

CONSOLIDATED HEARINGS BOARD

IN THE MATTER OF Sections 2 and 3 and 6 (3) of the Consolidated Hearings Act, 1981, S.O. 1981, c.20;

— and —
IN THE MATTER OF Section 12(2) of the Environmental Assessment Act, R.S.O. 1980, c.140;

— and —
IN THE MATTER OF Sections 30, 35 and 38 of the Environmental Protection Act, R.S.O. 1980, c.141, as amended;

— and —
IN THE MATTER OF Sections 24 and 61 (2) of the Ontario Water Resources Act, R.S.O. 1980, c.361, as amended;

— and —
IN THE MATTER OF Section 28 (3) of, and Regulation 164 under, the Conservation Authorities Act, R.S.O. 1980, c.85, as amended;

— and —
IN THE MATTER OF Section 40(12) of the Planning Act, S.O. 1983, c.1, as amended; in connection with site plan control of the sanitary landfill site;

— and —
IN THE MATTER OF Section 22(1) of the Planning Act, 1983 in connection with a referral to this Board by the Honourable Bernard Grandmaitre, Minister of Municipal Affairs, on a request by the Regional Municipality of Halton to amend the Official Plan for the Town of Milton to redesignate a parcel of land comprising Part Lots 3 and 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, Minister's File No. 24-OP-0208-A01;

— and —
IN THE MATTER OF Section 34(11) of the Planning Act, 1983 in connection with an appeal to this Board by the Regional Municipality of Halton for an order directing an amendment to By-law 61-85 of the Town of Milton to rezone the lands situated at 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;

— and —
IN THE MATTER OF Section 15(1) of the Planning Act, R.S.O. 1980 c.379 in connection with a referral by the Honourable Claude F. Bennett, Minister of Housing on a request by Tremaine Britannia Citizen's Group for consideration of part of the Official Plan for the Halton Planning Area with respect to Sections 1 to 5 inclusive, 7, 9 and 10 of Part III D3 Solid Waste Management, Minister's File No. OPC-0026;

— and —
IN THE MATTER OF Section 64 of the Ontario Municipal Board Act, R.S.O. 1980, c.347 as amended in connection with an application by the Regional Municipality of Halton for an order approving:

a) the acquisition of land for the construction, operation and maintenance of a sanitary landfill site to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton and to do so by one of two alternative methods as follows:

- (i) landfilling at the site referred to in Halton's Environmental Assessment as Site F in the City of Burlington;
- (ii) landfilling at the site commonly referred to in Halton's Environmental Assessment as Site D in the Town of Milton

at an estimated cost of \$12,775,000.00, and the borrowing of money by way of temporary advances not exceeding in the aggregate such estimated cost pending the sale of debentures, and

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

— and —
IN THE MATTER OF Section 193(5) and Paragraph 84 of Section 210 of the Municipal Act, R.S.O. 1980, c.302, as amended;

— and —
IN THE MATTER OF Sections 6, 7 and 8 of the Expropriations Act, R.S.O. 1980, c.148;

— and —
IN THE MATTER OF an undertaking of the Regional Municipality of Halton to provide facilities for the purpose of receiving, dumping and disposing of waste as required by section 137 of the REGIONAL MUNICIPALITY OF HALTON ACT, R.S.O. 1980, c.436, as amended, by acquiring the land for, constructing, operating and maintaining a landfill to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton.

VOLUME: 46

HELD AT: Oakville, Ontario

DATE: October 21, 1987

OFFICIAL REPORTERS

NETHERCUT & COMPANY LTD.

185 RICHMOND ST. W.,

TORONTO, ONT. M5V 1V3

TEL: 593-4802



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

WITNESS:STANLEY FEENSTRA (Resumed)

Cross-examination by Ms. Vigod (Cont'd)	10304
Cross-examination by Mr. Tidball	10340
Re-examination by Mr. Hodgson	10509
Morning Recess	10372
Luncheon Adjournment	10434
Afternoon Recess	10494

E X H I B I T S

<u>No.</u>	<u>Description</u>	<u>Page No.</u>
H-263	Chart "Evaulation of Ground-water Contaminant Migration"	10340
H-264A	Chart	10503
H-264B	Chart	10504
H-264C	Chart	10504



THE CONSOLIDATED HEARINGS BOARD

1 IN THE MATTER OF Sections 2 and 3 and 6(3) of the
2 Consolidated Hearings Act, 1981, S.O. 1981, c. 20;

- and -

3 IN THE MATTER OF Sections 12(2) of the Environmental
4 Assessment Act, R.S.O. 1980, c.140;

- and -

5 IN THE MATTER OF Sections 30, 35 and 38 of the
6 Environmental Protection Act, R.S.O. 1980, c.141, as
7 amended;

- and -

8 IN THE MATTER OF Sections 24 and 61(2) of the Ontario
9 Water Resources Act, R.S.O. 1980, c.361, as amended;

- and -

10 IN THE MATTER OF Section 28(3) of, and Regulation 164
11 under, the Conservation Authorities Act, R.S.O. 1980,
12 c.85, as amended;

- and -

13 IN THE MATTER OF Section 40(12) of the Planning Act,
14 S.O. 1983, c.1, as amended; in connection with site
15 plan control of the sanitary landfill site;

- and -

16 IN THE MATTER OF Section 22(1) of the Planning Act,
17 1983 in connection with a referral to this Board by the
18 Honourable Bernard Grandmaitre, Minister of Municipal
19 Affairs, on a request by the Regional Municipality of
20 Halton to amend the Official Plan for the Town of
21 Milton to redesignate a parcel of land comprising Part
22 Lots 3 and 4, Concession 2 N.S. in the Town of Milton
23 from "Agriculture" and "Conservation and Hazard Lands"
24 to permit the construction, operation and maintenance
25 of a landfill site, Minister's File No. 24-OP-0208-A01;

- and -

IN THE MATTER OF Section 34(11) of the Planning Act,
1983 in connection with an appeal to this Board by the
Regional Municipality of Halton for an order directing
an amendment to By-law 61-85 of the Town of Milton to
rezone the lands situated at 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;

- and -

IN THE MATTER OF Section 15(1) of the Planning Act,
R.S.O. 1980 ch.379 in connection with a referral by the
Honourable Claude F. Bennett, Minister of Housing on a
request by Tremaine Britannia Citizen's Group for
consideration of part of the Official Plan for the
Halton planning Area with respect to Sections 1 to 5
inclusive, 7, 9 and 10 of Part III D3 Solid Waste
Management, Minister's File No. OPC-0026;



- and -

IN THE MATTER OF Section 64 of the Ontario Municipal Board Act, R.S.O. 1980, c.347, as amended in connection with an application by the Regional Municipality of Halton for an order approving:

(a) The acquisition of land for the construction, operation and maintenance of a sanitary landfill site to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton and to do so by one of two alternative methods as follows:

(i) landfilling at the site referred to in Halton's Environmental Assessment as Site F in the City of Burlington;

(ii) landfilling at the site commonly referred to in Halton's Environmental Assessment as Site D in the Town of Milton.

at an estimated cost of \$12,775,000.00 and the borrowing of money by way of temporary advances not exceeding in the aggregate such estimated cost pending the sale of debentures, and

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

- and -

IN THE MATTER OF Section 193(5) and Paragraph 84 of Section 210 of the Municipal Act, R.S.O. 1980, c.302, as amended;

- and -

IN THE MATTER OF Sections 6, 7 and 8 of the Expropriations Act, R.S.O. 1980, c.148;

- and -

IN THE MATTER OF an undertaking of the Regional Municipality of Halton to provide facilities for the purpose of receiving, dumping and disposing of waste as required by section 137 of the REGIONAL MUNICIPALITY OF HALTON ACT, R.S.O. 1980, c.436, as amended, by acquiring the land for, constructing, operating and maintaining a landfill to contain 7.96 million cubic metres of waste in the Regional Municipality of Halton.

BEFORE: H. H. Lancaster, Q.C. - Chairman

Dr. D.J. Kingham - Member



Nethercut & Co. Ltd.

Toronto, Ontario

Hearing conducted at The Oakville
Granary Commercial Centre, 105 Robinson
Street, Oakville, Ontario, on
Wednesday, October 21st, 1987

VOLUME 46

APPEARANCES:

T.R. Lederer and H.D. Hodgson	for the Regional Municipality of Halton (Proponent)
J.R. Tidball	for the Ministry of the Environment
T. Vigod J.F. Castrilli	for the West Burlington Citizens Group
D. Estrin, F.E. Leitch and H. Dahme	for the Corporation of the Town of Milton
S.R. Garrod and A. Nurvo	for the Milton Area Citizens Coalition and several affected Milton area landowners
R.B. Tuer, Q.C. E.A. Cronk and F. Perrier	for National Sewer Pipe Limited
L.F. Longo	for Azova Investments Limited
M.J. McQuaid, Q.C. and C.J. Tzekas	for the City of Burlington
C. Mansfield	for the Ministry of Natural Resources
P. Renaud	for Cumis Limited



Nethercut & Co. Ltd.

Toronto, Ontario

APPEARANCES (Cont'd):

1	C. Stevenson	for Framgard Holdings,
2	P. Hancock	Fosseri Investments
3		Limited, Seriphos
4		Investments Limited and
5		Topic Investments
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

J.H. Olah

for the Halton Region
Conservation Authority

* * * * *

Nethercut & Co. Ltd.
Official Reporters
185 Richmond St. W.
Toronto, Ontario
M5V 1V3

Per: C. F. Nethercut, C.V.R.



1 ---Upon commencing at 9:30 a.m.

2 MR. LANCASTER: Thank you, please be
3 seated. We seem to be short a couple of players.

4 DR. KINGHAM: Did you have an overlay
5 of the well design?

6 STANLEY FEENSTRA (Resumed):

7 THE WITNESS: I do. That was out of
8 Exhibit 214.

9 DR. KINGHAM: I thought I recalled
10 something.

11 MR. LANCASTER: Ms. Vigod, I hope you
12 find yourself off a bit better this morning?

13 MS. VIGOD: Slightly better.

14 CROSS-EXAMINATION BY MS. VIGOD (Cont'd):

15 Q. Yesterday Dr. Kingham asked you
16 to calculate the geometric mean for these permeabilities,
17 and do you have that number for us?

18 A. Yes. The geometric mean of
19 the 13 hydraulic conductivity values, just using a
20 value of 1×10^{-8} for the tests which were determined
21 to be less than 10^{-8} , the mean is 6.3×10^{-7} centimetres
22 per second.

23 Q. To see if I understand that, that
24 would mean that the travel time would be approximately
25 six times faster than the model, just based on that



1 number.

2 A. Based on that number that is
3 correct. One thing I would like to point out which
4 slipped my mind yesterday, and I hope you will recall
5 and as I now recall; Mr. Sobanski indicated the areas
6 in which the packer tests were performed and the areas
7 in which piezometers were installed, and some of these
8 hydraulic conductivity values measured were the zones
9 they specifically identified as being fractured from
10 the rock core and they are potentially the most
11 permeable. So to some degree these numbers for the
12 weakly fractured shale are biased towards the high end
13 because those are the ends they intentionally tested.

14 Q. Are you saying that zone 3 is in
15 fact not one intact zone but has areas of local
16 permeability?

17 A. It is a weakly fractured shale,
18 not an unfractured shale.

19 Q. You would agree that those numbers
20 are obviously affected by the assumption of the 10^{-8}
21 readings in the wells with the zero?

22 A. Yes.

23 Q. There may be -- that would depend
24 upon a further look at the method used, the Neptune
25 water meter, and some of those variables you may not be



1 aware of?

2 A. Yes. This does suggest that these
3 tests were performed in areas where there were
4 fractures evident in the core and they were tested
5 to determine the hydraulic properties, and it suggests
6 that just the presence of fractures doesn't necessarily
7 mean that those fractures are continuous or transmit
8 waters. There are some zones where the core is
9 fractured or broken which do not possess a high
10 hydraulic conductivity.

11 Q. There may be other areas of
12 fractures or fractures through that weak shale that
13 obviously have not been tested?

14 A. That is true and these tests
15 does not represent the entire length of the borehole.

16 Q. Now, I would like to go back
17 to discussing the chemical data and the placement
18 of the wells south of the landfill and I think I
19 would like to put some general propositions to you.
20 First of all, would you agree that the placement of
21 monitoring wells in the proper location is important
22 in order to determine whether contaminants will be
23 able to be detected?

24 A. That is correct, yes.

25 Q. If we look back on Figure 6 on



1 page 62 of Exhibit H-40, the Site F report?

2 A. Page?

3 Q. 62. That is the computer
4 simulation and just so that I understand the vertical
5 lines, they are lines of equal potential and the
6 heavy black lines with the arrows are called stream
7 lines and they indicate the flow direction?

8 A. That is correct, principal flow
9 direction.

10 Q. So if you like we can follow the
11 flow of water along those lines, the black arrows, and
12 see where it is going. That is my understanding.

13 A. The predominant flow direction,
14 that is right.

15 Q. I believe you discussed with
16 Mr. McQuaid the location of, for example, GL 24 which
17 is right near HC5, and if you want to check that on
18 Figure 2?

19 A. It is west of HC5, but in the
20 same general sort of north/south location.

21 Q. If we were looking-- just point
22 that out?

23 A. I can point that out for the Board.
24 GL 24 is located right here south of the Burlington
25 site and HC5 is located east and in the southern part



1 of Site F.

2 Q. Basically the same?

3 A. Yes.

4 Q. If we were then looking, I guess
5 near to HC5 on this figure, Figure 6, we would see
6 that water would flow vertically down that stream tube
7 through the weakly fractured unit into the highly
8 fractured unit and then it would go laterally until
9 we see that sort of heavy black shaded area where
10 the discharge zone is located?

11 A. As represented on this figure, that
12 is correct.

13 Q. You would agree that in fact
14 if any well is installed above that highly fractured
15 unit, outside of the landfill area proper, that it is
16 likely that contamination would not reach that well
17 simply because the flow as we have discussed through
18 the weakly fractured unit is downward?

19 A. Predominantly downward.

20 Q. Predominantly downward.

21 A. That is correct. We would expect
22 some degree of lateral flow through the upper zone
23 two, the moderately -- weathered moderately fractured
24 shale, at least until it was either captured somewhere
25 on-site, which is the intention, I understand, but also



1 as you recall from looking at this figure, there are
2 some zones in zone 3 or some areas within zone 3
3 where there is a higher horizontal hydraulic conductivity
4 and I wouldn't venture to say there are no zones,
5 no areas within zone 3 where there may be some lateral
6 migration.

7 Q. It would be more of an ify
8 proposition, and if you were going to design or put in
9 monitoring wells to look for contaminants ...

10 A. If I was putting in a boring and
11 I did the hydraulic testing and determined a zone
12 that was 10^{-5} , an area that was 10^{-5} centimetres
13 per second, and even if that was a zone I considered
14 to be zone 3, I would instrument that zone to evaluate
15 the potential lateral migration through that zone.

16 Q. Ideally you would be looking for
17 this highly fractured zone in order to catch where
18 the bulk of the contamination --

19 A. That would be the primary target,
20 yes.

21 Q. Then, the second proposition, and
22 I believe we discussed this briefly, but given
23 Mr. Sobanski's model, we wouldn't expect to see weakly
24 adsorbed contaminants off-site at either the Bayview or
25 Burlington sites for approximately 35 to 45 years after



1 the refuse was placed on this site, and are those
2 fair numbers?

3 A. Figure 13a, as I recall, on page
4 107.

5 Q. I believe that that's right.

6 A. 35 to 40 years to migrate through
7 the weakly fractured shale and make it down to the
8 highly fractured shale zone, correct.

9 Q. And we have discussed then the
10 fact that Burlington has only been in operation for
11 15 years and Bayview for 30?

12 A. That's right.

13 Q. We have the time factor as well
14 as the placement of wells as being an important
15 factor in coming to some conclusions about contaminant
16 migration at these sites?

17 A. Yes.

18 Q. Also just a point about the
19 Bayview site. We have had some discussion about
20 the fact that the leachate does not contain high
21 levels of volatiles as compared to the Burlington
22 leachate?

23 A. That is a generalization, yes,
24 but there are some compounds present in the Bayview
25 landfill leachate, but not in particularly high



1 concentrations; chlorobenzene and dichlorobenzene
2 are present.

3 Q. First of all would it be fair
4 to say that you will never see large amounts of volatiles
5 off-site because of low levels in the leachate?

6 A. We are not precisely sure what the
7 levels were in the past and whether the leachate
8 concentrations or the concentrations of volatile
9 organic chemicals reflect the composition of the leachate
10 as it has been for the last 30 years. Certainly
11 even if one considered the results of the monitoring
12 in Bayview actually reflected the groundwater conditions,
13 based on the present leachate chemistry we would
14 certainly expect things not to get any worse.

15 Q. Now, I put this to you just as
16 a hypothetical, but would you agree that if the burning
17 of refuse had taken place at Bayview, and I am afraid
18 I only have anecdotal stories on that, but if burning
19 had taken place, would you agree that volatile chemicals,
20 some of them would have burned off and that could be
21 some explanation as to the lower levels. Does that
22 make sense?

23 A. Certainly if a large proportion
24 of the waste was burned, I would strongly doubt that
25 any of the contaminants we are interested in here



1 would have remained in the ash and in the residues
2 after burning.

3 Q. So if there had been burning
4 at an earlier date and then later the burning stopped,
5 you might have seen obviously some of these volatiles
6 burned off and then you would see the remaining
7 volatiles?

8 A. That is possible, yes. In the
9 days the Bayview site was operated, it is also quite
10 possible to expect much less rigorous disposal sort
11 of scrutiny. I would have expected a larger variety
12 of wastes could have gone into the Bayview site, but
13 that would really be dependent on the surrounding
14 industries and commercial depositors.

15 Q. In any event, in terms of this
16 site and the predictions for Site F, you are expecting
17 leachate closer to that at the Burlington site, and I
18 believe that that is what you stated all along?

19 A. That is what we have assumed.
20 My true expectation is that we would be somewhat less
21 than Burlington.

22 Q. Now, just to follow up on the
23 point of the lateral versus vertical flow for a moment;
24 if you turn to page 75 in H-40 we see the water balance,
25 the schematic there, and do you have that?



1 A. Page 75?

2 Q. Yes.

3 A. Yes.

4 Q. If we just look at unit 3 for
5 a moment, we can see that 0.58 litres per second flows
6 down and 1×10^{-4} litres per second flows across or
7 laterally?

8 A. That is correct.

9 Q. You would agree, as I understand it,
10 that means that for every 5800, I guess, litres that
11 flows down, one litre would flow sideways.

12 A. Based on the assumptions that
13 were made here for the hydraulic characteristics of
14 that unit, that is correct. Obviously this is a
15 representation of the entire unit and it doesn't take
16 into account local differences which I would hope that
17 a monitoring program would attempt to take into account,
18 local variations encountered at the drilling sites.

19 Q. But that would explain or
20 could explain, for example, the lower numbers in say
21 the Gartner Lee well that was placed in unit 3 because
22 you have this dilution factor and just a small amount
23 of lateral flow that you have been picking up. That
24 could be one reasonable explanation?

25 A. Why we don't see contaminants



Toronto, Ontario

1 in unit 3 at a distance from the landfill? That is
2 very true.

3 Q. Okay. Again, I guess when
4 we are looking at those wells, none of those wells
5 were actually...

6 DR. KINGHAM: "Those wells?"

7 THE WITNESS: These hydraulic conductivity
8 values, Exhibit WB-262.

9 MS. VIGOD: Q. I will back up. Again,
10 just one last general proposition. If we assume
11 there is in fact a somewhat faster time than the
12 35 to 45 years as you have predicted, there may still
13 be a period where we are still not seeing contaminants
14 because of the time factor, and again depending upon
15 the placement of wells and because of the newness of
16 the Burlington site, even if the travel time was
17 20 or 25 years, we would be in the same dilemma?

18 A. Depending upon the positioning
19 of your monitoring wells, that is correct, but you
20 would certainly expect to have seen some evidence of
21 contaminant migration in the moderately
22 weathered fractured zone and at least close to the
23 landfill in the underlying weakly fractured shale to
24 some degree.

25 Q. Again depending on where the



1 positions were?

2 A. Yes, and these are close to the
3 landfill.

4 Q. Your conclusion regarding the
5 applicability of the Bayview and Burlington results,
6 I take it, is based on the assumption that the geology
7 and hydrostratigraphy are pretty well the same and,
8 in other words, you are saying they could be used
9 as a predictive model?

10 A. That is correct.

11 Q. If we make that assumption,
12 would you agree that we are still not in a position
13 to conclude that -- exactly where the plume is moving
14 and, due to the factors we have described, the time
15 and positioning of the wells, we may not have a
16 conclusive answer at this point in time?

17 A. I think we certainly have an
18 indication, however, of some of the processes that will
19 be acting on contaminant migration in the fractured
20 shale. The fact that particularly at the Bayview
21 site there is little evidence for significant
22 migration either in zone 3, the moderately -- weathered
23 moderately fractured shale or in any of the deeper
24 units suggests that the processes such as matrix
25 diffusion must have a fairly significant effect on



1 contaminant migration.

2 That process, matrix diffusion, was
3 not considered in the contaminant transport simulations
4 conducted at Site F.

5 Q. Well what ...

6 A. If I could continue, there are
7 a variety of processes that will contribute and the
8 simulations performed for Site F suggest that given
9 the hydrostratigraphic conceptualization of the flow
10 system, the potential for adsorption of these volatile
11 organic chemicals and the relatively long flow path
12 length to the discharge zone, there will be a fairly
13 significant degree of attenuation irrespective of
14 matrix diffusion.

15 Now, what the observations or at the
16 Bayview and Burlington sites suggest to us is that
17 due to the effect of matrix diffusion, our simulations
18 as we performed at Site F in 1986 are probably excessively
19 conservative, because we would have predicted significant
20 migration in the weathered moderately fractured shale
21 on the basis of the contaminant transport models that
22 we put together.

23 Q. First of all, in terms of the
24 Bayview site, given the low volatiles in the leachate,
25 what would in your professional opinion be a marker that



1 could be used to delineate a plume at this site?

2 A. At the present time?

3 Q. Yes. At Bayview.

4 A. At Bayview site at the present
5 time, chlorobenzene and paradichlorobenzene are present
6 in the leachate at several tens of micrograms per
7 litre which would be fairly diagnostic chemicals.
8 With respect to the Bayview, although this is specula-
9 ting on what the chemical composition of the leachate
10 was at Bayview initially, but given the age of the
11 landfill and our experience with other landfills of
12 similar age in Ontario, which was certainly used
13 to some degree for the co-disposal of some quantities
14 of industrial and commercial wastes, I think it
15 would be surprising to expect there would be no other
16 volatile compounds present during the life of the
17 Bayview site.

18 Q. But we have no waybill information,
19 and some of it may have been burned out and we just
20 don't know at this point.

21 MR. HODGSON: I didn't object the
22 first time my friend indicated she had anecdotal
23 evidence of burning, but it seems to be that anecdotal
24 evidence is not good enough for this hearing and is
25 she undertaking to call some evidence as to whether



Toronto, Ontario

1 there was in fact burning at the landfill?

2 MS. VIGOD: Let's leave it at this point
3 because I said I was posing it as a hypothetical, and
4 I take it Mr. Feenstra is saying he doesn't know and
5 there are a number of factors that would have to be
6 determined or that might have some play in determining
7 whether volatiles...

8 MR. HODGSON: That's not good enough,
9 Mr. Chairman. As we all know at this kind of hearing,
10 if we let insinuations get into the evidence they get
11 repeated and repeated and repeated and we all forget
12 the fact that no one has ever brought proof to establish
13 a fact in the first place. I think my friend is obligat-
14 ed to either quit insinuating this happened or call
15 the evidence and I don't suggest for the moment if
16 she has the evidence fine and if she can tell us she
17 can call it later and that's fine as well.

18 MS. VIGOD: We may have some evidence
19 but for now I think -- at this point we just don't
20 have it.

21 MR. LANCASTER: I think the Board
22 should have the evidence on that fact and we don't
23 want to assume that it could be an important factor.

24 MS. VIGOD: Q. On the final point
25 on organics, would this mean that TCA might have been



1 in the leachate at some point, even though we don't
2 see it now. Does this follow from some of the explana-
3 tions you have been giving?

4 A. I believe if TCA were in the
5 leachate early on, it is possible it could have dis-
6 appeared now. If TCA had been in the leachate originally
7 in fairly significant concentrations, I also would have
8 expected to see the associated breakdown products, 1, 1,
9 1-dichloroethane-- 1, 1-dichloroethane, 1, 1-dichloroethylene
10 and compounds like vinylchloride and chloroethane.

11 The fact that 1, 1, 1-trichloroethane
12 is not present now would not be completely conclusive
13 and the fact that neither 1, 1, 1-trichloroethane
14 nor any of its breakdown products is present now in
15 the leachate would suggest to me that 1, 1, 1-tri-
16 chloroethane likely wasn't a major constituent.

17 Q. As far as these breakdown products,
18 do you know what levels you would expect to see them
19 in in relation to the parent compounds?

20 A. They can be as high or even
21 higher in concentration and the breakdowns can actually
22 be quite extensive.

23 Q. I would like to get back to a
24 point that Mr. Sobanski referred to you on answering
25 questions on the attenuation capabilities of the shale,



1 and you will remember it was right at the end of
2 my cross-examination?

3 A. I recall something about it.

4 Q. If we could turn to page 99 of
5 H-40 -- I am sorry, the appendix, the appendix
6 with the shale results, Appendix 3.

7 A. Is that immediately following
8 the borehole logs?

9 Q. Yes, that is right. I am sorry,
10 but it is Appendix 3 and it is the third page from
11 the back of the appendix, just following the Trow soil
12 analysis.

13 DR. KINGHAM: The one that is entitled
14 Cation Exchange Capacities?

15 MS. VIGOD: Yes, Site F.

16 Q. We see the cation exchange
17 capacity for the various units for the shale is 66
18 milliequivalents per 100 grams?

19 A. That is correct.

20 Q. And I believe Mr. Sobanski's
21 evidence or report states that that would indicate
22 a high capacity to take positive ions out of solution?

23 A. That is correct, yes.

24 Q. Can we confirm in fact the sample
25 analysis was done on a crushed sample less than 80 mesh and



1 you see that by the asterisk?

2 A. Yes.

3 Q. My understanding is that what
4 you did is take the rock, crush it up and pass it
5 through a seive and then you would test it with a
6 solution or with a metal with a known concentration?

7 A. Actually sodium to be exact.

8 Q. And then you would see how much
9 goes out of solution and ends up on the rock . Is
10 that fair?

11 A. Yes. The method is a method as
12 set out by Page et al in 1982 in a volume produced
13 by the American Society of Agronomy on soil testing.
14 There are a variety of methods of analyzing cation
15 exchange capacity and obviously, as you can imagine,
16 soils are easy to deal with and rocks are not quite
17 so easy to deal with. The standard procedure in
18 testing the cation exchange capacity of a consolidated
19 material like a rock is to actually crush the sample
20 or disaggregate the sample if that is possible and
21 analyze a certain grain size.

22 In the case of a crystalline rock like a
23 granite, obviously crushing it up and analyzing it
24 really doesn't give you much of a reflection of the
25 actual surface properties of the particles you have



1 produced. In the case of a sandstone or a shale or
2 a siltstone material, it is probably more representative
3 given the fact that most of the actual particles of
4 soil are very soil particles to begin with, but they
5 are somewhat cemented together and so the act of
6 crushing them probably doesn't affect the surface
7 characteristics of the individual particles to the
8 same degree as another type of rock, but certainly it
9 is a procedure that has to be followed for the purposes
10 of testing and it may impart some increase in cation
11 exchange capacity as a result of the crushing operation.

12 Q. I am asking this really in the
13 context of fracture flow versus matrix flow?

14 A. This would only relate to matrix
15 flow because the actual surface characteristics
16 of the minerals along the fractures may be quite
17 different and also when assessing the degree of adsorp-
18 tion along the cracks, you have to express it in
19 terms of the actual fracture area as I described, most
20 likely last Wednesday, rather than the bulk weight
21 of the sample as the cation exchange capacity is
22 expressed.

23 Q. And in fact at Site F we would
24 expect most of the flow would be through the fractures?

25 A. In zone 2, the weathered zone, and



1 in 4, the highly fractured zone, that is correct, but
2 in the weakly fractured shale we would still expect
3 the bulk of the vertical flow to be through the inter-
4 granular pore space or the matrix of the shale.

5 Q. So I understand this concept of
6 crushed rock, if for example we spilled water on the
7 floor and threw sand on it to blot it, it would obviously
8 be more effective than throwing a rock on it and
9 obviously water moving through the fractures would
10 not have much time to attenuate?

11 A. That is very true, very true,
12 and I might also comment on these values as I believe
13 anyone is very familiar with cation exchange capacity
14 values, they would look at those numbers and think
15 they are rather on the high side. I had the very same
16 concerns. I went over the actual analysis, and these
17 analyses were conducted at Zenon while I was there,
18 and I went over the analytical procedures and other
19 procedures with the analyst and I could find no
20 experimental difficulties with the results, but they
21 are somewhat high.

22 Within the context of attenuation
23 capacity for inter-granular flow, a media that has a
24 cation exchange capacity over 10, 10 or 20 milli-
25 equivalents per litre, would be considered-- considered



1 to possess a fairly significant attenuation capacity
2 and the actual value of these numbers probably isn't
3 as significant as the fact they are somewhat higher
4 than 10 to 20.

5 Q. Finally, Mr. Feenstra, I would
6 just like to return actually to your report and the
7 exhibits filed by Ms. Cronk. First of all, in your
8 contaminant modelling you would agree that the two
9 most important units are the weakly fractured shale
10 and the discharge till, in terms of contaminant migra-
11 tion?

12 A. At Site F, yes.

13 Q. You have estimated, as I understand
14 it, the travel time through the weakly fractured shale
15 to be approximately 30 years, to the face of the
16 shale, and if you want to look at -- if we look at
17 Figure 3-26 in H-86, it would be approximately 30
18 years to the face of the weakly fractured shale?

19 A. That is correct.

20 Q. This in fact would mean, would it
21 not, a non-adsorbed contaminant according to this
22 model would get to the property boundary within
23 approximately 30 years?

24 A. That is also correct and, based
25 on the hydraulic conductivity of 10^{-2} for the highly



1 fractured shale zone, zone 3, and a transport porosity
2 of .001 -- excuse me -- .01.

3 Q. As we discussed, even if that
4 highly fractured unit was somewhat less pervious,
5 you would perhaps still add a year on to that time?

6 A. As was discussed I believe in
7 my direct examination, yes, I also considered the
8 hydraulic conductivity of that zone to be something
9 in the order of 1×10^{-4} centimetres per second and
10 that would add a few years on to that.

11 Q. A few years. Just so we understand
12 it, the model is reported in H-40 and would give us
13 somewhere around 30 years and with a 10^{-4} permeability
14 in that highly fractured zone, it might be 30 or 32
15 years. Would that be fair?

16 A. That is fair, yes. Reducing the
17 hydraulic conductivity of the highly fractured zone,
18 what it does, if we assume the hydraulic conductivity
19 is somewhat lower, given the actual fracture frequency
20 we observe, for the purpose of contaminant migration
21 I think we also have to correspondingly decrease the
22 transport porosity based on that relationship, that
23 graph, Exhibit -- I should remember all these numbers --
24 H-242.

25 So, in effect a reduction in the



1 hydraulic conductivity of a factor of 100 for the
2 highly fractured zone only results in a reduction
3 in the linear groundwater velocity or the velocity of
4 a non-adsorbed contaminant by a factor of 10. The
5 reduction of the hydraulic conductivity however by a
6 fracture of 100 in the highly fractured zone will
7 reduce the volumetric flow of water by the same factor,
8 a factor of 100.

9 Q. For the timing let me refer back
10 to the models used by you and Mr. Sobanski in the
11 report.

12 A. Yes.

13 Q. So we have, as I said, a non-
14 adsorbed contaminant which would get to the property
15 boundary within approximately 30 years by this?

16 A. That is correct.

17 Q. And the additional travel time
18 you calculated to get through the discharge zone
19 was an additional 30 years and that would be the time
20 to travel through the discharge till?

21 A. Through the discharge zone till,
22 correct.

23 Q. That would give you 60 years to
24 the discharge zone?

25 A. That is correct.



1 Q. If we turn to page 31 of your
2 report...

3 A. H-86?

4 Q. H-86. And if we look about
5 halfway down the last paragraph we will see you have
6 predicted a 60 year travel time to the site boundary
7 at Site D in the event of a site failure or a trap
8 failure; right? That would be for the non-adsorbed -- for
9 chlorides?

10 A. Page 31?

11 Q. Page 31.

12 A. This relates to Site D.

13 Q. That is what I said.

14 A. Sorry, to the site boundary.

15 Q. That is with the trap not working.

16 Would it be fair to compare that to the 30 years to
17 the site boundary, or let's not say compare it, but
18 with the site operating you would see 30 years to the
19 site boundary at Site F as we have just discussed?

20 A. On the basis of the computer model,
21 that is correct. I think our conclusions with respect
22 to Site F and the impacts at Site F. are tempered
23 somewhat compared to the conclusions in this report
24 based on subsequent operations at Bayview and Burlington,
25 but for the purposes of comparing these model results,



1 that would be fair.

2 Q. If we turn to Ms. Cronk's exhibits
3 and if we start with N -- first of all looking at
4 N-255, 256 and 257. First of all, and I am not going
5 to go through this again as you discussed with
6 Mr. McQuaid, but Ms. Cronk had you compare the
7 situation at Site D with hydraulic trap failure and
8 the situation at F with the site under normal operating
9 conditions, and we have already discussed if you
10 discussed both sites operating under normal conditions
11 we see that straight line, or if you like no impact
12 indicated on B-259?

13 A. That is correct. For the
14 purposes of all of these scenarios we have been
15 discussing, and just to get my own thoughts in order
16 this morning, I make a little chart.

17 Q. Can you bear with me and then we
18 will put in your chart.

19 A. Which I think -- it was certainly
20 illustrative to me this morning.

21 Q. Perhaps we are going on the same
22 wavelength. If we look at N-255, first of all, as you
23 can see, Ms. Cronk had you comparing the concentrations
24 at the site boundary at D with the discharge zone at
25 Site F. Would it be fairer in fact to look at the site



1 boundary at F which would be Figure 3-32. Do you want
2 to just turn to that?

3 DR. KINGHAM: 3-32 in H-86 or H-86A?

4 MS. VIGOD: H-86.

5 Q. Do you see that?

6 A. I see it.

7 Q. Would that in fact -- again
8 taking into account we are still talking about one
9 with the system working and one without the system
10 working, but would it be a fair comparison at the
11 site boundary level at least?

12 A. If one were strictly comparing
13 the site boundaries then one should probably compare
14 Figure 3-21 as either shown in the report or on N-255
15 with Figure 3-32 on H-86.

16 However, whether it is a fair comparison
17 or not, I am not sure, but certainly it is comparing
18 the same sort of geographical criterion, but in terms
19 of the actual impact and the possible influence of
20 contamination at the site boundary, it has a definite
21 relationship at Site D where there are groundwater
22 users utilizing water from the granular units close
23 to the site boundary and there is no such comparable
24 impact in terms of groundwater users or a surface water
25 receptor at or close to the site boundary at Site F.

1 Although ~~these~~ site boundaries you can
2 use as a geographical comparison, the actual impact is
3 somewhat different.

4 Q. You would agree that according
5 to that model you would see a 20-year ...

6 A. A 30-year.

7 Q. A 30-year breakout time as
8 opposed to slightly more than I guess a 40-year time
9 as depicted on 3-35?

10 A. That is correct.

11 Q. And again a similar comparison
12 could be made with the other two exhibits produced
13 by Ms. Cronk and put to you?

14 A. That is also correct if one is
15 simply comparing the site boundaries.

16 Q. Again we would further -- we have
17 discussed the fact that with the underdrains not working
18 at F, you would expect to see some mounding and I
19 believe you used the figures of 60 per cent additional
20 time?

21 A. I believe that is correct.

22 Q. Again to get a fairer comparison
23 with the systems failure, you would have to again--
24 it would be a faster time?

25 A. Faster velocity, slightly shorter



1 time.

2 Q. Shorter time at Site F. Okay.

3 But, the bottom line I put it to you, Mr. Feenstra,
4 is that at Site D the design proposed, the design
5 with the hydraulic trap, does not allow for off-site
6 migration whereas at Site F the design contemplated
7 knowingly allows for off-site migration of leachate;
8 is that fair?

9 A. It allows for the movement of
10 leachate into the underlying bedrock formations
11 and whether the off-site migration is significant or
12 not, that is obviously open to some debate here and
13 I would not agree with that, but strictly going right
14 along with the scenario, this is actually what my
15 chart relates to.

16 Q. All right.

17 A. What I have actually shown here
18 are the three principal scenarios that I think one
19 needs to consider. These scenarios are all based
20 on scenarios which have already been discussed and
21 conclusions which have already been discussed and I
22 just tried to put them on one piece of paper.

23 MR. ESTRIN: Could you move it over as
24 we can't see the left side?

25 THE WITNESS: It was just folded back a



1 little bit.

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

9 MS. VIGOD: Q. That's right.

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

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

16 Q. Okay.

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

21 For Site D when everything is operating
22 as planned, there is no leachate movement into the
23 underlying granular units and there is contaminant
24 migration through the upper unweathered till by
25 diffusion, but our estimation is that those contaminants



1 will not reach the upper granular units -- reach the
2 granular units, be they upper or the lower, depending
3 upon which one exists at which particular point in
4 space.

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

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

15 DR. KINGHAM: How do you define "signi-
16 ficant" in each of these cases?

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



1 In this case it would occur also over a
2 period of several tens of years. In this case there
3 would be a significant impact on the groundwater
4 quality at the site boundary in the granular units
5 in an aquifer which is currently used for water
6 supply.

7 In the case of the failure of the under-
8 drain system at Site F, there would still be some move-
9 ment into the shale bedrock, although albeit slightly
10 larger quantity and movement at slightly higher
11 rates, but even in this case I still suggest there
12 would be a fairly insignificant impact on the ground-
13 water, the shale groundwater underlying Site F.

14 The third case, where there is a failure
15 of the engineered systems and the implementation of
16 effective contingencies, the contingencies as
17 Mr. Sobanski has discussed in terms of purge well
18 systems at both sites, and at Site D it would also
19 relate to putting in recovery wells within the refuse
20 to lower the level of mounding or some other measure
21 with respect to the refuse to reduce the level of
22 mounding and basically make the hydraulic trap effective
23 again.

24 What that would do is cease or halt
25 the further movement of leachate into the granular units



1 at the time the contingencies were implemented and
2 the purge wells systems could be used to intercept any
3 off-site migration through the granular units and if
4 these two contingencies were effective, again there
5 would be no impact at Site D.

6 At Site F, if one realized that there
7 was off-site movement of leachate at a level that
8 was deemed to be significant or unacceptable, this
9 type of discharge could also be intercepted with a
10 purge well system to prevent any off-site migration
11 and, in this case again, if the contingency is effective
12 at cutting off off-site migration, then again there
13 would be no impact.

14 Q. Just a few questions arising from
15 that. First of all, as you have put it, for the first
16 scenario you have no impact and then as we have said
17 I guess your adjective "significant" is subject to
18 some debate, but you would agree there is impact?

19 A. "Significant" means...

20 Q. Site F and the first line?

21 A. Okay.

22 Q. You would agree that there is
23 impact and the debate is around what significant is,
24 is that fair?

25 A. That could be discussed, certainly.



1 Q. Okay.

2 MR. HODGSON: It will even get discussed
3 before this is over!

4 MS. VIGOD: Q. Let me ask you, what
5 is the most likely scenario during the life of the
6 site, of your scenarios?

7 A. During the life of the site,
8 speaking not as a landfill design engineer. and not
9 having addressed the issues of the longevity of
10 leachate collection systems, over the 20-year life
11 of the landfill I would expect in both cases this
12 scenario, scenario 1 would be applicable, and in the
13 longer term, greater than 20 years, that I can't comment
14 on as an expert.

15 Q. I take it in your modelling, in
16 your scenario 2, the failure scenario, I believe we
17 had some discussion that you looked at what happened with
18 two-thirds of the tiles failing and a certain
19 degree of mounding or could we say you used a fairly
20 conservative failure scenario?

21 A. The failures scenario we used
22 for Site D I think would reflect a large scale failure.

23 Q. "A large scale failure." So
24 I guess somewhere you have a continuum of potential
25 failures that would result in less impact?



1 A. That is true. This is for a
2 large scale failure.

3 Q. All right. My last question
4 is how easy is it to monitor Site F as compared to
5 Site D? Would it be fair to say that Site D is easier
6 to monitor?

7 A. I think from a point you raised
8 yesterday, to some degree it would be easier to monitor
9 at Site D and largely because at Site D the actual
10 important hydrostratigraphic units, i.e. the units
11 that transmit the majority of the water and potentially
12 the majority of the contaminants, are defined strictly
13 by their texture which you can observe in core samples
14 on-site while you are doing the drilling. The obvious
15 important hydrostratigraphic zones at Site D aren't --

16 Q. F.

17 A. Sorry, Site F; they are not that
18 obvious visually and one must perform a close examination
19 of the rock core and do some hydraulic testing and
20 probably do some pumping tests to determine inter-
21 connectivity of the zones one is interested in, and
22 from that point of view monitoring at Site D would
23 be more straightforward.

24 Q. As we discussed both in terms
25 of the hydrostratigraphy and also as far as chemical



1 indicators, and we have discussed some of the problems
2 at Site F?

3 A. At Site D you would certainly
4 not get the same degree of interference from the high
5 background concentrations of chloride and some of the
6 other inorganic indicators that are present at Site F.

7 Q. And you would be able to use
8 I guess you could say more conventional and reliable
9 predictable methods at Site D than at Site F?

10 A. I am not sure they would be
11 necessarily more reliable or more predictable. I
12 would tend to agree with the conclusions of Dr. Cherry
13 in his paper, and I can't even recall the exhibit
14 number anymore, but where he suggested the contaminants
15 of most concern at municipal landfills are the volatile
16 organics and I think most of the effect related to
17 monitoring should also be directed at those kind of
18 chemicals in addition to the traditional groundwater
19 monitoring parameters.

20 Q. If the chlorides are moving at
21 a relatively safe speed, faster than the volatiles,
22 which are easier to monitor?

23 A. That is true.

24 Q. Chlorides, I take it?

25 A. It would be very appropriate to



Toronto, Ontario

1 monitor chlorides at Site D because the impact of
2 chlorides will be significant with respect to the use
3 of that groundwater for drinking water supplies, where
4 that is not the case at Site F.

5 MS. VIGOD: Thank you, Mr. Feenstra,
6 those are my questions.

7 MR. LANCASTER: Mr. Hodgson, I think
8 we should mark this chart as H-263.

9 MR. ESTRIN: I wonder if Mr. Hodgson
10 would consider having that made into a typed version.

11 MS. VIGOD: That is what I was about
12 to ask.

13 MR. HODGSON: I will have it embossed
14 in plastic.

15 MR. LANCASTER: The information is not
16 new but it is quite convenient.

17 MR. HODGSON: We will be happy to have
18 that done.

19 DR. KINGHAM: It does raise one
20 question for clarification while it is before us.
21 The right-hand column for Site F, no significant
22 impact if everything is working and no significant
23 impact for the failure of the engineering features and
24 no impact if you put contingencies in place. The
25 question obviously is why are the contingencies not in



Toronto, Ontario

1 place in scenario 1 as part of the primary engineered
2 features which would then lead to Site F giving no
3 impact at stage 1.

4 THE WITNESS: That is certainly an
5 option, but as far as I understand with respect to
6 the development of the site and monitoring of the site,
7 that had not been planned, but it would certainly be
8 possible at Site F, the contingencies being a purge
9 well system, to have those place during the general
10 operation of the site if it was deemed necessary.

11 ---EXHIBIT NO. H-263: Chart "Evaluation of Ground-
12 water Contaminant Migration"

13 MR. LANCASTER: Mr. Tidball.

14 CROSS-EXAMINATION BY MR. TIDBALL:

15 MR. TIDBALL: I am assuming I will be somewhat
16 longer than half an hour and can I assume that we
17 will break at around eleven?

18 MR. LANCASTER: We normally do if that
19 is convenient for you at that time.

20 MR. TIDBALL: I think probably so.

21 MR. LANCASTER: If you can make it so.

22 MR. TIDBALL: Q. Mr. Feenstra, could
23 I first take you to the area of leachate chemistry and
24 I have a few questions in that area. In your witness
25 statement and again I think during your evidence and



1 in fact in the last few minutes with Ms. Vigod you were
2 talking about the primary concern from landfills and
3 I thought from your point of view, but I thought you
4 referred to a paper as being the volatile organics?

5 A. Yes.

6 Q. That is your concern?

7 A. That is my concern, yes.

8 Q. That is the same at either site
9 and we can talk about that in terms of the monitoring
10 you suggest?

11 A. That is correct.

12 Q. I wonder more out of curiosity
13 than anything, have you any concern for the other
14 organics such as the base neutrals or the acid
15 extractables?

16 A. In general. I would expect that
17 at least on some of the occasions in any monitoring
18 program one would analyze for those compounds and
19 I think one would certainly analyze for those compounds
20 in the leachate, but, in general, it is my expectation
21 that they would very seldom be considered to be mobile
22 or of much concern.

23 Q. It is a question of mobility
24 as opposed to effect?

25 A. That is correct.



1 Q. Along the same lines, and I know
2 your evidence on metals and I don't think we need to
3 cover that, but are the conventional parameters, the
4 chlorides and sulphates, a concern to you in terms of
5 effect?

6 A. In terms of effect at Site D, the
7 chlorides and the other inorganic constituents, it would
8 be because the water in the granular units is presently
9 being used for drinking water supply. At Site D --
10 excuse me -- at Site F I would not regard those
11 parameters as being of the same magnitude of importance.

12 Q. Can I refer you to Table 1 in the
13 witness statement, H-86A, and the comparison of the
14 landfill leachate analyses from the Bayview and
15 Burlington sites. I am wondering in a general sense,
16 first of all, if you could give any opinion on the
17 numbers of samples that would be necessary to provide
18 you or anyone else with some confidence that the
19 samples are representative of the leachate?

20 A. In terms of an ongoing monitoring
21 program?

22 Q. All right.

23 A. Or a sort of one time characteriza-
24 tion?

25 Q. Let's start with the one time



Toronto, Ontario

1 characterization and then we can move on to an ongoing
2 monitoring program?

3 A. The way leachate is typically
4 characterized unfortunately is on a one-time basis
5 where either one, or a small number being three or four,
6 samples are collected over a reasonably short period
7 of time. If one looks at the monitoring that has been
8 conducted by Gartner Lee at the Burlington site, I
9 think it is shown in Table 1 between April 1984 and
10 mid-1986, you would see the concentrations are really
11 quite variable for many of the compounds.

12 Unfortunately with this particular data
13 set, all these analyses were performed by the Ministry
14 of the Environment labs in Rexdale and I am certain
15 that at least three of the ten to 12 samplings, the
16 samples from those occasions were subjected to storage
17 times of approximately two months, considerably longer
18 than the recommended storage time as recommended by the
19 U.S. EPA, and I am not which other samples were subjected
20 to the fairly long storage times, and it is possible
21 that if some of the samples were analyzed promptly and
22 some were analyzed with an extended storage time,
23 that might reflect some of the variability or might
24 be the cause of some of the variability we see in these
25 analyses.



1 I would not think it would be unreasonable
2 during the operation of the landfill to monitor the
3 leachate quality quarterly, four times a year, or
4 possibly six times a year to actually reflect changes
5 in the leachate composition.

6 Q. Would it be your suggestion that
7 that kind of monitoring would be for the full suite --
8 certainly for the volatile organics?

9 A. Certainly the volatile organics,
10 and what other compounds are deemed to be of concern
11 with respect to groundwater monitoring programs which
12 would be chloride and the other inorganic indicators
13 at Site D, and offhand I can't think of any other ones
14 which might be important at Site F, but there may be
15 a few.

16 Q. Just on something you said a
17 moment ago about the effect of long storage time. Is
18 my information correct that in fact the effect of
19 long storage time is that you just have a certain
20 uncertainty about the data and in fact it may be valid
21 and in fact it may be invalid but you just don't know?

22 A. That is true. The possibility
23 or the potential for the storage of samples for a
24 longer period of time for the analysis of volatile
25 organics is potential losses from the sampling containers



1 Q. In fact depending on how a sample
2 is taken and stored and lots of other things that go
3 into it other than straight time, it may be that
4 some samples should be sampled or analyzed significantly
5 sooner than 14 days, I would assume?

6 A. I am certainly aware of researchers
7 in the field of groundwater contamination who would
8 suggest that they have observed losses from traditional
9 sampling containers, a volatile vial
10 with a septum cap, in just
11 several days and albeit those were small losses, and
12 those were percentage losses; whereas I believe storing
13 samples for a period of two months prior to analysis
14 could result in much larger losses than that.

15 Q. Can I take you to Exhibit H-83,
16 the plume delineation study done by Gartner Lee at
17 the Burlington site, and specifically to Table 4, page
18 27. First of all, just so that we all understand it,
19 am I correct that the values on Table 4 have been
20 transposed by you in your Table 1 in your witness
21 statement, and you have simply put in the minimum,
22 maximum and indicated a mean?

23 A. That is correct.

24 Q. When you use the expression
25 "minimum" you are speaking about minimum detectable?

A. The minimum detected, correct.



Toronto, Ontario

1 Q. Because I think in all of the
2 parameters except toluene there are instances of non-
3 detectability?

4 A. That is correct. I didn't make
5 that clear on the table and I probably should have and
6 the reason being is that I have my spread sheet blows
7 up if I have zero values when I am calculating means.

8 Q. I guess we are all trapped by
9 computers; I know that I am.

10 Now, when we started this whole conversa-
11 tion you indicated that I guess unfortunately most
12 leachate characterization is a one-shot deal?

13 A. That is correct. I don't think I
14 have seen an ongoing monitoring program of leachate
15 that included these types of chemicals.

16 Q. Can we assume, therefore, that the
17 sort of breadth and number of samples taken here, you
18 would call it good from the point of view of trying
19 to characterize leachate?

20 A. Yes.

21 Q. This is the kind of thing you are
22 recommending take place in the future?

23 A. I would suggest this type of
24 monitoring continue, that is right.

25 Q. I am wondering how that compares



Toronto, Ontario

1 to what was done at Bayview. First of all, before we
2 even get to Bayview, perhaps you could refresh all our
3 memories on where Pollutec got their data from?

4 A. I understand the Pollutec data
5 is from sampling of LW 1.

6 Q. I started on Bayview and back-
7 tracked a little bit?

8 A. I understand that was collected
9 from a manhole access to the leachate collection system
10 at the Burlington site, the same location Gartner Lee
11 collected its samples of leachate. I am not exactly
12 sure precisely where it is, but it is somewhere in the
13 south end of the Burlington site.

14 Q. I think it is probably not
15 disputed that it is probably the main manhole for the
16 leachate collection system?

17 A. Yes.

18 Q. That was a one-time sampling?

19 A. That is correct and those were
20 analyses performed within 24 hours of sampling.

21 Q. Now, if we could then move to the
22 Bayview sampling; again the Pollutec samples were a
23 one-time sample?

24 A. That is correct, from the leachate
25 monitoring well LW 1.



1 Q. Is LW 1 the one they found leachate
2 in? It is my impression that some of the leachate
3 wells they sampled, they didn't find something you would
4 call leachate in terms of colour and odour?

5 A. Conestoga-Rovers sampled all six
6 leachate wells and the data I reported in my Table 1
7 were the maximum concentrations detected in all six and
8 if you want me to check I can determine whether LW 1
9 was the highest.

10 Q. Could you please?

11 A. Just visually scanning over the
12 results from Conestoga-Rovers, LW 1 -- LW 4 is at least
13 comparable to the concentrations of volatile organics
14 found in LW 1 and in terms of the range of chemicals
15 identified and the concentrations. There were also
16 significant concentrations of some of the same chemicals
17 found in LW 2, LW 3, somewhat lower concentrations in
18 LW 5 and LW 6.

19 Q. You took the maximum concentration
20 for each of the parameters from whichever of the wells
21 it happened to come from?

22 A. That is correct.

23 Q. The Conestoga-Rovers, was that
24 a one-time sample?

25 A. I believe that was on one



1 least a variability of a factor of 3. I am not precisely
2 sure if the concentrations of chloride relate to the
3 flow rates being lower and higher flow rates when
4 dilution may occur in the springtime when there is a
5 good deal of infiltration; I don't believe those
6 comparisons have been done at this time.

7 But, the variability in the volatile
8 organic constituents is much different and much larger
9 than either flow rates for chlorides.

10 Q. You would attribute that to the
11 storage time problem?

12 A. I would think that that would be
13 a factor that would be contributing to that, yes.

14 Q. Thank you, Mr. Feenstra, that
15 is helpful.

16 Now, could we move to your evidence
17 on Site D. I had a couple of questions picking up
18 from I guess Mr. Estrin. There were a couple of things
19 I am not absolutely clear on and I just wanted to be
20 sure I understood it. Referring to the porosity in
21 the weathered till, which seems to be the main subject
22 of discussion for Site D, you used what is called the
23 Snow method, or that was used and that is what is
24 discussed as being used?

25 A. The graph, H-244 which I showed



Toronto, Ontario

1 you, is based on the relationship developed by Snow.

2 Q. When we talk about the Snow method,
3 we can refer to H-244?

4 A. Yes.

5 Q. Could we get that out, H-244?

6 A. Certainly.

7 Q. This is from the exhibit from the
8 book, Rock Slope Engineering?

9 A. That is correct.

10 DR. KINGHAM: Which number is that?

11 MR. TIDBALL: H-244, the relationship
12 between permeability and fracture aperture, and I think
13 that is what we titled it for the purposes of the exhibits.

14 THE WITNESS: Shall I show this?

15 MR. TIDBALL: Q. That might be useful.
16 I don't think we need turn the lights off. Will it
17 be a major problem?

18 A. Doug will look after us. Maybe.

19 Q. I don't want to spend considerable
20 time on this, but there were some points I was not
21 sure of. Am I correct, and I think this comes from
22 your evidence-in-chief, but you take fracture frequency
23 and permeability and you calculate the fracture
24 aperture or joint openings?

25 A. The individual joint openings.



1 occasion.

2 Q. The Pollutec sampling at Bayview
3 was a one-time sampling?

4 A. That is also correct.

5 Q. I take it from everything you have
6 said so far that in terms of the reliability of the
7 data, you would give more weight to the Gartner Lee
8 results in Table 4?

9 A. No actually.

10 Q. All right.

11 A. I would actually put more weight
12 on the Pollutec results from the Burlington site
13 given my concerns with storage times of the Gartner Lee
14 samples.

15 Q. So the storage time problem to
16 you is significant enough to sort of outweigh the fact
17 a greater number of samples were taken?

18 A. I don't think it is coincidence
19 that even the maximum concentrations identified by
20 Gartner Lee for all the compounds with one exception
21 are lower than the values determined by Pollutec.

22 Q. Just one final question on that.
23 If we look at Table 4, again from the Gartner Lee
24 plume delineation study, H-83, I just wanted your
25 opinion on the variability we find, and let's look at,



1 for example, the contaminant everyone seems to be
2 focusing on, the 1, 1, 1-trichloroethane. Now, it is
3 obvious from your data that we are ranging not simply
4 from 11, and I am sorry I am looking at the wrong thing,
5 but from 4 to 236 -- it ranges from non-detectable
6 up to 236?

7 A. That is correct.

8 Q. Is that the kind of variability
9 you would expect or is it somehow related to a storage
10 problem?

11 A. Unfortunately I had some of these
12 data actually plotted up but I don't have 1, 1, 1-
13 trichloroethane on an overhead. I believe that some
14 of that is associated with the storage time and handling.
15 There will obviously be a variability in leachate
16 concentrations seasonally, because there are times
17 when infiltration into the refuse will be greater than
18 at other times, and I think that that is expressed
19 by the variations in the actual leachate flow rate
20 at different times of the year. I have not reviewed
21 that data specifically, but I understand that flows
22 can vary by about a factor of 3.

23 Likewise, there is variability in the
24 chloride concentrations in the leachate, and not nearly
25 as markedly scattered as the volatile organics, but at



Toronto, Ontario

1 Q. Then you total them up?

2 A. And then express it as a
3 porosity or a percentage of the area.

4 Q. In the case of the weathered
5 till for Site D, the permeability value was calculated
6 from the Hvorslev tests, is that correct?

7 A. At Site D I don't believe it was,
8 and I don't believe there was any permeabilities or
9 any hydraulic conductivities determined at Site D
10 as high as 10^{-5} centimetres per second.

11 Q. It was an assumed value?

12 A. That is correct.

13 Q. And I think there was some
14 significant evidence from Mr. Sobanski on that point
15 if we look back in the transcript, as I recall?

16 A. I don't actually recall being
17 here for that, for just precisely where that estimate
18 came from, but I think that's an estimate that
19 hydrogeologists in Ontario traditionally have used for
20 weathered till in the last several years.

21 Q. I wonder if you could help me
22 from where fracture frequency, where you obtain that
23 kind of data?

24 A. There was not specific information
25 from Site D, I understand, and based on the depth of



Toronto, Ontario

1 weathering, the depth of the weathered zone at Site
2 D being comparable to what has been seen in the
3 Sarnia area and the fracture frequencies identified
4 in the Sarnia area, varying from approximately 10 or
5 so joints per metre, 5 or 10 joints per metre up to
6 about 20 fractures per metre, and it was determined
7 that the estimate, or our estimate for the fracture
8 frequency in this till, given the nature of the
9 weathering, seemed to be fairly comparable and would
10 likely be also fairly comparable.

11 Now, you can see going to this figure
12 the actual joint opening here, the size is not highly
13 dependent on the number of joints per metre that one
14 assumes and of course that does enter into the calcula-
15 tion and you must multiply by the number of joints
16 that exist, but I think you will find the calculated
17 porosity only varies a small amount with respect to
18 going from 10 joints per metre to 20 joints per metre.

19 One also has to assume a fracture
20 frequency.

21 Q. Just to tie that off, in your
22 opinion the assumptions made about fracture frequency
23 were reasonable?

24 A. I believe they were, yes.

25 Q. I want to ask you a couple of



Toronto, Ontario

1 questions on your phrase, and I always put it in
2 quotes because I think it is something you have
3 coined, but you can tell me, but the phrase "apparent
4 transport porosity"?

5 A. Yes, that is one of my phrases.

6 Q. My question is have you coined
7 a new phrase?

8 A. Yes, I believe that that is true,
9 because in many cases we very seldom had to consider,
10 certainly at this level of detail, the migration of
11 contaminants through fractured porous media. Obviously
12 people have been researching this type of problem
13 for the last number of years, but I would hazard to
14 say that no one has ever discussed it quite in this
15 manner before.

16 So, the apparent transport porosity
17 is a number that would actually reflect the difference,
18 or help reflect the difference between the physical
19 movement of water through the fractures and the move-
20 ment of a contaminant through the fractures.

21 Q. Is apparent transport porosity
22 simply a way to account for the effects of matrix
23 diffusion in a normal calculation of porosity?

24 A. That is correct, yes.

25 Q. I thought that that was so and I



Toronto, Ontario

1 simply wanted to confirm it for the record. That
2 essentially is what it is, and you have found a way,
3 if you will, to put matrix diffusion in?

4 A. When one observes a case where
5 one is actually seeing and has measured the rate of
6 contaminant migration through a fractured media, you
7 can actually back-calculate what the apparent transport
8 porosity was and that value being somewhat higher than
9 the real transport porosity for water due to the effect
10 of matrix diffusion. So, in some ways the ratio of
11 the apparent transport porosity to the actual transport
12 porosity for water reflects almost a bulk retardation
13 or attenuation factor.

14 Q. I assume in the years to come
15 as research is done on this, conceivably calculations
16 could be devised or simple factors could be postulated
17 that would be shown to be correct for various types of
18 strata?

19 A. I would hope that that would be
20 correct and also for different scales. Obviously the
21 laboratory or the field experiment conducted at Sarnia,
22 it was only measured over a distance of 2 metres.
23 Although I suspect the relative importance of the
24 effect of matrix diffusion would be the same if measured
25 over 50 or 100 metres, that has not actually been



Toronto, Ontario

1 demonstrated at this stage.

2 Q. I guess the remaining question
3 is the similarity, and we have been through this and
4 I only want to touch on it, but the similarity between
5 the weathered tills at Sarnia, and that is what we
6 are basing this on, and the weathered till at Site D?

7 A. That is correct. In terms of the
8 actual contaminant migration in the two sites, I would
9 fully expect them to be comparable, mainly because the
10 factors which will determine contaminant transport in
11 the respective areas are the fact that the upper weather-
12 ed till is indeed weathered to a depth of 3 to 5 metres,
13 which seems to be apparent from the tritium results
14 at both sites, and the fact that these fractures exist
15 is important and the actual diffusive properties, the
16 values for the diffusion coefficients for clay materials
17 only varies by a very small amount, whether one is in
18 a glacial till or a lacustrine clay or some kind of
19 marine clay deposit.

20 The diffusion coefficient for a non-
21 adsorbed contaminant like chloride only varies from 4×10^{-6}
22 centimetres squared per second to approximately 6×10^{-6}
23 centimetres squared per second, so it varies over
24 a very small range, and I would expect the effect of
25 matrix diffusion and the characteristics of contaminant



1 migration through the two clay sites would be quite
2 comparable, irrespective of the other physical
3 differences.

4 Q. That certainly ties it up for me.

5 A. Do we need this anymore?

6 Q. No, thank you.

7 Mr. Feenstra, could I refer you to
8 the table, either one of your tables or a table from
9 H-39, Figure 3-1 from Exhibit H-86 and it is simply
10 the schematic of contaminant pathways at Site D?

11 A. Yes.

12 Q. That is the one that shows the
13 various arrows and the various pathways?

14 A. Yes.

15 Q. The first question is a confirming
16 question, because I suspect you had something to do
17 with it, but at my request Mr. Sobanski produced an
18 exhibit which was filed as E-159, and I don't know if
19 we have that or not?

20 A. I will check.

21 Q. I think I have another copy if
22 you need it.

23 A. No, but I should have it here.
24 Yes, I have got that.

25 Q. E-159. Can you confirm, and



1 I wanted to cover this off because this here is your
2 area in terms of what was done by the consultants, but
3 can you confirm that you agree with this figure and
4 I am not sure if you did it or Mr. Sobanski?

5 A. I generated this figure for
6 Mr. Sobanski.

7 Q. The question was simply is it
8 this figure that therefore confirms or leads you to
9 sort of dismiss the possible contaminant pathway
10 down through the bedrock because of the effects?

11 A. That is correct, because of the
12 predicted effect in terms of very low concentrations
13 and the very long period of time.

14 Q. Can we look then at Figure 3-1.
15 Something has been brewing in the back of my mind
16 for some time and I don't understand it and I put
17 it to Mr. Sobanski and I am not sure I now understand
18 it any better, but I thought I might put it to you
19 in a slightly different way. I am trying to under-
20 stand, if you will, a picture in my mind in cross-
21 section as to what flow, simply hydraulic flow at
22 this point, looks like at Site D. I start with
23 Figure 3-1 because that illustrates the pathway and
24 I know that is not the hydraulic flow, that illustrates
25 the pathway, but I am wondering what it looks like



1 compared to Site F and I wonder if you are able to
2 give an opinion. The question is simply if you did
3 a Flownet model on Site D and generated something
4 that looked like the Flownet model, and we don't need
5 to look at it because we are all familiar with it, but
6 it is in the Site F report which shows the stream
7 tubes and the sort of movement through the highly
8 fractured unit; if you did that for Site D would it
9 look the same and the quantities I don't think are of
10 concern, but in direct terms of the direction of the
11 arrows, would it look the same?

12 A. Oh, I think it certainly would.

13 Q. It would?

14 A. There would be downward gradients
15 through the unweathered upper till and the upper part
16 of the lower till to the granular units and to some
17 degree, and I am not precisely sure what the hydraulic
18 relationship between the two different granular units
19 is, but I would expect it would still flow from the
20 upper down into the lower, albeit at a fairly smaller
21 flow with lateral migration through the

22
23 granular units -- I heard a variety of evidence on
24 actual groundwater flow directions in those units and
25 I am not sure I have a conclusion precisely as to where



Toronto, Ontario

1 it is going anymore, other than the assumption that
2 for the case of the landfill it will go off-site in
3 some direction, and there would be continued potential --
4 that would probably be the bulk of most of the flow.

5 So, actually I have not compared the
6 volumetric flow rates, but the flow rates to the perimeter
7 is also very small because the zone is thin and the
8 hydraulic gradients are very shallow, very small.

9 Q. The problem I had, and I think we
10 are coming to it rapidly, but as I understood it in
11 terms of flux at Site F, almost all of anything that
12 comes through the landfill drains laterally through
13 the highly fractured unit, whereas at Site D something
14 like 72 per cent of the flux is still downward, and
15 if you look at Figure 3-1, and I think Mr. McQuaid
16 had an exhibit and I can't recall the number, but
17 it illustrated the percentages, but I think it is
18 something like 72 per cent is going downward through
19 the lower till and then laterally migrating in the
20 shale bedrock and that is what I am trying to get
21 a picture of.

22 MR. HODGSON: Can I get a correction
23 on that picture as put to the witness. You said in
24 terms of flux "almost all goes through the highly
25 fractured unit", but is he referring to that portion of



Toronto, Ontario

1 the leachate that in fact goes through the massive
2 unit to the highly fractured unit or is he just saying
3 all the leachate generated at Site F goes down to the
4 highly fractured?

5 MR. TIDBALL: Q. I did not want to create
6 that impression. In terms of what goes downward through
7 the leachate collection system, and we
8 have heard efficiencies
9 anywhere from 93 to 99 per cent, in terms of what goes
10 downward at Site F. I was under the impression that
11 in terms of the total quantity it all moved laterally
12 through the highly fractured unit off-site to the
13 discharge zone and I was trying to understand how that
14 compares with Site D and I know it is a natural
15 situation and much more than 5 per cent.

16 A. I think the difference in the way
17 the calculations may have been done is that at Site
18 F, once we get below the highly fractured unit there
19 is no unit of a high hydraulic conductivity at a
20 further depth to enhance further downward flow. I
21 understand that that is the case at Site D with the
22 fractured shale bedrock underlying the lower till at
23 Site D.

24 I believe if you model Site D as we
25 did at Site F and incorporated the shale bedrock into
the finite element grid, I think that that would



Toronto, Ontario

1 probably reflect the water balance, and I am trying
2 to find it and what figure it was at Site D, but is
3 shown in the Site D report.

4 Q. If I could refer you to B-207,
5 I believe that is the exhibit that Mr. McQuaid put
6 to Mr. Sobanski and Mr. Beechinor, and it is Figure 3
7 from the Site D report with some notations of discharges
8 and percentages of infiltration and that is where I am
9 getting this 72 per cent, Exhibit B-207.

10 MR. LANCASTER: Mr. Tidball, it is
11 after eleven o'clock.

12 MR. TIDBALL: Perhaps it would be
13 convenient to break at this point. Thank you,
14 Mr. Chairman.

15 MR. LANCASTER: Fifteen minutes.

16 ---Recess

17 MR. LANCASTER: Thank you, please
18 be seated.

19 MS. CRONK: I wonder if I might with the
20 consent of Mr. Tidball and interrupt his recommencement
21 to raise a timing problem. The best way to put
22 it is that a number of counsel, I amongst them, have
23 some problems with tomorrow and we are trying to
24 accommodate the situation, and realizing that
25



1 Mr. Hiraishi is the next witness. I know Mr. Estrin
2 has some difficulty with tomorrow about which he can
3 tell you and I have a long-standing commitment from
4 five months ago to be in Montreal tomorrow and it would
5 be very difficult to avoid that, but if absolutely
6 need be it could be accommodated.

7 Our concern is in the normal course
8 of cross-examination both Mr. Estrin and myself would
9 be on our feet tomorrow and we spoke with a number of
10 other counsel to see if we could work our way around
11 it and I hoped perhaps Mr. Tidball might be in a
12 position to precede us in cross-examination were
13 he -- if he would take the better part of tomorrow
14 and that would resolve the problem and he can speak
15 to that and that may not be possible.

16 I have also canvassed the availability
17 of some other counsel for Friday of this week if it
18 were convenient for the Board instead of sitting
19 tomorrow, and a number of us are available Friday and
20 can reshuffle things to do that and at Mr. Hodgson's
21 request I thought it better to raise the matter of
22 scheduling now rather than wait until noon. I am
23 not seeking an adjournment, I will be available tomorrow
24 if that is the necessary solution, but I have not
25 asked this of you before and it is a problem that poses



1 larger than normal difficulty, especially for
2 me, and I wonder if we could take a few moments now
3 to explore a possible solution and whatever the
4 Board directs obviously we will do.

5 MR. LANCASTER: Certainly Friday is the
6 best solution if that is possible. We don't want to
7 compel you to be here tomorrow, but, on the other hand,
8 we don't want to go ahead without you here. You should
9 be here to hear the examination-in-chief as well. I
10 guess it is the same for Mr. Estrin.

11 MR. HODGSON: The examination-in-chief,
12 and I am sorry to interrupt, but the examination in
13 chief will be completed this afternoon. It will be
14 very brief.

15 MR. LANCASTER: You know that and I
16 don't.

17 MR. ESTRIN: I am assuming I would
18 be expected to go next and I am ready to start whenever
19 it is completed this afternoon, but my problem is
20 tomorrow I am one of two speakers for the Canadian
21 Environmental Advisory Council Conference in Toronto
22 and I don't have a prepared text someone else can
23 deliver, and that makes it very embarrassing if I am
24 not there.

25 I am prepared to start this afternoon and



Toronto, Ontario

1 it is not without precedent that a cross-examination
2 by one counsel is interrupted because he can't
3 come back and if that is what is necessary that is
4 another alternative.

5 MR. LANCASTER: Is Friday satisfactory
6 to all? Is there any problem with Friday?

7 MS. CRONK: I can tell you I
8 did not have an opportunity to speak to Ms. Vigod or
9 Mr. Tidball about their availability Friday, but I
10 understand it is acceptable to the balance.

11 MR. LANCASTER: Mr. Tidball, you are
12 on your feet.

13 MR. TIDBALL: I wanted to follow up
14 on what Ms. Cronk was mentioning. There was a concern
15 expressed that I would be the appropriate person to
16 cross-examine first, given the fact that the Ministry would
17 have certain concerns relating to design and conditions
18 people would want to hear, and I sympathize with that,
19 but my problem is an obvious one, I have been preparing
20 for Mr. Feenstra and have not really been able to turn
21 around immediately and be prepared to cross-examine
22 Mr. Hiraishi tomorrow and I apologize for that, but
23 even the length of time necessary to be briefed because
24 of course I have other people working on it, but I
25 don't think I am in a position to do it.



1 MR. LANCASTER: That lends support to
2 the fact about the problem of certain people on Thursday
3 and is Friday all right?

4 MR. TIDBALL: Yes, I believe so.

5 MS. VIGOD: I have some difficulty in
6 that I have a meeting that is in fact scheduled for
7 my ability to be there on Friday, but I think I could
8 get out of it this Friday. I would take it that
9 probably we wouldn't get to my having to cross-examine
10 Friday and that is where I have difficulty, but I could
11 be available and I think other counsel will show up
12 Friday and that may be the answer.

13 MR. McQUAID: Mr. Tzekas has said he
14 will reschedule his Friday appointments.

15 MR. LANCASTER: That seems to be the
16 best solution.

17 MR. HODGSON: If I could make a
18 suggestion. First of all, Mr. Hiraishi advises me
19 he has a meeting on Friday and it would greatly
20 inconvenience him to be here Friday, but he is prepared
21 to reschedule his meeting providing all counsel agree
22 to be nice to him during cross-examination.
23 If we could obtain that quid pro quo, we could advance
24 the discussions from that point. It seems to me that
25 what we have discovered from this discussion is that



1 we can sit both Thursday and Friday and I don't see
2 any reason why Mr. Tidball can't be prepared to go
3 tomorrow. With the greatest of respect, he has had
4 Mr. Hiraishi's reports for a year and I happen to know
5 that his instructing person met with Mr. Hiraishi
6 for about half of Monday to give us a preview of
7 the conditions the Ministry will ask for on the
8 Certificate of Approval. That is out of the way and
9 my colleague Ms. Rogers sat in on that meeting and it
10 took place during the progress of this hearing on
11 Monday and I think, with the greatest of respect, that
12 Mr. Tidball should be ready and should go ahead
13 tomorrow and let's sit on Friday as well and advance
14 the hearing. I see no reason why we can't sit
15 both days and we can't move this along.

16 Furthermore, with the greatest of
17 respect to Mr. Tiball, it has been said previously in
18 this hearing and I would like to repeat it, but in the
19 circumstances of the kind of cross-examination that
20 the Ministry makes of a design and operations witness,
21 Mr. Tidball should go first or very close to the
22 beginning because other counsel other than my client,
23 other counsel should know what it is the Ministry
24 are asking and it should be the conditions under
25 which each of these two sites be operated should either



1 of the sites or both sites be approved at some point.

2 I think we should hear from Mr. Tidball
3 and I think it would put some pressure on him and in
4 the circumstances we all know with his infinite capacities
5 that he can manage that.

6 MS. CRONK: Mr. Tidball, I am sorry,
7 but I would not want my remarks to be taken that I
8 didn't have some submissions to be made to you on the
9 order. I was trying to relieve the timing problem,
10 but I am concerned about the fact, and I know my
11 colleagues on behalf of Milton are as well, that we
12 do not have at all a clear understanding of the
13 conditions that will be urged upon you by the Ministry
14 of the Environment. Clearly from my client's point
15 of view the conditions we urge with respect to Site F
16 is something we would have to deal with and I
17 was going to make submissions to you in any event
18 if Mr. Tidball should go first, but I didn't want to
19 be quite as honest and as direct as to suggest he
20 do it tomorrow in my absence, but I do support
21 Mr. Hodgson's remarks that he should proceed at
22 whatever is the intended time.

23 MR. LANCASTER: It seems that the
24 Ministry is more neutral in this matter than the
25 other parties. It would seem advisable they go first.



Toronto, Ontario

1 MR. TIDBALL: I can sympathize with
2 that and I find myself in the very awkward position
3 where I am certainly prepared to go tomorrow, but
4 it is simply a question of the amount of time that
5 would be required to brief me and I can work all night
6 on it, but that's not the issue. The issue is I assume
7 I could conceivably be sort of longer and more wandering
8 than I otherwise would like to be, but if my friends
9 are content with that I certainly am.

10 MR. LANCASTER: All that concerns
11 the Board is that all counsel hear the examination-in-
12 chief and if that's completed today I see there will
13 be no problem and we can arrange tomorrow and Friday
14 to the convenience of everybody, even if it is only
15 a half a day or part of a day.

16 Would that work it out? I will leave
17 that up to counsel to decide who goes where and when.

22A 18 MR. TIDBALL: Rather than saying it
19 later, I understand this afternoon that Mr. Hodgson
20 will deal with Mr. Hiraishi very briefly and simply
21 leave the question of design more for cross-examination,
22 if I can put it that way, and unfortunately I have a
23 commitment I cannot break at four o'clock this after-
24 noon which was specifically set up with senior
25 management at the Ministry and just so you know when I



Toronto, Ontario

1 things are dealt with on a case by case basis and
2 in the normal situation when the decision is left to
3 the Approvals Director under Part V of the Environmental
4 Protection Act, many are frankly done even after a
5 hearing and we are faced with the position of putting
6 this together now and I can't delude the Board, and
7 I don't want to leave the impression that there is
8 some finite set of conditions that will flow out of
9 my cross-examination.

10 What will flow out of my cross-examination
11 is some concerns and some definite areas where we
12 want conditions, but I want it to be clear that other
13 things will come up in this hearing that may or may
14 not be raised by other parties that the Ministry is
15 prepared to say that we think it is a good idea and
16 we are prepared to make it a condition.

17 I hope it's understood that what we have
18 at this point is almost an interim set of conditions,
19 but it won't be in a form on a piece of paper, I am
20 sorry that I can distribute and say here there are,
21 1,2,3,4,5,6,7,8,9,10 and we will go through them; it
22 won't be in that format.

23 MR. LANCASTER: That is what I meant
24 when I said the Ministry has concerns now but the
25 conditions will come later if any.



Toronto, Ontario

1 MR. TIDBALL: I certainly can concede
2 that I should go first and I have no problem with that
3 at all and I apologize for the timing. I guess I
4 had been kidding myself with the fact that
5 Mr. Hiraishi might be considerably longer and I assumed
6 I would have over the weekend, and Mr. Hodgson quite
7 admirably has succeeded in scoping the examination-
8 in-chief down to a couple of hours and that is what
9 has caused the problem. I am prepared to go first
10 tomorrow if we could make some arrangement to start
11 perhaps a little bit later.

12 MR. LANCASTER: That's fine, but we
13 would like to keep going and take advantage of all the
14 time and we could start at 10:00 or 10:30, but what
15 did you mean by later?

16 MR. HODGSON: Friday.

17 MR. TIDBALL: Later would be Friday.

18 MR. LANCASTER: 3200 hours?

19 MR. TIDBALL: Could we say eleven at
20 this point and let me confer with some of my associates
21 on this.

22 MR. LANCASTER: We are willing to do
23 that and it is up to you people to arrange it to your
24 best advantage, but eleven o'clock is fine or any other
25 time.



Toronto, Ontario

1 leave at three or at the break, that that is why I
2 am going, but I am not concerned that I would miss
3 anything critical in terms of the examination-in-
4 chief because I certainly am briefed on that.
5 I am just picking up on your point when you said it
6 was important that all counsel hear the examination-
7 in-chief.

8 MR. LANCASTER: The opportunity is here
9 and whether you exercise it or not is up to you.

10 MR. HODGSON: I was going to say that
11 Mr. Estrin had already agreed to go first and if the
12 examination-in-chief does in fact get completed early
13 today, perhaps he could begin on Friday.

14 MR. ESTRIN: I am prepared to start
15 and continue on Friday, but I think the issue of where
16 the Ministry fits in should be resolved. I am prepared
17 to start, but I think the issue of where the Ministry
18 fits in should be resolved. I am prepared to start
19 but if it seems appropriate as I think it has been
20 pointed out that we have the opportunity of hearing
21 from the Ministry and it would seem to me the Ministry
22 should go on Thursday or Friday or whenever, because
23 they obviously will raise a whole series of questions
24 we have no knowledge of and the normal rule we talked
25 about yesterday, if it applies, I would have no



1 opportunity of discussing those things with the
2 witness because I would have already had my turn.

3 So, it is the same for all of us as I
4 understand it. I think we should try and figure out
5 a way of having the Ministry essentially proceed and,
6 as I say, I am ready to start as long as we can
7 interrupt it.

8 MR. LANCASTER: I rather agree with
9 Mr. Estrin that the Ministry is more neutral than the
10 other parties and they don't care which site as long
11 as it meets the conditions of the Ministry. I think
12 perhaps these conditions or that situation should be
13 made available or known to both parties, both the
14 Burlington group and the Milton group prior to their
15 examination.

16 MR. TIDBALL: If I could speak to that
17 briefly. We had some discussions about this and I
18 don't recall whether it was in the in camera session
19 with the Board or subsequent sessions with counsel,
20 but it is something of a myth that has been built
21 up that there is a standard set of conditions that the
22 Ministry has, or a set of conditions the Ministry
23 has with respect to both these sites which have been
24 ready for months and that we have not distributed
25 them or that we have them ready. The fact is that these



1 MR. TIDBALL: I should say I would
2 consent to going first as long as Mr. Hodgson never
3 tries to say I tried to delay anything.

4 MR. HODGSON: Until you try and delay
5 something I will never say it.

6 MR. LANCASTER: We will sit tomorrow
7 at eleven o'clock and we will sit Friday at ten o'clock,
8 9:30? Let's make it 9:30. I would like to keep to
9 that hour if we can.

10 MS. CRONK: Thank you.

11 MR. TIDBALL: Q. Mr. Feenstra, can we
12 pick up where we left off. I think we were looking
13 at B-207 and the question being if you did a Flownet
14 model on the Site D hydrogeologic regime, would it
15 look like, at least in form, the model that has been
16 done for Site F?

17 A. It would look roughly like the
18 model conducted at Site F. The principal difference,
19 however, being that the lower part, the lower-most unit
20 at Site D would be modelled as a reasonably high
21 hydraulic conductivity fractured shale which reflects
22 the properties of the shale bedrock underlying the
23 overburden at Site D.

24 So, that basically allows an additional
25 pathway for further downward movement of groundwater



1 through the unconsolidated or overburden deposits at
2 Site D. That situation doesn't exactly exist as
3 evaluated in Figure 7, the water balance schematic
4 at Site F or in the finite element models developed
5 for Site F.

6 Beneath the highly fractured shale zone, uni
7 zone 4, there is no unit at a deeper depth that has a
8 higher hydraulic conductivity. In other words, there
9 is no where else for water to go once it has reached
10 the highly fractured zone at Site F and, correspondingly,
11 the models between Site F and D would be somewhat
12 different.

13 Q. All right. I don't think we
14 need the figure out, but if you can imagine the Flownet
15 model, I take it that that model is capable of generating
16 those stream tubes in fact in two different directions
17 and you would have arrows going down and arrows going
18 out?

19 A. When you have an interface where
20 there is a sufficient degree of contrast or a difference
21 between the hydraulic conductivities, you can achieve
22 that.

23 Q. In fact at Site D, if there were
24 a number of stream tubes, the majority of them would
25 be going down and a minority would be going laterally



Toronto, Ontario

1 through the granular units?

2 A. That is correct.

3 Q. Now, just a couple more questions
4 on Site D, and one that I guess relates to chemistry
5 and it came out of something you said the other day
6 and it just occurred to me. If you analyzed for trace
7 contaminants at Site D, and I understand that has not
8 been done probably with good reason, but would you
9 expect to find something?

10 A. In the wells as they were
11 installed?

12 Q. Yes.

13 A. I am not certain of the actual
14 types of installations installed at Site D, but I
15 would just assume they were PVC pipe that wasn't cleaned
16 in any special way before it was installed. I do
17 suspect they had threaded couplings rather than solvent-
18 welded couplings. It is quite possible that you may
19 detect trace levels of various chemicals in those
20 wells, that is correct.

21 Q. I was following up on a comment
22 you made about the fact that if you drilled a well --
23 I am sorry, that is something different -- but you
24 were talking about background contaminants in other
25 areas?



Toronto, Ontario

1 A. Yes. I think if we drilled a
2 well, and where is a good location, say in the
3 industrial park at Trafalgar Road and the Q.E.W., I
4 am quite sure you would find something.

5 Q. That is a different issue and
6 that is not the well construction problem?

7 A. No.

8 Q. One final thing on Site D. I
9 wanted to put to you the same question I put to
10 Mr. Sobanski. The question is when you are evaluating
11 Site D, all of the models you ran with the exception
12 I guess of the one Mr. McQuaid gave you yesterday which
13 showed no curve, were based on a failure scenario and
14 the models you ran to predict contaminant movement
15 at Site D except with respect to diffusion were all
16 related to a failure scenario?

17 A. That is correct.

18 Q. The question is, Mr. Feenstra,
19 I wonder if you have an opinion on how long the
20 hydraulic trap would have to operate in order to
21 obviate any need for the collection of leachate.
22 If I could refer you to Figure 3-11 in your report,
23 H-86, the declining chloride concentration curve, and
24 I believe you made some similar assumptions about
25 declining curves ...



1 A. That is correct, for organics .

2 Q. I am wondering if you can provide
3 the Board with any opinion on how long that leachate
4 collection system is going to have to work before it
5 doesn't matter because you don't have enough
6 contaminants inputting to cause a significant concern?

7 A. I have not modelled that specifi-
8 cally and that actually could be done. With respect
9 to chloride ...

10 DR. KINGHAM: Could you help us first
11 by telling us whether the start time is from the start-
12 up of the landfill or the completion of the landfill,
13 if you know?

14 THE WITNESS: Well, generally that
15 would be from completion of the landfill, because
16 studies have suggested that the maximum leachate strength
17 develops either shortly before or shortly following
18 completion of a landfill itself.

19 MR. TIDBALL: Q. I don't want to take
20 an inordinate amount of time on this, but let me put
21 to you -- I asked Mr. Sobanski the question and I
22 wanted to know if you agreed. He prefaced it by saying
23 everyone would jump on him for saying it, but he
24 assumed if you could collect all the leachate for a
25 period of 20 to 30 years that would be the kind of time



Toronto, Ontario

1 period you would want to talk about in terms of the
2 life of that system before there was any concern?

3 A. With the projected declines in
4 leachate strength as shown in Figure 3-11 following
5 closure of the landfill, with respect to Site D, if
6 you operated the leachate collection system for a
7 period of 30 years and with a resultant decline in
8 leachate strength of a factor of about 6 or 7, I believe,
9 without actually re-running the models, that the
10 height of the peak, the chloride peak observed in the
11 lower granular units at some point in the future would
12 be close to correspondingly diminished by that same
13 factor.

14 So, rather than getting an additional
15 300 milligrams of chloride or some other non-adsorbed
16 contaminant at the site boundary at some point in the
17 future, the height of that peak would be considerably
18 lower and so the impact would correspondingly be
19 reduced.

20 Q. So, in your opinion you can look
21 at the decline curve and whatever factor you reduce
22 it by, because at that point that is the input?

23 A. Yes.

24 Q. That is your initial input?

25 A. The maximum initial input.



1 Q. All the curves are correspondingly
2 reduced?

3 A. That is correct.

4 Q. Could I then turn your attention
5 to Site F and I wanted to start with a few questions
6 about the Gartner Lee work at Burlington. Do I under-
7 stand correctly that the Gartner Lee wells, the
8 stainless steel wells installed for the purposes of
9 detecting the movement of trace organics weren't instrumented
10 in the same fashion that the wells were instrumented
11 at Site F. Perhaps I can expand on that a little bit.

12 It was my understanding of Mr. Sobanski's
13 evidence, and I think you even referred to it this
14 morning, that the difference between Hydrology Consul-
15 tants and everybody else in this particular area is
16 that they deliberately instrumented into fractures?

17 A. That is correct.

18 Q. Am I right that Gartner Lee
19 did not do that?

20 A. It is my understanding that that
21 is correct.

22 Q. If they happened to hit a fracture
23 zone it was more coincidence than anything else?

24 A. I believe that that's the case.

25 Q. That applies to the new well



Toronto, Ontario

1 GL 32 which is the one directly south of the scale-
2 house?

3 A. I am not sure of that particular
4 well, but I recall discussions of that hole being
5 cored and the installations being conducted in the
6 same manner that Hydrology Consultants installed
7 their installations.

8 I have not had confirmation, but I
9 believe that that was not done and the hole wasn't
10 cored.

11 Q. In terms of the differences
12 between the two and the ability to detect the movement
13 of leachate, I wonder if you have any opinion on
14 whether it matters?

15 A. It depends to some degree on
16 what type of installations one would be installing
17 at Site F. I believe traditionally the standard
18 piezometers that have gone in at Site F have had a
19 relatively short intake, that is the length of the
20 filter pack and screen in the piezometer itself which
21 allows water to come in has been relatively short,
22 I believe something in the order of 1-1/2 to 2 or 2-1/2
23 metres. I think most of them are typically 1-1/2
24 metres.

25 Given the nature of the fracturing



Toronto, Ontario

1 even in the highly fractured zone, I would suggest that
2 it might be prudent to lengthen that, that intake
3 somewhat, and maybe in the range of 3 to 4 metres, just
4 to give one a greater opportunity for intersecting
5 some of the fractures, some of the water-bearing
6 fractures in a particular zone.

7 Q. I appreciate that from the point
8 of view of what should be done in the future in
9 terms of the monitoring system, Mr. Feenstra, but I am
10 wondering if you have any comment on what has been
11 done to date and I guess the question specifically
12 is do you have any opinion on the ability of the
13 Gartner Lee wells, given the way they were instrumented,
14 to detect the movement of leachate through fractures?

15 A. Obviously not knowing precisely
16 where they were installed with respect to the high
17 hydraulic conductivity zones that might exist at those
18 locations, one really can't be definitive one way or
19 the other whether they would be good or bad, but I
20 guess one would just have to recognize that they may
21 not be in the most ideal zones for monitoring.

22 Q. I wanted to follow up on some
23 of the discussions you had with both Mr. McQuaid and
24 Ms. Vigod regarding Gartner Lee well 24 which is the well
25 25 metres from the landfill that Gartner Lee concluded



1 was impacted by leachate and you have concluded it is
2 not. Is that fair?

3 A. That is correct.

4 Q. I took it from your discussions
5 with both Mr. McQuaid and Ms. Vigod that in your
6 opinion we should be seeing impacts at that well in
7 the weathered shale?

8 A. That is correct.

9 Q. That is what we have called
10 unit 2?

11 A. Unit 2, the moderately fractured
12 weathered shale; correct.

13 Q. You wouldn't expect to see impact
14 in those wells in the deeper zones, and I don't want
15 to go over that discussion, but it is mainly because
16 of the travel time through the massive shale?

17 A. Our expectation would be that
18 the travel times would be sufficient that we may
19 not see things at depth. So, in terms of migration
20 through the weakly fractured zone, depending on
21 precisely where your monitoring wells were installed,
22 you might expect some evidence of contamination at
23 a slightly greater depth than zone 2.

24 Q. In coming to the conclusion about
25 GL 24, I gather you must be making some assumptions



1 about where that well is instrumented vis-à-vis the
2 different shale units?

3 A. That is correct.

4 Q. What assumptions were those?

5 A. The assumption being that at least
6 the upper interval is in the weathered shale zone and
7 I don't recall the precise depth.

8 Q. Could we go to the borehole log?

9 A. Certainly.

10 Q. Exhibit 83, page 48?

11 A. Yes.

12 Q. That is the borehole log for
13 borehole 24 and I find it somewhat problematic
14 just trying to compare it to Hydrology Consultants
15 because they are calling the depth from 1.2 metres to
16 18.3 metres the weathered shale?

17 A. That is correct.

18 Q. That is what we might call the
19 older approach and Hydrology Consultants approached it
20 differently?

21 A. That is true and I don't think
22 it would be possible to conclude that all that represents
23 the weathered moderately fractured shale.

24 Q. Is it fair to say that somewhere
25 in there we should expect to see, based on the Hydrology



Toronto, Ontario

1 Consultants model, we should expect to see the massive
2 unit?

3 A. Let me check the elevations.

4 I think we would have expected somewhere in that
5 interval to see the weakly fractured unit.

6 Q. My attention was only drawn to
7 this because, I guess, of the discussion you had with
8 Ms. Vigod when I gather the evidence is that GL 24 is
9 an approximate location in the north-south direction
10 equivalent to HC5?

11 A. That is correct.

12 Q. If you could go to Exhibit H-220,
13 and if you could put that up, I will tell you my
14 problem directly. As I look at HC5 and I understand
15 there are differences as you go east-west?

16 A. Yes.

17 Q. Just as an example, I believe
18 HC5, HC6 and HC7 are basically in the same north-south
19 locations but I believe the elevations of the weakly
20 fractured shale zone varied by approximately 5 metres.

21 Now, I am looking at this simply in
22 this context. If I look at HC5, given how
23 Mr. Beechinor has interpreted the various units, in
24 fact HC5 is the well that he essentially has the
25 massive shale virtually surfacing or sub-cropping



1 under the till, does he not?

2 A. That is correct.

3 Q. At HC6, that was one of the other
4 wells, and can you confirm that he has approximately,
5 I guess to be fair, perhaps 3 metres of weathered shale?

6 A. Approximately 3, correct.

7 Q. And at HC7 he has approximately the
8 same, 5 or 6 metres?

9 A. Actually probably only about 3
10 or 4 metres at HC7. At these particular locations there
11 is also 3 to 4 to 5 metres of overburden.

12 Q. If you could back to the borehole
13 log for GLA 24, I note there that the till extends down
14 to about 1.2 metres?

15 A. That is correct, yes.

16 Q. Then the shale starts. Now, if
17 this is fair, and please tell me if it is not, but
18 is it fair to use or compare HC5, 6 and 7 over here
19 and sort of interpret a possible delineation between
20 the weathered shale and the massive shale?

21 A. Acknowledging a certain variability,
22 it is certainly possible to project over in that
23 direction and just recognizing that even between 5, 6
24 and 7, the elevation will vary and the variability
25 could be in the order of 3 to 5 metres.



1 Q. As I understand at GL 24,
2 piezometer 3 is instrumented between 5 and 6.2 metres
3 below grade?

4 A. That is correct. That actually
5 shows up on the borehole log under the column which
6 says monitor details.

7 Q. It shows up but it is hard to tell
8 the exact -- I was taking that off the monitor details
9 found several pages later?

10 A. Yes.

11 Q. Is it then your opinion that that
12 piezometer is instrumented in the weathered shale?

13 A. Yes.

14 Q. That is the piezometer that you
15 say we should be seeing evidence of movement because
16 there wasn't formerly any collection from the older
17 part of the Burlington site?

18 A. That is correct.

19 Q. It is that monitor on which you
20 base your conclusion that since we are not seeing it
21 there must be significant attenuation?

22 A. That is the primary monitor, right.

23 Q. I want to go to that directly. I
24 am wondering if you could comment on what level of
25 confidence you have in that interpretation, the fact



1 movement at the same time?

2 A. That is correct.

3 Q. Have you factored that in?

4 A. That would depend upon whether the
5 actual pathway -- are you talking about lateral movement
6 through the weakly fractured shale?

7 Q. I assume if we have a piezometer --
8 I guess so. If we have a piezometer in the massive
9 shale at that location, there would have to be some
10 lateral movement of leachate to see it there?

11 A. Either lateral movement through
12 the weathered zone or through the weakly fractured zone,
13 most likely through the weathered zone.

14 Q. You are suggesting that we might
15 expect to see evidence of contamination at piezometer
16 2 since you would expect some migration through the
17 weathered zone and then downward movement through the
18 massive unit?

19 A. That could be possible, yes.

20 Q. All right.

21 A. I think one can get
22 some degree -- let me just check the piezometers again.
23 I am just trying to look at the actual hydraulic con-
24 ductivities measured in piezometer 24. In Figure 3
25 on page 13 there doesn't appear to be a value plotted
for 24-3 that I can note. Actually if you go to Table 1



1 on page 11, it shows the hydarulic conductivity measure-
2 ments for the three piezometers in GLA 24, and these
3 are in metres per second.

4 Q. So we take off two numbers so
5 10^{-9} becomes 10^{-7} ?

6 A. That is correct. That is actually
7 fairly low even at a shallow depth and goes up to
8 9×10^{-6} in piezometer 2 and between 2 and 4×10^{-6}
9 centimetres per second even in the deep piezometer,
10 piezometer 1.

11 Q. They are fairly low permeabilities.
12 I just want to understand ...

13 A. They would sort of be middling
14 between what one I believe would expect for the weakly
15 fractured shale and what one would expect for the
16 weathered moderately fractured shale, so it doesn't
17 lend a great deal of conclusive evidence.

18 Q. They are just not conclusive and
19 that is the best we can say?

20 A. At this stage it would be hard
21 to conclude one way or another to say whether they
22 represented the weakly fractured shale zone or the
23 weathered shale zone.

24 Q. I wanted to come back to the point
25 about your conclusion about the Gartner Lee data,



Toronto, Ontario

1 it is all being attenuated through matrix diffusion
2 or some other mechanisms?

3 A. Just looking at the other eleva-
4 tions, it may also be possible that piezometer 2 could
5 also be in the weathered zone.

6 Q. What is the basis for that?

7 A. Given the elevations of the weakly
8 fractured shale -- did we make this an exhibit? Yes,
9 on Exhibit WB-261, if we look at the variation, the
10 elevation of the top of the weakly fractured shale
11 varying from about 121 at HC7, which is the furthest
12 east, here, HC7, going to approximately 118 at HC6 and
13 HC5, and not necessarily suggesting there is a trend
14 to lower elevations in a westerly direction, but just
15 the fact that there is a difference of about 3 metres
16 in those elevations.

17 Now, piezometer 2 occurs at an elevation
18 of about 115, so it is possible that that could also
19 be in the weathered zone, but at this stage we can't
20 tell for sure.

21 Q. Is it possible that both of them
22 are in the massive zone?

23 A. That may also be the case.

24 Q. All right.

25 A. But I think it would
be unlikely for the upper one, piezometer 3.



Toronto, Ontario

1 Q. If piezometers -- no, let me
2 start with piezometer 2. Piezometer 2 is in the massive
3 shale and we wouldn't be expecting to see contaminants
4 there, the volatile organics we have been talking
5 about?

6 A. I am sorry, I was looking at some-
7 thing else.

8 Q. Given your model, and you went
9 through this with Ms. Vigod extensively this morning
10 already, but we wouldn't expect to see contaminants
11 in piezometer 2 at the borehole if in fact it is in
12 the massive shale unit, unit 3?

13 A. That would depend somewhat on the
14 actual thickness of unit 3 between piezometer 2 and
15 the moderately weathered -- excuse me -- the weathered
16 moderately fractured shale. I have a problem with that.
17 Basically the thickness of the weakly fractured shale
18 between the overlying weathered unit and that piezometer.
19 We are not precisely sure what that distance is. If
20 it is only several metres, it is possible that contamin-
21 ants might be present at that location given the 15
22 years of travel time.

23 Q. What about when you factor in
24 the fact that it is something like 25 metres south of
25 the toe of the landfill, so there would have to be lateral



Toronto, Ontario

1 especially as it relates to GLA 24. It seemed to me
2 there were other interpretations, and I take it you
3 would agree there are other interpretations other than
4 we are simply witnessing the effects of matrix
5 diffusion to explain the lack of contaminants at
6 GLA 24?

7 A. There may be factors other than
8 matrix diffusion acting, that is correct.

9 Q. The question is would you agree
10 with me that there are other interpretations of why
11 we are not seeing contaminants at that location and I
12 might put a couple to you and you can agree or not?

13 A. Certainly.

14 Q. Can we agree that it could be
15 that leachate is not being seen because the monitors
16 or the piezometers aren't instrumented in the way that
17 Hydrology Consultants did; that is, looking for fractures?

18 A. It is true that we do not know
19 precisely which zones those piezometers are installed
20 in; correct.

21 Q. And we don't know precisely which
22 fractures carry the bulk of the groundwater?

23 A. That is true.

24 Q. Can we agree that that is a
25 possibility as well?



1 A. Yes.

2 Q. Is it possible that all the
3 leachate is being collected?

4 A. At the present time?

5 Q. Yes.

6 A. I haven't reviewed in detail the
7 design of the toe drain system, but it is my under-
8 standing that the toe drain system was not extended a
9 significant depth into the weathered shale.

10 Q. It is in fact a toe drain as
11 opposed to a perimeter drain?

12 A. That is correct.

13 Q. Would I understand it then that
14 you would assume there would be some movement beneath
15 that toe drain in the weathered shale?

16 A. I would have assumed that, yes.

17 Q. Is it also a possibility that
18 rather than simply not being seen by the piezometers,
19 leachate has not arrived yet. I take it you wouldn't
20 agree with that because you are assuming that at
21 least one and perhaps two of the piezometers are in the
22 weathered shale?

23 A. That is correct. I think in the
24 weathered shale we would have assumed contaminants
25 would have arrived in the 15 years that the landfill has



1 been in operation.

2 Q. Based on what I guess would be the
3 primary other possibility, the possibility that we are
4 not seeing it because of the way the wells were
5 instrumented, I wonder if you could give us your
6 opinion on the level of confidence you have in your
7 conclusion that because we are not seeing it that means
8 that it is being attenuated?

9 A. To some degree I think that the
10 level of confidence or the level of reliability that
11 relates to Burlington also draws on observations at
12 Bayview.

13 Q. So they are related in the sense
14 that it is an overall conclusion?

15 A. That's true, yes.

16 Q. Perhaps then we can talk about it
17 after some discussion of the Bayview data. Now, if
18 we could then move to the results from the Bayview
19 site. There has been some significant discussion
20 on this already, Mr. Feenstra, but I want to make sure
21 I have it absolutely right and given the cross-examination
22 of Ms. Cronk and Mr. Estrin about other possible
23 sources of contamination, I simply want to make sure
24 I understand what your evidence is.

25 I understood at the beginning that your



Toronto, Ontario

1 evidence with regard to the data from the Waterloo
2 study was related specifically to problems you had had
3 with well construction and specifically the fact that the
4 pipes weren't precleaned and the fact that glues were
5 used in constructing them?

6 A. The Waterloo study, yes, that is
7 correct.

8 Q. I simply wanted to clarify in my
9 own mind what weight you give to the other factors, and
10 in fact I have it that there were in fact two lists
11 put to you and in some way they overlapped and if we
12 could go through them briefly one at a time; in a
13 question from Mr. Estrin about other possible sources
14 of contamination, I wasn't sure of any study he was
15 relating that to, but you listed the possibilities of
16 contamination from I think two types of pumps?

17 A. Specifically related to the
18 Gartner Lee studies at the Burlington landfill.

19 Q. Do they relate in any way to the
20 Waterloo study?

21 A. No, they do not.

22 Q. And the sample containers?

23 A. The sample containers also relate
24 only to the Gartner Lee study and the sampling equip-
25 ment used in the U of W study, as we have described



1 involved sampling tubes with adsorption of the volatile
2 organics on the Tanex granular carbon in the tubes.
3 Because of the blank tubes that were analyzed for the
4 Waterloo study, I think we have a good indication of
5 not only the possible presence of contaminants that were
6 in the air during sampling and during storage, but also
7 any contamination actually derived from the tube
8 materials, the absorbent materials or any other part of
9 the sampling apparatus.

10 Q. And we are able then to in one
11 of two ways, either the way you propose which is to take
12 the maximum blank value or the way Dr. Pankow did it
13 which was to average it?

14 A. Average it and do a statistical
15 evaluation of the detection limit...

16 Q. We can conclude what you can
17 deduct, if you will, for that kind of contamination?

18 A. That is correct.

19 Q. Ms. Cronk also put a series
20 of possible other sources to you and I would like to
21 go through them as well. One was Teflon tubing, and
22 is that a possible source of contamination with the
23 Waterloo wells?

24 A. It is not. It was the Teflon
25 tubing that was used in the shallow monitors in the



1 Gartner Lee study that could be sampled using
2 peristolic pumps.

3 Q. The next was insufficient develop-
4 ment of the wells. I take it that is related to the
5 ability of any particular well to flush out any
6 contaminants that got in from well construction?

7 A. From well construction and
8 possibly any interconnection of more pervious zones
9 at shallow depths which have leaked into the borings
10 during drilling.

11 Q. Is it your evidence that that
12 was a problem with the Waterloo data?

13 A. That may have been a problem in
14 some of the installations mainly because in the WAT
15 style multi-level piezometers only small quantities
16 of water can actually be purged from the test intervals
17 prior to sampling, small volumes ranging from less than
18 a litre to approximately 6 litres.

19 Q. That is a function of the type
20 of well it is?

21 A. The type of well it is and
22 they are very small tubes to sample from and it is
23 hard to get large quantities of water out.

24 Q. That is a factor in your opinion?

25 A. That could be a factor, yes.



Toronto, Ontario

1 Q. What about the packer
2 material, the Dowell sealant?

3 A. That could be a factor and, as
4 I described to Ms. Cronk, I believe, I recently
5 co-ordinated some laboratory testings for Solvinst
6 Canada, the company that produces a multi-level
7 piezometer for commercial use, and we tested out the
8 water in contact with the Dowell polymer material and
9 the only compounds we find in the current formulation
10 are toluene and dichloromethane and at quite significant
11 concentrations, p.p.m. levels, milligrams per litre
12 levels not micrograms and not really much of anything
13 else.

14 I don't recall that in any of the
15 Waterloo multi-levels any dichloromethane was found
16 and obviously toluene was found as you may recall.
17 It is a valid point raised by Ms. Cronk that we don't
18 precisely know what the formulation of this material
19 was back in 1983 or '84 and it is possible there may
20 have been other chemicals associated with Dowell at that
21 time, but based on our present information I wouldn't
22 think it is the Dowell that is a primary conduit for
23 contamination.

24 Q. Have you any reason to believe
25 the formulation has changed?



1 think we would expect it to be very different.

2 The reproduceability based on the
3 duplicate and triplicate analysis I think would largely
4 reflect the laboratory precision of the analysis. It
5 is very seldom actually that anyone takes duplicate
6 and triplicate groundwater analyses, mainly on the
7 basis of cost.

8 Q. I think that covers the two lists
9 I proposed to put to you. I asked you about the sampling
10 itself and you commented about the blanks being
11 representative of things picked up in the actual
12 cartridge?

13 A. Yes.

14 Q. Is the Tanex itself a possible
15 source?

16 A. That is a possible source, yes.
17 and mainly because the Tanex is actually purified or
18 cleaned in a similar method but it is cleaned thermally
19 and sometimes cleaned with various solvents, but
20 primarily the final step is the final desorption, the
21 same kind of procedure used to remove the chemicals
22 from the cartridges after you have collected the
23 samples.

24 Q. For the record, the Tanex is the
25 material found in the cartridge?



1 A. The absorbent material in the
2 cartridge; correct.

3 Q. Having done all that, I want to
4 then come back to understanding exactly what your
5 position is. As I understand it, your opinion on the
6 Waterloo data is primarily based on well construction;
7 is that fair?

8 A. That is correct, yes.

9 Q. Can I take it that you would
10 agree with me that that interpretation is not con-
11 clusive?

12 A. Which interpretation?

13 Q. I am sorry, your opinion is not
14 conclusive?

15 A. I am not altogether sure what
16 sampling or investigation one could do to make it
17 more conclusive. I would say the fact that there are
18 chemical concentrations in the background wells,
19 particularly WAT 2 and MB 14, the relatively low
20 concentrations of contaminants detected in the Waterloo
21 and Morrison Beatty wells over a large area and a
22 very great distance, up to a very great distance from
23 the landfill site, combined with the fact that if we
24 regarded the data to truly reflect groundwater concentra-
25 tions, I think we would be hard-pressed to come up with



Toronto, Ontario

1 a sceanrio of attenuation mechanisms that would allow
2 the movement of trace concentrations those great
3 distances with very little change in concentration.

4 I would believe that the conclusion or
5 interpretation is quite conclusive.

6 Q. Can I follow-up on that and
7 look at the area of well construction , following up
8 from some of the things Mr. McQuaid asked you. I take
9 it that you in former jobs with Golder especially and
10 perhaps with Zenon, and you can correct me, but you
11 have actually constructed and instrumented wells?

12 A. Yes.

13 Q. Have you had similar problems where
14 you have concluded it was from well construction?

15 A. Yes, particularly for compounds
16 like phenols, and yes and in almost the same era when
17 we were using PVC pipe that we didn't clean first and
18 solvent-welded couplings and we would go into a back-
19 ground area in a fairly shallow groundwater system and
20 detect 2,4, 10, 20 ppb or micrograms per litre of phenols
21 and that was of considerable concern to us.

22 Q. Have you had problems ...

23 A. That was even in the days before
24 normal consultants were analyzing for volatile organics.

25 Q. Have you had problems yourself with



Toronto, Ontario

1 volatile organics?

2 A. We had some problems at a couple
3 of sites in the Niagara Falls area.

4 Q. Niagara Falls, New York?

5 A. Niagara Falls, New York. and I
6 believe the compounds were benzene and toluene.

7 Q. With respect to the probability
8 that there is some contamination resulting from the
9 glues, I would take it from your evidence yesterday
10 that if in fact methyl ethyl ketones and tetra-
11 hydrofuran had been analyzed for, some results would give
12 you another data point to give you more confidence?

13 A. Yes, it certainly would and it
14 would have been useful information. It is my
15 understanding that Professor Cherry intends to go
16 back and sample some of those wells to confirm that
17 point at some point in the future.

18 Q. Those two contaminants are the
19 primary components of the glues, and you had a lengthy
20 discussion yesterday and I don't wish to repeat it, but
21 those are the things you look for?

22 A. Those are the main components for
23 the majority of PCV solvent cements.

24 Q. Are there studies on this sort of
25 thing, and I am not asking for them particularly?



1 A. There are.

2 Q. There are levels, known levels
3 in which you would expect to find that kind of material?

4 A. The methyl ethyl ketones and
5 tetrahydrofurans?

6 Q. Yes.

7 A. They are highly soluble in water
8 and I would expect if there was a significant amount
9 of contamination for those compounds that they would
10 be in thousands of micrograms per litre and not just
11 a few micrograms per litre.

12 Q. Is there anything you could
13 similarly do about -- that could make all of this
14 more conclusive about the other side of this, the fact
15 that the pipe wasn't pre-cleaned?

16 A. I guess it is possible that in
17 one of the larger diameter Morrison Beatty wells,
18 one could go in and try and extensively flush --
19 extensively purge the monitoring well and possibly
20 even introduce organic free deionized water down the
21 well with the intention of basically trying to clean
22 the pipe in situ. That is certainly possible for
23 the inside of the pipe, but I am not sure how possible
24 it would be for any contaminants that were actually
25 derived from the outside of the pipe and things



22B 1 external to the pipe.

2 Q. Is there anything similar to what
3 you were discussing about the glue? The composition of
4 ABS cement is widely known and we have been discussing
5 that, but is there anything like that and I am referring
6 to comments you made about the use of cutting oils?

7 A. I am sorry.

8 Q. The use of cutting oils in the
9 manufacture of the pipe. Is there some kind of chemical
10 fingerprint of the cutting oils, for example?

11 A. I am not precisely familiar with
12 what types of cutting oils are used on PVC. I have
13 not investigated that specifically and I don't recall
14 ever seeing any groundwater-related papers on it, but
15 that would be useful information. I am aware that
16 the cutting oils used for the machining of steel products
17 or metal products often have solvents such a small
18 quantity of solvents such as 1, 1, 1-tetrachloroethane
19 as a constituent component.

20 Q. I think the third bullet point
21 you make on page 15 of your witness statement has to
22 do with the presence of benzene, toluene and ethyl
23 benzene and you have been asked questions about that,
24 but I want to confirm a couple of things. I take it
25 you agree that those compounds can occur naturally in



Toronto, Ontario

1 Queenston shale?

2 A. I would expect they could. They
3 occur naturally in the Rochester shale which is
4 stratigraphically higher in the sequence of the
5 Paeleozoic rocks in Ontario, somewhat younger, and also
6 in the lower part of the Lockport formation which is
7 the dolostone cap rock for the Niagara Escarpment.

8 Q. From your point of view as an
9 expert if you were designing some kind of monitoring
10 system for Site F, can I assume that you would not
11 propose to monitor for or put any weight on benzene,
12 toluene or ethyl benzenes because of that?

13 A. In a typical volatile organic
14 analysis scan, benzene and ethyl benzene, toluene and
15 most of the time xylene is also included.

16 Q. You get it anyway?

17 A. You get it anyway, but I think
18 it is true, you could certainly put less weight on the
19 results of those constituents with respect to the
20 migration from the landfill, contaminant migration
21 from the landfill than for the chlorinated organics.

22 Q. I take it we can agree they are not
23 a reliable indicator for that or can we not?

24 A. I think it would actually depend
25 on what was found in properly installed background wells



Toronto, Ontario

1 and largely over the site. If you could establish at
2 this particular location and in this particular
3 hydrogeological environment that in your background
4 monitors and generally over the site that you don't
5 find significant concentrations of benzene, toluene or
6 ethyl benzene or xylene, then in fact they may be
7 reasonable indicators that the concentrations in the
8 leachate are high enough.

9 In other words, it is possible at Site
10 F these aromatic constituents could occur naturally
11 in the groundwater, but I don't actually see evidence
12 of that at the present time, other than the trace
13 concentrations identified in the most recent Gartner
14 Lee study and I am not sure whether they reflect
15 groundwater concentrations.

16 Q. If I could follow up from that
17 a little bit, could you get out Exhibit H-247, the
18 letter from Dr. Pankow to Dr. Cherry?

19 A. Yes.

20 Q. I am referring to the third
21 paragraph and I don't know if it is necessary to read
22 it as I am sure you are familiar with it, Mr. Feenstra.
23 I am wondering about the point Dr. Pankow makes about
24 the possibilities of hot spots, and I think by that
25 he means areas or localized areas of high levels of



1 toluene and he is talking about toluene specifically?

2 A. That's true. I believe he is
3 referring specifically to one result in MB 17 where I
4 believe the toluene concentration was as high as 133
5 micrograms per litre -- the duplicate analysis for
6 that piezometer was 75 and 133.

7 Q. I simply wanted to follow up on
8 what you said a minute ago about the possibility that
9 you could use those if you found consistently low
10 levels or non-detection in background wells given
11 that kind of comment?

12 A. One would certainly have to use
13 a different level of care in interpretation in
14 evaluating those results compared to the chlorinated
15 organics, but what I am saying is that they could be
16 of some use and I don't think they should be dismissed
17 altogether.

18 Q. If I could draw your attention
19 to your discussion of the background findings, that is
20 the table on page 16 of your witness statement, H-86A.
21 I was wondering, Mr. Feenstra, if it would be a
22 reasonable approach to take the background data and
23 do with it much like you have done with the blank data
24 and simply subtract the highest levels you find of the
25 various contaminants as being caused by wells construction



1 contamination and use that as sort of another
2 detection limit, if you will?

3 A. Could you explain that again?

4 Q. Yes, I am sure it was fairly
5 awkward. As I understood what you did with the
6 blank data as opposed to Dr. Pankow, you took all the
7 blank data and lumped it together and looked for the
8 highest value of each compound and you established
9 a number and then you simply -- for all the other
10 results you subtracted from that and if you ended
11 up with a negative number, -- that is the highest
12 blank had a higher concentration than that particular
13 sample, you simply recorded it as LTB?

14 A. I didn't subtract the numbers.
15 When the actual results shown was less than the
16 maximum concentration of the blank, I noted it as LTB.

17 Q. I didn't mean to imply you always
18 subtracted, but just that was my way of expressing it?

19 A. I guess I come from a school of
20 thought that one shouldn't alter the chemical data in
21 terms of subtracting -- it basically turns out to be
22 a field blank from the results.

23 Q. I know that's how you did it in
24 the blanks, but is it reasonable -- let me put it this
25 way; is it reasonable to take the same approach with



Toronto, Ontario

1 the data from the background wells, simply take the
2 maximum concentration you found in the background well
3 and compare it to the other results and only consider
4 those to be valid which exceed the maximum background?

5 A. I think to some degree it depends
6 upon the source of the contamination, because obviously
7 you are trying to correct for the effects of any
8 extraneous contamination, but I think it depends upon
9 the source of contamination and how variable you expect
10 that that might be and also how many background data
11 points one has.

12 With respect to the blank analyses, we
13 have 20 blank results and sampling from 35 piezometers.
14 That is an extremely high ratio of blank tests to the
15 number of samples. I think -- actually in that case
16 one might be justified, or one certainly is justified
17 in calculating the maximum and probably even calculating
18 a more rigorous statistic representing the blank
19 concentrations and determining what your detection
20 limit is accordingly.

21 With only four background well results,
22 I am not sure that that would be entirely appropriate,
23 especially given the source of the contamination
24 which could be quite different from one pipe to the
25 next, and given one pipe being one piezometer installa-



1 tion from another because they are physically
2 different pieces of pipe and they have gone through a
3 different history as to how much water has been purged
4 from them and how much they have been flushed.

5 I am not sure that that would be
6 representative.

7 Q. I gather your suggestion is if
8 you had more background wells, more data, you could
9 take that kind of approach?

10 A. You very well could, that is
11 correct.

12 Q. Now, you suggested another factor
13 is the variability of what you might expect to find?

14 A. That is correct.

15 Q. Do you have any sense of what
16 kind of variability you would expect from the well
17 construction contamination?

18 A. Well, I think the only sense of
19 that is reflected in the table on page 16 and in the
20 various background wells in which some chemicals were
21 detected, for example, 1, 1, 1-trichloroethane going
22 from less than the maximum blank value, which I believe
23 was .32 micrograms per litre, to 3.9 to 5.2 to 3.1
24 and paradichlorobenze which is 1.4, dichlorobenzene
25 varies from 0004 up to .22. Looking at the various



1 chemicals on that table I think that it suggests
2 that the potential variation is quite large.

3 Q. Is it large enough to encompass
4 the type of variation we see in the results for the
5 1, 1, 1-TCA?

6 A. I think it probably is for the
7 TCA and most of the other chemicals, with the exception
8 of toluene. The very high concentrations identified
9 in several of the groundwater samples of toluene,
10 especially the 75 and 133 micrograms per litre;
11 concentrations that high begin to be difficult to
12 attribute those to a degree of contamination one
13 would expect from dirty pipe and solvent-welded joints.
14 It is not impossible, but I think it is certainly
15 becoming more difficult to explain, and it is entirely
16 possible that some of the benzene, toluene and ethyl
17 benzene results shown in Table 2 reflect in some part
18 actual groundwater concentrations, be they natural or quite
19 possibly natural concentrations.

20 Q. Just to conclude on that point
21 slightly, I gather from your table, and I am not sure
22 it has a number, Table 2, the total results, as I
23 read the table the TCA results vary anywhere from what
24 you have reported as lower than the maximum blank
25 right up to 27, 28, 29 in some of the WAT 7 results?



1 A. I believe the highest is 29.

2 Q. I gather from all of this that
3 your opinion is that the variability is such that that
4 is a reasonable variability to find from well construc-
5 tion?

6 A. Up into those values and into
7 the hundreds I think would be more difficult to explain.

8 Q. What about the chlorobenzene?
9 I am looking back at the table on page 16 which shows
10 the results for the background piezometers and
11 chlorobenzene is either non-detected in three of them
12 and lower than the blank, the maximum blank in the
13 other. Is that data more valid?

14 A. More valid than what?

15 Q. Than the 1, 1, 1-TCA.

16 A. I am not altogether sure that it
17 is given that we only have four background analyses and
18 the concentration of chlorobenzene was fairly low.
19 Certainly the assessment of the validity of the chloro-
20 benzene concentrations is much more in question because
21 you actually did not detect it in the background well
22 as you did several of these other compounds.

23 Q. But it was found in other
24 wells down-gradient?

25 A. It was found in many of the other



Toronto, Ontario

1 wells as I recall. It should be in the histograms
2 actually. Just quickly scanning over Table 2, it
3 was detected in roughly half of the monitoring wells,
4 or maybe slightly less than half, but approximately
5 half.

6 Q. In terms of lateral extent in a
7 north-south direction, the last place it is detected
8 at the Bayview landfill is at MB 12, is that right,
9 in the deeper piezometer?

10 A. I must get out a figure. I am
11 just checking, but chlorobenzene was found in MB 12, it
12 was not found in WAT 7 and I just spied a correction
13 required on Table 2 that no one has pointed out to me
14 yet.

15 Q. Oh, dear! Let me find it...

16 A. I was going to point it out ...
17 for MB 13-2, the one result for chlorobenzene identified
18 as .00929. If you go up to the top of the page and
19 compare it to the maximum blank value, it is obviously
20 less than the blank and that should read LTB on that
21 particular sample. It is the very bottom line.
22 Chlorobenzene was not detected at levels greater than
23 the maximum blank in WAT 7, WAT 13 or WAT 18 or 16 or
24 17.

25 Q. The farthest down-gradient well



Toronto, Ontario

1 detected is MB 12?

2 A. MB 12, that is correct.

3 Q. Do you have an opinion on why it
4 is not valid to use chlorobenzene, to use the chloro-
5 benzene data as being indicative of leachate?

6 A. Well, I guess largely it was
7 convicted by implication with the other compounds that
8 were present in the background wells.

9 Q. Can you confirm for me that in fact
10 chlorobenzene is found in the leachate at Bayview itself?

11 A. Yes, it is.

12 Q. Mr. Feenstra, is it -- can you
13 agree with me that there are other interpretations
14 of at least some of this data than yours?

15 A. Yes, there are few aspects of
16 hydrogeology that aren't a subject of interpretation.

17 Q. I always find that a safe question
18 actually.

19 MR. HODGSON: Could it be a valid inter-
20 pretation and perhaps that would qualify it in the
21 usual way?

22 MR. TIDBALL: Q. I am prepared to put
23 that to you. Are there other equally valid inter-
24 pretations, and I am comparing this to your inter-
25 pretation?



1 A. For most data sets there are.

2 Q. We are off the general question
3 and given your interpretation or your opinion about
4 the validity of the Waterloo data, I am simply asking
5 you if there are other equally valid interpretations?

6 MR. HODGSON: Mr. Chairman, that is so
7 speculative. Perhaps he would like to put an inter-
8 pretation to the witness and ask him if it is equally
9 valid, or frame the question as is it possible there
10 are other equally valid interpretations. I admit
11 it is very speculative, but at least it leaves it open
12 that some day someone will come along with an
13 interpretation which can then be put to the witness
14 as to whether the fact is valid, but the question as
15 framed is, with the greatest respect, useless.

16 MR. TIDBALL: I was simply putting
17 Mr. Hodgson's question before he had a chance to do
18 it in reply.

19 THE WITNESS: I find it difficult to
20 assess the validity without knowing the interpretation.

21 MR. TIDBALL: Q. Is it an equally
22 valid interpretation of the data from the Waterloo
23 study that it shows migration of contaminants from
24 the Bayview site?

25 A. Contaminants being volatile organic



1 chemicals?

2 Q. Yes, that being the results
3 reported on.

4 A. I think the conclusion on the
5 volatile organic chemicals would be --a conclusion of
6 migration from the Bayview site would be relatively
7 tenuous based on the chemicals identified in the
8 various piezometers and the occurrence of many or
9 most of those chemicals in the background installations.

10 Not all the chemicals are found in
11 every background installation. Some of them such as
12 trichloroethane -- actually trichloroethane isn't even
13 found in all the background installations, -but para-
14 dichlorobenzene is found in all four, benzene is not,
15 toluene is, ethyl benzene is not, and to some degree
16 the variability between the four background installations
17 and the fact that most of the chemicals I guess with
18 the exception of two were identified in at least one
19 of the installations, one must question the majority
20 of the volatile organic analyses given the nature of
21 the extraneous contamination suggested, and given
22 that we know many of these chemicals can be derived
23 from the use of uncleaned pipe and solvent-welded
24 PVC couplings, but we can't precisely say which ones
25 are and which ones aren't.



1 So, to some degree it is guilt
2 by association, but that is the basis of the conclusion.

3 Q. The guilt by association refers
4 to the chlorobenzene?

5 A. Chlorobenzene and I guess one
6 might even wonder about benzene and ethyl benzene
7 not being found, or only being found in two of the four
8 background wells and they would be classified in the
9 same category.

10 Q. But the ethyl benzene is subject
11 to the caveat about the possibility of contamination
12 from the shale itself?

13 A. Oh, ethyl benzene and benzene,
14 yes.

15 Q. Given the kinds of uncertainties
16 that are prevalent in all of this, Mr. Feenstra,
17 can we agree that it would be a conservative approach
18 to assume that the Waterloo data reflects the move-
19 ment of contaminants?

20 A. That would certainly be a conservative
21 approach, yes.

22 Q. That is the point I wanted to
23 come down to. If we assume --

24 A. In fact that was precisely the
25 approach taken in 1986 for our contaminant transport



1 modelling.

2 Q. If we assume that for the moment,
3 that the Waterloo data does reflect movement of
4 leachate, does it matter?

5 A. The concentrations are low and
6 with very few exceptions for any of the chemicals
7 identified do the concentrations of volatile organics
8 exceed drinking water standards established by other
9 regulatory agencies. The main -- I guess the main
10 consideration of the impact of that groundwater
11 contamination would be twofold. No one actually uses
12 groundwater from the deeper shale formations for
13 drinking water supplies, mainly because of elevated
14 concentrations, naturally occurring concentrations of
15 chloride and sulphate and other inorganic constituents.

16 Wells south of the site, south of the
17 CNR; there have been identified some groundwater
18 users at a distance of 1.5 kilometres from the landfills.
19 The groundwater users in these areas utilize ground-
20 water from shallow wells, either in the overburden or
21 in the very shallow part of the shale bedrock in that
22 area, and in that shallow flow system the actual ground-
23 water chemical composition of the groundwater, although
24 not pristine, it is certainly within drinking water
25 standards for chloride, and I believe in most cases



Toronto, Ontario

1 also for sulphate.

2 The main receptors of any ground-
3 water contamination emanating from either Bayview,
4 Burlington or the proposed Site F is suggested to
5 either discharge to the ground surface or to the shallow
6 groundwater flow system south of the site, that being
7 either in the discharge zone between the CNR and Highway
8 403 as indicated in Exhibit H-85, the last figure
9 we were looking at yesterday...

10 Q. In the interrogatory?

11 A. In the interrogatories,
12 correct, and also possibly because there are upward
13 groundwater hydraulic gradients in HC10, HC11 and HC12.
14 I don't think it is possible to draw a distinct
15 delineation of this discharge zone at the CNR track,
16 that is not a magical boundary, and some of this
17 discharge could also be occurring south of the CNR
18 tracks. If one considers that the chloride
19 concentrations in the deeper part of the shale are
20 measured in thousands of milligrams per litre, some-
21 times over 10,000 milligrams per litre of chloride,
22 acknowledging that there are upward groundwater
23 gradients suggesting some degree of groundwater discharge
24 from the deeper shale, and if one examines the chloride
25 concentrations in the shallow groundwater in this area



Toronto, Ontario

1 where there are some groundwater users, with these
2 concentrations averaging 50 milligrams per litre, it
3 leads one to the conclusion that if in fact there is --
4 well, there does appear to be groundwater discharge
5 but the actual rate of groundwater discharge from
6 deeper in the shale to the shallow groundwater zones
7 is very, very low.

8 So, any discharge that does occur
9 is very extensively diluted and that degree of dilution
10 which would be several hundred times based on the
11 difference between the chloride concentrations at
12 depth and the chloride concentrations in the shallow
13 groundwater zone, and which was also referred to as
14 the fresh water rind in Mr. Sobanski's testimony, that
15 dilution factor would also apply to any other ground-
16 water contaminants such as the volatile organics
17 that might have actually made their way that distance
18 from the site.

19 In addition, if there is any discharge
20 of groundwater containing low concentrations of these
21 volatile organic chemicals, it discharges to the marshy
22 area in this zone between Highway 403 and the CNR and
23 it is one of the attributes of this class of chemicals,
24 the fact that they are relatively mobile and also it
25 suggests, and not strongly adsorbed on organic matter



Toronto, Ontario

1 and geological materials, but also is a property that
2 relates to how they bioaccumulate in aquatic systems or
3 biological systems, and the conclusion there is that
4 they don't.

5 These materials or these chemicals
6 aren't strongly associated with organic materials and
7 don't bioaccumulate in plant and animal material and
8 so from the point of view of discharge into a surface
9 water environment that is not used for drinking water,
10 there are a variety of factors that must be considered
11 and one is that they don't bioaccumulate and most of
12 these chemicals aren't acutely toxic to aquatic life
13 and unlike other chemicals, and a disinfectant might
14 be the case, they are not toxic to aquatic life in
15 concentrations of 10 to 1000 micrograms per litre and
16 in a surface water environment, because they are
17 volatile they will be readily lost to the atmosphere
18 and in the atmosphere they undergo fairly significant
19 photodecomposition by ultraviolet light and are
20 degraded in that manner.

21 In many ways the impact of these kinds
22 of chemicals, although they are mobile in a groundwater
23 system, and certainly very significant with regard
24 to water used for drinking water in concentrations --
25 in concentrations defined by drinking water standards



Toronto, Ontario

1 from other jurisdictions, they are quite unlike other
2 chemicals in the fact that they are not a true
3 concern with respect to discharge to surface water
4 environments and with respect to toxicity and their
5 persistance in that environment.

6 Q. Can I take from all of that that
7 the answer to the does it matter question was no?

8 A. That is correct. I am sorry I
9 didn't conclude it that way.

10 Q. I appreciate the answer.

11 Mr. Chairman, I am about to move to the
12 last area I have which has to do with the monitoring
13 programs for both Site D and F and, given the fact
14 that my estimates so far have been wildly inaccurate,
15 I don't know how long it will take me, perhaps a half
16 an hour and I am mindful of the fact that Mr. Feenstra
17 has a commitment...

18 THE WITNESS: My meeting will begin
19 when I arrive in Waterloo.

20 MR. HODGSON: I think Mr. Tidball is
21 trying to keep going so he doesn't have to cross-
22 examine tomorrow.

23 MR. TIDBALL: I will never admit to it.

24 MR. LANCASTER: Say until 2:15.

25 ---Luncheon Adjournment at 1:03 p.m.



1 ---Upon resuming at 2:15 p.m.

2 MR. LANCASTER: Be seated please.

3 MS. CRONK: One more matter on the order
4 of counsel for cross-examination. I had not realized
5 at the time I addressed you before, but Ms. Mansfield
6 is present today and she has confirmed that she signifies
7 an intention to cross-examination Mr. Hiraishi.

8 We had a discussion about the merits and fairness of
9 her preceding Milton and obviously me on behalf of
10 National Sewer Pipe, and she has agreed to follow
11 Mr. Tidball in the order of cross-examination. If
12 that is where we are we will put her on some time
13 tomorrow afternoon and that relieves a bit of the timing
14 problem and I thought that I would pass that on to
15 you.

16 MR. LANCASTER: I think we are going
17 to have a busy afternoon today.

18 MR. TIDBALL: I heard a rumour to that
19 effect.

20 Q. Mr. Feenstra, I wanted to turn
21 my attention to the whole issue of monitoring and to
22 talk about monitoring both Sites F and D and I wanted
23 to specifically ask about any recommendations you might
24 have with respect to both sites. Prior to doing that
25 there are some questions by way of introduction, I



Toronto, Ontario

1 suppose, and the first is did you have any input into
2 the monitoring program as set out in the Hydrology
3 Consultants' reports and as described by Mr. Sobanski
4 in chief?

5 A. No, I did not.

6 Q. I want to refer you to something
7 I asked Mr. Sobanski. At the beginning of my cross-
8 examination, I think you were here?

9 A. I can't recall.

10 Q. At the beginning of my cross-
11 examination of Mr. Sobanski, and the day was June 18,
12 but I put to him three criteria I asked him whether
13 he could agree were criteria that would go to the
14 acceptability of any particular site for landfilling.
15 I don't want to refer all three to you, but I do
16 want to refer to the second.

17 The second one, and he agreed it was
18 a reasonable criteria, but the second is that it should
19 be a criterion that you should be able to develop a
20 monitoring program which should be capable of identifying
21 the movement of landfill-derived contaminants. Can
22 you agree with the fact that that should be one
23 criterion for the acceptability of a landfill?

24 A. I would agree with that.

25 Q. First dealing with Site F, and



Toronto, Ontario

1 before I get into specific questions about your
2 thoughts on monitoring, I wanted to approach it at
3 a more general level because it occurs to me that
4 the monitoring program that has been designed has been
5 relatively dependent on the geologic and especially the
6 hydrostratigraphic interpretation of that site by
7 Trow, specifically by Mr. Beechinor and Mr. Sobanski.

8 A. To some degree that is correct.

9 Q. So, I start this whole area
10 with whether for the purposes of designing a monitoring
11 program you can agree with that interpretation; the
12 four shale units and the highly fractured unit four
13 acting as what amounts to an underdrain for the whole
14 site?

15 A. I think as a framework
16 for the sub-surface environment beneath Site F, yes,
17 I would agree with that conceptualization.

18 Q. You agree?

19 A. Acknowledging that perhaps there
20 will be variations from location to location in that
21 environment. I think that is evidenced by the tritium
22 results between HC5 and HC8 which indicate tritium penetrat on
23 through much of the thickness of the shale at HC5 and
24 a very minimal penetration by tritium in HC8, reflecting
25 that in some areas the highly fractured zones and not



Toronto, Ontario

1 just the highly fractured unit zone 3, but the fracture
2 zones other than that may in some areas not be connected
3 with the fracture zones in other areas necessarily.

4 Q. You have told the Board already
5 I believe that with respect to the highly fractured
6 unit, I guess you disagree with Mr. Sobanski or took
7 a different position than Mr. Sobanski in that you
8 would have assigned a higher permeability value to
9 that unit?

10 A. Lower.

11 Q. Lower. A lower permeability.
12 You would have assigned 10^{-4} ?

13 A. In my evaluation of the pumping
14 test results, rather than dividing the transmissivity
15 determined by the pumping test by a thickness of
16 .3 metres, I would have selected the thickness
17 represented by the length of the open section in the
18 pumping well, and I can't recall the exact numbers,
19 but I believe it was something in the order of 18 metres,
20 17 or 18 metres, but considerably longer than .3 metres
21 anyway, and that would result in a correspondingly
22 lower value for the calculated hydraulic conductivity.

23 As I recall, I calculated the hydraulic
24 conductivity for the network of piezometers in which
25 there was a hydraulic response, and I believe the geo-



1 metric mean was 3×10^{-4} centimetres per second.

2 Q. I take it that it would be proper
3 in designing a monitoring program to take into account
4 the fact that there could be, and I don't know how to
5 put this exactly, and not errors in interpretation, but
6 the fact that the interpretation may not reflect field
7 conditions?

8 A. The interpretation or the
9 conceptualization of the flow system as it has developed
10 is meant to reflect what you might consider typical
11 conditions for that site and there are some areas
12 where the conditions could vary somewhat from that
13 interpretation; correct.

14 Q. And it is sensible in that sense
15 to set up a monitoring program to account for those
16 types of contingencies?

17 A. It would be.

18 Q. One more question in that area.
19 Mr. Sobanski put before this Board two versions of the
20 Flownet model and one is found in Exhibit H-40 and
21 one is filed with the Board as H-221. Do you have
22 Exhibit H-221 as well, Mr. Feenstra?

23 A. I thought I did.

24 Q. It is the last page of the exhibit,
25 a three-page exhibit, and it is the last page?



1 A. Yes, I have that now.

2 Q. Mr. Sobanski expressed some
3 opinion on both of these models and I don't want to
4 misstate what he said, but I think the effect of what
5 he said was that he preferred the second model, the
6 H-221 in the sense that it was a better fit, although
7 he was prepared to sort of live with both of them, one
8 being more conservative than the other, and I wonder
9 if you have an opinion on what model is the more likely
10 model for this site?

11 A. I guess I can't argue with the
12 computer with regard to which one appears to be a
13 better fit. The case that was run with anisoprity
14 as presented in Exhibit H-221 I believe would imply
15 a vertical hydraulic conductivity of the weakly
16 fractured shale of 10^{-8} centimetres per second being
17 a factor of 10 lower than the 10^{-7} that was assumed
18 previously.

19 Q. We are talking about the massive
20 unit and not the highly fractured?

21 A. The weakly fractured zone.

22 Q. I like the unit 3 and 4 business.

23 A. Unit 3.

24 Q. Thank you.

25 A. Zone 3. Based on tritium analyses



1 at the site, both at Site F and at Bayview in the
2 Morrison Beatty wells, I am not sure that a vertical
3 hydraulic conductivity for that weakly fractured shale in
4 that range would be consistent with the tritium we
5 find at depth in some of the zones.

6 Although I would concur with the
7 hydraulic conductivity used for the highly fractured
8 shale unit of 10^{-4} , I am not sure that I feel that
9 comfortable with using a lower value for the vertical
10 hydraulic conductivity for the weakly fractured shale.

11 Q. Would the effect of leaving the
12 vertical hydraulic conductivity in the weakly fractured
13 shale at the same level as was originally modelled
14 be that you would end up with a model somewhere in between
15 these two?

16 A. In terms of goodness of fit,
17 I really couldn't say.

18 Q. Finally, before we go on to the
19 monitoring program itself, I wanted to ask you a
20 little bit about your conclusions with respect to the
21 Burlington and Bayview data insofar as it gives you
22 confidence in your contaminant modelling.

23 I took from your evidence-in-chief
24 and from your cross-examination, your comments in cross-
25 examination to Mr. Garrod, that your position is that



1 without the Burlington and Bayview data, you are less
2 confident in the ability of your contamination migra-
3 tion model to predict what will really happen at this
4 site, but the existence of that data as you interpreted
5 it, and I don't know how to express it, but it gives
6 you a warmer feeling or gives you more confidence in the
7 data or in the model, sorry?

8 A. I can't recall my exact words,
9 but what would be evident is that without the benefit
10 of the data from the Bayview and Burlington sites,
11 I think it would have led us to suggest that the impact
12 resulting from Site F might have been somewhat higher
13 than I think we would suggest at the present time.

14 Q. That is with respect to the weather-
15 ed zone?

16 A. The weathered zone and the deeper
17 zones in the shale.

18 Q. In the sense -- have I got it
19 right, the fact that you don't find or in your opinion
20 as you interpret the Burlington and Bayview data, the
21 fact you don't see leachate at depth or contaminants
22 at depth indicates to you that in fact the massive
23 shale at unit 3 is acting as you have modelled it should
24 act, and in fact we are in middle of the 30-year travel
25 time through that unit?



1 A. At Burlington?

2 Q. Burlington or Bayview actually.

3 A. I am not sure I caught what the
4 question was.

5 Q. The question is with respect to
6 the deep zones, with respect to not the weathered shale
7 but what has been characterized as unit 4, the highly
8 fractured unit, the fact that you interpret the data
9 as not showing any evidence of leachate migration into
10 that zone, is that what you are saying or are you saying
11 that that fact gives you more confidence that the model
12 is right in that you were predicting a 30-year travel
13 time through the massive shale. I just want to under-
14 stand what your position is.

15 A. I am not sure that we have evaluated
16 observations at the sites to compare them to the model
17 results quite in that way, in order to evaluate whether
18 the model results are right or not. I think to some
19 degree the fact that we don't see contamination deeper
20 within the zones in the shale is consistent with our
21 conceptualization of the flow system and the appropriate
22 travel times as estimated by the modelling.

23 That doesn't necessarily imply that the
24 model is right per se, but that the observations be
25 consistent with the model.



1 Q. Can you use it in a relative
2 sense, comparing it to the modelling exercise at
3 Site D? Does it do anything to a relative level of
4 confidence?

5 A. Yes, I guess to some degree it
6 would, it would increase the level of confidence in the
7 applicability of the contaminant transport models and
8 compared to Site D where that type of comparison is
9 just not possible.

10 Q. To a significant level in your
11 opinion?

12 A. It is a reasonably relative
13 term, but, yes. The comparison of a field example or
14 field observations with any type of calculation or
15 model results I think would have to be considered
16 as a reasonably significant confirmation of the
17 estimates or calculations.

18 Q. Now, with respect to Site F,
19 I want to ask you specifically about several things
20 with respect to monitoring programs. I want to ask
21 you specifically about locations, about construction
22 of those wells, and whether in fact new wells are
23 needed or not, frequency of monitoring, the parameters
24 which you think should be monitored for, and sampling
25 techniques that might be used. I want to ask you that



Toronto, Ontario

1 within the context of some uncertainty with respect
2 to the actual fate of leachate coming from this site.

3 I have noted down what I thought to
4 be perhaps four alternative scenarios that aren't out
5 of the question. The first one is that the site
6 behaves as predicted, the leachate or contaminants
7 move along the highly fractured unit and discharge
8 up into the discharge zone till, and that is the model,
9 if you will, put forward by Mr. Sobanski?

10 A. Yes.

11 Q. The second one is the same thing
12 occurs as Mr. Sobanski described, I think in some
13 cross-examination; in fact the contaminants didn't
14 move upwards through the discharge zone till but
15 moved laterally along the till/shale interface and
16 do you recall Mr. Sobanski saying that in cross-
17 examination?

18 A. I recall something along that line.

19 Q. I guess a variation of that would
20 be rather than moving along the till/shale interface, it
21 moves laterally in the shale itself and I think
22 Mr. Sobanski talked about that and you will recall
23 his evidence with respect to the unlikelihood of being
24 able to see it if it got around the houses in Aldershot?

25 A. I don't actually recall that aspect.



1 Q. Another one it seems to me
2 is one that I think you were talking more about this
3 morning, that the discharge zone is much bigger and
4 there is discharge up into the till over a much more
5 widespread area and in fact extending down to where we
6 see upward gradients at HC10, 11 and 12?

7 A. 10, 11 and 12.

8 Q. The last possible scenario I put
9 to you is that leachate is in fact not coming up at
10 all but goes into some deeper system and ends up
11 eventually in Lake Ontario. I am wondering, first of
12 all, would you agree with me that those scenarios
13 should all be looked at in terms of designing a
14 monitoring program or do we need to look at any of
15 them other than the one that has been predicted?

16 A. I think it depends to some
17 degree on your overall viewpoint. Certainly the first
18 line of monitoring, whatever scenario you select,
19 would be located fairly closely to the landfill itself.
20 The decision to monitor at which specific distance
21 to monitor, I think, becomes a more difficult question
22 and it depends largely on what scenario of the four
23 you described we considered to be the most significant
24 from the viewpoint of its potential impact.



1 present time, I think in each one of those scenarios,
2 if one monitored only close to the landfill site itself,
3 on-site close to the margin of the landfill and possibly
4 along Highway 403, which would be close to the site
5 boundary, whatever scenario one chose to look at, either
6 discharge to the ground surface in the area of the
7 discharge zone that was discussed before between Highway
8 403 and the CNR, movement laterally through that till
9 toward the south, discharge upward into the area in the
10 vicinity of Plains Road, I think -- what was the
11 fourth one? Oh, Hamilton Harbour.

12 In each of those scenarios I think the
13 lead time one would have between the detection of
14 contaminant migration on the site here, in the shale bed-
15 rock and its appearance-- not necessarily its appearance
16 but an impact resulting from that migration in any of
17 these zones, I think the lead time would be sufficiently
18 long that upon detection at the site boundary or
19 immediately south of the landfill, one could implement
20 a scheme at a distance further south.

21 I am not sure initially whether it would
22 be appropriate or prudent to determine ahead of time
23 without some additional information which of these
24 particular zones would be the best to monitor in the
25 long-term.



1 Q. In the short-term the key is
2 the monitors that are immediately proximate to the
3 landfill?

4 A. I believe that that is the case,
5 yes.

6 Q. Could you pull out, and I think it
7 is probably on a large board, but Drawing 22 from
8 Exhibit H-40, the monitoring system it's called as
9 proposed by Mr. Sobanski?

10 A. Is that just an aerial photograph
11 of the site or a map?

12 Q. An aerial photograph.

13 A. Okay. While Mr. Hodgson is
14 looking for the exhibit this is a copy of Figure 22.

15 Q. That's fine.

16 A. With the appropriate numbers, I
17 believe.

18 Q. That is even better. I don't
19 have my copy so I don't know about the numbers so I am
20 relying on you, Mr. Feenstra. What we are talking about
21 is that series of wells immediately south of the
22 landfill, between there and the North Service Road.

23 A. This area in here, in this little
24 wedge (indicating)?

25 Q. ~ Yes.



1 A. I guess that would include the
2 monitors in this location also.

3 Q. I believe so. Those were the
4 monitoring wells we were talking about that are of
5 critical concern.

6 A. Those would be the first line of
7 monitoring which might suggest migration through the
8 sub-surface.

9 Q. Now, first of all, would I be
10 right that you would propose a more rigorous method of
11 installing these wells to try and avoid the problems
12 we have been talking about at length for the last
13 few days?

14 A. It would my intention anyway
15 that these monitoring wells would be installed
16 specifically for the purpose of sampling and analysis
17 of the volatile organic chemicals and, that being the
18 case, yes.

19 Q. All right.

20 A. I think a variety of precautions
21 should be undertaken to prevent potential contamination
22 from the sampling materials itself or during drilling
23 or during well installations.

24 Q. I assume we are talking about
25 stainless steel wells?



1 A. Stainless steel wells, steam
2 cleaned on-site. I would think that that would also
3 include confirmation, rinses of the stainless steel
4 casing, analysis of the rinse water to document whether
5 there is any contaminants associated with the well
6 materials itself. I would think the actual placement
7 vertically of the zones to be monitored would be
8 performed in much the same way as the investigations
9 conducted by Hydrology Consultants on Site F, and that
10 would be the deepest hole at a particular location
11 should be cored and the core examined very carefully
12 to identify fracture zones or zones of discontinuities
13 and at that stage I would also suggest that hydraulic
14 testing be conducted in the borehole to document or to
15 confirm whether the fracture zones as identified are
16 actually zones of high hydraulic conductivity.

17 There is one slight modification;
18 rather than doing a packer test where water is pumped
19 in , to do a packer test where water is actually
20 removed rather than introducing water into the formation.

21 Q. Would you propose instrumenting
22 any zone that you found that was relatively transmissive.
23 Is that the proper term?

24 A. Transmissive is a good term to use,
25 yes. Certainly the major zones, major in terms of either



1 the hydraulic conductivity value that was determined
2 or the thickness or vertical extent of the zone, the
3 major zones, they should certainly be instrumented
4 but precisely how many zones you should instrument and
5 to what level of detail you should go to, I couldn't
6 make that assessment at this time and that would depend
7 somewhat on the actual findings in the specific borehole
8 locations.

9 Q. You made a suggestion this morning,
10 Mr. Feenstra, that you would be looking at something in
11 the order of a screen length of 2 to 3 metres as opposed
12 to the shorter length that has been used?

13 A. I would make them slightly longer
14 than the metre or metre and a half used on the site
15 previously.

16 Q. Does that cause any problem with
17 respect to dilution and detectability in looking for
18 trace levels of volatile organics?

19 A. In this particular case I doubt
20 if it does. For specific fracture zones within a
21 rock mass that is relatively unfractured, say a
22 specific transmissive zone interpreted to lie within
23 the middle of zone 3; in other words, the rest of the
24 interval that is screened in the monitoring well is
25 relatively impermeable, then the majority of the water



1 will be coming through the fracture zones you have
2 instrumented and you won't get a great deal of dilution.
3 With respect to the highly fractured zone, although in
4 some areas the discontinuities or fractures that are
5 primarily horizontal or sub-horizontal in this zone
6 may not be perfectly connected vertically, I
7 would think in general we would be surprised to find
8 that one set of fractures within a zone we have
9 identified as being reasonably highly fractured is
10 isolated from the zones immediately above and below.

11 So, I don't think there would be the
12 situation where we would have one or two fractures in
13 the highly fractured zone transmitting the bulk of the
14 water and other equally transmissive zones delivering
15 clean water to our monitoring well while we are
16 sampling. I would think that that would be fairly
17 unlikely.

18 Q. In deciding to where instrument,
19 what kind of weight do you give to the interpretation
20 that has been done already at this site, and I refer
21 you specifically to the existence of a highly fractured
22 unit at the 100 to 110 metre elevation? Do you sort
23 of discard that and start from scratch and say let's
24 look for the transmissive zones, or do you concentrate
25 on that, those particular elevations, and make sure that



Toronto, Ontario

1 that is all screened?

2 A. I think you obviously have to
3 take into account the investigations that have been
4 performed on the site in the past, and that should
5 certainly give you the elevations and the characteristics
6 as a target to be looking for specifically when one
7 puts in a borehole. If you are implying that you should
8 go in and automatically instrument the zone between
9 125 and 110 metres, in most areas in the south end
10 of the site, I don't think that would be the most
11 appropriate thing to do. I think it should largely
12 depend upon what is found at the particular location.

13 To some degree any uncertainties related
14 to the transmissivity or the hydraulic conductivity
15 of a particular zone, or the interconnection of that
16 particular zone with zones above and below in the same
17 boring or laterally in other borings, could be documented
18 reasonably well by doing a series of pumping tests to
19 confirm that the zones that your installations are
20 set in are in fact the zones, the predominant zones
21 that transmit water.

22 Q. With respect to that, Drawing 22...

23 A. I might point out that it is
24 certainly possible to do that kind of monitoring and
25 give oneself the assurance that you are monitoring the



1 appropriate zones, but I might also point out that that
2 approach is actually quite different than the approach
3 taken at most waste disposal sites in Ontario.

4 Q. I think we could agree.

5 A. It would be considerably more
6 costly than a typical monitoring program.

7 Q. Do you have any comment at all on
8 sort of the extent, geographic extent and total number
9 of the monitors proposed by Mr. Sobanski in interrogatory
10 22, the ones down by the North Service Road?

11 A. I believe the suggested number of
12 monitors along the south side of the landfill would
13 include, 1, 2, 3, 4 locations along -- immediately
14 adjacent to the landfill, sort of on the Site F
15 property, and another four between the property and
16 Highway 403 and so that would be approximately 8
17 locations.

18 Q. Is that sufficient in your opinion?

19 A. In terms of number of locations
20 I would think that that would certainly be adequate
21 for the first phase of the monitoring program.
22 Obviously it is dependent on what one finds in coring,
23 in examining the rock core, and what one finds in terms
24 of permeable zones and interconnections between those
25 permeable zones. Given the radius of influence of the



1 pumping well at PW 1 which extended as far north as
2 MB 12 and as far east as MB 16 and south at HC9,
3 it is evident that some particular zones are quite
4 extensive, over a distance of several hundred metres.

5 So, having four or approximately four
6 monitoring locations along the south end of the site and
7 spaced at approximately 100 to 150 metres would be a
8 good first step.

9 Q. I suppose, Mr. Feenstra, that your
10 latter comments go to the point that monitoring programs
11 are in some sense dynamic and certain flexibilities
12 have to be maintained?

13 A. I think they certainly should be,
14 that is correct.

15 Q. What kind of sampling technique
16 would you recommend for these monitoring wells?

17 A. With respect to volatile organic
18 contaminants and the fact that the water levels in
19 many of these wells are going to be fairly deep because
20 of the strong downward gradients, probably the most
21 efficient way of sampling would be the use of dedicated
22 pumps, positive displacement pumps such as air-
23 driven bladder pumps where the air does not come in
24 direct contact with the sample itself. The sample is
25 not put under any kind of vacuum or stress such as that



1 which would tend to encourage the loss of volatiles,
2 and these pumps can either be bought out of totally
3 PCV construction with no solvent-welded joints but
4 made by machine companies and they can be readily
5 cleaned and demonstrated to be cleaned by doing final
6 rinses of the pumps.

7 These pumps are also available in
8 Teflon at a considerable additional cost. My opinion
9 at the present time is that Teflon does not have
10 any inherent property that makes it far superior to
11 PCV as long as the pump and materials are cleaned
12 are checked prior to use.

13 I would suggest that such pumps be
14 actually left in place and dedicated to the wells
15 to avoid having to reclean them all the time for one
16 thing, but also to avoid the use of any potential
17 cross-contamination of borings.

18 Q. That is what Gartner Lee is doing
19 at the Burlington site?

20 A. They are using a slightly
21 different pump and it is actually a mechanical water
22 lift pump, but I believe those types of pumps are now
23 installed in all the wells and would be intended to be
24 left in the wells in which they are installed.

25 Q. What kind of frequency is



1 required for analysis for volatiles and is it any
2 different than the analysis for anything else?

3 A. I don't think there is any
4 fundamental reason why the analysis, the sampling and
5 analysis of volatiles should be anymore frequent than
6 any other water quality parameters at any other location.
7 Given the estimated travel times through the system
8 based on the groundwater velocities, one might be able
9 to rationalize either annual or biannual twice a year
10 monitoring of groundwater quality, and I think that is
11 reasonably typical or at least annual monitoring is
12 typical of most landfill sites in Ontario.

13 In the United States at landfill sites
14 and other hazardous waste disposal facilities, regard-
15 less of the environment, the geological environment,
16 there is usually a requirement for quarterly monitoring,
17 and I don't think you could argue specifically that
18 quarterly monitoring is necessary over biannual
19 monitoring and to some degree it depends on costs and
20 the sensitivity of the monitoring results.

21 Finally, are there specific parameters
22 you would recommend as being essential to look for in
23 terms of a monitoring program at Site F?

24 A. Specific parameters by chemical?
25 By chemical group it would be a scan for volatile



1 organics.

2 Q. As I understand it, if you do a scan
3 you get them all anyway?

4 A. That is correct, whether they are
5 done by straight gas chromatography with whatever
6 variety of detector is chosen or by MSGC, mass
7 spec gas chromatography, you would get a scan indicating
8 the presence of the whole scale of volatile organics you
9 would be interested in which includes the chlorinated
10 compounds and the aromatics like benzene and toluene.

11 Q. I guess one final comment on that.
12 I notice from looking at Drawing 22 that it appears
13 from this that wells HC8 and MB 17, at least on that end
14 of the landfill, are being proposed for use within the
15 monitoring network and have you any comment on either
16 or both of their suitability for that purpose?

17 A. It could probably be demonstrated
18 by sampling and analyzing them whether you would feel
19 there may be any extraneous contamination associated
20 with the installations at those two locations. To be
21 consistent with the remainder of the installation
22 program, and certainly in terms of justifying the
23 results at some later date, I would suggest it would
24 be prudent to make monitoring installations at those
25 locations consistent with the new installations elsewhere,



1 and I would be reluctant to use the old installations
2 for the purposes of analyzing for trace organics.

3 Q. Mr. Feenstra, this whole discussion
4 was premised on the fact that what we are talking about
5 here is Phrase I, and we started with the notion that
6 there are varying possibilities, it would appear, or
7 at least there are possibilities that leachate or
8 the contaminants may discharge at different places.
9 Is that whole area in your opinion to be left for a
10 later phase?

11 A. I would think that that kind of
12 approach could reasonably be taken and implemented at
13 a later stage, depending upon the monitoring results
14 close to the landfill. In the particular case at
15 Site F where even though we may observe off-site
16 migration, the immediate impact of that off-site
17 migration would be relatively low in terms of there
18 are no potential groundwater users downstream, down-
19 gradient except at considerable distance, and our
20 expected impact on any surface water environment
21 will also be low.

22 I think those considerations are
23 somewhat different than at Site D, where monitoring
24 at the site boundary or immediately adjacent to the
25 site upon detection of any chemical contaminants in the



1 granular units, that puts the contaminants immediately
2 in a zone where groundwater is used for drinking water
3 supply, even though you will have some lead time before
4 things migrate off-site.

5 There is still a fairly distinct
6 potential impact on the groundwater use.

7 Q. I take it then the whole thing
8 at Site F -- would have been right that the whole
9 trick at Site F then, Mr. Feenstra, is to be certain
10 that we are able to detect things moving at the
11 boundary?

12 A. I wouldn't call it "a trick," but
13 that would be the objective.

14 Q. I was searching for a word. I
15 was going to say game, but that didn't seem right
16 either. Are you confident that a monitoring program
17 can be designed to do that?

18 A. I am confident a monitoring
19 program could be designed to do that with the recogni-
20 tion that it would probably be unlike any other
21 monitoring program developed for a landfill in Southern
22 Ontario and for the benefit of the operators of this
23 site, at considerably more expense than the typical
24 monitoring program.

25 Q. Could I then turn your attention



1 to Site D. I want to ask you the same sort of
2 questions on Site D, Mr. Feenstra?

3 A. Will I need a figure like this
4 for Site D?

5 Q. That might be helpful. I start
6 with the same type of questions, although I think
7 briefer, with Site D as I did with Site F. For
8 the purposes of monitoring, can we concentrate, or can
9 we be -- to what extent can we be guided by the hydro-
10 stratigraphic interpretation -- hydrostratigraphic
11 interpretation that has been put on this site by
12 Mr. Sobanski and Mr. Beechinor?

13 A. I think in some ways the hydro-
14 stratigraphic interpretation at Site D -- not that the
15 interpretation is better defined, but it is more
16 readily possible to define what exists in, say, for
17 instance, a new monitoring location on the basis of
18 what is actually found and observed in the soil core
19 samples as they are recovered in the field. In other
20 words, the pathways of off-site migration are primarily
21 the granular units and the granular units of any
22 significant thickness when one does continuous core
23 sampling are readily apparent, unlike the transmissive
24 zones at Site F where one has to do some hydraulic
25 testing to actually demonstrate that the fractured zones



1 and discontinuities one observes are actually the
2 transmissive zones.

3 Q. Would I assume then that when
4 you drill new monitoring wells at Site D, you would
5 look for those areas, -- we have been calling them
6 the granular units?

7 A. The granular units, that is
8 correct.

9 Q. I take it you would agree that
10 you would then instrument the granular units?

11 A. Instrument the granular units
12 specifically, that is correct.

13 Q. What else would you instrument?
14 I assume you would instrument the weathered zone?

15 A. You would also instrument the
16 weathered zone, that is correct.

17 Q. Is there any need for monitoring
18 in either the upper till or the lower till in areas
19 where the granular units don't occur?

20 A. "In areas where the granular
21 units don't occur" and there is no other evidence
22 of any type of difference in the actual nature of the
23 upper granular unit -- the upper till or the lower till.
24 If it is not readily possible to illustrate that there
25 is a pathway or a zone of higher hydraulic conductivity



1 that could constitute a pathway, I would suggest that
2 it might not be necessary to monitor those zones.

3 Q. Now, could you look at the drawing
4 you put up there, Drawing 24 from the Site D report,
5 H-39?

6 A. This is also Exhibit B-213.

7 Q. I believe Mr. McQuaid also went
8 through this monitoring program with Mr. Sobanski and
9 numbered all the monitoring locations?

10 A. Yes, I believe that that is
11 correct.

12 Q. Have you any comment -- it is
13 slightly different from Site F in that it is not such
14 a narrow spot that must be monitored?

15 A. That is correct. The possibility
16 would be that there could be off-site migration through
17 the granular units in a variety of directions, and
18 not that the directions will take place -- it will
19 go in all directions at the same time, but we are not
20 precisely sure in what direction it would go.

21 Q. Have you any comment on the geo-
22 graphic distribution of the monitoring wells proposed
23 by Mr. Sobanski?

24 A. In general they are reasonably
25 uniformly distributed around the site with possibly a



Toronto, Ontario

1 higher concentration or closer spacing in the area
2 on the west side of the site, between the site and
3 the nearest identified groundwater users.

4 Q. I am just asking for your
5 opinion on it and is it sufficient?

6 A. Oh, is it sufficient?

7 Q. I should have been more specific.

8 A. In terms of the separation or
9 spacing between the monitoring locations, they are
10 quite a bit further spaced than as proposed for Site
11 F, mainly because as we have indicated we have to monitor
12 all four sides in this particular case. I think the
13 actual spacing will, to some degree, or should to some
14 degree be determined by the actual continuity of the
15 granular units as identified in the additional drilling
16 and the installation of the initial groundwater
17 monitoring locations.

18 I think the possibility for the upper
19 granular units being more homogeneous and more
20 extensive comparatively compared to the highly
21 fractured zone and the transmissive zones at Site F
22 are reasonably high. In other words, to some degree
23 one would have the expectation, or I would certainly
24 have the expectation that these granular units could
25 be much more extensive and much more homogeneous



1 than the highly fractured zone at Site F and, conse-
2 quently, the fact that the spacing of the monitoring
3 stations is greater is not of undue concern to me,
4 provided that the results of the geological investiga-
5 tions at these new monitoring locations bears out the
6 fact that the zones that you are monitoring are in
7 fact continuous and correlatable from one location to
8 another, and possibly even to the stage where one can
9 pump the granular units at a particular location and
10 note a response in adjacent monitoring locations to
11 ensure there is hydraulic connection in the zone you
12 are monitoring.

13 Q. With respect to the weathered
14 zone, could you comment on the possible use of trench
15 monitors at this site as you described are being used
16 at the Tricil site near Sarnia?

17 A. I don't think I described the
18 use of trench monitors per se at the Tricil site.

19 Q. I thought at some point in your
20 evidence you described the existence of trench
21 monitoring devices that were being used at the
22 Tricil landfill site?

23 A. I am aware they are being used
24 at the Ridge landfill site outside of Blenheim.

25 Q. I am sorry, I am drawing on some



1 past knowledge?

2 A. There may be trench monitors at
3 the Tricil landfill site, I am not sure.

4 Q. I don't suppose it matters; the
5 type described at Ridge?

6 A. For monitoring in the weathered
7 zone I would think that the use of some type of trench
8 monitoring system or large diameter boring as described
9 or as suggested by Dr. Cherry and his colleagues at the
10 University of Waterloo would certainly be more
11 appropriate than a reasonably small diameter boring
12 of conventional design.

13 Q. In your opinion should that
14 type of device be used at Site D?

15 A. I would recommend that type of
16 device be used, yes.

17 Q. With respect to the instrumenting
18 of these wells, have you the same comments regarding
19 the screening lengths that you did at Site F? You
20 will recall at Site F you suggested a 1 to 1-1/2 metre
21 screen might be too short and you thought something
22 in the order of 2 to 3 metres might be better?

23 A. In this particular case in terms
24 of monitoring the granular units I would suggest the
25 entire granular unit be screened by the monitoring well



Toronto, Ontario

1 and with the expectation that the granular units are
2 in the range of 2 to 3 metres in thickness. I think
3 if they were found to be much thicker than that in
4 some locations, one might go to a monitor in the upper
5 part and a separate monitor in the lower part, but
6 we wouldn't expect that to be the case.

7 Q. Construction of the wells at
8 Site D. Do you have the same concerns about the use
9 of stainless steel wells et cetera, and I won't bother
10 taking you through that, but the kind of discussion we
11 had on Site F?

12 A. The considerations for the
13 installation of the wells at Site D should be similar
14 than what we discussed at Site F.

15 Q. What about frequency? Is it the
16 same?

17 A. There would be no basis to select
18 something different at Site D.

19 Q. And the same thing with sampling
20 techniques, I assume?

21 A. That is correct.

22 Q. What about parameters?

23 A. At Site D certainly the monitoring
24 and sampling for the inorganic parameters such as
25 chloride in particular I think becomes important



1 because of the concern or potential impact of those
2 parameters on the water quality in the granular units
3 that is used for a drinking water supply.

4 Q. Is there any need to monitor
5 for volatile organics?

6 A. Oh, I would say there certainly
7 is, yes.

8 Q. With the same kind of frequency
9 as Site F?

10 A. When the hydraulic trap -- I
11 think there could be a case made for less frequent
12 monitoring of the groundwater -- less frequent
13 sampling and analysis of the groundwater at Site D
14 provided one is comfortable with the monitoring of
15 mounding, the monitoring of mounding of leachate in the
16 landfill and the performance of the hydraulic trap
17 system. I think if one could be confident that you
18 could determine that the hydraulic trap was functioning
19 properly, I would suspect that one might not need to
20 monitor the groundwater underlying the sites as
21 frequently as quarterly.

22 Q. Would you have any comment on
23 how frequently, assuming you could monitor the mound?

24 A. I wouldn't certainly go to any
25 longer than annually.



1 Q. In terms of monitoring the mound,
2 how does one do that effectively?

3 A. Well, one will get some indication
4 of the performance of the leachate collection system
5 by monitoring the leachate flows that are evident
6 in the various manholes and access locations to the
7 collection system. My suggestion would actually be
8 if one wanted to get very good indication of the
9 level of leachate within the landfill during operation
10 and following operation, and that would be the installa-
11 tion of pressure transducers in the base of the landfill
12 before refuse is placed. There are a variety of these
13 products available and many of them have been used in
14 geotechnical applications for a great number of years.
15 At the Keele Valley landfill while with Golder
16 Associates we installed something called a vibrating
17 wire piezometer which is basically a kind of pressure
18 transducer directly on the clay liner of the landfill
19 with the cable extending out towards the margin of the
20 landfill so the pressure inside the landfill could
21 be determined remotely at the margin of the landfill.
22 Although they are not precisely accurate to centimetres
23 of hydraulic head, they certainly give a good indica-
24 tion of the rate of leachate build-up in a landfill
25 and probably they would be accurate to within 10 or



1 20 centimetres.

2 Q. You made the same recommendation
3 with respect to Site F?

4 A. At Site F I am not precisely
5 sure what the benefit of knowing the degree of leachate
6 mounding would be within the landfill, other than the
7 fact that it might be an early warning of possible
8 leachate springs out the sides at some time in the
9 future.

10 Q. Finally, Mr. Feenstra, I think
11 you mentioned this morning the need for monitoring
12 of leachate strength and I think you said you would
13 be looking, or in your opinion there should be some-
14 thing like 4 to 6 times a year monitoring of the leachate?

15 A. Of the leachate, yes.

16 Q. Does that apply to both sites?

17 A. That would apply to both sites,
18 yes.

19 Q. For either site we would be looking
20 at what we might call a full suite of contaminants,
21 including the volatile organics?

22 A. I think it would be appropriate to
23 monitor for a whole suite of chemicals. If anything,
24 it might give an indication of precisely what type of
25 refuse is actually being accepted, and it is quite



1 possible there may be materials entering the landfill
2 that really shouldn't be.

3 Q. And one would get that?

4 A. One would certainly get some
5 indication that that was a possibility. Obviously
6 it would be too late for the materials already
7 deposited, but during the operation of the landfill
8 it might provide some type of warning that more
9 scrutiny might be used in screening materials and
10 generators that are bringing refuse to the landfill.

11 MR. TIDBALL: Thank you very much,
12 Mr. Feenstra. Those are all my questions, Mr. Chairman.

13 DR. KINGHAM: We have a few questions
14 for Mr. Feenstra as well. Let me start out by
15 saying that I am learning that in the legal world
16 as well as the scientific world time is relative.
17 I thought I knew what that meant and when a canvass
18 was being taken last night as to how long it would
19 likely be before you were free, it seemed at that time
20 it might be 45 minutes before I would begin. That
21 was yesterday afternoon at coffee.

22 THE WITNESS: How many days ago was
23 that?

24 DR. KINGHAM: I informed Mr. Hodgson
25 I probably had about a half an hour's worth of



1 questions, but I don't know if that is in the legal
2 timeframe or the scientific timeframe. I think we
3 are very fortunate ...

4 MR. ESTRIN: As long as you are asking
5 the questions, it is legal.

6 DR. KINGHAM: ... in having a witness who
7 is both a hydrogeologist and a hydrogeochemist and it is
8 a combination of knowledge which obviously is quite
9 important to this Board.

10 I have a number of questions and some
11 of which are fairly short. First of all, the journal
12 in which the paper by Pankow, Isobell, Hewetson and
13 Cherry was published was what?

14 THE WITNESS: "Ground Water". It is
15 called "Ground Water", two words.

16 DR. KINGHAM: Is it a fairly authori-
17 tative journal or respected journal?

18 THE WITNESS: Actually I believe it was
19 one probably of the first groundwater-related journals
20 that I believe began publication sometime in the
21 sixties.

22 DR. KINGHAM: Have you published in it?

23 THE WITNESS: Once.

24 DR. KINGHAM: Is it referred?

25 THE WITNESS: It is.



1 DR. KINGHAM: What does it mean to be
2 refereed?

3 THE WITNESS: A refereed paper implies
4 that it was subjected to peer review both in terms of
5 technical content and editorial content.

6 DR. KINGHAM: There is one question
7 which has come up time and time again and it started
8 with Ms. Cronk comparing, as she described it, like
9 with like in terms of those various charts, and it
10 continued with Mr. McQuaid's B-259 and his version
11 of like with like and it continued this morning with
12 Ms. Vigod's calling into play Figure 3-32 and her
13 appreciation of like with like and it has led me
14 to the conclusion that I don't yet know whether we
15 are comparing like with unlike or like with like?

16 I would like you to take a look at
17 3-32 and I think Ms. Vigod was comparing that with
18 one of the figures Ms. Cronk had brought forward and
19 I would like to know what the Board should compare it
20 with in your view. Is 332 to be compared with B-259
21 or with one of the series. 255 to 258?

22 In essence is this a
23 case of the uncoupled transient model assumed with
24 the engineered solution in operation at Site F?

25 THE WITNESS: Figure 3-32 actually



1 represents the conditions at Site F with the
2 leachate -- excuse me -- the underdrain system in
3 operation. In other words, the underdrain system will
4 be collecting a significant proportion of the leachate
5 and I believe Mr. Sobanski estimated it to be approximately
6 95 per cent, but there would be some movement of
7 leachate downward into the underlying shale.

8 Now, this situation or the results of
9 this simulation shown in Figure 3-32 would only be
10 slightly different for the case when the underdrain
11 system was not functioning at all and when the under-
12 drain system is not functioning, that will result in
13 the mounding of leachate within the landfill and it
14 will increase the hydraulic gradients forcing leachate
15 downward into the underlying flow system.

16 Because the existing vertical groundwater
17 gradients are already strongly vertical, the results
18 of this mound will be relatively small.

19 DR. KINGHAM: I think we do understand
20 that, but the question is what is the "like" with which
21 this should be compared if the Board is comparing like
22 with like? Would it be B-259 or would it be No. 255
23 and 256?

24 THE WITNESS: To go back to yesterday
25 when I was responding to Mr. McQuaid, Figure 3-32



1 as drawn reflects the conditions for when the under-
2 drain system is working at Site F as designed, and
3 that figure could be compared to B-259 which would
4 be the predicted chloride concentration at the site
5 boundary in the granular units at Site D with the
6 hydraulic trap in operation.

7 DR. KINGHAM: So, if you removed these
8 charts from in front of your Exhibit 263, it would be
9 scenario one and this would be an output of scenario
10 one for Site F and B-259 would be an output for scenario
11 one for Site D?

12 THE WITNESS: That is correct.

13 DR. KINGHAM: Okay.

14 THE WITNESS: If I could continue?

15 DR. KINGHAM: Sorry.

16 THE WITNESS: Figure 3-32, although it
17 is denoted as the chloride concentration at the base
18 of the weakly fractured shale; given the estimated
19 travel times through the highly fractured zone, I
20 think one could consider this result to reflect the
21 concentrations at the site boundary, because that
22 travel time will be very short compared to the tens
23 of years shown in this figure.

24 If we go to Exhibit N-255, that shows
25 the chloride on the left-hand side in Figure 3-31,



1 the chloride concentrations at the site boundary
2 in the granular units for the case where there has
3 been a failure of the engineered features and no
4 contingency measures have been implemented, and so
5 that would refer to this case.

6 Now, although it was not specifically
7 modelled as such for Site F, Figure 3-32, or this
8 condition for Site F for failure of the underdrain
9 system would be similar to Figure 3-32 with only
10 a slight increase -- a slight reduction in the time
11 for the first arrival and a slight increase in the
12 height of the peak. It will be quite similar to
13 Figure 3-32.

14 DR. KINGHAM: Okay.

15 THE WITNESS: I hope that helps.

16 DR. KINGHAM: It does. It makes it
17 a lot clearer, thank you. I would like you to remind
18 us, if you could, about the essential factor that
19 led to the change between Figure 3-2 of H-86 and
20 No. 1 of H-86A, and H-86A is your witness statement
21 where I believe you have shifted the time axis and
22 I don't quite recall the essential reason for that
23 shift?

24 THE WITNESS: 3-32 is diffusion down-
25 ward through the upper till at Site D.



1 DR. KINGHAM: Figure 1 of H-86A on
2 page 7 and in H-86 I believe it is 3-2.

3 THE WITNESS: Yes.

4 DR. KINGHAM: There is quite a shift there
5 and I just wanted ...

6 THE WITNESS: Yes, that difference
7 relates to the actual formulation of the effective
8 diffusion coefficient that was described in H-86A.
9 Since the preparation of that report I have determined
10 that my initial review of that formulation from the
11 literature that existed at that time was not quite
12 appropriate.

13 DR. KINGHAM: So this reflects a change
14 in the diffusion coefficient?

15 THE WITNESS: In the diffusion co-
16 efficient, that is correct, an increase in the value of
17 the diffusion coefficient resulting from the fact
18 that the actual porosity term which I included in
19 the formulation of the diffusion coefficient in H-86
20 should not have been in that formulation.

21 DR. KINGHAM: Okay. I think that
22 figure is in fact the one that led to the interpretation
23 that weakly adsorbed organic contaminants would travel
24 something like 220 centimetres into the area below the
25 landfill?



1 THE WITNESS: I believe that that is
2 correct, yes.

3 DR. KINGHAM: Let's talk about tritium
4 for a bit. There has been an awful lot of discussion
5 about tritium, but can we talk about tritium as a
6 contaminant?

7 THE WITNESS: Yes.

8 DR. KINGHAM: How does it compare with
9 other contaminants, volatile organics, ions and so on?

10 THE WITNESS: In terms of mobility?

11 DR. KINGHAM: In terms of mobility.

12 THE WITNESS: It would be considered
13 to be generally as mobile as chloride and basically
14 reflecting the movement of the water molecules them-
15 selves, the water molecules being the main source of
16 hydrogen in the groundwater, although there are other
17 hydrogen-containing constituents on a molecular basis,
18 and it would be assumed that the actual partitioning
19 of tritium between the hydrogen in the water molecules
20 and the hydrogen as hydrogen ion and the hydrogen
21 in the bicarbonate ion would predominantly be in the
22 water.

23 DR. KINGHAM: It would move essentially
24 with the groundwater movement?

25 THE WITNESS: That is correct.



1 DR. KINGHAM: The leading edge of
2 contaminants, as it were?

3 THE WITNESS: That is correct, yes.

4 DR. KINGHAM: When you look at the
5 glacial till tritium results you observed as in
6 Drawing No. 22 of H-39, the tritium has penetrated
7 to a depth of a little greater than 5 metres,
8 5 or 6 metres, and that well was drilled to a depth
9 presumably of 20 metres, the bottom of the scale?

10 THE WITNESS: Actually each of these
11 measurements are taken from a well installed in a
12 different borehole and I believe at this location
13 the deepest piezometer was just over 12 metres,
14 with the value for the tritium in the upper granular
15 unit being taken from a slightly different location.

16 DR. KINGHAM: Is there any issue
17 in the case of these wells in the glacial till of
18 purging the well with water? I believe you referred
19 to using water that was Burlington tap water for
20 wells in F versus Kitchener-Waterloo water and
21 so on?

22 THE WITNESS: Yes. That was for the
23 water used in the Waterloo multi-level piezometers
24 that was required to be injected inside the casing
25 to make the packer swell.



1 DR. KINGHAM: That is not at issue
2 in these wells at Site D?

3 THE WITNESS: No, it is not. I under-
4 stand the majority of the borings that went in at
5 Site D remained dry or free of water during drilling
6 and water was not specifically used during the drilling.

7 DR. KINGHAM: Does it surprise you that
8 this particular material has not gone to a depth --
9 I should say post-1952 tritium has not gone to a depth
10 greater than 5 or 6 metres in this area?

11 THE WITNESS: This is entirely consistent
12 with a large number of similar profiles conducted or
13 measured in the Sarnia area, and I believe there has
14 been at least a dozen, and possibly more sites instru-
15 mented in this way with multi piezometers installed
16 at different depths.

17 During the Ph.D work of Donald Desaulnier
18 at the University of Waterloo, he also instigated two
19 sites in clay glacial till in Wisconsin, a site in
20 the lacustrine glacial clays in New Liskeard, the
21 marine clay desposits in the Montreal area, and he
22 found quite similar profiles with the penetration of
23 tritium being restricted to the zone that was
24 obviously weathered and fissured and in some areas
25 that penetration was only 3 metres or so and in other



Toronto, Ontario

1 areas in glacial till in Sarnia it was 6 metres,
2 but in New Liskeard for some reason it is 10 metres,
3 but the penetration of tritium is correlated with the
4 degree or depth of weathering in those types of deposits.

5 DR. KINGHAM: So, in general in glacial
6 tills whether you have landfills and hydraulic traps
7 or not, you would not expect tritium as a fairly mobile
8 indicator of contamination to go down to more than
9 5 or 6 metres?

10 THE WITNESS: In clay till materials,
11 yes, that is correct.

24-B 12 DR. KINGHAM: In fractured shale material
13 where there may be vertical fractures, what would you
14 expect?

15 THE WITNESS: I would expect the down-
16 ward movement would be more extensive and basically --
17 in other words -- penetration would be deeper provided
18 there were no zones within the shale strata that were
19 very low hydraulic conductivity, low being measured
20 in comparison to the unweathered upper till in this
21 situation in the 10^{-8} range or 10^{-8} centimetres per
22 second.

23 DR. KINGHAM: I am going to put a
24 scenario to you if you could put up H-220, and you
25 have got that before you and you have a telephone in



1 you hand and you are looking at the WAT wells with
2 the tritium numbers circled there and you see WAT 5,
3 for example, with tritium at 45 units at the bottom and at
4 WAT 7 with 24 units at the bottom, and at the other
5 end of the telephone is the lab operator or the
6 scintillation detector saying I have got your tritium
7 results and he reads them off to you in order, for
8 example, for HC5 of 9 at the top, 14 in the middle and
9 36 at the bottom.

10 Would your immediate reaction to that
11 be to say have you got it right or should they be the
12 other way around?

13 THE WITNESS: That would be my first
14 question, yes.

15 DR. KINGHAM: Why would you react that
16 way?

17 THE WITNESS: Mainly because I would
18 have suspected --I would have suspected to find slightly
19 higher tritium concentrations in this particular system
20 fairly close to the ground surface where the actual
21 input is. Tritium is going to be subjected to some
22 degree of attenuation like other contaminants due to
23 matrix diffusion.

24 DR. KINGHAM: I guess what I am getting
25 at and what I have trouble understanding is that we have



1 DR. KINGHAM: The leading edge of
2 contaminants, as it were?

3 THE WITNESS: That is correct, yes.

4 DR. KINGHAM: When you look at the
5 glacial till tritium results you observed as in
6 Drawing No. 22 of H-39, the tritium has penetrated
7 to a depth of a little greater than 5 metres,
8 5 or 6 metres, and that well was drilled to a depth
9 presumably of 20 metres, the bottom of the scale?

10 THE WITNESS: Actually each of these
11 measurements are taken from a well installed in a
12 different borehole and I believe at this location
13 the deepest piezometer was just over 12 metres,
14 with the value for the tritium in the upper granular
15 unit being taken from a slightly different location.

16 DR. KINGHAM: Is there any issue
17 in the case of these wells in the glacial till of
18 purging the well with water? I believe you referred
19 to using water that was Burlington tap water for
20 wells in F versus Kitchener-Waterloo water and
21 so on?

22 THE WITNESS: Yes. That was for the
23 water used in the Waterloo multi-level piezometers
24 that was required to be injected inside the casing
25 to make the packer swell.



1 DR. KINGHAM: That is not at issue
2 in these wells at Site D?

3 THE WITNESS: No, it is not. I under-
4 stand the majority of the borings that went in at
5 Site D remained dry or free of water during drilling
6 and water was not specifically used during the drilling.

7 DR. KINGHAM: Does it surprise you that
8 this particular material has not gone to a depth --
9 I should say post-1952 tritium has not gone to a depth
10 greater than 5 or 6 metres in this area?

11 THE WITNESS: This is entirely consistent
12 with a large number of similar profiles conducted or
13 measured in the Sarnia area, and I believe there has
14 been at least a dozen, and possibly more sites instru-
15 mented in this way with multi piezometers installed
16 at different depths.

17 During the Ph.D work of Donald Desaulnier
18 at the University of Waterloo, he also instigated two
19 sites in clay glacial till in Wisconsin, a site in
20 the lacustrine glacial clays in New Liskeard, the
21 marine clay desposits in the Montreal area, and he
22 found quite similar profiles with the penetration of
23 tritium being restricted to the zone that was
24 obviously weathered and fissured and in some areas
25 that penetration was only 3 metres or so and in other



Toronto, Ontario

1 areas in glacial till in Sarnia it was 6 metres,
2 but in New Liskeard for some reason it is 10 metres,
3 but the penetration of tritium is correlated with the
4 degree or depth of weathering in those types of deposits.

5 DR. KINGHAM: So, in general in glacial
6 tills whether you have landfills and hydraulic traps
7 or not, you would not expect tritium as a fairly mobile
8 indicator of contaminant to go down to more than
9 5 or 6 metres?

10 THE WITNESS: In clay till materials,
11 yes, that is correct.

24-B

12 DR. KINGHAM: In fractured shale material
13 where there may be vertical fractures, what would you
14 expect?

15 THE WITNESS: I would expect the down-
16 ward movement would be more extensive and basically --
17 in other words -- penetration would be deeper provided
18 there were no zones within the shale strata that were
19 very low hydraulic conductivity, low being measured
20 in comparison to the unweathered upper till in this
21 situation in the 10^{-8} range or 10^{-8} centimetres per
22 second.

23 DR. KINGHAM: I am going to put a
24 scenario to you if you could put up H-220, and you
25 have got that before you and you have a telephone in



1 DR. KINGHAM: That is not at issue
2 in these wells at Site D?

3 THE WITNESS: No, it is not. I under-
4 stand the majority of the borings that went in at
5 Site D remained dry or free of water during drilling
6 and water was not specifically used during the drilling.

7 DR. KINGHAM: Does it surprise you that
8 this particular material has not gone to a depth --
9 I should say post-1952 tritium has not gone to a depth
10 greater than 5 or 6 metres in this area?

11 THE WITNESS: This is entirely consistent
12 with a large number of similar profiles conducted or
13 measured in the Sarnia area, and I believe there has
14 been at least a dozen, and possibly more sites instru-
15 mented in this way with multi piezometers installed
16 at different depths.

17 During the Ph.D work of Donald Desaulnier
18 at the University of Waterloo, he also instigated two
19 sites in clay glacial till in Wisconsin, a site in
20 the lacustrine glacial clays in New Liskeard, the
21 marine clay desposits in the Montreal area, and he
22 found quite similar profiles with the penetration of
23 tritium being restricted to the zone that was
24 obviously weathered and fissured and in some areas
25 that penetration was only 3 metres or so and in other



Toronto, Ontario

1 areas in glacial till in Sarnia it was 6 metres,
2 but in New Liskeard for some reason it is 10 metres,
3 but the penetration of tritium is correlated with the
4 degree or depth of weathering in those types of deposits.

5 DR. KINGHAM: So, in general in glacial
6 tills whether you have landfills and hydraulic traps
7 or not, you would not expect tritium as a fairly mobile
8 indicator of contaminant to go down to more than
9 5 or 6 metres?

10 THE WITNESS: In clay till materials,
11 yes, that is correct.

24-B

12 DR. KINGHAM: In fractured shale material
13 where there may be vertical fractures, what would you
14 expect?

15 THE WITNESS: I would expect the down-
16 ward movement would be more extensive and basically --
17 in other words -- penetration would be deeper provided
18 there were no zones within the shale strata that were
19 very low hydraulic conductivity, low being measured
20 in comparison to the unweathered upper till in this
21 situation in the 10^{-8} range or 10^{-8} centimetres per
22 second.

23 DR. KINGHAM: I am going to put a
24 scenario to you if you could put up H-220, and you
25 have got that before you and you have a telephone in



Toronto, Ontario

1 you hand and you are looking at the WAT wells with
2 the tritium numbers circled there and you see WAT 5,
3 for example, with tritium at 45 units at the bottom and at
4 WAT 7 with 24 units at the bottom, and at the other
5 end of the telephone is the lab operator or the
6 scintillation detector saying I have got your tritium
7 results and he reads them off to you in order, for
8 example, for HC5 of 9 at the top, 14 in the middle and
9 36 at the bottom.

10 Would your immediate reaction to that
11 be to say have you got it right or should they be the
12 other way around?

13 THE WITNESS: That would be my first
14 question, yes.

15 DR. KINGHAM: Why would you react that
16 way?

17 THE WITNESS: Mainly because I would
18 have suspected --I would have suspected to find slightly
19 higher tritium concentrations in this particular system
20 fairly close to the ground surface where the actual
21 input is. Tritium is going to be subjected to some
22 degree of attenuation like other contaminants due to
23 matrix diffusion.

24 DR. KINGHAM: I guess what I am getting
25 at and what I have trouble understanding is that we have



Toronto, Ontario

1 got these tritium measurements literally all over the
2 map on this diagram and with a tendency of high
3 levels at the bottom.

4 Is it your evidence then that we should
5 have some great caution about those tritium levels?

6 THE WITNESS: I have a particular caution
7 with respect to the tritium levels in the WAT multi-
8 levels as I described earlier yesterday, I believe,
9 the fact that some of these intervals were known to have
10 leaked following installation and that Burlington city
11 water which contained tritium was used. It is possible
12 that some tritiated water did enter into the formations
13 around these test intervals and given the fact that
14 not much water was purged out prior to sampling, or
15 it wasn't possible to purge out much water prior to
16 sampling, that these tritium values may in some way
17 by an artifact of that.

18 However, in the Morrison Beatty wells
19 there are also areas where there are high levels of
20 tritium at depth. I am not sure if there is a
21 high level in any Morrison Beatty wells below the
22 highly fractured zone, but at least in the highly
23 fractured zone there are some high concentrations,
24 particularly in MB 16 which I noticed there and MB 12.

25 DR. KINGHAM: So, are you telling us



1 that in your view the tritium values on this are
2 not of great significance?

3 THE WITNESS: In general it is not
4 possible to use tritium to make a quantitative estimate
5 of flow pathways based on its numerical value because
6 the actual input can vary considerably from 1950 to
7 1960 with the input concentrations in precipitation
8 ranging from several thousand tritium units to several
9 hundred to now being approximately 100, and at any
10 particular location in the flow system we are not
11 really sure when that water recharged at any particular
12 location.

13 In other words, the tritium values of
14 50 in a particular well could either reflect water
15 that infiltrated 12 years ago when concentrations were
16 100 or 200, or water -- reflect water which infiltrated
17 30 years ago that was -- I can't even work that out,
18 it is a half life -- much higher than that. In
19 other words, several hundred or more than several
20 hundred tritium units.

21 Based on the actual numerical value
22 of the tritium, we are not actually able to tell
23 where that water came from because the input source has
24 been variable. What I think it does allow you to do,
25 however, is if you find tritium at detectable levels,



Toronto, Ontario

1 it would indicate that it is water that has recharged
2 the flow system in the past 30 or 35 years, but I am
3 not sure you can be much more quantitative than that.

4 Now, if we go to, I believe,
5 Figure 13a in H-40, page 107 as I recall...

6 DR. KINGHAM: That's it.

7 THE WITNESS: You would expect
8 tritium to behave similar to a non-adsorbed contaminant
9 such as chloride. If you look at the conceptualization
10 of the groundwater flow system based on these three
11 zones and migration of water containing tritium through
12 zone 3, you would have expected to begin to see tritium
13 at some concentrations, depending on what the actual
14 input was, but somewhere in the order of 20 to 40
15 years.

16 The fact we find tritium in this highly
17 fractured zone should not really be much of a surprise.

18 DR. KINGHAM: As you say, because of the
19 half life of tritium which is 12 years, I think?

20 THE WITNESS: 12.3 years.

21 DR. KINGHAM: You can't use it much for
22 a diagnostic in terms of its concentration in the
23 groundwater but only an indicator in areas where you
24 have a fairly stable geology as to whether it has got
25 in at all, for example, in the case of Site D?



1 THE WITNESS: Its presence indicates
2 that it has gotten in in a particular period of time,
3 that being since tritium was introduced into the
4 atmosphere and precipitation in the early 1950's.
5 At Site D I think we can now be allowed to be
6 slightly quantitative in the use of tritium, not by
7 looking at its particular concentrations per se, but
8 at its presence at some depth in the unweathered upper
9 till.

10 We have to make an assumption that the
11 upper 3 or 4 metres of the upper till is what Dr. Cherry
12 has referred to, and I believe we have used the phrase
13 here the active zone. It is fissured and weathered
14 and groundwater flow through that zone is fairly rapid.
15 If we make that assumption and indicate that the first
16 4 metres, or through the first 4 metres of the upper
17 till groundwater flow is reasonably rapid, then we would
18 expect whatever rain falls on top of this zone to
19 penetrate down fairly quickly and move off laterally
20 in general, that there will be tritium in that zone.

21 But, in the unweathered till underlying
22 that, if we make the initial assumption that when
23 tritium was first introduced into atmospheric
24 precipitation in the early 1950's that the tritium
25 penetrated downward to the base of the weathered zone



1 | why am I pointing to this -- and starts to migrate
2 | downward through the unweathered till as a result of
3 | groundwater flow, albeit slow groundwater flow,
4 | we can actually calculate the travel time as reflected
5 | by the depth of penetration which would appear to be
6 | approximately 2 metres or something of that order, based
7 | on Figure 22 in the Site D report, H-39.

8 | Now that also assumes there is downward
9 | gradient and at that particular location at which
10 | the tritium was measured there were very significant
11 | downward gradients, I believe between the two piezometers
12 | where tritium is found in the upper part of the un-
13 | weathered till and the next piezometer down; I believe
14 | the hydraulic gradient was as high as approximately
15 | .5 or .6 as I recall. That actually showed up in
16 | an exhibit somewhere, but I can't precisely recall the
17 | number. Oh, here we are. That's not quite the one.
18 | Of course you can never find an exhibit when you want
19 | to find one. Okay.

20 | Between the piezometers shown in Figure
21 | 22 which is at the back of the Site D report, the
22 | hydraulic gradient between the piezometers showing
23 | 16.1 tritium units and 2.7 tritium units was .52
24 | and the hydraulic gradient between the piezometers
25 | showing 2.7 and 1.36 tritium units was .99, so there



1 are very strong downward gradients at this particular
2 location and those are the hydraulic gradients which
3 one should consider in evaluating tritium movement at
4 this location.

5 DR. KINGHAM: We heard a lot of
6 evidence, and I am not sure that we have got it all
7 down pat, about the problem of adhesives in well pipes.
8 Is it good for us to imagine that this is like putting
9 pieces of plumbing together with a solvent coupling?

10 THE WITNESS: That is exactly the same.

11 DR. KINGHAM: The solvent material
12 is essentially something like methyl ethyl ketone or
13 tetrahydrofuran which may be contaminated with
14 a number...

15 THE WITNESS: That's right.

16 DR. KINGHAM: After you put the pipes
17 together one hopes that most of the solvent has
18 hardened and evaporated or gone away essentially?

19 THE WITNESS: I think if one glued
20 their pipe together and let it sit out in the air
21 for several days that would probably be the case.

22 DR. KINGHAM: Is that the normal practice?

23 THE WITNESS: No, the normal practice
24 is to glue it together and put it in the hole as
25 quickly as you can manage it, and so in many cases the



1 actual opportunity for all the residuals of solvents
2 and softened PCV to harden and lose whatever volatiles
3 might be associated with it is gone because you put
4 it in the ground or let water come up in your piezometer
5 and cover it up.

6 DR. KINGHAM: And contained it?

7 THE WITNESS: Yes. It is also kept
8 at quite a low temperature.

9 DR. KINGHAM: Have you a feel for what
10 the concentrations of a contaminant like a chlorinated
11 olephthatic hydrocarbon like TCA might be in a solvent
12 which is essentially unchlorinated?

13 THE WITNESS: In the actual solvent
14 itself?

15 DR. KINGHAM: Are we talking one per
16 cent or a tenth of one per cent?

17 THE WITNESS: I think they would be
18 very low percentages if even in the percentage range.

19 DR. KINGHAM: Can you put up the diagram,
20 I think you gave it to us in the main evidence from
21 Exhibit E-214 which showed the picture of the sampling
22 system used in the WAT wells. I would like you to slide
23 it up so that all that is really showing is the lower
24 right-hand corner. That is fine.

25 Now, where the sample goes in, are we



1 to understand it goes in in that small orifice at
2 the side?

3 THE WITNESS: That is correct, through
4 a small -- I believe it is a PVC elbow.

5 DR. KINGHAM: And that is threaded into
6 the side of the pipe?

7 THE WITNESS: I believe that that
8 version was.

9 DR. KINGHAM: Then it goes to what
10 is called tubing that goes up to the top of the hole?

11 THE WITNESS: That is correct, poly-
12 ethylene tubing.

13 DR. KINGHAM: And the polyethylene
14 tubing, is that attached with a solvent at the elbow
15 or is it slid over?

16 THE WITNESS: I believe it is just a
17 slide fit onto a standard -- I am not sure how to
18 describe it -- like a slide-on pipefitting.

19 DR. KINGHAM: Are you concerned
20 about contamination in that polyethylene tubing as
21 a source of contamination in the sample tubing, the
22 part that goes up, the small diameter tubing?

23 THE WITNESS: The tubing itself?
24 Not generally. I think certainly it has been my
25 experience that in most polyethylene tubings, the fact



1 that it is not really stored in a warehouse or a machine-
2 shop generally, or that type of manufacturing
3 facility, it is not generally that dirty so I wouldn't
4 expect contamination to result from the polyethylene
5 tubing.

6 DR. KINGHAM: If we move up to the left
7 from the area you have just been showing us on Figure
8 13a of Exhibit 214 to where we see the joints between
9 packer units and the enlarged portions, the small circle
10 in the middle of that, the source of the contamination,
11 would you tell us, is from where those lengths of
12 pipe are joined together, above and below?

13 THE WITNESS: These are solvent-welded
14 couplings above and below the intervals and above and
15 below each packer.

16 DR. KINGHAM: In the case where you are
17 operating and the packers are swollen against the
18 sides of the well, are you concerned with sources
19 of contaminants above and below the packed-off units?

20 THE WITNESS: As I recall this system,
21 before the next interval, and I am not sure if there
22 is another packer before the next sampling interval
23 or not.

24 DR. KINGHAM: I am just trying to get
25 a feel so we can understand the importance of this



1 often-discussed subject and perhaps we will have to
2 wait for Miss Hewetson to explain it, but as we
3 understood it from those diagrams you have a solvent-
4 welded joint above and below your smpling point A and
5 most of the solvent is between the pipe and the coupling.

6 THE WITNESS: Yes, so it could gain
7 either access through the water that is recovered either
8 from outside, or in the annulus of the borehole on the
9 outside of the pipe and possibly inside, although the
10 inside of the casings were eventually grouted with a
11 thick bentonite grout after it was found that several
12 of these leaked and, in other words, there was an
13 interconnection between the water in the annulus out
14 here and I believe the water inside the casing, but
15 that was corrected eventually by putting a very thick
16 impermeable grout in the centre of the casing and
17 actually pumping it in.

18 One thing I might suggest or will also
19 mention, just to indicate that there are a lot of
20 considerations and we are always coming up with new
21 ones it seems, but the actual potential for diffusion
22 through the polyethylene tubing. If there were
23 chemical contaminants either in the water inside the
24 casing, it is hard to imagine how much would diffuse
25 through the bentonite grout, but there is potential for



1 diffusion of these chemicals through the thin-walled
2 polyethylene tubing and that has been demonstrated
3 at several field sites by none other than the University
4 of Waterloo and which would also -- which in some
5 cases might give you a memory effect in the fact that
6 even if one is taking clean water through here, water
7 that has been sitting in this tube for any period of
8 time prior to sampling might actually acquire chemicals
9 by diffusion through the tubing. I don't know if
10 that is a significant effect in this case, but I would
11 suggest it would be a minor effect if it was apparent
12 here.

13 MR. HODGSON: May I interrupt? Perhaps
14 we should go back and review the subject of scheduling.
15 I raise it now because it might be a good time for us to
16 break.

17 DR. KINGHAM: Have I used my half hour?

18 MR. HODGSON: I think the situation is
19 now that you are not finished and I have some re-
20 examination and I don't expect to be long, but it is
21 going to take a few minutes and I don't think it is
22 realistic to start Mr. Hiraishi after we have finished
23 this witness today. A number of my friends are
24 in the position where they won't be here tomorrow to
25 hear the examination-in-chief and Mr. Tidball, as we



1 know, has a critical problem as well.

2 In fairness to everyone, and I hate
3 doing this, particularly since I pushed so hard, but
4 I wonder if we should just now decide to let
5 Mr. Hiraishi stand down and start the hearing on
6 Friday morning at 9:30 and have Mr. Hiraishi in chief at
7 that time and I think that wouldn't be the fairest
8 way to deal with the problem for everyone concerned.

9 DR. KINGHAM: Does that create any
10 problems we have not yet heard? It sounds like the
11 solution. That seems fine.

12 MR. LANCASTER: That shall be so.

13 DR. KINGHAM: Shall we take a short
14 break?

15 THE WITNESS: I am always appreciative
16 of a break.

17 MR. LANCASTER: Let's do that.

18 ---Recess

19 MR. LANCASTER: Thank you, please be
20 seated.

21 DR. KINGHAM: Someone seems to be
22 missing and just after we formulated a whole mess
23 more questions.

24 MR. HODGSON: I believe the witness
25 will be here momentarily. We can't start without him.



1 THE WITNESS: I am sorry about that.
2 I was just telling someone why I am not in Waterloo.

3 DR. KINGHAM: One of the questions we
4 put to Mr. Sobanski and Mr. Beechinor in the course
5 of their presentation of evidence had to do with the
6 assumptions about the migration of contaminants in
7 groundwater through the uppermost layers at both
8 sites, and I think you made the same or similar
9 assumptions about contaminant migration through the
10 weathered shale at Site F and whether or not it
11 should be considered, and contaminant migration through
12 the weathered till at Site D and whether or not it
13 should be considered.

14 I guess the question we are left with
15 on the Board is what is the rationale for assuming
16 that you need not consider contaminant migration
17 through the weathered shale at Site F because of
18 human intervention, how the site would be engineered,
19 but you cannot ignore such migration at Site D despite
20 engineering design to prevent it. It is again a
21 question of trying to compare like to like?

22 THE WITNESS: I can't actually
23 recount in detail the rationale for why lateral
24 migration through the weathered shale was not
25 specifically considered. It was my impression, and I



Toronto, Ontario

1 guess I was directed along those lines by Trow
2 Hydrology Consultants, that lateral migration would
3 somehow be controlled on-site, either by natural
4 discharge into the streams on-site which would be
5 collected or collection by the perimeter drain system.

6 At Site D, there is no perimeter
7 drain as part of the primary engineering design from
8 what I understand and on that basis then, I guess there
9 are no features built in, specifically built in to the
10 design at Site D at the present time, which would
11 prevent lateral migration through the weathered till
12 at that site in the event of failure of the hydraulic
13 trap and the development of leachate mounding within
14 the landfill.

15 There are, however, very simple engineer-
16 ing means that could be used to prevent that migration
17 through the lateral till; and not having been involved
18 in the landfill design I really can't comment about
19 why or why not those features were incorporated in
20 the design. These features, the features at the margin
21 of the landfill, that is where the landfill contacts
22 the weathered upper till, could consist of just an
23 area -- because migration through the weathered zone
24 is primarily through fractures in the till, if one
25 excavated several metres into the till and replaced the



1 till and compacted, it mixed it, basically disturbed
2 the fracture pattern, within a sense what would be a
3 clay liner, and put granular bedding of some sort
4 or a granular drain on that sideslope of the landfill,
5 that would be a very effective cutoff for any leachate
6 migration laterally outward through that zone.

7 As far as I am aware, that is not
8 specifically incorporated into the current Site D design,
9 engineering design, although I understand that that
10 design will certainly undergo some revision and
11 finalization before it is actually implemented.

12 DR. KINGHAM: I guess what we are
13 having difficulty with is strictly the situation of
14 where you have anticipated problems in one area and
15 proposed measures to prevent them and to compare
16 that situation with the other situation.

17 So, in the case of Site D, if the
18 hydraulic trap fails, then lateral migration through
19 the weathered shale becomes important. Isn't that
20 what you are telling us?

21 THE WITNESS: Yes, and without any
22 modification of the existing design.

23 DR. KINGHAM: I am sorry, I shouldn't
24 have said weathered shale, but weathered till?

25 THE WITNESS: Yes.



Toronto, Ontario

1 DR. KINGHAM: At Site F in the event
2 the underdrain system does not work, does contaminant
3 migration through the weathered shale mound become
4 important or not?

5 THE WITNESS: I would believe that
6 contaminant migration through the weathered shale,
7 if it were not managed in some way at the site boundary,
8 it would be a problem whether the underdrains are
9 in operation or they are not in operation to some
10 extent. I would expect there to be some lateral
11 migration, given that the underdrain system is not
12 entirely or 100 per cent efficient in the collection
13 of leachate, and those involved in the actual landfill
14 design may correct me on that, and I am sure you
15 will bring up that same question with Mr. Hiraishi,
16 but that is my understanding.

17 DR. KINGHAM: We will move quickly
18 to another subject. We would like to understand a
19 little more clearly the implications of your
20 responses to some questions to Mr. McQuaid for which
21 I have tried my own hand at artistry which you will
22 find on the front few pages of the adjacent flip chart.
23 So if you could just change the relative positions
24 of the flip charts or bring the second one slightly
25 forward.



1 Let's see if we can understand what
2 you have said. Now, just slip the pages back. What
3 I have tried to do is understand your explanation that
4 if there was ready conduction through unit 3, the
5 weakly fractured shale, then there would not be a
6 hydraulic head between units 2 and 4 and in essence
7 the water would run through and out?

8 THE WITNESS: That is correct. In
9 other words, the actual water level established in
10 this upper zone would be somewhat lower because of
11 transmission through this zone 3.

12 DR. KINGHAM: In that case contaminants
13 would move right along with the water if that were
14 the case?

15 THE WITNESS: Yes.

16 DR. KINGHAM: If you turn over the page
17 to the next page, were you telling us that the situation
18 is a bit more of one where the connection between zones
19 2 and 4 is a constriction and that is the reason why
20 the hydraulic head is maintained and the water does
21 not flow readily through to unit 4?

22 THE WITNESS: That is correct. It
23 does not imply there are no fractures or no inter-
24 connections because it is quite unlikely that that
25 could be the case because there are vertical fracture



1 features observed in a variety of quarry floors in shales
2 in the surrounding area so we fully expect there
3 to be some vertical connections, limited vertical
4 connections in some areas.

5 DR. KINGHAM: The question the Board
6 has is where are the contaminants in this picture. In
7 the previous picture the contaminants moved quickly
8 down with the water and were drawn and in this image
9 where the fractures are vertical fractures but they
10 restrict the flow of water, are we to understand that
11 the contaminants beneath Bayview and the Burlington
12 landfill site are in some way down those fractures as
13 of now?

14 THE WITNESS: In the case as proposed
15 in the hydrostratigraphy at Site F, although we are
16 acknowledging there may be some vertical connections
17 by fractures, we are suggesting that the bulk of the
18 water and therefore the bulk of the contaminant
19 migration does not actually occur through these fractures,
20 and in this scenario we are assuming that this is
21 basically impermeable and all the water is moving
22 through the cracks, but we are suggesting that the
23 bulk of the actual water movement is through the
24 inter-granular pore space in the shale itself.

25 DR. KINGHAM: I think that is important



1 for the transcript to get down clearly. You are
2 telling us that your assumption is that most of the
3 migration of groundwater and therefore contaminants
4 through the weakly fractured shale is between grains of
5 that shale rather than along fracture boundaries?

6 THE WITNESS: That is correct.
7 That is reflected in the transport porosity used
8 for that unit, the transport porosity of .1 reflecting
9 the inter-granular porosity rather than the porosity
10 of any fracture features.

11 DR. KINGHAM: In any event is it your
12 evidence that the contaminants associated with the
13 two existing landfill sites are somewhere in that
14 weakly fractured unit making their way down to the
15 highly fractured unit?

16 THE WITNESS: That would be the expecta-
17 tion, yes.

18 DR. KINGHAM: Could you turn over one
19 more page, and this is a question which also I put
20 to Mr. Sobanski and Mr. Beechinor and would appreciate
21 your views on the perspective of contaminant migration.
22 If the Bayview site or the Burlington site are
23 releasing leachate which is predominantly moving down
24 to a much lower stratum and you put wells in between
25 there and your expected point of emergence, have those



1 wells been put into places where you would expect to
2 find the leachate emerging?

3 THE WITNESS: To some degree just to
4 clarify that in the early days or most of the days of
5 operation following operation of the Bayview site
6 and in the early days of operation of the Burlington
7 site, there was no mechanism for actually preventing
8 contaminant migration through this upper zone, through
9 the weathered moderately fractured shale, and there
10 would certainly be an expectation of finding some
11 level of contaminants in this zone up here.

12 Now, not suggesting -- not meaning
13 to suggest that all lateral migration at either site
14 is controlled at the present time with the toe drain
15 systems as installed, but in the case of Site F, it
16 is certainly my understanding that this shallow pathway
17 would not exist through the weathered zone, but it is
18 a very good point, the monitoring well installations
19 that are certainly installed in the future should be
20 very carefully placed based on the projected groundwater
21 pathways.

22 DR. KINGHAM: One would want to be
23 sure that one was finding the most probable pathway?

24 THE WITNESS: That is correct.

25 DR. KINGHAM: My final question is



1 related to this...

2 MR. HODGSON: Before you move on,
3 I wonder if those three drawings should be marked as
4 exhibits? This could be the K series of exhibits.

5 DR. KINGHAM: Or the CB series of
6 exhibits. I don't know that we need them, but I am
7 easy and if you want them fine.

8 MR. LANCASTER: For your reference we
9 can but hardly for the Board. We can't very well go
10 to our own evidence.

11 MR. HODGSON: With the greatest respect
12 I don't think it is your own evidence anymore because
13 you put them to the witness and the witness has spoken
14 to them and we may all want to refer to the text of
15 this particular bit of evidence and that document in
16 argument.

17 MR. LANCASTER: Author unknown.

18 MS. CRONK: I think on that basis that
19 is the test of admissability of evidence in future.

20 DR. KINGHAM: We will give the exhibits
21 to Halton and I guess we will make them -- they will
22 have to be -- what are they?

23 MR. LANCASTER: They will be H-264A, B
24 and C.

25 ---EXHIBIT NO. H-264A: Chart



Toronto, Ontario

1 ---EXHIBIT NO. H-264B: Chart

2 ---EXHIBIT NO. H-264C: Chart

3
4 MR. HODGSON: Before we move too
5 quickly we had better have a description. H-264A--
6 I think the witness can give the descriptions.

7 DR. KINGHAM: Preferably.

8 MR. HODGSON: How about Site F without
9 a massive unit.

10 THE WITNESS: It is a rather crude
11 description, but probably quite apt. Site F
12 without a weakly fractured shale zone, zone 3.

13 The second is site F with a weakly
14 fractured shale zone and H-264C is monitoring of deep
15 shale groundwater pathway.

16 DR. KINGHAM: It is clearly our
17 intent just to better understand some very complex
18 matters brought out in the last two weeks, both in
19 your main evidence and in cross-examination for which
20 we have no ready illustration of what it was that
21 was being discussed. What we do have an illustration
22 for, however, is infiltration into the weathered shale
23 described on page 124 and drawn on page 125 of H-40,
24 and I am recalling your response to questions from
25 Mr. Garrod on Monday about what would happen on-site.



1 if the underdrain system did not work, and I recall
2 you described there would be mounding within the site?

3 THE WITNESS: That is correct.

4 DR. KINGHAM: Something like the mounding
5 which I guess is shown on page 125, Figure 21, and I
6 believe your evidence was that most of the leachate
7 would then come out at the base of the landfill, the
8 toe of the landfill, or most of the additional leachate
9 would come out.

10 THE WITNESS: That is correct.

11 DR. KINGHAM: Can you explain that to
12 us in terms of both the figure and the accompanying
13 text. Figure 21 shows that with that mounding, about
14 30 cubic metres per year unit with cross-section would
15 come out at the toe and about 33 cubic metres per
16 year of unit with cross-section would come out in the
17 discharge area and that would be a total of about 65
18 cubic metres per year with the majority of it -- I am
19 sorry -- 63 cubic metres?

20 THE WITNESS: I can't see where the
21 figures are coming from.

22 DR. KINGHAM: Figure 21. You see the
23 arrows indicating where water would emerge from the
24 system and one is in the vicinity of HC8, and that is
25 the one I guess you were referring to in terms of



1 leachate emerging at the base of the landfill, and
2 the other is down-gradient and they show 30 cubic
3 metres per year unit with cross-section and
4 33 metres per year unit with cross-section respectively.

5 THE WITNESS: I am not precisely sure
6 as I was not involved in the actual computer simulations
7 that resulted in these.

8 DR. KINGHAM: Perhaps we can go to your
9 own evidence. Your feeling is that it would come
10 out at the toe of the landfill, or most of the excess
11 infiltration would come out at the toe?

12 THE WITNESS: And there would be
13 additional leachate collected -- I guess we are not
14 collecting anything, so most of it would come out at the
15 toe, that is correct.

16 Now, I am not precisely sure where
17 the 30 cubic metres per year at HC8 would have been
18 derived from, but if we had, and considering it
19 very simplistically, if we had 300 millimetres a year
20 assumed to be infiltrating into the landfill, which
21 I believe is the design infiltration rate described, and
22 maybe it was even earlier in the text and I don't recall
23 precisely where, and we increased -- we have 300
24 millimetres per year and under conditions where the
25 underdrain system is operating, approximately 14



1 millimetres penetrating deeper into the underlying
2 shale, and if for some reason we actually cease
3 operation of the underdrain system or if the underdrain
4 system fails, and based on the hydraulic conductivity
5 of the underlying strata and the proportional increase
6 in hydraulic gradient driving groundwater down, we
7 can only move 22 millimetres per year deeper into the
8 shale; then what goes out the side in that upper zone
9 should be the actual differential between the 300
10 millimetres per year and the 23 millimetres per year
11 that infiltrates into the shale.

12 DR. KINGHAM: I wanted to ask about
13 those figures. You are reading the figures from the
14 bottom of page 124?

15 THE WITNESS: That is correct.

16 DR. KINGHAM: In the bottom paragraph
17 on page 124, the first sentence reflects an increased
18 infiltration into the underlying weathered shale of
19 8.9 millimetres over the original 13.7 millimetres
20 which comes from earlier in the text, and that is a
21 65 per cent increase in the infiltration?

22 THE WITNESS: Yes.

23 DR. KINGHAM: 8.9 over 13.7. What
24 I don't understand about that from the point of view
25 of contaminant discharge is that the text goes on to



1 say that the discharge from the highly fractured
2 shale units south of Highway 403 would increase
3 by about 3,000 cubic metres a year over its earlier
4 17,000 cubic metres per year and that is an increase
5 of 21 per cent.

6 So, what I would like you to explain
7 to us, if you can, is if you have an increase of 65
8 per cent in the leachate containing the contaminants,
9 where does the remainder go if only 21 per cent of it
10 comes out in the discharge area containing those
11 contaminants and where does the other 44 per cent go?

12 THE WITNESS: I am not precisely sure.
13 I wasn't involved in these actual calculations.

14 DR. KINGHAM: Nevertheless that would
15 affect contaminant movement, whatever the contaminant
16 movement is, and how much of it comes up in the discharge
17 zone?

18 THE WITNESS: That would affect not
19 only the rate of contaminant migration through the
20 weakly fractured shale downward, but also the volume
21 of contaminated groundwater flow through the highly
22 fractured zone. Based on this modelling and these
23 calculations, I am afraid you would have to discuss
24 that with Mr. Sobanski or Mr. Beechinor who actually
25 did these calculations. I am afraid I can't enlighten



1 you on that.

2 DR. KINGHAM: It came to our attention
3 as I say just through the responses to Mr. Garrod and
4 your main evidence about your expectation that it
5 would come out the side; the contaminated leachate
6 would come out the side. I think this is all the
7 questions I have. Mr. Hodgson.

8 RE-EXAMINATION BY MR. HODGSON:

9 Q. Mr. Feenstra, have you a copy of
10 Exhibit N-254, the paper by Dr. Quigley?

11 A. Yes.

12 Q. I would ask you to turn in that
13 paper to page 338 if you would. You will recall that
14 looking at -- I guess looking at column 2 or 3, the
15 one entitled "Total Carbonate in the Till", your
16 attention was brought to this particular column during
17 cross-examination by Ms. Cronk?

18 A. That is correct.

19 Q. You were asked about the total
20 carbonate content of the Sarnia till in relation to the
21 carbonate content of the till at Site D. What this
22 figure shows is that there appears to be a very low
23 carbonate content in approximately the first metre and
24 then it rises dramatically in the second metre. Is that
25 your reading of this column?



1 A. That is correct.

2 Q. Would you go back to Exhibit 245
3 which is your diagram of the University of Waterloo
4 tracer study in Sarnia, and I can give you a copy of
5 that to save time.

6 A. Yes.

7 Q. Perhaps you could put it up on
8 the overhead. I would like you to again confirm for
9 the Board that in your description of how the study
10 was conducted, I believe you indicated that the water
11 level in the input trench was elevated in relation to
12 the water level in the receiver trench?

13 A. Yes, it was.

14 Q. Do you recall how much the head
15 was; what is the head differential between the two
16 trenches?

17 A. Approximately a metre.

18 Q. How much of the till was blocked
19 off by that dark blue line you have drawn?

20 A. The upper one metre of the
21 till was actually blocked off to prevent groundwater
22 flow through this zone in the recognition that many
23 of the cracks above the natural water table might
24 be considerably more open than the fractures which are
25 present at depths below the water table. Rather than



1 getting a biased hydraulic conductivity estimate or
2 tracer travel time through this upper zone through which
3 groundwater will not be flowing anyway, the zone was
4 cut off with a bentonite and plastic liner.

5 Q. The upper zone that was cut off
6 in the experiment conducted, is that the zone indicated
7 on page 338 of N-254 as the zone with the low carbonate
8 content?

9 A. That is the case.

10 Q. If we are comparing the tills,
11 we would be interested in the carbonate content from
12 the second metre to the fifth metre?

13 A. The second metre to the fourth
14 metre.

15 Q. Could you take out a copy of
16 Exhibit 249, please. This is another paper put to
17 you in cross-examination and this time by Pankow,
18 Isabell, Hewetson and Cherry?

19 A. Yes.

20 Q. I would ask you to turn to page
21 385 of that paper and to the first sentence under the
22 word "Results" where it reads in part, starting in the
23 second line:

24 "Three clearly landfill related compounds
25 were 1, 1, 1-trichloroethane, chlorobenzene



1 and paradichlorobenzene..."

2 And I believe this sentence was put to you by
3 Mr. McQuaid in his cross-examination. I would like
4 to ask you, first of all, when the authors of this
5 paper wrote this paper, to your knowledge did they
6 have any knowledge of the nature of the contaminants
7 that may have been deposited in Bayview and that is
8 to say had they done any tests of the leachate that
9 existed in the Bayview landfill site?

10 A. Not the leachate specifically,
11 but there were groundwater monitors I understand, and
12 this is Exhibit E-214-D5, but there are monitoring
13 wells installed at OW57--OW15, excuse me--immediately
14 beneath the waste and in the absence of any leachate
15 analyses, I believe these results from these wells
16 were used to reflect the leachate composition.

17 Q. Do you recall what was found in
18 that leachate well and were these three substances
19 found in OW15?

20 A. MB15. In MB15-3, which I
21 believe is the deeper one, I believe that that is this
22 lower well at MB15, but there were a variety of chemicals
23 detected which include the 1, 1, 1-trichloroethane,
24 benzene, toluene, chlorobenzene, ethylbenzene, paradi-
25 chlorobenzene.



1 Q. Was that the extent of the knowledge
2 that these researchers had of the nature of the
3 composition of leachate in the Bayview landfill?

4 A. That was the information available
5 at that time, yes.

6 Q. Based upon that information
7 would you have drawn the conclusion they drew?

8 MR. McQUAID: This is not proper reply
9 as he is now cross-examining and this is not reply.

10 MR. HODGSON: Mr. McQuaid put this
11 document to the witness and I am entitled to go back
12 and ask the witness to clarify the evidence that was
13 given. He specifically put this sentence to the
14 witness and I believe on the basis of Mr. McQuaid
15 put this sentence, I can go back and ask him whether
16 he agrees with the conclusion and that is all I am
17 doing.

18 THE WITNESS: Based on the information
19 available at that time it certainly was a reasonable
20 conclusion.

21 MR. HODGSON: Q. Based on the informa-
22 tion we have today is it a reasonable conclusion?

23 A. I would suggest there is consider-
24 able doubt that that is a reasonable conclusion given
25 that the additional information we have from the Bayview



1 Park landfill leachate, the Burlington landfill
2 leachate and the groundwater monitoring at the
3 Burlington landfill site in addition to the
4 investigations conducted by Hydrology Consultants on
5 Site F. So there is a considerably larger body of
6 information that exists at this time than existed
7 at the time this paper was prepared in 1984.

24A

8 Q. Thank you. Could I ask you to
9 turn to your report, H-86 at Figure 3-26?

10 A. Figure 3-26?

11 Q. Yes. I believe Ms. Vigod had you
12 looking at this figure when she was asking you some
13 questions about findings with respect to tritiated
14 water at Site F. First I would like you to tell us,
15 and I believe Dr. Kingham already brought this up
16 today, but I want you to confirm for the Board that
17 when we are discussing the movement of tritiated water
18 through the ground, which curve should we be looking
19 at, $R=1.0$ or $R=4.8$?

20 A. Because we would consider that
21 tritium would behave as essentially a non-adsorbed
22 constituent like chloride, we would have to use the
23 curve marked $R=1.0$.

24 Q. Looking at the curve $R=1.0$,
25 and picking the 30-year point on that curve, could you



Toronto, Ontario

1 indicate for the Board what you would predict from the
2 model as shown on Figure 3-26 as to the extent of
3 tritium migration through the shale unit you are
4 modelling here which I believe is the weakly fractured
5 shale?

6 A. That is correct and at the 30-year
7 time period the predicted relative concentration is
8 .1 which suggests that we would certainly expect to
9 find tritium, or we could certainly expect to find
10 tritium in the highly fractured zone at the base of
11 the weakly fractured shale in that time period.

12 Q. When did elevated levels of
13 tritiated water begin to enter into the groundwater
14 system at Site F?

15 A. That would be sometime in the
16 early 1950's.

17 Q. And for a time period are we
18 looking at a range of something like 30 to 35 years?

19 A. That is correct.

20 Q. Assuming for the moment it was
21 35 years, what would be the C/C_0 of tritiated water
22 at the base of the weakly fractured shale at the
23 35th year.

24 A. It would approximately .2 or a
25 relative concentration of .2.



1 Q. Looking at the range of years,
2 30 to 35 years on Figure 3-26, and considering your
3 knowledge as to the likely levels of tritium in the
4 tritiated water that landed on the landfill in the
5 period 30 to 35 years ago, taking your calculation of
6 C/C_0 , what would you anticipate would be the levels of
7 tritiated -- of tritium to be detected at the base of
8 the weakly fractured shale in this time period, 30 to
9 35 years?

10 A. I think as I described earlier
11 this afternoon to Dr. Kingham, I don't believe it is
12 possible to quantify what that tritium concentration
13 would be other than to say that it should be a level
14 greater than probably two or three tritium units and
15 certainly detectable by the analytical methods
16 that were used in the Hydrology Consultants study,
17 although I can't recall the exact detection
18 limit, but the detection limit identified in E-214 for
19 the tritium results performed in the UW study.

20 It is quite possible that water which
21 recharged in the early 1950's should have contained
22 several tritium units and it may not have been
23 detectable at that time but I will just check. It
24 would appear to be that the detection limit in the
25 UW study for the sampling certainly in November of



Toronto, Ontario

1 1983 had a detection limit of somewhere around 1 or
2 2 tritium units, somewhere around that range, and so
3 tritium should have been detectable by that method
4 also.

5 Q. All right. Now, when boreholes --
6 the first conclusion is that your model predicts a
7 finding of tritiated water, elevated levels of
8 tritiated water in the highly fractured shale at this
9 time. Is that what we are to understand from Figure
10 3-26?

11 A. The finding of tritiated water
12 in the highly fractured shale would be consistent with
13 the modelling of contaminant migration through the
14 weakly fractured shale.

15 Q. Now, just to refer to another
16 aspect of tritium testing; when boreholes are created,
17 is there any possibility before the testing occurs
18 of some interconnection of the zones through which
19 the borehole passes at the ground surface all the way
20 down to the highly fractured shale, and assuming the
21 borehole was that deep, that could inadvertently affect
22 the testing for tritium in the highly fractured shale?

23 A. That is a possibility, yes.
24 For the Morrison Beatty type piezometers which are
25 either 1-1/2 or 2 inch piezometers installed in, I



1 believe in 1980, it is my understanding that those
2 have been at least purged and sampled, purged of reason-
3 ably significant volumes of water compared to the
4 several litres removed from the Waterloo piezometers,
5 and it would be my expectation that if any such
6 contamination had occurred, it may have been alleviated
7 in the MB series wells by repeated sampling and purging.

8 Q. I would like to take you back
9 for a moment to Exhibit N-254. When we looked at
10 page 338 of N-254...

11 A. N-254?

12 Q. The Quigley article.

13 A. Yes.

14 Q. At page 338 I had you eyeball --
15 I think I did the eyeballing of the carbonate level
16 of page 338 and suggested it was a metre or for the
17 first metre it appeared to be somewhat absent.
18 Ms. Cronk pointed out to me on pages 340 and 341 that
19 there is a suggestion that carbonate was leached to a
20 depth not of one metre but of 1.5 metres, and you will
21 find that in the first line on page 341.

22 A. Yes, I see that.

23 Q. I just wanted to confirm that for
24 the record.

25 A. That is correct.



1 Q. Now, Mr. Feenstra, I would ask
2 you to go to Exhibit WB-262 which is already up there,
3 it is on the board, the document that Ms. Vigod had
4 you prepare yesterday?

5 A. Yes.

6 Q. This morning you calculated a
7 geometric mean for the K values measured in the weakly
8 fractured massive shale unit at Site F and you came
9 up with a recorded number of 6.3×10^{-7} centimetres
10 per second. I believe you gave this evidence
11 yesterday, but I would like you to confirm, is that
12 geometric mean which has been calculated now, is it
13 calculated for the horizontal hydraulic conductivity
14 or the vertical hydraulic conductivity?

15 A. That represents the horizontal
16 hydraulic conductivity as determined by packer tests
17 and Hvorslev tests in the monitoring wells.

18 Q. If that is the horizontal
19 conductivity, what in your opinion is the related vertical
20 hydraulic conductivity of that particular unit, unit 3?

21 A. Well, it is not possible to
22 precisely determine or even estimate what the vertical
23 hydraulic conductivity is, but in a geological material
24 such as shale which is laid down in thin horizontal
25 layers, it would certainly be an expectation that the



Toronto, Ontario

1 vertical hydraulic conductivity may be somewhat less
2 than that value and the degree of anisoprity that is
3 commonly assumed for units like this would be
4 approximately a factor of 10 lower hydraulic conduc-
5 tivity.

6 Q. Is it one magnitude lower?

7 A. Correct. Rather than something
8 in the range of 6.3×10^{-7} , 6.3×10^{-8} .

9 Q. That then would be approximately
10 the hydraulic conductivity that Mr. Sobanski assumed
11 for his so-called second run of the model, H-221?

12 A. Actually that value would be
13 close to the value that was used initially; 6×10^{-8}
14 is fairly close to 1×10^{-7} and that would represent
15 the hydraulic conductivity used in the first model
16 run, the model run presented in Exhibit H-40.

17 Q. Is that the hydraulic conductivity
18 that you used in doing your modelling of contaminant
19 migration?

20 A. Yes, that is correct.

21 Q. Now, you will recall yesterday
22 that Ms. Vigod asked you some questions about the
23 thickness of the so-called massive shale or unit 3 at
24 Site F and she put to you an Exhibit, WB-261, and
25 suggested to you that the mean or the geometric mean,



Toronto, Ontario

1 I can never tell the difference, but based on the bore-
2 hole information she gave you on WB-261 was 10.7 metres?

3 MR. McQUAID: That was the average.

4 MR. HODGSON: Q. That was the average.

5 Now, can you indicate from what portion of Site 7 were
6 the thickness that are recorded on WB-261 taken?

7 A. This is a zone in the southern
8 half of Site F, a portion of which would underlie the
9 southern part -- I have lost the Exhibit -- 220, some
10 of which would underly the southern portion of the
11 landfill and some would be south of the landfill itself.
12 I certainly don't want to lose this exhibit.

13 MS. VIGOD: Could the witness clarify
14 that please?

15 DR. KINGHAM: I think he plans to
16 clarify it when he gets the exhibit up.

17 THE WITNESS: I will also correct what
18 I said. With the exception of HC8, which is very close
19 to the landfill boundary, the wells HC3, 4, 5, 6 and 7
20 would all be in the southern part of Site 7 and HC7
21 being over to the east of the landfill in this area
22 and it would not be underlain -- it would not underlie
23 the landfill as proposed.

24 MR. HODGSON: Q. When you model
25 contaminant migration are you concerned about contaminant



1 migration only to the southern half of the landfill
2 at Site F?

3 A. No, we are concerned with migration
4 beneath the entire base of the landfill, although the
5 southern half is the half that is closer to the area
6 of concern, the south being the direction of groundwater
7 flow.

8 Q. Have you independently considered
9 the appropriate thickness of unit 3 to be taken for
10 purposes of your modelling or have you accepted that
11 information from Mr. Beechinor?

12 A. For the modelling I conducted in
13 my report?

14 Q. Yes.

15 A. I accepted that information from
16 Mr. Beechinor.

17 Q. Do you still accept Mr. Beechinor's
18 interpretation that an appropriate thickness to accept
19 over the whole of Site 7 would be 15 metres?

20 A. 15 metres based on the evidence
21 that Mr. Beechinor presented would certainly be typi-
22 cal of what you might call the average or mean
23 condition south of Site F, recognizing the fact that
24 the weakly fractured zone is interpreted to be somewhat
25 thicker to the north end, something greater than 15



1 metres and I believe Mr. Beechinor mentioned 20 metres
2 in thickness and somewhat thinner at the south end.

3 Q. Taking you to questions that
4 were put to you both by Ms. Vigod and by Mr. Tidball,
5 you were asked about the location of the discharge
6 zone and I simply want to ask you if it matters where
7 the discharge zone is from your point of view, from the
8 point of view of your contaminant model?

9 A. From the point of view of
10 contaminant modelling, with the component models as
11 simulated, no, it does not, because lateral migration
12 through the highly fractured zone is quite rapid and
13 so whether the lateral transport distance is 1000 metres
14 or 1200 metres or 1500 metres is really of little
15 consequence in terms of migration through that zone.

16 Q. In terms of what will reach that
17 zone, wherever it is, is it a matter of concern to you
18 that it may or may not be further south than suggested
19 by Mr. Sobanski in his evidence?

20 A. Could you repeat that question,
21 please?

22 Q. In terms of the contaminants,
23 the contaminant loading that will reach that zone as
24 suggested by the modelling you have done, does it
25 matter whether or not the discharge zone is further



1 to the south and was suggested by Mr. Sobanski in
2 his evidence?

3 A. No, I don't believe it would.
4 When I mentioned the fact that groundwater velocities
5 through that zone are expected to be quite rapid,
6 certainly the groundwater velocities are expected to
7 be and for the purposes of the modelling conducted
8 in 1986 and described in H-86 where we did not take
9 into account any possible effect of matrix diffusion,
10 the corresponding rate of contaminant migration would
11 also be quite rapid.

12 Matrix diffusion -- I would think we
13 have the full expectation that matrix diffusion will
14 be effective or will be active in attenuating contaminant
15 migration through that zone and in that case the
16 actual flow path length will have an effect.
17 In other words, the greater the distance of migration
18 through that fractured zone, the larger potential
19 there will be for attenuating by processes such as
20 matrix diffusion, although that was not specifically
21 considered in the models.

22 Q. Later discharge means more
23 attenuation?

24 A. More flowpath length means
25 more attenuation, that is correct.



1 Q. Whether the flowpath is long or
2 short are you satisfied that the degree of attenuation
3 is acceptable for the purposes of siting a landfill?

4 MR. McQUAID: How is that reply?
5 You are asking the witness to repeat his evidence and
6 you are cross-examining and there is a whole line of
7 questions asking him to contradict things said in
8 cross-examination or to repeat it and this is not
9 proper reply.

10 MR. HODGSON: He can go back
11 through his cross-examination and I can go back in
12 reply to anything raised in cross-examination and
13 ask the witness to clarify his evidence and I believe
14 that that is exactly what I am doing.

15 MR. McQUAID: I am asking you to rule
16 as I am objecting to that question as it is clearly
17 inappropriate.

18 MR. LANCASTER: Could you ask the
19 question again?

20 MR. HODGSON: I think I would like to
21 have it played back.

22 THE REPORTER: (Reading back)

23 "MR. HODGSON: Q. Whether the flowpath
24 is long or short are you satisfied that
25 the degree of attenuation is acceptable



Toronto, Ontario

1 for the purposes of siting a
2 landfill?"

3 MR. LANCASTER: I think that question
4 should be put as I would want it clarified.

5 MR. HODGSON: Q. Thank you. Can you
6 remember the question?

7 A. I would appreciate if you would
8 repeat it again.

9 Q. I asked whether the flowpath
10 from Site F to the discharge area, given that there
11 is some suggestion the discharge area may not be where
12 Mr. Sobanski suggested where it was, whether the flow-
13 path is a long flowpath to a further discharge area
14 or a short flowpath to the discharge area suggested
15 by Mr. Sobanski and are you satisfied that attenuation
16 will be satisfactory for the purposes of siting a
17 landfill at Site F?

18 A. There are basically two parts to
19 the response to that question. The first one being
20 that with respect to attenuation of contaminant migra-
21 tion in the sub-surface itself, I would fully expect
22 attenuation processes to be capable of reducing
23 concentration from the landfill to a level at which
24 they would not exceed the drinking water standards
25 for the majority of those compounds.



1 As I described to Mr. Tidball earlier
2 this morning, even if we do have contaminants that
3 reach that discharge zone, there are also a number of
4 other factors that need to be considered and those
5 could be viewed as -- also viewed as attenuation
6 processes but ones which occur not in the deep groundwater
7 flow system, but ones which occur actually in the
8 discharge zones.

9 As I suggested, any groundwater discharge
10 bearing volatile organic chemicals discharged to the
11 ground surface or the marshy area in the zone between
12 Highway 403 and the CNR, the concentrations of those
13 chemicals will be reduced by volatilization from
14 the surface water into the atmosphere, and the concern
15 for these volatile organic chemicals is somewhat low
16 with respect to the toxicity of these chemicals
17 related to biological and aquatic life and the fact
18 that these chemicals are not of concern from the
19 viewpoint of bioaccumulation of these particular
20 chemicals.

21 Within the zone further to the south
22 of the CNR where monitoring has demonstrated there are
23 upward groundwater hydraulic gradients, suggesting
24 groundwater flow from the deeper shale up into the
25 shallow flow system, the shallow flow system being



1 reflected by the fresh water rind or a zone of water
2 with fairly low chloride and other salt concentrations
3 that is used for water supply by such shallow wells
4 in this area.

5 The fact that there are high salt
6 concentrations at depth in the shale, upward hydraulic
7 gradients suggesting some degree of groundwater
8 discharge, and very little evidence of upward discharge
9 of the salty water in that shallow zone, groundwater
10 in the very shallow shale and in the overburden, it
11 would suggest there is a great degree of dilution of
12 any groundwater discharge from depth in the shale
13 coming up in this particular zone, and that degree of
14 dilution could also apply to any other volatile
15 organic chemicals present in the groundwater in this
16 location and were discharging upward to the shallow
17 groundwater.

18 So, going way back to the original
19 question, yes, I would fully expect the degree of
20 attenuation exhibited by this site to be suitable for
21 the siting of a landfill at Site F.

22 Q. Thank you. Ms. Vigod asked you
23 some questions about matrix diffusion and where matrix
24 diffusion can be done and how useful it is. Have
25 you ever done any modelling -- have you ever done any



1 matrix diffusion modelling in a fractured medium?

2 A. I have.

3 Q. Where was that?

4 A. It was the evaluation of
5 contaminant migration through a fractured shale --
6 excuse me -- a fractured sandstone formation in
7 Northern Saskatchewan with respect to the injection
8 of contaminated minewater or process water from the
9 uranium mine.

10 Q. Have you an opinion as to the
11 appropriateness of modelling matrix diffusion in a
12 fractured medium?

13 A. Matrix diffusion certainly
14 can be modelled for fairly simple geometries of
15 fractures, that is for a single fracture or a series
16 of parallel fractures. One has to assume various
17 parameters for the actual groundwater flow rate through
18 the cracks, through the fractures, the actual size
19 of the fracture openings and the fracture spacing.

20 The measurement of the diffusion co-
21 efficient, the diffusion coefficient value obviously
22 being very important to the degree of diffusion out
23 into the matrix, is relatively easy to measure and
24 determine in comparison to some of these other
25 parameters related to the characteristics of the



1 fractures.

2 I believe that matrix diffusion models
3 can certainly be used to illustrate the potential
4 effects of matrix diffusion. The direct application
5 of the use of those models to a real field case where
6 the actual fracture orientations and fracture properties
7 aren't precisely known, I would think would be in some
8 question, and I don't recall there being a case where
9 matrix diffusion models has been directly compared to
10 a field case in order to sort of verify the results
11 or verify the relationship between the model results
12 and what is actually observed in the field.

13 Q. Whether or not the modelling
14 is possible in some circumstances, do you believe
15 that matrix diffusion is a factor to be at least
16 considered if not modelled?

17 A. The model calculations and some—
18 laboratory scale experiments have indicated and
19 certainly suggest that matrix diffusion should be
20 a very important process in a fractured porous medium
21 like fractured shale or fractured clay.

22 Q. Mr. Feenstra, would you turn
23 up Exhibit H-264C which is the drawing that appeared
24 out of nowhere and it has subsequently been marked?

25 DR. KINGHAM: The Halton exhibit.



1 MR. HODGSON: Q. I want to take you
2 back to the cross-examination from first Ms. Vigod
3 and then Mr. Tidball and finally Dr. Kingham.

4 MS. CRONK: I don't think it was
5 quite cross-examination by Dr. Kingham, if you meant
6 to suggest that.

7 MR. HODGSON: I certainly didn't mean to
8 suggest that.

9 The questions by Ms. Vigod, then by
10 Mr. Tidball and Dr. Kingham on the subject of whether
11 or not monitoring was being effective in respect of
12 any migration of contaminants from the existing land-
13 fills to the left and right, as it were, of Site F.

14 Q. With respect to the landfill
15 on the left of Site F, the Burlington landfill
16 looked at from this perspective, I would ask you if
17 you would turn up Exhibit H-83 and go to page 12,
18 the Gartner Lee Plume Delineation Study.

19 A. Yes.

20 Q. Page 12. You will recall,
21 Mr. Feenstra, both Ms. Vigod and Mr. Tidball were
22 especially interested in monitor 24 and perhaps you
23 could put up the exhibit, the Gartner Lee map from
24 the Gartner Lee H-83 that has shown on it the exact
25 location of the monitoring wells. Could you simply



1 outline in red for the Board monitor 24. That is the
2 monitor that Ms. Vigod suggested was somewhat
3 comparable in latitude to HC5, is that right?

4 A. That is correct.

5 Q. She asked you to draw various
6 comparisons between the hydrostratigraphy at HC5 and
7 the hydrostratigraphy at monitor 24?

8 A. That is correct.

9 Q. Are there any monitors -- does
10 Gartner Lee have any monitors south and closer to
11 Highway 403?

12 A. That were sampled for trace organics
13 or any monitors in general?

14 Q. That were sampled for trace organics?

15 A. GLA 26 and 27.

16 Q. Can I ask you to look at page
17 12 of the Gartner Lee report, the last paragraph on
18 the page:

19 "In the 'Halton Region Landfill Technical'
20 (study) a conceptual hydrogeological model
21 was presented for the adjacent property...
22 In this model is a wedge of highly
23 fractured shale which occurs at an ele-
24 vation of about 100 to 110 m in the
25 vicinity of the North Service Road.



1 Hydraulic conductivity values associated
2 with this highly fractured zone were
3 in the range of 1×10^{-4} (metres per
4 second) ..."

5 Which is 1×10^{-6} centimetres?

6 A. 10^{-2} centimetres per second.

7 Q. My report says 1×10^{-4} ?

8 A. That is the same as 1×10^{-2}
9 centimetres.

10 Q. I apologize. Then it goes on:
11 "...The higher hydraulic conductivity
12 values which were obtained from
13 monitors 26-1, 27-1 and borehole 17
14 tend to confirm the presence of this
15 highly fractured shale unit. However,
16 other installations completed at similar
17 elevations (e.g., 16, 24-1 and 26-2)
18 have hydraulic conductivity values
19 up to two orders of magnitude lower."

20 Then I would ask you to turn to page 13 where there
21 is a figure which has on the left -- which is the
22 X axis and which is the Y axis?

23 A. The vertical one is the Y axis.

24 Q. It has the elevation of the

25 screened interval of the Gartner Lee wells and on the X



Toronto, Ontario

1 axis it has the hydraulic conductivities at the
2 particular elevations and it shows, for example, that
3 26-1, which is at about 103 metres, has a very low
4 hydraulic conductivity?

5 A. High.

6 Q. Sorry, a very high hydraulic
7 conductivity?

8 A. Yes.

9 Q. And 27-1 has a fairly high
10 hydraulic conductivity?

11 A. Yes.

12 Q. And some others are scattered in
13 there as well?

14 A. That is correct.

15 Q. Now, looking at Exhibit H-264C,
16 and keeping in mind this other information from the
17 Gartner Lee report, do you have any opinion which you
18 could share with the Board as to whether or not the
19 monitoring that Gartner Lee is doing at the adjacent
20 site can be expected to be effective in terms of being
21 done in areas where leachate might be expected to
22 migrate?

23 A. Well, based on the conclusions
24 or the discussion presented in the Gartner Lee report,
25 it would tend to suggest that at least in the deep



1 borings at GLA 26 and GLA 27, Gartner Lee determined
2 hydraulic conductivities that were reasonably high
3 with respect to the other monitors in other parts
4 of the shale and it appears to me that they probably
5 attributed that higher hydraulic conductivity to
6 this highly fractured zone which they indicated or
7 would have expected to find at an elevation between
8 100 and 110 metres in the area south of the Burlington
9 site.

24B 10 In other words, they had wells in this
11 pathway zone south of 403 in their opinion.

12 Q. In your opinion have they detected
13 any leachate migrating to those particular wells,
14 the deeper wells with the lower hydraulic conductivities?

15 A. In my opinion they have not and
16 I might also point out that is also Gartner Lee's
17 own opinion with respect to their results.

18 Q. On those two wells?

19 A. They will have an opportunity
20 to provide that in writing to the Region in the future.

21 Q. Now, it is hard for me to tell
22 where I am in the cross-examination, but I think I
23 am still with Ms. Vigod. Yes, I am.

24 Could I ask you to go to your
25 Figure 3-26. Things get said at hearings and get



Toronto, Ontario

1 repeated at hearings until everyone assumes they are
2 a fact and the fact that was put to you both by
3 Ms. Vigod and by Mr. Tidball based upon Figure
4 3-26 is that the time it will take contaminants to
5 go from out the bottom of a proposed landfill at
6 Site F and reach the boundary of the site is 30 years.

7 Now, would you interpret for us from
8 Figure 3-26 what exactly is it you are going to predict
9 will reach the boundary in 30 years?

10 A. The boundary? Based on this
11 simulation with the various input parameters as defined
12 on this figure, at 30 years we would have expected
13 or we would expect to find concentrations of non-
14 adsorbed contaminants such as chloride, although we
15 probably would not be able to identify chloride at
16 Site F because of the high concentrations within the
17 groundwater naturally, but at concentrations approximately
18 10 per cent of the input levels and we would just be
19 possibly starting to detect the presence of some
20 weakly adsorbed organic contaminants at that time
21 at very low concentrations and they might not even
22 be detectable at that time, depending upon the input
23 level.

24 Q. Comparing the chlorides expected
25 in the leachate with the chlorides measured in the



1 groundwater at Site F, in your opinion, looking at
2 Figure 3-26, when would we be able to detect a
3 significant movement of chlorides from the landfill
4 to the site boundary?

5 A. I doubt that we ever would, based
6 on the chloride concentrations present naturally in
7 the groundwater beneath the site.

8 Q. Looking at the weakly adsorbed
9 contaminant, how long will it be before significant
10 levels of weakly adsorbed contaminants will be
11 detectable at the site boundary based upon Figure
12 3-26?

13 A. That would depend to a large
14 degree on the actual input concentrations. If we
15 assume for the purpose of this illustration it being
16 a constant contaminant input, if we assume a constant in-
17 put of something in the range of 1000 micrograms per
18 litre, then we should be able to start detecting
19 something in 30 to 35 years, given the detection limit
20 of several p.p.b. for most of those volatile organic
21 contaminants.

22 Q. Finally, Mr. Feenstra, if I could
23 ask you to turn to the exhibit you created, I think
24 it is H-263...

25 DR. KINGHAM: The horizontal one on the



1 table.

2 THE WITNESS: I am just making some
3 room for it.

4 MR. HODGSON: Q. Now, you will recall that
5 we got into this subject because Ms. Cronk put three
6 exhibits to you and asked you to compare Site F with
7 Site D based upon contaminant migration and the ability
8 of the underlying materials I believe to attenuate
9 any leachate that might be moving through them, and you
10 responded to her request by comparing F to Site D in
11 term of more favourable in terms of contaminant migration.

12 The subject was then taken up by
13 Mr. McQuaid who sought to put a different comparison
14 to you. He asked you to remember that D was going
15 to have a hydraulic trap and no significant contaminants
16 would escape from Site D while the hydraulic trap was
17 operating. Then he asked you "based on operating
18 conditions", which site was preferable and you told
19 him it was Site D.

20 So we now have Site F preferable on
21 one set of comparisons and Site D preferable on another
22 set of comparisons. The subject was further pursued
23 by Ms. Vigod and I confess that I can't quite now
24 recall just how she wanted to frame her comparison,
25 but during the course of her cross-examination you



1 produced Exhibit H-263.

2 Now, based on the fact that we have
3 two opinions from you as to which site is preferable
4 based on two different input parameters, as you might
5 put it, I am not struggling to find what I believe
6 Dr. Kingham referred to as an apples to apples compari-
7 son.

8 First I would like to ask you,
9 just as a sub-text to this, is each one of these two
10 sites suitable for landfill from your point of view?

11 A. Each of these sites, each of these
12 two sites could be made suitable for a landfill given
13 the appropriate operation of their engineered features
14 and the implementation of appropriate contingencies
15 if they become required in the future, yes.

16 Now, that would reflect the third
17 scenario.

18 Q. The third scenario?

19 A. Yes, the fact that in the event
20 that your engineered features did not operate as
21 planned and effective contingencies were implemented,
22 there should be no impact from either of these two
23 sites with respect to contaminant migration into the
24 groundwater.

25 Q. Am I to understand that



1 Mr. McQuaid's comparison really refers to your line 1
2 primary features in operation or primary engineered
3 features in operation?

4 A. That is correct.

5 Q. Ms. Cronk's comparison is more
6 or less in respect of line 2?

7 A. That is also correct, yes.

8 Q. So we don't have a comparison
9 based on line 3 and I don't know whether or not from
10 your point of view in an apples and apples comparison
11 we should have a comparison at line 3 or if we should
12 have a comparison based on all three lines. So I
13 wanted to ask you if it is your opinion that each
14 of these sites can be engineered to be a suitable
15 landfill, have you any opinion to share with this Board
16 as to which of the two you would recommend?

17 MR. McQUAID: How will Ms. Cronk and I
18 be able to get a crack at that one?

19 MR. HODGSON: I didn't ask my friends
20 to cross-examine on a site comparison. I didn't
21 ask any questions on the subject in chief and didn't
22 intend that the subject would ever come up but it
23 did come up and we have two comparisons, one going to
24 F and one to D, and it seems to me with the greatest
25 of respect I am entitled to come back to the subjects



1 my friends were so happy to explore with their apples
2 and oranges comparisons and now we can just have it as
3 apples and apples, which site does this witness say
4 is the preferable site?

5 MR. McQUAID: We didn't expect the
6 witness to argue the case for the lawyers, but we now
7 have our position based on certain factors and it is
8 up to us to argue based on that evidence and you don't
9 ask the witness now to argue the case for you.

10 MR. HODGSON: I am not asking him to
11 argue the case but I am asking for his professional
12 opinion to be shared with this panel as to which of
13 these two sites he prefers based upon his special
14 expertise.

15 MS. CRONK: I am affected by the question
16 as well. I don't know what the answer will be, but
17 technically it seems to me that the question was not
18 put and this area was not explored in direct
19 examination and I thought that remarkable at the time
20 and that is why I dealt with it in cross. Technically
21 within re-examination it is within the realm of what
22 is permissible under the rules, and I may regret that,
23 but technically I support Mr. Hodgson's view, he
24 is entitled to put the question.

25 DR. KINGHAM: We have a little bit of



1 difficulty since while we feel the question should be
2 allowed in recognition of the fact that the matter
3 was raised in cross-examination rather than the main
4 examination, we are not entirely clear on the specifics
5 of the question, even though you said it a few minutes
6 ago and perhaps you could make it clearer as to whether
7 you were asking this witness given all three scenarios
8 and considering the permutations and combinations
9 of all three at the same time -- is that the essence
10 of your question?

11 MR. HODGSON: I wanted to leave it to
12 the witness who created this document. As I understood
13 his evidence he had given a comparison based on line 1
14 that D was more suitable and a comparison based on
15 line 2 that F was more suitable, but those were narrowly-
16 framed and carefully narrowly-framed questions from
17 two counsel with opposing points of view. I wanted
18 to have this witness tell us what he thinks is an
19 apples and apples comparison so we would have his
20 evidence as to what he should be comparing and then I
21 would like to have the answer if he has an answer and
22 of course if he doesn't have an answer, I can accept
23 that.

24 THE WITNESS: I am glad you framed it
25 that way. It actually becomes quite difficult because



Toronto, Ontario

1 in order to compare the sites totally in recognition of
2 each of these three scenarios one must make some
3 decisions about which scenario is going to be most
4 important or most likely and certainly in my opinion
5 with time, either during operation of the landfill and
6 following operation of the landfill, the actual scenario
7 is probably going to change.

8 As I expressed earlier today, during
9 the operational life of the landfill, which is expected
10 to be approximately 20 years, I would fully expect
11 the leachate collection system to work admirably at
12 Site D and I would not anticipate a failure in that
13 timeframe, but based on my understanding of the
14 considerations, I don't think it is possible to
15 project that the hydraulic trap will work indefinitely,
16 and indeed maybe the Region doesn't even want to
17 operate the hydraulic trap indefinitely, depending
18 on the quality of the leachate that is evident.

19 So, it becomes very difficult to decide
20 whether one will use this as a scenario and saying
21 things will operate perfectly from now on and well
22 into the future, or if one will acknowledge that there
23 will be a failure of the engineering features and in
24 which one will take no contingency plans or implement
25 no contingencies to control any off-site migration.



1 I actually feel that this is quite
2 unlikely, the fact ...

3 DR. KINGHAM: "This" being?

4 THE WITNESS: Scenario 2; the fact
5 that the engineering features will be noted as having
6 failed as a result of the site monitoring and nothing
7 would be done to correct that.

8 So, in some ways I think the second
9 scenario could be reasonably considered to be in-
10 appropriate because I just don't think the combination
11 of the site operations and the regulatory agencies
12 involved would allow this to occur, given that
13 the site will be monitored and any impacts or any
14 failure of the engineered system should be able to
15 be identified. I think if proper care is taken
16 in monitoring and operation of the site, then that
17 is perfectly feasible.

18 The third scenario, failure of the
19 engineered system and the implementation of effective
20 contingencies; certainly if the primary engineering
21 features fail, I feel there is the basis to conclude
22 that effective contingencies can be designed and
23 developed and I certainly would not want to be held
24 to any cost estimates I would make on those at the
25 present time, but I think it is certainly within the



1 available technology to provide effective contingencies
2 for any failures of the engineering systems that might
3 be in place in the future.

4 So, that brings me to the case then
5 where you have got two possible scenarios, Site D and
6 Site F in one case during operation of the site where
7 there will be no impact because there will be no egress
8 of leachate from the landfill through to the granular
9 units, and in Site F where we expect there to be some
10 movement into the shale bedrock but we do not expect
11 there to be a significant impact, although movement
12 into the shale should be identified by future
13 monitoring.

14 We just don't expect the impact of those
15 chemical contaminations in the shale to be particularly
16 significant from an environmental point of view.

17 In this particular case then, if
18 one is going to commit to the implementation of
19 effective contingencies upon the identification of
20 any failure, I think again you can be fairly confident
21 that you will be able to operate the contingencies
22 in a manner in which there will be no impact.

23 So, although it might not be an answer
24 that everyone would want to hear, on this basis and
25 for these scenarios, I would think that Site D and



1 Site F would still be rather comparable in terms of
2 the potential impact on groundwater contamination.

3 MR. HODGSON: Q. I am sure that's the
4 answer Mr. McQuaid wanted to hear.

5 DR. KINGHAM: To end the day on a
6 little bit higher note, if you will open Exhibit H-40
7 to page 124 and 125 again, I misread and I wish to
8 apologize, or rather I misled you in the last paragraph
9 on page 124 which is entirely consistent with Figure
10 21 and your evidence, and I would prefer to hear it
11 come from you rather than me.

12 A careful reading of the last paragraph
13 on page 124 suggests 15,000 cubic metres per year coming
14 out of the toe if the underdrain system doesn't work,
15 and that is the last sentence on page 124.

16 THE WITNESS: Yes.

17 DR. KINGHAM: And an increase of 3,000
18 cubic metres coming out in the expected discharge
19 area, and I think that's what you said in your main
20 evidence or in response to cross-examination, you
21 expected most of it would come out of the toe?

22 THE WITNESS: And a small increase
23 going downward.

24 DR. KINGHAM: It is a matter of adding
25 all the numbers together to arrive at the percentages



1 shown on the figure. Does that satisfy you that
2 in fact the figure and the text and your evidence were
3 consistent?

4 THE WITNESS: I trust your judgment on
5 this, but I really haven't had the opportunity to compare
6 obviously as was evident earlier this afternoon when
7 I couldn't reconcile the numbers myself.

8 MR. HODGSON: Thank you. We have
9 two classes of witnesses at this hearing, volunteers
10 and draftees, and, Mr. Feenstra, you are the first
11 draftee. Thank you very much.

12 MR. LANCASTER: We will adjourn now
13 until 9:30 on Friday.

14
15 ---Adjournment at 5:37 p.m.

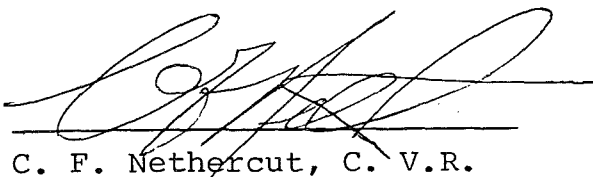
16
17 Certified Correct

18

19

20

21


C. F. Nethercut, C. V.R.

22

23

24

(Page 10600 follows)

25

