

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 54 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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WITNESSES:

1 ANTHONY J. CRUTCHER (Resumed)
2 JOHN M. PETRIE (Resumed)
3 Cross-examination by Mr. Hodgson (Cont'd) 28906
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Management, Minister's File No. OPC-0026;



Nethercut & Co. Ltd.

Toronto, Ontario

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(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:

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BEFORE: H. H. Lancaster, Q.C. - Chairman
Dr. D.J. Kingham - Member



Nethercut & Co. Ltd.

Toronto, Ontario

Hearing conducted at The Oakville
Granary Commercial Centre, 105 Robinson
Street, Oakville, Ontario, on
Friday, April 8, 1988

VOLUME 120

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
		Investments Limited and
		Topic Investments
4	J.H. Olah	for the Halton Region
5		Conservation Authority

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185 Richmond St. W.
Toronto, Ontario
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Per: C. F. Nethercut, C.V.R.



--- Upon Commencing at 9:30:

1 MR. LANCASTER: Good morning, thank
2 you, please be seated.

3 ANTHONY J. CRUTCHER (Resumed):

4 JOHN M. PETRIE (Resumed):

5 MR. FEENSTRA: I don't have any
6 questions.

7 MR. CRUTCHER: Are we done?

8 MR. FEENSTRA: No, I mean I just don't
9 have any questions.

10 MR. HODGSON: Mr. Chairman, and
11 Dr. Kingham, we have completed a response to a request
12 made by Dr. Kingham some time ago concerning
13 infiltration at the sites in question and let me
14 indicate in advance that we have completed half the
15 assignment and we have deliberately omitted half the
16 assignment. As I recollect the request, Dr. Kingham,
17 you indicated from your recollections from the evidence
18 that various investigators had suggested various
19 infiltration rates and you were having some
20 difficulties relating the various numbers being
21 suggested and you thought it would be appropriate if we
22 could find some way of assimilating those numbers.

23 We have prepared tables which assimilate
24 numbers, but what you will not find is any reference to
25



any investigators. It was my personal view that putting that on this document was really part of the argument and I couldn't see how I could put that on a document and fairly put it to a witness and have a witness confirm that that was somebody else's evidence.

DR. KINGHAM: This will be useful as it stands, I think and we can read the record, and we have made notes and now we can deal with Site F exfiltration, so many millimetres based on 50 hectares and make that into gallons per day if we want or whatever we want to use it for. I just wanted to make sure we didn't miss-use the information.

MR. HODGSON: I think we can all refer back to this and I will be cross-examining on some aspects of exfiltration and I think it will be possible to relate numbers quite usefully back to this document.

MR. LANCASTER: We will mark this H-690.

---EXHIBIT NO. H-690: Chart-"Infiltration Rate Conversions"

MR. McQUAID: Could I interrupt to make a small observation. When we talked about tank trucks many months ago, somebody gave me the estimate that they were 4000 gallon per day -- you have 4000 on there. It was 6000 when I saw it?

MS. CRONK: I should be one who should be objecting because I was using a different size tank



truck and now you are objecting.

1 MR. McQUAID: All right.

2 MS. CRONK: I have not left yet.

3 MR. HODGSON: We would be happy if Ms.
4 Cronk would put in her order quickly while the computer
5 is still here, we would be happy to amend the menu.

6 MS. CRONK: I will take it up with the
7 expert.

8 MR. HODGSON: You will note there are
9 more columns on the page and we haven't put in cubic
10 schools or cubic hospitals of leachate yet, but
11 undoubtedly somebody will want that kind of evidence
12 before we are finished, probably toward the end of the
13 day that kind of a request will be made.

14 MR. LANCASTER: Can you measure it by
15 the handful?

16 DR. KINGHAM: Thank you.

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

18 Q. Mr. Petrie -- and I might note we
19 didn't number the pages, and Mr. Feenstra's magical
20 machine does everything but number pages so perhaps we
21 could agree that the Burlington landfill site is page 1
22 and the Bayview landfill site is page 2, Site F is page
23 3 and Site D is page 4, and would that be satisfactory?

24 MR. LANCASTER: Fine.

25 MR. HODGSON: Q. Mr. Petrie, if we



1 could go back to the subject of models for a moment --
2 just for a moment, but for a while. I believe it has
3 been your evidence that there is some question as to
4 the utility of using an equivalent porous media model
5 to model a site where most of the media are fractured
6 rock rather than equivalent porous media; is that
7 correct?

8 MR. PETRIE: A. If a site is fractured
9 and recognizing that the geometry of the fractures have
10 not been defined, then the question arises can you use
11 a model which does not consider the fracture geometry
12 being an equivalent porous media one, I believe that is
13 what you meant, and I do have a question as to how
14 applicable that is.

15 Q. You have given some considerable
16 amount of evidence about the pumping tests performed at
17 Site F, about the three pumping tests performed at Site
18 F?

19 A. Yes.

20 Q. In fact you have drawn some
21 conclusions from the results of your analyses of those
22 pumping tests which you have used in your infiltration
23 calculations?

24 A. Yes.

25 Q. Namely, that the bulk horizontal



1 hydraulic conductivity of the fractured shale is $2 \times$
2 10^{-4} ?

3 A. Correct.

4 Q. Do you feel comfortable using the
5 number of 2×10^{-4} and do you feel comfortable that
6 that is a useful and appropriate conclusion to derive
7 from the pumping tests?

8 A. It is the calculated hydraulic
9 conductivity from the test data.

10 Q. Would you agree with me,
11 Mr. Petrie, that the Theis method of analyzing pumping
12 tests is a method developed for equivalent porous
13 media?

14 A. Correct, it is.

15 Q. The Jacob method for analyzing
16 pumping tests is a method for analyzing equivalent
17 porous media?

18 A. It is.

19 Q. Notwithstanding that those methods
20 of analysis were developed for one media, you feel
21 comfortable transposing them for use in a different
22 media?

23 A. I believe I qualified it in some
24 sense in the report, or in chief, where I said I felt
25 difficult transposing it directing to some of those



1 wells for which a very small drawdown was recorded and
2 I felt it inappropriate to use the Theis or Jacob and a
3 small drawdown leads to a high transmissivity and a
4 high permeability and my concern with a small drawdown
5 is that I felt it reflected a less direct fracture
6 connection. Were I to have taken the figures as they
7 stand in H-40A, I would have calculated a much higher
8 hydraulic conductivity. While I have used a method
9 developed for equivalent porous media, I used it with
10 some caution.

11 Q. Would you agree with me that in
12 using a computer model such as Flonet for an equivalent
13 porous media that it would also follow that one should
14 use it with some caution?

15 A. Yes.

16 Q. Going back to page 129 of B-617,
17 you say:

18 "The hydraulic conductivities of the
19 calibrated models are non-unique."

20 If we flip ahead in this document to page 137, we have
21 an echo of that conclusion in the first full paragraph
22 under the heading "Conclusions":

23 "CRA concludes that the modeling of Site
24 F will not produce a unique solution due
25 to various possible hydrogeological



1 interpretations."

2 Now, would you agree with me going back to the comment
3 on page 129 that not only are the hydraulic
4 conductivities not unique, but it is possible to run
5 the model with non-unique, to use your expression,
6 stratigraphic layers?

7 A. Do you mean to vary the hydrologic
8 conductivity within a layer?

9 Q. I mean one can take out a layer
10 and run the model by taking out a layer?

11 A. You must keep the same number of
12 grids in the system. You mean to change the properties
13 of a layer so it matches that of another layer?

14 Q. Yes.

15 A. Yes. You can do that.

16 Q. If you have a definition of a
17 layer with certain properties at X and certain
18 properties at Y, you can move the whole thing up?

19 A. Yes, and then you would have to
20 insert something in the space, so to speak.

21 Q. The point is you can move
22 everything around when you are modeling, can't you?

23 A. Yes.

24 Q. Would you agree with me that when
25 you ran a whole new set of runs on your computer of



1 cases 1 through 11, that you maintained the layering
2 system, as it were, that it was your belief Trow had
3 used when they ran their model 1 and model 2?

4 A. We were given the model and so we
5 ran it and I don't believe it is a belief that Trow
6 used it because that is the input data Trow provided to
7 us.

8 Q. Notwithstanding that you
9 discovered their error as to the mislocation of the
10 highly fractured zone, you ran it with the highly
11 fractured zone dislocated?

12 A. We ran it with the highly
13 fractured zone in the same place Trow had run with the
14 highly fractured zone. Now, I wanted to make an
15 additional comment on that. I was thinking over the
16 evening what would have happened had we run with the
17 highly fractured shale in the position that Trow have
18 plotted it. If one can turn to page 54, I can give you
19 some ideas of what may have happened.

20 I recall my rationale at the time for
21 not changing the layers was I wanted to be able to
22 compare our model results to Trow, and that was the
23 intention of doing the sensitivity analysis and not
24 trying to redefine the site in any way, shape or form.

25 With reference to the figure on page 54,



1 if one was to raise the dark brown layer which is
2 indicated in the legend ...

3 Q. What page are you on?

4 A. 54, the coloured figure.

5 Q. If one was to raise the dark brown
6 layer, that is where you were?

7 A. Correct, the highly fractured
8 shale unit, you would move it up an equivalent distance
9 and the geometries of the system are fixed in some
10 fashion so you would move it up one complete layer and
11 it would then be essentially 10 metres higher than its
12 current position and in essence straddle that which is
13 shown in the background to this figure as the highly
14 fractured shale.

15 What that would suggest, were you to do
16 that, is that you would not have downward gradients
17 between piezometer 2 and piezometer 1 at HC5 and you
18 would probably not have very strong downward gradients
19 between piezometer 2 and piezometer 1 at HC4. Putting
20 that drain layer higher you would probably draw more
21 water into the system because there would be a shorter
22 flowpath through the weakly fractured massive shale,
23 unit 3, and you would probably have -- you would have
24 more steep gradients -- I beg your pardon, you would
25 have less steep gradients in places where I believe we



1 see strong gradients, and I think you would find a
2 strong pronounced gradient change within the system and
3 that would probably be a much more poor fit of the
4 field data.

5 Q. Mr. Petrie, I think in every one
6 of the sentences you used to describe that situation,
7 you used the word "probably"?

8 A. I have not done it so I can't
9 tell.

10 Q. You don't know?

11 A. I cannot, but I am giving you my
12 opinion as to what would probably happen.

13 Q. You don't know?

14 A. I do not.

15 Q. It is purely speculative on your
16 part to suggest what might happen without doing it?

17 A. It isn't purely speculative.

18 Q. It wouldn't be a lot of trouble to
19 do it, and it would not have been a lot of trouble for
20 CRA once they had all the software loaded into this
21 system and all the input data from Trow, it wouldn't
22 have been a whole lot of trouble to change the nodes
23 around so the highly fractured shale fell into the zone
24 defined as highly fractured shale?

25 A. That would be an advantage to this



1 process and we can undertake to do that.

2 Q. In fact just thinking about this
3 situation we have at Site D, your firm, is it fair to
4 say, were concerned about the hydraulic conductivity
5 assigned to the unweathered till at Site D?

6 A. Our concern arose not specifically
7 from the word that Trow did, but in the work provided
8 by Milton where they provided estimates of one order of
9 magnitude higher and that prompted our concern for
10 demonstrating that the till was indeed a low permeable
11 unit.

12 Q. Mr. Petrie, would you agree with
13 me that you didn't learn about Milton's concern until
14 you read the reports produced by Dr. Charlesworth and
15 Dr. Rowe?

16 A. I believe in part, and I am
17 recalling in cross-examination, I believe points were
18 put to Mr. Sobanski to the effect that the till
19 permeability could be much higher than he had
20 indicated.

21 Q. That is when your concern arose?

22 A. I believe that to be the case.

23 Q. You collected samples from Trow?

24 A. Yes.

25 Q. You sent them to Golder's and had



1 triaxial tests done on them?

2 A. We did.

3 Q. After Dr. Rowe and

4 Dr. Charlesworth left the witness box, you took a
5 drilling rig out to Site D and cored a new hole and
6 got a new sample of till and had another triaxial test
7 done?

8 A. We did.

9 Q. Would you agree with me, that
10 where your firm is concerned about where the weight of
11 the evidence stands on an issue of vital importance to
12 this hearing, your firm is prepared to stand -- your
13 firm is prepared to go to a lot of trouble and a lot of
14 expense to make sure that the best evidence is before
15 this Board?

16 A. With respect to expense, we spent
17 more effort, I suspect, in reviewing this model. As I
18 indicated yesterday, the model may only occupy five
19 portions of the test you referred to, but I have
20 referred to additional portions which show that the
21 model seemed to provide a basis for a lot of the
22 conclusions drawn by Trow and we wished to review the
23 model to see if those conclusions could be
24 substantiated by the work undertaken by Trow, and we
25 came to the conclusion that they could not. We were



1 not in the position of redefining the site and it is
2 our opinion we could not define the layers in the site
3 such that they could be realistically modelled.

4 Q. I accept your evidence that you
5 spent more money on the modeling than you did on the
6 triaxial testing. I suggest as well that it wouldn't
7 have been very much trouble having discovered
8 Mr. Sobanski had made a mistake in his modeling for you
9 to have corrected it so this Board would have the best
10 evidence as to how this model interpreted this site?

11 A. I agree and, as I intimated to you
12 earlier, based on my recollections of thinking it
13 through last night, it was my opinion that to do so
14 would imply that one could define this site in some
15 fashion, and I am not undertaking to do that. I can
16 undertake to do it quite easily over the weekend, and
17 we could run that with the drain in a more appropriate
18 position; if that would be of interest to yourself, we
19 can do so.

20 Q. I think it would be a useful
21 exercise for us to have that data on both model 1 and
22 model 2 and I don't want an opportunity to cross-
23 examine further, but I am sure that somebody will be
24 able to test the evidence.

25 Now, Mr. Petrie, could we please turn to



1 page 131. Mr. Petrie, what we see on page 131 is a
2 coloured-up representation of the stratigraphic inputs
3 and the K inputs to what is called the CRA calibrated
4 hydrostratigraphy?

5 A. That is what we see.

6 Q. I suppose it would have been
7 possible -- no, let's just continue to look at this
8 page for a moment. Can we compare, please, what is
9 being modelled by CRA with what was modeled by Trow?
10 Starting with the on-site till, that is the red
11 material; correct?

12 A. I believe so, yes.

13 Q. And till -- "and till" -- Trow
14 modelled that till with a K of 1×10^{-7} ?

15 A. Yes, I believe so.

16 Q. And you modelled it ...

17 A. We did not change the value.

18 Q. We hold that constant. They
19 modelled the weathered shale at 1×10^{-5} ?

20 A. They measured the weathered shale
21 where they thought it was at 1×10^{-5} , yes.

22 Q. That is your green stuff?

23 A. The green material shown has a
24 hydraulic conductivity of 1×10^{-5} , yes.

25 Q. You modelled that at 1×10^{-5} and



1 they modelled that stuff at 1×10^{-5} ?

2 A. I am not sure we have exactly the
3 same geometry, I don't recall.

4 Q. Let's assume the geometries are
5 somewhat similar, but I am not suggesting they are
6 identical. This is the material that you have been
7 telling us for three weeks now has a bulk horizontal
8 conductivity of 2×10^{-4} ?

9 A. Yes.

10 Q. Why does it have a conductivity of
11 1×10^{-5} in this model?

12 A. Because I indicated to you and the
13 Board in chief that we set out to undertake this
14 modeling to reproduce the observed hydraulic gradients
15 at both on-site and off-site well nests. I believe
16 prior to this time in the report we have already
17 expressed our uncertainties with regard to using an
18 equivalent porous media model in fractured shale rock.

19 We simply said the modeling can be done
20 a little better in order to reproduce the gradients
21 and, having done that, we said it doesn't necessarily
22 confirm the hydrostratigraphy in any way, shape or
23 form. We have indicated it is non-unique and different
24 sets of hydraulic conductivities have been entered in
25 in order to reproduce the gradients.



1 Q. I could have sworn you told me
2 yesterday that when an experienced competent
3 hydrogeologist sets about in a modeling exercise he
4 takes the data generated in the field and interprets
5 that data to develop the hydrostratigraphy and then he
6 sets about modeling?

7 A. That is not what we did.

8 Q. You have interpreted the field
9 data to tell us that that green stuff has a bulk
10 hydraulic conductivity of 2×10^{-4} and I want to know
11 why if it is 2×10^{-4} you modelled it at 1×10^{-5} ?

12 A. We did not -- let me back up. At
13 this point in the report we felt the site could not be
14 defined and were merely undertaking an exercise; in
15 having reviewed the Trow model, could different geology
16 be input to reproduce the gradients more effectively
17 and we have demonstrated that it could. I believe we
18 conclude in this section that we feel it doesn't
19 confirm the hydrostratigraphy at the site in any way
20 shape or form.

21 Q. The weakly fractured shale, that's
22 the brown stuff, and you have assigned it -- Trow
23 assigned it a hydraulic conductivity of 1×10^{-7} and
24 you have given the brown stuff a hydraulic conductivity
25 of 2.2×10^{-7} ?



1 A. 2.2×10^{-7} and the brown has that
2 value.

3 Q. Those are virtually the same
4 value, are they not?

5 A. Yes.

6 Q. The highly fractured shale, I
7 guess that's the blue stuff, they gave it a hydraulic
8 conductivity of 1×10^{-3} and you have given it a value
9 of 8.1×10^{-4} ?

10 A. The blue layer has a hydraulic
11 conductivity of 8.1×10^{-4} .

12 Q. I have a very distinct
13 recollection that on the first week in which you were
14 giving evidence in these proceedings, you told us that
15 that layer could not have a hydraulic conductivity
16 higher than 10^{-5} ?

17 A. Correct, and I have not sought in
18 this exercise to reproduce the field hydraulic
19 conductivities at all. At this point in the report we
20 have expressed concern, and I don't believe that model
21 can be adequately used to assess the site. Part of the
22 difficulty is a function of the grid spacing. The grid
23 spaces are 10 metres apart in general and they diminish
24 going from left to right, or north to south, across the
25 site.



1 With such a coarse grid, one cannot
2 reproduce adequately the data on-site in any fashion
3 that I believe supports the hydrostratigraphic
4 definition of the site. We merely sought to
5 demonstrate that by changing some of the values we
6 could reproduce the gradients more effectively and,
7 having done so, we said this does not confirm the
8 hydrostratigraphy of the site.

9 Q. The discharge zone till, they
10 assigned a K value of 3×10^{-6} and you have assigned a
11 value of 3×10^{-6} ?

12 A. I think the geometries are not the
13 same but I see values of those numbers on page 131,
14 yes.

15 Q. Then we have some new layers, and
16 first of all we have a white layer, and that has a K
17 value of 1×10^{-6} then a yellow layer, and do you see
18 the yellow layer?

19 A. Yes.

20 Q. It is a funny looking layer, but
21 it has a value of 3.6×10^{-7} ?

22 A. It does.

23 Q. Then we have a beige layer and it
24 has a K value of 1×10^{-4} ?

25 A. Yes.



1 Q. Then an orange layer and it has a
2 K of 2.9×10^{-7} ?

3 A. Yes.

4 Q. Now, Mr. Petrie, you told us
5 yesterday that when an experienced competent
6 hydrogeologist models, he models his interpretation of
7 the field data?

8 A. If that is the exercise at hand
9 and I have indicated that that is not the exercise
10 here.

11 Q. Would you agree with me that for
12 the white, yellow, orange and beige layers, you don't
13 have a scrap of evidence to suggest those layers exist
14 at all?

15 A. Quite correct. I am also saying
16 we don't have good evidence to suggest the layers can
17 be defined in any way, shape or form.

18 Q. Mr. Petrie, believe me, we have
19 all heard you give that evidence and we have all got
20 that evidence. Now, Mr. Petrie, I suggest ...

21 MR. McQUAID: In order to answer the
22 question he must make that point again so he can answer
23 your question. He is certainly entitled to do that and
24 you can't cut him off.

25 MR. HODGSON: I don't think I cut him



1 off.

2 MR. McQUAID: The object of that comment
3 which was not a question was to be argumentative and
4 say we have heard you, but if he has to say that, or
5 make that comment again in order to answer your
6 question, he is entitled to do so.

7 MR. HODGSON: Q. Now, Mr. Petrie, let's
8 turn back to page 130. On page 130, the middle
9 paragraph:

10 "It must be emphasized that the
11 calibrated CRA flow model does not
12 confirm the hydrogeological system
13 modelled, but does give a reasonable
14 approximation of the regional
15 groundwater flow system at this site."

16 I take it from that that what you were trying to give
17 us with the model was a reasonable approximation of the
18 groundwater flow system at this site?

19 DR. KINGHAM: Was that not amended on
20 March 24?

21 MR. HODGSON: I am sorry.

22 Q. Does the amendment read:

23 "...approximation of the flow system in
24 the region of the site."

25 MR. PETRIE: A. I have "flow field in



1 the vicinity of the site."

2 DR. KINGHAM: "Flow field in the
3 vicinity of the site."

4 MR. HODGSON: Q. "...but (it) does give
5 a reasonable approximation of the flow
6 field in the vicinity of the site."

7 Then, could I ask you to look at some evidence you gave
8 the very first week of this proceeding. Would you turn
9 up the transcript to page 25515?

10 MR. PETRIE: A. 25515.

11 Q. You will recall, Mr. Petrie, if we
12 turn back just to page 25512 that there was a long
13 discussion about the appropriateness of your giving
14 evidence on the subject of computer modeling. In the
15 course of that conversation Mr. McQuaid asked you a
16 question at 25512:

17 "Q. Mr. Petrie, I wonder if I could
18 ask you to just begin by indicating your
19 role in the preparation of this portion
20 of the report, specifically the section
21 beginning with groundwater flow
22 modelling, and what involvement you had
23 in modeling specifically?"

24 And then you give us a lengthy description of how the
25 modeling came about and your role in it, and you tell



1 us at the bottom of page 25513:

2 "The critique you have before you, being
3 section B.4, relates almost entirely, as
4 I recall, to the applicability of this
5 model to the site. I wish to point out
6 that a groundwater flow model is a tool,
7 and as a hydrogeologist I have to
8 evaluate all the tool at my disposal, in
9 this case this specific tool, i.e., the
10 Flonet model as employed by Trow was
11 indeed incorporated into their report."

12 Et cetera, et cetera. I read that sentence simply to
13 remind you and confirm the evidence you gave me
14 yesterday which is that to the experienced competent
15 hydrogeologist, computer modeling is a tool, and you
16 see it as a tool and you told us on that day that you
17 saw it as a tool.

18 Now, could I ask you to turn to 25515,
19 and here we have the following statement at line 20:

20 "Now, in running the model, one can
21 manipulate a variety of the input data
22 and obviously that manipulation ought to
23 be done in conjunction with a
24 hydrogeologist. That hydrogeologist was
25 myself and the input data that we



1 entered into that model I felt
2 appropriately represented the data that
3 could realistically be used at this
4 site. Thus, we did not run models that
5 we felt did not represent portions of
6 the cycle or cannot be supported by the
7 hydrostratigraphy. That was one
8 exercise of that work."

9 Q. So that was one exercise of that
10 work?

11 A. Could I suggest the word "cycle"
12 might have been "site"?

13 Q. I am happy with that change.

14 A. I don't know what it means, cycle.

15 Q. Court Reporters are nearly perfect
16 and we always tell them they are perfect, but we don't
17 believe they ever are perfect and I don't mind at all
18 having that changed, and we also note the current Court
19 Reporter didn't sign this one -- yes, he did.

20 Mr. Petrie, let's go back and reread a
21 portion of that passage:

22 "Now, in running the model, one can
23 manipulate a variety of the input data
24 and obviously that manipulation ought to
25 be done in conjunction with a



1 hydrogeologist. That hydrogeologist was
2 myself and the input data that we
3 entered into that model I felt
4 appropriately represented the data that
5 could realistically be used at this
6 site. Thus, we did not run models that
7 we felt did not represent portions of
8 the site or cannot be supported by the
9 hydrostratigraphy."

10 Now, Mr. Petrie, you are in the witness box and you
11 have been sworn to tell the truth, the whole truth and
12 nothing but the truth. When you made those statements
13 were they true statements?

14 A. Yes.

15 Q. Are they true statements today?

16 A. I could offer a qualifier to them.
17 They are still true today.

18 Q. Please offer the qualifier?

19 A. Can I just read the text again?

20 We are referencing part C of the document and I note at
21 the top of 25515 that the text of part C is pages 116
22 to 138. There were two exercises undertaken in this
23 portion of the report and one is the sensitivity
24 analysis in which we ran 11 cases, and it was my
25 recollection that in running those 11 cases we selected



1 values for the hydraulic conductivity for those layers
2 that were appropriate.

3 For example, we ran a highly fractured
4 shale unit at 10^{-2} , being Trow's initial number. We
5 ran a weakly fractured shale at 10^{-6} which as I recall
6 was approximately -- a little higher than the geometric
7 mean for the values reported by Trow for the weakly
8 fractured shale unit, and those are realizable values.
9 You will notice that the range of values that we have
10 on page 131; we see the lowest value of 1×10^{-7} and a
11 highest value of 8×10^{-4} and they are also within the
12 range of hydraulic conductivities developed for this
13 site. That is what that statement was intended to
14 reference, that the values input are realizable and
15 perhaps your question relates to are they realizable at
16 the exact point of entry, but we did not attempt to
17 delineate the site in any fashion such in order to
18 model it.

19 Q. Let's go back and rehearse the
20 context. This answer was given in the context of a
21 lengthy discussion to which you were a passive and an
22 active participant about the appropriateness of your
23 giving evidence about modeling and you were defending
24 your right as the hydrogeologist in the witness box to
25 talk about the model in the face of a challenge to your



1 yes, we can reproduce a reasonable flow field. We then
2 said that does not confirm the hydrostratigraphy and we
3 also made some comments to the effect, noting page 136
4 of our document, the last paragraph:

5 "Regardless of the good fit of the
6 hydraulic heads via any of the previous
7 simulations, there can always be errors
8 in some of the calculated nodal values.
9 This is not uncommon in fractured rock
10 media. Hydraulic head distributions
11 within a fractured rock environment are
12 usually very complex, as demonstrated by
13 the WAT multilevel piezometers... it is
14 therefore no unusual to find in
15 fractured rock groundwater moving in
16 different directions from the regional
17 gradients... the various calculated
18 hydraulic heads, regardless of the
19 associated difference between simulated
20 and measured values, may not at all
21 reflect a representative value within
22 the local hydrogeological flow regime.

23 An equivalent porous media model
24 such as FLONET does not incorporate the
25 effects of a complex fracture network.



1 The flow characteristics, as produced by
2 FLONET, cannot accommodate the local
3 complex variations of groundwater flow
4 as seen at this site."

5 I believe we have concluded quite definitively you
6 cannot use this model in the manner it was done in
7 order to confirm the hydrostratigraphy of the site.

8 Q. On page 156 of B-617 there is, to
9 use your word, a schematic representation of a flow
10 model with 15 metres of shale and with a bulk
11 horizontal hydraulic conductivity of 2×10^{-4} ?

12 A. It is not a model.

13 Q. But it is an interpretation of a
14 flow system and you could have modelled it, couldn't
15 you?

16 A. This is a very simplified
17 schematic.

18 Q. It is also --

19 A. One could model it if one so
20 chose.

21 Q. There is also on this page a very
22 simplified schematic interpretation of a flow system
23 with 30 metres of shale with a bulk hydraulic
24 conductivity of 2×10^{-4} ?

25 A. Correct.



1 Q. That is also something you could
2 model?

3 A. Correct.

4 Q. On page 114 we have a third
5 interpretation of the flow system at Site F, the
6 weathered fractured bedrock, a lower permeable --
7 sorry, a less permeable zone and drain or drains and I
8 suggest to you that that, being your third
9 interpretation of the flow system at Site F, is
10 something you could have modelled?

11 A. For a start, the two figures on
12 156 are not hydrogeologic interpretations as I believe
13 you called them. Our conceptualization of the site is
14 on 114. We could not model that because we could not
15 define where the layers are. We couldn't enter into
16 the Flonet model the fracture geometry because we do
17 not know it. The grid for the model as it was
18 developed and used by Trow is approximately 10 metres
19 or about 8 metres as I recall under the site. That
20 grid is far too coarse to be able to reproduce the
21 variable gradients we see under the site.

22 Q. Did you say you couldn't model the
23 interpretation on 114?

24 A. Correct, I don't know where the
25 layers are.



1 Q. I see. So, CRA's interpretation
2 has interpreted the hydrogeology of the site as follows
3 and on page 114 we have your interpretation?

4 A. As we discussed yesterday.

5 Q. You are saying you can't model it
6 because you don't know where the layers are?

7 A. Correct.

8 Q. What is the point then of modeling
9 it at all?

10 A. I haven't modelled the site,
11 Mr. Hodgson.

12 Q. What do I see on page 131?

13 A. You see an attempt by CRA to
14 reproduce the gradients at the site and, as I have told
15 you two or three times this morning, it was in no way
16 an attempt to confirm the hydrostratigraphy of the
17 site.

18 Q. I suggest that what we see on page
19 131 is CRA's and your fourth interpretation of the flow
20 system at Site F?

21 A. You are not correct.

22 Q. With four new fantasy layers
23 inserted?

24 A. That is not correct.

25 MR. CRUTCHER: Could I make a comment?



1 Q. Sure.

2 MR. CRUTCHER: A. The section you were
3 referring to was the section that Ms. Cronk took -- had
4 a lot of questions regarding the expertise of
5 Mr. Petrie on talking about this section. We were
6 initially dealing with part B of the section and at
7 this time we were attempting to discuss ...

8 Q. Just a minute, Mr. Crutcher. Are
9 you standing here now to advise this Board as to how to
10 interpret Mr. Petrie's statements in the transcript?

11 A. Not at all.

12 Q. Please don't, because I don't
13 think that's your right.

14 A. I am trying to explain that I
15 think there is probably a more appropriate section
16 within the transcript if you want to refer to part C
17 which would clarify the position we took in chief on
18 this section and this is not the part in the
19 transcript. That is what I am trying to make clear.
20 We were discussing part B and Ms. Cronk stood up and
21 that is what I was trying to see ...

22 Q. If you are telling me that you are
23 looking at part B then you are interpreting
24 Mr. Petrie's words and I don't accept you have a right
25 to do that.



1 A. I indicated I think there is a
2 more appropriate section within the transcripts to be
3 able to deal with this and to provide our
4 interpretation of part C.

5 Q. If there is something else in the
6 transcript, we can argue it. Mr. Petrie made some
7 statements and I have cross-examined him on the
8 statements and I have finished cross-examining him on
9 the statements and I will not listen to Mr. Crutcher
10 interpret Mr. Petrie's statements willingly.

11 MR. LANCASTER: That can be brought out
12 later if you wish.

13 MR. HODGSON: Q. Now, Mr. Petrie, could
14 I ask you -- we have up on the left-hand side H-650 and
15 could you put up on the right-hand side Exhibit -- oh,
16 I see. Mr. Petrie, you will recall some time ago we
17 discussed H-653 and H-650 and H-653 was an attempt to
18 calculate an exfiltration rate across a notional liner
19 that was 1.2 metres thick and had a vertical hydraulic
20 conductivity of 1×10^{-8} ?

21 MR. PETRIE: A. Correct.

22 Q. That 1×10^{-8} was the design
23 parameter for the liner proposed by your firm for Site
24 F?

25 A. Right.



1 Q. Would you agree that your firm has
2 yet to model how much exfiltration there will be across
3 the liner?

4 A. Correct.

5 Q. What we did on H-653 was based on
6 developing a head of 1.9 metres and you will recall
7 that that head was developed on the basis of the Rothe
8 equation?

9 A. Correct.

10 Q. Would you agree that the best
11 we can do by way of understanding how much exfiltration
12 there will be across the liner proposed is that there
13 will be approximately 8.14 millimetres per annum?

14 A. The infiltration across the liner
15 is in part a function of the head buildup on the top of
16 the liner and the position of the water table beneath
17 the liner. I believe there was some point of confusion
18 when we addressed that initially and perhaps I could
19 clarify it and make sure we have the same point
20 of departure for your questions. Is that appropriate?

21 Q. The last time we had somebody
22 clarify some evidence we were here for an extra day,
23 but go ahead.

24 A. I will just get my calculator and
25 complete that and then I can explain what it is. I



1 have shown on this figure in red a liner of 1.2 metres
2 thickness which is consistent with the liner thickness
3 we had previously on H-653, a vertical hydraulic
4 conductivity of 1×10^{-8} and a 1.9 metre mound within
5 the waste.

6 I have indicated in blue by horizontal
7 dashed lines position (a) and position (b) and position
8 (a) is the case is if the water table is at the top of
9 the liner, i.e., the liner was excavated into the water
10 table, and at position (a) we would have a vertical
11 gradient or I and subscript V of a change in head over
12 the length of the flowpath equal to 1.58 and
13 multiplying by the vertical hydraulic conductivity of
14 the liner we end up with 5 millimetres per annum as the
15 flux through that liner for condition (a).

16 For condition (b) where the water table
17 is at the base of the liner, we would end up with a
18 vertical gradient of 2.58 and multiplying by the
19 conductivity to get a Darcy velocity or flux, 8.1
20 millimetres per annum and that is the point I wish to
21 clarify.

22 DR. KINGHAM: We would understand the
23 difference between (a) and (b) being whether the liner
24 is saturated.

25 MR. PETRIE: Yes.



1 DR. KINGHAM: In case (a) it is
2 saturated and in case (b) the liner is not saturated at
3 all.

4 MR. PETRIE: It would be permeated with
5 liquid from here, but the base of it sits at the water
6 table, yes.

7 MR. HODGSON: Q. Would you agree it is
8 possible that the liner as proposed and constructed
9 will in fact not be at -- the base will not be at the
10 water table but the water table will be beneath the
11 base.

12 MR. PETRIE: A. That is a design
13 consideration but in portions of the site where it is
14 ravinous, or where the ravines are deep.

15 Q. I realize you are hungry but we
16 have an hour and a half to go.

17 A. I only felt I was hungry. Where
18 there are ravines the water table is significantly
19 lower than it is under the upland portions of the site
20 or the upper areas between the ravines, and in
21 constructing a liner or preparing a site for
22 landfilling, there obviously will be some contouring of
23 the surface beforehand and portions of the site is
24 where the water table would be at surface and the liner
25 could easily be installed into the water table and on



1 other portions it may be not so easy to achieve.

2 Q. I thought you were going to
3 install a sand drainage blanket under the liner?

4 A. Correct.

5 Q. And you were going to stop an
6 awful lot infiltration across that liner by the very
7 fact of putting it there, are you not?

8 A. I am sorry, I am misunderstanding
9 the point.

10 Q. Isn't the water table at Site F
11 now a function of, among other things, how much rain
12 falls on the site?

13 A. And the topography.

14 Q. And the topography?

15 A. Yes.

16 Q. And the K value of the materials
17 underneath?

18 A. Yes.

19 Q. If you stop the rain by putting a
20 liner on, then you are not feeding the water table and
21 if you put a drainage blanket underneath the liner,
22 keeping in mind that all of this is on approximately a
23 2 per cent slope?

24 A. Approximately.

25 Q. You won't be able to guarantee



1 credentials, your qualifications, and I am not re-
2 raising that issue by any means, but your
3 qualifications to give this kind of evidence were being
4 challenged and you were defending your right to give
5 your qualifications to give evidence about the modeling
6 by explaining why it is that a hydrogeologist should be
7 involved in this exercise?

8 A. As I recall it, that is it.

9 Q. If I may go back and re-read the
10 passage I read to you, let's start two sentences
11 before:

12 "Given that there were two models
13 provided at that point in time,..."

14 DR. KINGHAM: What volume is that?

15 MR. HODGSON: It is volume 106 and you
16 won't find it there because I have given the witness
17 that copy. If you like we can break for a moment.

18 DR. KINGHAM: It is okay.

19 MR. HODGSON: "Given that there were two
20 models provided at that point in time,
21 both which were purported to define the
22 groundwater flow system at the site, we
23 felt that we had to undertake a more
24 elaborate evaluation..."

25 Mr. Chairman, and Dr. Kingham, on page 25515 in the



1 middle of the page where the paragraph begins:

2 "Given that there were two models
3 provided at that point in time, both
4 which were purported to define the
5 groundwater flow system at the site, we
6 felt that we had to undertake a more
7 elaborate evaluation. Therefore, in
8 part C ..."

9 So now we are at part C, the part we were talking about
10 this morning with this lovely page 131?

11 A. Excuse me, but there are other
12 parts to part C and that starts at page 116 which is
13 noted at the top of the transcript.

14 Q. "Therefore, in part C we ran the
15 model. Now, in running the model, one
16 can manipulate a variety of the input
17 data and obviously that manipulation
18 ought to be done in conjunction with a
19 hydrogeologist."

20 It is very important, isn't it, to have a
21 hydrogeologist involved in the input data to modeling
22 and that is the point you are making; agreed?

23 A. Yes.

24 Q. "That hydrogeologist was myself
25 and the input data that we entered into



1 that model I felt appropriately
2 represented the data that could
3 realistically be used at this site.
4 Thus, we did not run models..."

5 in the plural:

6 "...that we felt did not represent
7 portions of the site or cannot be
8 supported by the hydrostratigraphy."

9 And those are your words, are they not?

10 A. That is what is written here.

11 Q. What we find on page 131, and I
12 suggest to you what we find in the whole of your
13 section C.4.3, is a hydrostratigraphy that you have
14 modelled that is nothing more than a figment of your
15 imagination?

16 A. I disagree entirely.

17 Q. You have inserted four layers for
18 which you have no hydrostratigraphic -- no
19 hydrogeological information of any kind and you have
20 already agreed with me this morning that you had no
21 information of any kind?

22 A. Correct. But, could I refer
23 you ...

24 Q. The exercise ...

25 MR. McQUAID: Let him answer.



1 MR. PETRIE: Can I refer you back to the
2 transcript again starting at 25515? I note part C goes
3 from page 116 to 138 and on page 25516, line 14, we
4 address the second part of these activities. What you
5 have been reading to me was focusing on the sensitivity
6 analysis in the first part of portion C. Starting at
7 the top of page 25516, the third line: "That was one
8 exercise of that work." That is the sensitivity
9 analysis and models, the plural you repeated in line 1,
10 refers to the 11 cases, is it, that are summarized for
11 example on page 121, where we addressed the highly
12 fractured shale unit 4 and the weakly fractured shale
13 unit 3. Those 11 cases are models, plural.

14 MR. HODGSON: Q. Let's take those one
15 at a time. You are in the witness box and you are
16 defending your right to give evidence about the models,
17 and you described for us why it is that a
18 hydrogeologist should be the person who is inputting the
19 data and that defence is that:

20 "That hydrogeologist was myself and the
21 input data that we entered into that
22 model I felt appropriately represented
23 the data that could realistically be
24 used at this site. Thus, we did not
25 run models that we felt did not



1 represent portions of the site or cannot
2 be supported by the hydrostratigraphy."

3 You are telling me that I am to read that sentence and
4 conclude that that sentence relates and only relates to
5 the models that are all described on Table C.4.2,
6 sensitivity analysis results?

7 A. That is indicated on line 3 and
8 that was one exercise of the work.

9 Q. Now, I am to understand am I, that
10 for the 11 models that are modeled on C.4.2 that each
11 of those 11 models represents input data that we
12 entered into that model that:

13 "...I felt appropriate represented the
14 data that could realistically be used at
15 this site. Thus, we did not run models
16 that we felt did not represent portions
17 of the site or cannot be supported by
18 the hydrostratigraphy."

19 A. In undertaking a sensitivity...

20 Q. Excuse me, but I want my question
21 answered?

22 A. That is what the words say.

23 Q. I want the question answered?

24 A. I believe you asked if that is
25 what is said?



1 Q. You are telling us that these
2 words on pages 25515 and 25516 which I just read to
3 you, that you believe that you used input data on cases
4 1 through 11 that could realistically be used at this
5 site, i.e., data that supported the hydrostratigraphy
6 at this site?

7 A. Yes, but I wish to add a qualifier
8 before you take my words out of context. We were
9 undertaking a sensitivity analysis of this model and in
10 order to do that one must vary the parameters. It is a
11 pointless exercise to run the model using exactly the
12 same parameters and one must vary them. Did we vary
13 them beyond the range of hydrogeologic common sense?
14 No, we did not. The values you can see on those pages
15 can all be found in the general sense in the Trow
16 report. That is not to say, necessarily, they are
17 Trow's values, but they represent values they have
18 supplied as part of their exercise of this work. We
19 just used them in a different, shall I say order or
20 manner, to different layers to investigate the
21 sensitivity of the system to variations in the
22 hydraulic conductivity and that is what a sensitivity
23 analysis is in a general sense.

24 Q. You have told us repeatedly that
25 you don't think that you understand Site F?



1 A. I have told you repeatedly that is
2 correct.

3 Q. I suggest to you that if you don't
4 have even the most basic understanding of Site F you
5 have nothing to input into a model to run?

6 A. The sensitivity analysis was
7 Trow's model and as I indicated to you they drew a lot
8 of conclusions from that model with respect to
9 infiltration, engineering design, contaminant flow
10 paths and it appeared to us that an evaluation of that
11 model was warranted. What you have before you is an
12 evaluation of Trow's model. I have not indicated to
13 you that I can abide by that layering in any way, shape
14 or form.

15 Q. Fine. I am to take that last
16 sentence that you have not indicated to me that you can
17 abide by that layering in any shape or form; and those
18 were your words?

19 A. Those are my words.

20 Q. I am to read those and those are
21 to be totally consistent with these words at the top of
22 25516:

23 "Thus, we did not run models that we
24 felt did not represent portions of the
25 site or cannot be supported by the



1 hydrostratigraphy."

2 And I am to take those two sentences and I am supposed
3 to assume that they jibe with one another and aren't
4 mutually inconsistent, and is that your evidence?

5 A. I see your concern. One may
6 construe from those words that I was in some way, shape
7 or form in agreement with the hydrostratigraphic
8 definition of the site but I have intimated many times
9 that I am not, so I think it is inappropriate to read
10 those words in that fashion. I am indicating to you,
11 that the values we input to the model had some degree
12 of basis or could be supported in a general way by data
13 developed by Trow at this site. In doing so we could
14 then evaluate the model which they produced and based
15 upon their interpretation of the site and that is how
16 we evaluated their model.

17 Q. I think I have your evidence and I
18 think I can leave the rest for argument. Let's go back
19 to page 131 but don't go away from that transcript
20 because I will come back to it. Looking at page 131
21 you have told me that you don't have any basis in fact
22 for asserting the white, yellow, orange or beige
23 layers?

24 A. As I indicated to you the reason
25 for doing this model was to see if we could produce



1 what, in our mind, was a better rendition of the flow
2 field.

3 Q. Mr. Petrie, how can you produce a
4 better rendition of anything by fantasizing up four new
5 layers for which you have no geological information
6 whatsoever and sticking them into the model. I suggest
7 to you, Mr. Petrie, that this exercise on page 131
8 doesn't rise above the level of what teenagers do with
9 computers?

10 A. I resent that implication,
11 Mr. Hodgson.

12 Q. Explain to me, please, how it
13 rises above the level of what teenagers do with
14 computers?

15 A. We have concluded, based on our
16 review of the Trow model, that it did not fit the
17 gradient data very well, specifically at HC -- I forget
18 the number -- HC11 beneath Aldershot and HC14 which was
19 the discharge zone that Trow had defined. As I recall
20 it the location of that discharge zone on NSP property
21 was in some way seen favourably by Trow with respect to
22 assessing the site as being suitable for landfilling.

23 If the model does not reproduce the
24 field gradients in the area that is most critical, then
25 we set out to see if we could reproduce the gradients



1 better and was the limitations in the model per se or
2 could the model be modified in order to reproduce the
3 gradients? The layering can be modified to give a
4 better fit of the gradients. The gradients are the
5 real field data and as I have indicated before when we
6 started our discussion of the hydrogeological
7 conceptualization of this site, that conceptualization
8 must be based on, I felt, an explanation which could
9 support the gradients observed, and recognizing that I
10 have not considered the density contrasts within the
11 flow system, but I was seeking to reproduce the
12 hydraulic gradients. I believe we say, up front
13 somewhere, that we do not believe that this calibrated
14 model in any way represents the hydrogeology of the
15 site.

16 Q. The purpose of the exercise we see
17 presented on page 131 was to see how far you could get
18 the highly permeable zone to extend downsite so you
19 could have discharge at HC11 where you wanted it?

20 A. We have discharge at HC11, but I
21 was merely seeking to find a reasonable explanation
22 and, having done so, I then said, as I have felt all
23 along, the site is underdrained and because we have
24 discharge gradients under Aldershot then the mechanism
25 of underdraining has to extend in some fashion at least



1 that distance. I would not use the model to support
2 specifically that observation and that observation was
3 in my mind long before we received the model.

4 It may transpire this is not a
5 particularly beneficial portion of the report and by
6 changing the layers we can match the heads better, and
7 all we are doing is indicating that we know which way
8 the water flows, but we knew which way the water flowed
9 before we had the model.

10 Q. At page 130 of your report you
11 say:

12 "It must be emphasized the calibrated
13 CRA flow model does not confirm the
14 hydrogeologic system modelled, but does
15 give a reasonable approximation of the
16 flow field in the vicinity of this
17 site."

18 And on page 25516 of the transcript in the middle of
19 the page it says, or you have said:

20 "A second part of the activities
21 undertaken in part C relates to our
22 manipulation of the model to provide for
23 us a better reproduction of the
24 groundwater flow system at the site."

25 So, I suggest you have two statements that are



1 virtually identical and confirming what it is that you
2 say are your intentions in this section, C.4.3, CRA's
3 flow model in B-617; correct?

4 A. I believe that to be correct.

5 Q. When we look at the results we see
6 you have fantasized up four new layers and inserted
7 them in the model with no basis, no foundation
8 whatsoever, and in total contradiction of what you told
9 us a responsible, serious, competent, experienced
10 hydrogeologist does when he models and he starts by
11 looking at his field data and interpreting the
12 hydrostratigraphy and modeling his interpretation?

13 A. A hydrogeologist starts by looking
14 at the field data and the field data we sought to
15 reproduce by the modeling was the vertical hydraulic
16 gradients. I was of the opinion that the
17 hydrostratigraphy at this site cannot be defined and
18 therefore I was at a loss as to what sort of layers I
19 could put into a system and I did not believe I could
20 define those layers, a quandary of some sort perhaps.
21 So I suggested let's just elongate the drain to see if
22 that would provide an explanation for the upward
23 gradients I see at HC11. In doing so, we found the
24 head changes would vary within the system so we
25 modified a few of the hydraulic conductivities and,



1 yes, we can reproduce a reasonable flow field. We then
2 said that does not confirm the hydrostratigraphy and we
3 also made some comments to the effect, noting page 136
4 of our document, the last paragraph:

5 "Regardless of the good fit of the
6 hydraulic heads via any of the previous
7 simulations, there can always be errors
8 in some of the calculated nodal values.
9 This is not uncommon in fractured rock
10 media. Hydraulic head distributions
11 within a fractured rock environment are
12 usually very complex, as demonstrated by
13 the WAT multilevel piezometers... it is
14 therefore no unusual to find in
15 fractured rock groundwater moving in
16 different directions from the regional
17 gradients... the various calculated
18 hydraulic heads, regardless of the
19 associated difference between simulated
20 and measured values, may not at all
21 reflect a representative value within
22 the local hydrogeological flow regime.

23 An equivalent porous media model
24 such as FLONET does not incorporate the
25 effects of a complex fracture network.



1 The flow characteristics, as produced by
2 FLONET, cannot accommodate the local
3 complex variations of groundwater flow
4 as seen at this site."

5 I believe we have concluded quite definitively you
6 cannot use this model in the manner it was done in
7 order to confirm the hydrostratigraphy of the site.

8 Q. On page 156 of B-617 there is, to
9 use your word, a schematic representation of a flow
10 model with 15 metres of shale and with a bulk
11 horizontal hydraulic conductivity of 2×10^{-4} ?

12 A. It is not a model.

13 Q. But it is an interpretation of a
14 flow system and you could have modelled it, couldn't
15 you?

16 A. This is a very simplified
17 schematic.

18 Q. It is also --

19 A. One could model it if one so
20 chose.

21 Q. There is also on this page a very
22 simplified schematic interpretation of a flow system
23 with 30 metres of shale with a bulk hydraulic
24 conductivity of 2×10^{-4} ?

25 A. Correct.



1 Q. That is also something you could
2 model?

3 A. Correct.

4 Q. On page 114 we have a third
5 interpretation of the flow system at Site F, the
6 weathered fractured bedrock, a lower permeable --
7 sorry, a less permeable zone and drain or drains and I
8 suggest to you that that, being your third
9 interpretation of the flow system at Site F, is
10 something you could have modelled?

11 A. For a start, the two figures on
12 156 are not hydrogeologic interpretations as I believe
13 you called them. Our conceptualization of the site is
14 on 114. We could not model that because we could not
15 define where the layers are. We couldn't enter into
16 the Flonet model the fracture geometry because we do
17 not know it. The grid for the model as it was
18 developed and used by Trow is approximately 10 metres
19 or about 8 metres as I recall under the site. That
20 grid is far too coarse to be able to reproduce the
21 variable gradients we see under the site.

22 Q. Did you say you couldn't model the
23 interpretation on 114?

24 A. Correct, I don't know where the
25 layers are.



1 Q. I see. So, CRA's interpretation
2 has interpreted the hydrogeology of the site as follows
3 and on page 114 we have your interpretation?

4 A. As we discussed yesterday.

5 Q. You are saying you can't model it
6 because you don't know where the layers are?

7 A. Correct.

8 Q. What is the point then of modeling
9 it at all?

10 A. I haven't modelled the site,
11 Mr. Hodgson.

12 Q. What do I see on page 131?

13 A. You see an attempt by CRA to
14 reproduce the gradients at the site and, as I have told
15 you two or three times this morning, it was in no way
16 an attempt to confirm the hydrostratigraphy of the
17 site.

18 Q. I suggest that what we see on page
19 131 is CRA's and your fourth interpretation of the flow
20 system at Site F?

21 A. You are not correct.

22 Q. With four new fantasy layers
23 inserted?

24 A. That is not correct.

25 MR. CRUTCHER: Could I make a comment?



1 Q. Sure.

2 MR. CRUTCHER: A. The section you were
3 referring to was the section that Ms. Cronk took -- had
4 a lot of questions regarding the expertise of
5 Mr. Petrie on talking about this section. We were
6 initially dealing with part B of the section and at
7 this time we were attempting to discuss ...

8 Q. Just a minute, Mr. Crutcher. Are
9 you standing here now to advise this Board as to how to
10 interpret Mr. Petrie's statements in the transcript?

11 A. Not at all.

12 Q. Please don't, because I don't
13 think that's your right.

14 A. I am trying to explain that I
15 think there is probably a more appropriate section
16 within the transcript if you want to refer to part C
17 which would clarify the position we took in chief on
18 this section and this is not the part in the
19 transcript. That is what I am trying to make clear.
20 We were discussing part B and Ms. Cronk stood up and
21 that is what I was trying to see ...

22 Q. If you are telling me that you are
23 looking at part B then you are interpreting
24 Mr. Petrie's words and I don't accept you have a right
25 to do that.



1 A. I indicated I think there is a
2 more appropriate section within the transcripts to be
3 able to deal with this and to provide our
4 interpretation of part C.

5 Q. If there is something else in the
6 transcript, we can argue it. Mr. Petrie made some
7 statements and I have cross-examined him on the
8 statements and I have finished cross-examining him on
9 the statements and I will not listen to Mr. Crutcher
10 interpret Mr. Petrie's statements willingly.

11 MR. LANCASTER: That can be brought out
12 later if you wish.

13 MR. HODGSON: Q. Now, Mr. Petrie, could
14 I ask you -- we have up on the left-hand side H-650 and
15 could you put up on the right-hand side Exhibit -- oh,
16 I see. Mr. Petrie, you will recall some time ago we
17 discussed H-653 and H-650 and H-653 was an attempt to
18 calculate an exfiltration rate across a notional liner
19 that was 1.2 metres thick and had a vertical hydraulic
20 conductivity of 1×10^{-8} ?

21 MR. PETRIE: A. Correct.

22 Q. That 1×10^{-8} was the design
23 parameter for the liner proposed by your firm for Site
24 F?

25 A. Right.



1 Q. Would you agree that your firm has
2 yet to model how much exfiltration there will be across
3 the liner?

4 A. Correct.

5 Q. What we did on H-653 was based on
6 developing a head of 1.9 metres and you will recall
7 that that head was developed on the basis of the Rothe
8 equation?

9 A. Correct.

10 Q. Would you agree that the best
11 we can do by way of understanding how much exfiltration
12 there will be across the liner proposed is that there
13 will be approximately 8.14 millimetres per annum?

14 A. The infiltration across the liner
15 is in part a function of the head buildup on the top of
16 the liner and the position of the water table beneath
17 the liner. I believe there was some point of confusion
18 when we addressed that initially and perhaps I could
19 clarify it and make sure we have the same point
20 of departure for your questions. Is that appropriate?

21 Q. The last time we had somebody
22 clarify some evidence we were here for an extra day,
23 but go ahead.

24 A. I will just get my calculator and
25 complete that and then I can explain what it is. I



1 have shown on this figure in red a liner of 1.2 metres
2 thickness which is consistent with the liner thickness
3 we had previously on H-653, a vertical hydraulic
4 conductivity of 1×10^{-8} and a 1.9 metre mound within
5 the waste.

6 I have indicated in blue by horizontal
7 dashed lines position (a) and position (b) and position
8 (a) is the case is if the water table is at the top of
9 the liner, i.e., the liner was excavated into the water
10 table, and at position (a) we would have a vertical
11 gradient or I and subscript V of a change in head over
12 the length of the flowpath equal to 1.58 and
13 multiplying by the vertical hydraulic conductivity of
14 the liner we end up with 5 millimetres per annum as the
15 flux through that liner for condition (a).

16 For condition (b) where the water table
17 is at the base of the liner, we would end up with a
18 vertical gradient of 2.58 and multiplying by the
19 conductivity to get a Darcy velocity or flux, 8.1
20 millimetres per annum and that is the point I wish to
21 clarify.

22 DR. KINGHAM: We would understand the
23 difference between (a) and (b) being whether the liner
24 is saturated.

25 MR. PETRIE: Yes.



1 DR. KINGHAM: In case (a) it is
2 saturated and in case (b) the liner is not saturated at
3 all.

4 MR. PETRIE: It would be permeated with
5 liquid from here, but the base of it sits at the water
6 table, yes.

7 MR. HODGSON: Q. Would you agree it is
8 possible that the liner as proposed and constructed
9 will in fact not be at -- the base will not be at the
10 water table but the water table will be beneath the
11 base.

12 MR. PETRIE: A. That is a design
13 consideration but in portions of the site where it is
14 ravinous, or where the ravines are deep.

15 Q. I realize you are hungry but we
16 have an hour and a half to go.

17 A. I only felt I was hungry. Where
18 there are ravines the water table is significantly
19 lower than it is under the upland portions of the site
20 or the upper areas between the ravines, and in
21 constructing a liner or preparing a site for
22 landfilling, there obviously will be some contouring of
23 the surface beforehand and portions of the site is
24 where the water table would be at surface and the liner
25 could easily be installed into the water table and on



1 other portions it may be not so easy to achieve.

2 Q. I thought you were going to
3 install a sand drainage blanket under the liner?

4 A. Correct.

5 Q. And you were going to stop an
6 awful lot infiltration across that liner by the very
7 fact of putting it there, are you not?

8 A. I am sorry, I am misunderstanding
9 the point.

10 Q. Isn't the water table at Site F
11 now a function of, among other things, how much rain
12 falls on the site?

13 A. And the topography.

14 Q. And the topography?

15 A. Yes.

16 Q. And the K value of the materials
17 underneath?

18 A. Yes.

19 Q. If you stop the rain by putting a
20 liner on, then you are not feeding the water table and
21 if you put a drainage blanket underneath the liner,
22 keeping in mind that all of this is on approximately a
23 2 per cent slope?

24 A. Approximately.

25 Q. You won't be able to guarantee



1 that you can keep the water table even at the base of
2 the liner never mind up in the liner?

3 A. That would depend on the sort of
4 controls you exercised on the hydraulics of the
5 drainage layer. If the drainage layer was free
6 draining to the base of the site, then the point you
7 raise is most pertinent. However, the drainage layer
8 could be designed such that it is not free draining
9 from the top of the site to the bottom of the site and
10 that again is a design option.

11 Q. This whole question of how much
12 exfiltration there will be across this liner, that is
13 something you could have modelled, is it not?

14 A. I couldn't model?

15 Q. That is something that CRA could
16 have modelled?

17 A. We could have and I believe the
18 calculation you see before you is adequate with respect
19 to a flux through the liner and with the
20 characteristics proposed.

21 Q. The issue of adequacy or
22 inadequacy I suggest may turn in part on the fact that
23 you are suggesting to this Board that they order the
24 Region of Halton to pay an extra \$18 million to build
25 this liner?



1 A. I have considered this site is not
2 hydrogeologically ...

3 Q. May I finish my question?

4 A. Yes. My apologies.

5 Q. You are suggesting to the Board
6 that they order the Region of Halton to pay an extra
7 \$18 million to install a liner at Site F, and you
8 haven't even modelled exfiltration across the liner so
9 you can give the Board some reasonably reliable
10 evidence as to how much infiltration it will allow once
11 it is installed?

12 A. I have concluded on the basis of
13 the hydrogeology before us that I cannot support the
14 definition of the site postulated by Trow. To my mind
15 the site cannot be defined hydrogeologically and, as
16 such, to my mind it is not hydrogeologically suitable
17 for landfilling and therefore the question arose as we
18 addressed in part C, could an ultimate design be
19 considered more feasible?

20 Q. I think my question was that you
21 are proposing to the Region or to the Board that they
22 order the Region to pay an extra \$18 million to
23 landfill at Site F and you haven't modelled
24 exfiltration across that liner. Where is the
25 justification for building the liner if it won't reduce



1 the exfiltration?

2 A. It provides a degree of
3 predictability with respect to the performance of the
4 site that is not available in the geological media. I
5 have indicated the site is hydrogeologically not
6 suitable and we have suggested an alternate design that
7 to my mind provides a degree of predictability and
8 places less reliance on the uncertainties of the
9 hydrogeologic regime.

10 Q. But we don't know what the
11 exfiltration will be across the liner?

12 A. The calculations you see before
13 you for the given gradient conditions provide a flux
14 through a liner of that design. Obviously the
15 exfiltration through the liner in the field would have
16 to be evaluated with respect to the field performance
17 of the liner and the drainage blanket allows that. In
18 placing a liner, field tests can be undertaken to
19 determine the in-placed hydraulic conductivity of the
20 liner.

21 Q. Will spend \$18 million and then
22 find how it works and is that the proposal?

23 A. I am suggesting the site is
24 hydrogeologically unsuitable.

25 Q. You are proposing that it be



1 landfilled with a liner?

2 A. I am not proposing it be
3 landfilled with a liner, but I am suggesting an
4 alternate design, or Mr. Crutcher and I are suggesting
5 an alternative design, and we are not the proponent for
6 the site, Mr. Hodgson.

7 Q. I want to come back to this
8 problem of what the exfiltration across the liner is
9 but I take it that we have your evidence and I take it
10 your best evidence at the moment is that the
11 approximate exfiltration across the liner will be
12 somewhere in the area of 5 to 8.4 millimetres?

13 A. For the gradient conditions and
14 the hydraulic conductivities, yes.

15 DR. KINGHAM: Is that 8.4 or 8.1?

16 MR. PETRIE: 8.1.

17 MR. HODGSON: Could we mark that as an
18 exhibit?

19 MR. LANCASTER: H-691. This was done at
20 your request?

21 MR. HODGSON: This was done at his
22 initiative so it should be a B exhibit.

23 MR. LANCASTER: All right.

24 ---EXHIBIT NO. B-691: Chart drawn by witness

25 MR. HODGSON: Q. I want to go back to



1 H-650 and I think we have a document prepared on that
2 which you have already seen and it doesn't do very much
3 but it does help us to get a better understanding of
4 how we can use the data presented on it.

5 Now, Mr. Petrie, you will recall when I
6 was cross-examining you on H-650 which you were kind
7 enough to assist me with because I think I was
8 responsible for the geometry of the system and you were
9 responsible for the numbers?

10 MR. PETRIE: A. I believe they are my
11 calculations and your values.

12 Q. When we got down -- what we were
13 doing was we were first calculating what would a
14 notional exfiltration be across B and did we write down
15 a value, a thickness across B?

16 A. I assume we have and I recall the
17 value of 7.3 being from one of your earlier exhibits.

18 Q. I think we can relate that back.

19 Q. H-649?

20 A. H-649, yes.

21 Q. I got you to agree that using the
22 geometry of your system on page 156 that the
23 exfiltration across B was a function of the depth of B
24 and therefore the exfiltration was 54.5 millimetres at
25 a depth -- 27.3 millimetres at 15 and it could be as



1 low as 7.3 millimetres at 4?

2 A. Using the calculations, yes.

3 Q. Let me just check. You will
4 recall too that these values are for the 1.9 metre
5 mound and therefore the horizontal gradient of .036?

6 A. Yes.

7 Q. That is shown on H-650?

8 A. Correct, it is.

9 Q. What I wanted to go back to is you
10 did a calculation for me of the exfiltration across D
11 and across D we had a vertical hydraulic conductivity
12 of 1×10^{-8} , a vertical gradient of 0.5 and we got
13 Darcy flux of 1.58 millimetres per annum?

14 A. Yes.

15 Q. I will confess you took me by
16 surprise by telling me that 1.5 millimetres per annum
17 couldn't be directly related to 7.3 millimetres per
18 annum and it wasn't you who took me by surprise but
19 Mr. Feenstra who shocked me. All we have done on this
20 latest exhibit ...

21 MR. LANCASTER: H-692.

22 ---EXHIBIT NO. H-692: Chart - Scenario for
23 Exfiltration from Site F

24 MR. HODGSON: Q. We have gone through
25 that calculation presented on H-650 in order to show



1 that while it was correct that in theory you can't
2 really add the 1.58 to the 7.3, in practice it turns
3 out that you can and I wonder if you can agree with the
4 calculation on H-692?

5 MR. PETRIE: A. With respect to the
6 mathematics. What it has assumed is that there is no
7 inflow into the system from the upgradient side; is
8 that correct?

9 Q. Yes.

10 A. The mathematics is correct and if
11 there is no inflow into the system from the upgradient
12 side and there is no flow in and out of the plane of
13 the paper, then for the given hydraulic conductivity
14 values and gradients you have, then that is correct.

15 Q. Just working with the geometry we
16 see on H-650, can we agree that holding the flow coming
17 from upgradient constant and talking about how much
18 leachate could escape from a notional Site F built upon
19 a geometry of these dimensions, the total exfiltration
20 on a per annum basis of leachate would be 7.3
21 millimetres per annum across B and 1.5 millimetres per
22 annum across D for a total exfiltration of 9.125
23 millimetres per annum?

24 A. I see 8.9.

25 Q. Sorry, 8.9?



1 A. Could I question one thing? You
2 said holding the upgradient flow constant, and I didn't
3 understand.

4 Q. You kept asking about the flow
5 that is coming laterally.

6 A. You said there was no flow and so
7 we are holding no flow constant?

8 Q. Yes.

9 A. I misunderstood. Holding no flow
10 constant and for the geometry you have provided, adding
11 those numbers comes to 8.9 millimetres per annum?

12 Q. Right. Would you agree that 8.9
13 metres per annum compares favourably with the 8.4
14 millimetres per annum we see on B-691?

15 A. I am sorry, but that's an 8.1.
16 Could I make that a bit more legible. Could you repeat
17 your question?

18 Q. Would you agree with me that the
19 8.9 millimetres on Exhibit H-692 compares favourably
20 with the 8.1 millimetres on B-691?

21 A. Yes.

22 Q. Now, would you also agree with me
23 that if we collapse B into even a smaller amount than 4
24 metres that it would have the effect of reducing the
25 exfiltration on Exhibit H-650?



1 A. And the converse is also true,
2 yes.

3 Q. If in fact it was discovered, or
4 if in fact it was collapsed to 2 metres and if that 2
5 metres was intercepted in some way, then would you
6 agree that in order to calculate exfiltration on H-650
7 we would just be dealing with the amount that moved
8 across D?

9 A. If you trapped B whatever
10 thickness it was and if you could define the thickness,
11 yes.

12 Q. Suppose we had Mr. Crutcher put in
13 a 20-foot clay key and a 20-foot clay key could
14 potentially intercept some leachate, could it not?

15 A. I think you would need some sort
16 of drainage inside the key, but, yes.

17 Q. If it was designed by
18 Mr. Crutcher it would have everything in it needed
19 to intercept leachate, would it not?

20 A. I believe that it would.

21 Q. Then, Mr. Petrie, is the situation
22 that we are in something like this; Mr. Sobanski has
23 proposed in his evidence that there is beneath Site F a
24 unit of massive shale and in his development of the
25 hydrostratigraphy he assigned a vertical hydraulic



1 conductivity to that unit of 1×10^{-7} ?

2 A. He also assigned a 1×10^{-8} as
3 well.

4 Q. Yes.

5 A. He had two values as I recall.

6 Q. If that unit or units were there,
7 would you agree with me, just thinking about
8 exfiltration across D, the exfiltration across D could
9 indeed be as low as is calculated on H-650?

10 A. If it is there and horizontal and
11 has the hydraulic values described, it could indeed be
12 that low.

13 Q. If it should turn out either that
14 B -- if it should turn out that B exists and is not
15 intercepted, then the amount of exfiltration across B
16 would be a function of its depth?

17 A. Yes.

18 Q. If B exists and interception takes
19 place at B, then in order to understand the total
20 exfiltration from Site F, we would be dealing with the
21 D layer?

22 A. If it was a layer we would, yes.

23 Q. Could we change the hypothesis
24 slightly. Imagine that the Board approved Site F with
25 a liner designed by Mr. Crutcher and so the blue line I



1 have added to H-650 is Mr. Crutcher's liner and it is
2 1.2 metres deep and it has a sand blanket underneath it
3 and it has tile spacing so we can hold these constant
4 that are consistent with Exhibit B-691; and I take it
5 the ones you were using here were 50 metres?

6 A. The same as we had on the previous
7 exhibit.

8 Q. Could we agree that Mr. Crutcher's
9 landfill design would have a designed hydraulic head no
10 higher than 1.9 metres?

11 A. Using that spacing for the
12 collection system on top of the liner, I am not sure
13 what he has proposed for that. Do you want me to
14 assume ...

15 Q. Assume that.

16 A. It is Mr. Crutcher's design so I
17 am not sure on.

18 Q. I had asked you whether the drain
19 spacing in his design was 50 metres and I thought
20 someone confirmed it was?

21 A. I confirmed it was the same as we
22 had two exhibits before.

23 Q. Let's hold the drain spacings
24 constant and if it turns out to be different we can go
25 back and modify the calculations since we know how to



1 do them now?

2 A. Correct.

3 Q. Let's just compare the situation
4 on B-691 with the situation of H-650. The calculation
5 on B-691 about exfiltration across the liner, and let
6 me draw a little arrow so I can be very clear on what I
7 mean, but what I mean is the exfiltration from my point
8 X, which I have put a 1 on, to my point Y, which I have
9 put a 2 on, and I want to talk about exfiltration
10 across that liner to just down to the sand
11 blanket/shale interface?

12 A. At the base of the sand blanket?

13 Q. Yes. Would you agree with me that
14 as a useful starting point for understanding
15 exfiltration across that liner that we could use your
16 calculations on B-691?

17 A. Yes.

18 Q. We could assign a value that was
19 within the range you have given us on B-691, either 5
20 or 8.1?

21 A. For the water table conditions
22 described, yes.

23 Q. Let's take your most favourable
24 exfiltration number and work with the 5 millimetres.
25 Let's assume that that is the correct number. 5



1 millimetres can move from X to Y across the liner in
2 Exhibit H-650?

3 A. Yes.

4 Q. Now, Mr. Petrie, wouldn't it be
5 ironical if it turned out that Mr. Sobanski was right
6 and there was in fact a unit of massive shale under
7 Site F with a vertical hydraulic conductivity of
8 1×10^{-8} and the site was constructed with a liner,
9 because wouldn't you agree with me that even though you
10 can get 5 millimetres of exfiltration across the liner
11 from X to Y, the total amount of leachate that can
12 escape from Site F might in fact turn out to be less
13 than 5 millimetres?

14 For example, if B was engineered so any
15 leachate going across B was intercepted, then it might
16 turn out that even though you could get 5 millimetres
17 of infiltration across the liner, only 1.58 millimetres
18 of that could get down into the shale and head for
19 Aldershot?

20 A. Are you proposing to intercept it
21 at B and put a liner as well? I am a bit confused.

22 Q. I am suggesting a hypothetical
23 situation where B is engineered so there is no
24 exfiltration into the natural environment across B?

25 A. And you are putting in a liner as



1 well?

2 Q. And a liner, yes. Liners are
3 sometimes built with toe drains, are they not?

4 A. Yes. I really can't comment on
5 that because I am not a design engineer.

6 Q. Accept my hypothesis for a minute.
7 Accept my hypothesis there is no exfiltration across B,
8 however managed?

9 A. I can accept that.

10 Q. Aren't we in the peculiar
11 situation that there could be exfiltration across that
12 liner of 5 millimetres but of that 5 millimetres only
13 1.58 millimetres per annum could actually get into the
14 natural environment because that is all that could move
15 across D?

16 A. For the geometry and the numbers
17 you have presented, yes.

18 Q. Isn't this question of a liner,
19 doesn't it really come down, Mr. Petrie, to a \$18
20 million gamble as to whether or not D is there?

21 A. The question in my mind with
22 respect to the liner is if we don't understand the site
23 then to my mind the site is hydrogeologically not
24 suitable. If one wants to proceed with a landfilling
25 proposal, we have suggested a liner can give you a



1 degree of assurance as to what is going on.

2 Q. But if the Board should decide
3 they have that degree of assurance to begin with, they
4 might well be in a situation where there would have
5 exfiltration into the natural environment without a
6 liner than they would have -- not with a liner because
7 I am suggesting that even if you add the liner it is
8 possible there will be less exfiltration than the
9 amount of exfiltration that can get across the liner?

10 A. You will have to run that by me
11 again.

12 Q. I have run it by you before. We
13 can get exfiltration of 5 millimetres across that
14 liner?

15 A. On the numbers we have provided,
16 yes.

17 Q. But if there is no exfiltration
18 across B and if D exists, of the 5 millimetres that can
19 get across the liner, only 1.58 can get into the
20 natural environment?

21 A. Yes, yes, that is correct.

22 Q. It comes back to an \$18 million
23 gamble as to whether D is there?

24 A. Being continuous and having the
25 hydraulic properties defined, I am not sure if I would



1 use the word gamble to describe that at all.

2 MR. HODGSON: This would be a
3 convenient time, Mr. Chairman.

4 MR. LANCASTER: All right, fifteen
5 minutes.

6 ---Recess

7 MR. LANCASTER: Please be seated.

8 MR. ESTRIN: Perhaps I could rise to
9 save time, but I expect that the undertaking
10 volunteered by CRA to do some new modeling just before
11 the coffee break and to the extent they do that and
12 present that during their cross-examination, I wanted
13 to advise the Board that Dr. Rowe who is our expert in
14 the modeling area is out of the continent for the next
15 two weeks and I won't be able to have the opportunity
16 to review it with him.

17 If CRA does indeed present such new
18 modeling, I would like to reserve the opportunity to
19 have the right to cross-examine once I have had the
20 change to consult with Dr. Rowe. It remains to be seen
21 whether in fact they will do this, but obviously this
22 is the kind of exercise they thought was important they
23 should have done some time ago and then we would have
24 had an adequate opportunity to be prepared to do it.

25 MR. McQUAID: Just a minute ...



1 MR. LANCASTER: It wasn't the witnesses
2 thought but the Region's thought.

3 MR. McQUAID: It is the Region's thought
4 and Mr. Estrin will have to work out with Mr. Hodgson
5 how to handle it because Mr. Hodgson has requested it
6 and not CRA and the responsibility is not CRA's. I
7 suggest Mr. Estrin hold his fire until we see.

8 MR. LANCASTER: Yes, until we see what
9 transpires.

10 DR. KINGHAM: On another point I wonder
11 if you could clarify Exhibit H-692 is drawn from H-650
12 and my recollection is that the lateral flow shown on
13 there was itself drawn from H-649 and I just want to
14 make sure we are to understand that the 7.3 millimetres
15 per annum can be translated as 7.3 millimetres per
16 annum per square metre of the surface area of the site
17 when it is considered in proportion to the 1.58
18 millimetres per annum per square metre of the surface
19 area of the site exiting.

20 I want to make sure I have it right on
21 this exhibit presented just before the break. That is
22 the only way the Board can make sense of the sum of the
23 vertical and lateral flows, is that they each relate
24 back through to the same unit area, being the same
25 square metre of surface area at the site.



1 MR. PETRIE: I believe that that should
2 be the case but I wish to clarify it in my own mind if
3 I may. Correct. The flow exiting the geometry shown
4 on H-650 relates to the infiltration over the area --
5 exfiltration over the complete area of Site F.

6 DR. KINGHAM: That is the way we
7 understood it, but it is just that H-692 with the arrow
8 across the 4 metre band gave the impression the lateral
9 flow was 7.3 millimetres per annum per unit of area
10 which would work out to quite a different number. We
11 understand that now to relate to the proportion of flow
12 which would move laterally.

13 MR. PETRIE: This is Halton's exhibit
14 H-692 and perhaps they could clarify that.

15 DR. KINGHAM: We have your confirmation
16 at least that that number corresponds.

17 MR. PETRIE: That is my understanding.

18 DR. KINGHAM: Crossing a unit length
19 across the site. Thank you.

20 MR. HODGSON: I apologize for being
21 late, but I wanted to see if I could finish by noon and
22 I was upstairs drawing diagonal lines across pages in
23 my notes.

24 Q. Mr. Petrie, you have presented to
25 the Board on page 156 of B-617 a conceptualization of a



1 flow system with 15 metres of shale and with a bulk
2 hydraulic conductivity of 2×10^{-4} . You have presented
3 on page 156 a conceptualization of a flow system with
4 30 metres of shale with a bulk horizontal hydraulic
5 conductivity with 2×10^{-4} . You have presented on page
6 114 of B-617 a flow system that is three-layered, it
7 has a heterogeneous upper weathered and fractured
8 bedrock zone which mantles the entire site, a thick
9 lower permeable zone with permeabilities ranging from 1
10 $\times 10^{-6}$ centimetres per second to less than 1×10^{-8}
11 centimetres per second and a moderately drain or drains
12 within this sequence of thick, lower permeable strata.

13 Finally, on page 131, you have presented
14 a flow system with nine different colour coded strata,
15 four of which you have told us have no basis in
16 geological fact. My last question to you before I
17 complete my cross-examination of you is if it should
18 turn out that this Board in its deliberations on these
19 proceedings is attempting to conclude from the evidence
20 what they should find is the flow system at Site F, and
21 if they should be deliberating on your evidence, would
22 you please advise me so I understand which flow system
23 would you have the Board remember you by; one of the
24 two on page 156, the one on page 114 or the one on
25 page 131?



1 MR. PETRIE: A. 156 is not a flow
2 system. 131 was an attempt to reproduce the vertical
3 gradients at the site. Our conceptualization of the
4 site is provided on page 114.

5 Q. So I have your evidence then that
6 you would like to be remembered by the flow system on
7 page 114?

8 A. Being remembered has nothing to do
9 with it, I suggest, Mr. Hodgson.

10 Q. Thank you, Mr. Petrie. I have
11 some questions for you, Mr. Crutcher.

12 A. You mentioned you were going to
13 come back to the chlorides and I wish to offer some
14 additional comments.

15 Q. I don't recall it, but please go
16 ahead.

17 MR. McQUAID: You asked him to check all
18 of these.

19 MR. HODGSON: Q. I didn't indicate that
20 but go ahead. I am sorry I don't think the witness is
21 quoting you. He said I indicated I wanted to come back
22 to the chlorides and I don't think he is making the
23 same point you are making.

24 MR. McQUAID: Whether he is or isn't you
25 asked him to check every document and drawing put to



1 him and he is saying he understood you wanted to come
2 back to something.

3 MR. HODGSON: I had already agreed and I
4 don't know what your objection is.

5 MR. PETRIE: In reviewing the chloride
6 data and trying to come up with the pattern of flow at
7 this site, one thing I notice is the depth to which low
8 chloride concentrations are encountered in HC4. You
9 have indicated in your hypothesis that low chloride
10 concentrations could be construed to reflect more
11 active flow, I believe those were your words, or
12 something to that effect, more recent flow, and the
13 high chloride levels could be inferred to reflect slow
14 flow or old water or something to that effect.

15 Looking at the distribution of chlorides
16 at depth, we notice chlorides of less than 50 down at
17 approximately 15 metres in HC4. We note at depth in
18 HC4 we have chlorides of approximately 9000. Moving
19 down the slope on the site for where we have chloride
20 data we come to the next site, well HC5, for which at a
21 generally similar elevation to the bottom of HC4 we
22 have chlorides of 1100.

23 We note at HC5 that there are lower
24 chloride values higher up in the system and we also
25 note there is till on the site there. Just looking at



1 the chlorides again and noting the position of the till
2 on the site, it would indicate to me that perhaps there
3 is more active flushing in the areas of the site
4 without till.

5 That is not to be said everywhere,
6 because as you go laterally on the site from HC4 we
7 have MB1 which I believe was plotted at the correct
8 elevation and the chloride levels are much higher.
9 Just focusing on the chloride levels at HC4 relative to
10 MB1, there appears to be much more active flushing at
11 HC4.

12 Again moving downslope from HC4 we are
13 passing underneath the till and the chloride
14 concentrations appear to get higher as we move
15 downslope. This, in my mind, is a function of passing
16 water passing through rock that contains the natural
17 chloride concentrations such that the further down the
18 flow system the water passes it dissolves more and more
19 chlorides. to see an increasing chloride concentration
20 as one moves downslope is consistent with a general
21 pattern of infiltration in the area of HC4 and lateral
22 flow beneath the till off-site.

23 However, HC8 does not fit that picture
24 very well at all. HC8 at the property boundary on the
25 cross-section has chlorides in excess of 5000.



1 However, looking off the section at HC8 we see lower
2 chloride levels in MB-16 and I think one of the GL
3 series wells, GL-26. It occurs to me that in those
4 portions of the site where we don't have the till they
5 would appear to have lower chloride concentrations such
6 that maybe the presence of till in some manner impedes
7 the infiltration into the site and beneath the till we
8 have lateral flow.

9 In reviewing the data Mr. Feenstra
10 provided with respect to using deionized water on
11 crushed rock to come up with some sort of maximum -- I
12 believe that was the appropriate description --
13 chloride concentrations, we noted at the site we are
14 not passing deionized water but infiltration which
15 progressively picks up more and more salt or dissolves
16 more and more salt as it moves down the slope.

17 The suggestion I therefore have is that
18 with respect to the chloride distribution, it would
19 appear the infiltration is more pronounced where there
20 is no till and in some fashion the flow is moving
21 laterally beneath the till and as it passes through
22 more and more of the shales it picks up chloride
23 concentrations. As I indicated, the picture is not
24 entirely consistent because at HC 8 we end up with
25 very, very high chlorides which suggest that perhaps in



1 some fashion the flow moving generally southward is
2 deflected around HC8, to put it crudely, and may move
3 with a slightly easterly or slightly westerly
4 component.

5 I should also note that as I understand
6 it, the proposal for landfilling would be to remove
7 much of the thin veneer of till lying on the southern
8 portion of the site, or at least on the upper portions,
9 such that more rock would be exposed to provide a base
10 for landfilling and also any eventuality of landfilling
11 would have ponded -- not ponded water, but would have a
12 potential source of fluid on top of the rock for
13 exfiltration.

14 That does not provide us with a
15 definitive value for exfiltration at the site, but
16 recognizing that the lowest chloride levels are found
17 deepest at HC4, which is sort of in general midway on
18 Site F, and those chloride levels are not matched
19 laterally at least going to the east to downgradient of
20 Bayview where there is till at the surface suggests
21 that the presence of till may in some way influence the
22 rate of infiltration at present and that removing of
23 the till for landfill may also -- it would increase
24 potentially the exfiltration rate into the rock.

25 MR. HODGSON: Q. Mr. Petrie, if the



1 till at the north end of the site has a hydraulic
2 conductivity of 10^{-7} and that is lower than the
3 hydraulic conductivity of the exposed shale, wouldn't
4 it follow, as day follows night, that it reduces the
5 infiltration into the shale?

6 MR. PETRIE: A. Yes.

7 Q. Would you agree with me that HC4-
8 85 is in the middle of the site?

9 A. I do.

10 Q. And HC8-85 is at the south end of
11 the site?

12 A. Correct.

13 Q. And HC8-85 is a borehole with very
14 low tritium from top to bottom?

15 A. Yes.

16 Q. Very high chlorides from top to
17 bottom?

18 A. Yes.

19 Q. HC8-85 is fairly close to MB17?

20 A. We discussed that lateral
21 difference the other week and found it was 300 feet or
22 something if I recall. I beg your pardon, Mr. Crutcher
23 reminds me it is metres, 300 metres.

24 Q. MB-17 was the borehole that had
25 the natural gas in it?



1 A. It was.

2 Q. Suggesting it had very low
3 permeability?

4 A. Somewhere in the system it
5 probably does.

6 Q. Thank you. Mr. Crutcher, could I
7 ask you to turn in Exhibit B-617 to page 141.

8 MR. CRUTCHER: A. Yes.

9 Q. What I am trying to understand
10 here, and I am trying to skip through a few pages and
11 try to understand the structure of the argument that is
12 being presented here. You say on page 141:

13 "However, the studies undertaken to date
14 at the Burlington and Bayview Park
15 landfill sites have not identified a
16 major contaminant plume. Identified
17 contaminant levels are low, sporadic and
18 local to the landfills and some of the
19 contaminants probably result from
20 extraneous sources. In addition, the
21 bedrock groundwater is of poor quality
22 and it cannot reasonably be considered
23 as an exploitable resource.

24 From a strictly technical perspective,
25 an argument can be made that the



1 contaminant release from Site F to the
2 natural environment would not cause any
3 adverse impacts as it would be
4 diluted/dispersed/attenuated/masked
5 within the naturally poor quality
6 groundwater."

7 Now, I take it that what you are saying here is that
8 there is -- you used the word argument?

9 A. Yes.

10 Q. Are you suggesting the case
11 against landfilling at Site F is technically weak and
12 is that the position we are to take from the statement:

13 "From a strictly technical perspective,
14 an argument can be made that the
15 contaminant release from Site F to the
16 natural environment would not cause any
17 adverse impacts,..."

18 blah, blah, blah?

19 A. The rationale for that is mainly
20 because we haven't been able to identify a plume and
21 therefore that argument could be made.

22 Q. I see. Now, you go on to discuss
23 on page 143, and this seems to be a sort of
24 philosophical discussion of the concept of public
25 interest, and you discuss the fears and concerns of the



1 citizens of Aldershot?

2 A. Yes.

3 Q. And you say:

4 "It is sufficient simply to acknowledge
5 the wide range of serious effects to
6 which these fears and concerns pre-
7 dispose the Aldershot residents. ... it
8 is sufficient simply to acknowledge the
9 wide range of serious effects to which
10 these fears and concerns predispose the
11 Aldershot residents."

12 I had some difficulty with that and what is "the wide
13 range of serious effects to which these fears and
14 concerns predispose the Aldershot residents?"

15 A. I go on to indicate that the fears
16 and concerns I am aware of which -- and expressed at
17 forums I have attended, they are very concerned about
18 uncontrolled leachate migration into the Aldershot
19 community and to them the community is anything in that
20 particular area. What I was trying to identify under
21 this point was that they have these concerns.

22 Q. What are "the wide range of
23 serious effects to which these fears and concerns
24 predispose the Aldershot residents." Let's re-arrange
25 the sentence, 'these fears and concerns predispose the



1 Aldershot residents to a wide range of serious
2 effects.' Is that a fair re-arrangement?

3 A. Could you do that again?

4 Q. 'These fears and concerns
5 predispose the Aldershot residents to a wide range of
6 serious effects.' Is that what the sentence is
7 supposed to say?

8 A. No.

9 Q. What is it supposed to say?

10 A. The intent of the sentence was
11 that the residents, and we are dealing with a public
12 interest discussion and the intent of the sentence was
13 that the residents have a concern about having a
14 landfill there and about having the leachate migrating
15 downgradient towards their part of the world.

16 Q. "The inescapable conclusion is
17 that inevitable but indeterminant
18 contaminant migration is not in their
19 public interest."

20 I take it the "inescapable conclusion" is meant to
21 follow from all of the evidence you have compiled in
22 the previous sentence?

23 A. It is actually intended to fall
24 from the whole report. There would be contaminant
25 migration migrating downgradient through Aldershot.



1 Q. Then:
2 "CRA believes that the construction of a
3 low permeable liner at Site F would
4 permit the prediction with relative
5 confidence of the relatively minute but
6 inevitable leakage through that liner
7 and that such leakage predictions can be
8 verified through monitor devices."

9 Not focusing on all the details that are brought
10 forward in that sentence, do I take it from the fact
11 that that sentence I have just read follows from the
12 previous paragraph that the structure of the argument
13 here is that the reason why we need a liner at Site F
14 is because we have to have a low rate of infiltration
15 in order to satisfy the fears and concerns of the
16 residents of Aldershot?

17 A. And we can monitor that liner and
18 demonstrate that it is performing adequately.

19 Q. Are you finished?

20 A. Yes.

21 Q. The whole issue of a liner turns
22 on the rate of infiltration, doesn't it?

23 A. That's a major portion of it, yes.

24 Q. Now, Mr. Crutcher, have you got a
25 copy of H-675, your ...



1 A. Yes, I do, the remedial measures
2 report on Bayview.

3 Q. Yes. Can you turn up Table 8.1,
4 the second last page of that document? The situation
5 as I understand the evidence we have before us,
6 Mr. Crutcher, is that landfilling was discontinued at
7 Bayview in 1972. Would I be correct in assuming that
8 some time probably between 1972 and 1980 the garbage in
9 the landfill reached what you civil engineers who have
10 studied these things describe as field condition...

11 MR. ESTRIN: Field capacity.

12 MR. CRUTCHER: Thank you, Mr. Estrin,
13 yes.

14 MR. HODGSON: Mr. Estrin is well
15 qualified in this area.

16 Q. It reached field capacity so that
17 meant it reached a stage of equilibrium?

18 MR. CRUTCHER: A. Yes.

19 Q. The state of equilibrium that it
20 was in was that it could only hold so much rainwater
21 within the matrix of the garbage and some portion of it
22 had to escape the system and is to be assumed that some
23 portion was exfiltrating the bottom of the landfill?

24 A. Yes.

25 Q. Some portion was exfiltrating the



1 landfill from a number of seepages?

2 A. Correct.

3 Q. Gartner Lee estimated these
4 seepages at 5 gallons per minute?

5 A. Yes.

6 Q. That is a lot of leachate, is it
7 not?

8 A. I don't know what you mean by a
9 lot.

10 Q. We have our tables here so we can
11 work back from 5 gallons a minute. On page 2 of H-690,
12 4.7 gallons per minute translated into hearing terms is
13 75 millimetres per year of infiltration?

14 A. That doesn't sound correct. H-90?

15 Q. H-690.

16 A. What page?

17 Q. Page 2, Bayview landfill
18 exfiltration rates based on a 15 hectare area.

19 A. Yes.

20 Q. Looking at the table and I am
21 reading 4.7 because that's as close on the table as we
22 come to 5?

23 A. I see that.

24 Q. That would suggest infiltration
25 into the landfill of 75 millimetres per year?



1 A. Yes, it does.

2 Q. Translating that into Ms. Vigod's
3 comfortable notion, that is 619 tanker trucks a year of
4 leachate that was escaping Bayview through leachate
5 seeps; correct?

6 A. Yes.

7 Q. Running overland into Indian
8 Creek?

9 A. Yes.

10 Q. And making its way through the
11 Aldershot community?

12 A. Yes, and probably being treated by
13 the swamps.

14 Q. That problem was identified by the
15 Ministry of the Environment as early as 1978?

16 A. Something of that order.

17 Q. Gartner Lee wrote a report for
18 your client, the City of Burlington, on that subject in
19 1982?

20 A. 1981-82.

21 Q. You were retained to address that
22 problem in June of 1985?

23 A. That is correct.

24 Q. And works to intercept that
25 leachate flow were put into place and operational in



1 December of 1986?

2 A. Correct.

3 Q. So for the period of time from
4 1987 to '86 is it correct that 619 tanker trucks per
5 year of leachate seeped out of that landfill and made
6 its way through Aldershot by way of Indian Creek?

7 A. Something of that order.

8 Q. Then, Mr. Petrie, when you were
9 retained you were prepared the remedial alternative
10 report, H-675?

11 A. Mr. Crutcher.

12 Q. I am sorry, I've been examining
13 Mr. Petrie too long.

14 A. I was just trying to get Mr.
15 Petrie to sit down. Sorry.

16 Q. The alternative that you in fact
17 were finally authorized to incorporate into the
18 situation at Bayview was a variation on either
19 alternative 6 or alternative 7, was it not?

20 A. What we were to do, if you
21 refer -- I think you have put ...

22 Q. I don't want to go into a whole
23 lot of detail.

24 A. Eventually a variation of that was
25 installed.



1 Q. The sumps and the toe drain on the
2 west side?

3 A. And that was done after some
4 consultation with the Ministry of the Environment.

5 Q. It would be reasonable to
6 approximate that the final solution at Bayview would be
7 alternatives 6 and 7 and that's a fair approximation?

8 A. Yes. It changed somewhat, but it
9 is essentially that concept.

10 Q. The estimated efficiency of this
11 solution was 75 per cent, plus or minus, and that is
12 what we see on Table 8.1?

13 A. Correct.

14 Q. Let's call it the 75 per cent
15 solution. You have put into effect the 75 per cent
16 solution at Bayview. No additional land was acquired
17 was it?

18 A. Not as of yet, and the proceedings
19 are underway.

20 Q. Something happened to the
21 expropriation proceedings and they didn't go ahead?

22 A. Somehow they are on some kind of
23 hold basis and I don't really understand the process
24 and where it is sitting.

25 Q. Notwithstanding that Ms. Cronk's



1 client still owns the land, but the reliability is that
2 you get the efficiency of dumping leachate on the land
3 so you get the extra 5 per cent no matter who owns the
4 land?

5 A. Yes.

6 Q. Ms. Cronk, with all her talent
7 can't hold out her hand and stop leachate from coming
8 across NSP's lands. Is it fair to say that the
9 solution in place at Bayview is an 80 per cent solution
10 and in fact to be fair to your representation on this
11 page, greater than an 80 per cent solution?

12 A. And all those numbers are based on
13 the infiltration rate as estimated by Gartner Lee at
14 6.5 inches per year.

15 Q. You will recall that in preparing
16 H-675 you were working with an infiltration number that
17 Gartner Lee had used which was 6.5 inches per year, but
18 will you agree that in your subsequent design report at
19 page 15 the estimated infiltration rate is the
20 estimated infiltration rate that all you design
21 engineers throw around at these hearings and it is
22 somewhere between 15 and 30 centimetres per year?

23 A. I don't have that report, but
24 those are the numbers we normally use.

25 Q. The situation we have is it not is



1 this; you have in place the 80 per cent solution and
2 notwithstanding you haven't acquired NSP's lands, and
3 we can assume can we not that 20 per cent of the
4 leachate generated at Bayview is still escaping into
5 the natural environment?

6 A. Again that is based off the
7 infiltration rate -- the percentages are based off the
8 infiltration rate as provided by Gartner Lee which is
9 6.5 inches which I believe translates into 165
10 millimetres.

11 Q. 165 millimetres?

12 A. A year.

13 Q. 20 per cent of 165 millimetres is
14 escaping into the natural environment, correct?

15 A. By our estimates.

16 Q. What is .2 of 160?

17 A. 33 millimetres.

18 Q. So we have 33 millimetres escaping
19 to the environment and assuming that the infiltration
20 into the top of Bayview is only 165, but if it is 300
21 then the amount of escape would be 20 per cent of 300,
22 wouldn't it?

23 A. Yes.

24 Q. That would make it 60 millimetres
25 per year?



1 A. Very good on your mental math.

2 Q. So what we have is we currently
3 have in place a retrofitted engineered landfill at
4 Bayview that on the estimates you have provided us is
5 allowing somewhere between 33 and 60 millimetres of
6 infiltration per year to escape into the natural
7 environment. Since we are talking about Bayview and
8 infiltration into Bayview, it may again be appropriate
9 to refer to H-690 and 33 inches or 33 millimetres of
10 infiltration translates in Ms. Vigod's terms into
11 somewhere between 248 and 289 tanker trucks a year,
12 correct?

13 A. I am just looking. Yes, it does.

14 Q. And 60 millimetres translates into
15 somewhere between 413 and 619 tanker trucks per year?

16 A. That is correct.

17 Q. There is still a lot of leachate
18 escaping from Burlington's landfill at Bayview into the
19 natural environment?

20 A. Yes, but I note that that leachate
21 is of low strength.

22 Q. I appreciate that qualification.

23 Now, at the Burlington landfill site we
24 don't know necessarily how much is escaping to the
25 natural environment, but it is your evidence and



1 Mr. Petrie's evidence in B-617 that infiltration --
2 exfiltration from Site F could be as high as 50 to 100
3 millimetres per year; correct?

4 A. Yes, that is correct, per year.

5 Q. Would it not follow if it is going
6 to be 50 to 100 millimetres per year from Site F that
7 it then has to 50 to 100 millimetres per year from the
8 Burlington landfill site?

9 A. Not directly, but the implication
10 is that you would expect it to be somewhat similar.

11 Q. You would even expect to see that
12 at Bayview?

13 A. To some extent.

14 Q. There is a bit of an
15 inconsistency, would you not agree, between the
16 calculation in B-617 and the implications we have drawn
17 from looking at H-675?

18 A. Can you explain that?

19 Q. We have agreed the exfiltration
20 based on H-675 is somewhere between 33 and 60
21 millimetres per year?

22 A. The numbers calculate to that,
23 yes.

24 Q. But B-617 tells us we should
25 expect 50 to 100 millimetres per year?



1 A. But you will recall we felt the 50
2 millimetres per year was a reasonable estimate and 100
3 was on the upper end and so I don't really see the
4 inconsistency.

5 Q. Now, at Site F you have presented
6 in this report the calculation that exfiltration across
7 the liner will be 3.15 millimetres per year at the top
8 of page 158. I don't want to confuse or mislead
9 anyone, and I don't understand the status of your
10 evidence, so could you clarify. Mr. Petrie did B-691
11 for us before the break and gave us a range of
12 exfiltration across a notional liner of between 5 and
13 8.1 millimetres?

14 A. Correct.

15 Q. Are we to take that range of 5 to
16 8.1 millimetres and substitute it for the 3.15 we find
17 on page 158, or are we to go with the number on 158?

18 A. I will give you a long-winded
19 answer and then I will attempt the more direct. The
20 calculation has presented a hydraulic gradient of a
21 unit that was not based off a design on the liner and
22 we did not calculate the head in the liner. As you
23 pointed out to us under Mr. Sobanski's design, he would
24 have a 1.9 metre head. We therefore on the calculation
25 presented on B-691, looked at two scenarios with that



1 head on the liner and, yes, I am in concurrence with
2 these two scenarios, that the exfiltration with that
3 head on the liner would be 5 millimetres per annum up
4 to 8.1 millimetres per annum depending upon the
5 location of the water table.

6 I note that in our design that we had
7 incorporated a drainage blanket over the liner and in
8 fact it was a more protective blanket but it was in
9 fact a drainage blanket, and that would have the effect
10 of placing a 10^{-3} sand layer over the liner which would
11 reduce the head, and I believe conceptually we had the
12 drain spacing approximately the same and we would have
13 to calculate out the actual head on the liner based off
14 the design, but we have not done that, but I suspect it
15 will be somewhat lower than 1.9 metres. I would also
16 note that when you were using this example as in B-691,
17 that to actually calculate the head on the liner you
18 would take more of the average as Dr. Rowe had done,
19 the average head on the liner rather than the peak head
20 and that would reduce the head somewhat as well.

21 So, the actual exfiltration through the
22 liner is very dependent on the actual head on the liner
23 and so we would have to calculate that out. So, what
24 would be more correct to be placed in here would be a
25 range in exfiltration depending upon the head on the



1 liner. We have not calculated the head on the liner
2 based on the design we have proposed or the concept
3 design we have proposed for the liner and in fact that
4 would be appropriate to do to provide the Board with
5 the best number on exfiltration under a design mode.

6 I cannot give you a direct answer on
7 what it is at this time.

8 Q. I think you will find,
9 Mr. Crutcher, if you look at H-648, that the head
10 calculated is an average head, but I don't want to
11 argue with you or dispute it with you in any way. You
12 are the witness who has come here on behalf of your
13 firm, CRA, to tell this Board that if it is to permit
14 landfilling at Site F it should not do so unless it
15 orders the Region to build a liner and you are the
16 person who has come here to tell us that the liner will
17 cost \$18 million. You are also telling me you haven't
18 figured out what the head will be on the liner and I
19 take it from that that you don't know what the
20 exfiltration will be across the liner. Can you then at
21 least suggest a range of exfiltration across the liner
22 so I can continue my cross-examination, because I am
23 happy to have a range?

24 A. Taking a range of exfiltrations, I
25 would say, reviewing the numbers that have been



1 presented, that we would be dealing with an
2 exfiltration of 8.1 millimetres or less.

3 Q. Is it your view that 8.1
4 millimetres of exfiltration into the natural
5 environment from Site F with a liner is an acceptable
6 exfiltration?

7 A. It is about the best we can do.

8 Q. Now, Mr. Crutcher, would you agree
9 with me that we have an apparent inconsistency between
10 a situation in which your client, the City of
11 Burlington, is permitting exfiltration into the natural
12 environment at the present time of anywhere from 33 to
13 60 millimetres of leachate, albeit though as you point
14 out weaker leachate from the Bayview landfill site, and
15 your estimate is that somewhere between 50 and 100
16 millimetres of leachate is exfiltrating the Burlington
17 landfill site and going into the natural environment.

18 I take it, Mr. Crutcher, that you
19 haven't suggested to your client or anyone else that
20 any contingency measures possible at the Burlington
21 landfill site be invoked, have you?

22 A. What contingency measures at
23 Burlington landfill site?

24 Q. If there is 50 to 100 millimetres
25 of leachate escaping from the Burlington landfill site,



1 don't you think it would be appropriate to use
2 contingency measures to prevent all that leachate
3 getting out into the environment?

4 A. We haven't addressed that issue.

5 Q. We have a situation of enormous
6 exfiltration from the Burlington landfill site on your
7 evidence and substantial exfiltration from the Bayview
8 landfill site on your evidence and an insistence that
9 we can't have more than 8.1 millimetres per year escape
10 from Site F. Do you agree there is an apparent
11 inconsistency in that situation?

12 A. No. First of all our dealings
13 have primarily been with the Bayview landfill site so I
14 would like to talk to the Bayview landfill site. We
15 made a number of recommendations to our client and the
16 first one was install a leachate collection system and
17 install it as deep as practical to pick up as much of
18 the shallow groundwater flow as we can and to allow
19 sufficient room for a contingency cutoff wall when we
20 had further knowledge on the site, to acquire in some
21 fashion downgradient lands, all of which have been
22 enacted on and they are proceeding.

23 There was one very big difference
24 between the existing Bayview landfill site and the
25 proposed Site F, Bayview is an existing situation and



1 we were dealing with an remedial activity and on Site F
2 we are dealing with a proposed one. If I was in a
3 position to place a landfill site at the Bayview Park
4 landfill, I would have advised my client they should
5 have installed a liner for leachate control.

6 Q. You have already advised your
7 client that they can install a clay key and get greater
8 than 90 per cent effectiveness at Bayview and they
9 haven't done it, have they?

10 A. Not as of yet.

11 Q. Don't you agree there is an
12 apparent inconsistency between the modest proposal to
13 put in a clay key at Bayview to get up to 90 per cent
14 efficiency and the insistence that no landfilling occur
15 at Site F unless we get down to 8.1 millimetres per
16 year of infiltration?

17 A. I am sorry, could you say that
18 again?

19 Q. Don't you see an apparent
20 inconsistency between a failure to install a clay key
21 that could have got you down to 90 per cent efficiency
22 at least and the insistence so that your -- Bayview has
23 been retrofittively engineered to the 75 per cent
24 solution rather than the 90 per cent solution looking
25 at Table 8.1 in H-675, but Site F has to be engineered



1 so that it only has an exfiltration of 8.1 millimetres
2 per annum. Isn't there an apparent inconsistency in
3 those two situations?

4 A. We are dealing with an existing
5 site versus a proposed site and also on the existing
6 site we have a very dilute leachate and I would note
7 that that system has just been installed and the city
8 was looking for at the performance at the system. It
9 was based off a number of estimates on the site, and we
10 could not advise them definitively what is this number,
11 but it was decided to leave room so we could go in and
12 install a contingency system if, at a later time, it
13 was determined that that was appropriate.

14 Q. The City of Burlington has known
15 since 1978 that leachate was spewing out of Bayview
16 into Indian Creek and making its way through Aldershot
17 to Lake Ontario, correct?

18 A. It had some awareness of that,
19 yes.

20 Q. They got really interested in
21 dealing with the problem in June of 1985 at about the
22 time that Site F was designated as the preferred
23 landfill site, Stage 2C of the Walker, Wright, Young
24 reports?

25 A. In '81-82 they commissioned a



1 report to look at that.

2 Q. I didn't hear an answer to my
3 question.

4 A. They implemented the contingency
5 measures in '85-86.

6 Q. They got mobilized to deal with
7 the problem in June of 1985 at the very time the Stage
8 2C reports were before Regional Council for
9 finalization, correct?

10 A. I am not sure the two have any
11 connection but the timing is correct.

12 Q. And your report which was written
13 in a big hurry, and I don't criticize you for it, but
14 in June and early July, 1985, saw its implementation in
15 December of 1986; correct?

16 A. Yes, and that was done on a fast
17 track basis.

18 Q. A lot of leachate escaped from the
19 Bayview landfill site in the interim?

20 A. I should also note that in 1985
21 the City of Burlington installed the clay plugs to
22 attempt to reduce any migration or reduce the leachate
23 emanating from the site as a temporary...

24 Q. Now, Mr. Petrie -- Mr. Crutcher, I
25 have suggested an apparent inconsistency and I am not



1 going to suggest that isn't a real inconsistency and I
2 will tell you why I believe there is not a real
3 inconsistency.

4 I suggest to you, Mr. Crutcher, that
5 given the fact that we have in evidence from H-625 the
6 Gartner Lee 1987 monitoring report of the Burlington
7 landfill site, you will recall on page 11 of that
8 report that Gartner Lee are collecting 253 millimetres
9 of leachate per year and 253 millimetres you would
10 agree, Mr. Crutcher, falls well within the range that
11 all of you design engineers propose -- I am sorry, of
12 about 150 to 300 millimetres per year; right?

13 A. Yes.

14 Q. Would you agree that it is very
15 possible that the Burlington landfill site with its
16 retrofitted toe drain system and its underdrain at the
17 north end, is collecting virtually all of the leachate
18 that is generated at the Burlington landfill site?

19 A. Based off the 253, and are you
20 using that number?

21 Q. Yes.

22 A. On the 253 they have noted an
23 estimated infiltration of 253 plus leakage to the
24 shale, but they have not allowed for any groundwater
25 inputs into the landfill and I don't know if that is a



1 factor or not and I would anticipate a factor would add
2 some water to that flow. We have a periphery system
3 around the lower part of the site and I also think that
4 that would add some groundwater into the measured
5 flows. So, to be able to say that 253 all came through
6 infiltration I don't think you can relate that
7 directly.

8 Q. Would you agree with me that it is
9 very possible that the Burlington landfill site as it
10 is currently engineered is collecting virtually all of
11 the leachate generated in that site?

12 A. It is collecting a good portion,
13 but I do not know.

14 Q. It is possible it is collecting
15 virtually all, is it not, it is possible?

16 A. I think it is unlikely.

17 Q. It is possible. At Bayview,
18 Mr. Crutcher, where we have the 75 per cent solution
19 you had the misfortune that your monitoring equipment
20 had malfunctioned or the City's monitoring equipment
21 has malfunctioned so you don't know how much leachate
22 you are collecting?

23 A. That is correct.

24 Q. It is possible that you are
25 collecting more than 75 per cent; isn't it?



1 A. Yes, it is possible.

2 Q. It is possible that the Bayview
3 landfill site exfiltrates very little leachate out the
4 bottom?

5 A. I also think that is unlikely as I
6 thought it was unlikely at Burlington.

7 Q. Would you agree with me,
8 Mr. Crutcher, just looking at H-650 and B-691 that it
9 is very possible that if a landfill is constructed at
10 Site F there will be very little escape of leachate
11 into the natural environment?

12 A. I would not agree.

13 Q. Do you want to tell me why?

14 A. The escape of the mound of
15 leachate is very dependent on the hydraulic
16 characteristics of the underlying shales. We have
17 reviewed all of the data that was available at some
18 length and we have gone through further review with
19 your cross-examination. In our mind that does not
20 provide any definitive basis to determine the estimates
21 of infiltration.

22 The basis -- if I refer to H-650, the
23 basis of your exfiltration of the 1.5 millimetres per
24 annum vertically through unit D is based upon an
25 assumed vertical hydraulic conductivity of 1×10^{-8} and



1 if that was 1×10^{-7} then that would increase -- I
2 think it is directly proportional to 15.8 millimetres
3 per annum.

4 The thickness of unit B, and you have
5 shown a calculation of 7.3 millimetres per annum, but
6 that thickness I believe is assumed to be 4 metres and
7 in fact it is very dependent on what the thickness of
8 the unit is. We do not have the vertical -- we have
9 very little definitive information on the vertical
10 hydraulic conductivity or the horizontal hydraulic
11 conductivity nor the thickness of the upper fractured
12 layer, or more fractured layer I should say.

13 Q. If the upper fractured layer is
14 only 4 metres thick, Mr. Crutcher, I suggest that you
15 with your clay key could entrap the leachate that would
16 otherwise pass across B, don't you agree?

17 A. That would make a total -- at this
18 particular location there is about 4 to 6 metres of
19 till so you would be looking at 5 plus 4 which is 9
20 metres so you have about a 30-foot excavation to be
21 able to get down to that depth, and that would
22 certainly be a major undertaking, but yes, you could do
23 that.

24 Q. The real gamble, I suggest to you,
25 Mr. Crutcher, at Site F is whether or not those very



1 tight layers of shale you can see on the table before
2 you go across the entire site, is it not?

3 A. Where there is a tight layer and I
4 don't consider it a gamble, but where there is a tight
5 layer across the bottom of the site and we don't know
6 what elevation that is.

7 Q. It doesn't matter what elevation
8 it is because as long as you can cut off the
9 exfiltration across the fractured shale?

10 A. There are limits to engineering
11 practicality.

12 Q. There are alternatives to clay
13 keys, are there not?

14 A. Yes.

15 Q. So we have a situation where we
16 have five boreholes on-site and on the table we have
17 examples from five boreholes of five units of very
18 tight shale?

19 A. Portions of them.

20 Q. And we have got more units over
21 there on the floor and we have borehole records that
22 tell us that the RQD of the rock beneath these is very
23 often better than the rock we see here. So the
24 situation comes down to whether or not you are prepared
25 to take a gamble, an \$18 million gamble as to whether



1 or not what we can see exists, and at the moment we can
2 see it does exist because there is already a liner
3 under Site F, don't you agree?

4 A. The presumption is that it is a
5 continuous layer and I don't see that.

6 Q. Mr. Crutcher, I suggest to you
7 that you have always, since 1984, assumed that Site F
8 could not be landfilled without a liner and that
9 conclusion about a liner is not a conclusion you
10 reached after a tortuous arduous trip through the data.
11 That is a conclusion you started with without looking
12 at the data?

13 A. We looked at the data, the early
14 data, and drew that conclusion and looked a great deal
15 at the present data and it did not sway us from that
16 original conclusion, or the original opinion. It
17 wasn't really a conclusion. Mainly because we did not
18 have a definition of the site which would be able to
19 support us to take a different position than that.

20 Q. Can you turn to page 88 of B-617,
21 please. After a lengthy discussion of the monitoring
22 program we find on this page at the top:

23 "CRA considers that the monitoring
24 program ..."

25 Can I cross-examine you and are you CRA?



1 A. I am one of the members.

2 Q. "CRA considers that the monitoring
3 program suggested by Mr. Feenstra is
4 aimed at defining the contaminant
5 flowpaths and the hydraulic
6 characteristics of those flowpaths."

7 Jumping down:

8 "CRA concludes that the contaminant
9 flowpaths are not defined, nor is the
10 rate of groundwater flow in such zones
11 defined. The monitoring program
12 suggested by Mr. Feenstra is aimed at
13 additional characterization of the site
14 and, therefore, should be undertaken
15 prior to an assessment being made of the
16 suitability of this site for
17 landfilling."

18 Do you see that sentence?

19 A. I do.

20 Q. Let me tell you what I thought
21 when I read that sentence. I thought there was an
22 apparent inconsistency between that sentence and your
23 recommendation that Site F be landfilled with a liner.
24 It seemed to me that what that sentence was telling us
25 was something that we in fact have heard from Mr.



1 Petrie, which is that we don't have enough information
2 to interpret the hydrostratigraphy at Site F and
3 therefore this sentence is suggesting let's go get more
4 information and it reads:

5 "The monitoring program suggested by
6 Mr. Feenstra is aimed at additional
7 characterization of the site and
8 therefore should be undertaken prior to
9 an assessment being made of the
10 suitability of this site for
11 landfilling."

12 Do you agree there is an apparent inconsistency between
13 recommending the site be landfilled with a liner and
14 recommending that we go out and get more data because
15 we can't make a decision about the suitability of this
16 site for landfilling until we have that data?

17 A. No. You have two options
18 available. You can go out and get more data and if on
19 getting more data and doing a rigorous analysis and
20 preparing a report that goes through that analysis,
21 that goes through a critical review, if it supports the
22 conclusions then based off that you can then re-look at
23 the site.

24 The report before us, H-40, I don't
25 believe it supports the conclusions and therefore we



1 conclude the site was not suitable. You can go do more
2 work and prepare a new report and re-evaluate the site,
3 and then come forward and that is what it is saying,
4 and we were of the opinion that what Mr. Feenstra was
5 putting forward was in fact more investigations at the
6 site in an attempt to define the site.

7 The other choice you have is to say this
8 site is very complex and we recognize that additional
9 work will provide additional information, but it will
10 not be able to help us characterize the site any more
11 definitively and if we place a liner at the site the
12 primary basis of containment at the site is the liner
13 so the need for defining the natural system is somewhat
14 reduced.

15 Q. Let me go back and see if I can
16 understand what you have told me, and I think I do
17 understand. What you are saying is that it seemed to a
18 reader of page 88, what appeared to be an apparent
19 inconsistency is not a real inconsistency for this
20 reason; as an engineer you view the situation as a
21 situation in which we have two alternative modes of
22 proceeding. Mode 1 is we can make sure we understand
23 the hydrostratigraphy and once we understand the
24 hydrostratigraphy we can then decide upon an
25 appropriate landfill design.



1 Mode 2 is to skip the understanding of
2 the hydrostratigraphy and jump to the final solution of
3 a fully engineered lined landfill system and if we jump
4 to the solution of a fully engineered lined landfill we
5 don't have to understand the hydrostratigraphy and we
6 don't have to worry about the fact we misunderstand the
7 hydrostratigraphy. Have I got your answer right?

8 A. To some degree, and the emphasis
9 is somewhat different. The difference by placing the
10 engineered solution, that being the liner, is the
11 prediction and the monitoring is based off the liner
12 and not the natural hydrogeologic system and so the
13 need to understand the natural system is not as high.

14 Q. With a liner?

15 A. With a liner.

16 Q. Right. That is a view you hold
17 today?

18 A. That's a view I have held for a
19 considerable period of time.

20 Q. You will recall this morning I
21 gave you copies of some information generated by you
22 and your colleague at Conestoga-Rovers and I would like
23 now to show you those documents and to give copies to
24 everyone else.

25 I am showing you, first of all, the



1 minutes of a meeting that took place in the Region of
2 Halton Engineering and Public Works building on
3 November 26th, 1985 and in attendance is Mr. McKay for
4 the Regional of Halton, Mr. Smith from the Region of
5 Halton, some parenthetic lawyer from Toronto named
6 Hodgson, Mr. Beechinor and then you, Mr. Crutcher, and
7 a colleague of yours, a Mr. Mateyk, M-a-t-e-y-k?

8 A. That is correct.

9 Q. You will see on the last page it
10 says minutes taken by Mike Mateyk?

11 A. Mateyk.

12 Q. Can you confirm this document was
13 a document prepared by Mr. Mateyk of CRA?

14 A. It was.

15 Q. Since we are cross-examining CRA
16 is it fair to ask you questions about this document?

17 A. I have no problems with that.

18 MR. LANCASTER: H-693.

19 ---EXHIBIT NO. H-693: Minutes of November 26, 1985

20 MR. HODGSON: Q. So everyone can focus
21 on both documents together, we also have a letter
22 written by Mr. Mateyk to Mr. Smith of the Region of
23 Halton and this letter is dated the 8th of February,
24 1986 from Mr. Mateyk?

25 MR. CRUTCHER: A. Mateyk.



1 Q. At Conestoga-Rovers?

2 A. It is.

3 Q. This letter references statements
4 made by you, Mr. Crutcher.

5 A. It is referencing the comments on
6 minutes prepared by the Region of Halton from the same
7 meeting and commenting on that and they are not the
8 same minutes you have as H-693. There is another set
9 of minutes.

10 Q. I appreciate that what we don't
11 have before us are the minutes prepared by the Region
12 of Halton, but if we did have minutes prepared by the
13 Region of Halton we would have an unholy fight on our
14 hands as to how we could use them and I don't propose
15 to even suggest we refer to those minutes, I just want
16 to look at documents generated by your office.

17 I want to look at these documents
18 because I think they help us interpret the statements
19 you made on page 88 of B-617 and evidence you have
20 already given us. If you could refer, first of all, to
21 the minutes, H-693, I guess the letter will be 694?

22 MR. LANCASTER: Yes, H-694.

23 ---EXHIBIT NO. H-694: Letter of February 8, 1986 from
CRA to Region of Halton

24 MR. HODGSON: Q. At page 2 of the
25 minutes we have Mr. Mateyk recording a comment from



1 you:

2 "Initially Tony Crutcher stated that in
3 order to properly evaluate the
4 hydrogeology data, CRA would need the
5 basis of the site design for the design
6 would dictate the level of site
7 hydrogeology required."

8 That is an opinion which you have just expressed to us,
9 an opinion which you say you have held for some period
10 of time. It is fair to say Mr. Mateyk has represented
11 accurately the statement you made at that meeting?

12 A. I don't actually recall the
13 statements I made at the meeting, but that sentence
14 seems a fair representation of what I would say.

15 Q. That is an opinion you hold?

16 A. I hold and still do.

17 Q. You held then and still hold it
18 today?

19 A. It is a basic design philosophy
20 that I have used throughout my career.

21 Q. If we go to page 3, the second
22 last paragraph above the heading of tritium testing on
23 page 3 of H-693?

24 A. Yes.

25 Q. There is a statement:



1 "Tony Crutcher restated that it is
2 difficult for CRA to evaluate the
3 program for the engineering design is
4 not presented. If a liner is to be
5 installed then CRA would consider this
6 level of work not necessary. If,
7 however, the basic position is 'no
8 liner' then CRA can develop comments.
9 Mr. McKay stated that CRA should
10 consider 'no liner' the Region's
11 position at the present time."

12 Can we keep those two passages I have read in mind and
13 also look at Exhibit H-694. I appreciate the
14 awkwardness of what we are doing with H-694 because we
15 have Mr. Mateyk writing back to Mr. Smith and
16 correcting a version of the minutes that clearly were
17 prepared by Mr. Smith or someone else at the Region,
18 and the reference is:

19 "Under item 1- Original Hydrogeological
20 Work Program Comments, in the last
21 paragraph it is stated that, 'the only
22 safe design would be a clay liner'."

23 And then the letter says:

24 "Mr. Crutcher did say that CRA felt a
25 liner was necessary, however, he did not



1 specify a clay liner."

2 Do I have it right, that at that meeting it was your
3 view that a liner was necessary although you wanted to
4 quibble with the statement you had said a clay liner.
5 Is that fair?

6 A. That is essentially correct. We
7 were commenting on the second phase or were asked to
8 comment on the second phase of hydrogeologic work
9 undertaken at Site F, and we were of the opinion on
10 reviewing what we had of the first phase data and
11 knowledge of the site that a liner would be a wise way
12 to proceed.

13 Q. "Under Item 2- 'Additional
14 Hydrogeological Work Program Comments',
15 in the first paragraph it is stated
16 that, 'T. Crutcher indicated he does not
17 have any concerns with respect to the
18 additional hydrogeological work program,
19 and it is advisable to confirm
20 parameters using a variety of methods'."

21 And then Mr. Mateyk goes on:

22 "This statement is out of context.
23 Mr. Crutcher did state it is advisable
24 to confirm parameters using a variety of
25 methods. However, this statement was



1 made while discussing the proposed
2 tritium testing at Sites 5 and 8; and
3 does not refer to the program as a
4 whole. At no time did Mr. Crutcher state
5 that he had no concerns regarding the
6 additional hydrogeological work. It is
7 suggested this paragraph be amended as
8 follows:..."

9 And now we have Mr. Mateyk's proposed statement to be
10 put into these minutes so they reflect accurately
11 statements you made at this meeting and the paragraph
12 is now to read:

13 "T. Crutcher indicated that if the
14 position to be taken is that of 'no
15 liner', then additional hydrogeological
16 work is necessary. The use of tritium
17 as an indication of hydraulic
18 conductivity is advisable to confirm
19 this parameter."

20 Now, Mr. Crutcher, would you agree with me -- perhaps
21 let me go back and just fill in if we could. The
22 context of this meeting, as you will recall,
23 Mr. Crutcher, is that Hydrology Consultants were given
24 a budget to do some work in the summer of 1985 and they
25 went out and they did a round of drilling and then they



1 reported back to their client that they felt they
2 needed to do some tritium testing, some pump tests and
3 some more drilling. Do you remember that?

4 A. Yes.

5 Q. When they reported this to their
6 client a series of meetings were arranged and one of
7 those meetings being between Mr. Beechinor of Hydrology
8 Consultants and yourself and Mr. Mateyk?

9 A. That is correct.

10 Q. What was put before you
11 representing the City of Burlington was the proposed
12 new work program and comments were being solicited from
13 you, correct?

14 A. That is correct.

15 Q. Is it not fair to read the
16 combination of the letter, H-694, and the minutes as
17 prepared by your office, H-693, to say that you, Tony
18 Crutcher, took the following position; a liner is
19 needed at Site F and if you are going to put in a liner
20 at Site F then you don't really need to go out there
21 and scrap around in the hydrogeological environment
22 trying to define it. You had best get on defining your
23 liner.

24 If, on the other hand, you are not going
25 to jump to the conclusion you need a liner at Site F,



1 you had better go out and do a good job of defining the
2 hydrostratigraphy. Is that a fair statement of the
3 position you took at that meeting?

4 A. It wouldn't be my words, but yes,
5 it is a fair representation.

6 Q. So, do I have your evidence,
7 Mr. Crutcher, that as of the 26th of November, 1985 you
8 thought that Site F required a liner?

9 A. Yes.

10 Q. As of the 26th of November, 1985
11 you didn't have all the hydrogeological data we have at
12 this hearing today, did you?

13 A. No.

14 Q. It wasn't available, was it?

15 A. No.

16 Q. You didn't have your 1986 and 1987
17 monitoring reports. You didn't have Gartner Lee's 1986
18 and '87 monitoring reports?

19 A. That is correct.

20 Q. You didn't have the results of
21 Trow's second round of drilling?

22 A. Nor did we have much of the
23 results of the first round. We had preliminary
24 results.

25 Q. You didn't have the chloride data,



1 you didn't have the tritium data. Are you saying yes?

2 A. We had portions.

3 Q. But you didn't have it the way we
4 have it today?

5 A. Not the way it is presented.

6 Q. You didn't have the results of the
7 pumping tests?

8 A. No.

9 Q. And your colleague thinks a lot of
10 the pumping tests?

11 A. He does.

12 Q. You didn't have the enormous
13 amount of the data we have now, but you had already
14 concluded based on what your understanding was at the
15 time that a liner was necessary, correct?

16 A. We were concluding based on the
17 data that was available at the time that the site was
18 complex, and we didn't think additional work at the
19 site would change that understanding of the site. Trow
20 had a differing opinion and they felt that doing
21 additional work may help and we said then go ahead and
22 do additional work if that is the way and then we will
23 look at what you have at that time.

24 When we received Trow's final report, H-
25 40, they had in fact characterized the site and that



1 was much to our surprise because we had passed this
2 earlier opinion and when we looked at the data in much
3 detail we did not believe that the characterization
4 that Trow put forward was supportable.

5 Q. After you got all the data you
6 still didn't think it was supportable?

7 A. Not the characterization Trow put
8 forward.

9 Q. But would you agree with me,
10 Mr. Crutcher, that you started out on the assumption
11 that a liner was necessary in order to landfill at
12 Site F?

13 A. I had that opinion when we were
14 reviewing our initial work and our understanding of the
15 site primarily from the Burlington landfill site and
16 landfilling on shales was very difficult to be able to
17 understand what was happening with the leachate and
18 therefore it was a very difficult proposition to go
19 ahead and get approved. I felt that you took your
20 prime idea of a site was to get an engineered system
21 then your chance of getting that approved would be
22 higher.

23 Q. I am suggesting, Mr. Crutcher,
24 that you have never had in the four years you have been
25 looking at the Burlington/Bayview and Site F situation,



1 you have never had an open mind about the possibility
2 that Site F could be landfilled without a liner; have
3 you?

4 A. That's not true.

5 MR. HODGSON: Thank you, Mr. Petrie and
6 thank you, Mr. Crutcher and thank you, Mr. Chairman.

7 MR. LANCASTER: Thank you, Mr. Hodgson.

8 Have we determined who will be the next
9 counsel to cross-examine? Mr. Garrod?

10 MR. GARROD: I think I am nominated,
11 Mr. Chairman. I am not sure how long I will be but I
12 suspect I will finish today, assuming we are now
13 breaking for lunch and I would need that time at least
14 and I may carry over to Monday, depending on how things
15 go.

16 MR. LANCASTER: That's quite all right.
17 So, we will break until two o'clock.

18 ---Luncheon Adjournment at 12:42 p.m.

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

2 MR. LANCASTER: Thank you, please be
3 seated. One thing for certain, if we sit on another
4 Friday we have to leave longer for lunch.

5 CROSS-EXAMINATION BY MR. GARROD:

6 Q. Mr. Petrie, could I start with
7 you, please?

8 MR. PETRIE: A. Yes.

9 Q. I think you know I act for the
10 people who live on and around Site D?

11 A. That I understand.

12 Q. Perhaps I could start with
13 something I would like to get out of the way before I
14 start my serious questions of you. Do you recall
15 giving an answer to Mr. McQuaid that 15 was 1-1/2
16 orders of magnitude during the course of your evidence?

17 A. I do.

18 Q. Have you had time to reflect on
19 that since?

20 A. I have had 10 seconds to reflect
21 on it, and I suspect it is worthy of reflection, yes.

22 Q. Would you agree that that's not
23 correct?

24 A. I do.

25 MR. HODGSON: What's correct?



1 MR. GARROD: Q. Can you say what 1-1/2
2 orders of magnitude is?

3 MR. PETRIE: A. 50.

4 Q. I suspect you are wrong in that
5 too. One order of magnitude is 10 and 2 is 100 so it
6 is not a linear relationship?

7 A. No, it is not.

8 Q. So let's drop it.

9 A. Fine.

10 Q. In reviewing your experience and
11 qualifications last night, Mr. Petrie, I reached
12 certain conclusions and I wondered if you would agree
13 with them. First of all, you had a background before
14 joining CRA in 1984 that was, if I can call it
15 predominantly that of initially being a hard rock
16 geologist concerned with matters such as mining or ores
17 in what I would call igneous rocks, basically that is
18 where your work started?

19 A. In New Zealand we use the term
20 hard rock for crystalline work, so I did a lot of my
21 university work in New Zealand and a lot of my work in
22 New Zealand in what we called -- I don't know if soft
23 rock is applicable but sandstones and shales.

24 Q. For the purposes of looking for
25 mineral deposits?



1 A. Yes, a lot of that was in
2 sedimentary rocks which are not crystalline rocks.

3 Q. Are we talking about minerals like
4 copper?

5 A. Yes, minable ore.

6 Q. Then you took what would appear to
7 be somewhat of a change of direction in your career
8 path and got into looking at the development of water
9 supplies?

10 A. Somewhat of a change, yes.

11 Q. A change of direction, if you
12 like, within the geology field?

13 A. Correct.

14 Q. That seemed to start at about
15 1975?

16 A. Yes, the very beginning.

17 Q. That's when you joined the British
18 Columbia Ministry of the Environment?

19 A. Yes, and I had had some exposure
20 to well drilling in some of those courses I did in New
21 Zealand and I had a brother who was a well driller for
22 a while, so I had some exposure.

23 Q. Genetically?

24 A. Minimal exposure, correct.

25 Q. You then worked for the B.C.



1 Ministry of the Environment for I think about two years
2 and I think from reviewing the transcript you said most
3 of that work was evaluating and developing groundwater
4 supplies?

5 A. Two and a half years, yes, and
6 much of it was related to that.

7 Q. Then you went for a year, I think
8 it was, and did a diploma in groundwater development in
9 Israel?

10 A. Correct. I believe it was a six
11 or eight month course and I was there for a year.

12 Q. That again involved essentially
13 looking for water supplies, or the topic is the topic
14 of looking for how to develop water supplies out of the
15 ground for drinking or for irrigation purposes?

16 A. Yes, but in arid zones typically
17 there is a paucity of water, so having an understanding
18 of the flow system is quite critical in understanding
19 arid hydrology, yes.

20 Q. I am sure it is. You then spent,
21 I think it was, two to three years in Ethiopia?

22 A. Yes.

23 Q. Doing essentially the same thing?

24 A. Essentially.

25 Q. Helping people find water supplies



1 and developing those water supplies?

2 A. Correct. Developing, testing,
3 yes.

4 Q. You returned to Canada in about
5 1981?

6 A. That rings a bell.

7 Q. And again went out to British
8 Columbia?

9 A. Correct.

10 Q. You worked briefly with two
11 private firms again developing groundwater supplies?

12 A. Principally.

13 Q. And then it appeared to me you
14 then decided to embark on another something of a career
15 change, a career direction and a new career direction,
16 would that be fair?

17 A. In general, but much of the work
18 you do in water supply work is essentially the science
19 of hydrogeology, so perhaps it is better to say I
20 became better qualified in much of the work I was
21 already doing.

22 Q. You wanted to pursue some
23 different direction in the work in which you were
24 involved?

25 A. I wanted an opportunity to pursue



1 more and different projects.

2 Q. You enrolled in the hydrogeology
3 Master of Science program at the University of
4 Waterloo?

5 A. I did.

6 Q. In 1982?

7 A. Yes.

8 Q. You were there until 1984 when you
9 graduated?

10 A. Correct.

11 Q. Would I be correct that that was
12 essentially your first exposure to topics such as waste
13 disposal sites and their impact on groundwater and
14 contaminant hydrogeology?

15 A. The first detailed exposure and I
16 had worked with on programs in B.C. associated with
17 groundwater pollution problems adjacent to landfills,
18 but it was more in a review capacity and in the mid-
19 seventies the level of work in British Columbia was not
20 particularly rigorous.

21 Q. You undertook a project at the
22 University of Waterloo?

23 A. Correct.

24 Q. That was to evaluate some
25 hydrogeological responses in till in Ontario and I



1 understand that during that you pumped a confined
2 aquifer under the till and monitored certain changes in
3 it?

4 A. Correct.

5 Q. Would that have been your first
6 experience with trying to understand a till environment
7 in Ontario?

8 A. In Ontario, yes.

9 Q. Upon graduation you then, I think
10 you said, you immediately joined with Conestoga-Rovers?

11 A. That is correct.

12 Q. You became a senior hydrogeologist
13 with the firm?

14 A. That is the label I have here,
15 yes.

16 Q. That is the firm or the label you
17 started with as well?

18 A. We are not very good with labels
19 at CRA. I am not sure what I was described as within
20 the company, but I was a senior person with respect to
21 the hydrogeology background, yes.

22 Q. Are there junior hydrogeologists?

23 A. We have some less experienced
24 hydrogeologists, yes.

25 Q. People who hadn't been out in the



1 workforce previously, I assume, before they went to
2 school?

3 A. Yes, and some of less academic
4 exposure as well.

5 Q. Some with Bachelor's degrees?

6 A. Yes.

7 Q. What month in 1984 did you start
8 with CRA?

9 A. My recollection is September.

10 Q. You were immediately given the
11 assignment of preparing the response of the City of
12 Burlington to the Stage 2C documents which Trow had
13 produced?

14 A. I was not.

15 Q. Sorry. I understood you were
16 given that assignment?

17 A. Yes, but not immediately.

18 Q. Sorry.

19 A. I thought the implication was that
20 day one I started on that, but I did not start on that
21 on day one at my employment with CRA.

22 Q. You started with CRA in September
23 and when did you start on the project for the City of
24 Burlington?

25 A. I don't recall, but possibly



1 around the beginning of '85.

2 Q. January?

3 A. Perhaps, yes.

4 Q. You had been there through the
5 fall of 1984?

6 A. Correct.

7 Q. Would it be fair -- you knew, I
8 take it, Mr. Petrie, that when you started that job as
9 Mr. Crutcher indicated, the client had a certain
10 position in this with regard to whether or not
11 landfilling should occur at Site F?

12 A. The client had some feelings
13 respecting that, yes.

14 Q. I put it to you that the client
15 had indicated very strongly that it did not want
16 landfilling to go to Site F and that was a part of the
17 public record?

18 A. I am not aware of the public
19 record, but we discussed it in our office, yes.

20 Q. You were aware of that position?

21 A. In general, yes.

22 Q. You were aware I take it also that
23 the City of Burlington was a new client of the firm you
24 had just joined?

25 A. I do recall Mr. Crutcher



1 indicating to the Board earlier that he had some
2 relationships with the City of Burlington respecting
3 the '84 expansion, which presumably was in '84, so CRA
4 has some exposure to the City of Burlington before my
5 arriving at CRA, yes.

6 Q. But it was a relatively new
7 client?

8 A. I cannot say.

9 Q. You don't know the history of it?

10 A. Not in great detail.

11 Q. You were aware I take it of the
12 position of Mr. Crutcher as he has outlined it, about
13 when he concluded that a liner was necessary at Site F,
14 the evidence Mr. Crutcher just gave today on that and I
15 presume you were aware of that at the time?

16 A. In a general sense, yes.

17 Q. And I wonder if I could summarize
18 your circumstances in the following way and see if you
19 agree. You were in a relatively new job at the time
20 you were doing the 2C report, the response report?

21 A. I had been in the company less
22 than six months, yes.

23 Q. This was a relatively new career
24 direction for you?

25 A. On the grounds that I had not had



1 a Master's degree in hydrogeology before that time, it
2 may be considered as new, yes.

3 Q. In fact you had no previous
4 experience in evaluating the suitability of lands for
5 waste disposal?

6 A. I have had lots of experience in
7 evaluating lands for water supply and groundwater flow
8 capacities, flow regimes, and much which impinges upon
9 deliberations for landfill siting.

10 Q. But you had not previously
11 evaluated the suitability of any parcel of land for
12 waste disposal purposes?

13 A. I had not previously evaluated
14 them, no.

15 Q. And you had a client who was
16 strongly opposed to Site F being used for landfill
17 purposes?

18 A. I am not so sure I had discussions
19 with the client at those times and perhaps
20 Mr. Crutcher could speak to the client's feelings or
21 the City of Burlington.

22 Q. You have indicated to me you were
23 at least aware of it?

24 A. You used the word "strongly" and I
25 am not sure I can say I knew how strong their feelings



1 were. Q. But there was no doubt they were
2 opposed?

3 A. That was my understanding.

4 Q. You had a supervisor who felt that
5 a liner was necessary at Site F?

6 A. Mr. Crutcher indicated to the
7 Board this morning that based on the data available to
8 him at the time there was a large measure of
9 uncertainty respecting the site definition and a liner
10 may be warranted.

11 Q. The answer to my question is yes?

12 A. Yes.

13 Q. You had the job then of writing
14 the response document to the 2C material in a
15 relatively short timeframe, am I correct?

16 A. I don't have the timeframe in mind
17 and I don't know if it was short.

18 Q. Do you remember there was a
19 deadline for submissions at 2C?

20 A. But I don't have the timeframe in
21 mind and I understand there probably was a deadline.

22 Q. Do you remember working on that?

23 A. I definitely worked on that
24 document, yes.

25 Q. Do you remember working to a



1 deadline?

2 A. I remember getting it out on the
3 date in question but I don't remember the specifics of
4 the deadline.

5 Q. It was actually submitted on the
6 deadline?

7 A. That I cannot say.

8 Q. Did you -- would it be fair to say
9 also, Mr. Crutcher -- I am sorry, I have started early
10 -- Mr. Petrie, that all of your work experience in
11 terms of assessing the suitability of lands for waste
12 disposal sites has been gained at CRA since you joined
13 that firm?

14 A. The bulk of it, yes.

15 Q. Therefore, it has been gained, I
16 suggest to you, since you started this project which
17 was essentially when you started at CRA?

18 A. I can't recall my first day at CRA
19 working on waste disposal sites, but I have worked on
20 waste disposal sites since I joined CRA and this was
21 not the first waste disposal site I worked on, and it
22 was then a proposal.

23 Q. I suggest many of the things you
24 have testified about in this hearing are matters that
25 you had not been involved in prior to January of 1985



1 when you started work on this project?

2 A. I can't agree to that. The
3 patterns of groundwater flow measurements, water
4 levels, definition of hydrostratigraphic horizons is
5 all part and parcel of water supply investigations as
6 well.

7 Q. You would certainly not get
8 involved in detailed contaminant hydrogeology when you
9 were developing water supplies?

10 A. In a general sense, no.

11 Q. And you would not, I suggest to
12 you, get involved in hydrogeochemistry?

13 A. Back in the seventies when I did
14 some preliminary work on landfills, chlorides was the
15 element of concern and I suggest most hydrogeologists
16 in the seventies were looking at inorganic constituents
17 and I would say that was the field of hydrogeochemistry
18 then as it related to landfills and in the eighties the
19 emphasis has changed in a marked manner toward organic
20 constituents as well.

21 Q. You were involved in a little work
22 with salt water intrusions in B.C., for example?

23 A. Yes.

24 Q. I wonder, Mr. Petrie, from my
25 reading of your response document to the 2C work,



1 everywhere where Site F is mentioned in that report and
2 signed by you, Mr. Crutcher, it is referred to as
3 escarpment Site F. Do you recall that?

4 A. It is my recollection that the
5 whole document has that notation.

6 Q. The whole response document from
7 the City of Burlington?

8 A. Correct.

9 Q. Not just the part that CRA
10 authored?

11 A. That is my understanding.

12 Q. That would be the part CRA
13 authored as well as the part authored by Ecoplans?

14 A. That was the other consultant I
15 believe with whom we were associated, yes.

16 Q. I noticed that terminology of
17 escarpment Site F was also used by Mr. Boggs in his
18 covering letter, Mr. Boggs being the Chief
19 Administrative Officer for the City of Burlington at
20 that time?

21 A. I don't see a copy of his covering
22 letter.

23 Q. This is H-71, Mr. Petrie, if that
24 assists you?

25 A. It would if I had it. Perhaps you



1 could refresh my memory.

2 Q. I think the record will speak for
3 itself in that regard. My question to you is whose
4 decision was it that everywhere where Site F was
5 mentioned in this response document it should be called
6 escarpment Site F rather than the terminology Trow had
7 given?

8 A. I do not know.

9 Q. It wasn't your decision?

10 A. It wasn't my decision.

11 Q. Mr. Crutcher, was it your
12 decision?

13 MR. CRUTCHER: A. It was not.

14 Q. Can I take it it was a decision of
15 your client that the site should be referred to as
16 escarpment Site F?

17 A. It was.

18 Q. You amended your response document
19 to reflect that?

20 A. They asked us at the outset to
21 amend it and it was prepared that way.

22 Q. What was the rationale for that in
23 a hydrogeology report to refer to the site as
24 escarpment Site F?

25 A. It meant nothing to me and I was



1 referring to the site and I think they wanted it
2 referred to as escarpment Site F to note it was near
3 the escarpment.

4 Q. You did this in response to what
5 your client wanted you to do?

6 A. It was a simple request.

7 Q. Mr. Petrie, you had some
8 discussion with Mr. Hodgson ...

9 MR. PETRIE: A. Mr. Hodgson.

10 Q. Yes, about scientific method. I
11 have always understood the scientific method as follows
12 and I wonder if you agree. First of all a scientist
13 generates a hypothesis?

14 A. In a general sense, yes.

15 Q. Is there some specific sense in
16 which you disagree?

17 A. If the data has already been
18 generated, he may wish to do some preliminary review to
19 see what direction he might investigate further or
20 develop a hypothesis. A hypothesis may not be
21 developed in a vacuum.

22 Q. In any event a hypothesis is
23 developed and then a scientist goes about either
24 conducting experiments or reviewing available data?

25 A. Correct.



1 Q. And collecting data, evaluating
2 data, reviewing the data?

3 A. Yes.

4 Q. Thirdly, the scientist would
5 analyze that data?

6 A. Yes.

7 Q. Finally he would draw some
8 conclusions from that data to see whether or not the
9 hypothesis is supported?

10 A. Correct.

11 Q. Would you agree with me -- the
12 final step I suppose is that the scientist would either
13 accept or reject the hypothesis generated?

14 A. Or he may modify it in some
15 fashion.

16 Q. Do you agree that if you are
17 following the scientific method we have just outlined
18 that it is not appropriate to use the hypothesis that
19 is being tested as a justification for interpreting
20 data one way or the other?

21 A. Could you run that one by me
22 again?

23 Q. If you are interested in testing a
24 hypothesis and you have gathered some data, would you
25 not agree that if you are trying to analyze that data



1 you should not be using your hypothesis as a
2 justification for interpreting the data one way or the
3 other?

4 A. I don't believe I would agree with
5 that entirely, because one may do so and then ask the
6 opposite question, where is does the hypothesis not fit
7 and you might approach the problem from both ends.

8 Q. So you see it as a proper part of
9 the scientific method to take a hypothesis you are
10 trying to test and to use it to assist you to interpret
11 the data that is then going to be used to prove the
12 hypothesis?

13 A. That is part of the process, yes.

14 Q. You consider that part of a valid
15 scientific method?

16 A. Correct, and I indicated you may
17 take an opposite hypothesis or some variance of it to
18 see how that would fit or not fit.

19 Q. Is that not what is commonly
20 called circular reasoning?

21 A. Not to my mind.

22 Q. Well, let me give you a simple
23 example. We have a hypothesis that a particular site
24 is an extremely complex site and is a difficult site to
25 understand and we gather a lot of data and we want to



1 then analyze and evaluate that data and determine which
2 of it is good data and which of it is bad data. Should
3 we not make those decisions about the data without
4 resorting back to the hypothesis that the site is
5 complex as a reason for including all of the data?

6 A. I would endeavour to do that in
7 some fashion, yes.

8 Q. I suggest one should be rigorous
9 about doing that if one is to be following a scientific
10 method?

11 A. For a scientific method that is
12 indeed part of it, yes.

13 Q. If we are not following that
14 method, do you agree we are not following that
15 scientific method we have just discussed?

16 A. The scientific method you just
17 described; if we are not following it we are not
18 following it. I have to agree with you.

19 Q. What would we call a method that
20 somebody wanted to use that had that circular element
21 in it. Would that be a quasi-scientific method?

22 A. I don't know, I don't have a word
23 for it.

24 Q. It is certainly not a scientific
25 method. Would you agree with me?



1 A. Science was the object of the
2 exercise, so it is probably not a pure scientific
3 method.

4 Q. After your conclusions that
5 Mr. Crutcher discussed as a result of your review of
6 the stage 2C material, a lot of new information came to
7 light which your firm assessed and Mr. Hodgson
8 mentioned that to you earlier?

9 A. He did.

10 Q. And you assessed that data and you
11 have now been questioned about it for many days by
12 Mr. Hodgson and I don't intend to get into that,
13 Mr. Petrie. Do you agree with me that as far as the
14 monitoring information that was generated for the
15 Burlington landfill site and the Bayview landfill site
16 is concerned, what it shows us is that there is not any
17 downgradient contamination to any significant degree
18 that is found in that data?

19 A. Any organic contamination to
20 significant degree, correct, with a couple of
21 exceptions that Gartner Lee have noted on their site,
22 yes.

23 Q. Any landfill derived
24 contamination?

25 A. I believe that was specifying



1 organics as being a big difficulty at that site and
2 evaluating the inorganic constituents.

3 Q. What that tells us, wouldn't you
4 agree, is that if there is inorganic contamination
5 emanating from the landfill, that it is
6 indistinguishable from the background quality of the
7 water?

8 A. For the positions of where the
9 monitoring well screens are, yes.

10 Q. So, what you have I suggest, Mr.
11 Petrie, with that data is nothing that supports a
12 hypothesis that the site is causing downgradient
13 contamination?

14 A. I do not conclude the site is
15 causing downgradient contamination.

16 Q. But you conclude it cannot be
17 ruled out?

18 A. Correct.

19 Q. That it isn't?

20 A. Correct.

21 Q. So what you have then is not
22 support for your hypothesis, but an argument as to why
23 that data doesn't completely rule out your hypothesis?

24 A. In a general sense perhaps.

25 Q. That argument that you develop for



1 not completely ruling out your hypothesis depends on
2 your interpretation that the site is complex, doesn't
3 it?

4 A. There are other elements that
5 impinge upon it and one that was discussed earlier this
6 morning. The total mass of leachate generated at the
7 site, and I believe the numbers quoted earlier were
8 about 250 millimetres per annum and if only 50, and I
9 am recalling numbers, but is captured by the collection
10 system at Bayview, then there is an imbalance in the
11 mathematics and where is that fluid going? I don't
12 know.

13 Q. What you are postulating is that
14 there may be some small scale local complexities that
15 have resulted in all of the monitoring wells south of
16 Bayview and all of the monitoring wells south of
17 Burlington missing the leachate plume?

18 A. In part and that which moves to
19 depth and which may pass beneath them, yes.

20 Q. That interpretation I suggest
21 depends on your hypothesis that the site is
22 unpredictable and complex?

23 A. That is consistent with the
24 hydraulic head data for a start, yes.

25 Q. In interpreting the results of



1 that monitoring data I suggest to you that you have
2 utilized your hypothesis to support itself?

3 A. I have also used the data to
4 support that.

5 Q. I suggest to you you have done the
6 same thing with your hydraulic gradient data.
7 Everywhere where there is an anomaly, Mr. Petrie, you
8 did not discount that anomaly because of your opinion
9 that the site is complex and unpredictable, isn't that
10 true?

11 A. I believe some of the water level
12 data was discredited as Miss Hewetson pointed out later
13 that some of her piezometers were not functioning
14 correctly and to include that data would lead to a more
15 convoluted picture.

16 Q. Unless the data could be
17 exclusively proven to you to be bad data you included
18 it -- let me put it this way, you refused to exclude it
19 on the basis that the site was complex and
20 unpredictable?

21 A. Some of the data had been provided
22 to us from Trow because in the document we were
23 required to critique and the function of our critique
24 was such that we felt the site could not be approved or
25 the site was not hydrogeologically suitable on the



1 basis of the data they provided.

2 Q. You did not discount any anomaly
3 at Site F that could not be definitively proven to be
4 bad data, did you, Mr. Petrie?

5 A. No, that is not correct.

6 Q. Well, what did you discount at
7 Site F that was an anomaly, Mr. Petrie?

8 A. The toluene occurrences that were
9 encountered in the recent monitoring we undertook for
10 Bayview, and I indicated there were two potential
11 sources, the landfill and natural. There were no
12 chlorinated organics in connection with the toluene and
13 it seemed unlikely to be a landfill derived source and
14 also there were no other natural hydrocarbons
15 associated with the toluene and it did not strike me as
16 conclusively a natural source, and so to that end we
17 recommended some additional works which may set out to
18 demonstrate that.

19 With respect to some of the pumping test
20 data, there are calculated values provided Mr. Sobanski
21 which would lead to very high values for hydraulic
22 conductivity if one took those at face value, but I did
23 not take those at face value.

24 Q. At Site D when you engaged in a
25 similar exercise and when you found an anomaly you



1 discounted it on the basis that you predicted this site
2 would be uniform?

3 A. We are dealing with a very
4 different site. At Site D we have layered stratigraphy
5 which is very easily identified.

6 Q. That's your hypothesis?

7 A. That is the proposal put forward
8 before this Board.

9 Q. That is your hypothesis of Site D?

10 A. That is the data that was
11 available from Trow and the hydrostratigraphy has been
12 relatively easily identified by Trow, but the question
13 remains what variation can one encounter within each of
14 the layers. I am indicating the framework for
15 assessing Site D is a very different framework than the
16 one which assesses, in a pure hydrogeologic sense, Site
17 F.

18 Q. That is your hypothesis, that the
19 framework of the two sites is very different?

20 A. That is the information that I am
21 giving to you.

22 Q. It is the hypothesis you have
23 generated from the data you had at both sites?

24 A. The two sites are obviously
25 different and I didn't think that that was in question.



1 Q. Therefore, at Site D, when you
2 found some small scale local anomalies in some holes
3 where there were upward gradients and downward
4 gradients you discounted that information as not being
5 of any significance?

6 A. I did not discount it. I
7 indicated that for the site we are looking at the layer
8 of primary concern is the unweathered upper till.
9 Moving down in the system, the next layer of most
10 concern with respect to assessing the suitability of
11 the site for a landfill is the potential off-site
12 pathways of which there is the upper granular unit and
13 the lower granular unit. At Site F I could not
14 categorize the flowpaths and that is where we differ in
15 our assessment of the two sites.

16 Q. I understand your opinion,
17 Mr. Petrie. I wonder if you could turn to page 42 of
18 your Site F report. There are not many places where I
19 want to ask you about detail in these reports, but when
20 I read this paragraph it didn't quite make sense. I am
21 talking about the paragraph at the top of page 42,
22 particularly the last sentence where it says:

23 "CRA considers it more appropriate to
24 use the well depth below the bedrock
25 surface as the aquifer thickness in



1 order to calculate the hydraulic
2 conductivity of that portion of the
3 bedrock exposed to the effects of
4 pumping."

5 To put this in context, do you recognize this as part
6 of your discussion of the pumping tests at Site F?

7 A. I do.

8 Q. You criticized at the top of that
9 paragraph Mr. Sobanski for assuming an aquifer
10 thickness of 0.3 metres and you say that your firm
11 considers it more appropriate to use the well depth
12 below the bedrock surface?

13 A. Correct. Ideally that should read
14 below the base of the casings, but we are only talking
15 a metre or so difference.

16 Q. What we are talking about is the
17 amount of rock that is open to the hole -- open to the
18 test?

19 A. That is correct.

20 Q. Am I missing something,
21 Mr. Petrie, because it was my understanding that that
22 is not what you did when you did your calculations for
23 PW-1. You assumed an aquifer thickness I think of 5 or
24 7 metres and not the entire well depth?

25 A. I did not assume an aquifer



1 thickness as such and I demonstrated, based on the
2 response of that well, in my mind the bulk of the water
3 was being generated in one restricted interval of the
4 exposed borehole wall and I used that thickness. It is
5 something, the number you quoted there.

6 Q. Five or 7 metres?

7 A. Correct.

8 Q. So am I right then, am I not, that
9 you did not do what this sentence would indicate, that
10 is you would use the well depth below the bedrock
11 surface as the aquifer thickness. You exercised some
12 judgment in determining what the appropriate aquifer
13 thickness was?

14 A. I did.

15 Q. So this sentence strictly speaking
16 is not correct?

17 A. Well, it is a general statement.

18 Q. It is a general statement that you
19 would use the depth below the bedrock as the aquifer
20 thickness except where your judgment indicates that you
21 should use something different. Is that fair?

22 A. That's fair.

23 Q. In fact, in this case you
24 exercised some judgment that the appropriate thickness
25 was the top 5 or 7 metres?



1 A. Something to that effect.

2 Q. Mr. Sobanski exercised his
3 judgment that the appropriate thickness was 0.3 metres?

4 A. He did.

5 Q. Your difference with Mr. Sobanski
6 is not a fundamental one that you should not be
7 reducing the aquifer thickness, your difference with
8 Mr. Sobanski is one of degree, I suggest?

9 A. That is not correct.

10 Q. Well, Mr. Sobanski, would you not
11 agree, exercised his judgment in deciding the full
12 aquifer thickness was not appropriate, but that some
13 smaller amount was appropriate?

14 A. He indicated a smaller amount was
15 appropriate. However, in generating his
16 hydrostratigraphic framework he then applied the value
17 resulting from that smaller amount over a much thicker
18 interval.

19 Q. Mr. Petrie, that may or may not be
20 true, but I am not asking you that. I am asking you as
21 to whether or not when you are interpreting these
22 results there is a fundamental difference between you
23 and Mr. Sobanski or one of degree. You have agreed
24 with me that both of you rejected the idea of using the
25 full well depth below the bedrock surface and you



1 exercised your judgment and decided that 5 or 7 metres
2 was appropriate as the screening interval and
3 Mr. Sobanski used his judgment and agreed or thought it
4 was 0.3 metres. Would you not agree that on that issue
5 alone, and that's all I am asking about, your
6 difference with Mr. Sobanski is one of degree and not a
7 fundamental difference?

8 A. Perhaps we went different
9 directions with the information as well.

10 Q. That may or may not be so, but on
11 that issue it is a difference of degree of
12 interpretation?

13 A. Perhaps.

14 Q. What do you mean "perhaps"?

15 A. I am not sure what you are getting
16 at. His calculation led him to develop a value which I
17 believe he described as a fracture permeability and I
18 developed a value which I described as an aquifer
19 permeability. Perhaps we were dealing with different
20 terms here.

21 Q. Mr. Petrie, for the purposes of my
22 question I don't take issue with what you did with the
23 information once you used your judgment. Your text on
24 page 42 in the last paragraph -- the last sentence of
25 the first paragraph says to me that you should use the



1 full well depth below the bedrock surface?

2 A. It suggests it is more appropriate
3 to use that, yes.

4 Q. You have agreed that you would use
5 your judgment in reducing that where you considered it
6 appropriate to do so?

7 A. We have suggested to use the full
8 well depth because the aquifer thickness have not been
9 defined. In reviewing the data from that test it
10 appears one could make some interpretation as regards
11 the appropriate thickness for that well, yes.

12 Q. That was your judgment?

13 A. That was my judgment.

14 Q. Mr. Sobanski exercised his
15 judgment differently?

16 A. He exercised his judgment
17 differently.

18 Q. But you are not saying that
19 Mr. Sobanski was not entitled to exercise judgment in
20 this circumstance?

21 A. Mr. Sobanski is quite entitled to
22 exercise his judgment.

23 Q. As you did?

24 A. As I did.

25 Q. Your judgments were different?



1 A. That is correct.

2 Q. I would like to ask you a little
3 bit about infiltration and I hope it won't take me a
4 week and a half.

5 MR. HODGSON: I am not sure if that was
6 a compliment or a criticism.

7 MR. PETRIE: I don't know if it was a
8 question.

9 MR. GARROD: Q. There was no question
10 there, Mr. Petrie. Maybe I should wait for an answer
11 and then frame my question. When we are considering
12 infiltration into a landfill site, Mr. Petrie, I think
13 it is fair to say that when we have been discussing it
14 over the last couple of weeks or when you were
15 discussing it with Mr. Hodgson you were talking about
16 an annual infiltration rate?

17 MR. PETRIE: A. Yes.

18 Q. Do you agree with me that the
19 annual infiltration rate would not actually be evenly
20 distributed in every month of the year?

21 A. Most likely, yes. I am agreeing.

22 Q. Thank you. So, therefore, there
23 is some seasonal variation to it?

24 A. There is.

25 Q. And when we think about the



1 circumstances under which infiltration will occur and
2 when it will not occur, it seems intuitively correct to
3 me that when ground is frozen there will be less of the
4 water available for infiltration that is able to
5 infiltrate than when it is not frozen?

6 A. Do you mean a landfill or native
7 ground?

8 Q. I am talking about whatever
9 material we have we are worried about material
10 infiltrating into or water infiltrating into?

11 A. You started with a landfill and
12 landfills sometimes have enough heat in them that you
13 don't have frozen conditions right through the cover
14 materials perhaps.

15 Q. What are you telling me?

16 A. You started with a landfill and if
17 your question is is there no infiltration into a
18 landfill in some months, I suspect there may be in some
19 fashion.

20 Q. So you are suggesting the seasonal
21 variation in a landfill may not be as pronounced?

22 A. I am not suggesting that, but I am
23 just saying there may be infiltration through the
24 winter months in a landfill as well.

25 Q. There may be some.



1 A. That is correct.

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3 bit about infiltration and I hope it won't take me a
4 week and a half.

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6 a compliment or a criticism.

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17 your question is is there no infiltration into a
18 landfill in some months, I suspect there may be in some
19 fashion.

20 Q. So you are suggesting the seasonal
21 variation in a landfill may not be as pronounced?

22 A. I am not suggesting that, but I am
23 just saying there may be infiltration through the
24 winter months in a landfill as well.

25 Q. There may be some.



- 1 A. There may be some.
- 2 Q. Would you agree to this extent; we
- 3 have some water falling down out of the sky?
- 4 A. It happens.
- 5 Q. It may fall as snow?
- 6 A. It may, yes.
- 7 Q. In the winter it is quite likely
- 8 to. Some of that, if we try to picture a flow diagram
- 9 in our minds, some of that precipitation, depending
- 10 upon the season, I suppose in any season, will
- 11 evaporate or go back to the atmosphere as
- 12 transpiration?
- 13 A. Correct.
- 14 Q. That is lost to our system?
- 15 A. Yes.
- 16 Q. It is not of concern to us?
- 17 A. We are not addressing it on this
- 18 scale, no.
- 19 Q. Of the rest some will go into the
- 20 cover of the landfill?
- 21 A. Correct.
- 22 Q. Some will run off?
- 23 A. Correct.
- 24 Q. Those are the only two choices?
- 25 A. Yes.



1 Q. Let's think about it in terms of
2 the seasons again. After we have had whatever
3 evaporates, we have a certain amount left, so let's
4 call that X. Would you agree with me that in the
5 winter months, say, January, February and March that
6 most of X will run off, perhaps 95 per cent, and only a
7 relatively small amount or per cent of X will go into
8 the cover of the landfill?

9 A. Perhaps. I am not so familiar
10 with winter events but, yes.

11 Q. You are the expert in this area
12 and I would like your evidence. Do you agree ...

13 A. In a general sense frozen ground
14 conditions, if there is warmth enough to melt the snow
15 there will be some runoff, yes.

16 Q. In fact if any snow piles up on
17 the landfill in January, February and March, when March
18 comes along and it melts it is likely to run off more
19 than go into the landfill?

20 A. Probably.

21 Q. That is intuitively sensible?

22 A. I take no issue with that.

23 Q. Would you agree with me -- are you
24 able to put any percentage on that, Mr. Petrie?

25 A. I can't.



1 Q. Could you agree with me that it is
2 going to be a high percentage of it would run off
3 compared to the amount that would go into the cover of
4 the landfill during January, February and March?

5 A. Probably.

6 Q. Probably three-quarters?

7 A. I couldn't answer that.

8 Q. Certainly more than half.

9 A. I couldn't say that.

10 Q. You couldn't say that?

11 A. No. I have indicated it is
12 probably more than goes in.

13 Q. Probably more than half?

14 A. Probably.

15 Q. So we have a landfill that is
16 receiving precipitation and some of it is gone by
17 evapotranspiration and the rest of it that is left in
18 January, February and March, we have half of it
19 probably running off. Are you saying yes?

20 A. Perhaps, yes.

21 Q. You told me probably?

22 A. I am not entirely sure. In March
23 we sometimes find significant water level rises in some
24 landfills and so the runoff component when you get
25 snowmelt does lead to some infiltration and much



1 depends on the frozen ground conditions beneath the
2 snow cover. If you had snow on the ground before you
3 had significant freezing, then you may find the ground
4 is not particularly freezing and when you get snow melt
5 you quite a bit of infiltration. If you had frozen
6 ground conditions prior to snow covering it, you may
7 find when the snow melts there is still frozen ground
8 so there is runoff so it is, I assume, a site-by-site,
9 season-by-season phenomenon.

10 Q. On average if you took all the
11 January, February's and March's and averaged them over
12 a number of years, would you agree that more would run
13 off than would go into the landfill?

14 A. I said probably.

15 Q. I would hate to force you to be
16 more definitive.

17 MR. McQUAID: Mr. Chairman, there have
18 been a series of comments made to the witness starting
19 with Mr. Hodgson and now Mr. Garrod. I don't think the
20 witnesses need that.

21 MR. GARROD: I am sorry, Mr. Chairman,
22 that was not intended as a snipe.

23 Q. You can't be more definitive?

24 MR. PETRIE: A. No, I can't as I have
25 indicated.



1 Q. Can you help me with any of the
2 other months of the year or am I getting beyond
3 something ...

4 A. The other months of the year have
5 different conditions and I can help you and perhaps you
6 could pose your question and I will see if I can answer
7 it.

8 Q. I am interested in this proportion
9 between what runs off in various months and what goes
10 into the landfill in various months?

11 A. It varies seasonally as you have
12 indicated and I agreed.

13 Q. I have your evidence that probably
14 half will run off for January, February and March?

15 A. Probably.

16 Q. And half would go into the
17 landfill?

18 A. Probably.

19 Q. What would happen in April and May
20 if we call those the spring months. What sort of
21 proportions would you be looking at there? How does it
22 change?

23 A. You would have more infiltration
24 in those months depending of course again on the
25 rainfall events.



1 Q. So then the proportion -- it
2 doesn't depend upon the rainfall because we are talking
3 percentages?

4 A. It depends upon the rainfall
5 events. If you don't get much rainfall you won't get
6 much infiltration during those periods.

7 Q. But of the events or the
8 precipitation that falls, I am interested in the
9 percentage of that after evapotranspiration that goes
10 into the landfill rather than running off?

11 A. Yes.

12 Q. It doesn't matter how much falls,
13 or does it?

14 A. It does because if the soils are
15 dry you will get one infiltration regime and if the
16 soils are at field capacity you may get a different
17 one.

18 Q. Can we assume in April and May the
19 soils are relatively wet; does that seem sensible?

20 A. It happens. I am not sure what
21 you are getting at all and I find it difficult to be
22 definitive.

23 Q. I am trying to get at what your
24 evidence is, Mr. Petrie, and I have ...

25 A. I am not sure I have addressed



1 infiltration into the landfill at all at this hearing
2 to date.

3 Q. That may or may not be the case
4 but are you telling me that it is beyond your
5 expertise?

6 A. Mr. Crutcher has more experience
7 with infiltration into landfills than I do.

8 Q. Are you telling me that the
9 questions I am asking you are beyond your expertise?

10 A. I didn't say that. I said
11 Mr. Crutcher has more experience with infiltration into
12 landfills than I do and I suggest his experience is
13 more than mine.

14 Q. But you are experienced and
15 sufficiently knowledgeable to answer the questions I am
16 asking on this topic?

17 A. I have been a little vague on some
18 of your questions. I have some opinions and if you
19 wish to get a more definitive opinion, perhaps you
20 should pose the questions to Mr. Crutcher.

21 Q. Perhaps I will do that, but I
22 would like your opinion first. Are you able to give me
23 an opinion in this breakdown between the amount that
24 will run off of the landfill in April, May -- you can
25 break them down into individual months if you would



1 like, but can you give me an opinion as to what
2 percentage of the precipitation after
3 evapotranspiration will run off versus the amount that
4 will go in?

5 A. I am not able to give you a
6 definitive opinion.

7 Q. I don't want a definitive opinion
8 but I would like your opinion as to what is probably
9 going to happen?

10 A. Relative to that which
11 infiltrates, again it very much depends on the
12 capacities of the landfill and what sort of cover
13 materials you have available and whether you are
14 dealing with sloped surfaces or an engineered cover or
15 an open landfill.

16 Q. Let's deal with the landfill we
17 are familiar with, the Burlington landfill?

18 A. If you want an opinion on the
19 performance of the Burlington landfill, perhaps we
20 could take it from this document, H-625.

21 Q. Those are the opinions of Gartner
22 Lee?

23 A. They have recorded the data and
24 provided the estimates of rainfall and have come up
25 with an annual water balance on the site, so I suggest



1 we could find the information you seek here.

2 Q. Mr. Petrie, you understand Gartner
3 Lee was unable to quantify the amount of runoff as
4 opposed to the amount that went into the landfill?

5 A. That is my recollection, yes.

6 Q. You understand that that is what I
7 am seeking your opinion on?

8 A. I am telling you I don't have a
9 definitive opinion.

10 Q. I am telling you I would like your
11 opinion on what would probably happen.

12 A. More would run off in April than
13 the summer months.

14 Q. Okay. That's a start. We have
15 more running off in April than in the summer months.
16 Would it be fair to say that at least some of it in the
17 summer months will run off?

18 A. It would depend on the frequency
19 of the rainfall events and the saturation of the soil
20 materials encountered.

21 Q. But not all the rainfall that
22 falls on the Burlington landfill site in the summer
23 months would go into the landfill?

24 A. Very little would go into the
25 landfill in the summer.



- 1 Q. Why is that?
- 2 A. We have a soil moisture deficit in
- 3 the summer.
- 4 Q. Most of that would run off?
- 5 A. Right, probably most of it would
- 6 transpire and be held up in the soil and evaporate.
- 7 Q. You are misunderstanding.
- 8 A. Perhaps I am. I am at a loss.
- 9 Q. I am talking to you about the
- 10 water after evapotranspiration. I am asking about the
- 11 summer months. What will happen to that water?
- 12 A. In the summer months the
- 13 evapotranspiration -- theoretical evapotranspiration
- 14 will exceed precipitation and there is no balance
- 15 during the summer.
- 16 Q. There is none to run off and none
- 17 to infiltrate in the summer months?
- 18 A. In general, yes.
- 19 Q. Then we consider the fall and we
- 20 start getting saturated conditions again?
- 21 A. Correct.
- 22 Q. And late fall we would have
- 23 perhaps some frozen conditions again?
- 24 A. Perhaps.
- 25 Q. What happens in that period of



1 time?

2 A. Due to a saturated condition you
3 would expect much more infiltration into the landfill
4 and when frozen ground conditions occur you would
5 expect much less.

6 Q. So we have then, if we can
7 summarize, we would probably have more than half of it
8 running off in January, February and March?

9 A. Yes.

10 Q. We have probably less than half of
11 it running off in April and May?

12 A. Yes.

13 Q. We probably have all of it
14 evapotranspiring in the summer months?

15 A. Probably.

16 Q. And then in the fall it sort of
17 happens in reverse again?

18 A. Correct.

19 Q. Let me ask you if we could turn to
20 page 11 of Exhibit 625. This you will see, Mr. Petrie,
21 is the water budget information Gartner Lee generated
22 in their most recent report for the Burlington landfill
23 site?

24 A. That is correct.

25 Q. There is this little schematic on



1 the bottom half of page 11 that we have all been
2 looking at?

3 A. Yes.

4 Q. So we see if we can focus on
5 measured precipitation, 805 millimetres, 100 per cent?

6 A. Yes.

7 Q. You have no quarrel with that
8 number I take it?

9 A. No.

10 Q. You see the calculated
11 evapotranspiration is 480 millimetres or 60 per cent
12 and you have no quarrel with that?

13 A. It is a calculation taken from
14 some site data I gather in Hamilton, but in the general
15 sense I have no quarrel.

16 Q. It sounds reasonable to you?

17 A. Yes.

18 Q. You have measured volume of
19 collected leachate, 253 millimetres or 31 per cent, and
20 you don't quarrel with their collection, do you?

21 A. No, I do not.

22 Q. Then we have some unknowns on this
23 diagram. We have what I am calling (i) and can I get
24 you to put an (i) beside the arrow immediately below
25 the tip of the landfill mound. Do you see that, the



1 one called estimated infiltration?

2 A. I see where you mean.

3 Q. I am calling that (i) for
4 infiltration?

5 A. Right.

6 Q. That is 253 millimetres plus the
7 leakage to the shale?

8 A. As it is written, yes.

9 Q. Out of the bottom of the landfill
10 we have leakage to shale bedrock and I am calling that
11 (e) for exfiltration and is that consistent?

12 A. Yes, it is.

13 Q. We don't know that volume?

14 A. Correct.

15 Q. We then have estimated surface
16 runoff which is 72 millimetres minus the leakage to
17 shale?

18 A. That's what it says here.

19 Q. Well, everything adds up so far,
20 does it not?

21 A. Yes, and you are reading it to me
22 and I am agreeing that is what it says.

23 Q. That would be about 9 per cent if
24 we took evapotranspiration as 60 per cent and the
25 collective volume as 31 with leaves us with 9 per cent



1 which is the 72 millimetres?

2 A. That would appear to be the case.

3 Q. Starting from the original 805
4 that fell on the ground?

5 A. Correct.

6 Q. What I would like to do with you
7 is explore the implications of how much runoff we would
8 have on a seasonal basis, because what we have here is
9 72 millimetres total estimated runoff over the year, is
10 that correct?

11 A. Correct, an annual water budget.

12 Q. You told me in your opinion that
13 we probably have 50 per cent of the amount that is left
14 over after evapotranspiration running off in January,
15 February and March?

16 A. I thought that that may be the
17 case.

18 Q. If we flip to the back of this
19 document at page 89 -- I am sorry, I think I have given
20 you the wrong page number. Page 89?

21 A. I have it.

22 Q. This tells us how much
23 precipitation falls each month?

24 A. Yes.

25 Q. It tells us also how much



1 evapotranspirates each month?

2 A. It does.

3 Q. In the last column on the right-
4 hand side it tells us how much is left over that could
5 possibly go either into the landfill or run off?

6 A. Correct.

7 Q. If we take your estimate that
8 probably 50 per cent runs off on January, February and
9 March, what does that number give us. First of all,
10 would you agree there is 142 millimetres that is left
11 over after evapotranspiration in January, February and
12 March?

13 A. Adding those three numbers for
14 January, February and March, I see 142 millimetres.

15 Q. Half of that is 71?

16 A. Correct.

17 Q. What we have here is runoff --
18 let's assume for the minute that there isn't any more
19 runoff for the rest of the year. Would you assume that
20 with me?

21 A. Yes, I can.

22 Q. We have runoff occurring in this
23 year then of 71 millimetres?

24 A. Yes.

25 Q. That would mean that when we turn



1 back to page 11 and we want to figure out what the
2 leakage to shale would be, the leakage to shale would
3 be 1 millimetre per year, wouldn't it?

4 A. If you were to do it like that,
5 yes.

6 Q. In fact whatever amount runs off
7 will take away from that 72 millimetres?

8 A. The way this water budget is
9 balanced, yes.

10 Q. If we take these numbers as
11 accurate, the worst case at Burlington is 72
12 millimetres infiltrating and even if nothing runs off?

13 A. For the numbers they have
14 provided, that appears to be the worst case. They do
15 not address changes in storage within the system and it
16 is not in this document, so I assume the changes in
17 storage are zero, and, as Mr. Crutcher pointed out,
18 perhaps this collection system is also collecting some
19 groundwater flowing into the site in some fashion.

20 So, while it is a balance, perhaps it is
21 not a concise balance.

22 Q. Can we explore that a little bit.
23 I think there was a map that showed the configuration
24 of the Burlington landfill site, and it is clipped on
25 to one of your air photos behind you. Perhaps it would



1 be better if we used one of these maps from the
2 monitoring report because I think they are more recent
3 and they are larger. I wonder if you could take one of
4 them out of your report?

5 A. Mine has already been exhibited
6 from our report and perhaps I should retrieve that or I
7 shall lose all of our maps.

8 Q. I am afraid I can't assist you on
9 what map that was.

10 MR. HODGSON: Either Figure 1 or Figure
11 4 was made an exhibit during my cross-examination.

12 MR. GARROD: Q. That one will do.

13 MR. PETRIE: A. That one? It is not
14 from my report.

15 Q. Has it got a number on it?

16 A. It has the number B-217A.

17 Q. What I am interested in are your
18 comments that perhaps the leachate collection system at
19 Burlington is collecting some water other than the
20 water that comes in down through the top of the
21 landfill?

22 A. Those were Mr. Crutcher's comments
23 and I just repeated them.

24 Q. I assumed you were adopting them
25 by repeating them, or am I wrong?



1 A. I was indicating to you that that
2 is what had been said earlier.

3 Q. Do you agree with that?

4 A. I have not evaluated it at great
5 depth.

6 Q. Let's evaluate it together on the
7 map behind you. Would you agree that to the north of
8 the Burlington landfill site there is the Falcon Creek
9 valley?

10 A. Yes.

11 Q. That runs down the western side of
12 the landfill?

13 A. Yes.

14 Q. Would you agree, therefore, that
15 there could not be coming into this site any
16 significant amount of groundwater from the north or
17 from the west?

18 A. Correct.

19 Q. Because of the way the topography
20 lies, and because of the regional groundwater flow
21 directions it wouldn't come in from the east either,
22 would it?

23 A. Generally there is mounding within
24 the landfill as I recall the water table configurations
25 and I can't recall if there is a component of flow onto



1 the site from the east. There does not appear to be
2 one.

3 Q. There isn't, in fact all the
4 arrows of Gartner Lee show it going the other way?

5 A. It does appear that way, yes.

6 Q. What we have here is quite a
7 unique situation where we have a landfill site and a
8 collection system where we know that what is being
9 collected is coming only from what comes down through
10 the cover of this landfill and not in through the
11 sides?

12 A. That is probably a fair
13 representation.

14 MR. CRUTCHER: May I comment on that?

15 Q. You may.

16 MR. CRUTCHER: A. When I made that
17 comment I did not know whether in fact it was
18 collecting groundwater, but I know they installed a
19 periphery leachate collection system along the bottom
20 third of the site and it depends to what depth they
21 installed that system and what the water table
22 configurations were at the time, but that is at the
23 edge of the site and you would have a groundwater flow,
24 a leachate flow from one side and a groundwater flow
25 potentially from the other side, and that is what I was



1 referring to.

2 It is similar to Bayview, the Bayview
3 leachate collection system which will have a
4 groundwater flow component to it as well.

5 Q. That is in the glacial till?

6 A. Which site?

7 Q. The site you just discussed.

8 A. I discussed both.

9 Q. Your explanation at the Burlington
10 site?

11 A. At the Burlington site a portion
12 of it will be in the shale.

13 Q. A portion?

14 A. Yes.

15 Q. But most of it is in the till?

16 A. The north part of the site is in
17 the till.

18 Q. You are talking about the
19 underdrain system as I understood?

20 A. The underdrain system is on the
21 northern part of the Burlington landfill site and the
22 periphery system is along the southern portion. The
23 one I specifically referred to was the southern portion
24 and the system I believe would be in the shale, but I
25 don't know the actual depth of the excavation, and it



1 was the comment as a possibility and I did not see it
2 being addressed.

3 Q. That is a relatively minor source
4 of error in the scheme of things, don't you agree?

5 A. I don't know the level.

6 Q. Do you still have Exhibit 625 in
7 front of you?

8 MR. PETRIE: A. Yes, I do.

9 Q. Do you recall Gartner Lee
10 addressed this question themselves at page 12 where
11 they say in the second paragraph:

12 "The water budget illustrated in Figure
13 3 assumes that there is negligible
14 ground water inflow into the landfill.
15 This assumption appears reasonable since
16 the landfill covers most of the local
17 ground water recharge area and the low
18 permeability till soils at the north end
19 of the landfill are not expected to
20 yield much water."

21 A. I see those words.

22 Q. Gartner Lee considered that to be
23 a reasonable assumption?

24 A. Yes. They state it appears to be
25 a reasonable assumption, yes.



1 Q. Mr. Petrie, if we were to assume
2 that the infiltration into the Burlington landfill site
3 is 50 to 100 millimetres per year, we would have to be
4 assuming a number of things about these calculations we
5 have just gone through. We would have to assume, first
6 of all, that virtually all of the water that did not
7 evapotranspire went into the landfill site, is that
8 correct?

9 A. I am sorry, could you start that
10 again? I missed the gist of your question.

11 Q. If we wanted to try to understand
12 how we could get an exfiltration rate at Burlington of
13 72 -- of 50 to 100 millimetres per year, we would have
14 to assume a number of things about the water balance we
15 have just discussed?

16 A. Correct.

17 Q. One of the things we would have to
18 assume is that there was essentially zero runoff?

19 A. Looking at the numbers you have
20 before you, if you reduce the runoff to zero, then as
21 you indicated you would have 72 millimetres
22 exfiltrating to the shale.

23 Q. We would have to assume that of
24 the zero runoff, if we assumed zero runoff, the balance
25 going into the landfill completely misses the



1 collection system and all goes out the bottom?

2 A. Yes.

3 Q. If we are going to put another 72
4 millimetres into the top we must also get it past the
5 collectors and out the bottom?

6 A. Well, at the southern part or
7 portion of the site the collectors are not in the
8 landfill but around the periphery.

9 Q. We must get it down through the
10 bottom before it can flow towards the collectors?

11 A. Correct.

12 Q. We would have to have a vertical
13 hydraulic permeability greater than the horizontal one
14 along the base of the landfill in order for the water
15 to want to go down deep rather than run horizontally?

16 A. It very much depends on the
17 fracture geometry and the head within the system. You
18 have a driving force, you are pushing more water in and
19 because you are not running it off you will have higher
20 leachate mounding and there will be a change in the
21 head distribution beneath the landfill, and so the
22 driving forces would change.

23 Q. We would have to have a massive
24 fracturing at the base of that landfill site?

25 A. You would have to have significant



1 fracturing, yes, or significant contrast in
2 permeability.

3 Q. Which means massive fracturing?

4 A. Yes.

5 Q. If we had massive fracturing of
6 the upper part of the base of that landfill site, it
7 would be very likely that that would extend off-site
8 and south of that site; wouldn't it?

9 A. Perhaps.

10 Q. Mr. Petrie, if we were going to
11 make an assumption that the base of the Burlington
12 landfill site was massively fractured...

13 A. That is your assumption.

14 Q. You have told me that that is an
15 assumption we have to make in order to get all of these
16 72 millimetres of water exfiltrating from the site?

17 A. For the water balance we have
18 before us, yes.

19 Q. Does it seem unreasonable to you
20 to assume that if that was the case that the upper
21 shale south of the Burlington site would also be
22 massively fractured?

23 A. It would be consistent to expect
24 more fracturing there if you were going to have massive
25 fracturing at the base of the landfill, yes.



1 Q. If that was the case we could find
2 that contaminant plume with the monitors that Gartner
3 Lee have put there, couldn't we?

4 A. Perhaps, but then the other
5 question that comes to mind when I look at this is
6 where do the other 253 millimetres per year go prior to
7 the installation of this peripheral collection system.

8 Q. I wonder -- I don't know what time
9 it is, but if this was a point at which you wanted to
10 break?

11 MR. LANCASTER: I was going to suggest
12 that I would like to break early today or rise earlier
13 today and so if there is a conveniently place in the
14 next half hour or so for you...

15 MR. GARROD: I have forgotten, but have
16 we had an afternoon break?

17 MR. LANCASTER: We haven't.

18 MR. GARROD: You are suggesting I
19 continue?

20 MR. LANCASTER: Continue through for an
21 appropriate time for you, say within the next half
22 hour, as it is going on 3:30 now.

23 MR. GARROD: Thank you, I will continue.

24 MR. LANCASTER: Unless you wish a break.

25 MR. GARROD: No, fine.



1 MR. LANCASTER: Perhaps the witness
2 would?

3 MR. GARROD: I wouldn't want to deprive
4 Mr. Nethercut either.

5 Q. I would like to explore, if I
6 could, some of these small scale complexities you are
7 concerned about at Site F, the small scale local
8 complexities. Now, I wonder if you could turn in your
9 report, the Site F report, 617...

10 A. I have it.

11 Q. ...to page 95. What we have here,
12 as I understand it, is some potentiometric lines that
13 have been drawn in based on the data generated south of
14 the Bayview site?

15 A. Correct, and this was taken
16 directly from Miss Hewetson's thesis.

17 Q. What this tells us -- I have
18 always understood, and perhaps you can correct me if I
19 am wrong, but you can draw flow lines at 90 degrees to
20 the potentiometric lines and that tells you your flow
21 directions?

22 A. Only if the scales are the same on
23 both axes for one and, secondly, in dealing with
24 fractured media, the exact flow lines are constrained
25 by the fracture geometry but in porous media you are



1 quite correct.

2 Q. The flows might zigzag a little
3 bit to get to where they want to go?

4 A. They would zigzag in conformity
5 with the fracture pattern.

6 Q. In discussing your evidence when
7 you gave it in chief, you talked about this second last
8 piezometer in WAT 4 and the loop around it you made of
9 your 120 metre contour. Do you see that?

10 A. I didn't make that loop as this
11 contour distribution was taken directly from
12 Miss Hewetson. It was her figure.

13 Q. By reproducing it in your report
14 were you adopting it or did you intend to criticize
15 that?

16 A. I meant to show what other
17 researchers had provided at this site.

18 Q. What is your opinion about the
19 validity of that anomalous data point?

20 A. I do recall discussion through the
21 hearing that two piezometers, and I don't recall which
22 well nest, but I have it in my document somewhere if I
23 could have a minute to find it.

24 The two lower piezometers, 9 and 10 at
25 WAT 7 are apparently plugged in some fashion or record



1 anomalous water level values and that is as I have
2 shown it on page 34 of B-617. Here we have the same
3 information and WAT 7 is the graph at the bottom of the
4 page.

5 Q. I will let you continue, but I was
6 talking about WAT 4?

7 A. I beg your pardon, I have my wells
8 confused. I didn't recall from reading Miss Hewetson's
9 thesis that the lower elevations at WAT 4 were in
10 question and so in that sense I have reproduced her
11 data, yes.

12 Q. Are you adopting that as a real
13 data point or are you telling us it is an anomalous
14 data point we should discount?

15 A. I am telling you there is an
16 erratic hydraulic head profile at WAT 4 as I see before
17 me on that set of data.

18 Q. Implicit in that then I take it
19 you were accepting that as a valid data point?

20 A. I am accepting it as data provided
21 by another researcher.

22 Q. Are you accepting it after having
23 evaluated it or are you accepting it without evaluating
24 it?

25 A. I have not measured the well



1 myself.

2 Q. I didn't ask you that.

3 A. That is an evaluation.

4 Q. I am asking you whether you
5 evaluated that data point in light of the sea of data
6 points that surround it and formed an opinion as to
7 whether or not it was a data point that had any
8 validity to it?

9 A. I recall questioning Miss Hewetson
10 on these profiles at one point in time and that is when
11 I believe she indicated to me that the two lower ones
12 in WAT 4 were in question and perhaps the profile she
13 developed for WAT 4 was in error, but I don't remember
14 her indicating to me that WAT 7 was in error and I
15 don't recall asking specifically -- I am sorry.

16 Q. We are talking WAT 4.

17 A. I beg your pardon, I have it
18 confused. When I questioned her about the piezometer
19 profiles she indicated that at WAT 7 she had some
20 concern with some of the piezometers and I believe she
21 indicated to me that it was the ones I referenced
22 before, to which end I did not reproduce that data on
23 the page I referenced earlier.

24 I also note at WAT 4 she does not have a
25 uniform distribution of measuring points down the



1 profile. If you look at the figure on page 95 you will
2 note in general the little squares on WAT 4 are
3 equidistant until you come to the bottom and there is a
4 gap and an isolated point, a second gap and another
5 isolated point and my recollection of our discussion,
6 which was some time ago, was that the second to bottom
7 and fourth to bottom piezometers were faulty in some
8 fashion and in my opinion she recalled the third to
9 bottom one, the one that gave the lower pressure head
10 was not in error.

11 Q. Perhaps I can try again. By
12 including this in here are you accepting that data
13 point as a valid data point upon which conclusions
14 should be drawn or are you telling us it is an
15 anomalous data point we should reject?

16 A. Miss Hewetson concluded in her
17 thesis that she felt the site was complex and she
18 listed a lot of criteria by which she developed it. I
19 reviewed her criteria and came to a similar conclusion,
20 there are complexities on this site. I reproduced her
21 data as she developed it and it contributes to the
22 picture.

23 Q. I am prepared to stay here as long
24 as necessary and I am prepared to repeat the question
25 as many times as I have to. If you look at the second



1 data point, the second from the bottom in WAT 4 as
2 reproduced on Figure C.3.1 you have told me this was
3 reproduced from Miss Hewetson's thesis?

4 A. Correct.

5 Q. I am asking you now what is your
6 opinion, is this an anomalous data point we should
7 reject or is this a data point upon which we should
8 draw conclusions?

9 A. I would not draw a conclusion
10 based upon any one data point. It is data provided and
11 I am including it in my consideration of this site.

12 Q. Do you then adopt -- do you draw
13 any conclusion from that data point?

14 A. From that one data point, no. I
15 note the reference in the pressure head profile -- a
16 low pressure zone was encountered at that elevation and
17 so I suppose in a sense I did draw some conclusions
18 from it.

19 Q. Where do you draw those
20 conclusions?

21 A. I believe I referenced that in the
22 text somewhere.

23 Q. You do draw conclusions from that
24 data point?

25 MR. McQUAID: He wants to look for it.



1 MR. PETRIE: Page 96.

2 MR. GARROD: Q. The next page?

3 MR. PETRIE: A. Yes, the fourth line
4 down:

5 "...there is a low pressure zone at an
6 elevation of 100 masl which is expected
7 to define a discrete zone of active
8 groundwater flow."

9 So I do draw some conclusions based on that point.

10 Q. I take it you are implicitly
11 telling this Board and perhaps explicitly so that this
12 data point is a valid data point upon which a competent
13 and experienced hydrogeologist can draw conclusions?

14 A. I have drawn some conclusions on
15 that data point, and other data points.

16 Q. You would have the Board rely on
17 those conclusions?

18 A. I would have them consider my
19 conclusions along with everybody elses.

20 Q. That is one of the small scale
21 complexities?

22 A. I see about 15 small scale
23 complexities on that page. It is one.

24 Q. That is one?

25 A. Correct.



1 Q. That is the most noticeable one,
2 would you not agree?

3 A. The other complexities I note are
4 in WAT 4 we have a low pressure zone at about 115
5 metres elevation, a higher pressure zone at 110 and
6 moving over to WAT 7 we have a low pressure zone at 100
7 and again at 90 with a higher pressure zone in between.
8 We have numerous reversals in gradient within the
9 system and at WAT 2 a low pressure zone at 140 metres
10 elevation with upward and downward flow converging on
11 that point.

12 Q. You have accepted every one of
13 those small scale complexities as a point on which we
14 should draw conclusions?

15 A. Yes.

16 Q. You have not rejected any of these
17 small scale complexities as bad data?

18 A. No, I have not.

19 Q. You have also taken this data from
20 south of the Bayview landfill site?

21 A. This is the Bayview landfill site,
22 yes.

23 Q. You have extrapolated from that
24 data that these small scale complexities also exist
25 under Site F?



1 A. I have extrapolated in a general
2 sense that complexities exist under Site F, yes.

3 Q. So, could you also assume that
4 these small scale complexities exist under the
5 Burlington site?

6 A. That would be fair.

7 Q. You have extrapolated that across
8 all three sites?

9 A. One could.

10 Q. You have?

11 A. You asked me "could you" and I
12 said one could.

13 Q. And you did?

14 A. Yes.

15 Q. While we are on the subject of
16 extrapolation, Mr. Petrie, am I correct that you also
17 extrapolated your conclusion from pumping tests 1, 2
18 and 3 that the upper zone was approximately 2×10^{-4}
19 permeability and you extrapolated that conclusion
20 across all of Site F?

21 A. Yes, although I could not define
22 the zone.

23 Q. You could not define the depth of
24 the zone?

25 A. I could not define its geometry,



1 that is correct.

2 Q. By geometry you mean the depth of
3 the zone?

4 A. Yes.

5 Q. Because you did extrapolate it in
6 a two-dimensional sense across the entire site?

7 A. Correct.

8 Q. Did you extrapolate that
9 conclusion to the Bayview site or to the Burlington
10 site?

11 A. I noted at the Burlington site
12 that the packer test data had given lower values of
13 hydraulic conductivities with reference to the range of
14 values generated.

15 Q. As did the ones on Site F?

16 A. Correct. Trow's values for packer
17 testing I believe ranged up to approximately 1×10^{-3}
18 and I recall Gartner Lee's ranged up to about 1×10^{-5}
19 and I note in their most recent monitoring report, H-
20 625, that they have provided a new value for a new
21 installation, if I can find the reference to that
22 value. On page 18 of H-625, Gartner Lee are discussing
23 three new groundwater monitors installed, being well
24 nest 32, and they provide measurements for the
25 hydraulic conductivities and here they are in metres



1 per second so you have to add a value of 2 to the
2 little exponent to come up with a value in centimetres
3 per second and we note the values they provide are
4 within the range of those previously reported for the
5 shallow bedrock at the site.

6 However, the value of 2×10^{-6} metres
7 per second which is 2×10^{-4} centimetres per second is
8 one of the highest shale hydraulic conductivities
9 measured on this site. So, after X number years and X
10 number of tests they have encountered a value of 10^{-4}
11 centimetres per second which is in the order of the
12 values encountered by Trow at two wells for which they
13 did packer tests and for the three installations where
14 they pump tested.

15 Q. Perhaps you misunderstood my
16 question. I was asking you if you had extrapolated the
17 results that you had extrapolated across all of Site F
18 to the Burlington site and the Bayview site, or did you
19 stop at the boundary when you did your extrapolation?

20 A. I noted that with respect to the
21 data developed for Burlington it was different than the
22 data developed at Site F.

23 Q. I would just like an answer yes or
24 no, if you could?

25 A. I noted differences so I did not



1 extend my extrapolation under the Burlington site.

2 Q. You extrapolated your 2×10^{-4}
3 throughout all of Site F, but you stopped at the
4 boundary between Site F and the Burlington site?

5 A. That's putting it rather crudely,
6 but yes.

7 Q. I don't wish to be crude. Did you
8 extrapolate your 2×10^{-4} under the Bayview site?

9 A. I notice two of the values were
10 generated from downgradient of the Bayview site.

11 Q. Did you extrapolate 2×10^{-4} for
12 the upper zone to the Bayview site?

13 A. I did not directly address the
14 bedrock hydraulic conductivity beneath the Bayview
15 site.

16 Q. Would it be reasonable or
17 unreasonable to extrapolate 2×10^{-4} hydraulic
18 conductivity for the upper layer of the shale to under
19 the Bayview site?

20 A. It may not be unreasonable.

21 Q. "May not be unreasonable"?

22 A. It is reasonable.

23 Q. Thank you. If it is reasonable to
24 extrapolate it under the Bayview site you are saying it
25 is not reasonable to extrapolate it to the Burlington



1 site because of the packer test results you just
2 reviewed?

3 A. There is no data respecting the
4 hydraulic conductivity of the bedrock beneath the
5 Bayview site. At the Bayview site there have been
6 extensive hydrogeologic investigations carried out for
7 X number of years, and I don't have the number at my
8 fingertips, but I notice that we have drilled up to 32
9 observation wells or nests of wells and have done quite
10 a large amount of hydraulic conductivity testing and
11 Gartner Lee noted in their last report that they have
12 encountered their highest value at one location and I
13 am noting at Site F, more values of that order, and
14 higher were developed by Trow. I note there appear to
15 be hydraulic conductivity contrasts at Site F and the
16 adjacent Burlington site but I do not know the
17 hydraulic conductivity under the Bayview site.

18 Q. In your discussion with
19 Mr. Hodgson, you agreed that you had extrapolated the 2
20 $\times 10^{-4}$ downgradient off Site F on a continuous basis in
21 order to generate the numbers?

22 A. Not in order to generate the
23 numbers, but in order to be able to carry water from
24 the site because that layer must be continuous in some
25 fashion.



1 Q. We have three pumping tests
2 results now and perhaps we can look at your report on
3 page 19 and this is Figure B.1.1?

4 A. Page 19 is, yes.

5 Q. This shows us the location of the
6 pumping well test where you obtained this
7 interpretation?

8 A. Correct.

9 Q. We see PW-1 is down by the North
10 Service Road south of the Bayview site?

11 A. We do.

12 Q. PW-3 is south of the Bayview site
13 only closer to the site?

14 A. Yes.

15 Q. PW-2 is on the west side of Site F
16 close to the Burlington site?

17 A. Correct.

18 Q. What you have told me from those
19 three data points is you have extrapolated a figure of
20 2×10^{-4} all the way within the solid dashed line we
21 see on this figure that encircles the L-shape for
22 Site F?

23 A. For conceptual purposes, yes.

24 Q. You have also extrapolated it or
25 you think it would be reasonable to extrapolate it



1 under the Bayview site and you have also extrapolated
2 it south of Highway 403 for what distance, Mr. Petrie?

3 A. I did not define the distance.

4 Q. It would be, I suggest to you --
5 it would have to go all the way to lake?

6 A. It would have to go to HC11 to
7 account for the upward gradients at that point.

8 Q. At least?

9 A. Yes.

10 Q. The result you obtained from PW-2
11 on the west side of Site F cannot be extrapolated
12 beyond the solid dotted line that delimits Site F from
13 the Burlington sanitary landfill site?

14 A. As I have noted before there is a
15 vast amount of data on that site for which we recently
16 have one value which comes to light which even
17 approaches what value you are referring to and I have
18 extrapolated it.

19 Q. Is that your explanation as to why
20 the landfill site at Burlington has been no problem and
21 why Site F would be a disaster?

22 A. I have not said Site F would be a
23 disaster and I have not said Burlington has been no
24 problem.

25 Q. Is that a reason why you see a



1 difference between landfilling at the Burlington site
2 and Site F?

3 A. It is in part, yes, because we
4 have hydraulic conductivities from pumping tests that
5 are higher than I would have envisaged.

6 MR. GARROD: Mr. Chairman, this would be
7 a convenient place to break.

8 MR. LANCASTER: Fine. All right. Nine-
9 thirty Monday morning.

10 ---Adjournment at 3:45 p.m.

11

12 Certified Correct

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C. F. Nethercut, C.V.R.

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17 (Page 29150 follows)

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