vary or rescind other findings concerning the following; Public Health and Safety of site F; the "reasonable use" policy of the Ministry; that site D is "acceptable" and "suitable" notwithstanding the failure by the Region to comply with the "engineered facilities" policy of the Ministry; that site F was unacceptable from a planning perspective; that site D was hydrogeologically acceptable on the evidence presented; that the economics favoured site D.

NSP asked for substituted findings as follows:

(i) that site F was acceptable for landfilling, subject to conditions proposed at the hearing;

(ii) that, in any event, site F was acceptable if designed with a liner subject to conditions proposed at the hearing;

(iii) that landfills which permitted leachate loses may still be acceptable in appropriate circumstances, if they accorded with the "reasonable use" policy of the Ministry;

(iv) that site D was unacceptable and unsuitable as not being in compliance with the "engineered facilities" policy of the Ministry;

(v) that site F was acceptable from a planning perspective;

(vi) that it was uncertain on the evidence whether site D was hydrogeologically acceptable with or without a liner;

(vii) that the economics of landfilling did not favour site D over site F.

3. In the alternative a new public hearing be required to reconsider the question of approval of site F (independently of the approval of site D) on various grounds set out in paragraph 2 above.

4. Other options and other forms of relief sought by NSP are set out in the applications of NSP or in the reply filed by NSP.

The decision of the Board dated February 24, 1989 (and addendum dated March 2, 1989) is confirmed.

Recommended ______________________
Minister of Community
and Social Services and
Acting Chairman, Cabinet
Committee on Legislation

Concurred ______________________
Chairman

Approved and Ordered July 6th, 1989 ______________________
Date

Lieutenant Governor