

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 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.

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Toronto, Ontario

I N D E X

WITNESSES:

1 Dr. Ronald Kerry Rowe (Resumed)
2 Dr. David Leonard Charlesworth (Resumed)
3 Cross-examination by Mr. Hodgson (Cont'd) 21404
4 Cross-examination by Mr. McQuaid 21519

E X H I B I T S

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

Dr. D.J. Kingham - Member



Hearing conducted at The Oakville
Granary Commercial Centre, 105 Robinson
Street, Oakville, Ontario, on Thursday,
February 11, 1988

VOLUME 90

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



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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	J.H. Olah	for the Halton Region
8		Conservation Authority
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Per: C.F. Nethercut, C.V.R.



1 --- Upon Commencing at 9:50:

2 MR. LANCASTER: Please be seated. We
3 really came down to see if we have a complement or not.

4 DR. RONALD KERRY ROWE (RESUMED):

5 DR. DAVID LEONARD CHARLESWORTH (RESUMED):

6 MR. HODGSON: I am sorry, Mr. Chairman.

7 CROSS-EXAMINATION BY MR. HODGSON (Cont'd):

8 Q. Dr. Charlesworth, looking again at
9 your cross-section, the one that comes down First Line,
10 RB.

11 DR. CHARLESWORTH: A. RB.

12 Q. Would you point out again for the
13 Board the Chlon and Pompa wells -- I am sorry, the
14 Chaput and Pompa wells and I think the Chaput well is
15 the well to the north, 4074?

16 A. Yes.

17 Q. Pompa is 5663?

18 A. I think that's right. Do you want
19 me to check?

20 Q. I would like you to check and then
21 I would like you to write it on the figures so it is on
22 there and available and easy to refer to?

23 A. 4074 is Chaput and 5663 is Pompa.

24 DR. KINGHAM: Is the one between
25



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Toronto, Ontario

21405

Rowe, Charlesworth,
cr ex (Hodgson)

Chlon,...

1 DR. CHARLESWORTH: Yes.

2 DR. KINGHAM: ...and while you are at it
3 on your figure RB-RB, we tried to mark this earlier,
4 but is MB OW-2, is that the Martin well you referred to
5 further to the right?

6 DR. CHARLESWORTH: To the right of MB
7 OW-2.

8 DR. KINGHAM: At MB OW-2?

9 DR. CHARLESWORTH: Between MB OW-2 and
10 HC 3-85.

11 DR. KINGHAM: Is the Reed well next?

12 DR. CHARLESWORTH: Yes, the solid dot is
13 next, 14 HC.

14 MR. HODGSON: Q. Dr. Charlesworth, you
15 were kind enough to make available to me last week
16 photocopies of the water well records from Chaput and
17 Pompa. Do you have copies available that you can make
18 use of?

19 DR. CHARLESWORTH: A. Yes.

20 Q. I would like you to confirm, first
21 of all with regard to the Chaput well, that this is a
22 bored well?

23 A. Yes.

24 Q. Once the boring was completed it
25



1 was lined with a 30-inch concrete casing. Is that what
2 it tells us on the water well record?

3 A. Yes.

4 Q. Would you agree with me that if it
5 has a 30-inch concrete casing that there is a
6 significant possibility that it was drilled with an
7 auger that has a diameter greater than 30 inches?

8 A. Yes.

9 Q. From your experience with this
10 kind of a bored well, how big is the auger that bores
11 these wells?

12 A. I am not sure what it would be in
13 that case.

14 Q. But more than 30 inches?

15 A. Maybe 48 inches -- 36 inches
16 probably.

17 Q. Would you agree with me,
18 Dr. Charlesworth, that drilling with a 30-inch auger
19 would make it difficult to miss a significant granular
20 unit on your way down?

21 A. One would expect them to encounter
22 it, but I wouldn't rule out the possibility that they
23 may miss it. But I would expect if it was a major
24 water bearing zone to encounter it, but it has been
25 known, I guess that is the point I am making, for these



1 water well records to miss zones.

2 Q. But you would expect it. Would
3 you also agree with me that one of the reasons for
4 boring a 30-inch or installing a 30-inch well as
5 opposed to auguring a six inch well is if you are in
6 less permeable materials and if you have a larger
7 diameter well, then you will have more storage in the
8 well?

9 A. Yes. If you have a large diameter
10 well, you have more storage, correct.

11 Q. So if you pump your well to do the
12 automatic dishwasher and do the baby diapers, there is
13 still some water left to drink before you go to bed?

14 A. Yes.

15 Q. If you had a six-inch well and you
16 were in relatively impermeable materials, it is
17 possible you would draw it right down over the short
18 run?

19 A. Yes, you don't have the storage.

20 Q. Just looking at the Chaput well --
21 we have looked at the Chaput well -- but looking at the
22 Pompa well, would you agree that it is also a well that
23 was augured by an auger that exceeded 30 inches in
24 diameter?

25 A. I am sorry, could I get a copy? I



1 have two copies of Chaput here. This is Pompa, yes.

2 Q. Would you agree that the Pompa
3 well is also a bored well?

4 A. I would.

5 Q. It was bored with an auger that
6 exceeded 30 inches in diameter?

7 A. That is correct.

8 Q. I would like you -- I have already
9 given you a copy of a summary of the chemistry data
10 that was compiled at Site D and I am asking you to
11 accept it subject to check?

12 A. Yes.

13 Q. This data was taken from a
14 combination of H-39A Appendix 11 and your exhibit H --
15 I am sorry, your Exhibit M-462, I believe, which is an
16 update of the water chemistry data presented in your
17 report, M-438?

18 A. I think that is right.

19 Q. Dr. Charlesworth, looking first at
20 the water data from the Martin well which you told us
21 yesterday is a bedrock well, would you agree with me
22 that this particular well has got high sulphates,
23 sulphates that exceed MOE standards?

24 A. Yes.

25 Q. And chlorides that vary from very



1 high to much below the MOE standard to quite
2 acceptable?

3 A. Yes.

4 Q. In fact that data doesn't appear
5 to be very useful data, does it, because you have
6 sampled the one well six months apart and how far apart
7 were these samplings done?

8 A. They were done a few months apart,
9 over about a six month period.

10 Q. Do you have any idea when that
11 bedrock well -- is it a bored well?

12 A. It is a relatively new drilled
13 well is my understanding.

14 Q. Is it possible the first time you
15 tested it it was not yet stabilized?

16 A. Well, I just --

17 Q. I wondered if you know whether --
18 the relationship between your first date of testing and
19 the date the well was constructed?

20 A. I would have to check that. I
21 don't know how close it was to the actual construction.

22 Q. Am I right in assuming that when
23 you create a new well it takes a certain length of time
24 for the well to stabilize?

25 A. The chemistry -- not usually in



1 terms of that kind of swing of chlorides. It is
2 possible, but I would expect if the well had actually
3 been in use for a number of weeks, and I have no reason
4 to believe assume it wasn't in use for a couple of
5 weeks, but I would think it would have stabilized and
6 it is a possibility it hadn't if it was just drilled
7 before, but that is something I would have to check.

8 Q. Comparing the water chemistry
9 which you have sampled at this Martin well which is a
10 bedrock well and the three wells, Chaput, Chlon and
11 Pompa, and I think we established yesterday in evidence
12 we are unsure as the exact relationship of those wells
13 to the bedrock and the assumption is they are in an
14 overburden unit?

15 A. Yes.

16 Q. They may be quite close to the
17 bedrock in fact?

18 A. They may be close to the bedrock,
19 yes.

20 Q. Would you agree that in terms of
21 elevated chlorides and in terms of elevated sulphates,
22 there seems to be a lot of similarity between the
23 wells, Chaput, Chlon, Pompa and Martin?

24 A. Well, the Martin well spans a
25 range such that it encompasses the values from the



1 other wells.

2 Q. Let's start with chlorides. Would
3 you agree that all three wells at one time or another
4 have had chloride measurements that exceeded MOE
5 standards?

6 A. Yes, I would.

7 Q. In fact, of the four wells, only
8 two, the Chlon well and the Martin well, have had
9 measurements that fell below MOE standards?

10 A. The Chlon well, yes.

11 Q. The Martin well has two readings
12 for sulphates that exceed MOE standards?

13 A. That is correct.

14 Q. The Pompa well has one sulphate
15 reading that exceeds MOE standards and with regard to
16 the other -- the Pompa well has also exceeded MOE
17 standards on two occasions?

18 A. Yes.

19 Q. The Chlon well and the Chaput well
20 fall below MOE standards on sulphates?

21 A. That is correct.

22 Q. Interestingly enough, just looking
23 at these four wells in geographical terms, the two
24 wells with the highest sulphates are the two wells
25 closest together, the Pompa well and the Martin well.



1 In geographic extent they are not very far apart. Can
2 you look at M-438A behind you, and indicate ...

3 A. The Martin well -- they are the
4 closest yes, but there is about the same distance
5 between those as there is between the Pompa well and
6 the Chaput well.

7 Q. I think you agreed with me
8 yesterday that if Site D was approved for landfilling
9 it would not be appropriate that the Martin well and
10 the Reed well be continued to be used because they are
11 on-site?

12 A. They are on-site wells, I agree.

13 Q. Would you also agree, just looking
14 at the four wells, Martin, Pompa, Chlon and Chaput,
15 that these four homeowners do not appear to have tapped
16 into a very high quality groundwater resource?

17 A. Well, they have tapped --
18 certainly it is not high quality in that it does exceed
19 the guidelines, but of course it is water that they are
20 using.

21 Q. What is the effect of drinking
22 water with high sulphates?

23 A. You get used to it eventually, but
24 it is primarily a laxative effect.

25 Q. You can cut down on your bran



1 consumption if you are drinking high sulphates, is that
2 the idea?

3 A. I think you would still be advised
4 to have a high bran concentration.

5 Q. I am sorry, we seem to have lapsed
6 into medical advice here. Do you think it is possible,
7 Dr. Charlesworth, that the Pompas and the Martins are
8 buying drinking water and just using their wells for
9 other purposes?

10 A. It is conceivable, although they
11 indicated that they did drink the water.

12 Q. They did?

13 A. Yes.

14 Q. Do you know whether or not the
15 Chaputs and the Chlons drink their water?

16 A. I would have to check the records
17 of the field survey.

18 Q. Have you talked personally with
19 them?

20 A. I haven't talked personally with
21 them.

22 Q. Any of the four homeowners?

23 A. No.

24 Q. Perhaps we can wait for their
25 evidence. Now, just looking at the chemistry data on



1 this -- summarized on this document, would you agree
2 with me that the groundwater in the area of Site D,
3 while it may in fact be used on whatever basis, limited
4 or otherwise, it is not a very valuable groundwater
5 resource?

6 A. Well, all things are relative. If
7 it is usable and it is what you have got, then I guess
8 it is valuable, but relative to some other areas it is
9 not, but, as I say, all things are relative.

10 Q. We don't expect the Town of Milton
11 to come out and develop it for future development
12 around the Town of Milton?

13 A. I wouldn't expect them to do that.

14 Q. Would you also agree with me that
15 since it was possible for the Martins to develop a
16 bedrock well and it was also possible for most of the
17 neighbours of the Chaputs, Chlons and Pompas to develop
18 and use a bedrock well, that in fact the Chaputs the
19 Chlons and the Pompas have an alternative resource in
20 that they could potentially develop a bedrock well if
21 necessary or one could be developed for them if
22 necessary?

23 A. Possibly, although in terms of
24 quality, for example, we don't know how it is on a
25 long-term sustained basis, but they had higher



1 sulphates somewhat and they had a higher chloride and
2 then lower chlorides, so they do have a fluctuating
3 quality and it may be that it is somewhat worse, but it
4 is a possibility that you could develop the water.

5 Q. You could develop a bedrock well
6 for each one of those homeowners?

7 A. It is possible. You don't know
8 until you drill a well.

9 Q. I am not suggesting anyone should
10 cavalierly go out and destroy their wells and tell them
11 they can always dig a bedrock well. I simply want your
12 evidence as to whether a bedrock well is an alternative
13 or potentially an alternative source of supply for each
14 one of these three, what we believe on the evidence we
15 have now to be overburden wells, however close to the
16 bedrock they may in fact turn out to be?

17 A. It is an alternative. But, if
18 their existing wells were adversely impacted, I don't
19 think there is enough evidence to say conclusively at
20 this point that the bedrock well would not be.

21 Q. That's fair, Dr. Charlesworth. It
22 is possible, is it not, that if the gradients are
23 upward from the bedrock and if each of these three
24 homeowners had a bedrock well, that their water
25 supplies would be protected, even if it should turn out



1 that by some misfortune overburden materials in the
2 area were contaminated?

3 A. That is possible. There is some
4 degree of uncertainty about it.

5 Q. I agree.

6 MR. McQUAID: Is this going to be
7 marked?

8 MR. LANCASTER: This will be H-498.

9 ---EXHIBIT NO. H-498: Groundwater Quality Site D

10 MR. HODGSON: I also gave
11 Dr. Charlesworth a summary of some points that he and I
12 were discussing yesterday and I also handed it out to
13 my friends.

14 MR. LANCASTER: H-499.

15 ---EXHIBIT NO. H-499: Hydrogeological conditions
16 at Site D

17 MR. HODGSON: Q. Dr. Charlesworth,
18 everything that goes around comes around. You will see
19 some faint relationship across the top of this document
20 to something you and I discussed last Thursday when we
21 started on this journey we have taken at Site D -- Site
22 F and Site D. With regard to the headings, optimistic,
23 reasonable and pessimistic, would you agree with me
24 that what is pessimistic and what is optimistic when we
25 talk about the groundwater in the area of Site D is a
matter of context and optimistic in the context of



1 contaminant migration may turn out to be pessimistic in
2 the context of water resource development?

3 DR. CHARLESWORTH: A. Yes, I would
4 agree with you.

5 Q. Would you agree with me for the
6 purposes of the discussion here, we are discussing the
7 groundwater at Site D on the assumption that a landfill
8 is being proposed at Site D and we are looking at the
9 groundwater from the point of view of potential impacts
10 on that groundwater?

11 A. So optimistic would be least
12 impact.

13 Q. Optimistic would then imply, would
14 you agree, that yes, should contaminants escape the
15 site there would be less impact rather than more
16 impact?

17 A. Okay. I was asking for
18 clarification on that, but, yes. We could say least
19 impact and most impact across the top from left to
20 right.

21 Q. Dr. Charlesworth, could we go
22 through this document and attempt to agree on the
23 statements contained in it, or if we can't agree then I
24 would ask you propose an amendment and we will all
25 scratch the amendment in so we will understand it, how



1 you would like the Board to understand your evidence
2 after all the exercise here.

3 In the middle category, reasonable I
4 have put in brackets "most likely" and would you accept
5 for our discussion that when we are talking about
6 reasonable we are talking about what we are most likely
7 to find at Site D, and based upon what we have already
8 found at Site D, and what we would reasonably expect if
9 some more drilling was carried out?

10 A. Okay.

11 Q. Can you accept that?

12 A. Yes.

13 Q. Would you agree with me ...

14 A. It probably doesn't fit in with
15 what I just said, tying it to the impact, optimistic
16 being the least impact, but we will assume the middle
17 column is what we are most likely to find.

18 Q. We shouldn't think of optimistic,
19 reasonable and pessimistic in terms of impact because
20 we are not assessing the impact here. I am asking what
21 is the most likely thing you are going to find
22 underneath the ground in terms of granular units, and
23 we are focusing on the granular units?

24 A. Certainly.

25 Q. And then under pessimistic, what



1 is the worst thing we could find from the point of view
2 of being concerned about contaminant migration, and
3 from the point of contaminant migration what is the
4 best thing we could conceivably find. The words have
5 that meaning?

6 A. There is a slight difference
7 between tying it into impact and perhaps if we looked
8 at it in terms of what we are likely to find and then
9 what it is in terms of impact.

10 Q. That's fair. Let's look at what
11 we are likely to find and talk about impacts later?

12 A. Okay.

13 Q. In that context we could really
14 evaluate the site simply indifferently as to whether or
15 not it is contaminant migration or water resource
16 development we are worried about. We could simply
17 think in terms of what is most likely there, what is
18 less likely to be there from a pessimistic point of
19 view and from an optimistic point of view.

20 From a most likely point of view would
21 you agree the upper granular unit:

22 "-has limited lateral extent on-site"?

23 A. I think it could be -- "limited
24 lateral extent on-site." It could be as much as the 70
25 per cent figure given in the Trow report. Is that what



1 you would call a limited extent?

2 Q. It has to be your evidence. What
3 do you think?

4 A. But it is your word and you are
5 asking me to agree it has limited lateral extent and I
6 am asking what you mean by limited lateral extent?

7 Q. I am comfortable with a
8 percentage. Can we talk about the fill area and the
9 area occupied by the buffer zone as the site for the
10 purposes of this discussion?

11 A. Yes.

12 Q. Having that portion of the area
13 known as Site D in mind, when I suggest it has limited
14 lateral extent I mean by that that the upper granular
15 unit does not underlie all or even a substantial
16 portion of that area, on the evidence we now have?

17 A. No. We could get into an argument
18 of semantics of what is a significant proportion
19 because I think it could quite easily be approaching
20 the figure Trow gave in their report which I think was
21 around 70 per cent, from my recollection.

22 Q. But that is not what we see from
23 the evidence you presented in your Figure 6?

24 A. I don't think that Figure 6
25 represents the most likely. Figure 6 represents a



1 minimum and a maximum.

2 Q. Would you agree with me that
3 somewhere between the minimum and the maximum is the
4 most likely?

5 A. Yes.

6 Q. Look at the maximum on your Figure
7 6?

8 A. Yes.

9 Q. The maximum does not encompass the
10 whole of the fill area and the buffer?

11 A. No.

12 Q. The minimum you would agree covers
13 approximately 50 per cent of that area at most?

14 A. Yes.

15 Q. When I say it has a limited
16 lateral extent, what would you like your evidence to be
17 as to what is most likely the lateral extent of the
18 upper granular unit in relation to the fill area and
19 the buffer zone?

20 A. We are speculating.

21 Q. We are not just speculating are
22 we? The 24 boreholes and 18 of them continuously
23 cored, and this isn't the time for us to imagine that
24 we will have fantasies in or out of the witness box.
25 Let's look at the data and have your evidence for this



1 Board as to what is most likely at this site based on
2 that data?

3 A. I tried to make it clear
4 yesterday, and we did discuss where they have firm data
5 indicating where it existed and where there were in my
6 mind still uncertainties that needed to be resolved and
7 I am not indulging in fantasies. I am being asked to
8 speculate and I am saying...

9 Q. You are being asked to interpret
10 and not speculate. You can speculate if you want, but
11 I am asking you to interpret?

12 A. I am saying that there are
13 deficiencies in the data and I can interpret or
14 reasonably interpret the upper granular unit as
15 underlying more than 50 per cent, and certainly more
16 than the minimum we have shown.

17 Q. Pick a percentage; has limited
18 lateral extent on-site, i.e., covers approximately X
19 per cent. Give the Board your best understanding of
20 what that per cent is for the area of the fill and the
21 buffer?

22 A. And the buffer. 65 per cent?

23 Q. Thank you. The second statement
24 reads:

25 "-extends off-site in a true westerly



1 direction but is less than 0.3 m in
2 thickness at the First Line."

3 Is that a reasonable interpretation of the upper
4 granular unit at Site D?

5 A. I think it could be easily more
6 than 0.3 metres.

7 Q. Put a number on it?

8 A. It could be a metre in parts.

9 Q. Shall we put that as 1 for you?

10 A. Yes.

11 Q. So you want that to read 1.0
12 metres?

13 A. It could be.

14 Q. It now reads:

15 "-extends off-site in a true westerly
16 direction but is less than (1.0m) in
17 thickness at the First Line."

18 A. I would expect that its thickness
19 would vary from zero at the southern end of First Line
20 to perhaps in excess of a metre as you move, and I use
21 north in the local context, along First Line.

22 Q. You would like your evidence to be
23 thickness varies along First Line from zero at the
24 southern end ...

25 A. That is a possibility.



1 DR. KINGHAM: I would like to understand
2 this evidence. Are we to understand that you are
3 telling this Board that it is most likely that the
4 upper granular unit extends across First Line at a
5 thickness of a metre or so? That is where I am having
6 trouble with this scenario. Is it a most likely, or a
7 possibly or could? I would like to know and I want to
8 understand what you are telling us.

9 DR. CHARLESWORTH: I think it is likely
10 that in parts it could be.

11 MR. HODGSON: Q. Dr. Charlesworth, if I
12 may interrupt, and pardon me, Dr. Kingham, but we will
13 go through the possible but less likely on the
14 pessimistic side and the possible but less likely on
15 the optimistic side, and no one will sue you if it
16 turns out your prediction of the most likely turns out
17 to be incorrect, and I am sure everyone will be very
18 pleased if it turns out to be very correct. We want
19 your best evidence as an experienced hydrogeologist who
20 has done a lot of drilling in these kind of materials
21 and interpreted these materials on a great number of
22 occasions -- is that not correct?

23 DR. CHARLESWORTH: A. Yes.

24 Q. As to what is most likely from the
25 data we now have?



1 A. I think it is likely that at least
2 in part along First Line it exceeds a metre in
3 thickness along the northern part, the northern half of
4 the site. I think there is a likelihood that a series
5 of boreholes down there would encounter it.

6 Q. To the north. You mean somewhere
7 toward the area of HC 1-85?

8 A. Somewhere along the section from
9 the Chaput well -- between the Chaput well and 1-85. I
10 think it thins obviously as you get toward 1-85. I
11 think it thins as you go south. It would be from zero
12 to more than a metre.

13 Q. The third statement:

14 "-has a $K=1.0 \times 10^{-2}$ cm/s on-site but
15 decreases as it extends off-site."

16 Is that a reasonable, i.e., the most likely, statement
17 about it?

18 A. Yes.

19 Q. The lower granular unit:

20 "-more extensive and probably more
21 important in the flow system than the
22 UGU."

23 That is almost really quoting from your report?

24 A. I would agree. I think that that
25 may well turn out to be the case and it is likely to be



1 the case.

2 Q. "-extends off-site in a true
3 westerly direction but thins as it
4 extends off-site."

5 A. Yes, I would agree with that.

6 Q. "-relatively low K ($<1 \times 10^{-3}$ cm/s)
7 in all but a limited area on-site."

8 A. I think the figure is probably
9 correct. It is relatively low or it is high relative
10 to the tills, obviously.

11 Q. Yes. It is basically a silt unit?

12 A. I think the figure you have quoted
13 there is a likely value you would find if you tested
14 that at a number of locations.

15 DR. KINGHAM: So we can understand, are
16 you saying a relatively low K for a granular unit?

17 DR. CHARLESWORTH: Yes.

18 MR. HODGSON: Q. With the
19 qualifications you have put on and which I think we
20 have all penned into the document we have in front of
21 us, you agree that the middle column represents a
22 reasonable, i.e., most likely scenario for what exists
23 at Site D?

24 A. Yes.

25 Q. Now, Dr. Charlesworth, before we



1 go to the pessimistic from the point of view of
2 contaminant migration scenario, I wonder if you would
3 indulge me, and I do mean indulge me because I know how
4 much of a strain it will be for you to do this, but I
5 want you to adopt a more hopeful attitude. I would
6 like you to not fantasize about good things, but just
7 keep in mind that sometimes good things can actually
8 happen.

9 MR. ESTRIN: Mr. Chairman, Mr. Hodgson
10 is insinuating without getting sarcastic. He should be
11 asked to withhold his sarcasm.

12 MR. LANCASTER: There is a degree of
13 insinuation there.

14 MR. HODGSON: Actually there was not
15 meant to be any sarcasm or insinuation in what I said
16 and I apologize to you and to the witness if it seemed
17 that way. I was really trying -- I am trying to place
18 in context the kind of exercise I am asking the witness
19 to engage in. I know how reluctant he will be to give
20 this kind of evidence, but I want to have confidence
21 that we will not interpret this site in light of this
22 evidence necessarily, but I think it is important that
23 the Board have a balanced view of what the
24 possibilities are at Site D, and I would like this
25 witnesses evidence for what the more hopeful



1 possibilities are.

2 MR. LANCASTER: The Board would like to
3 have the evidence not from what is there because no
4 one's exactly what is there, but the best evidence
5 based on what appears to be there, and your
6 interpretation.

7 DR. CHARLESWORTH: Yes, Mr. Chairman.

8 MR. HODGSON: Q. Could I take you to
9 this optimistic column and ask you about the upper
10 granular unit. Looking at it from the point of view --
11 looking at it from a hopeful point of view?

12 DR. CHARLESWORTH: A. Yes.

13 Q. The other thing I would like to
14 qualify is when we talk about this optimistic scenario
15 I don't want to suggest for a minute that any
16 responsible hydrogeologist in Ontario, and certainly
17 not anyone we know of involved in this hearing would
18 ever recommend landfilling at this site based on this
19 optimistic scenario. I am not suggesting for a minute
20 you should recommend it on that basis.

21 A. Fine.

22 Q. Things could turn out better than
23 we expect?

24 A. Yes.

25 Q. I want to get an idea of what is a



1 reasonable range of better than we expect. The upper
2 granular unit:

3 "-does not extend far beyond the buffer
4 zones in any direction."

5 A. Yes.

6 Q. It is possible?

7 A. Yes.

8 Q. "-underlies no more than 1/3 the
9 landfill area."

10 A. Yes, I would say, just eyeballing
11 it, yes.

12 Q. The lower granular unit:

13 "-does not extend far beyond the buffer
14 zones in any direction."

15 A. Yes. That is also possible, yes.

16 Q. "Any groundwater flow in the UGU
17 or LGU will be controlled by the flow
18 through the Lower Till $K=2.0 \times 10^{-6}$ cm/s."

19 And I just meant to give a range, but it is much lower
20 than this?

21 A. You mean it doesn't go anywhere
22 and it is encompassed all the way around by those
23 units?

24 Q. I am suggesting in an optimistic
25 scenario that it is possible that these granular units



1 which have been identified are in fact notwithstanding
2 their thickness and lateral extent as we now know it,
3 sand lenses or higher hydraulic conductivity lenses?

4 A. Yes.

5 Q. Do you agree that is possible?

6 A. That is possible.

7 Q. Then --

8 A. Albeit a big lens in the case of
9 the lower granular unit.

10 Q. I appreciate that. We certainly
11 can't stand here and imagine it will disappear when we
12 landfill. It is there and it is substantial and it is
13 well defined in your cross-sections. Now, let's look
14 at the site from a pessimistic point of view, and the
15 pessimistic point of view is from the point of view of
16 a hydrogeologist who is interpreting this site from the
17 point of view of possible recommendation or lack of
18 recommendation, that it would be suitable for a solid
19 waste management facility or a landfill.

20 If you are going to make a mistake about
21 the hydrostratigraphy of the sites you want to err on
22 the side of caution, and so looking at the point of
23 view -- this scenario is less likely than the
24 reasonable scenario we have gone through but from the
25 point of view of any concern about contaminant



1 migration this is a more appropriate way to interpret
2 the site. On that statement about what we mean by
3 pessimistic we are still talking about possible, but
4 less likely, where the upper granular unit:

5 "-extends off-site in more than the
6 westerly direction."

7 A. Yes.

8 Q. That is possible?

9 A. It is possible.

10 Q. But less likely than what we said
11 about it in the middle scenario or the reasonable
12 scenario?

13 A. Yes.

14 MR. ESTRIN: That's two questions.

15 MR. HODGSON: He answered the first one.

16 MR. ESTRIN: The middle column refers to
17 the extent on-site and the right-hand column talks
18 about it off-site.

19 MR. HODGSON: The middle column says
20 on-site in the first sentence and in the second
21 sentence it talks about where it goes off-site, and the
22 first principle of legal research is to read on.

23 MR. ESTRIN: Yes, and that is exactly my
24 concern. Mr. Hodgson is reading on and not explaining
25 what his question is.



1 MR. LANCASTER: Let's go on with it.

2 MR. HODGSON: Q. "LGU - extends off-site
3 in more than the westerly direction."

4 And do you agree that is a possible but less likely
5 scenario than what we discussed as the reasonable and
6 more likely scenario?

7 DR. CHARLESWORTH: A. Yes. I would say
8 under reasonable, and it is not a major thing, but even
9 under reasonable it probably extends off-site, off the
10 area you were specifically referring to, the buffer
11 zone and to a small extent in the bottom half of the L,
12 but not off the whole site. So I think ...

13 Q. Could you please turn around and
14 show us on M-438A what you are saying is a reasonable,
15 i.e., most likely interpretation?

16 A. I am saying the reasonable extends
17 in this direction.

18 Q. That is First Line?

19 A. The First Line direction and then
20 you were referring specifically to the landfill and
21 buffer zone and there is evidence of it extending a
22 short distance along the bottom part of the L.

23 Q. Can we add in the middle column
24 "limited lateral extent into the L of Site D." Is that
25 a fair addition?



1 A. Yes.

2 Q. I had never appreciated until this
3 hearing that the letter L needs to be divided up into
4 two parts so we can talk about its vertical and
5 horizontal member. I am told the Eskimos have 33 words
6 for snow because they need 33 words for snow and we
7 need one, but we need two words for the L. Reading
8 along in the upper granular unit:

9 "-has a K equal to or greater than
10 1×10^{-2} cm/s and has a thickness of
11 approximately 1m as it extends off-
12 site."

13 A. Yes, and consistent thickness you
14 are talking about there.

15 Q. I wouldn't put to you that it has
16 a consistent thickness?

17 A. I am just clarifying it because I
18 had added up to one metre in the middle column for --
19 and to be logical if we are being pessimistic there
20 must be a difference between that.

21 Q. We are talking about the thickness
22 as it extends off-site and I would like to have your
23 evidence as to what you think from a pessimistic point
24 of view...

25 A. I was trying to clarify a small



1 point there, Mr. Chairman, and I am happy to leave the
2 one metre in.

3 Q. You are comfortable with the
4 statement as it is drafted. Is that what you are
5 saying?

6 A. Yes, I am comfortable with it.

7 Q. Then the lower granular unit:
8 "-extends off-site in more than the
9 westerly direction."

10 A. Yes, I think that is the more
11 pessimistic interpretation. I keep getting caught on
12 these directions and if I could just go back to the
13 middle column, I think it would be reasonable to assume
14 some extension of the upper granular unit, and we are
15 back to the L, the lower granular unit, or reasonable
16 to assume some extension down the bedrock valley toward
17 the true east on the assumption that it has been missed
18 by the boreholes, for example, in HC 1-86, that cluster
19 of wells, and so I would add that to your middle
20 column.

21 Q. Likely extension down the L?

22 A. I am saying likely extension along
23 bedrock valley to the east and there is a good chance
24 one would find that if you drilled there.

25 Q. Is it also likely that it thins



1 out as it moves in that direction?

2 A. Yes, it would be likely that it
3 thins in that direction.

4 Q. You amended the first sentence
5 under LGU -- you haven't amended it but you have added
6 something under LGU in the middle column, so back under
7 the pessimistic column, can you agree with the
8 statement under the pessimistic column:

9 "-extends off-site in more than the
10 westerly direction."

11 I am sorry, more than the directions indicated in the
12 middle column?

13 A. Yes.

14 Q. What we have done in the middle
15 column is say where it is most likely to go and in the
16 pessimistic column you have added to that and said it
17 is likely to go other places or it is possible it will
18 go other places as well. Is that a fair pessimistic
19 interpretation of your point of view?

20 A. Yes, that would be a pessimistic
21 interpretation.

22 Q. Then it:

23 "-has a K somewhat higher than the
24 measured 3×10^{-4} cm/s."

25 Let me point out what I am getting at. There is a



1 pumping test which established a K value at one
2 location of 3×10^{-4} and there are any number of
3 boreholes where the material has been brought up and
4 examined and you can examine it and feel the silt in
5 your hands, and you as an experienced hydrogeologist
6 just picking up materials can estimate K's within a
7 reasonable range that way, can you not?

8 A. I would hesitate to that. You can
9 guess but you can't put too much weight on it, but I
10 would accept ...

11 Q. From a conservative point of view
12 you would want to take account of the possibility that
13 this unit is more permeable and therefore better able
14 to transmit water. Would you agree with that as a
15 pessimistic interpretation?

16 A. Yes. The pessimistic
17 interpretation would be that you had less than 10^{-3} in
18 your middle column and here you would say 10^{-3} , so $3 \times$
19 10^{-4} .

20 Q. It is higher?

21 A. Somewhat higher. Yes, I can go
22 with that statement.

23 Q. "-has a thickness of 2 m or more
24 extending off-site."

25 A. Yes, I would agree with that.



1 Q. You have agreed with me that the
2 middle scenario is a reasonable, i.e. most likely
3 scenario as you have amended it. Would you agree with
4 me that the pessimistic scenario is what you have
5 described as a conservative scenario?

6 A. Just on the thickness, I think
7 under reasonable, maybe at one zone along First Line it
8 could be extending off in terms of its total thickness
9 greater than 2 metres, that one zone there, and I don't
10 think you referred to the thickness in the middle
11 column.

12 Q. I suggested it thins as it
13 extended off-site?

14 A. Yes, but I think it is possible
15 that at about the mid-point of First Line it exceeds
16 two metres, and I think for a relatively short distance
17 along there -- that is not unreasonable to think that
18 we might find that, and I would still leave your
19 comment under the pessimistic column.

20 Q. Do you agree that the pessimistic
21 column describes a conservative interpretation of the
22 hydrostratigraphy at Site D?

23 A. Yes.

24 Q. Is it a very conservative
25 interpretation, a relatively conservative



1 interpretation or a modestly conservative
2 interpretation?

3 A. All factors taken in combination,
4 I would say it would be very conservative, but any one
5 of those parameters -- you could well have a
6 combination. You look at all the worst cases and say
7 you are very conservative and here we assume you have
8 all the worst cases but you may have a combination.

9 Q. Thank you, Dr. Charlesworth, I am
10 going to give you a respite.

11 DR. KINGHAM: Before you leave that,
12 there is only one thing that is still not clear to us
13 and nothing may turn on it, but it is a minor
14 mathematical problem. The range of 3×10^{-4}
15 centimetres per second up to 10^{-3} centimetres per
16 second is covered by both the reasonable and
17 pessimistic columns, but what about that area between 3
18 $\times 10^{-4}$ and 10^{-3} , is it one or both or either intended?

19 MR. HODGSON: Are you referring to the
20 LGU?

21 DR. KINGHAM: Yes.

22 MR. HODGSON: Under the reasonable
23 column, the relatively low or less than 1×10^{-3} ?

24 DR. KINGHAM: That's right. You see
25 your 1×10^{-3} is a higher value than your 3×10^{-4} and



1 I am wondering what you are meaning by higher and
2 lower?

3 DR. CHARLESWORTH: I had a bit of
4 trouble with that myself, Mr. Chairman, or rather
5 Dr. Kingham.

6 DR. KINGHAM: Let me ask you first, it
7 was your evidence that anything less than 1×10^{-3} for
8 a granular unit is a relatively low conductivity and I
9 think that that is what you said yesterday?

10 DR. CHARLESWORTH: I am saying
11 relatively in that context you would be applying it to
12 a granular unit.

13 DR. KINGHAM: But 3×10^{-4} is less than
14 10^{-3} ?

15 MR. HODGSON: Perhaps I could correct it
16 this way and see what the witness would like his
17 evidence to be. I was simply trying to suggest under
18 the pessimistic column that it was a better than a
19 worst conduit for water and I was trying to suggest it
20 had a hydraulic conductivity higher than the measured
21 value taken at HC 4-85. I am comfortable with changing
22 3×10^{-4} to -- just a minute let me get some advice.

23 The suggestion is that it be interpreted
24 or you interpret the pessimistic column that higher
25 than 3×10^{-4} would suggest a range up to 1×10^{-3} and



1 we leave the middle column as is, but I would have to
2 see what the witness is comfortable with because I do
3 want it as his interpretation.

4 Q. Are you comfortable with it?

5 DR. CHARLESWORTH: A. I am confused. I
6 would like to make a comment on it but I would like
7 to have it clarified.

8 Q. I don't think we can clarify it, I
9 think we should just imagine those number spaces are
10 blank and get your evidence?

11 A. You are asking me to tell you what
12 I think the hydraulic conductivity of the lower
13 granular unit is.

14 Q. I am. You are in the witness box
15 and under the reasonable scenario; let's go back to the
16 upper granular unit and we are saying relatively low K
17 and then a suggestion for how low in all but a limited
18 area on-site and the suggestion is that it is less than
19 1×10^{-3} in all but a limited area on-site. You agreed
20 earlier that that was likely. Can you still agree it
21 is likely?

22 A. I would suggest...

23 Q. I am sorry, I meant to say lower
24 granular unit.

25 DR. KINGHAM: That's understood.



1 DR. CHARLESWORTH: I think it is likely
2 that you will find it in the order of -- we have that
3 value so let's say it is reasonable to say you would
4 find a value in the order of 3×10^{-4} and probably not
5 higher than that and, to be pessimistic ...

6 MR. HODGSON: Q. Relatively low, $3 \times$
7 10^{-4} in all but a limited area on-site and is that what
8 you want to read under reasonable? Does that work if
9 we do that, relatively low, 3×10^{-4} in all but a
10 limited area on-site and you could put a little
11 squiggly more or less in front of 3×10^{-4} . Is that
12 what squiggly means?

13 DR. CHARLESWORTH: A. Yes. I would
14 say hydraulic conductivity and I don't think we need
15 relatively low so let's say a hydraulic conductivity of
16 3×10^{-4} and then under pessimistic ...

17 Q. It says a K of 3×10^{-4} and take
18 out everything else but "in all but a limited area on-
19 site"? I am just trying to get it clarified.

20 A. I appreciate that as I am trying
21 to clarify it as well in my own mind and whether that
22 would be reasonable to expect. We have a dearth of
23 information so I think we could say it would be --
24 let's say it is reasonable to assume it is in the order
25 of 3×10^{-4} on-site and generally 3×10^{-4} and then



1 under pessimistic, it would be pessimistic to assume
2 that it was greater than 3×10^{-4} .

3 Q. Which is what it says, higher than
4 3×10^{-4} ?

5 A. Yes.

6 Q. So we can leave that statement as
7 it is written?

8 A. You can leave that as it is.

9 Q. There was one other thing I wanted
10 to raise. Could you put back up the overhead you had
11 yesterday that indicated a suggestion for drilling, et
12 cetera. I have forgotten the exhibit number and is it
13 written on there?

14 A. M-495.

15 Q. I just wondered when you carried
16 out the drilling program you suggested yesterday or at
17 lunch hour you depicted eight holes shown in red on
18 this exhibit. Would it also be your recommendation
19 that it would be useful to conduct pumping tests in any
20 of those holes?

21 A. Yes. In terms of -- certainly in
22 terms of proving the contingency plans I would
23 recommend that pump tests rather than being conducted
24 here be conducted over in the vicinity of First Line.

25 Q. But it would be useful to have



1 another pump test?

2 A. Yes. I wouldn't do it until I had
3 drilled these holes and defined the unit and I would
4 not presume to select the location.

5 Q. Would I be correct in
6 understanding that when you do a pump test you install
7 a larger diameter well?

8 A. Yes, normally.

9 Q. A six-inch well?

10 A. You can decide upon that depending
11 on your expected yield, but a six-inch well would be
12 reasonable on this site?

13 Q. Are the piezometer nests on Site D
14 six-inch wells or five-inch wells or four-inch wells?

15 A. They are smaller diameter.

16 Q. Smaller than six inches?

17 A. Yes.

18 Q. If you were wandering around Site
19 D and you found a six-inch well, would you determine
20 that that was likely somebody's pumping well?

21 A. Yes, you would.

22 Q. Dr. Charlesworth, could you turn
23 that on, please?

24 A. Sorry.

25 Q. Can you help the Board and can you



1 show the Board where on Site D Morrison Beatty
2 installed their pumping well?

3 A. No. You asked me about that
4 yesterday at lunch and I think -- I am not sure and I
5 don't remember-- but we saw some data at a very early
6 stage and I had forgotten about it until you asked me
7 what had been done yesterday, but we looked at it and
8 found it was not much use to us in terms of
9 interpretation. I think it was in this area, but I am
10 not sure.

11 Q. The Morrison Beatty pumping well
12 was in the area -- you are pointing to HC 2-85?

13 A. I think it was in that area, but I
14 am not sure. I think it was in the vicinity of one of
15 the Trow pumping wells, and, as I say, you mentioned it
16 yesterday at lunch time and it completely slipped my
17 mind and I would have tried to check last night.

18 Q. Do you know in what granular unit,
19 if any, the pumping was screened?

20 A. As I said yesterday I looked at
21 the information a long time ago and I just cannot
22 recall and I remember not being able to get any useful
23 information out of it, and I thought that Trow's data
24 was superior to that data.

25 Q. If someone drilled a pumping well



1 they must have done some stratigraphic interpretation
2 when they drilled the well?

3 A. Yes, they had already drilled
4 their holes and Morrison Beatty have some holes on-
5 site.

6 Q. I know they have some holes on-
7 site, and they have four holes we have the logs for,
8 and are there any more?

9 A. Not that I am aware of.

10 Q. Is this pumping well one of the
11 Morrison Beatty holes we have a log for?

12 A. I don't know. It may be been
13 drilled alongside one of those.

14 Q. Do you know whether or not there
15 is a log for that hole?

16 A. I don't know.

17 Q. Is it your understanding that when
18 someone drills a pumping well that it is necessary to
19 file data with the Ontario Ministry of the Environment?

20 A. That is the correct procedure.

21 Q. Do you know whether or not any
22 data was filed on this pumping well?

23 A. I assume it was.

24 Q. Do you have a copy of that data?

25 A. Not with me.



1 Q. Does it exist?

2 A. I don't know. I don't remember.

3 Q. When a hydrogeologist carries out
4 a pumping test, and we had some evidence from
5 Mr. Sobanski and Mr. Beechinor, but I honestly don't
6 know what kind of data is generated or what kind of
7 records are kept when you do a pumping test and I
8 assume you keep records -- No. 1, you keep records when
9 you drill a hole?

10 A. Yes.

11 Q. There wouldn't be much point in
12 doing a pumping test unless you pump from a granular
13 unit; would you agree?

14 A. You would have difficulty
15 pumping -- you pump something which water will come out
16 of.

17 Q. You want some kind of a unit that
18 has water in it so you must do some stratigraphic
19 interpretation to know where to screen your well?

20 A. Yes, unless you are doing it on a
21 hit and miss basis.

22 Q. There should be a record as to
23 where this well is screened?

24 A. Yes.

25 Q. When you do a pumping test, what



1 do you do?

2 A. You pump the well and record the
3 water level and record the rate that the well is pumped
4 at and you measure the water level ideally in
5 observation holes other than a pumping well, although
6 sometimes water levels are just measured in the pumping
7 well.

8 Q. And do you know whether or not
9 this pumping test was conducted with measurements taken
10 in other wells?

11 A. My recollection is that it was a
12 step drawdown test and I really have difficulty in
13 recalling what the observations were.

14 Q. Do you have a complete set of data
15 for this pumping test as far as you know?

16 A. I would have to look for it. My
17 recollection is that there are a number of water level
18 measurements at different pumping rates, step drawdown
19 test, but I can't remember.

20 Q. I think you have given evidence
21 that more information is better than less information
22 when we are interpreting Site D?

23 A. Yes.

24 Q. Would you agree that if there is
25 any information at all that is useful from that pumping



1 test, that the Board should have that information?

2 A. Yes, and all the information
3 available is potentially helpful but it may not be in
4 fact.

5 Q. Do you agree we should at least
6 have the opportunity to examine this information to see
7 whether or not it is useful?

8 A. Yes.

9 Q. Thank you, Dr. Charlesworth. I am
10 now going to turn to Dr. Rowe.

11 MR. LANCASTER: Mr. Hodgson, it is going
12 on eleven and I think we will take our break now.

13 MR. HODGSON: Certainly.

14 MR. LANCASTER: I think it would be a
15 good time if you are going to change over.

16 ---Recess

17 MR. LANCASTER: Please be seated.

18 MR. HODGSON: Mr. Estrin has promised to
19 take me out to lunch if I finish by noon. So perhaps,
20 Dr. Rowe, would be co-operative and answer my questions
21 quickly.

22 DR. ROWE: I always try and be co-
23 operative.

24 MR. HODGSON: Q. I've noticed. Just to
25 go back to the beginning of column 8 on page 27, we



1 have been discussing the upper granular unit and we
2 took a bit of a detour off the main road with your
3 colleague with our discussion of the upper granular
4 unit. Do you recall that you had agreed with me, I
5 believe, that the imagined configuration for the upper
6 granular unit in case 8 is a dimension going off-site
7 of one metre depth by 390 metres in width?

8 DR. ROWE: A. I agreed that that was
9 one way of interpreting it, yes.

10 Q. You also said during my
11 questioning that it wouldn't make a difference if it
12 was one metre which I thought you meant -- when I heard
13 it I thought you were telling me it wouldn't make any
14 difference if it was 390 metres wide at the site and
15 let's call it one metre wide notionally at the Chlon
16 well, but my colleagues tell me it wouldn't make any
17 difference if it was one metre wide on-site and one
18 metre wide at the Chlon well?

19 A. I don't think I said it wouldn't
20 make any difference, but I think I was saying you would
21 still get a substantial effect and whether it was 390
22 metres wide or 39 metres wide or even 10, if there is a
23 channel of granular unit spreading out from that site
24 towards one of those wells, there will still be a
25 substantial effect of the order of which I have



1 calculated will not be precisely the same.

2 Q. The point I was trying to make
3 with you, Dr. Rowe, is if you could build a metre -- if
4 you could build a metre -- if you could build a mound
5 of 15 metres and pile it up over a cell that had
6 beneath it an upper granular unit the dimensions of
7 which were one metre wide and one metre deep and extend
8 it off-site from that cell straight to the Chlon well,
9 to take a possible worst case and you don't have to
10 agree it is "the" worst case, it certainly would be
11 possible under your scenario to push a lot of
12 contaminants along that upper granular unit toward that
13 well?

14 A. It certainly would.

15 Q. But you would also agree with me,
16 would you not, that the amount of contaminant that is
17 exiting would still only be 62.2 metres per annum of
18 Darcy Velocity and if we only had a one metre channel
19 we would only get basically one metre of material to go
20 through it?

21 A. I am sorry, perhaps I am missing
22 something.

23 Q. Let me ask it differently. I
24 asked you to calculate based upon your calculated Darcy
25 Velocity how many cubic metres, or how many cubic



1 litres, it doesn't matter which of actual leachate is
2 exiting the landfill each year?

3 A. Correct.

4 Q. All I am trying to suggest is that
5 if the upper granular unit extends off-site and is
6 continuous off-site, but if the channel that the upper
7 granular unit moves in is very confined, then the
8 amount of contaminant, not the level of contamination,
9 but the amount in absolute terms of contaminant that
10 can move through it will be governed by its size?

11 A. Yes, indeed that's true. Now we
12 calculated if I recall correctly that if that zone were
13 390 metres wide, we would be looking at something like
14 24 million litres and of course that must be put in
15 perspective. It sounds like a big number and it is a
16 big number, but I also calculate the infiltration on
17 the site at about 150 million litres per year.

18 If it were 390 metres wide in this worst
19 case scenario, you would have about 24 million litres.
20 It was 39 metres wide you would have 2.4 million
21 litres.

22 Q. Which could move through it with
23 that amount of head?

24 A. Yes.

25 Q. If you wanted to move more liquid



1 through it you would need more head?

2 A. Yes.

3 Q. Even with 15 metres of head in the
4 landfill you would run out of enough head to move all
5 the leachate through a confined space?

6 A. I am not suggesting --

7 Q. I know you are not and I am not
8 implying you are suggesting anything, but I am trying
9 to have you explain to this Board how the hydraulic
10 system works in terms of the movement of contaminants
11 off-site. It is governed by the size of the upper
12 granular unit?

13 A. The total volume of contaminants
14 transported off-site, but the impact isn't.

15 Q. The impact in terms of
16 concentration?

17 A. Concentration and the time at
18 which it occurs.

19 Q. I am talking about the quantity of
20 leachate you could pump off-site.

21 A. Indeed you are quite correct. The
22 quantity is proportionate to the size.

23 Q. Assuming a hypothetical which is
24 it is not cell 4 and 5 that fail but cell 1 and 2, and
25 cells 1 and 2 are over an upper granular unit that when



1 it crosses First Line, instead of being a metre deep it
2 is only 6 inches deep, and just accept that
3 hypothetical. Also accept the hypothetical that it
4 narrows from being a hypothetical 390 metres wide so
5 that by the time it is across First Line it is 200
6 metres wide and six inches deep.

7 I would like you to agree with me that
8 even if it is continuous at those dimensions in terms
9 of the operation of your case 8, a thinning out of the
10 upper granular unit in that way would back up the whole
11 system and would affect substantially in absolute
12 terms, in terms of cubic metres of leachate, the amount
13 of leachate you can in fact move through that system
14 and move off-site in a given year?

15 A. You are correct, it would affect
16 the amount of leachate in absolute terms.

17 Q. So your worst case, and I am
18 talking about the amount of leachate in absolute terms,
19 it depends upon an upper granular unit that in fact has
20 the dimensions of one metre by 390 metres?

21 A. No. I don't think -- the worst
22 case results I am reporting are in terms of contaminant
23 impact, peak concentration and time of arrival.

24 Q. But in terms of quantity of
25 leachate you can move off-site, and I will come to



1 concentration in the next column, but the quantity of
2 leachate you can move off-site, it depends upon that,
3 does it not?

4 A. It does.

5 Q. Then can I take you to column 9,
6 and you can tell we are getting to the end?

7 MR. LANCASTER: How can you tell that?

8 DR. ROWE: Could I comment? Yesterday
9 we spent quite some time, and you hypothesized that the
10 hydraulic conductivity of the upper granular unit might
11 be an order of magnitude less and I think Dr.
12 Charlesworth indicated in agreement with you today that
13 it could in fact be higher than the value of
14 8×10^{-3} centimetres per second; so from that
15 perspective it is not a worst case. I am just pointing
16 that out.

17 MR. HODGSON: Q. If the hydraulic
18 conductivity is higher, that improves the ability to
19 move material through it?

20 DR. ROWE: A. Correct.

21 Q. If it is lower, that diminishes
22 the ability?

23 A. That is correct. We discussed
24 the lower side and you hypothesized an order of
25 magnitude lower and I am saying there is another side



1 to the coin.

2 Q. There are two sides to the coin?

3 A. Yes.

4 Q. It could be higher and if it is
5 higher it makes for better contaminant migration?

6 A. Correct.

7 Q. From the point of view of someone
8 who wants to move contaminants, and there can't be
9 anybody in the room in that order, but if on the other
10 hand the hydraulic conductivity moved in the other
11 direction and in fact was lower, that again I think you
12 have agreed would-back the whole system up?

13 A. I agreed to that yesterday, but I
14 was just highlighting that you have established this
15 morning a value of 1.1×10^{-2} whereas in fact I used
16 8×10^{-3} , but that is just for clarity.

17 Q. Could I take you briefly back to
18 Site F. You agreed with Mr. Tidball that it was
19 possible that underdrains were not even needed at Site
20 F?

21 A. That is what I agreed to but I was
22 not advocating it.

23 Q. Pardon?

24 A. I didn't advocate that.

25 Q. What I wanted to suggest is, in



1 fact, while it was possible to get by without
2 underdrains at Site F, you were recommending
3 underdrains be installed at Site F?

4 A. Correct.

5 Q. You have agreed with me that you
6 are an engineer and engineers are practical men, or
7 women, excuse me Mr. Estrin, and I think we are talking
8 about Dr. Rowe here and I don't think we are that
9 confused.

10 From an engineering perspective you
11 would agree with me, Dr. Rowe, that it wouldn't make
12 sense to install an expensive underdrain system at Site
13 F if it would clog off in six months?

14 A. If it was going to clog off in six
15 months I would agree with you.

16 Q. You don't expect the leachate
17 system at Site F to clog off in six months, do you?

18 A. I certainly do not and nor have I
19 ever suggested any, including at Site D, would clog off
20 in six months.

21 Q. When we look at the essay by
22 Messrs. Puig, Gouy and LeBroue, we should read it in
23 the context of the fact that they were talking about
24 drains in an environment quite different from a
25 landfill environment?



1 A. I am not sure it is as different
2 as you might suggest.

3 Q. They were talking about a
4 situation where they were very concerned about clogging
5 by ferric oxide, were they not?

6 A. That was one aspect of their
7 paper.

8 Q. An important aspect?

9 A. Certainly it was an important
10 aspect.

11 Q. Ferric oxide is iron that has
12 oxidized?

13 A. That is my understanding, although
14 I am not a chemist.

15 Q. If you are not a chemist then
16 don't let me take you beyond any knowledge you may
17 have, but let me ask whether you would agree that
18 landfill leachates generate substantial quantities of
19 at least two gases, methane and carbon dioxide?

20 A. That is my understanding.

21 Q. Methane is a gas that I am told
22 can only be generated in an oxygen deficient
23 environment. Do you understand that?

24 A. I will take your word for it.

25 Q. I am further instructed that



1 landfill leachates are notoriously oxygen deficient and
2 I think it is called an anaerobic environment?

3 A. I understand that term.

4 Q. In order to take some iron that
5 was in the leachate and oxidize it, it would follow you
6 need oxygen?

7 A. It would.

8 Q. To the extent that landfill
9 leachate is oxygen deficient, would you not agree that
10 ferric oxide is not going to be something that is
11 generated in a landfill environment?

12 A. I am not sure I am qualified to
13 say that.

14 Q. Fine, then let's leave the subject
15 right there, because we have already had somebody here
16 who was qualified to say something about that and
17 perhaps he can come back and clarify it for us, but I
18 don't want to go beyond your stated expertise.

19 A. If I could just comment though,
20 that that doesn't decrease my concerns about clogging.

21 Q. I appreciate that, Dr. Rowe, it
22 doesn't decrease my concerns about clogging. Would you
23 agree with me, Dr. Rowe, that at Site F a properly
24 constructed set of underdrains that are carefully
25 maintained should be capable of intercepting leachate



1 in the garbage and transmitting it off-site for at
2 least 25 to 35 years?

3 A. I don't know, and it is my opinion
4 that we don't have the data base to establish that
5 fact.

6 Q. Would it be reasonable on the data
7 we have to assume that carefully designed and carefully
8 maintained, it could at least operate for 25 years?

9 A. Sorry, it is a possibility I will
10 agree with you, but I don't think we have the data base
11 to establish that they will last for 25 years.

12 Q. If we had evidence to suggest that
13 leachate, and I appreciate the reason that we don't
14 have a data base is because underdrains have not been
15 used long enough?

16 A. That's right.

17 Q. If we have data that establishes
18 that underdrains have been used in a solid waste
19 municipal landfill environment for 15 years and are
20 still operating, that would suggest that we can at
21 least operate them for 15 years if they are properly
22 installed and properly maintained?

23 A. In the environment that you are
24 talking about, and it depends on the environment and
25 clogging depends upon the waste you are disposing of



1 and depends on the daily cover and your filter design
2 and a lot of factors. One must be very careful
3 extrapolating from one site to another whether you are
4 talking about the hydraulic conductivity of tills or
5 whether you are talking about leachate collection
6 systems.

7 Q. I appreciate that. As an
8 engineer wouldn't you agree with me that it would be
9 your expectation that if we are going to invest the
10 kind of money that is now being invested in underdrain
11 systems in Ontario, that engineers who are designing
12 them reasonably expect them to last for at least 25
13 years if properly installed and properly maintained?

14 A. Properly installed and properly
15 maintained, I would certainly feel comfortable with 20
16 years.

17 Q. 20 years?

18 A. Yes.

19 Q. You would agree with me that
20 that's as true at Site D as it is at Site F?

21 A. No. There is an aspect to it. At
22 Site D and Site F one is paid to install similar drains
23 and to that extent there is similarity. The difference
24 is based particularly on the design proposed at the
25 moment and that is I see greater difficulty in



1 maintaining the drains at Site D, as Mr. Hiraishi
2 discussed in his evidence and as I reviewed, there is a
3 considerable portion of the site where using the
4 current proposed system, they can't get at the drains
5 to clean them readily.

6 Also, we discussed the effect of slope.
7 At Site F we have a much greater slope of the drains
8 than at Site D, and that is beneficial with respect to
9 maintaining a working system. In addition to that, and
10 there is another factor here which has just slipped my
11 memory.

12 Q. Perhaps you could take out your
13 drawing of the drains at Site D and we can discuss them
14 and perhaps your memory will be prompted by my further
15 questions. You will notice -- focusing on the question
16 of access to drains at Site D?

17 A. Would you prefer I put up your
18 exhibit?

19 Q. It would probably be easier.

20 A. I think it might be. I am putting
21 up H-41-D2.

22 Q. Thank you. Now, Dr. Rowe,
23 Mr. Hiraishi has designed all of the cells, and going
24 back to the old casual informal method of direction,
25 with north-south tiles, is that correct?



1 A. That is correct.

2 Q. Would you agree with me that
3 focusing, first of all, on cell 1 that it should be
4 possible at the base of the slope on -- at the north
5 side of cell 1 to install clean-outs at the end of each
6 one of the tiles that are running in cell 1?

7 A. I would agree not only it is
8 possible, but it would be prudent to do so.

9 Q. You recommend that?

10 A. I would.

11 Q. You wouldn't recommend a manhole
12 at the end of every one but just a clean-out?

13 A. I doubt in my opinion -- the
14 manhole is not necessarily from the standpoint of
15 clean-out, but I think Mr. Hiraishi, if I recall, spoke
16 to the difficulties of putting clean-outs without a
17 manhole.

18 Q. You would recommend at least
19 clean-outs. Would you defer to Mr. Hiraishi as an
20 experienced landfill designer in terms of the need to
21 also add a manhole where he has a clean-out?

22 A. I would.

23 Q. Would you also agree with me that
24 it should be possible in cell 5 at the bottom, at the
25 subheader end of each one of the tiles to install a



1 clean-out there?

2 A. I would. It hasn't been done, but
3 it is possible and it should be done.

4 Q. You recommend that?

5 A. I certainly do.

6 Q. I am asking for your
7 recommendations so please don't hesitate to give them.
8 In cells 2, 3 and 4, would you agree with me that the
9 problem with the current design is that you can't put a
10 clean-out at the end of every one of the cells because
11 you have this problem that the mound over the middle of
12 the landfill is very high?

13 A. That is correct.

14 Q. Would you -- with the experience
15 you have in this area and your knowledge about drains,
16 Dr. Rowe, would you recommend that in cells 2, 3 and 4,
17 Mr. Hiraishi modify his designs and have his
18 underdrains trend in an east-west rather than a north-
19 south direction, so he would then be in a position as
20 he is with cells 1 and 5 to install clean-outs at the
21 end of each run?

22 A. From the perspective of the
23 drainage I would agree that that is a sensible thing to
24 do. One would have to look at the broader context of
25 the design and I am surprised he didn't do that in the



1 first place.

2 Q. Would you recommend it?

3 A. I would recommend it from that
4 point of view. I would not presume to have considered
5 all the other aspects of the design.

6 Q. I am not going to cross-examine
7 you as though you had, and let me suggest to you that
8 other aspects of the design are that if you did that
9 you would have to look at the question of whether you
10 need 1, 2 or more pumping stations and those are the
11 kind of questions that would be raised by that?

12 A. Those questions would be raised
13 and you would also have to look at the question of
14 slope, the effect that that would have on your contour
15 levels, and there are a number of issues that would
16 have to be addressed in concert with that redesigning.
17 It is not something one can do on the stand, redesign a
18 landfill.

19 Q. I appreciate that, but one can
20 make recommendations or suggestions for appropriate
21 consideration?

22 A. Certainly.

23 Q. At that level you would make as a
24 suggestion for appropriate consideration east-west
25 trending of underdrains in cells 2, 3 and 4?



1 A. From the perspective of being able
2 to clean the drains, I think that is a sensible thing
3 to do and it may have other impacts.

4 Q. It should be considered?

5 A. It certainly should be considered,
6 yes.

7 Q. Thank you. In considering it
8 would you agree that it wouldn't be necessary -- it is
9 Mr. Hiraishi's exhibit, but I am sure he would forgive
10 you if you drew one drain across cell 2 and I will give
11 you a ruler if you would like a ruler?

12 A. I would appreciate that. I have
13 got one. Can I seek clarification...

14 Q. Wherever you would like an
15 underdrain in any of cells 2, 3 or 4, I don't care, but
16 I just want one drawn across?

17 A. An east-west drain?

18 Q. An east-west drain in cell 2 at an
19 appropriate place. I am not going to cross-examine on
20 why you only put one in.

21 A. The other aspect we haven't
22 discussed is the capacity to clean over distance. They
23 may wish to be able to clean, and it may be advisable
24 to be able to clean from both directions.

25 Q. That is exactly why I had you do



1 that. One recommendation is that you put a clean-out
2 at both ends?

3 A. I would.

4 Q. You are concerned about the slope
5 on the drains?

6 A. Yes.

7 Q. One method of installing that
8 drain would be to have it all slope from east to west
9 or west to east; would you agree?

10 A. It is a method that is probably
11 not the method I would adopt.

12 Q. I suggest the method you would
13 recommend is to have a little bit of a height in the
14 middle of the base; isn't that right?

15 A. Yes.

16 Q. And have the drains, in fact,
17 sloped in both directions?

18 A. From the perspective of drainage,
19 that is what I would do.

20 Q. Now, Dr. Rowe, I don't want to
21 take this next subject too far, but let's talk about
22 slope for a minute because I would like the Board to
23 understand the difficulty of the subject. You are
24 recommending that underdrains have a slope of 2 per
25 cent?



1 A. That is the desirable slope and in
2 fact I have friends who think that that is not steep
3 enough.

4 Q. And I have friends who don't think
5 about it all, and I will need just your evidence and
6 not your friends' evidence.

7 A. My friends are professionals
8 involved in this field.

9 Q. I appreciate that, but I can't
10 cross-examine your friends, I can only cross-examine
11 you, and I need only your evidence please. If I am
12 taking you beyond your area of expertise don't hesitate
13 to tell me.

14 Would you agree with me -- you have
15 suggested a 2 per cent slope and you have told me that
16 if you had better than a 2 per cent slope, terrific,
17 but at Site F we have the fortune that we are building
18 a landfill on the side of a hill, so you get the slope
19 as a premium with the site selection?

20 A. In fact if I recall correctly the
21 slope at the base is close to 4 per cent, and we can
22 check that, but the drains themselves are 2 per cent.

23 Q. All right. Now, at cell D, would
24 you agree we have a difficult trade-off problem in that
25 it is possible to get some slope on the drain by



1 contouring the base of the cell?

2 A. Yes.

3 Q. But the difficulty in contouring
4 the base of the cell is that some areas will be higher
5 and some will be lower and where it is lower you are
6 thinning out the protective layer of upper tight till?

7 A. That is a concern, yes, and that
8 is one of the factors I was referring to when I said
9 you had to redesign this thing and you have to think
10 about other factors and that is one of the factors.

11 Q. One of the difficulties or one of
12 the sensitivities also in designing at Site D is that
13 since we all agree Site D has to be operated at least
14 for some period of time with a hydraulic trap, and if
15 you take that as a premise to the question, whatever
16 you do in terms of designing an underdrain, you must
17 design it so that when you install garbage on top of it
18 you can still avoid having the mound in the garbage
19 exceed the critical number, whether it is 181.6 or some
20 slight variation of that?

21 A. That is correct.

22 Q. So, you have go -- really the
23 difference between 181.6 and the base of the upper till
24 is the room in which you can manoeuvre in terms of how
25 you design your -- did I say upper till?



1 A. Perhaps you could rephrase the
2 question.

3 Q. What I am trying to explain is
4 that you can't have the drain come up above 181.6?

5 A. You can't have the mound come up
6 above it.

7 Q. It follows ipso facto that you
8 can't have the drain above 181.6?

9 A. Certainly.

10 Q. You don't want the drains cut too
11 deeply into the upper till?

12 A. That is correct.

13 Q. Those are the constraints?

14 A. That is part of the problem at
15 Site D.

16 Q. Would you agree with me that if it
17 becomes necessary and you obviously have not redesigned
18 this site, but if it became necessary in trading off
19 those two problems, and one is maintaining the
20 hydraulic trap and maintaining the integrity and depth
21 of the upper till; if it became necessary in fact to
22 give the drains less than a 2 per cent slope, and if it
23 was impossible to design this site with drains that
24 have that kind of slope, would you agree it would be
25 more appropriate to clean the drains more frequently?



1 A. I would agree with you, yes.

2 Q. Would you agree with me that it is
3 possible, not only to clean these drains with water and
4 fire hoses, but also they can be chemically cleaned?

5 A. They certainly can. That,
6 however, will not clean the filters.

7 Q. I appreciate that. There is no
8 evidence that there will be a geotextile filter used at
9 this site?

10 A. It would not make a great deal of
11 difference whether a geotextile or granular filter,
12 there is still potential for clogging of both. A
13 geotextile is a replacement for a granular filter.

14 Q. I don't believe Mr. Hiraishi ever
15 suggested he was going to put in a geotextile filter?

16 A. I am certainly not suggesting he
17 did, I am simply saying there are problems.

18 Q. There is a potential for clogging
19 with any kind of filter material?

20 A. Correct.

21 Q. Would you agree with me that it is
22 at least possible that a properly designed or
23 redesigned underdrain system at Site D, properly and
24 carefully maintained should be able to work for at
25 least 25 years?



1 A. I would agree that that is
2 possible.

3 Q. Could I take you please to your
4 overhead, the overhead where you have described the
5 equivalent height of leachate?

6 A. Yes. I think that is M-466. Am I
7 understanding you correctly?

8 Q. No.

9 A. Sorry.

10 Q. I can find it quicker in M-442.
11 It is Figure 9 in M-442.

12 A. I have to translate this from one
13 numbering scheme to the other. This is overhead 53.

14 Q. That is the one. Now, you have
15 already in another context explained what it is I want
16 you to explain again, but I would like you to explain
17 it again in the context of what we see in column 9
18 which is the equivalent height of leachate in column 9,
19 which is 5.0 metres?

20 A. That is correct.

21 Q. I have to tell you that the
22 numbers in your column 9 don't speak to me, but that's
23 all right. I want to see if we can translate them so
24 that they speak to the Board. First of all, the
25 concentration curve you used in case 8 is your middle



1 concentration curve?

2 A. That is correct.

3 Q. Go ahead and do your calculation.

4 A. I was trying to make sure there
5 wasn't a trap here, that's all.

6 Q. You over-estimate my talents, but
7 thank you. There is no trap here.

8 A. Okay. I will take your word for
9 it.

10 Q. You have explained this in another
11 context, but first of all you agreed that the curve you
12 used was the middle curve?

13 A. That is correct, the curve I have
14 used in all but case 4 is the middle curve which
15 corresponds to a mass of 4400 tonnes.

16 Q. That curve you have described in
17 your evidence as a conservative curve?

18 A. I think it is reasonable, but
19 based on the evidence I have got it is slightly
20 conservative, yes.

21 Q. In fact I think I heard you say
22 the curve below it was a reasonable curve and if you
23 were a betting man you would bet on that curve?

24 A. Based on the evidence available,
25 which of course is restricted to the shorter time span,



1 but it certainly agrees fairly well with Trow's
2 idealization of the real data, and I plotted it up on
3 the real data and it seems reasonable, in fact I have
4 it as an overhead if you wish.

5 Q. I don't, I want to work with this,
6 thank you. I would like you to explain to the Board
7 the following; would you with a pen trace across the
8 time scale to the year 25?

9 A. Trace across.

10 Q. I want you to put a little mark in
11 the middle of the time scale at 25?

12 A. All right, I will certainly do
13 that. Am I understanding you correctly?

14 Q. Fine. You agreed that properly
15 maintained and designed, et cetera, et cetera, the
16 landfill drains at Site D could reasonably be expected
17 to last 25 years. Working from that assumption would
18 you agree with me that if this Board is to understand
19 the -- let me just phrase the question a bit
20 differently. If the landfill leachate drains worked
21 for 25 years and assuming the hydraulic trap works for
22 that whole 25 years, so that on January 1 of the 26th
23 year after cells 4 and 5 and 6 close, bang, we are into
24 case 8 and all the underdrains seal off, but the
25 subheaders continue to work. Would you agree with me



1 that the contaminant loading available to pump into the
2 upper granular unit on January 1st in year 26 is the
3 area under the curve that is depicted by a line
4 perpendicular to where you have indicated that year 25?

5 A. That is correct, whichever curve
6 you think is appropriate.

7 Q. Would you take out your ruler and
8 drop a perpendicular, as Dr. Kingham once said at this
9 hearing, except I want you to elevate your
10 perpendicular up from the 25 and have it intersect all
11 three of your curves?

12 A. Okay. Perhaps I shall do that in
13 a different colour to try and make the discussion a bit
14 easier. I will use what I call yellow, and I think I
15 have done what you asked me to do.

16 Q. Thank you very much. Could I ask
17 you to colour in the area under the curve that is
18 your -- I guess it is your most likely curve, your blue
19 dotted line curve. Would you colour that area in in
20 orange?

21 A. That is not the curve I would
22 design on.

23 Q. I understand and I am not trying
24 to skew your evidence but I want to be able to speak
25 colours instead of numbers.



1 A. One must also realize that the
2 validity of any of these colours decreases as one moves
3 away from the origin of time because this is based on a
4 limited data base.

5 Q. Would you colour in the area under
6 the curve that is under your conservative curve, the
7 one you used in case 8 in a different colour, and if
8 you are running out of colours I think I have some
9 here, I have blue, black, red, orange and brown.

10 A. I have any of those that you would
11 like as well. Would you like brown?

12 Q. It looks too much like orange.
13 How about blue?

14 A. Blue? Certainly. Blue might get
15 confused with that other line:

16 Q. Is there another colour that will
17 work because I don't want to mess up your drawing.
18 Perhaps you could hatch it?

19 A. Could I use orange or is it to
20 close to yellow?

21 Q. Use yellow, that's all right.
22 Let's see how it works.

23 A. I will try and hatch it in yellow.
24 Am I understanding what you are asking me to do?

25 Q. Yes. Would you hatch the area



1 under the worse case curve, your Site F curve in, let's
2 say, in green?

3 A. Okay.

4 Q. Mr. McQuaid wants me to qualify.
5 When I said your Site F curve I was suggesting at Site
6 F you did some of your modeling using that worst case
7 curve, the highest curve?

8 A. At Site F, correct.

9 Q. I shouldn't refer to it in the
10 evidence as the Site F curve, but the worst case curve;
11 so we have three curves, the most likely, the
12 conservative and the worst case curve?

13 A. The bulk of my modeling, as you
14 indicated, at Site F was using this curve, but at Site
15 D I used the curve for a mass of 4400 tonnes and at
16 Site F I used 7800 tonnes.

17 Q. Dr. Rowe, with all of the
18 qualifications you have put on the data you have
19 summarized on this curve, which is your curve, would
20 you agree with me that if the landfill fails on the 1st
21 day of January in the 26th year after closure, that the
22 amount of contaminant available to be transported off-
23 site of cells 4 and 5 or any other cell that happened
24 to fail after 25 years, would be the area under the
25 curve you have depicted in orange and in hatched



1 yellow?

2 A. That would be true based on the
3 data available and assuming the initial concentration
4 was 1500 milligrams per litre.

5 Q. If it was lower there would be
6 less?

7 A. That is correct, and if it was
8 higher it would be more.

9 Q. Would you mind drawing a
10 horizontal line across from your conservative curve
11 where the perpendicular intersects it over to the left-
12 hand margin so we can get a reading as to the
13 concentration, the maximum concentration on the day of
14 failure?

15 A. I will endeavour to do that.
16 That's as best as I can do it on the stand.

17 Q. That is your worst case curve?

18 A. Yes.

19 Q. That's not the one you used in
20 case 8?

21 A. Perhaps I misunderstood.

22 Q. That is fine. Since you have
23 drawn that line put a number on it somewhere between
24 600 and 800. Just take a guess, Dr. Rowe, I am not
25 trying to mousetrap you with this evidence, but I just



1 want an eyeball estimate of the leachate level?

2 A. That is an eyeball, let's say 680.

3 Q. Do the same for your conservative
4 curve and your most likely curve?

5 A. Yes. That is about 390 as long as
6 I am not going cross-eyed and I think that this one is
7 about 275.

8 Q. Would you agree with me, Dr. Rowe,
9 that if the landfill failed on January 1st of its 25th
10 anniversary, the contaminant loading, and you have
11 already agreed that the contaminant loading using your
12 conservative curve is the area under the yellow hatched
13 line and the orange line?

14 A. That is my 4400 tonnes figure?

15 Q. Yes. That is the contaminant
16 loading?

17 A. That is correct.

18 Q. This curve tells us that that is
19 the amount of contaminants left in the cell which if
20 they are not going to leave by the drainage system will
21 leave some other way and presumably they will move down
22 through any granular material available and move off-
23 site?

24 A. That is correct.

25 Q. Would you agree on your



1 conservative curve -- I won't ask you to agree. Can
2 you estimate for the Board, please, of the total area
3 under the conservative curve, what proportion of the
4 landfill contaminants remain to be transported off-site
5 on the failure date?

6 A. That's very difficult to do by
7 eye. I could guess, and that's all I am doing, but
8 perhaps 30 per cent as a guess.

9 Q. Let's call it 30 per cent?

10 A. If anything hinges on it I would
11 want to check it.

12 Q. Nothing hinges on it, I just want
13 to have relative -- we are saying if the hydraulic trap
14 operates for 25 years, 70 per cent of the contaminants
15 buried in the landfill will have left the landfill by
16 means of the collection system, and if the collection
17 system fails, then 30 per cent of the contaminants
18 remain to be transported off-site by some other
19 mechanism?

20 A. That is correct, subject to
21 correction on the 30 per cent.

22 Q. We are talking in relative terms,
23 30 per cent, 40 per cent, it doesn't matter, it is a
24 smaller proportion than the total?

25 A. Oh, yes.



1 Q. That is on your conservative
2 curve, so eyeball please your most likely curve and
3 give us a percentage on that?

4 A. You are talking about the purple
5 curve, the 4400 tonnes.

6 Q. You have already given us the
7 purple curve?

8 A. Then you are talking about the
9 green?

10 Q. The blue curve which I thought you
11 said was the most likely situation?

12 A. I thought you said the
13 conservative.

14 Q. Originally you eyeballed the
15 conservative curve and I thought what you were telling
16 us that the percentage of the contaminants under the
17 conservative curve being the purple curve was 30 per
18 cent of the total?

19 A. Right, that's correct, and this is
20 also a conservative curve and I thought you said the
21 conservative curve and I was confused.

22 Q. I called that your worst case
23 curve. I have a problem with language and I like words
24 not to describe the same thing. Under the blue curve?

25 A. Under the blue curve.



1 Q. Which I thought was your most
2 likely curve?

3 A. Certainly within this range is
4 most likely. As you can see as time goes on, Trow in
5 the absence of data has assumed this would happen, and
6 my calculation says this would happen but with the
7 qualification we don't know precisely what is going to
8 happen.

9 Q. Under the blue curve how much have
10 you coloured in in orange?

11 A. Well, I would have to guess. 20
12 per cent? It is very, very difficult guessing. I
13 don't like guessing.

14 Q. How do you do the calculation, and
15 is there a mathematical technique?

16 A. Yes, you work out what the area is
17 under the curve and take the proportion of this area to
18 that area, but I am very wary of looking at a curve and
19 just guessing.

20 Q. I appreciate ...

21 A. For the sake of argument --

22 Q. That is why you are qualified to
23 give opinion evidence in this proceeding and I am not?

24 A. You want me to guess.

25 MR. ESTRIN: Despite what Mr. Hodgson



1 said a moment ago that it really doesn't matter to him,
2 I have considerable doubts about where all that will
3 end up a few months from now. Certainly if this is
4 something Dr. Rowe can do over lunch hour he could do
5 it and I think we would all be better off to have a
6 better number.

7 MR. LANCASTER: The Board is aware it is
8 a rough estimation at this point in time.

9 MR. HODGSON: If Dr. Rowe would like a
10 more accurate number I would be pleased to have his
11 evidence.

12 MR. ESTRIN: You may not have to do it
13 over a lunch hour because you will have about a week
14 until I get to my re-examination.

15 DR. ROWE: Just for the sake of
16 argument, I will check it. I don't want to mislead the
17 Board, because I am guessing on the curve.

18 MR. HODGSON: Q. Given Mr. Estrin's
19 suggestion which I think is helpful, for the purposes
20 of this cross-examination, we will talk about the area
21 under the conservative curve as 30 per cent and the
22 area under the more reasonable curve is 20 per cent,
23 and we all correct the transcript later when you
24 provide us with what you mathematically calculate is
25 the exact percentage under the curves and we will have



1 the transcript then read those percentages. Would that
2 be a fair way to do it?

3 DR. ROWE: A. Certainly, I have no
4 objection to that.

5 MR. ESTRIN: While we are doing this
6 could we have him calculate the area under Trow's curve
7 which is not a curve but a line?

8 DR. ROWE: I will just make a note.

9 MR. HODGSON: Q. Is it possible, it is
10 not a curve?

11 DR. ROWE: A. I can calculate the curve
12 under their line up to 80 years or I could project it
13 to 200, which would you prefer?

14 Q. I want your best evidence and I am
15 not a mathematician or a geotechnical engineer and I am
16 not going to give you a suggestion?

17 A. I will certainly calculate the
18 areas for you.

19 Q. For completeness you may as well
20 as do what I have called your worst case curve, which I
21 guess is the green curve?

22 A. Sure.

23 Q. Just so we can understand how this
24 curve works, at Site F we are looking at a situation
25 where on day one we are all predicting that some



1 proportion, however minuscule in your evidence, some
2 proportion of the leachate sitting in the landfill on
3 day one will start moving out the bottom?

4 A. That is correct.

5 Q. When we use this curve it would be
6 appropriate at Site F, no matter which of the three
7 curves, it would be appropriate to consider that on day
8 one the concentration of the material moving out of is
9 the concentration of the material at day one which is
10 somewhere around 1400?

11 A. Yes, that's right.

12 Q. That is the situation at Site F?

13 A. That is what our model decided.

14 Q. The situation at Site D in your
15 scenario A is that the hydraulic conductivity of the
16 waste is greater than 1×10^{-4} and a mound is created
17 immediately and leachate at full strength starts moving
18 out the bottom immediately. So, we would read this
19 curve from the top in case A?

20 A. Yes. The leachate starts moving
21 out after the mound has been developed which is the
22 time the leachate is developing in strength.

23 Q. But not very long?

24 A. That's right.

25 Q. Given the mound in case A?



1 A. Yes.

2 Q. Would you agree with me that at
3 Site D in your cases B and C, you have to decide in
4 doing your calculations of impact off-site what day the
5 tiles seal off. For example, in your case 8 which is
6 scenario B, case 8, if the leachate system operates for
7 25 years then on this evidence you have presented on
8 this table until you do your recalculations, 70 per
9 cent of the contaminants have already been collected
10 and transported off-site by the collection system?

11 A. That's correct.

12 Q. What we are looking at then is you
13 are attempting to do a failure scenario on the
14 assumption that 30 per cent of the contaminants remain
15 and given my hypothesis about a 25 year operating
16 period before failure?

17 A. Yes. One could interpret it that
18 way. I am not quite sure I follow.

19 Q. It is fair to interpret it that
20 way, isn't it, Dr. Rowe?

21 A. The calculation stands alone, but
22 you can interpret it ...

23 Q. Understanding the data we have in
24 front of us, isn't the situation we have got that no
25 one thinks and you don't think the leachate collection



1 system at Site D will fail the instant it is installed?

2 A. That is correct.

3 Q. While it operates it will
4 transport contaminants off-site?

5 A. Correct.

6 Q. The strongest contaminants are at
7 the initial point of landfilling; are they not?

8 A. Correct.

9 Q. The longer that hydraulic trap
10 works then the longer that contaminant collection
11 system operates the more contaminants it will collect
12 and transport off-site?

13 A. That is correct.

14 Q. Once you pick a notional failure
15 date using your data from this we could get an idea as
16 to how much in bulk loading, how much contaminant has
17 not been transported off-site, but is left sitting in
18 that landfill which is available now to be transported
19 in some other direction than off-site through the
20 collection system?

21 A. Indeed that is correct and that is
22 what I tried to do on Exhibit 444 OH-60A. Would you
23 like me to put it up?

24 Q. I am not going to prefer anything
25 of the sort. OH-60A?



1 A. Yes.

2 Q. 60A.

3 A. That's right. It was marked as M-
4 444 and I am interpreting the data just the way you are
5 suggesting.

6 Q. You are saying if the leachate
7 collection system operates taking your example 1, if it
8 operates for 80 years, and it fails on the 80th year,
9 on the day of failure the amount of contaminant left
10 will have a negligible impact off-site?

11 A. It will have an impact of -- make
12 sure I understand. We are looking at case 9, the top
13 line?

14 Q. Yes.

15 A. In case 9 if the original source
16 of leachate was 1500 milligrams per litre and if the
17 hydraulic trap worked for 65 years and after the 65th
18 year the impact off-site would be less than 25
19 milligrams and if it worked for 80 years then the
20 impact off-site based on this calculation and
21 essentially the scenario you have been developing, it
22 would be 10 milligrams per litre, and that is what I
23 tried to indicate with this overhead.

24 Q. Is that using the middle curve,
25 the conservative curve?



1 A. Yes, from my recollection it was.

2 Q. Let's go back to the overhead that
3 shows us the result of your case 8?

4 A. Okay. I think you are referring
5 to overhead 57.

6 Q. I am. All I want you to do is
7 agree that in your overhead 57 in order for the failure
8 scenario you have depicted to work, the failure would
9 have to happen immediately after closure because
10 otherwise you wouldn't have contaminants at the
11 strength necessary to get you to 1260 milligrams per
12 litre in 24 years after the date of failure?

13 A. That is correct. Those times I
14 gave is the time until you have actually got leachate
15 moving down into the system under the conditions
16 assumed in the case.

17 Q. So, case 8 is the worst possible
18 imaginable failure and it is a situation where we may
19 as well not to have bothered to install the underdrains
20 because they never work, and all the contaminants that
21 is left in the landfill and available to be transported
22 off-site through the bottom. The only thing that ever
23 worked in case 8 is the subheaders?

24 A. Yes, if you interpreted it
25 directly in the form that it is given in that chart,



1 that is correct. But, as I pointed out, it can be
2 interpreted many ways depending upon your initial
3 concentration and what I have tried to indicate to the
4 Board in OH-60A was another way of interpreting it.

5 Q. I am not interpreting it, you are
6 interpreting it. What your interpretation is meant to
7 convey to this Board is that on case 8, if case 8
8 happens, off-site impacts 24 years after the day of
9 failure would be 1260 milligrams per litre?

10 A. Correct.

11 Q. I am asking you to agree that you
12 assumed in your case 8 that the underdrains never
13 worked, not for one day?

14 A. That is correct, in case 8, but
15 now can I qualify that, please?

16 That is those numbers precisely given
17 there that correspond to what you just said. However,
18 you can interpret those numbers irrespective of when
19 the failure occurs.

20 Q. I agree 100 per cent that that can
21 be done but that is not what you did. If you would
22 like to do that, and just left me finish this, but
23 wouldn't you agree with me that if the failure occurred
24 25 years after those underdrains had been operating,
25 and when 70 per cent of the bulk contaminant loading in



1 cells 4 and 5 had been in fact collected and taken to a
2 treatment centre somewhere off-site, and the day of
3 failure occurred on that 25th year, then on this
4 scenario it would take 24 more years to get a peak
5 concentration at the boundary and that peak
6 concentration would have to fall below 390 milligrams
7 per litre because that was the maximum concentration
8 you had on failure day?

9 A. Can I take that a piece at a time
10 and I will try and not miss any of it.

11 If the leachate collection tiles worked
12 for 25 years and the failure then began to develop we
13 would of course start moving through scenario 11 before
14 we got to case 8. You would have a partial failure and
15 then the failure developing. It is unlikely they would
16 all go at once so you would have movement through
17 scenario 11 before you get to 8.

18 However, supposing that were to occur.
19 Then you are suggesting if I understand correctly that
20 it will take another -- you are asking me if it fails
21 on year 25 and it takes another 14 years or 15 years to
22 develop a mound, that would bring us to 40 years and
23 what would be the impact off-site.

24 Q. 39 years to be fair?

25 A. All right, 39 years, but 40 years



1 is easier.

2 Q. I don't think I am suggesting -- I
3 am not suggesting and I think you are going in a
4 different direction than I want you to go, so let me
5 tell you the direction and if there is some other
6 direction you want to go Mr. Estrin will ask you and I
7 will deal with that and you certainly should, but if
8 the leachate collection system works for 25 years, only
9 30 per cent of the bulk contaminants remain in the site
10 on the day of failure?

11 A. If it works for 25 years only
12 about 30 per cent remains, all right.

13 Q. The maximum strength of the
14 chlorides is 390 milligrams per litre, approximately?

15 A. Based on that curve that is
16 correct.

17 Q. Based on the curve. If it was the
18 most likely curve it would be 275 milligrams per litre?

19 A. Yes.

20 Q. That's the maximum concentration
21 of chloride you have got in the cell on failure day?

22 A. That is correct.

23 Q. Now, if on that day you start
24 building your mound one metre a year so that 14 years
25 later you have a 15 metre head in the landfill and you



1 are driving out those leachates, all I am suggesting is
2 that the maximum boundary concentration you can get
3 would be the 390 because that was the maximum
4 concentration you had to start when you started driving
5 it out the bottom, and in fact the boundary
6 concentration would be much less than 390. However,
7 something less?

8 A. Something less.

9 Q. Something less than 390. Looking
10 at the curve you have got up there, something less than
11 390 is a lot less than 1260?

12 A. Certainly but it is a lot more
13 than the boundary impact allowed, according to
14 Dr. Charlesworth.

15 Q. Dr. Rowe, I am trying to
16 understand your cases. Won't you agree that cases 6,
17 7, 8, 9 and 10 all assume that the underdrains never
18 worked, never took any contaminants off-site, and only
19 the subheaders worked and all the contaminants were in
20 that landfill and available to be transported down
21 through the upper granular unit and off-site. That is
22 the assumption, don't you agree, of cases 6, 7, 8, 9
23 and 10?

24 A. For the numbers that are given as
25 concentrations directly, that is true.



1 Q. Right. That is a worst case?

2 A. That is a worst case.

3 Q. That is an almost unimaginable
4 case, isn't it?

5 A. Certainly case 8 is very, very
6 unlikely, yes.

7 Q. Unimaginable? It is unimaginable
8 that these underdrains won't work for one day?

9 A. I agree that that's true.

10 Q. I even have your evidence that it
11 is reasonable to assume that well installed and well
12 maintained they might last for 25 years?

13 A. I don't think I said they might, I
14 said it was a possibility.

15 Q. I didn't hear your answer and
16 would you mind repeating it?

17 A. You said -- in fact I understood
18 you to say that I said -- I said it is a possibility
19 they could last 25 years was my answer.

20 Q. If they lasted 25 years your
21 scenario, your case 8 has to be redone to take account
22 of the fact that most of the contaminants have
23 already been transported off-site on the failure date?

24 A. It doesn't have to be redone and
25 that is the point I have been trying to make.



1 Q. That's the beauty of it, we can
2 just tinker with it.

3 A. That's right and there are
4 mathematical equations.

5 Q. I appreciate that.

6 A. I can interpret that if you tell
7 me when it is going to fail I can tell you.

8 Q. I told you when it is going to
9 fail, January 1st, after 25 years of operations and you
10 can now redo that whole calculation and tell us based
11 on all the other assumptions you have made in case 8
12 what the boundary impact will be on that failure date?

13 A. I don't have to redo it because
14 the information is in the charts, and that is the point
15 I am trying to make.

16 MR. ESTRIN: Try and answer the
17 question.

18 MR. HODGSON: Q. What is the boundary
19 level?

20 DR. ROWE: A. You told me it starts off
21 at 390 and I can tell you what it is. It is about 330.

22 Q. Sorry?

23 A. About 330 milligrams per litre.
24 That's the beauty of the chart. You can interpret them
25 for whatever year.



1 Q. If it is the beauty of the chart
2 tell us for the record what you did with your
3 calculator because I know I have someone here who can
4 do it with his.

5 A. Sure. There is no magic to it.
6 If you say that when the system fails, if I understood
7 you, we have 390 milligrams entering the system and
8 that can be related and it is simply a proportion. We
9 know from case 8 that if it starts at 1500 it is
10 attenuated to 1260 and we can get that ratio and
11 multiply by the starting concentration and that's all
12 there is to it. There is no magic.

13 MR. ESTRIN: What was the number?

14 DR. ROWE: 330 in round numbers.

15 MR. HODGSON: Q. That is a very, very,
16 very, very conservative way to do this calculation,
17 don't you agree in case 8, to assume that the
18 underdrains never worked for one day?

19 DR. ROWE: A. Well, perhaps I am not
20 explaining myself.

21 Q. You can drop some of the very's,
22 but it is very conservative?

23 A. To say that the impact will be
24 1260 is conservative but to use that figure the way I
25 intend it to be used and as I illustrated on overhead



1 OH-60A, is a reasonable thing to do.

2 Q. I want to know whether or not the
3 assumption that the underdrains never worked isn't a
4 very conservative assumption?

5 A. The assumption that the
6 underdrains never worked is a very conservative
7 assumption.

8 Q. Would it give you any comfort to
9 know that Mr. Feenstra made exactly the same assumption
10 in his impact assessment off-site?

11 A. I am sure it would give me
12 comfort.

13 Q. It happens to be the case, but you
14 can check that.

15 A. I am aware of that, but I am
16 trying to point out that you don't have to make that
17 assumption to use these same results.

18 Q. We don't get 1260 millilitres of
19 impact on the 24th year after failure, unless the 24th
20 year after failure is the first year after landfilling?

21 A. That is correct.

22 Q. Thank you. Now, let's go back to
23 page 27 and your case 8 and could we just briefly run
24 through the columns and see where we are. In order to
25 accept -- what you are doing here, you would agree, is



1 you are doing a risk assessment?

2 A. I wouldn't have used that word.

3 Q. What word would you use?

4 A. In all of these cases I am trying
5 to assess what range of values of potential impact is
6 likely to occur.

7 Q. Aren't we from the point of view
8 of the Board attempting to assist the Board in
9 understanding the comparative risks of landfilling at
10 Site F and Site D?

11 A. Yes, if we put it in the very
12 narrow framework of risk assessment. I am wary of the
13 word risk because it means different things to
14 different people, but in the narrow context I agree
15 with you.

16 Q. In the narrow context you would
17 agree that case 8 is a risk assessment?

18 A. Yes.

19 Q. To accept the conclusions of case
20 8, because this is also a modeling exercise; is it not?

21 A. Yes.

22 Q. We are trying to model reality?

23 A. Yes.

24 Q. There is no point in fantasizing
25 and we want something that relates to something that is



1 going on in the world around us?

2 A. Right.

3 Q. In order to accept the results of
4 case 8 would you agree you would have to first of all
5 believe that underdrains clog but not subheaders?

6 A. Yes.

7 Q. No. 2, the failure goes undetected
8 for 14 years that takes to build the mound?

9 A. Yes.

10 Q. And the ten more years it takes to
11 drive the concentration at a concentration of 1260
12 millilitres to the site boundary?

13 A. Yes.

14 Q. 3: that the K of the waste is
15 lower than 10^{-4} and it may be as low as 10^{-5} ?

16 A. Yes.

17 Q. No. 4, a mound of 15 metres
18 actually can be built up?

19 A. Yes.

20 Q. No. 5, that the hydraulic
21 conductivity of the upper till is as high as 4×10^{-7} ?

22 A. Yes.

23 Q. Did I say 4?

24 A. 4×10^{-7} .

25 Q. That was my No. 5. No. 6, that



1 the upper granular unit has a high hydraulic
2 conductivity and is very large and extends off-site
3 continuously?

4 A. It doesn't have to be very large,
5 but it does have to extend off-site and I use the
6 hydraulic conductivity which was less than the value
7 you agreed with Dr. Charlesworth on this morning.

8 Q. You used the hydraulic
9 conductivity of 3×10^{-3} ?

10 A. Yes.

11 Q. Which is a high hydraulic
12 conductivity for a granular unit?

13 A. Not as high as the value you
14 agreed with Dr. Charlesworth on.

15 Q. I appreciate that but it is a nice
16 water bearing zone?

17 A. I agree.

18 Q. Finally No. 7, you have to believe
19 that failure occurs the day the cells are closed off?

20 A. Only if you wish to interpret the
21 1260 as an absolute value.

22 Q. That happens to be until this
23 moment the only interpretation you gave us. Given that
24 you are going to get an impact of 1260 milligrams per
25 litre at the site boundary after 24 years of failure,





1 you have to believe that the leachate drains never
2 worked and that failure occurred on the day the cells
3 were closed off?

4 A. Correct.

5 Q. In case 8 the only thing you have
6 to believe -- there are two things you don't have to
7 believe. You don't have to believe that the piezometer
8 pressure in the upper granular unit at the boundary is
9 181.5 because that is more or less a measured value?

10 A. I wouldn't agree with that.

11 Q. That is the only measured value in
12 this whole case 8; is it not?

13 A. It is also an estimate based on
14 the limited data.

15 Q. But it is an estimate within a
16 very small range?

17 A. I would think the same of the
18 hydraulic conductivity of the upper till.

19 Q. 181.5 is conservative and it is
20 your most reasonable interpretation of the data
21 available as to the boundary head condition at that
22 site at this time?

23 A. It is reasonable and not
24 conservative.

25 Q. We don't have to believe that and



1 we can accept that one?

2 A. I still think you have to believe
3 it.

4 Q. The other thing we don't have to
5 believe is we don't have to believe that elephants can
6 fly. Everything else in this hypothesis we have to
7 believe?

8 A. This is a worst case situation I
9 agree, and I agreed to that, and indicated in the
10 evidence and this is the outside of the envelope and it
11 can be used in more ways than the ways you are
12 interpreting it and I attempted to indicate to the
13 Board that in my evidence in overhead OH-60A, and
14 before you even get to case 8 you have to pass through
15 case 11. The impacts -- we are saying this is all be
16 turned on instantaneously and you are right, that is
17 what the assumption is, but contaminant is moving down
18 to the system before it goes on. I agree it is an
19 idealization to assume the whole thing stops
20 immediately, but if one is going to try and bound what
21 is going to happen, you must make some assumptions.

22 Q. I will give you the fact that
23 this is your conservative case. Can we go back through
24 the beliefs again and perhaps you could agree with me
25 that the results in case 8 would be less dramatic,



1 i.e., the number of milligrams per litre at the site
2 boundary would be a lot less if, No. 1., the
3 underdrains don't all clog off instantaneously all
4 together, and as you said you would have to then pass
5 to case 11?

6 A. That is correct.

7 Q. That would give a lower impact?

8 A. Initially.

9 Q. Secondly it would give us a lower
10 impact, would it not, if the failure was in fact
11 detected and somebody tried to do something about it?

12 A. Yes, if the failure is detected
13 and somebody does something about it.

14 Q. That would make a difference? No.
15 3 it would make a difference if the K of the waste was
16 in fact 1×10^{-4} or higher?

17 A. Yes. You can also examine 10 in
18 that situation.

19 Q. We can also examine K-6 which
20 looks at that situation with a hydraulic conductivity
21 of the waste that varies between 7.4×10^{-4} and
22 1×10^{-3} which compared to case 8 is a much higher
23 hydraulic conductivity and you can't even build a mound
24 and 183.8 is a pretty modest mound by your standard?

25 A. My standards are given in this



1 table and I tried to look at a range of values. I
2 looked at two extremes and one extreme is the hydraulic
3 trap working indefinitely and the other extreme is case
4 8 and I think the probability of either of those
5 occurring is low.

6 Q. Concentrating on the K of the
7 waste for a moment, we have your cases that give us
8 some indication of what kind of impacts we could expect
9 with slightly higher hydraulic conductivity for waste,
10 but what would happen in all of your scenarios, 6, 7,
11 8, 9 and 10 if the K of the waste turned out to be
12 3×10^{-2} ?

13 A. If the K of the waste turned out
14 to be 3×10^{-2} you would have very small, if any,
15 significant mound. I can calculate it.

16 Q. At 3×10^{-2} -- I wouldn't mind if
17 you calculated it over lunch time, but at 3×10^{-2} you
18 almost I suspect would be in the situation wouldn't you
19 agree where the subheaders could do the collecting of
20 the leachate without the underdrains?

21 A. 3×10^{-2} . If that were true over
22 the entire site and I don't for a moment believe it is
23 likely to be, yes.

24 Q. When you do your Roth equation do
25 you take into account the hydraulic conductivity of the



1 material that the mound is sitting on?

2 A. No. That is exactly why we have a
3 range of values indicated in column 2 to try and take
4 account of that fact that. It is recognizing that the
5 equation itself does not take that into account and is
6 trying to reflect what the implications of that are.

7 Q. In fact if you lowered the
8 hydraulic conductivity of the upper till and assumed
9 that the waste was much more permeable in the range of
10 3×10^{-2} what you would expect is what, a situation
11 where you would get more mounding or less mounding?

12 A. I am sorry, would you say that
13 again?

14 Q. If you lower the hydraulic
15 conductivity of the upper till, let's say for argument
16 sake, 8×10^{-8} and you used 3×10^{-2} as the K for the
17 waste, what do you get then, more mounding or less
18 mounding? I am trying to understand and I want the
19 Board to understand what is the impact on mounding or
20 more or less hydraulic conductivity to the till
21 material sitting under the mound in relative terms?

22 A. If the till material is tighter it
23 means that less of the water will be going down into
24 the underlying soil and all other things being equal,
25 you have probably got potential for a higher mound, but



1 that is not the way I chose to interpret it.

2 Q. Looking at column 4, you would
3 agree all other things being equal on your scenario 8,
4 and the hydraulic conductivity of the till is in fact
5 lower, you will get a lot less impact at the boundaries
6 than the 1260 milligrams per litre injected in this
7 case?

8 A. If the hydraulic conductivity of
9 the upper till is substantially less, then you will
10 have less impact and I looked at a range of different
11 values and case 9 looks at the hydraulic conductivity
12 of the till being 8×10^{-8} which is Trow's value which
13 I think is an unrealistically low value. It is my
14 opinion it is unrealistically low.

15 Q. You will also notice -- I am
16 sorry.

17 A. I really did try and consider a
18 range of cases as you can see.

19 Q. I can see you considered a range
20 of cases and I will come back to ask you to one or two
21 things about them after lunch. Would you also agree
22 that we get different results in your case if the
23 hydraulic conductivity of the upper granular unit
24 starts to diminish?

25 A. Yes, and we agreed to that



1 yesterday.

2 Q. We get dramatically different
3 results in case 8 if the upper granular unit pinches
4 off and isn't continuous off-site?

5 A. Yes, if that were the case which
6 has not been established.

7 Q. But you are not giving an opinion
8 on that subject, are you?

9 A. No, I was using the opinions of
10 both Trow and Dr. Charlesworth.

11 Q. Finally in case 8 we get
12 dramatically different results if the underdrains work
13 for some period of time before closing off?

14 A. You will get lower concentrations,
15 I agree, and you would still have unacceptable off-site
16 impact unless those drains worked for periods of over
17 65 years.

18 MR. HODGSON: It is 12:25 and I think if
19 I could continue for ten or fifteen minutes I could in
20 fact finish and it might be useful for everyone if I
21 did.

22 MR. LANCASTER: I think so.

23 MR. HODGSON: I am getting tired and I
24 know it will be quicker if I am on my feet longer.

25 Q. Could we go back to your fairly



1 scenarios 2, 3, 4 and 5?

2 A. Certainly.

3 Q. Would you agree with me that in
4 each one of those scenarios you don't have any scenario
5 at all if the K of the garbage is 1×10^{-4} or greater?

6 A. Sorry, 1×10^{-4} ...

7 Q. Greater if the permeability of the
8 garbage is 1×10^{-4} or greater, those cases fall by the
9 wayside?

10 A. That's right. If it is one -- I
11 am getting tongue-tied. If it is 1×10^{-4} or greater
12 then it is as Trow postulated.

13 Q. Would you also agree that in your
14 cases 2 through 5 that you didn't model 8×10^{-8} ?

15 A. I think it's an unrealistic value
16 but Trow considered it in theirs.

17 Q. If you had modelled it you would
18 get lower impact?

19 A. That is correct.

20 Q. Would you agree with me in your
21 cases 11 and 12 that you are not going to get the kind
22 of impacts you are predicting if the hydraulic
23 conductivity of the garbage is 1×10^{-4} or greater?

24 A. That is correct.

25 Q. In fact even if two drains --



1 three consecutive drains seal off at 1×10^{-3} the
2 drains around it would pick up all the leachate, would
3 they not, without a mound building?

4 A. At 1×10^{-3} ? Yes, that is
5 probably true.

6 Q. In fact, Dr. Rowe, you would agree
7 with me in scenarios 11 and 12 you could by picking
8 notional hydraulic conductivity numbers that went in
9 steps like 1×10^{-4} , 7×10^{-3} , 3×10^{-3} , 1×10^{-3} , $8 \times$
10 10^{-2} , 5×10^{-2} and 3×10^{-2} , you could calculate based
11 upon those various hydraulic conductivities for garbage
12 and how much or how many tiles in a row would have to
13 seal off until you got a mound, couldn't you?

14 A. Yes, one could.

15 Q. The lower you got the permeability
16 of the garbage the more failures you could have across
17 the base of the landfill without reversing the
18 hydraulic trap?

19 A. That's right, and let's not forget
20 these numbers we are quoting are not based on data.

21 Q. My question was wrong, and
22 Mr. Feenstra should have told me the higher the
23 permeability of the garbage, the more tiles you can
24 have, consecutive tiles you can have fail in your
25 underdrain system without a mound building up that



1 exceeds the critical number, whatever that turns out to
2 be?

3 A. Whatever you said is what I
4 understood you to say and that is what I answered.

5 Q. I wanted the record to be clear
6 because Mr. Estrin will be arguing this later and we
7 will get confused?

8 A. Sorry.

9 Q. Would you also agree that in your
10 scenario C you haven't modelled 8×10^{-8} as the K of
11 the upper till?

12 A. No. And I would like to address
13 that issue if I could. I would like to put up my
14 overhead showing the landfill. There is our landfill
15 and I am putting up OH-37A and I would like to look at
16 what data we have on the hydraulic conductivity of this
17 upper till and I think it is reported in
18 Dr. Charlesworth's report as it in Trow's, but let's
19 just see where these values are.

20 Now, if I want to look we have data -- I
21 am referring to page 5-9 of the report and he has
22 recorded here from Trow a hydraulic conductivity of
23 5×10^{-8} at HC 1-86. So there we have 5×10^{-8} and at
24 HC 2-86 we have 1.7×10^{-7} and so we find HC 2-86 and
25 there it is and it is 1.7×10^{-7} , and at HC 3-86, if I



1 can find it, it is 6.3×10^{-8} and at 1-85 which is up
2 here, we have 7.9×10^{-6} and at 6-85 which is down
3 here, we have 2×10^{-7} .

4 So, here we have four of those five bits
5 of data in proximity to where we are going to landfill
6 and that's four pieces of information in the most
7 critical unit over an area of 500,000 square metres.
8 One piece of data for every 125,000 square metres.
9 Look at the numbers. At cells 4 and 5 we have
10 1.7×10^{-7} , 2×10^{-7} and looking at that data alone, I
11 think there is due cause for concern that the hydraulic
12 conductivity down near cells 4 and 5 is not 8×10^{-8} .

13 Q. Have you a number that comes close
14 to 8×10^{-7} ?

15 A. I haven't.

16 Q. It is a wild guess on your behalf?
17 It is an absolute wild guess?

18 A. If I could address that issue,
19 Mr. Chairman, I think we agreed yesterday and Mr.
20 Hodgson indicated that the critical unit is the upper
21 till unit and in my view that is the critical unit. We
22 have a very small amount of data and we do have one
23 number up here of 7.9×10^{-6} and that is one-quarter of
24 the data we have in the area of landfilling and we are
25 throwing it away. You will appreciate it is higher



1 than 8×10^{-7} . We have very little data and this is
2 the critical unit, and if we are designing with any
3 level of safety, we apply a factor of safety to it.

4 If we were looking at stability and were
5 looking at the shear strength of the soil and I was
6 building a building on it, I would not use an average
7 value, I would apply a factor of safety. 8×10^{-8} is
8 even the average value of the critical areas and let's
9 suppose for the sake of argument we say that the
10 typical value is 2×10^{-7} . I think one should in
11 evaluating impact apply some factor to it and
12 particularly when one is assuming that these things are
13 log normally distributed.

14 Q. Dr. Rowe, you are trying to
15 provide this Board with an assessment of the risks, the
16 relative risks of landfilling of these two sites?

17 A. That was your choice of words.

18 Q. Are you here for some other
19 purpose?

20 A. I am trying to indicate the
21 relative potential impact of the two sites.

22 Q. Assessing the potential impact we
23 have to assess the risk of putting a landfill on this
24 space, do we not?

25 A. Yes.



1 Q. You don't have a measured value up
2 there that is anything close to 8×10^{-7} , do you, for
3 the upper till?

4 A. I have a value of 7.9×10^{-6} .

5 Q. You heard your colleague say that
6 that should be considered part of the upper till?

7 A. I think he debated that question.

8 Q. Other than value, because I won't
9 debate that value with you, have you a value up there
10 even closer to 8×10^{-7} excluding HC 1-85?

11 A. No.

12 Q. What we have here is a till with
13 20 per cent clay?

14 A. Yes.

15 Q. A good till?

16 A. I think we went through that also.

17 Q. We went through that also and I
18 don't want to go back through that. The point I want
19 to make is that your 4×10^{-7} is already a conservative
20 number?

21 A. It is not particularly
22 conservative if this data is log normally distributed.

23 Q. It is a conservative number?

24 A. In terms of a log normal
25 distribution, it has a factor of safety of about 1.09.



1 Q. A reasonable number for this till
2 would be in the range of 1×10^{-7} , would it not?

3 A. There is very little data on which
4 to base that.

5 Q. We wouldn't be dreaming if we
6 thought the hydraulic conductivity was 1×10^{-7} , would
7 we?

8 A. It is a possibility.

9 Q. It is a possibility, a reasonable
10 number?

11 A. 1×10^{-7} is not an unreasonable
12 number and I wouldn't design based on it.

13 Q. So your number of 4×10^{-7} you
14 would agree is a conservative number?

15 A. I think it is a reasonable and
16 probably conservative.

17 Q. Would you agree with me in case 8
18 except for the boundary head case, you used exceedingly
19 conservative parameters for every input in case 8?

20 A. Certainly case 8 is the most
21 conservative case I looked at.

22 Q. Wouldn't you agree with me,
23 Dr. Rowe, that we don't get a very realistic impact on
24 the likely behaviour of any engineering facility
25 anywhere if we ignore every measured value we have but



1 one and multiply all of your conservative values
2 together. Wouldn't you agree that the result is that
3 you have a bridge design for California that you want
4 to build in Ontario. You have used so many
5 conservative assumptions that you are off the scale of
6 what is possible at Site D?

7 A. I think we are on the limits of
8 what is possible. I don't know -- I attempted in
9 looking at this range of cases not to be grossly over-
10 conservative and that is the outside of the envelope.
11 I used a boundary head which you would agree is not
12 conservative and I used a hydraulic conductivity of the
13 upper granular unit which you agreed was not
14 conservative. I did use a conservative value for the
15 hydraulic conductivity of the waste in case 8 and I use
16 values in case 6 which I do not consider to be
17 conservative. I considered the hydraulic conductivity
18 of the till I used in case 8 was a reasonable value.

19 Q. It was conservative a minute ago
20 and did it become reasonable in two minutes?

21 A. I think I said it was reasonable
22 and probably conservative, but it is right on the
23 borderline of whether it is reasonable or conservative.
24 It is not in your zone of very conservative, it is
25 right on the borderline in my opinion. Did I miss any



1 of them? I was trying to address all those points. I
2 think I answered that. I think it is on the limits of
3 reasonableness in case 8, and I certainly agree with
4 that and I indicated at the outset, it was on the
5 bounds of the envelope and obviously you are focusing
6 on the bounds of the envelope and I looked at a whole
7 range of other cases which have less impact but,
8 nevertheless, significant impact off-site.

9 Q. I want to suggest, looking at
10 column 2 in cases 2 through 12 that in virtually ever
11 case your hydraulic conductivities for that waste are
12 so high that you are on the limits of reasonableness --
13 or so low that you are on the limits of reasonableness
14 for almost every case you modelled and on that one
15 parameter you are on the limits of reasonableness in
16 every case, but perhaps six?

17 A. That depends on the cover material
18 they are going to use for this site. As I understood,
19 it was going to be the clay till.

20 Q. This is the clay till where you
21 could put six inches over a lift of four metres of
22 garbage and compress it and you could get a hydraulic
23 conductivity of 10^{-7} , but in situ after it has had two
24 kilometres of ice sitting on it for a few millennia, it
25 doesn't have a K of 10^{-7} because 8×10^{-7} , Dr. Rowe, is



1 not what you mean by a K of 10^{-7} , is it?

2 A. 8×10^{-7} , no.

3 Q. That is what you call 10^{-6} ?

4 A. It is getting close.

5 Q. In situ the clay material has a K
6 of 10^{-6} but after you take 6 inches of it off, scrape
7 it off the bottom of the landfill and store it
8 somewhere and carry it back and bulldoze it across the
9 lift of four metres of squishy, messy, ugly garbage,
10 run your bulldozer back and forth over it a few times,
11 it now has a K of 10^{-7} and better than it got after it
12 had 2 kilometres of ice sitting on it for a few
13 millennia. Is that a reasonable scenario?

14 A. The way you presented it it isn't,
15 but there are a number of issues raised in that
16 question. Firstly it is necessary better to have 2
17 kilometres of ice sitting on it. That depends upon how
18 the till was laid down and it depends on the fabric of
19 the till. When that ice is removed you can get
20 cracking within the till just as you do within the
21 shale which increases the hydraulic conductivity. This
22 second issue is whether you have four metres of garbage
23 and six inches of till. That doesn't sound like a 4 to
24 1 ratio or anything approaching it to me.

25 I can't remember if there were any other



1 points in your question?

2 MR. HODGSON: I don't think there
3 were.

4 Mr. Chairman, I taught university for
5 six years and I got use to always having the last word
6 in my classes, and then I practiced in court for
7 another seven years, and I have gotten very used to
8 never having the last word, and I feel like I am back
9 in university and I will give Dr. Rowe the last word.

10 MR. LANCASTER: You have completed your
11 cross-examination?

12 MR. HODGSON: I am finished.

13 MR. LANCASTER: Two o'clock and
14 Mr. McQuaid.

15 MR. McQUAID: I will be ready.

16 --- Luncheon Adjournment at 12:40 p.m.

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---Upon resuming at 2:00 p.m.

1 MR. LANCASTER: Mr. McQuaid, before you
2 get started, I realize next week is a two-day week and
3 we are a bit behind schedule, but I wonder if it might
4 not be prudent to break off a little earlier tonight.
5 I don't know, it doesn't look like it is going to be
6 too good later on.

7 MR. MCQUAID: I understand there is more
8 coming.

9 MR. LANCASTER: Twenty years of sailing
10 indicates to me there is going to be a blow.

11 MR. MCQUAID: What time do you suggest
12 we might break?

13 MR. LANCASTER: No later than four and
14 that is why I asked you, but at a convenient point you
15 might break your cross-examination.

16 MR. MCQUAID: We will aim for four or
17 shortly before.

18 MR. LANCASTER: Something like that.

19 MR. ESTRIN: I wanted to indicate to the
20 Board that Mr. Hodgson asked about some pump test
21 results, if he had any with respect to the Morrison
22 Beatty pump tests and certainly there is some data
23 about that and I gave it to Mr. Hodgson and had he
24 requested it before he could have had it.

25 MR. HODGSON: It is very difficult to



1 ask for data when you don't know something happened.

2 MR. ESTRIN: I understand your
3 consultants discussed it with Morrison Beatty well
4 prior to this hearing, so I think your consultants were
5 generally aware of where the tests were done and the
6 results. So there is no lingering curiosity, there is
7 no other borehole as Mr. Hodgson seemed to allege, the
8 pump test was done in OW-3 which is one of the Morrison
9 Beatty holes drilled in '84, and so there is no new or
10 hidden stratigraphic information as Mr. Hodgson wished
11 to imply by his questions.

12 MR. HODGSON: I didn't wish to imply
13 anything. I wanted to find out from the witness what
14 information was available to him.

15 MR. ESTRIN: I am certainly inviting
16 Mr. Hodgson to ask Dr. Charlesworth anything he wants
17 about the information I have provided to him before he
18 finishes his cross-examination.

19 MR. LANCASTER: Is there anything
20 further.

21 MR. HODGSON: I walked in here five
22 minutes ago and was handed some results of a pump test
23 and in the absence of my advisors I haven't the
24 faintest idea of what a pump test means. If I could
25 ask questions at a later time that would be fine.



1 MR. LANCASTER: If there is anything
2 arising from that, certainly.

3 MR. HODGSON: Thank you.

4 MR. LANCASTER: Mr. McQuaid.

5 ---CROSS-EXAMINATION BY MR. McQUAID:

6 Q. Dr. Rowe, I would like to start
7 with you since I am going to go into a little bit of
8 history back to your original retainer. Historically I
9 think you explained that you were the first person
10 retained between yourself and Dr. Charlesworth, is that
11 correct?

12 DR. ROWE: A. That is correct.

13 Q. I think in your evidence, although
14 it seems some days ago for both of you as well as us,
15 you indicated you were retained, was it early in 1986?

16 A. You are testing my memory.

17 Q. Originally retained in July of
18 1986?

19 A. That is my recollection.

20 Q. Were you retained by Mr. Estrin or
21 were you retained by the Town?

22 MR. ESTRIN: That's a nice legal
23 question.

24 MR. McQUAID: Q. I wanted to know if
25 someone from the Town contacted you and then Mr. Estrin



1 was involved subsequently or did Mr. Estrin contact you
2 directly?

3 DR. ROWE: A. Mr. Estrin contacted me
4 directly, but I think I was engaged by the Town. I am
5 not sure of the legal niceties of that.

6 Q. I wanted to know how it had
7 arisen. You indicated to the Board that you had
8 reviewed, I think you said, between August and
9 September, you had reviewed 37 reports?

10 A. That sounds correct with respect
11 to Site F, yes.

12 Q. Okay. That is correct. With
13 regard to Site F. You indicated that you had then
14 looked at the Trow reports?

15 A. Correct.

16 Q. Is that correct?

17 A. Yes.

18 Q. What reports would that have been?
19 It certainly would not have been H-39 and H-40? You
20 would not have seen either reports H-39 or H-40 and so
21 what reports did you review at that time?

22 A. I am trying to refresh my memory.
23 I referred to Hydrology Consultants' draft technical
24 report, No. 7, Phase 2, Stage 2C, selection of
25 preferred site; hydrogeologic assessment and conceptual



1 design, Halton Environmental Assessment, January, 1985;
2 Halton Consultants Halton Assessment, hydrogeological
3 test drilling information, July 27, 1984; and what data
4 were you asking for?

5 Q. This was between August and
6 September you analyzed the 37 report, and I am saying
7 in that timeframe what report of Trow's would you have
8 had?

9 A. I think some time around September
10 the Halton Region landfill technical reports became
11 available and I have data dated September, 1986; so
12 that's then the period you are asking about, then I
13 would have seen those reports.

14 Q. Just stopping at that point in
15 time, this was before Dr. Charlesworth was retained,
16 and I think you indicated or he indicated Geocon was
17 retained in December, 1986?

18 A. That seems to concur with my
19 recollection.

20 Q. I think historically when we look
21 back we see in the record that Morrison Beatty had been
22 retained by the Town for certainly hydrogeological work
23 back around that period?

24 A. That is my understanding, although
25 I never had any direct communication with them



1 regarding this particular project.

2 Q. You did not have direct
3 discussions with any representative of Morrison Beatty?

4 A. Not with regard to this project as
5 far as I can remember.

6 Q. Not on Site D or Site F?

7 A. No.

8 Q. However, you indicated, I believe,
9 that you have looked at a Morrison Beatty report of
10 some kind?

11 A. That is correct.

12 Q. What report was that?

13 A. I had looked at Morrison Beatty's
14 Phase I progress report and I looked at Morrison
15 Beatty's Phase III hydrogeologic investigation report,
16 dated November, 1981 and these are with respect to Site
17 F, and I have a feeling there is another one here.

18 Somewhere along the line I saw Phase II,
19 Morrison Beatty's Phase II, hydrogeologic
20 investigation, again Site F.

21 Q. I guess I should backtrack. We
22 know historically as well as we heard from Mr. Estrin
23 either yesterday or the day before, that Milton was
24 concerned about an OWMC project that was on the
25 horizon, is that correct, and were you aware of that?



1 A. I was aware in a general sense.

2 Q. Did you have any discussions with
3 Morrison Beatty about the OWMC project?

4 A. No.

5 Q. Or the searches going on by OWMC?

6 A. No. In fact to the best of my
7 recollection I have never discussed either of these
8 sites with Morrison Beatty prior to this hearing.

9 Q. You just read the reports that are
10 referenced in the back of your witness statement or
11 your exhibits?

12 A. That is correct. It was my
13 understanding that at the stage I was involved,
14 Morrison Beatty had been retained by NSP and were
15 advising them.

16 Q. Have you subsequently had
17 discussions with Mr. Beatty?

18 A. In technical terms I don't think I
19 have. I have said hello to him since he has been here.

20 Q. Mr. Beatty is the gentleman
21 sitting to the left of Mr. Griffiths?

22 A. Yes, correct, and I don't recall
23 discussing the technical details.

24 Q. Do I understand then coming down
25 to the latter part of 1986 you were not discussing



1 hydrogeological aspects with any hydrogeologist who had
2 been retained by the Town of Milton?

3 A. In fact it was one of my
4 recommendations to the Town that they retain a
5 hydrogeologist so I could speak to him.

6 Q. Could you tell us what specific
7 areas and what led you to make that recommendation?
8 What specific areas were you seeking assistance on?

9 A. I had read the reports and it
10 struck me there were a number of areas particularly
11 with respect to Site F where I would like hydrogeologic
12 interpretation.

13 Q. Can you be more specific. What
14 particular hydrogeological interpretation were you
15 looking for?

16 A. In particular after I had read the
17 Trow reports I was interested to know for my own
18 benefit, Mr. Chairman, how realistic their geologic
19 interpretation had been. I was not in a position to
20 provide that opinion myself. I was surprised at the
21 extent of flow to the discharge zone and I thought that
22 that should be looked at, and also I had read Joan
23 Hewitson's thesis and a number of other people had said
24 there was a plume from the Burlington landfill and I
25 was interested for a hydrogeological opinion as well as



1 for my own assessment from a geotechnical perspective.

2 Q. Is it all hydrogeological matters
3 you were interested in obtaining assistance on,
4 hydrostratigraphy, discharge?

5 A. Yes.

6 Q. You expressed concern about the
7 extent of flow to the discharge area?

8 A. It is struck me as being a very
9 large number, but I thought a hydrogeologist should
10 look at it.

11 Q. What number was it that struck you
12 at that point in time as best as you can recollect?

13 A. I think it was something like 28
14 cubic metres per annum. I can check that, but that is
15 my recollection.

16 Q. You recommended -- did you
17 recommend specifically that Geocon or Dr. Charlesworth
18 be retained and had you known him and worked with him
19 before?

20 A. I had not met Dr. Charlesworth
21 before I had worked on this project, but I had
22 recommended that a well recognized firm be engaged of
23 which Geocon is one.

24 Q. I guess I am getting at it wasn't
25 your specific recommendation that Geocon or



1 Dr. Charlesworth -- you had recommended a firm be
2 retained?

3 A. That is correct. I think I
4 mentioned a number of names some of which are already
5 involved or were involved in this hearing from other
6 sources.

7 Q. We will come to that in a moment.
8 Let's just get this history clearly in our minds. In
9 your answers to Mr. Estrin you indicated that having
10 read these reports on Site F you had reached a general
11 conclusion about November of 1986?

12 A. That is correct.

13 Q. You said based on the Trow reports
14 it appeared that there was adequate attenuation and no
15 liner would be necessary at F?

16 A. That was my interpretation based
17 on the information available to me at that time and it
18 is still my interpretation.

19 Q. You felt that Trow had been too
20 conservative at that time?

21 A. Yes. I felt, Mr. Chairman, as I
22 indicated, I thought the flows they had indicated
23 seemed to be very high flows and I recognize they
24 hadn't considered matrix diffusion as an attenuation
25 mechanism, and I also -- at that time that was one of



1 the things.

2 Q. You thought the impact might even
3 be less?

4 A. That is correct.

5 Q. Correct?

6 A. Yes, I thought they had been quite
7 conservative.

8 Q. You indicated also that you also
9 concluded that the interpretation by Hewitson and
10 Cherry was questionable back then?

11 A. Yes, it looked suspicious to me
12 and didn't seem to make sense.

13 Q. But you are not a hydrogeologist?

14 A. No, but I was looking at it from a
15 contaminant migration perspective, and from that
16 perspective the way the different contaminants were
17 being identified in the various holes did not make
18 sense with the contaminant migration mechanisms I could
19 imagine.

20 Q. You indicated as well that at that
21 time you had in mind modelling?

22 A. That is correct.

23 Q. You had not done any of the
24 mathematical models that you presented to this Board at
25 that point?



1 A. I had not, correct.

2 Q. In fact you needed the assistance
3 of Dr. Charlesworth for some of the input before you
4 could really do the modeling isn't that correct?

5 A. I had two options. I could have
6 remodelled Trow's or else I needed additional input.

7 Q. We understand then I think from
8 Dr. Charlesworth at this point, but I think you were
9 here and I don't think there is any real issue on this,
10 but Dr. Charlesworth indicated he was retained in
11 December of 1986?

12 A. That corresponds with my
13 recollection.

14 Q. No real work was done until the
15 end of January, 1987 and then he went on to indicate
16 the work that he proceeded to do in April, May and June
17 of 1987?

18 A. Yes.

19 Q. We have filed and there has been
20 some considerable discussion with Mr. Hodgson and
21 Mr. Estrin, but the reports, both the Geocon reports
22 and your report, M-442 in the case of Site D, and I
23 guess it is M-440 in the case of Site F?

24 A. Correct.

25 Q. They are dated October, 1987?



1 A. Yes.

2 Q. Now, they do not contain the
3 overheads a good deal of the time which we have spent
4 on and those did not come forward until the witness
5 statement which is dated December 1987?

6 A. Yes, correct.

7 Q. Can you tell us when did you first
8 do your modeling in the form of the overheads we see,
9 or these overheads we see, when did they first come
10 into existence?

11 A. The overheads or the results in my
12 reports 442 and 444, because there is a lot of overlap
13 between the two.

14 Q. Which came first?

15 A. I did my reports first and I did
16 the modeling of that, and it is hard to remember
17 exactly when because it was over a period of time, but
18 my recollection is August through -- I was still
19 modeling in some cases up until early this year.

20 Q. August, 1987 is when you basically
21 started to write your report?

22 A. Yes, I was starting to put
23 together material for my report at that time.

24 Q. The modeling would have been done
25 in the fall of 1987?



1 A. That is correct.

2 Q. By modeling I mean the actual
3 number crunching?

4 A. Correct. The bulk of it was done.

5 Q. Does that mean it was about August
6 of 1987 that you received the input you needed from
7 Dr. Charlesworth in order to begin your modeling?

8 A. I certainly had received input and
9 I can't recall the exact date of it, but it obviously
10 was before I started the modeling, but I cannot
11 remember offhand what date he provided the information.

12 Q. You could have modeled on Trow's,
13 you said a moment ago, without Dr. Charlesworth but you
14 needed Dr. Charlesworth's input in order to do the
15 other cases or scenarios?

16 A. Correct. I was working on
17 Dr. Charlesworth's advice.

18 Q. Sometime in the summer of 1987?

19 A. That is correct, yes.

20 Q. Now, coming down to the summer of
21 1987, last year generally, Dr. Rowe. You did give us,
22 I think, a summary of your industrial experience and
23 let me go through it and get it historically again in
24 perspective. I am going back to your very early
25 evidence and the first note I had taken was you had



1 done -- and I am not sure if this is Dr. Rowe or if I
2 have this right -- yes, you made reference to the
3 Rabbit Lake operation?

4 A. That is correct.

5 Q. That was done with Geocon in 1981?

6 A. That sounds correct. I can check
7 my CV, but that is my recollection.

8 Q. Was that a contaminant migration
9 model?

10 A. That was reviewing their
11 contaminant migration modeling and providing some input
12 to them with respect to diffusion.

13 Q. Then you made reference to the
14 Warwick landfill?

15 A. Yes.

16 Q. You did something with Morrison
17 Beatty?

18 A. Correct.

19 Q. When was that?

20 A. If I recall correctly that was
21 1984.

22 Q. What was the purpose of your
23 retainer at that time?

24 A. What I was asked to do was model
25 potential impact on an aquifer beneath a proposed



1 landfill.

2 Q. Where was that?

3 A. At Warwick.

4 Q. Where is that?

5 A. Southwestern Ontario not too far
6 from home.

7 Q. That was modeling an aquifer?

8 A. Modeling a situation very
9 similar to Site D.

10 Q. Similar to Site D. Was it on
11 till?

12 A. Yes, right.

13 Q. Would those be the first two
14 contaminant migration studies or models you undertook
15 then?

16 A. I was involved during this period
17 of time and even until today with research work funded
18 on Confederation Road landfill in Sarnia.

19 Q. In that same period?

20 A. That is correct.

21 Q. Yes, you indicated that. You were
22 involved in the parameters as you put it and were you
23 actually doing the modeling on that?

24 A. I was. I think I said the
25 project itself involved monitoring field migration



1 rates and my colleague Dr. Quigley was doing that, and
2 determining relevant parameters, modeling migration and
3 comparing the observed and calculated migration.

4 Q. In the case of Warwick did you
5 conclude it was hydrogeologically acceptable?

6 A. I didn't make a hydrogeological
7 interpretation.

8 Q. How about in the case of the
9 Confederation landfill?

10 A. That was an existing landfill and
11 we were looking at the impacts arising from the
12 existing landfill and we were not providing an opinion
13 as to whether it was hydrogeologically suitable.

14 Q. You just supplied the model to
15 someone, is that what you are saying?

16 A. The Confederation Road landfill is
17 a landfill constructed in the seventies and it is
18 probably the best test case around for looking at
19 contamination migration from an existing landfill.

20 Q. Backtracking to Warwick for a
21 moment?

22 A. Sorry, could you ask the question
23 again?

24 Q. Did you just supply the model to a
25 hydrogeologist in the Warwick situation?



1 A. That's right. To Mr. Beatty.

2 Q. To Mr. Beatty?

3 A. That's right.

4 Q. Coming down to 1986 when you were
5 retained, how many other models for landfill sites were
6 you involved in coming to July of 1986 when you were
7 retained?

8 A. I was extensively involved in
9 research in this area and that is probably why
10 Mr. Estrin approached me. I have published on the
11 issue.

12 Q. But in terms of actual reports for
13 any hydrogeologist, would I be correct that coming to
14 July of 1986 we have the three you have worked on?

15 A. That is correct.

16 Q. You indicated to us that you have
17 a number of projects underway but they are basically
18 over the last 12 months, I understand?

19 A. That is correct.

20 Q. Is that correct?

21 A. Correct.

22 Q. Would I also be correct that this
23 is the first occasion on which you have testified in a
24 hearing with respect to your modeling?

25 A. That is correct.



1 Q. Thank you very much, Dr. Rowe, I
2 would like to switch to Dr. Charlesworth for a moment.

3 Dr. Charlesworth, you were retained, as
4 I understand it, in December of 1986 and did I
5 summarize it correctly, your initial reviews began at
6 the end of January, 1987 and then coming into April,
7 May, June of 1987 you began to do the bulk of your
8 work?

9 DR. CHARLESWORTH: A. Yes, I would say
10 that that is correct. I think we actually supplied the
11 parameters to Dr. Rowe a little earlier than he
12 indicated. I think it was around April or May?

13 DR. ROWE: It could have been, I was
14 away. I was away in May.

15 DR. CHARLESWORTH: That is right so he
16 may not have received them.

17 Q. I will get to that in a moment.
18 Let me go back to your early retainer. Could you be
19 very specific about what it was you were asked to
20 supply in terms of parameters as you referred to them?

21 DR. CHARLESWORTH: A. The original
22 retainer; I was approached or contacted by Geocon who
23 had been approached by Mr. Estrin and I was asked to
24 give advice, I would say in general terms on this
25 project at the outset.



1 Q. Were you giving this advice to
2 Geocon at this point or Mr. Estrin?

3 A. I was acting for Geocon.

4 Q. You are an independent consultant?

5 A. An independent consultant.

6 Q. Geocon calls you on occasion?

7 A. That is correct, yes.

8 Q. You are giving general advice to
9 Geocon at this point in January of 1987?

10 A. Yes. I guess I am giving general
11 advice to Mr. Estrin basically and reviewing the data
12 and talking to Dr. Rowe. I met with Dr. Rowe at that
13 point and it is hard to remember exactly how the sort
14 of scope of the work developed, but I was asked to
15 comment or rather attend meetings and comment in
16 general terms on the Trow reports and have input at
17 those meetings.

18 Q. Is there a letter or memo or some
19 report that you could refer us to as to what it was
20 that you actually supplied to Dr. Rowe in order for him
21 to run his models?

22 A. There are notes on file and there
23 is a memo, I am sure there is a covering memo that goes
24 with the data we gave him.

25 Q. Can you by recollection tell us



1 what -- if we were to go to page -- Table 2 in M-442,
2 Dr. Rowe's report on Site D, and Mr. Hodgson has set a
3 good example of sticking to this table and going across
4 the columns, but could you tell us which of these data
5 you were called upon to give to Dr. Rowe?

6 A. Which page?

7 Q. Site D opposite page 28. It is
8 actually page 27?

9 A. It appears to be missing in Dr.
10 Rowe's copy.

11 DR. KINGHAM: After the last two days
12 perhaps it was burned.

13 DR. CHARLESWORTH: Or worn out. In
14 terms of specific input to models, that applied more
15 directly to Site F and Dr. Rowe on his modeling of Site
16 D was primarily using Trow data. The information we
17 actually supplied to Dr. Rowe in the early -- late
18 spring or early summer of 1987 was data for Site F.

19 MR. McQUAID: Q. You were not called
20 upon then to give data for Site D. Is that what I
21 understand?

22 DR. CHARLESWORTH: A. I was not called
23 upon to give data for Site D. We did discuss some of
24 the aspects of the site and we had general discussions
25 and obviously we commented on Trow's reports on Site D.



1 Q. Over the weekend could you attempt
2 to produce that memo that passed the information on on
3 Site F?

4 A. Certainly.

5 Q. Were there any subsequent memos or
6 notes or anything of that nature in which you were
7 called upon to give any data on Site D specifically?

8 A. I don't recall, but I will check.
9 I don't remember giving any specific data on Site D,
10 but I will check into that.

11 Q. You may have answered this, but
12 bear with me. Were you given this raft of 37 reports
13 or documents or whatever it is that Dr. Rowe has listed
14 in his report at the early outset as well?

15 A. They came over in the early period
16 of 1987 and we didn't get a whole box full of reports
17 at one time. I am sure I got a box at one point, but
18 they took more than one box and so they came over a
19 period and there seemed to be an endless flow of data
20 arriving at the door.

21 Q. As we can all attest to, but all
22 of the same data Dr. Rowe had was made available to
23 you, correct?

24 A. I think so. I think it was
25 essentially the same list.



1 Q. When did you first get the
2 Morrison Beatty material, the reports and logs?

3 A. The specific logs we have
4 included?

5 Q. Yes, in M-438?

6 A. I don't recall exactly but I'd
7 guess probably around February -- in the same period of
8 January through March I would guess anyway.

9 Q. January, February or March, 1987?

10 A. I think it was in that period,
11 yes.

12 Q. Did you have discussions with
13 Mr. Beatty or anyone from Morrison Beatty?

14 A. No. My colleague who was assisting
15 on this, she contacted them and went over as we
16 indicated earlier to look at the samples, but at that
17 point I don't recall having any personal conversations.

18 Q. You had no direct conversations?

19 A. No.

20 Q. But Janet Hayes...

21 A. Haines.

22 Q. The lady sitting next to
23 Mr. Estrin.

24 A. She went to look at the soil
25 samples.



1 Q. And she had discussions with
2 Mr. Beatty and did she relate back?

3 A. I don't think she had discussions.
4 with Mr. Beatty, it was essentially looking at the
5 samples.

6 Q. I guess I am really asking did you
7 directly or indirectly try and pick up on information
8 from Mr. Beatty about what these test results or the
9 core logs or these other tests that might have been
10 undertaken by Mr. Beatty, what they would reveal?

11 A. Not really. We took the data in
12 the logs and I guess it wasn't clear to me exactly what
13 Morrison Beatty's involvement had been in the project.

14 Q. Did you not inquire?

15 A. I understood they had been doing
16 some work I thought primarily associated with the OWMC
17 site.

18 Q. Wouldn't that hydrogeologically be
19 of interest to you?

20 A. There was a considerable amount of
21 data and we did go and look at the cores and the
22 samples.

23 Q. What about this pumping test data
24 which Mr. Estrin offered to Mr. Hodgson. When did you
25 obtain that?



1 A. I don't remember. It must have
2 been around the same time as far as I can recall.

3 Q. You did not have any direct or
4 indirect discussions about those tests?

5 A. Miss Haines did talk to them and
6 she did speak to them at that point and it may have
7 coincided with looking at the cores, I am not sure, but
8 not in great detail. We looked at the results and
9 that was essentially ...

10 Q. What was the summary of what that
11 test had revealed and what was explained to you by
12 Miss Haines?

13 A. We found the data in terms of
14 actually --

15 Q. I am asking you a specific
16 question if you just listen. What did she tell you
17 back then as to the summary, or what she understood
18 were the results of the tests?

19 A. I am having difficulty and I am
20 even having difficulty recalling the data as you will
21 recall from this morning, but the impression that I
22 have now that was conveyed to me was that the test had
23 not really been carried out in a very rigorous manner
24 and it was not -- at that time we were focusing quite
25 strongly on the granular units, the upper granular unit



1 and the lower granular unit, and at that point as far
2 as I can recall, we ascertained the test was not in
3 fact conducted on those units and I think that is why
4 it played a less significant role in our analysis of
5 the site and maybe at the end got pushed into the
6 background somewhat.

7 Q. Would that have been because the
8 test in question did not find the upper granular or
9 lower granular to the extent you were looking?

10 MR. ESTRIN: Wait, I want the witness to
11 make sure he heard the question, because the last part
12 was to what he was looking, because it is clear that
13 Morrison Beatty was not looking for anything with
14 regard to the Region of Halton project, and were never
15 engaged in it.

16 MR. McQUAID: This is cross-examination
17 and I don't think Mr. Estrin should be allowed to get
18 up and aid his witness unless I have asked a question
19 which is improper and I see nothing wrong with the
20 question at all.

21 MR. LANCASTER: I don't recall the
22 question to tell you the truth.

23 MR. McQUAID: That is one of the
24 problems with unnecessary interruptions, because they
25 do throw off both the questioner and they aid the



1 answer, and that of course is one of the things I am
2 objecting to.

3 MR. ESTRIN: I am not attempting to
4 assist the witness, but I want to make sure the Board
5 has accurate information and it would be fair to ask
6 maybe one or two, but one would probably do it, but one
7 question that would establish what information, if
8 any ...

9 MR. MCQUAID: I don't want to ask a
10 question on the information handed to us, I wanted to
11 ask what historically this man was told about the
12 information back then and that's all I am asking him
13 about.

14 Q. Dr. Charlesworth, can you to the
15 best of your recollection, recall why that information
16 at that point was not of any assistance to you?

17 DR. CHARLESWORTH: A. I wouldn't say
18 it was not of any assistance, but to the rest of my
19 recollection we were advised that Morrison Beatty had
20 in fact done a pumping test on the site and I was
21 looking at the Trow data at that time and we were
22 understandably directing our attention to the granular
23 units because this had been identified by Trow as the
24 critical units. I looked at that information and
25 concluded that it was not helping me in my



1 understanding of those granular units and it had not
2 been carried out in a way to enable us to determine or
3 do any kind of reasonable analysis of the data in terms
4 of determining the aquifer characteristics and that is
5 as far as we went with it at that point.

6 Q. Is it possible sometimes when data
7 of this nature does not help that it does indicate the
8 absence of units?

9 A. No, I would say, if anything, if I
10 have committed a sin of omission it is in not -- in
11 fact it indicates that the unit that the test was into
12 which is quite a unit along the top of the bedrock, it
13 may be of more significance than we have given thought
14 to.

15 Q. All right.

16 A. I am sorry, but we did know from
17 the log of the borehole that it did penetrate the
18 units, the granular units, or that it had granular
19 layers to it.

20 Q. Let me just ask you a little bit
21 of background information so I am sure I understand
22 some of the data we have had and some of the techniques
23 discussed. Do I understand that if you are looking for
24 the conductivity, hydraulic conductivity of various
25 strata, we have had reference to three types of tests I



1 think that I can recall and I would ask you to comment.
2 We have heard of the Hvorslev or slug test and is that
3 one form of test?

4 A. Yes, that is correct.

5 Q. We have heard some reference to
6 looking at grain size analysis and I think you
7 indicated that is a bit crude in terms of trying to
8 establish hydraulic conductivity just from that?

9 A. Yes.

10 Q. It gives you some initial
11 impression and is that what it tells you?

12 A. Yes.

13 Q. There is the grain size analysis
14 and is it more crude than the Hvorslev/slug test?

15 A. Yes, generally.

16 Q. First impression from grain sizes
17 and better tests from Hvorslev/slug tests, is that
18 correct?

19 A. Yes.

20 Q. Then, in order of reliability
21 would the next better form of test be a laboratory
22 permeability test?

23 A. Not necessarily. I would not
24 necessarily say that a laboratory permeability test
25 will give you a better value than an in situ field



1 test.

2 Q. You equate them do you?

3 A. Yes. There are certain problems
4 in collecting the sample and subjecting it to the
5 laboratory test. I would favour an in situ field test
6 if you can be sure it is done correctly and the
7 boreholes are constructed correctly.

8 Q. If I understand correctly there
9 are certain problems in doing these Hvorslev or slug
10 tests as you may have referred to it and perhaps you
11 would confirm that for me, would you?

12 A. Yes, there are problems in all the
13 tests.

14 Q. There are problems with all the
15 tests if they are not done correctly?

16 A. Yes.

17 Q. If they are done correctly, I
18 gather you are saying as a hydrogeologist that you
19 would prefer the Hvorslev test to a laboratory
20 permeability test. Is that your evidence?

21 A. It would depend upon the nature of
22 the material.

23 Q. Let's take the tills at Site D
24 specifically. So, would you answer my question?

25 A. Which would I prefer?



1 Q. Yes, professionally as a
2 hydrogeologist.

3 A. I think I would like to look at
4 both values as a correlation which I would take -- I
5 would be influenced -- I think I would be most
6 influenced by the Hvorslev tests.

7 Q. Why is that?

8 A. If you have a reasonable number.
9 They will take into account variations occurring around
10 that particular borehole which you may miss on a small
11 sample you are analyzing in the laboratory and they may
12 also take into effect fractures which you may miss in a
13 laboratory sample.

14 Q. All right. If we are talking
15 about the unweathered till at Site D, there was no
16 indication of fractures in that till, was there?

17 A. There was none. I have a question
18 about that as well.

19 Q. Do you?

20 A. Yes.

21 Q. If you were to look then at trying
22 to determine the hydraulic conductivity of the till at
23 Site D, is it your evidence that you would place more
24 reliance on the Hvorslev than a laboratory permeability
25 or would you look at both or what would you do?



1 A. I think in the case of the till I
2 would have reservations about the Hvorslev tests unless
3 a lot of care had been taken in the actual construction
4 of the borehole, because of the problems we discussed
5 in terms of smearing, et cetera. If you are looking at
6 the ideal case and there are techniques being
7 investigated and rather than drilling the augur hole
8 you used a Shelby tube and took two Shelby tube samples
9 and removed the problem I have been talking about,
10 smearing on the borehole, and under those circumstances
11 a lot of care has to be taken in the construction of
12 the borehole to get reliable value.

13 Q. In Hvorslev?

14 A. Yes, in a till material.

15 Q. In a till material of the type we
16 are talking about at Site D, would I be correct,
17 Dr. Charlesworth, that you would place more reliability
18 on a laboratory permeability test generally?

19 A. I would like to look at a number
20 of analyses.

21 Q. Let me diverge for a moment.
22 Yesterday, or I think it was yesterday you made a
23 comment about the adversarial system, or about the fact
24 we are in an adversarial system?

25 A. Yes, that it appears to be.



1 Q. It appears to be?

2 A. Yes.

3 Q. Those are the rules I have been
4 given and the rules you have been given and what the
5 Board has to work under, correct?

6 A. It would appear so.

7 Q. But I want you to understand one
8 thing before we go much further. I understand you are
9 a Ph.D, correct?

10 A. Yes.

11 Q. Did you have to defend your
12 thesis?

13 A. Yes.

14 Q. Were you examined by a group of
15 peers?

16 A. In the British system you are
17 examined by one external examiner.

18 Q. One external examiner?

19 A. Yes.

20 Q. Did he ask you some questions
21 which might be considered to be of a cross-
22 examinational nature?

23 A. Yes.

24 Q. The piercing sort of nature and
25 testing your opinions and views?



1 A. Yes.

2 Q. I gather -- have you had occasion
3 to do that subsequently for Master's or Ph.D students
4 subsequently?

5 A. No, I haven't.

6 Q. You haven't?

7 A. I haven't worked in the academic
8 world since then.

9 Q. But you understand that opinions
10 are tested both in the academic world and they have to
11 be tested here as well?

12 A. Yes, I understand that.

13 Q. Did you discuss your evidence with
14 Mr. Estrin and discuss the nature of this hearing?

15 A. Prior to...

16 Q. Yes.

17 A. Yes.

18 Q. What do you understand your role
19 is in this particular proceeding in terms of offering
20 evidence?

21 A. I think my role is to give my best
22 opinion to the Board so they can then assess along with
23 the other opinions they will receive, Mr. Chairman, to
24 enable the Board to come to a decision regarding these
25 sites.



1 Q. By your best evidence, you mean
2 your best professional evidence?

3 A. I mean my best professional
4 evidence.

5 Q. And you are not called upon, and
6 you understand as lawyers we are supposed to argue the
7 case and you are supposed to offer your professional
8 opinions, correct?

9 A. I understand that.

10 Q. When I ask you the questions I am
11 really seeking within the realm of the area we have
12 been talking about for your professional opinion?

13 A. I recognize that.

14 Q. Now, getting back to what we were
15 talking about in tills, particularly at Site D, I asked
16 you the question very specifically whether having
17 regard to the problems of Hvorslev tests in the tills
18 you have described and coring problems that might
19 happen, smearing and so on, wouldn't you as a general
20 rule place more reliance on the results of the
21 laboratory permeability test than a Hvorslev test?

22 A. Yes. I am trying to give my best
23 professional opinion and I think one of the problems to
24 follow on from the little discussion we have just had,
25 is that sometimes -- at least the problem I have is



1 that when you are weighing these questions you can see
2 shades of grey in them and sometimes it is difficult to
3 give a specific answer and if you start to give the
4 answer and then you see yes, but this situation may
5 apply.

6 If I have hesitated, that is merely the
7 process I am going through. It is sometimes difficult
8 as I am sure you will understand when we are standing
9 up here, particularly after three weeks, to give,
10 particularly on an afternoon at the end of the week, to
11 always give a clear and concise an answer as we might
12 like to give.

13 So, I would say, to answer that
14 question, that there are problems with all the values
15 and you have to look at them all. One of the problems
16 with hydrogeology, and I guess we have said this
17 before, there are problems arriving at numbers and one
18 of the concerns I think we all have in this kind of
19 process is that there is a danger we can get locked
20 into numbers and is it 10^{-7} or 10^{-8} and however those
21 numbers are derived there is quite a potential, there
22 are potential errors involved, however they are
23 determined. If you haven't done them yourself or even
24 if you have done them yourself, you recognize the
25 errors and if you haven't done them yourself you have



1 concerns.

2 I would say if you could control and
3 take a lot of care about constructing the piezometer
4 and take a lot of time, you may well yet, or it is
5 possible you could get better values from an in situ
6 test, but there are difficulties inherent with that,
7 particularly in the fractured till.

8 I would look at all the values available
9 and I would like several laboratory tests and several
10 field tests and I would see how the ranges compared and
11 I would be tending to reject values which I thought
12 fell outside the range of the other values.

13 Q. I guess I thought I was asking you
14 about the general methodology you would prefer in terms
15 of reproducibility, reliability, and those are two main
16 adjectives I would use and if you had a laboratory
17 test, generally you could place more reliability on
18 that than you could the Hvorslev tests in the field,
19 just as a general rule. I may be wrong?

20 A. There are problems in collecting
21 the actual sample and installing it in your
22 permeameter.

23 Q. So, you really don't have any
24 preferences is what it really comes down to?

25 A. I think the reality of the



1 situation is you will do a large number of Hvorslev
2 tests or in situ tests of one kind or another and the
3 Hvorslev tests themselves are not necessarily the best
4 method as there are variations such as constant head
5 tests or constant discharge tests and they are very
6 difficult in very low permeability materials, but they
7 probably give a better result than a Hvorslev test
8 which is a transient test.

9 Q. I am not going to ask you at this
10 point in the afternoon to go into a lot of
11 interpretation and don't let me put you off by handing
12 you this document, and it is a weekend's work I guess,
13 and I am not going to ask you any questions about it
14 right now.

15 MR. LANCASTER: You have hit the
16 jackpot. This is Exhibit B-500.

17 MR. HODGSON: Is that a Bingo? It is
18 half a millennium.

19 MR. LANCASTER: Half a millennium.

20 ---EXHIBIT NO. B-500: Golder Associates Report,
21 dated November 23, 1987 to
Conestoga Rovers Associates

22 DR. KINGHAM: While they are sorting
23 that out, Dr. Charlesworth, I am sort of repeating
24 myself from yesterday and repeating the Chairman from
25 this morning. We understand and we appreciate there



1 are uncertainties throughout this and it would be based
2 on the limitations of those?

3 DR. CHARLESWORTH: Yes.

4 MR. McQUAID: Q. I just want to
5 identify this and tell you specifically what it is I
6 would like you to look at over the weekend?

7 DR CHARLESWORTH: A. Okay.

8 Q. This is -- I guess we could
9 identify it as a Golder Associates report dated
10 November 23, 1987 to Conestoga Rovers Associates and
11 that is the firm of hydrogeologists and consulting
12 engineers Burlington has retained. Just looking at it,
13 Dr. Charlesworth, it appears to be a hydraulic
14 conductivity test done by a constant head hydraulic
15 conductivity test means?

16 A. Yes, that appears to be the case.

17 Q. Do you have a copy, Dr. Rowe?

18 DR. ROWE: A. I have Mr. Estrin's copy.

19 MR. ESTRIN: If we are going to take an
20 afternoon break perhaps he could have a chance to read
21 it if you are going to question on it.

22 MR. McQUAID: There is no point in
23 reading the whole report because I am going to refer to
24 something very specific and I don't want the witness to
25 necessarily read the whole report, but I will direct



1 him to what I am going to ask him to do specifically
2 and that's the point of it. I just want to identify it
3 and say this is the area and then I want him to have
4 the opportunity to examine it.

5 MR. LANCASTER: Would it take long
6 because we weren't planning on a break this afternoon,
7 but to go straight through.

8 MR. MCQUAID: Let me identify the
9 document and it won't take very long, sir, three or
10 four minutes.

11 Q. You take your time over the
12 weekend and look at this, but I want to indicate to you
13 that I was going to identify it and then give you some
14 direction for when you are reading it, so it doesn't
15 take longer than it ought to.

16 DR. CHARLESWORTH: A. Fine.

17 Q. If I could refer you to Table 1,
18 the third page in the document. You will see there a
19 series of borehole numbers and SA numbers, CRA-1
20 through to 6?

21 A. Right.

22 Q. I want to direct your attention
23 specifically to CRA-2, 3 and 4, and you will see a
24 reference to the HC numbers?

25 A. CRA-2, 3 and 4?



1 Q. Yes, CRA-2, 3 and 4.

2 A. Right.

3 Q. Just so -- when you are reading
4 the document the first CRA-1 number, there is reference
5 to it in the third paragraph of B-500 and there was a
6 sample taken in a dry state and apparently it was
7 recompacted and so the results of that CRA-1 is from a
8 recompacted piece of the drilling core or the core?

9 A. Right.

10 Q. I want you to concentrate on the
11 CRA-2, 3 and 4 and the fifth one, that is in the
12 weathered upper till. I want you to assume that. I
13 want you to assume, and you can double-check for me if
14 you will by looking at the document, that CRA-2, 3 and
15 4 are in the unweathered till at Site D?

16 A. Okay.

17 Q. I will give you that assumption.

18 A. These are the samples from the
19 Trow boreholes?

20 Q. That is correct, and so when you
21 read that, bear that in mind?

22 A. Right.

23 Q. In particular what I would like to
24 address your attention to is the hydraulic
25 conductivities in the middle of the page, Table 1?



1 A. Right.

2 Q. They range from 1.45×10^{-8} to
3 6.95×10^{-9} ?

4 A. Right.

5 Q. Would I be correct that it would
6 be an acceptable methodology when looking at these
7 three numbers to look at the hydrogeologic conductivity
8 based on the geometric mean of those three numbers?

9 A. Yes.

10 Q. I want you at this point to
11 double-check for me the geometric mean over the
12 weekend?

13 A. Certainly.

14 Q. Can you determine whether it
15 is 1.4×10^{-8} ?

16 A. Right.

17 Q. Those were the questions I said I
18 would be addressing by Monday, Mr. Chairman. It would
19 be a convenient time to break. Did you say you wanted
20 to break?

21 DR. KINGHAM: The question was if he had
22 to study the paper for ten minutes would we take a
23 break and our preference was not to break.

24 MR. McQUAID: That is what I understood
25 so that is why I am approaching it on this basis. I



1 don't need a break, let's press on.

2 Q. Dr. Charlesworth, while you are on
3 your feet, and just to pick up on the material that we
4 have here, particularly I guess while we consider it, I
5 want to refer you to M-442, Dr. Rowe's report, and do
6 you have a copy there you can look at?

7 DR. CHARLESWORTH: A. Yes.

8 Q. Let's get one of these tear sheets
9 that we can mark on. Get a clean sheet if you will and
10 pull it out a bit so we can see it. Do you have page
11 27 there?

12 A. Yes.

13 Q. Of M-442?

14 A. Yes.

15 Q. We see in column 4 that the
16 hydraulic conductivity of the upper till is from
17 4×10^{-7} to 8×10^{-8} on the series Dr. Rowe has
18 modelled?

19 A. Yes.

20 Q. Now, would you be able, and I want
21 you as a hydrogeologist to answer this, not Dr. Rowe --
22 what did I say? It should be from 8×10^{-8} to
23 8×10^{-7} ?

24 A. I took it as that.

25 Q. If I didn't, that is what I meant.



1 Sorry. Now, if I was -- oh, I know what it was. I
2 want you to take or concentrate on case No. 8 for a
3 moment because we went into that in some detail this
4 morning and everyone is familiar with the numbers?

5 A. Right.

6 Q. I think the evidence, and we will
7 shortly have a sheet which summarizes from the
8 overheads the periods of time to reach the boundary
9 from the overheads of Dr. Rowe, overhead 45. I think
10 it indicates the time to reach the boundary in this
11 particular case is about six years. Would you put down
12 6 opposite that. Just write it down so you have a note
13 of it there?

14 A. Okay.

15 Q. I have added a column and shortly
16 I will I will put in for the benefit of the Board and
17 everyone here a time to reach column and a reference to
18 the years and the overheads they come from just so we
19 can cross-reference it on this page now that we have
20 had as much discussion on it as we have had.

21 I just want you to assume at this point
22 that I am correct and six years would be the time to
23 reach column 10?

24 A. Okay.

25 Q. What I wanted to ask you was



1 whether as a hydrogeologist would I be correct in
2 assuming that if I was to put to you that the hydraulic
3 conductivity in case No. 8 was changed from 4×10^{-7} to
4 1.4×10^{-8} that that, and I recognize that there may be
5 a small variation or adjustment, but what we would
6 expect or what you would expect as a hydrogeologist
7 would be that you would increase the time to reach by a
8 factor of $\frac{4 \times 10^{-7}}{1.4 \times 10^{-8}}$?
9

10 A. You are now talking about the time
11 to pass through that unit?

12 Q. Yes.

13 A. Yes.

14 Q. Would you mind writing that
15 down for me for a moment. Put 4×10^{-7} up at the top?

16 A. 4×10^{-7} .

17 Q. That is the numerator and the
18 denominator is 1.4×10^{-8} and then equals and this is a
19 pretty simple one and I will ask you to do that right
20 there if you don't mind?

21 A. 28.6.

22 Q. Would you write that down for us?

23 A. 28.57 actually.

24 Q. All right. Now, for us mortals
25 trying to read this page, would I be correct that when
we go back down to case 8, going back to page 27, if in



1 fact the hydraulic conductivity of the upper till were
2 to be changed to 1.4×10^{-8} , would I be correct that
3 you would change the time to reach, if it were six
4 years, you would multiple that by the 28.57?

5 A. Yes. Yes.

6 Q. Can you do that for us? Dr. Rowe,
7 can you confirm, and I realize there may be a small
8 adjustment, but generally what Dr. Charlesworth has
9 just attested to would be correct.

10 DR. ROWE: A. I would disagree with
11 about 70 years of it.

12 Q. You would disagree with what?

13 A. I would disagree with it by about
14 70 years because you are assuming that the whole 7
15 metres has a K of 1.4×10^{-8} and I understood we were
16 only talking about the upper till.

17 Q. I will come back to that at some
18 point. You multiply it but you say the factor is not
19 as direct as I have indicated?

20 A. That is correct.

21 DR. CHARLESWORTH: A. The six years is
22 the time to the upper granular unit, is that correct?

23 DR. ROWE: A. Yes.

24 DR. CHARLESWORTH: A. Rather than the
25 time through the upper till.



1 Q. I thought if we looked at overhead
2 58, and maybe I have over-simplified -- it may not be
3 58, so just bear with me for a moment. It is overhead
4 55.

5 Dr. Rowe, the time to get through the
6 upper granular unit was in the order -- we have case 5
7 at 5 years, case 2 as 3 years.

8 DR. ROWE: A. I think perhaps there
9 maybe some misunderstanding. Once it has reached the
10 unit this is how long it takes to get off-site and that
11 is what this column represents. Once it has reached
12 the upper granular unit then how long does it take to
13 travel 100 metres from beneath the landfill to off-
14 site.

15 Q. That is not the time through the
16 upper granular unit?

17 A. That's the time through it and I
18 am sorry if there has been any misunderstanding.

19 Q. Then let's go back. You can take
20 that overhead down.

21 A. Just to make it clear, that is the
22 travel time within the UGU itself, and what I
23 understood you were talking about was the travel time
24 primarily from the landfill down through the till
25 units.



1 Q. I have handed out a document and
2 let me mark it and then we will come back to this
3 discussion.

4 MR. LANCASTER: B-501.

5 ---EXHIBIT NO. B-501: Compilation of overheads

6 MR. McQUAID: Q. This is something I
7 would again ask you to check over the weekend. What we
8 have attempted to do is take from the overheads and put
9 them into column 10, the number of years that the
10 various overheads indicate as the period to reach the
11 boundary. If you would just make a note, and I am
12 sorry this somehow didn't get on the document, and it
13 may have been lost off the right-hand side. You see
14 the footnotes indicate the overheads they are from.

15 DR. ROWE: A. Perhaps as a point of
16 clarification, the information is in fact given on
17 Table 3 of page 41 of my report.

18 Q. I guess what I wanted to establish
19 at this point, Dr. Charlesworth, subject to the
20 adjustment we have to make for the time to go through
21 the upper granular, but if Dr. Rowe has modelled here
22 at 4×10^{-7} , there is a factor -- it is less than the
23 straight factor of 28.57 but you multiply the time to
24 reach by the factor you have indicated there, and the
25 mathematics you have done?



1 DR. CHARLESWORTH: A. What you can
2 say here is if you keep the head constant or keep these
3 parameters constant and if you change the hydraulic
4 conductivity from the 4×10^{-7} to the 1.4×10^{-8}
5 keeping everything constant for one unit or one
6 material, then you would increase the flow time by that
7 factor.

8 Q. The other figures that are
9 modeled, and let's take a brief moment and do those,
10 but it is 8×10^{-7} ?

11 A. You want to change that to
12 1.4×10^{-8} ?

13 Q. Yes, please.

14 A. 57.

15 Q. The other one is the one I can get
16 which is 8×10^{-8} and I was doing it when it was
17 1×10^{-8} , so divide that by 1.4×10^{-8} .

18 A. 5.7.

19 Q. I guess Dr. Rowe you had indicated
20 to us -- first of all those are the factors you would
21 multiply be for one type of strata, as
22 Dr. Charlesworth has indicated.

23 DR. ROWE: A. That is the factor and I
24 understand...

25 Q. That is all I want to know.



1 A. Just for the upper till?

2 Q. Just for the upper till, is that
3 correct. I am changing the upper till and if we wanted
4 to understand this document, Dr. Charlesworth, and I
5 realize in a simplified form, but you would multiply by
6 a factor in the order of the factor we are talking
7 about, and allowing for the time that it may have to go
8 through the upper granular unit, is that correct?

9 DR. CHARLESWORTH: A. And the time to
10 go through the lower till as well as it is going
11 through 4 metres of upper till and then 3 metres of
12 lower till before it reaches the upper granular unit.

13 Q. I see. If it was changed from
14 4×10^{-7} , you would multiply by 28.5 but the result
15 after you make an allowance for going through those
16 granular units is that it would be 100 years, is that
17 correct, approximately?

18 DR. ROWE: A. From my quick
19 calculations and subject to check, yes.

20 Q. Could you check that for us on the
21 weekend?

22 A. Yes.

23 Q. Similarly would you do it for the
24 other two numbers as well. If I multiplied -- if it is
25 100 years for 4×10^{-7} it would be approximately 200



1 years presumably if the model had been run at
2 8×10^{-7} ?

3 A. This is a very crude
4 approximation.

5 Q. If it was 8×10^{-8} , again it would
6 be something in the order of $5.7 \times$ whatever that factor
7 of 100 over 171 is?

8 A. It is not quite as simple as that.

9 Q. But you can work that out for us?

10 A. I can, but you are assuming the
11 head stays the same which is not correct.

12 Q. I want you to assume that?

13 A. Okay.

14 MR. LANCASTER: I think we had better
15 mark this, this tear sheet will be B-502.

16 ---EXHIBIT NO. B-502: Tear Sheet

17 MR. McQUAID: Q. Simply put,
18 Dr. Charlesworth, if the hydraulic conductivity of the
19 upper till was at a lower number ...

20 DR. CHARLESWORTH: A. Yes.

21 Q. ... you would multiply the time to
22 reach by some factor?

23 A. Yes.

24 Q. Of the nature we see on B-502;
25 correct? I have given you the assumption it is



1 1.4 x 10⁻⁸.

2 A. You would take the portion of the
3 time it takes to get through the two units and you
4 would multiply the portion -- you would take the time
5 it gets through the two units and you would be
6 multiplying the time it gets through the upper portion
7 by those factors and the bottom part of the flow path
8 presumably would not change.

9 MR. HODGSON: Mr. Chairman, if B-502 is
10 going into evidence it would be useful since we have
11 already had a correction, but six times 28.57 equals
12 171 and since it is mathematically correct but
13 conceptually wrong can we put a line through it so the
14 document does not reflect an error?

15 MR. McQUAID: That is fine.

16 DR. KINGHAM: So what you are left with
17 is a flip chart of the ratio of hydraulic
18 conductivities?

19 MR. McQUAID: That is right, sir.

20 Q. Just so we are clear this is not
21 changing any of the other assumptions Dr. Rowe had
22 which was complete failure for whatever period of time
23 we are talking about, isn't it, and no collection of
24 leachate.

25 DR. CHARLESWORTH: A. This is just a



1 addressing one parameter.

2 Q. Taking the 100 years as the figure
3 he had analyzed. If in fact in case 8 we changed the
4 hydraulic conductivity to 1.4×10^{-8} and assuming his
5 approximation of 100 years is correct as opposed to the
6 171 we have crossed out, would this not indicate to you
7 as a hydrogeologist that you would have at 100 years
8 approximately, assuming complete failure, given those
9 other parameters, you would have contaminant leachate
10 reaching the boundary?

11 A. Yes, subject to -- in general
12 terms, yes.

13 Q. Let me turn to another area,
14 Dr. Charlesworth. In your report, and I think this is
15 one we can get rid of because there wasn't really much
16 evidence you offered in terms of evidence in chief
17 about it, but in the back of the document, M-438, you
18 have -- the second last page is the extent of the silt
19 layer?

20 A. Yes.

21 Q. Dr. Rowe indicated when he gave
22 his evidence that it really was of little significance
23 in the modeling of time and flow?

24 A. Yes. I remember that is what
25 Dr. Rowe said.



1 Q. You gave Dr. Rowe the numbers he
2 used, isn't that correct?

3 A. No. He took the data from the
4 Trow report.

5 Q. Then you don't disagree with those
6 numbers. Would that be a more accurate way to put it?

7 A. All the numbers Dr. Rowe modeled,
8 he did ranges, but he re-did the Trow idealized
9 scenario for his modeling and had the same kind of
10 generalizations Trow did in their model.

11 Q. Is it not correct as well on his
12 document he also when he did his own modeling used the
13 silt layer and applied the same numbers as in the Trow
14 model?

15 A. Yes, that is my understanding.

16 Q. You don't disagree with those
17 numbers, do you?

18 A. I don't disagree with them as a
19 modeling scenario, no.

20 Q. Do you disagree with them from a
21 hydrogeological perspective as to their significance?

22 A. I don't think that the upper silt
23 unit is very significant.

24 Q. It is not significant from a
25 hydrogeological perspective respecting contaminant



1 transport, is it?

2 A. I don't think it is. Obviously
3 there is the potential for some movement along it under
4 certain scenarios, but I would not be too concerned
5 about it.

6 Q. I want to give you a couple more
7 documents to give you a chance to examine them over the
8 weekend. We have had a considerable amount of
9 discussion regarding the hydraulic conductivity of the
10 waste or refuse itself?

11 A. Yes.

12 Q. As I understand it in your exhibit
13 you had two references which Dr. Rowe used and they are
14 references 7 and 8, M-438, and there was reference 7
15 and I think Mr. Tidball asked you about reference 7 and
16 there is one reference in the appendix you identified
17 for him?

18 A. There was one value in there.

19 Q. In an appendix?

20 A. Of 7? I think it is an appendix,
21 yes.

22 Q. In the case of reference 8, do you
23 actually have a statement there and it is a reference
24 there or a range?

25 A. My recollection, and I don't have



1 it handy, but there is a range which they say is from
2 field tests and published data.

3 Q. Do you understand those field
4 tests would be the reference we see where it says the
5 investigation of leachate contamination found in ground
6 and surface waters at the Fresh Kills Landfill in New
7 York City?

8 A. Yes.

9 MR. McQUAID: This is the Fresh Kills
10 Landfill. We both inherited that name.

11 Q. There are two documents here or
12 portions of two documents and I will give you the
13 complete report. I think we could mark this and if
14 there is anything to be added as a result of
15 Dr. Charlesworth's review over the weekend, we will
16 attach to the exhibit on Monday if that would be
17 appropriate.

18 MR. LANCASTER: Whatever occurs. B-503.

19 ---EXHIBIT NO. B-503: Excerpt from Volume 1 of
20 Hydrogeological Report Re:
Fresh Kills Landfill, N.Y.

21 MR. McQUAID: Q. I didn't want to hand
22 you these full reports and have you guess what we were
23 getting at, so I want to direct your attention to the
24 sections which we have reproduced and then I will give
25 you the full reports over the weekend and if there is



1 anything you feel should be added to this I want you to
2 let us know on Monday?

3 A. Yes.

4 Q. Or Tuesday.

5 A. Yes.

6 Q. Just so you have the background,
7 the evidence of CRA will indicate that they have been
8 retained on certain aspects of the Fresh Kills landfill
9 site and to give some evidence and we have the reports
10 which I have put in front of you and we have those
11 reports for your examination, but I have asked the
12 consultants to go through the two reports and halfway
13 through this exhibit you will find reference to the
14 Brookfield Avenue landfill. When you are reading the
15 document, and actually let me refer you to page 1-1 and
16 I can highlight the first paragraph and give the
17 context to everyone and the context for you when you
18 are looking at these documents, but looking at the
19 introduction:

20 "This report presents the results of a
21 detailed hydrogeological investigation
22 of the City of New York's Fresh Kills
23 Landfill. The landfill site comprises
24 an area of approximately 3000 acres
25 within the Borough of Staten Island,



1 Richmond County, New York (Figure 1) and
2 consists of ten distinct mounds of
3 refuse which are, in general, bounded by
4 tidal streams and associated wetlands."

5 You will see a figure, and it is not Figure 1, but
6 Figure 13 three pages -- behind page 4-32, and in the
7 middle of that you will see a reference to Brookfield
8 Avenue. The second portion of the report, the fourth
9 page in, and they are switching copies on me here, but
10 you will see the fourth page in from the beginning ...

11 MR. ESTRIN: It is 4-32 near the
12 beginning. I have two pages 4-31 and they are
13 different.

14 MR. McQUAID: Q. It is two reports.
15 What I wanted to explain is that there is a second
16 report which you will find about half-way in entitled
17 "Brookfield Avenue Landfill".

18 DR. CHARLESWORTH: A. I have found
19 that.

20 Q. That is apparently -- it is either
21 sections 9 and 10 or 10 and 11 of the Fresh Kills
22 Landfill and they are contiguous.

23 A. Sections 10, 11 and 12?

24 Q. If you look at the Brookfield one,
25 and I am sorry we don't have the pages numbered, but



1 after the first page, 4-35 you will see the beginning
2 of the Brookfield Avenue Landfill?

3 A. Yes.

4 Q. And if you go over to page --
5 unfortunately it is numbered on the third page under,
6 the introduction to that report, and this explains the
7 first paragraph. The Brookfield, the second sentence:

8 "The landfill site comprises an area of
9 approximately 112 acres within the ..."

10 It describes where it is in New York:

11 "...and is the southeasternmost refuse
12 disposal area of the Fresh Kills
13 Landfill. The Brookfield Avenue Landfill
14 consists of sections 10 and 11 of the
15 Fresh Kills site."

16 A. Right.

17 Q. The first report is the entire
18 site and the second is sections 10 and 11?

19 A. All right.

20 Q. What I would like you to look at
21 and I will give you the full reports and they are quite
22 voluminous as you will see, but is -- I refer to page
23 4-34, the first page, the first section.

24 A. The first section? 4-34 which is
25 a table, Table 4.



1 Q. It has a page number at the
2 bottom?

3 DR. KINGHAM: It is two pages later
4 than that and the enumeration begins at the bottom.

5 MR. McQUAID: Q. I will read from the
6 first full sentence on that page. Do you have it?

7 DR. CHARLESWORTH: A. Yes.

8 Q. The first sentence and you have to
9 go back to understand, but I want you to concentrate on
10 this and the purpose of looking through the reports is
11 to determine whether there is any other portions of
12 these reports which should be included in this exhibit:

13 "As can be seen from the data presented
14 in Table 4, the calculated waste
15 permeabilities are similar and range
16 from 1.93×10^{-3} to 6.6×10^{-2} cm/sec.
17 While these values may appear to be
18 higher than typically reported in the
19 literature (i.e., 1.1×10^{-3} cm/sec as
20 an average) they do appear reasonable
21 for the Fresh Kill site. More
22 particularly, waste deposition during
23 the early part of the operation of the
24 site took place without compaction with
25 the waste face advancing into the marshy



1 areas to provide firm support. This type
2 of operation would yield loose,
3 relatively permeable waste."

4 I draw that to your attention because they seem to be
5 studying at this page and at the page back at 4-33, the
6 permeability of the Fresh Kills Landfill site?

7 A. Right.

8 Q. Then if you go over to the next
9 portion of the report, Dr. Charlesworth, at 4-30 you
10 will see in the first paragraph on 4-30 a repetition
11 basically of the same conclusions I have just referred
12 to on 4-34, the very -- I guess the fifth page from the
13 back, or the fourth page from the back.

14 Now, I am going to hand you these
15 reports and what I would like you to do, we have tried
16 to take those portions of those four reports I am
17 handing you and to just take those that have any
18 reference at all to the permeability, I am sorry, the
19 hydraulic conductivity of the refuse itself. If there
20 is anything that should be added I would you like you
21 to let us know on Monday.

22 A. I shall look forward to reading
23 them, but I don't relish carrying them.

24 Q. I understand that. Just let me
25 ask this; this report, the sections I have given you



1 would seem to suggest that the range they actually
2 calculated in these portions are from 1.93×10^{-3} to
3 5.1... I am sorry, I am on the second page and the
4 range was wider in the other one. It is 1.93×10^{-3} to
5 6.6×10^{-2} and that is page 4-34 and that is what it
6 seems to indicate?

7 A. 1.93×10^{-3} that is what that
8 seems to indicate.

9 Q. You can produce the table?

10 A. From the reference?

11 Q. Right.

12 A. Yes.

13 Q. Would you agree as a
14 hydrogeologist if you had a choice between the table
15 reference you indicated and the actual report that you
16 would feel more comfortable relying on the actual
17 report as to what the conductivities were found to be?

18 A. Yes. I would like to have the
19 reports rather than -- even just this short part.

20 Q. Even that, but your reference I
21 gather was just a summary of that or a reference of an
22 appendix or something of that nature?

23 A. It would appear to be, but
24 obviously I would have to read the report.

25 Q. It was a conference paper.



1 A. Yes.

2 MR. ESTRIN: Mr. Chairman, I think
3 Mr. McQuaid indicated that CRA was the consultants?

4 MR. MCQUAID: They were consulted on
5 certain aspects.

6 MR. ESTRIN: The reference now our
7 people have had and I have copies if anyone wants it,
8 but the reference, one of Dr. Charlesworth's references
9 is a paper, and anyone here can have it if they want
10 it, but the appendix where the Fresh Kills values are
11 taken from says estimates of permeability are based in
12 part on field tests for previous investigations at the
13 site. What I am wondering, and this is a 1982
14 presentation...

15 MR. MCQUAID: This is '83.

16 MR. ESTRIN: I am wondering if his
17 consultants have access to any of the previous
18 investigations which established the numbers
19 Dr. Charlesworth has been provided with and perhaps
20 they could produce them so we have all the data.

21 MR. MCQUAID: Q. We will worry about
22 that and Mr. Estrin and I can discuss that.

23 Q. Look at those reports,
24 Dr. Charlesworth, and I will ask you some questions?

25 DR. CHARLESWORTH: A. Certainly.



1 Q. Just one other document I want to
2 give to you to ask you to look at. Could I ask it be
3 marked as the next exhibit?

4 MR. LANCASTER: B-504.

5 ---EXHIBIT NO. B-504: Technology Transfer Conference
6 December 1, 1987

7 DR. ROWE: Could I ask when you are
8 handing out documents if I could have a copy?

9 MR. McQUAID: We will certainly get
10 you a copy at the end of the day.

11 Q. Dr. Charlesworth, this is noted as
12 being a paper delivered at the proceedings of the
13 Technology Transfer Conference, November 30 to December
14 1, 1987 and you will see the sponsorship of Environment
15 Ontario and so on. Are you familiar with that
16 conference?

17 DR. CHARLESWORTH: A. Yes.

18 Q. Have you seen this document
19 before?

20 A. Yes. But the date seems wrong. I
21 think I must have seen a draft or something. Or maybe
22 I am just losing track of time.

23 Q. What date did you have on the one
24 you had?

25 A. I don't know but it seems to be
earlier than November that I saw it. I am not sure. I



1 will check.

2 Q. I would refer you to the actual
3 content of the document. Since you have seen this
4 before we may not need to take too much time, but just
5 so I could get your understanding of it at this
6 particular point in time, first of all, can you confirm
7 that this is the result of a study which Dr. Cherry and
8 others seem to be undertaking to determine the
9 subsurface migration of contaminants through fractured
10 shale; is that correct?

11 A. That is correct.

12 Q. They describe in the introduction
13 first of all in the first sentence that this has become
14 an important consideration in the assessment of water
15 quality, the first sentence?

16 A. Yes.

17 Q. And they go on to indicate in a
18 sentence about midway down and they are referring to
19 the various sediments in the Oakville/ Mississauga/
20 Burlington area and you see those and they are
21 referring to sediments in the Queenston shale and the
22 Golden Horseshoe area, correct?

23 A. Yes, they are referring to various
24 rocks in that general area.

25 Q. Then there is a sentence just



1 after the description which says:

2 "Because fractured shale with low matrix
3 permeability underlies much of these
4 industrialized regions, it is probable
5 that fractures will play an important,
6 if not dominant role, in providing
7 pathways for subsurface migration of
8 toxic contaminants."

9 You would agree with that?

10 A. Yes.

11 Q. "This leads to the expectation
12 that very large contaminant plumes can
13 develop within fractured shale under
14 conditions of relatively low contaminant
15 mass flux into the shale."

16 Would you agree with that?

17 A. I am just reading it. It could
18 lead to that expectation.

19 Q. "Consequently, landfills and
20 industrial sites situated on fractured
21 shale can produce large plumes of
22 contaminated groundwater that extend
23 over considerable distances."

24 As a general statement you would agree?

25 A. A general statement, yes.



1 Q. Then it talks about risk
2 assessments:

3 "Risk assessments for the design,
4 siting, or clean up of such sites
5 require that hydrogeologic models be
6 used to estimate the extent and rates at
7 which contaminants may migrate from the
8 site to the accessible biosphere. The
9 most important step in predicting the
10 extent to which groundwater
11 contamination could occur is the
12 determination of the average velocity of
13 the non-reactive contaminants."

14 You have no disagreement with those statements?

15 A. To the extent, yes, I think it is
16 a reasonable statement.

17 Q. "In groundwater investigations,
18 however, the greatest difficulties and
19 uncertainties in measuring and modelling
20 groundwater velocities occur in
21 fractured rock."

22 MR. ESTRIN: Mr. McQuaid indicated he
23 was going to give this document to Dr. Charlesworth
24 over the weekend and I think he should certainly have
25 that opportunity.



1 MR. McQUAID: Q. Can you not tell me as
2 a general proposition, Dr. Charlesworth, whether you
3 agree with that or not as a statement at this point?

4 DR. CHARLESWORTH: A. Yes. It is a
5 general statement that most hydrogeologists have
6 subscribed to.

7 Q. The article goes on to describe
8 the experiment. There is an experiment ongoing I
9 gather to try and determine how you measure the key
10 parameter of fracture, aperture and fracture spacing;
11 is that what you understand?

12 A. I don't remember and I don't think
13 it is the same paper, but I was aware of some work they
14 were doing at the Clarkson Refinery site, but it
15 doesn't seem to be the same document I looked at, but I
16 would have to check.

17 Q. You may not have read this actual
18 paper?

19 A. I may not have read this actual
20 paper, but it relates to the same work.

21 Q. Bear with me, because I have a
22 question for Dr. Rowe as well. At page 12 in the
23 middle of the last paragraph, you see the formula No.
24 8?

25 A. Yes.



1 Q. About three-quarters of the way
2 down in the middle of the paragraph it says:

3 "To our knowledge, no record of a
4 successful natural gradient tracer test
5 in fractured rock exists in the
6 literature."

7 I wanted to ask you at this point is that your
8 knowledge as well or your experience?

9 A. I would have to look at the
10 overall context.

11 Q. This article seems to suggest that
12 this is the first test or experiment of this kind and I
13 wanted you to confirm whether Dr. Cherry is right or
14 the group is right in saying that that is the case or
15 not?

16 A. I will read the document with that
17 in mind.

18 Q. Then, Dr. Rowe, could I ask you,
19 have you ever seen this document before?

20 DR. ROWE: A. I don't believe I have.
21 This conference is usually an update on research that
22 is ongoing and like Dr. Charlesworth I thought I saw a
23 paper which was an earlier update but not this
24 particular one.

25 Q. A paper on the impending



1 experiment?

2 A. That's my recollection.

3 Q. Can you tell us to your knowledge
4 whether or not there is any record of successful
5 natural gradient tracer test in fractured rock in the
6 literature or did you leave that to Dr. Charlesworth?

7 A. I didn't look for that
8 specifically, the natural gradient tracer test, no, I
9 did not.

10 Q. Would that be an area you would
11 defer to Dr. Charlesworth on?

12 A. The natural gradient tracer test?

13 Q. Yes, in fractured rock?

14 A. In fractured rock, either of us
15 could look.

16 Q. You aren't able to contradict that
17 particular statement?

18 A. I am not able to contradict that
19 statement, that is correct.

20 Q. I think we can leave it at that
21 point and let you examine that over the weekend and we
22 can return to that some time on Monday.

23 MR. LANCASTER: Weather permitting at
24 9:30 in the morning.

25 ---Adjournment at 3:50 p.m.



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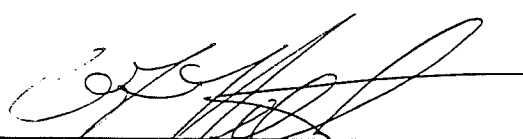
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