RED HILL VALLEY PARKWAY INQUIRY

TRANSCRIPT OF PROCEEDINGS
HEARD BEFORE THE HONOURABLE J. WILTON-SIEGEL
held via Arbitration Place Virtual
on Thursday, February 16, 2023 at 9:32 a.m.

VOLUME 82

940-100 Queen Street
Ottawa, Ontario K1P 1J9
(613) 564-2727

900-333 Bay Street
Toronto, Ontario M5H 2R2
(416) 861-8720

APPEARANCES:

Andrew C. Lewis Chloe Hendrie	For Red Hill Valley Parkway
Jonathan Chen	For City of Hamilton
Heather McIvor Colin Bourrier	For Province of Ontario
Rachel Laurion Chris Buck	For Dufferin Construction
Jennifer Roberts	For Golder Associates Inc.

INDEX

LIST OF EXHIBITS

Arbitration Place Virtual

--- Upon resuming on Thursday, February 16, 2023 at 9:32 a.m.

MR. LEWIS: Good morning, Commissioner and counsel.

JUSTICE WILTON-SIEGEL: Good morning.

MR. LEWIS: Dr. Flintsch.

DR. FLINTSCH: Good morning.

MR. LEWIS: I would like to open this phase of the hearings by acknowledging that the City of Hamilton is situated upon the traditional territories of the Erie, Neutral, Huron-Wendat, Haudenosaunee and Mississaugas. This land is covered by the Dish With One Spoon Wampum Belt Covenant, which was an agreement between the Haudenosaunee and Anishinaabek to share and care for the resources around the Great Lakes.

We further acknowledge that the land on which Hamilton sits is covered by the Between the Lakes Purchase, 1792, between the Crown and the Mississaugas of the Credit First Nation. Many of the counsel appearing today are in Toronto, which is on the traditional land of

the Huron-Wendat, the Seneca and most recently the Mississaugas of the Credit River. Today this meeting place is still home to many indigenous people from across Turtle Island and we're grateful to have the opportunity to work on this land.

Now, Registrar, we have today Dr. Gerardo Flintsch with us, and if you could please -- if the court reporter could affirm the witness.

AFFIRMED: DR. GERARDO FLINTSCH

EXAMINATION BY MR. LEWIS:

Q. Now, we have a number of expert reports that have been produced, one of which is Dr. Flintsch's, and I would like to make them, Commissioner, exhibits off the top in anticipation of the other witnesses as well testifying this week and next.

So, the first one is Dr. Flintsch's report, EXP191, and I believe, Registrar, that that is Exhibit 220. Is that correct?

THE REGISTRAR: Noted. Yes, correct.

EXHIBIT NO. 220:

Dr. Gerardo Flintsch's report, EXP191.

MR. LEWIS: And the next one is the report of Mr. Russell Brownlee of TNS, which is EXP192, Exhibit 221.

EXHIBIT NO. 221:
Mr. Russell Brownlee's report, EXP192.

MR. LEWIS: The report of Mr. David Hein, this includes his CV, which is HAM64775, Exhibit 222.

EXHIBIT NO. 222:
Mr. David Hein's report, which includes his CV, HAM64775.

MR. LEWIS: The report of Mr. Dewan Karim of 30FE, which is HAM64759, which is Exhibit 223.

EXHIBIT NO. 223:
Mr. Dewan Karim's report, HAM64759.

MR. LEWIS: And the report of Dr. Hassan Baaj, which is GOL7515, Exhibit 224.

EXHIBIT NO. 224:
Dr. Hassan Baaj's report,

GOL7515.

MR. LEWIS: And Dr. Baaj's CV, which is separate, GOL7519, which is Exhibit 225.

EXHIBIT NO. 225:

Dr. Hassan Baaj's CV,

GOL7519.

MR. LEWIS: Dr. Flintsch's and Mr. Brownlee's CVs were filed earlier, Exhibits 12 and 15 respectively, and Dr. Hein and Mr. Karim's reports include their CVs, just for completeness.

Now, Dr. Flintsch's report attaches as Appendix A his Primer on Friction, Friction Management and Stone Matrix Asphalt Mixes that he testified regarding in April, which is also Exhibit 13, but it's attached to the report that may be referred to on occasion.

We covered Dr. Flintsch's background and qualifications back when he testified in April. In the interest of time, I'm not going to repeat that exercise today, nor will I do that when Mr. Brownlee testifies. As I indicated, Dr. Flintsch's CV is Exhibit 12. And I don't intend to take Dr. Flintsch through every aspect of his report, Commissioner. Where there doesn't appear to be disagreement expressed by the

reports tendered by the participants, in the interest of time, I'll either be quick or just skip it, except to the extent that it's needed as background to the further evidence, but I'm going to focus primarily on parts of the report where there are disagreement or where clarification is required, hopefully.

BY MR. LEWIS:

Q. And, Dr. Flintsch, before we get started, I just wanted to ask you to confirm that you're aware of and understand you have an obligation to provide evidence that is fair, objective and non-partisan. We did not have you sign an acknowledgement of that sort. It's part of Rules of Civil Procedure, not the inquiry, but I would ask you to confirm you understand that obligation?

A. Yes, I do.

Q. And so, I just wanted to quickly, Dr. Flintsch, summarize the principal reviews you did of the testing that had been done by various parties, various individuals and companies on the RHVP. So, you reviewed the results of the locked-wheel testing conducted by the MTO using its ASTM E274 tester, first

conducted in 2007 and then each year, 2008 to 2014, except for 2013. Correct?

A. Correct.

Q. And you reviewed the results of the locked-wheel testing conducted by ARA on behalf of the City of Hamilton in May 2019, prior to the Red Hill Valley Parkway resurfacing that year and after the resurfacing later that year, in September. Correct?

A. Correct.

Q. You reviewed the results of the Tradewind testing conducted using a grip tester in November 2013 and the Tradewind report update those results?

A. Correct.

Q. You reviewed the results of the testing conducted by the -- the friction testing conducted by Englobe on behalf of the City using a grip tester in May 2019, prior to the Red Hill resurfacing that year?

A. Correct.

Q. You reviewed the British pendulum testing conducted by Golder in December 2017?

A. Correct.

Q. And, as well, the macrotexture results taken by Golder in December 2017?

A. Correct.

Q. And the macrotexture results taken by ARA in May 2019, prior to the resurfacing that year?

A. Yes.

Q. And you reviewed the polished stone value results conducted on the coarse aggregate conducted on the Red Hill asphalt cores taken by Golder in 2017?

A. Correct.

Q. And also the polished stone value results on the aggregate from the Demix Varennes quarry taken by the MTO in 1992 and 2008?

A. Correct.

Q. You reviewed the SMA mix design and laboratory and production results for the SMA and the aggregates used in the SMA submitted for approval, quality control, quality assurance and as well the production records for the SMA mix placed on the Red Hill?

A. Yes.

Q. And you reviewed various CIMA reports and safety reviews?

A. Correct.

Q. And finally the reports of Mr. Brownlee, Mr. Hein, Dr. Baaj and Mr. Karim. Is that right?

A. Correct.

Q. Okay. Now, if we could call up Dr. Flintsch's report, Exhibit 220, and image 3.

Commissioner, it isn't the case for all of the reports, but for Dr. Flintsch's reports, the report, the images correspond to the page number.

JUSTICE WILTON-SIEGEL: Okay. Thank you.

BY MR. LEWIS:

Q. Registrar, if we could pull up image 3, please.

In section 1, the third paragraph there, and this is just by way of very general background, you indicate that the frictional properties of pavements play a significant role in road safety and that the friction between a tire and a pavement is a

critical, you say, a critical factor in reducing potential crashes. Is that right?

A. Correct.

Q. But then in your Primer, I don't know that we need to go to it, it's at image 50 attached here, you indicate that:

> "Though deficient friction is seldom the main cause of a crash, there are situations where low friction can cause crashes in the presence of other contributing circumstances. For example, if a human error makes an emergency manoeuvre necessary, a crash may occur if the friction demanded by the manoeuvre is greater than the friction that the road surface can provide in that location. If the available friction is

exceeded, skidding or wheel slipping may lead to a loss of control or to a collision. On the other hand, if the friction is high, the collision may be avoided or its severity reduced."

Does that remain your general opinion, that deficient friction is seldom the main cause of a crash, but it can cause or contribute to crashes in the presence of other contributing factors?

A. Yes, it does.

Q. And is that the case where even there are set investigatory levels in a particular jurisdiction? Is there any particular level of skid resistance where a pavement can absolutely be said to be safe or unsafe or the friction adequate?

A. Not really. The friction demand is a condition by the context in which we operate and, of course, if you are in a straight line with very good visibility, then you may not as much friction as if you are transversing a

sharp curve and there's a lot of traffic.

Q. Okay. And if we could go to image 51, please, which is in the Primer. Just at the top there, you have a reference to wet weather collisions and that, as I understand it, an indication of low friction or friction problems can be indicated by the proportion of wet weather collisions, wet road collisions. Is that correct?

A. Correct.

Q. And if we could go back to image 26 and 27. And while he's doing that, the number of wet weather collisions compared to dry on the Red Hill is a theme that has come up, of course, during this inquiry and through your report. And just as a background to what we're going to be talking about, you have a discussion at the bottom of 26 and on to the top of 27 about the CIMA reports that -- some of the CIMA reports you reviewed, which indicates CIMA's reports of the percentages of wet surface collisions reported by CIMA. Do you see that?

A. Yes.

Q. And have you seen anything in the reports submitted by the City or Golder that questions these reports, the reported

numbers, as reported by CIMA?

A. No, I haven't.

Q. And you use the term, talking about the wet surface collision proportions, you refer to the numbers as high or unusually high, and maybe you could put some context to that. Where did the numbers of wet surface collisions reported by CIMA fall in your experience?

A. I do see there they're quite high because typical values are in the order of maybe 15, 25 percent, something like that, and here we are seeing a percentage of wet crashes in the 50s and higher even in some cases.

Q. Now, I'm going to move on from there. If you can go back to page 25 and 26 as well. Thank you, Registrar.

I'm going to move on by getting to some other things which I understand there's no disagreement between you and the City and Golder experts. And so, if I can summarize about the section 3 there, the laboratory and production results, I understand that you found that the SMA mix design was appropriate and though there were some departures from mix design values

and instances of low compaction in the asphalt placed, in your view, there was no significant negative impact on the frictional qualities of the SMA pavement. Is that right?

A. Yes.

Q. And also you indicate that nor would cracking or breaking of the aggregates due to over compaction, in your view, contribute to low friction. Is that a fair summary?

A. Yes.

Q. And, in addition, you have reviewed the report of Dr. Hassan Baaj, submitted by Golder?

A. Correct.

Q. And he conducted a review of the test results conducted specifically on the Demix aggregates used in the SMA that were conduct prior to the placement of the SMA pavement in August 2007, and Dr. Baaj described the various tests, the results, and opined that the aggregate met the relevant requirements at the time. You're familiar with that finding of his from his report?

A. Yes.

Q. And do you agree with

that assessment by Dr. Baaj and generally speaking his review of the aggregate related test results prior to repaving?

A. Yes, I do. I think it's very thorough.

Q. Thank you. If we could call up, go back two pages, to pages 23 and 24. This is section 2.1.6 on page 23 going on to 24 regarding macrotexture and the macrotexture test results obtained by Golder in December 2017 and ARA in May 2019 using, in both cases, the sand patch method. Is that right?

A. Correct.

Q. And you describe in the first paragraph of section 2.1.6 what macrotexture is and you testified about that in your testimony in April. And it's particularly important, macrotexture, as I understand it, for allowing the water to drain to permit for greater tire and pavement -- tire pavement adhesion. Is that right?

A. That's correct.

Q. And you found that the macrotexture results were appropriate. Is that correct?

A. That's correct.

Q. And going back to pages 21 and 22, I seem to be going in reverse order, but there's a section on British pendulum testing, 2.1.4 beginning on page 21 going to 22, and you reviewed, as you said, the results of the British pendulum testing conducted by Golder in 2017, from December 2017?

A. Correct.

Q. And you found that those results were very variable with several very low values, but that the results were unreliable because carried out at sub-zero Celsius temperatures. Is that right?

A. Correct.

Q. And that's also what Golder concluded and you concur with that. Is that right?

A. Yes, I do.

Q. Okay. I would like to move on, then, to the friction measurements proper and specifically the locked-wheel test results.

And so, if we could call up image 7 and, in particular, figure 2. And, as I understand it, from figure 2 -- maybe also if the

next paragraph as well, Registrar, if you're calling that up along with the first paragraph below the figure. Thank you.

That what you've done here is plotted all of the locked-wheel testing that was conducted on the Red Hill beginning on the left in 2007, which is the MTO testing before the Red Hill opened on two of the lanes, the two southbound lanes. Is that right?

A. Correct.

Q. And then from 2008 through 2014, with the exception of 2013, moving to the right, are the MTO, again, locked-wheel tester results. Is that correct?

A. Yes.

Q. And then on the right, the second last set of bars with the 2019b, that's the ARA locked-wheel test results. All of these are the per lane averages. Correct?

A. Correct.

Q. And that's the ARA testing from just prior to the resurfacing of the Red Hill in May 2019. Is that right?

A. Correct.

Q. And then the last one on

the right marked 2019a, that's the ARA locked-wheel testing after resurfacing in 2009?

A. Yes.

Q. Okay. And ARA, to my understanding, is they tested the entire length of the Red Hill, whereas the MTO tested a shorter portion, just under four kilometres in length, between Greenhill in the south and the CNR overhead structure in the north. Is that correct?

A. That's correct. ARA measure the entire length plus a few segments before and after.

Q. Right. And without --

A. But the average there are the ones just for the parkway.

Q. The ARA averages are for the portion which is, you determined, of the Red Hill itself?

A. Correct.

Q. Okay. We'll get to that when we look at the more detailed ARA results. Without getting into characterizing the results yet, as I understand your report and the line there, that it shows an increase in 2008 from 2007 after the initial preopening measurements were

taken by the MTO. Right?

A. Correct.

Q. And the increase, that would be expected for an SMA pavement?

A. Yes.

Q. Once it's opened and exposed to traffic?

A. Correct.

Q. Okay. And then a reduction, as shown on the lines, the dotted line there, of, I think you indicate in your report, of approximately 20 percent from 2008 to 2014?

A. Mm-hmm.

Q. Sorry, that's yes?

A. Yes.

Q. And then the 2019 ARA presurfacing results in the second column from the right are approximately the same, as you describe it, not exact, but approximately the same as the 2014 MTO results. Is that right?

A. Correct.

Q. And then finally on that, as it shows, a significant increase after resurfacing to levels that you characterize as slightly higher than those measured by the MTO in

2008?

A. Correct.

Q. Okay. And in the paragraph below the figure, as you indicate, the average FN90, FN meaning friction number and the 90 being the speed in kilometres at which the testing was taken by ARA in 2019, the average ranged by lane from 31 to 35. Is that right?

A. Correct.

Q. And what do the similar results between 2014 and 2019, the MTO in 2014 and ARA in 2019, pre-resurfacing results tell you? What does disclose to you?

A. They suggest that the friction level has stabilized after the initial polishing.

Q. It stabilized?

A. Yes, correct.

Q. Okay. And, sorry, what did you say about polishing, I think you said?

A. There's some initial loss of friction that happens in the first few years of service for any pavement, and in this case it, kind of, seems to have stabilized after 2014.

Q. All right. And if we

could go to pages 8 and 9, and these are figures 3 and 4, I understand that these graphs show your plotting of the ARA May 2019 pre-resurfacing locked-wheel test results and it indicates that it's based on the chainage provided by ARA in the files provided by ARA. Is that correct?

A. Correct.

Q. And at the left on page 8 is the plotting of the southbound lanes and on the right is the northbound lanes?

A. Correct.

Q. And the yellow vertical lines, I take it those demarcate the streets as they cross the Red Hill Valley Parkway. Is that right?

A. Yes. That's approximate location of the crossing the streets.

Q. Okay. Not exact but approximate?

A. Yes.

Q. Okay. And we are aware that the LINC at the south end of the Red Hill, we've heard evidence about this, that it was resurfaced in 2011 and that the QEW interchange at the north end of the Red Hill was completed in or

about late 2008 or early 2009. Can you describe what those grey zones on either side of both of figures 3 and 4 represent?

A. These are measurements taken and what I understand are outside the SMA pavement that's been reviewed and detailed in this hearing.

Q. Okay. And, as indicated on both of those, there's quite a sharp increase at the north end and an increase, although less extensive, at the south end. Is that right?

A. Correct.

Q. Okay. And for the results on the SMA Red Hill mainline themselves, there are, looking at the plotting, some individual results that are under FN30, though the average, as you've already indicated, by lane are above FN30. Is that correct?

A. That is correct.

Q. And is that the case for both, we're looking at the ARA results here. Is that the case for both the MTO 2014 and the ARA 2019 results?

A. Correct.

Q. Okay. Do you have any

reason to question the reliability or the accuracy of the MTO or ARA locked-wheel test results?

A. No.

Q. Okay. If we could now look at the grip tester results that you -- skid test results that you looked at.

If we go to page 10, Registrar, of Dr. Flintsch's report.

And so, as we looked at before, you reviewed the Tradewind results from its November 20, 2013 testing and then by the testing using a grip tester by Englobe in May 2019 as well. Is that right?

A. Correct.

Q. And you can take that down there, Registrar. Thank you.

And both of those tests were performed at 50 kilometres an hour, as is standard, as I understand, with the grip tester. Is that right?

A. Correct.

Q. And the same from the locked-wheel testing, which was performed at the posted 90 kilometres an hour speed. Correct?

A. Correct.

Q. Although we'll get to that later, ARA tested at 90 but also at 65 and I think 80 as well. Is that right? Sorry, you nodded.

A. Yes. Sorry.

Q. Thank you. And do you have any reason to question the reliability or accuracy of the Englobe or the grip tester test results?

A. No.

Q. And we'll get to the UK standard and we know that Mr. David Hein in his report disagrees with the use of the UK standard to apply the Tradewind results, grip tester results, but do you read his report as questioning the Tradewind testing itself or the accuracy of the results in and of themselves?

A. No, I don't think so.

Q. And as you testified in April in your Primer, grip testers and locked-wheel testers, they're not the same. They have -- it's a different machine, different technology and measures in a different way. Is that right?

A. That is correct.

Q. And they don't return immediately comparable results. Is that fair?

A. Yes.

Q. And in the middle of there where it says grip tester measurements, maybe you could call up that section, 2.1.2, Registrar. Sorry, that's 2.1.2.1. I mean above there, the 2.1.2 where it says grip tester measurements in those three paragraphs. Thank you. That's it. Thank you.

In the second paragraph there, you indicate that they're not immediately comparable to the MTO and ARA results. And then in the last sentence, second paragraph:

> "Directionally, one would expect the grip tester GN to be higher than the locked-wheel tester FN friction number."

And you testified about that issue in your testimony in April as well. Is that right?

A. Correct.

Q. And then you indicate in the third paragraph there that:

"Nevertheless -- "

And we'll get to the reasons for this, but you consider the grip tester results by both Tradewind and Englobe to be generally confirmatory of and consistent with the locked-wheel tester results obtained by the MTO and ARA, for reasons I will explain after discussing the grip tester results themselves.

And we'll get to those reasons as we go, but having reviewed Mr. Hein's report, do you still consider the grip tester results here to be generally confirmatory and consistent with the locked-wheel tester results?

A. Yes, I do.

Q. Okay. And then if you could take that down, Registrar, and if we could go to page 18. If you, Registrar, could just enlarge from the top of the page down to the end of that section, the two paragraphs below the figure. Thank you.

And you describe at the top paragraph above figure 9 the results taken by Tradewind in 2013 and Englobe in mid-2019 as being very similar to one another at the top of that page. What does that suggest to you with respect

to what you referred to earlier as the stabilization of friction levels with respect to the locked-wheel test results in 2014 and 2019?

A. Yes. I wrote there I believe that that's a confirmation that the values have stabilized after roughly 2013, 2014. The friction values have, kind of, reached a plateau.

Q. So, the grip tester results that are shown here that you described are consistent with the stabilization shown in the locked-wheel test results?

A. Correct.

Q. Okay. And in that figure 9 is, so I understand it, on the left, the 2013, that's a by lane averaging of the Tradewind results?

A. Correct.

Q. And on the right is the average by lane of the Englobe results in 2019 pre-resurfacing?

A. Correct.

Q. And immediately below figure 9, you wrote that the Englobe results shown in figures 7 and 8, which we will look at, also confirm the presence of localized areas with lower

friction as observed in the Tradewind report?

A. Correct.

Q. Okay. Is that consistent, generally speaking, as well with the locked-wheel testing results of the MTO and ARA.

A. Yes, it is consistent.

Q. I'm sorry, it is consistent?

A. Yes.

Q. And if we could go, Registrar, to pages 11 and 12, and these are figures 5 and 6 from your report and my understanding is that the chart itself in the grey with the blue and the purple lines and the chainage at the bottom showing the metres in chainage, that those are from the charts that appear in the Tradewind report themselves. Is that right?

A. Correct.

Q. And then, so we're clear on it, because it's a little hard to keep straight and it's been a while since we talked about this in the hearings for everyone, but at the top where you indicate in each figure, in the case of figure 5, it says southbound lanes, and figure 6,

northbound lanes, those are added for clarity because Tradewind uses eastbound and westbound, because they measured them at the same time as the LINC?

A. Correct.

Q. Southbound pertaining to the reference in Tradewind to westbound and northbound pertaining to westbound in the Tradewind report?

A. Yes. Sorry, the southbound is westbound and northbound is eastbound.

Q. Yes. If I said differently, I apologize, but that's correct. And there's a note on the bottom for clarity for that, if I got it right.

And the Tradewind results show, as I understand it, those are 100-metre intervals, each plot?

A. Correct. And that's the average for a series of measurements taken continuously over those 100-metres.

Q. And that's because the grip tester is a continuous friction measurement device which is continuingly measuring, but then

produces an average over, in this case, each 100-metre segment. Is that right?

A. That is correct. The analyst that's processing the data can choose how -- the averaging.

Q. And as distinct from the locked-wheel tester, which, because it applies, essentially, the brakes at periodic places, is measuring the skid resistance on the specific instances where the brakes are applied. Correct?

A. Correct, and it doesn't measure the whole length between tests. It just measure a short section when the wheel is fully locked. It measure the whole thing, but it does report -- well, reports all the -- it measures the test and then reports the average of the segment where the wheel is locked.

Q. Okay. And the line in the middle, as we've heard evidence about this, but the green line, which is just below 50 at 48, that is from the Tradewind report indicating the investigatory level which Tradewind applies, but that was using an older UK standard. Is that correct?

A. That is correct.

Q. And at the same time, as indicated in the Tradewind report, there are instances where the results dip and rise and, in some places, dipping below a grip number of 30. Is that right?

A. That is correct.

Q. And, again, directionally a grip number of 30 is not necessarily the same thing as an FN of 30. Right?

A. Correct.

Q. And then in both directions here but only on the outside lane, the one in blue, towards the left-hand side of each chart, which is in the direction of where the Red Hill joins the LINC, it increases from, in each case, around a grip number of 30 on the left-hand chart there and a little higher on the right-hand chart, increasing to a level at 50 or above. Right?

A. That is correct.

Q. And is that consistent with what you observed and discussed from the ARA locked-wheel test results in --

A. Yes, it is, and it seems again in this case they also testing a different

pavement at the beginning and end of the testing section.

Q. And how does that increased number -- we could go to the Tradewind report, but that increased elevated grip number on the left-hand side at the south end compare with the results that Tradewind took from the LINC?

A. Can you repeat that? Sorry.

Q. Yeah. How does where it increases to the level around 50 or above, how does that compare with the results that Tradewind obtained from its measurements on the LINC?

A. They seem to be consistent.

Q. Similar to that number?

A. Similar, yeah.

Q. Okay. And if we could go to pages 16 to 17, figures 7 and 8, these graphs are taken from the Englobe May 2019 grip tester results from the Red Hill in both directions. Is that correct?

A. Correct.

Q. And on the left in figure 7 is the southbound lanes, and on the

right, figure 8, are the northbound lanes?

A. Correct.

Q. And the results here are expressed, am I correct that on the left-hand side, the Y axis where it 0.1, 0.2, 0.3, 0.4, 0.5, et cetera, where it says friction number, is that the coefficient of the friction?

A. That's correct, and the grip number is 100 times higher than that, you divide by 100, so at 30 would be a 0.3 in this.

Q. Right. Okay. And it's fair to say there's some variability of results here?

A. Correct.

Q. And, as you said, Tradewind expressed the averages every 100-metres. Is that the same or different from Englobe?

A. It has higher resolution in this case. Shorter interval for --

Q. Shorter intervals?

A. Yeah. That's why you see, kind of, spiking in the other case.

Q. It's more spiky, a little bit more variation, because it's measuring over shorter intervals than Tradewind did?

A. Correct.
Q. Okay.
A. Tradewind report is kind of a little bit longer average in length, so it gets smooth in the curves a little bit.
Q. Okay. And again, in particular, in the northbound lanes in figure 8 on the right, at the left-hand side there is what appears to be and there's three plots there, which we'll get to, but there appears to be an increase on the left-hand side at the south end, again, towards where the LINC is?
A. Correct.
Q. And is that, again, generally speaking, consistent with what you've already described in the other tests?
A. Yes. It shows that the LINC has higher friction than the Parkway.
Q. And in the northbound lanes, as I said, there's three lines as opposed to two on the southbound lane chart, and so the blue on both sides, that's the inside lane, whereas the red line is the outside lane in both directions. Is that right?
A. Correct.

Q. And then there's a green line. What does that reflect?

A. The green line is an extra measurement that was taken in the middle of the lane that represent the area that has not been weathered by the traffic. It hasn't been polished by the action of the tires of the vehicles driving or at least much less only when you are overtaking it and so on. So, again, give an indication of kind of the original friction value of that particular road segment.

Q. Okay. And so, just to unpack that a bit, the other measurements on both directions are in the wheel paths of both lanes?

A. Correct.

Q. Whereas the green line in the northbound lanes is --

A. Is in the middle.

Q. In the middle. It indicates it's the outside lane that it's measures there?

A. Correct.

Q. And I won't go to it but we'll leave the charts up, but on page 18 right after this, you indicate that measurements were

also taken by Englobe in the middle of lane two, outside lane, in the northbound direction, and those results were higher than the measurements taken on the right wheel path in each lane, approximately 23 percent higher, again, supporting the assumption that the aggregate had polished on the wheel paths and that the drop in friction was due to this polishing as discussed for the Tradewind measurements which we'll come back to.

And so, we'll talk about it now. The Tradewind results showed a similar thing. Is that correct?

A. Yes, they do.

Q. Okay. And if we could go to page 14, Registrar, and if you could call up first the big bullet there below the table. It starts, "Measurements were also taken."

And so, this was, you're indicating that Tradewind also took measurements in the centre of the outside lane in the northbound direction. Is that right?

A. Correct.

Q. And is that the same lane that Englobe took in it that we were just looking at?

A. Yes.

Q. And you indicate that those results were higher than the measurements taken on the wheel paths in each lane, which is approximately 23 percent higher than the average of the two lanes in the same direction and 18 percent higher than the average of the wheel paths in all four lanes in both directions.

So, to stick for the moment with the first part, the 23 percent higher, it's 23 percent higher than the average in the two northbound lanes on the wheel paths?

A. Correct.

Q. Okay. And is that typical or unusual to see results with a higher friction results in the middle of the lane than on the wheel path?

A. No, not at all.

Q. Well, I said both. I said is it unusual or is it --

A. It's not unusual. It is what typically we see. The percent difference is what's different. In some cases, there's a small percentage, there's a high percentage, and that's depending on the -- mostly the polishing

characteristics of the aggregate.

Q. Okay. And, as you indicate in that paragraph, you indicate it supports the assumption that:

> "...the aggregate had polished on the wheel paths and that the drop in friction was at least partially due to this polishing. To maintain appropriate levels of friction over time, it is important that the aggregates exposed on the surface of the pavement maintain its microtexture."

And then you finish off:

> "Although there is always some wear or polishing due to the abrasive effect of the tire of the pavement, if the coarse aggregate sources are susceptible to polishing,

the reduction in friction over time can be significant, as discussed later in this report."

And so, is it fair that you attribute at least, in part or in whole, to the reduction in friction that you described earlier of approximately 20 percent between 2008 and 2013, 2014, as being due to the polishing of the aggregate?

A. Correct.

Q. Can you take that down, Registrar, please.

If we could go to pages 18 and 19 and my understanding is that you conducted a conversion of the grip tester results taken by both Tradewind and Englobe to the equivalent FN90R results of the locked-wheel testing conducted by the MTO and ARA; MTO in 2014 and ARA in 2019. Is that right?

A. Correct.

Q. And the FN90 that I referred to taken at 90 kilometres an hour, the friction number obtained at 90 kilometres an hour with a ribbed tire.

And at the bottom of the image at page 18 and the top of page 19, you explain the conversion exercise that you undertook. It's a four-step calculation. Is that correct?

A. That is correct. It has four steps and includes two conversions and two adjustments to correct the same for units in a way.

Q. To correct for units?

A. Yes.

Q. Okay. So, if you could describe each of those steps, please? They're set out there, but if you could just describe them for us.

A. The process include first a conversion from the grip number collected by the grip tester to what we call a SCRIM reading.

Q. Sorry, that's SCRIM?

A. SCRIM, yes. SCRIM reading that is collected by another continuous device that is used significantly around the world and it was discussed before in the Primer. And so, that's based on some correlations developed by the Transport Research Laboratory in the UK by

testing a wide range of surfaces on their testing facility.

And the second correction is step number 3 where I brought that number from the SCRIM back to the locked-wheel using another conversion equation that was developed under a Federal Highway Administration project that was led by my research team at Virginia Tech, but the testing was conducted independently at the Texas Transportation Institute again over a wide range of surfaces that go from very low friction to very high friction.

And, in between, there's a second step that just --

Q. Sorry, can I stop you for a moment, Dr. Flintsch? I think we may have an issue with the Commissioner's -- we may have to start over. I'm not sure. Hold on for one -- we'll go back. Sorry, the Commissioner's camera froze and his feed froze, so we may have to go back. Just give me one moment. We'll see if it comes back on very quickly.

If we could take five minutes, please, Registrar, to correct this and we will come back. If you could send people to their

breakout rooms, I would appreciate it. Thank you.

THE REGISTRAR: Absolutely.

We'll resume in five minutes.

MR. LEWIS: Thank you.

--- Recess taken at 10:31 a.m.

--- Upon resuming at 10:56 a.m.

MR. LEWIS: We're back. There was a technical glitch with the Commissioner's hardware, so we will in one moment resume, if we could, with Dr. Flintsch.

BY MR. LEWIS:

Q. And I'm going to ask you to start again in a moment with going back to step one. If you could repeat that, the Commissioner advises that's where his feed went out, somewhere in the middle of that, so if I could ask you just to collect your thoughts and come back to that stage in the exercise.

While you're doing that, I'm just advised that the Commissioner's asked if we could -- we'll count that as our morning break and we will continue through to the lunch break, which is scheduled for one, but if it makes sense to take an earlier make, then we may do that.

And last thing before we get

right back into it is, Registrar, I think I misspoke, I'm told I misspoke, when I made Dr. Baaj's report an exhibit, and that would be Exhibit 224. I think I said it's Golder 7515 but in fact it's 7517?

THE REGISTRAR: Noted.

MR. LEWIS: Thank you.

BY MR. LEWIS:

Q. With that now, Dr. Flintsch, sorry for the technical snafus. If I could ask you to go back to the conversion that you were describing with step one. Thank you.

A. Sure. No problem. As I was saying before, I look at the two different measurements and I decided to follow a two-step process that include two conversions from the grip tester to the SCRIM and from the SCRIM to the lock-wheel. And step one, what I did is I used a relationship developed in the UK by the Transport Research Laboratory on their testing facility. They have a testing facility with different pavement surfaces and they develop a correlation between the grip tester and the SCRIM reading.

And then in step three I used a different conversion that was developed by my

research group under contract with federal highway in collaboration with the Texas Transportation Institute to convert from the SCRIM measurement to a friction number measured by the locked-wheel at 40-miles per hour or approximately 65 kilometres per hour.

In between, I had to convert the units that are used for the SCRIM in the UK to the ones we use in the U.S. We don't apply a correction factor that is applied in the UK because that was introduced to correct, for account, in a change in the rubber used in the tires. That's why you have a 0.78. This is just that our measurements in the UK, they tried to reference their measurement to the previous type of rubber that was used in the SCRIM and the rest of the world, and we adopted with a new tire with a new type of rubber, we didn't need to do that correction.

And then the last one is to bring the measurements at 65 kilometres per hour to 90 kilometres per hour. That is the measurements that are done in Canada and the U.S. We do use the measure on all roads at the same speed. Again, if we use in a different speed, we

convert it and then report it as 40 miles per hour approximately, 65 kilometres per hour. So, that's why I applied this three step process.

And then the other comment is that equation in step three is also developed on a wide range of surfaces. That's why I felt that those were maybe the most appropriate steps to follow to get an estimate of what the conversion would be.

Q. And on step four, just the correction to bring it to 90, am I correct from what you've indicated there that you used the ARA measurements, because ARA did the testing both in 2019 at both 65 kilometres an hour and 90?

A. Correct.

Q. Okay. And in your Primer and back in April you did discuss the difficulties, acknowledged difficulties, with converting friction testing values obtained from different devices, and you state in the next paragraph, if you could call up the two paragraphs below number 4 on page 19, please, Registrar. Thank you.

In the second paragraph in that call out, you refer back to the Primer and

indicate that you recognize the difficulties in that the interconversions that you talked about are not very accurate and may not apply to pavements not included in their development. But then you say that, although this remains true, that you're confident that the conversion here, while not exact, is reasonably accurate in that it is at least or reasonably appropriate.

And then above that you indicate that the results are consistent between the MTO 2014 testing and the Tradewind November 2013 testing are consistent and show relatively low average friction levels six to seven years after construction. And then similarly it suggests that the results of presurfacing ARA and Englobe testing are consistent and show the friction levels had levelled off after 2013, 2014.

And then I'll ask you some questions about that, but if we could put up figure 10 that I believe shows the converted grip tester results. Yes. Thank you. This is on page 20 of your report. And once we look at this and make sure we understand what you've done here, I'll ask you for some questions about the

conversion, the accuracy of it.

So, as I understand this figure, it shows in the darker coloured bands from 2007 to 2012, 2014, and then the two on the right, the 2019b and 2019a, that shows the locked-wheel test that we had previously looked that both by the MTO and by ARA. Is that right?

A. Correct.

Q. And then you added, again by lane averages, the Tradewind results as converted by you in the column that's marked as 2013 with an asterisk. Is that right?

A. Correct.

Q. And the Englobe results from May 2019 in the column towards the right that's titled 2019b with an asterisk, also more lightly shaded. Is that right?

A. Yes.

Q. Again, colour coordinated with the same lane -- colouring for the same lanes.

And can you explain why you have come to the conclusion that the conversion of the grip tester results to the equivalent locked-wheel FN90 results are reasonably

appropriate, as you described it?

A. Yeah. And, again, as you mentioned before, I do recognize that it's very hard to convert from one skid tester to another and when we discussed this in length when we had the discussion of the primer.

In this particular case, I went through the conversions and then plotted and they gave a very similar results to the values collected with the locked-wheel were that, in a way, provided a check for this type of pavement, it seems to be working. So, that may work for another pavement, it may not, but in this case we get measurements from two devices and, after the conversion, they match, so it seems reasonable to say that this average conversion seems to be working for this particular pavement.

Q. And just to unpack that a bit, if I understand it correctly, you did the conversion first. Is that right?

A. Correct.

Q. And then you noted that they showed the similar, as converted, showed the similar trajectory and numbers as the ones in the years close to them. Is that a fair summary?

A. Correct.

Q. Okay. And similarly, if the line, the horizontal line, was it consistent with the levelling off that you described that was disclosed by the locked-wheel test results by the MTO and ARA?

A. Correct, so I have, kind of, a double verification and in a way the active values are similar to the ones that were measured in close to about the same date and they also confirmed that the friction has been roughly constant after that period, through that period from 2013, 2014, to 2019.

Q. Okay. And Mr. Hein, as you will have seen in his report for the City, he disagrees that the conversions are, as you've described it, although approximate, that they're reasonably accurate, and he indicates that the correlation cannot be accurately done.

So, the first thing I want to take you to, if we could go to Mr. Hein's report. So, this is, I believe, Registrar, the Hein report is Exhibit 222 and if we could go to images 16 to 17. And, unlike Dr. Flintsch's report, the page numbering is off by two, I believe, of the images,

so image 17 is page 15 and image 16 is page 14.

At the bottom of page 14, in paragraph 46 and going on to the next page, Mr. Hein refers to a number of different, three different, exercises or experiments conducted over the years, which, I think fair to say, for the conclusion that it's difficult to harmonize friction results and convert them.

Are you familiar with the experiments and endeavours that's he speaks of there in paragraph 48?

A. Yes, I am, and I also reviewed those and they're cited in the Primer.

Q. Okay. The one that you discussed in April that are referenced in your Primer?

A. Correct.

Q. And, again, you don't disagree with the general proposition that there's difficulties. You've described that. It's that, in this particular instance, you have comfort that they're reasonably accurate. Is that fair?

A. Correct.

Q. Okay. And then on page 15, that's image 17, at paragraph 49,

Mr. Hein -- no, sorry. I wanted to keep up the same thing there, Registrar, the same two pages. Maybe I misspoke, but it's images 16 to 17. Yes, thank you. And it's paragraph 49 at the bottom of the image 17.

Mr. Hein refers to your reasoning about the conversion results being generally in line with those measured by the MTO and ARA locked-wheel devices and refers to that as simplistic, that reasoning is simplistic, in that further independent testing would be necessary to validate in such conversion.

What do you say about the comment about it being simplistic?

A. Well, in a way, it's a simple check, so I kind of agree on that, but I do feel that simple doesn't mean wrong. I wouldn't recommend that you implement this conversion on a standard or anything like that, but in this particular case, we have one measurement and then apply the conversions and we got about the same number. That make me feel at least I understand. I'm not saying that should be adopted or anything like that, but in this particular case it gave me confidence that they're reasonable. And, again,

they're based on a lot of data collected over a lot of surfaces, so it's not that I started with faulty equations in a way.

Q. And so, if I understood that correctly, you're not saying that this should be exported to convert grip tester, grip numbers, to locked-wheel friction numbers at different speeds in all circumstances, in other circumstances. You're saying I think it works reasonably well here for the reasons that you described. Is that fair?

A. Correct.

Q. Okay. And he refers to further independent testing would be necessary to validate any such conversion. Do you know what that would be? We can ask Mr. Hein, but do you know what that's referring to?

A. I'm not sure, but what I presume it referred to is that we should test a grip tester and the locked-wheel under a variety of surfaces to verify these processes. Again, that's a fair statement. If you want to adopt an equation, I think that would be very reasonable.

Q. Thank you. You can take that down, Registrar. If we could go back to

Dr. Flintsch's report and call up page 14. Thank you. And if you could expand table 1, please.

And so, I just want to talk about the UK investigatory levels for a bit. And we know that the Tradewind report applied an earlier UK standard, an earlier version, and you, in your Primer, dealt with the one that was in place at the time of the Tradewind testing and, as well, the more recent subsequent one. And the one that was in place at the time of the Tradewind testing is this table 1. Is that correct?

A. Correct.

Q. And if you could take that down and just resume the page. Actually, the next page, 15. In the last paragraph of this section above 2.1.2.2, so it's, sort of, the just below the middle of page, Registrar, if you could call that out where it says, "At set out in the Primer."

You indicate that:

> "...unlike in some jurisdictions (notably as discussed in the Primer, the UK, Australia and New Zealand) there are no

published provincial or national standards in Ontario or Canada respecting highway friction investigatory levels or intervention levels. However, in my view, that does not mean standards imported from other jurisdictions for the purpose of evaluating the frictional qualities of pavements have no meaning or ought to be disregarded. To the contrary, British standards reproduced in table 1 can provide a good reference."

And Mr. Hein disagrees with that, I think it's fair to say. He indicates at various points that there has not been a basis to rely on the UK guidelines in Canada. In his view, it's not appropriate to rely on them in this circumstance.

And then if we could go -- maybe take down that call out and if we could go to Mr. Hein's report at image 14 and 15. And images 14 and 15 are pages 12 and 13.

After the references that I just referred to, those are in paragraphs 38 and 39, in paragraph 40, Mr. Hein talks about the Australian Austroads friction management program being fundamentally based on the UK friction model. And I think back in April in your Primer you discussed it was very similar to the Australian program. Is that right?

A. It is correct, yes.

Q. Yeah. But Mr. Hein indicates it was borrowed only after significant analysis and tailoring to the Australian conditions and that the same approach would have to be taken in Canada.

And then at paragraph 41, he reiterates that, that that same approach would have to be taken in Canada, as I just said, and that:

> "Before a particular jurisdiction's friction management policy is

adopted in Canada, there must be an analysis by the appropriate authority as to its applicability. Here, Dr. Flintsch appears to be suggesting the UK guideline should be used as a reference point in this inquiry. However, I have not seen and testing or analysis of its applicability to Canada, and more specifically, to the Red Hill Valley Parkway. I'm therefore unable to support the reliance on the UK guidelines to inform the road surface conditions on the Red Hill Valley Parkway."

Can you address Mr. Hein's critique?

A. Sure. I do agree 100 percent that if you want to adopt it as a

general policy, it has to be verified to the local conditions. But it doesn't mean that it cannot provide a reference point to say, well, if a -- let me phrase a little bit. If you don't have a better standard, then it makes sense to me to use the best international standard.

And, actually, a similar case happened here in the U.S. in the last AASHTO guide for pavement friction that was published about a month ago maybe or a couple of months ago, referenced this as a potential starting point for development such a policy in the U.S., so I don't think it's unreasonable to consider it as part of the information you're analyzing for determining if the friction is sufficient or not, to use international standard, so though I do agree that you wouldn't adopt a standard from another country without verifying it's applied properly to your country.

Q. And on that point about adopting it as a friction management program, as part of that and the standards themselves, we'll go back to it, but there's a reference in Mr. Hein's report where we he talks about, I think -- let me make sure I'm getting it

correctly. There could be high cost implications of importing a friction management and standards which potentially cannot be achievable or sustainable and that there's, of course, cost consequences to that. Can you comment on that?

A. Sure. And that's true. Depending on where you are, maybe in different, in the country, different provinces may have to have different policies because of the availability of aggregate and all of that. What the basic principle in what the UK standards are a basis that there's a relationship between friction and crashes and we discussed that in the Primer. The lower the friction, the higher the number of crashes. So, particular improvement in friction will result in a particularly reduction of crashes for a particular road. And, again, it would be different from a highway than from a local road because of all the factors that we discussed at the beginning that are involved in a crash, but the fundamental relationship is valid and that's the way that this British standard has been developed, based on the relationship between crashes and friction.

So, the fundamental principle

is valid. I think it's valid. It's been proven scientifically. Actually, some of the reports that our research group developed for the highway administration confirmed that in the U.S.

And, again, going back to a policy, I agree that if you don't have the high quality aggregate, you may not be able to provide a specific level of friction, so that's where the economics play a role and it's a policy decision, I agree, that somebody has to make about, well, how much risk I'm willing to take in terms of potential crashes and then how much I value that risk and then, based on that, I will establish a particular standard.

Q. And so, a couple of things there. Now, you're saying that if a jurisdiction, whenever they're using a standard or a friction management policy, there are trade-offs and there's always no road is completely safe and always a cost-benefit analysis that has to be entered into before you adopt a program holus-bolus. That's one part of it. Right?

A. Correct.

Q. And the other part, you did mention earlier, just in the context of

answering my questions, about the new AASHTO guide and I think you referenced that the UK standards are being used as a -- in what fashion --

A. The references in the guide as an example of such a policy.

Q. Okay. And including the friction demand categories and --

A. Yeah. That's a very good point that I should have highlighted. One of the key contributions of that policy is that the friction that you need is different depending on the roadway you are driving and it's not one number that can be applied across the board throughout all the network because, for example, the friction you need in a highway if you are in a straight section, is different than when you are traversing a curve, so a section where the friction supply that the pavement is provided may be good, when you get to a curve or you get to a ramp where the vehicles had more interaction, then the same level of friction may not be enough to meet the demand of the vehicles.

And, again, if you have more traffic, there's more interaction between the vehicle, and that probably is another factor which

contribute to even a higher demand. So, what I'm saying is that the demand of friction is not constant. It depends on the context of what you are driving in that particular road. Another important factor is the speed. The higher the speed, the higher the friction demand, because you will need longer to stop to or control your vehicle.

So, my point is you need to -- even these values that are provided in the UK, they don't mean that you are above that particular threshold, you are 100 percent safe. There's still some risk and those are some policies to guide, but you could even have a friction problem if the value is higher than the ones that are established in that policy.

Q. And to cover off that last point, you indicate that -- I think you said if you meet it, it doesn't mean that there's no risk if you meet the standard. And correlatively, as I think you discussed before, that if you are below whatever standard is applied, that doesn't mean inherently that the road is unsafe, either?

A. Yeah. It means --

Q. It works both ways.

Right?

A. -- that you have a higher risk and, again, how high that risk is, it depends on the particular conditions of your road, again, the geometry, the speed and so on. And also the climatic conditions. That's why we have wet crashes and dry crashes and so on.

Q. And if you were faced with a similar situation in the U.S. as you're dealing with here, would you give the same opinion with respect to the relevance of the Tradewind report results using the UK standards as a reference?

A. Yes, I could. Truly if you have some measurements and then you have a way to compare with a value that -- well, at least in another country is considered a reasonable to expect from a road, I will consider it. The other thing, if I don't believe the friction measurements, what I could have done -- and, again, the idea is not you're saying you have to react and treat. What the recommendation is you have to do a further investigation. So, if I don't trust the friction measurements, then I will ask somebody to measure with an equipment that I

feel comfortable with and double check, because just assuming it doesn't apply, I think it's riskier than saying, well, I will analyze and see if it does apply and if it's applied, then I'll try to fix it. And it doesn't apply, well, I don't have to worry about it.

I don't know if I was clear.

Q. I think so. It was to me. If it wasn't to the Commissioner, I expect he will --

JUSTICE WILTON-SIEGEL: I understand.

MR. LEWIS: Thank you.

BY MR. LEWIS:

Q. And along those lines, you, at various points in your report, characterize the results overall of the friction testing on the Red Hill as being relatively low. That's a term that you use a number of times. Is that a fair summary of your overall conclusion regarding the friction levels?

A. Yes, it is. And, again, it reflect the thing I mentioned before, that what I believe the supply of friction doesn't seem to meet the demand that the particular conditions on

this freeway require to have, I guess, a reasonable agreement.

Q. Sorry, reasonable agreement?

A. Well, sorry, yeah, that's not a happy word in a way. What I'm saying is that the friction supply is not enough to meet the demand for the vehicles in this particular condition.

Q. Okay. And Mr. Hein takes issue with that characterization and he refers to the wording of relatively low and he disagrees and relies, I think it's fair to say, you tell me if you disagree, I think it's fair to say that he relies on the MTO's -- he refers to it as a benchmark of FN30 used by the MTO. We've heard from a lot of MTO witnesses as to how the MTO uses it and we know that it's not a published or generally publicly available guideline, although it's not unknown, either, but that Mr. Hein indicates that these would be acceptable results in his view in Ontario using the FN30 threshold. Is that how you read his report on that point?

A. Yes, I do.

Q. Okay. And then married

up with he disagrees that there could be any use of the UK standard, that is the grip tester, so the average locked-wheel tester results by lane are above FN30 so that the results are acceptable and not relatively low. Do you have a comment on that?

A. Well, I agree that they would be acceptable to the current practice, but that doesn't mean that I could not help reduce crashes if I look -- aspire as a higher friction number. And, again, careful study may confirm or deny that, but I think that that would be something that could be quantified, whether or not it is appropriate to have a higher value for this particular case that may have a higher demand than the typical road for what that policy applies. And I'm sure that, again, that it could be that it is okay, but given that some of the other considerations, it may not be, so it's good to check whether or not that 30 is appropriate for this particular facility.

Q. And we've heard from many MTO witnesses, and I probably mis-asked the question, we've heard from a number of MTO witnesses about how the MTO uses and applies FN30

as a guideline, which includes that they, you know, look at the geometry and the wet weather collisions and potentially other factors, so I'm not asking you to comment on Mr. Hein's opinion on its use of it, because the MTO evidence is the evidence, but in terms of what you described as the other factors and the friction demand, is that still relevant when you're applying a single number?

A. Can you repeat the question? Sorry.

Q. Yeah. Do the considerations you referred to regarding friction demand and the collision rates and so forth, do those still have relevance when you're looking at a single threshold or guideline?

A. No, definitely.

Q. Okay.

A. Because that friction demand is independent of the number that you fix. That depends on the other factors that play a role, the vehicles and the human and how they interact. Because, again, if you have very low traffic on a straight road, you don't need the same friction that you need in a road that has a

lot of vehicles, a lot of ramps and curves and things like that. The demand depends on the context in which you are driving. And, again, that's nothing new. This has been recognized as far as the '60s in some of the reports that I've read, so...

Q. Okay. And so, I wonder if we could look at a document that Mr. Hein references. He refers to it at paragraph 10 of his report in image 4. He references the Highway 407 Concession Agreement, Schedule 20 -- there it is up on the screen, paragraph 10 -- and refers to the Highway 407 ETR as one of those and refers to the, among others, but the criteria for friction is identified as friction value of under 30 when travelling at the posted speed based on the 500-metre average values of friction.

And if we could go to that document, Registrar. It's HAM64455.

And, while that's coming up, the inquiry did hear from a witness on behalf of the company that operates the Highway 407 and he did refer to this agreement and the FN30 investigatory level that they were subject to by way of its concession agreement.

Sorry, Registrar, do you have that document, HAM64455? And I take it you have not seen this document until it was produced as part of Mr. Hein's report. Is that correct?

A. Correct.

Q. Okay. And if we could -- so, it's schedule 20, Safety and Standards Protocol.

If you go to image 6, please. And, at the bottom, there's a paragraph that says, if you could call that up, the bottom paragraph, and it says:

> "For freeway pavements, when the surface friction skid number reaches SN 100=30 as measured by a brake-force trailer conforming to ASTM standard E274 and E501, the concessionaire shall undertake immediate investigation and, if appropriate, establish and implement a schedule for immediate mitigation.

Remedial action is also to be undertaken whenever a surface friction problem is thought to exists, irrespective of the surface friction skid number."

So, the first thing, as I read this, it seems to me it requires an investigation of FN equals 30, I guess, not below. That appears to be what it says. Do you agree with that?

A. Yes.

Q. But then the last sentence about remedial action is also to be undertaken whenever a surface friction problem is thought to exist irrespective of surface friction skid number, is that long the lines of what you were talking about?

A. Yeah. I do believe that that's recognized in that problem, that the demand of friction is dependent on the context. And, again, 30 is a good guideline, but it may not be enough in all situations. That's the way I've read it myself, that it could be above 30 and still need some intervention or at least some

investigation because the surface frictions could be a problem.

Q. And I guess, conversely, even if that is the threshold, if it's below 30 but it doesn't appear to be any issue, then it may not be a problem?

A. Correct. That's why it's called an investigatory level in general. You need to investigate further to find out if it is a problem or not.

Q. Okay. And if we could make this an exhibit, Registrar. It's HAM64455.

THE REGISTRAR: Noted.

MR. LEWIS: Thank you.

EXHIBIT NO. 226: Highway 407 Concession Agreement, Schedule 20, HAM64455.

BY MR. LEWIS:

Q. Just give me one moment. If you can take that down. Thank you.

If we could go back to Mr. Hein's report on image 5, which is page 3 -- sorry, image 5, Registrar. Thank you. And I guess the prior page as well, if both could be up. Thank you.

So, Mr. Hein indicates, he, sort of, made a comparison to some levels in various U.S. states of comparing the MTO's FN30 guideline, and he then lists a number of U.S. states and the table refers to intervention levels, table 1. And Mr. Hein indicates above there that the terms intervention, desire, questionable review and investigatory level are commonly used for this purpose. It's titled Intervention Levels. Do you know if these are intervention levels or investigatory levels or what? Do you know?

A. I don't know the size of those intervention level and the regional synthesis where this is taken from.

Q. Okay. It could be either. It says intervention, but that doesn't necessarily mean it's an intervention level. Is that right, as the way you described it?

A. Yeah. I don't know if I make a comment that the intervention and investigatory levels are not the same thing.

Q. Right.

A. At least from the point of view in the U.S., the AASHTO guide recently

already recognized that the intervention level is when you have to do something, we have to fix the friction. An investigatory level that is higher than the intervention level requires that you investigate to find out if friction is good or not. But when we set an intervention level, and that's one of the reasons why we eliminated that the from the last version of the AASHTO guide, means you have to intervene, you have to fix it and provide a solution. So, if these are real intervention level, the investigatory levels should be higher than this.

Q. Right. Okay. And I think you referred to that in your testimony in April and in the Primer about in the newer AASHTO guide, that the intervention levels were eliminated I think on the basis essentially that you have to investigate anyway to determine if there's an issue?

A. Correct. And at that time it wasn't published, but now it is published and it's available.

Q. Okay. And these are taken from a prior iteration. Is that correct?

A. Correct. Well, these are

taken from NCHRP synthesis that they investigate the practice, but the original, I would say, framework for this goes back to another NCHRP report, much older, from the '60s.

Q. Okay. And do you agree, in any event, though, that the FN30, however it is applied by the MTO, falls, as Mr. Hein says, roughly in the middle of these levels that are indicated here on this chart?

A. Correct, although they are measured in a different speed, so that's another caveat there.

Q. Right. Yeah. And Mr. Hein refers to the averages by lane taken by the locked-wheel testers falling below FN30 as being, he refers to, as minor and inconsequential deviations. I don't need to go to it, but that's in paragraph 20 of his report. And then he sets out by lane from's 2019 presurfacing testing the averages taken at 500-metre segments.

If you could go to images -- start at image 7 and 8, Registrar, of Mr. Hein's report. Yeah. And it's pages 5 and 6.

And so, correct me if I'm wrong, but what Mr. Hein has done here is taken

each lane in each direction and indicated by 500-metre segments what the average is. Is that right?

A. Yes.

Q. Okay. And then if you go to the next page, page 7, so maybe keep up 6 and 7, images 8 and 9.

So, in this case, you see we have one northbound lane on the left and then a southbound lane and then on the top right on page 7 it's southbound lane two, and, again, each one those is a 500-metre segment and the red line across the middle is the FN30. Is that right?

A. Yes.

Q. And if one is positing FN30 as a hard guideline as a hard number at which it's acceptable or not acceptable, if a section, a 500-metre section, is below, what do you think about that? Is that a minor and inconsequential deviation in that context?

A. Well, there's two points in there. One, the accuracy of the measurements has to be taken into account, so when you said 31 or a 29, depending on when you measure it, how you measurement, it may be all valid because of the

accuracy of the equipment. So, in that sense, it is within the accuracy of the equipment.

But if you keep that in mind, also a 31 could be less than 30 if you measure it in another time. So, it all depends on how you interpret. Again, I don't see that necessarily if it's above 30, it's good, if below 30 is low. I think the 30 is a guideline, again, to trigger investigation. So, if you decide to apply it as a rigid number, if it's below 30, you should do an investigation because the whole road may not be below that standard, but you may have localized friction problems. And a lot of times that's the case. You may not need to fix the whole section, but you may have some problems in particular, localized problems, where the friction is lower than the rest. I don't know if I answer your question. Sorry.

Q. You did. Thank you. And then coming back -- you can take that down, please, Registrar. Thank you. I think on your last point, if I did get it correctly, your point is there's the standard deviations if the equipment isn't perfectly accurate and so forth, but, again, that the safety or whether or not

there is a problem isn't entirely dependent on whether, whatever the number is, whether it's above or below. Is that fair?

A. Correct. And, again, it depends on the context of where you are driving, the speed, the geometry, the drivers.

Q. Right. And that comes back to your term, I think, relatively low, to describe the friction results. Is that right?

A. That is correct.

Q. And do I understand that the things from you described that you're looking at and characterizing it that way, and there's a number of things but you tell me if I'm wrong about any of it, that, number 1, there's the reduction over time of approximately 20 percent with some results which dip significantly lower than the averages. Is that number 1?

A. Correct.

Q. And then in some cases below FN30, in that instance. Right?

A. Correct.

Q. And then the grip tester results being lower than the UK standards. That's another touch point?

A. Correct.

Q. And the CIMA reports indicating a consistently high percentage of wet surface collisions?

A. Correct.

Q. And to go along with that, you referred to geometry of the highway and speed, excessive speeds as well. Is that right?

A. Correct. And, again, all of these kind of provide a context, as I was talking about before, especially the last two points. If you have a high percentage of wet crashes and less than perfect geometry and higher speeds, that's an indication that you very likely will have a higher demand for friction that understand that normal conditions.

Q. And when you say less than perfect geometry, I assume what you mean is, you know, if perfect geometry is straight, a tangent section where there is little, you know, not many decision points, things like that, and low traffic perhaps, which is not exactly a geometry issue, but all of those things are issues where there is a less friction demand. Is that --

A. Yeah, you are correct.

Each time you have a curve and, again, if the curve is very, very, with a very high radius, may not be, but if the radius is significant, and you have to use some of that friction to transverse a curve, then the friction you have for safety, for braking and so on would be less because you're using already some of that friction to transverse the curve safely. And if you go fast, you need more friction.

Q. And then there's another use of the term relatively low, friction is -- in your report you comment on the abutting pavements to the Red Hill on the LINC and the QEW interchange, which have been measured as higher skid resistance levels, as where you described earlier.

And if we could go to page 10 of Dr. Flintsch's report, please. And in the top paragraph, if you could call that out, this is what I was just speaking of about the higher levels in the abutting pavements. And you indicate:

> "The difference between the friction on the adjacent highway

sections at either end of the RHVP compared with that on the RHVP itself make the relatively low friction on the RHVP more problematic. Those drivers reaching the RHVP from the adjacent highway sections with higher friction may have an expectation of friction levels that are not available on the RHVP."

And, again, you use the term relatively low here. Does this reflect your opinion?

A. Yes, it does.

Q. You can take that down, please.

But Mr. Hein, as, you know, disagrees with that. And if we could call up Mr. Hein's report at image 10, page 8. Yes. Thank you. In paragraphs 26 and 27, prior to that, he quotes the passage in your report that I just took you to. There we go. I won't read all

this, but I think Mr. Hein is saying here he disagrees with you and that differentials in friction and different pavement sections don't create issues for the average driver or expectations for them and it's usually only appreciated, such changes are only appreciated, by specialized drivers, like race car drivers and the like. Could you comment on that?

A. Sure. I do agree that regular drivers don't think about friction when they're driving, but I don't agree that this is not perceived by any way. It's because truly friction is related with a stopping distance, so if you are driving in a highway with a specific friction, then you kind of get used to what it is, how much brake effort you have to make, how much distance you have to keep, just an example, from the other vehicle. Then all of a sudden, if the friction is lower, you will need a much higher distance and you may not notice that, but then if you assume it's the same, you may not have enough distance to stop when you brake and crash into the vehicle in front of you. That's just an example. It's not that you are thinking about friction, but you kind of get used to driving on a part that is

safe. And, again, when it start to rain, we typically start to keep more distance from the vehicle in front of us because we know there's less friction there, but when the pavement is dry or if it's wet in both cases, I cannot tell that really there's been a change and that could become unsafe in a way.

So, I think, I know we don't think about friction, but in a way, the way we drive is conditioned by how we feel the vehicle is able to stop under regular driving conditions. So, of course, if it changes all the time, I will agree that -- but if it's significant sections that it's high friction and then all of a sudden lower, I may have more difficulty adjusting to that because I don't know that I need more distance.

Q. So, it's actually the converse, really. If I understood you correctly, that drivers, regular drivers, so you, me, maybe you know it better, but certainly me don't appreciate the differences in friction. Is that a good way to put it?

A. Correct.

Q. Okay.

A. But it does impact your sense of safety in a way and your safety because if you get used to one value and all of a sudden it's lower, you may not be aware that you need to keep a longer distance between you and the vehicle in front of you or that you need to slow down in a curve because you may not be able to transverse safely.

Q. You can take that down, please, Registrar.

So, I would like to go back to discuss the Tradewind report itself, followed by the Golder report recommendations. And if we could go to page 13 of your report. And you've already commented on the Tradewind report to an extent, so I'm not going to go through all of this, but if we look at the fourth and fifth bullets, please.

In these bullets, you're referring to the conclusion in the Tradewind report itself using the incorrect or the earlier UK investigatory level to a 48 grip number rather than the lower one that was current at the time, but that Tradewind recommended a more detailed investigation be conducted and possible remedial

action being considered to enhance the surface texture and friction characteristics of the Red Hill Valley Parkway based on the friction measurements recorded in the current survey. And then you indicate:

> "I concur with this recommendation. Although Tradewind used an earlier table with an earlier conversion to convert the investigatory levels for the SCRIM to GN -- "

Grip number:

> " -- and only one investigatory level for each demand category, the same conclusion would have been reached using the levels reported in 2005 and reproduced in table 1."

Which we've already looked at. And so, we've discussed why, in your view, the UK standards are a useful reference in a particular instance. Can you describe why an investigation

would be warranted based on this?

A. Yeah. I do feel it is a reasonable recommendation because, again, since there are not -- we do have some measurements and those measurements are below what is considered safe -- well, not considered safe but considered worth of an investigation in the UK, it makes sense to me, well, I should investigate and if you don't believe on the measurements, as I've mentioned before, the minimum I would need to do is verify that if I've used the equipment I'm used to, that the measurements are okay.

Q. By using --

A. And appropriate for the conditions I have.

Q. So, you mean, like, using a device that you recognize or if you don't recognize that standard, then a standard that you do recognize and a device that you're familiar with?

A. And the other thing, at least in the US, that we do when there's an investigation is look at the percentage of wet crashes and see that's about the typical values for what we consider a good friction road.

Q. Right. As part of the investigation?

A. As part of the investigation.

Q. And so, if you have a report that indicates there may be an issue, do you simply ignore it?

A. No. Especially when it relate to safety.

Q. I'm specifically talking about a friction report in this issue, so --

A. Yeah.

Q. And then if you could call up the last two bullets, Registrar.

Just to close off, I think you referred to this issue earlier, but here you talk about potentially using those standards, you could apply higher investigatory values, is the first bullet, based on the demand categories. Is that what that's referring to?

A. That is correct. The value was the used to the report was for, kind of, sections without any events, but curves are considered an event and, again, depending on the conditions, you could have decide, well, we have

several curves in the section, so I should use a higher value as an investigatory level. Again, going back, there may be a higher demand of friction in that section.

Q. And then in the second bullet all you refer to the localized sections of lower values as referred to in the Tradewind report?

A. Yeah. Correct.

Q. Is that just another indication of a potential concern?

A. Exactly.

JUSTICE WILTON-SIEGEL: If I could just ask a question with respect to wet weather accidents. Are you saying that the experience with wet weather accidents would incline you to -- would be one of the factors that would suggest that further investigation would be warranted?

THE WITNESS: Correct, or a confirmation that there's a friction problem. If you are low friction and a high percentage of crashes on wet weather, then that's a confirmation that probably you need to correct for improve the friction of that section.

JUSTICE WILTON-SIEGEL: In other words, you would start with the assumption that perhaps friction was lower than it had to be on that particular section where you're seeing that accident experience?

THE WITNESS: Correct. And that's the way, the way the accident reduction program in the U.S. have worked for many years. We just using a proactive approach where we measure friction. Before what we did is we look at places where we have a high percentage of wet crashes and then check if the friction is appropriate in these sections, so it was the opposite. Right now what we are saying, well, let's measure friction at the natural level so we can be proactive and find out places where we may -- friction may be contributing to crashes and then do the investigation. But before it says, well, we don't have enough equipment to measure friction everywhere, so let's look at the places where we have a high percent of crashes and then focus on those and see if friction is a problem. So, if you have the two, it's a confirmation that you have a problem.

And, again, I go back to the

fact that most dry and wet crashes increase when friction goes down, when you have lower friction, but the wet crashes increases a higher rate, since when the friction is deficient, more deficient, you get a higher percentage of wet crashes because you demand more -- it's not that you demand more friction. The friction value is lower when the pavement is wet and we discussed that in the Primer extensively.

MR. LEWIS: Does that answer your question, Commissioner?

JUSTICE WILTON-SIEGEL: Yes.

BY MR. LEWIS:

Q. And we know CIMA did do, in its 2015 and later reports, analyzed a higher, high levels, of wet weather collisions, as you mentioned. Is that, given the results in the Tradewind report, is that something that you would or would not have predicted?

A. Yeah, that's what I would expect. Again, what I believe is a confirmation that there is a friction problem.

Q. And then we discussed the Golder report in 2014 which attached the Tradewind report and made some recommendations.

If we could call up page 28 of Dr. Flintsch's report, please. And in the section 4.1.2, Golder, the first two paragraphs, if you could call that up, please, Registrar, in the middle.

And as we know and you refer to here, Golder recommended in its January 2014 report that -- there were a couple of things and the friction issue was embedded in it, which was that there was a recommendation to deal with cracking, longitudinal top-down cracking, by resurfacing, and on the remaining portion, to route and seal cracks, followed by applying a single layer of microsurfacing, and then the combination of the two, mill and overlay, and applying microsurfacing, as stated in the Golder report, by doing that, the issue of relatively low FN on the RHVP would also be addressed.

And you indicate that, of course, you're not opining about the cracking issue, but that you agree with Golder that doing that, the combination with the microsurfacing done properly, would have addressed the low friction issue at that time. That remains your view?

A. Yes.

Q. And so, Mr. Hein, in his report, he opines that it was not necessary for Hamilton to carry out microsurfacing on the Red Hill at that time, in 2014.

If we could go to the Hein report, image 12, please, which is page 10. And Mr. Hein, his comments in response are here. And then the question he poses at the start is question 4:

> "Comment on
> Dr. Flintsch's opinion
> that the RHVP should have
> been microsurfaced in
> 2014 and, at resurfacing,
> the RHVP was preferable
> to shot blasting in
> 2019."

I don't think there's any disagreement on the second part of it, so I'll focus on the first part, the microsurfacing in 2014.

Is that what you were saying in your report, that the City should have done it right then?

A. No. I agree with the

recommendation that it could have addressed the problem and I also agree with the recommendation they should have been investigated.

Q. Right.

A. Yeah.

Q. So, just to come back, if they were doing the microsurfacing along with the partial resurfacing, that would have addressed the issue. That's number 1?

A. If done properly, as I mentioned before, because there was some complete evidence in the literature about microsurfacing, in some cases worked very well, in others it didn't work as well.

Q. And I think the second part of the recommendation you agree with, I guess it's the Tradewind recommendation, about investigating. Right?

A. Correct.

Q. If you weren't going to address it, you should investigate it?

A. Correct.

Q. Okay. And think you described that issue.

JUSTICE WILTON-SIEGEL:

Perhaps I can ask, just to be clear, when you say it should have been investigated, do you mean that there should have been more testing using, as you described it, testing equipment with which one felt more familiar, such as the locked-wheel tester, or do you mean that there should have been an investigation into whether, given the various factors that create a demand for friction, there was a need for more friction than these levels as tested seemed to indicate?

THE WITNESS: Well, if I were doing it, I would have done both.

JUSTICE WILTON-SIEGEL: Okay.

THE WITNESS: Because the second part include looking at the crashes and the geometry of the road. But, again, this is, as we discussed before, there's a cost benefit part of it, so how much depends on the conditions. In this case, we did high traffic and high demand road. Probably I would do both.

BY MR. LEWIS:

Q. And, along those lines, just before we get into the issue of contributing factors to collisions and the issue of wet weather collisions, we discussed your view of whether a

particular level of friction declared by an investigatory level or a guideline depends on the demand and the circumstances and that's what you were just referring to.

With wet road conditions, is the question of whether inadequate friction is a contributing factor to elevated wet road collisions dependent on whether the friction levels are above or below or at a particular threshold, regardless of what that is?

A. No. Typically always more collisions in wet weather because, again, the friction is lower in the same location. Because we measure wet friction and during dry conditions the friction is higher than we are measuring really, so that's why it's less critical, but it does impact both and there's quite a bit of evidence to that effect. But, again, during wet conditions, we do get more crashes in percentage, maybe not in number, but in percentage, than during dry conditions. It also was the case that the lower the friction, the percentage start to increase.

Q. Okay. And at page 27 of your report, if we could go there, there's the

reference to, just starting there, "In a legal opinion." And then, Registrar, if you could call out that and the next two paragraphs, sort of the middle of the page.

JUSTICE WILTON-SIEGEL:

Page 27?

MR. LEWIS: Yes.

JUSTICE WILTON-SIEGEL: Sorry, Mr. Lewis. This is page 27 of Dr. Flintsch's report?

MR. LEWIS: Yes, that's correct. Sorry about that.

JUSTICE WILTON-SIEGEL: Thank you.

BY MR. LEWIS:

Q. And so, this is referring to comments by Mr. Malone to a lawyer, David Boghosian. It indicates:

> "When asked to rank in order of greatest contribution to the inordinate number of wet road crashes, Mr. Malone advised as follows."

And then Mr. Boghosian's memo

or opinion indicates the four bullets of:

> "Slipperiness of the road surface (i.e. the road is slipperier when wet than other roads which leads to greater accidents than on roads with similar large numbers of horizontal curves in wet road conditions)."

Second bullet:

> "Speeds exceeding the capability of the highway given the curvature of the road."

Third:

> "Curves in the road (there are a number of sharp curves having design speeds of 100 km/hr, whereas a high proportion of vehicles are substantially exceeding that speed."

And fourth:

"The close proximity of the on/off-ramps to each other leading to losses of control and/or drivers' errors as traffic attempts to merge onto the highway or cut across lanes to get off the highway."

And then the next paragraph, as indicated, Mr. Malone testified on October 31 and your report was due very shortly thereafter that, and so there's the indication below there where Mr. Malone testified on October 31 that, regarding that ranking, that he did feel that those points, those bullet points, were contributing factors but interrelated and that he would not rank them and you were asked to give your view on that, which is indicated in the last paragraph there, that the proportion of Red Hill Valley Parkway collisions that occurred on a wet surface was high, so you agree with that:

"I also agree that all of the listed factors, including slipperiness of

the road surface (low friction) probably contributed to this unusually high percentage of wet road collisions. However, I don't have enough scientific evidence to comment on the order of greater contribution attributed to Mr. Malone in the memo."

And so, in short, you agree with Mr. Malone that including all of those factors as contributors. Is that right.

A. Yes. Correct.

Q. But you don't rank them because they're all interrelated. Is that right?

A. That is correct. And, again, it's impossible to generalize. All of them are important. In a particular crash, one might be more important than the other, but I don't think it's possible to, at least based on what I've seen, that you can say, well, in all cases this is what is the main cause in general.

Q. Right. And so, I think you said that it was in a particular crash, one might be more important than the other, but in a generalized sense, you're not able to state?

A. Correct.

Q. And so, in that sense, do you agree that Mr. Hein, he indicates that if you're going to attribute something to a particular crash, you have to have a particular examination or a reconstruction of that particular collision. Would you agree with that?

A. I do agree with that.

Q. And in those four factors or those four bullets, I should say, if I understood what you said before correctly, that those three, the speeds, the curves, the on and off-ramps, that those are things that go towards the friction demand part of the analysis?

A. Correct.

Q. And although Mr. Hein disagrees with the conclusion that the friction levels on the Red Hill was relatively low, do you read, from your reading, any disagreement in Mr. Hein's report with your assessment that the friction level, however it's characterized, is a

contributor to the high level of wet weather collisions?

A. No.

Q. Commissioner, I'm at a natural break point and it's almost 12:30. I wonder if this would be a good time to take lunch?

JUSTICE WILTON-SIEGEL: That's fine. Why don't we take the usual lunch. I guess we'll take an hour and a quarter and that means we would return at quarter to 2:00.

MR. LEWIS: Okay. Thank you.

JUSTICE WILTON-SIEGEL: Thank you.

--- Luncheon recess taken at 12:27 p.m.

--- Upon resuming at 1:46 p.m.

MR. LEWIS: Good afternoon, Commissioner, counsel and Dr. Flintsch. May I proceed?

JUSTICE WILTON-SIEGEL: Yes, please proceed.

BY MR. LEWIS:

Q. Dr. Flintsch, I want to recapitulate a couple of things that you said to make sure I understand them completely in your comments about the Tradewind report and the Golder

report recommendations coming out of that. And so, I'm going to tell you how I understood it and correct me if I misinterpret it in any way.

As I understood it, that the remedial measures that were recommended in the Golder report, which was the mill and pave for the part of the Red Hill where the longitudinal cracking was identified as being an issue, and that the microsurfacing, if done properly, as you said, on the rest of the Red Hill would have addressed -- you agree that that would have addressed any friction issues. That's the first thing.

A. I agree, yes.

Q. But if those remedial measures recommended by Golder at that time weren't taken, that there should have been an investigation, as mentioned by the Tradewind report. Is that right?

A. Yes, I agree with that.

Q. Okay. And then I thought that was clear. Then the next thing was about two potential parts about the investigation. You referred to if there was a question about the applicability or the usefulness of the grip tester

results and the UK standards and so forth and that if it was thought that there was more familiar equipment, like the ASTM locked-wheel tester and so forth, if there were any questions about that, then further questions should have been done using the familiar equipment. Is that the first part of it?

A. Yeah. That's my opinion.

Q. Okay. And then in any event of whether that further testing was done, investigate whether the friction demand may be exceeding the available friction by reviewing the geometry, speeds, traffic, collisions, those sorts of things. Is that right?

A. Yes. Correct.

Q. Okay. Thank you. And I would like to go back to, briefly, your references to the CIMA reports in your report.

And, Registrar, this is at the bottom of page 26 and 27.

The bottom three paragraphs continuing on to page 27, but the bottom three of 26 on to 27 talks about the three CIMA reports you specifically reference: The 2013 CIMA review, done between the portion between Dartnall and

Greenhill Roads and potential issues there and recommendations; and then the 2015 RHVP detailed safety analysis bay CIMA, which refers to the 50 percent of the collisions on wet surfaces, suggesting friction problems and, in particular, the northbound mainline in the segment including the King Street interchange showed a high percentage and recommended friction testing as one of the countermeasures that should be considered, and also possible improvements recommended speed enforcement, installing slippery when wet signs; and then the January 2019 CIMA roadside safety assessment, which had a further analysis of wet surface collisions and opining that the findings that inadequate skid resistance and excessive speeds may be contributing factors to collisions and noting that the portions between Greenhill and King Street and King and Queenston had up to 88 percent of wet surface collisions.

And, again, what do these wet weather collisions proportions tell you? Do you agree with CIMA about your assessment?

A. Yes, I do. Again, as I said before, these are high collisions and in some cases, of course, very high. We are talking about

88 percent, as mentioned there. So, again, I feel that these are very high and they are a confirmation that, as we mentioned before, the demand for friction exceeds the supply, the friction that the pavement is supplying.

Q. And you've read the report of Mr. Dewan Karim of 30FE responding to Mr. Russell Brownlee's TNS report. Yes?

A. Yes.

Q. And in your report you wrote about the City's annual collision reports from 2017 to 2021 and indicated that you agreed with -- you relied upon and agreed with Mr. Brownlee's analysis about the significance of the trends, the collision trends, after the various countermeasures were enacted by the City and the resurfacing took place in 2019.

And Mr. Karim, one thing he takes issue with in Mr. Brownlee's report is relying on the statistics post the resurfacing because of the pandemic. First, that there's a short period of time prior to that, but then during the pandemic and indicating that the pandemic threw everything off, if I can paraphrase, and so the collision data from the

pandemic period in particular there, 2020 and 2021, is unreliable or at least insofar as it cannot be compared to pre-pandemic data so that, in effect, that you cannot reach conclusions pertaining to the effect of those countermeasures and the resurfacing because of the disconnect in the data due to the pandemic.

And I anticipate that Mr. Brownlee is going to testify that, after considering Mr. Karim's perspective on this point, that he has reconsidered and will agree with Mr. Karim about the pandemic era data and the unreliability of it.

And so, assuming that's the case, would that change your other conclusions in any respect?

A. No, although I note that I haven't done any research on the post pandemic crashes or anything like that. One of the reasons that we use the ratio between wet crashes and dry crashes for, kind of, assessing the friction issue is because -- and, again, this is one of the reasons, not the only reason. Is because when you divide by the number of dry crashes, you're kind of normalizing the conditions. And, again, I

don't have a very good specific basis for these, but I just based on what I know about this analysis, I feel that people will not try different -- the changes of that affected both the dry and wet conditions similarly. It would be very unlikely that people will change their behaviour in dry conditions but not in wet conditions and vice versa. If they change the behaviour, they will change both behaviours, so it shouldn't be affecting the way here. But again, this is just an opinion maybe instead of a scientific fact.

And the second thing, even if we -- I wouldn't trust the result. That's not the case, after the pandemic, that wouldn't change my conclusions because, again, the numbers you serve are very high, as I said before, independent of what happened after that. I suspect this will be confirmed with future assessment.

Q. Now I would like to talk about Dr. Hassan Baaj's report. I briefly mentioned that at the outset. Broadly speaking, he dealt with, I think, three broad issues. The first is what you agreed with, was that the front end testing, if I can put it that way, of the

Demix aggregate, that it met all the requirements for use at the time of the construction, and we already discussed that. And a second part is that with respect to there was the MTO testing done in 1992, a very long time ago now, that the MTO conducted and you mentioned it in your report and Dr. Baaj indicated that it's incorrect to compare anything to 1992. He agreed with you that variation isn't uncommon or to be expected in a quarry over time, and he goes into quite a bit of detail about that.

And so, you have a reference. It's at page 23, if we could go to it, to the 1992 testing. Yes it's that paragraph. Thank you. The first full paragraph on that page, if you could expand that just a bit. Sorry, the first full paragraph that starts, "The PSV." Yeah.

And so, in the middle of that, you note that the inservice pavement, PSV results, from December 2017 is consistent with the results of the MTO obtained from 1992, reported by the MTO in December 2007, but lower than the value of 52 that the MTO reported for the same aggregate source obtained from quarry in 2008. And then you note that the variation is not uncommon as

different rock seams are exploited over time.

So, just what do you say about what Dr. Baaj says about the 1992 results and maybe just describe what your intention was when you mentioned them?

A. I agree with him. Maybe the way I worded the sentence wasn't the best. I was asked to comment how well they were and how they were similar, but I didn't mean to say that they will have any impact whether the aggregate later on was acceptable or not. It was just the same value caught my attention, but I didn't meant to imply that we should say the aggregate was bad because of that.

Q. And then, as noted there, you refer to the PSV of 45 obtained from the inservice pavement, that it was extracted by Golder in 2017 and then tested shortly thereafter.

One thing I should note, Commissioner, at the bottom of this paragraph, and I confirmed this after Ms. Roberts pointed it or Ms. Ramaswamy pointed it out in December, that the third last line, when it talks about an aggregate susceptible to polishing loses its macrotexture because of the abrasive affect of traffic, that

that should be microtexture?

JUSTICE WILTON-SIEGEL:

Microtexture?

MR. LEWIS: Yes, and we confirmed that with Dr. Flintsch and advised counsel at that time.

BY MR. LEWIS:

Q. That's correct? That's just a typo there, doctor?

A. Yes.

Q. And so, we know that Dr. Baaj spends a considerable amount of time in his report talking about the unreliability of the PSV results taken from the inservice pavement in 2017. And so, just to back up for one second, am I correct that the observations in your report about the polishing is relating to that polishing is a cause of the approximately 20 percent drop in skid resistance over the time period that you have already discussed. That's the first thing. Is that correct?

A. Yes, it is correct. It's at least one of the factors related with that, yes.

Q. Okay. And if, as

Dr. Baaj suggests, that you cannot rely, none of us can rely on the 2017 PSV results of 45, does that change anything else in terms of about what the cause is in terms of polishing off the microtexture of the aggregate?

A. No.

Q. Okay. And in the sense that the polishing of the aggregate over time is the cause of the reduction in friction?

A. Correct.

Q. Okay. And if we could look at Dr. Baaj's conclusions or his report and if we could go, Registrar, to Dr. Baaj's report, image 26, which is page 25, I believe, so, this one is one page off image and page.

And Dr. Baaj indicates in the first -- in section 3.3 and referring to that drop in friction of approximately 20 percent, Dr. Baaj refers to you correctly as having described the drop as significant and that you appear to connect it to the PSV measured in 2017 from the inservice pavement. And then he disagrees, I think, with the drop in friction of 20 percent over a six-year period being significant. Can you comment on that?

A. Well, that depends on the aggregate you are using of course in the regular practices. In addition to that, it depends on where you start with. If you start with a very high friction value, then if you drop 20 percent, you still have high friction. But if we have a friction like we had that started with about 40 something and that being around 30, then it's more critical than in other cases. And, again, what I'm saying is it's relative, but I do feel that it is significant.

Q. Okay.

A. And, again, I don't have a lot of experience with other aggregates in Canada, so I couldn't comment if that's average or higher or lower than average.

Q. Okay. If we go to page 25, it's image 26, the next page. Wait. Sorry. Image 26. Maybe keep up that image and the next one, please. That's it. Thank you.

In the last paragraph on page 25, Dr. Baaj indicates that:

> "Aggregate polishing is in fact a significant contributor to the loss

of the skid resistance of pavements. As stated by Dr. Flintsch, the aggregate loses its microstructure because of the abrasive effect of traffic and this is true for all natural aggregates. Therefore, it is reasonable to expect aggregate as to polish during the pavement surface life. Aggregate polishing would happen faster when the traffic volume is higher than the anticipated design volume, which was the case with the RHVP."

Then he goes on, as we said, that he disagrees that the PSV testing is related to that or, from 2017, the PSV testing, to conclude that it's susceptible to polishing because it was altered by being in service.

So, the first thing is do you

read this conclusion by Dr. Baaj as agreeing with you about aggregate polishing being the cause or contributing factor to the reduction in friction, of whatever that was? Is that fair?

A. Yes. Yes.

Q. But disagreeing with you that you can use the 2017 PSV results to arrive at that conclusion?

A. Well, I did not use those results to arrive to that conclusion. I was just commenting that it's consistent. It's just an observation. It really is not a cause effect there. And I'm sorry if I implied that. I was just commenting that there's the polishing and there's a good amount of polishing, so consistent with the value that was obtained.

Q. Okay. And is it typical to do the PSV testing on inservice aggregates? Dr. Baaj says that it's not, that that's not the usual way of doing it.

A. No, I agree. I haven't seen it before.

Q. Okay. And then, as I understood it, and this is indicated in your report, that polished stone value is intended to

give a representation of the terminal frictional characteristics of the aggregate. Just so we understand, could you describe what that means? Is that the end point when it's fully polished. Is that what that means?

A. In theory, that's what it is looking for. Of course, in practice, you always need to end somewhere with a test, so you do so many cycles of polishing and then you stop. So, it may or may not be the terminal value in reality. So, that's why it very well could be that when you start with a lower value, you may end up with something lower than you would if you start with an original aggregate. But, in theory, the objective of the test would be to get the terminal polishing value. So, if that's the case, then it won't make a difference if you start with an aggregate that's already polished because you end up with -- but, again, one thing is the theory and another is the practice. I couldn't -- I never done this test myself, so I couldn't tell if that's the case or not.

Q. Okay. And I think that Dr. Baaj's overall point is that the inservice PSV results do not indicate what the original

frictional qualities of the aggregate was, that it indicates instead of, sort of, projecting its current state and projecting forward. But is that nevertheless consistent with indicating a loss of friction over time, that there has been polishing?

A. Yeah.

Q. And I think you indicated earlier that with respect to the polishing, you've talked about the results taken by Tradewind and Englobe, the friction results that were obtained from the wheel paths versus the centre lane, and that was something that you relied on on the issue of polishing. Is that right?

A. Correct.

Q. And, as well, that the macrotexture was, as you said, overall satisfactory?

A. Yes.

Q. Okay. And if we could go to your general observations and conclusions on pages 29 and 30. Back, Registrar, to Dr. Flintsch's report, pages 29 and 30.

I don't intend to read it out, but starting -- I think what we were just talking about, you refer about the macrotexture

measurements and the PSV value, but you've explained your perspective on that, and that the level of wear reflecting a decline in microtexture is something that's reflected overall by the testing.

Then if we could call up the bottom paragraph on 29 and as well the balance of 30 where it continues. Sorry, all three paragraphs on 30, if you can do that. Okay. Thank you. That was a complicated one, I appreciate, Registrar.

So, here, this is just a summary of your conclusions?

A. Can you repeat that?

Q. Is this a fair summary of your overall conclusions?

A. Yes. Yes, it is.

Q. Okay. And we've seen that the expert reports tendered by the City and Golder disagreed or semi-agreed with you on certain points and so forth and attempted to address those items. Is there anything that you have read in the participants' reports or discussion today that causes you to reconsider this overall conclusion?

A. No.
Q. Okay. And this still reflects your opinion?
A. Yes.
Q. Okay. Commissioner, I would just like to review my notes. I may be done. And I would like to just speak to participants' counsel, if I may, just to talk about their time estimates.
JUSTICE WILTON-SIEGEL: Sure. Well, then, why don't we take a five-minute break and I'll ask the registrar to put all the counsel in a separate breakout room.
MR. LEWIS: Thank you.
--- Recess taken at 2:16 p.m.
--- Upon resuming at 2:35 p.m.
MR. LEWIS: We're back. May I proceed, Commissioner? I just have, I think, one or two questions?
JUSTICE WILTON-SIEGEL: Please do so.
MR. LEWIS: Thank you.
BY MR. LEWIS:
Q. Dr. Flintsch, this is just on the issue of the pandemic era collision

statistics and whether anything can be drawn for that. And I just want to confirm the last part of your evidence on that. I think you indicated that, you know, if you can't rely on it, it wouldn't change your conclusions about pre-pandemic, but that once those statistics are normalized, going forward, is that what you were talking about, that if there is a reduction, that could be varied going forward. Is that what you were saying?

A. In part, yes, but I also said when we are doing the ratio between the wet and dry crashes, we are, kind of, normalizing the percentage also. So, I wouldn't expect that the percent between the wet and dry would change because of the pandemia because I don't expect the driving behaviour will be different when the pavement is dry or wet or at least the change in -- of course it's different, but the change in behaviour will be similar. And, of course, eventually the conditions will normalize and there would be more data to convey, so I think it's both.

Q. That's the point I was getting at, was the second part about whether it's

now or whenever, when traffic conditions have normalized. Is that what you were saying?

A. Yes.

Q. Okay. Thank you. I don't have any further questions Commissioner.

JUSTICE WILTON-SIEGEL: Okay.

MR. LEWIS: I understand that Ms. Roberts, on behalf of Golder, is going to lead off, followed for Mr. Chen for the City and Mr. Bourrier for the MTO after that and maybe Ms. Laurion for Dufferin at the end. Thank you.

JUSTICE WILTON-SIEGEL: Ms. Roberts.

MS. JENNIFER ROBERTS: Thank you, Commissioner. May I begin?

JUSTICE WILTON-SIEGEL: Yes, please proceed.

MS. JENNIFER ROBERTS: Thank you.

EXAMINATION BY MS. JENNIFER ROBERTS:

Q. Dr. Flintsch, I'm Jennifer Roberts, counsel for Golder. I have a few questions, but I think you covered off what I would have otherwise asked, so I will be fairly brief.

I just want to begin with a point from your evidence. And I'm going through my notes, so please forgive me if I've got this somewhat muddled, but this was the Commissioner's question. When he asked in the context of your evidence about whether the City had taken Golder's advise and implemented microsurfacing, that that would have improved friction, and then you said if they didn't do that, that they should have then done something about the advice provided by Tradewind and conducted further investigation.

And you mentioned that if they had been uncomfortable, I think that's your word, with the testing that had been done, they should have used a different kind of testing. Do you remember --

A. What I said if it was -- I don't believe in the result of the grip tester, but the grip tester is showing maybe I should be doing something. The minimum I would do is to go ahead and do testing with equipment I'm familiar with, like the locked-wheel.

Q. Okay. But I take it that you're not, in that answer, suggesting that there was any uncertainty or unreliability about the use

of a grip tester?

A. No. No. We've used it for several projects in the U.S., so no, I don't have any issues with that.

Q. So, your evidence is if the owner in this case was uncomfortable with the methodology, they should have just used a different methodology. Do I have that right?

A. Correct.

Q. Okay. Thank you. Okay. I just want to address your evidence about the expectation of friction on different sections of the road, and I think maybe the easiest way to do this is to look at one of the figures from your report.

Registrar, if I can ask you, please, to go to -- hold on, let me see if I can find it -- Dr. Flintsch's report, pages -- let's go to page 9, which is figure 4. Okay.

And you discuss in your report and you have testified today that drivers may have an expectation of friction going from one highway with high friction to another one with lower friction. Do you remember that part of your testimony?

A. Yes.

Q. Okay. And I think, if we -- and commission counsel took you to this. This is the -- you've put in a graph format the friction measurements by ARA before resurfacing and it shows changes at either end, which we've indicated is beyond the SMA asphalt, and that signifies the circumstance you're talking about where empirically there's a change in friction?

A. Correct.

Q. Okay. And I just want to address this point because I think, you know, as a driver, surely it's the case on any highway that, as that highway is surfaced and resurfaced over time, that there's consistently changes in friction?

A. That is correct, yes.

Q. Okay. And so, that expectation of friction is always going to be, you know, at least in part violated by just the ordinary resurfacing of a highway?

A. That is correct.

Q. Okay. Okay. Thank you. And let me -- forgive me, sir. I am jumping around a little bit.

A. No problem.

Q. I don't want to take you in detail through evidence you've already gone through. I just want to address the Golder recommendation to use microsurfacing.

Registrar, can you take down that call out, please. Thank you.

You say in your report that assuming that microsurfacing were properly done, that that would have improved friction. Now, taking that assumption that the microsurfacing was properly done, how long would you expect that the improved frictional characteristics would last?

A. That's a very good question and I don't know for sure, but I would expect that it would be several years.

Q. Okay. Thank you. And I want to go to a similar point in relation to your evidence about shot blasting and skid abrading. You address the recommendation to carry out shot blasting and skid abrading. And you address that recommendation and say in 2018 that, you know, by the time that that recommendation was given in 2018, that the resurfacing was already pending and you understood why that advice might not be taken,

bought resurfacing was a better answer. Do I have that evidence right?

A. What I said, if I remember correctly, is that in general, microsurfacing is a long-term solution. We're talking about several years. My experience with the shot blasting is when you have heavy traffic, it does provide some help, but it's only temporary. We're talking about months. So, you may have had to repeat it again if you -- but it depends on the conditions again and it's a treatment that has been used, but it's not widely used around the world.

Q. Okay. So, let me just dig into the treatment. And there some evidence on this point as to what shot blasting and skid abrading is and I understand that they're two slightly different techniques, but in both cases they essentially crudely roughen the surface texture?

A. That is correct. And one is a special case of the other. A skid abrader is a shot blasting technology with some special features that make it more efficient, at least in theory.

Q. Okay. And, as I understand it, and look to you for correction, effectively you're shooting metal into the surface of the highway and then using a magnet to pick it up and that process roughens the surface?

A. Yeah. The impact of the pellets, the steel pellets, break the aggregate and expose the microtexture basically.

Q. And you alluded to it already, but were either of these techniques of shot blasting, skid abrading, applied in 2016, 2016, how long in general terms would you expect the --

A. Yeah. Again, I don't have a lot of experience with those treatments, so it would be hard to say. But my opinion based on the limited applications, we did test some applications around Washington DC recently, we're talking about months.

Q. Months?

A. Yeah.

Q. Okay. Then I take it the techniques could have been used on sections of the Red Hill?

A. That is correct.

Q. Okay. So, if I'm following your evidence correctly, there were areas where objectively there were high numbers of collisions, particularly wet weather collisions, and as you describe it, that in those sections there's a very high demand for friction. And I take it, sir, that in those areas, that they could have been improved had the City used the techniques of skid abrading or shot blasting.

A. That's a lot of ifs, but if I had -- yeah, of course. The most critical locations are where you have low friction and a lot of -- high percent of wet crashes. So, if I were going to fix a section like that, I would emphasize fixing first the area, the localized areas, where I do have the lowest frictions and the highest percentage of wet crashes. And a skid abrader or shot blasting could have been one of the solutions. I know in the short term I've seen improvements. Again, I couldn't guess how long it would last. I don't think it would be a solution for five years, but it --

Q. No. Yeah. I appreciate that. Okay. So, it could have been applied as a technique to improve friction temporarily, as you

say, pending a more comprehensive pavement resurfacing?

A. Correct. And I know it is used. I had one student who did some work in Spain looking at these and it does provide a temporary solution. This was a concession they had to provide a specific level, so they would use this as a regular practice to keep the friction in acceptable values. So, there are experience like that.

Q. Okay. Thank you. I just want to go to a different topic. You were taken to it by commission counsel, Dr. Baaj's view that the decline in friction values of approximately 20 percent, he didn't think it was significant and you do. And so, I just want to note that and leave it.

I take it that the point you're actually making, the important point, is that regardless of whether you characterize the change as significant or not, that the friction was relatively low, pick your phrase, but your view is that the evidence from the high number of wet weather collisions and the high demand on friction because of the geometry and those other

factors, that clearly that means that however you call it, that there was insufficient friction for the demand. Do I understand you correctly?

A. Yes.

Q. Okay. Thank you. That's very helpful. Thank you, Dr. Flintsch. Those are my questions.

JUSTICE WILTON-SIEGEL: Okay. Mr. Lewis?

MR. LEWIS: Yes. I believe Mr. Chen is up next for the City.

MR. CHEN: May I proceed, Mr. Commissioner?

JUSTICE WILTON-SIEGEL: Yes, please do, Mr. Chen.

EXAMINATION BY MR. CHEN:

Q. Good afternoon, Dr. Flintsch.

A. Good afternoon.

Q. I'm counsel for the City. Just taking you back to your Primer, it discusses approaches that highway agencies use to specify and manage, you know, frictional properties of pavements in a number of jurisdictions, Australia, the UK and New Zealand. Do you recall that?

A. Yes.

Q. But with respect to Canada, in your Primer you state that you're unaware of any published -- this is paraphrasing -- provincial or national standards in Canada respecting highway friction investigatory or intervention levels. Do you recall that?

A. Yes.

Q. And then you go on to say that you consulted with colleagues to confirm that was your understanding. Right?

A. That is correct.

Q. And you contacted colleagues that had expertise, I suppose, in Canadian friction management practices?

A. Correct.

Q. And I take it you did that because they would have more knowledge and experience with respect to Canadian friction management practices?

A. That is correct. I look at the literature and websites and all of that and I couldn't find anything, but I wasn't sure, so that's why I felt it was a good idea to check with

some local colleagues to verify that was the case. I didn't want to miss anything, of course.

Q. Yeah. Fair. One of the those colleagues was a name you've mentioned today, David Hein. Do you recall that?

A. Yes, I did.

Q. And you e-mailed him for help on this topic?

A. Yes. He's a good friend and also a colleague in some of the activities of the (unintelligible) association and ASE.

Q. And do you recall asking Mr. Hein about specifically Canadian standards or policies that speak to, I guess, required or recommended friction levels?

A. Correct.

Q. All right. And you reached out to Mr. Hein because you recognized that he is a friction expert in Canada. Correct?

A. Correct.

Q. And I take it you're aware of the work that Mr. Hein has done in Canada with respect to pavements and friction testing?

A. Yes, some of it. I wouldn't say -- especially mostly the

international work, he's been very active internationally. That's when I interact with him more. I never work with him on the project in Canada, so I know what he's published about it, but not all his work.

Q. Right. But would you agree that Mr. Hein, being a friction expert in Canada, he has more experience than you conducting friction testing on Ontario roads, for example?

A. Of course, I never done any testing on Ontario roads, but I don't think that's a main -- I haven't done testing on roads. We use many different pieces of equipment, when I say me, our research group, on roads and all around the U.S. and, through my consulting work, I also been involved in a few other countries, but never in Canada. I agree with that part.

Q. Right. Never in Canada or Ontario for that matter?

A. Correct, although I was examiner for a couple of the students that did their Ph.D. dissertations on friction in Canada, so I do have some indirect knowledge because I had to review their dissertations.

Q. Okay. Indirect

knowledge. Thank you.

A. Yeah.

Q. So, just turning to Ontario and the practices here, in your report, and we've heard about it a lot in the inquiry, you refer to the friction number of 30 that's used by the MTO?

A. Mm-hmm. Yes.

Q. And you understand that the MTO uses, I'll just say FN30 for short, as an investigatory level?

A. That's what I understand. I cannot find a formal investigatory level because it's not a published number.

Q. Right. No, I understand that. And that FN30 investigatory level, you learned of that through preparing for this inquiry or in the course of this inquiry?

A. Correct.

Q. All right. You haven't previously in your work applied FN30 in any context?

A. Not really, not myself. We have assessed these because in the U.S. we are moving from a simple number to a friction demand

concept similar to the UK, so we've been using that concept, so we have defined investigatory levels, but we have and I know that several of the states have some numbers that they use, as they were already discussed in the proceeding.

Q. And, Mr. Hein, as you saw, I think Mr. Lewis had shown you one of the tables that Mr. Hein has included, the variation, you know, below 30, above 30. You recall that?

A. Correct.

Q. In your report, I just want to make sure I'm clear about this, you don't express an opinion on the MTO's use of FN30 for friction management purposes, practices?

A. No.

Q. Correct? And you also don't express an opinion on what Mr. Hein has said in his report about the use of FN30, in your report or in today's evidence?

A. In the report, I didn't have the other report, so I couldn't comment. I don't have any issues with the use of the number 30. What I could recommend is I would say that I don't see that that should be a value that -- and we talk about this. We know 30, it's

an unsafe road. Higher in safety, FN30, I'm sure is a safe road. What whether said several time is that how much friction is needed, the friction demand, depends on the context on that particular highway, things like the speed the vehicles are travelling, the geometry and all that. So, I do agree that this is a relevant value. I'm not sure that, as I said before, that means if you are below 30 you are safe or vice versa, if you are above -- sorry, the opposite. If you are below 30, you are not safe and if you are above 30 you are safe. That part, I don't have experience to tell you that because I haven't look at crashes versus friction in the Canada.

Q. Right.

A. Or in Ontario.

Q. Right. And I may have a question on that as we go on, but just so I'm clear, just from, you know, strictly speaking talking about investigatory level, you're not saying that you shouldn't use FN30?

A. That is correct.

Q. Okay. Registrar, could we bring up Dr. Flintsch's report, which is EXP191, image 6. At the same time, could we also

bring up image 7.

Dr. Flintsch, one of the comments that you make is that the RHVP friction values seem to have stabilized after 2014 or so. And, I take it, by stabilized, you know, you mean that there was a decrease in the initial years and in 2014 onwards to 2019 the friction values were more or less in the same range?

A. Correct.

Q. Okay. And figure 2, as the title suggests, what we see in that figure are average measurements for the lane. Correct?

A. Correct.

Q. And I take it looking at it, you know, from an average friction measurements in the way that you have done it is appropriate to, kind of, assess the friction values?

A. Can you repeat the question? Sorry, I did not understand it.

Q. Well, the way that the friction values are presented in this figure are average friction values and we're looking at this graph or this bar graph to determine the friction levels and what it is on the Red Hill. I take it

that because you presented it this way, it's a proper way of, you know, looking at the data?

A. Yes. Saying if it's okay to use the average versus the specific plot, I also present the specific plots, so I present it both ways. I think this is a reasonable way. What I was trying show in this plot is that friction drop significantly in the first few years. That was the main objective of showing it like this.

Q. Okay. And just one last point on this graph before we move off of it. I take it there is a FN30 in the line going through it. I take it we can agree that none of the bars on this figure fall below the FN30 line?

A. No.

Q. So, we can agree or you don't agree?

A. No. We agree that none of them -- none of the average fall below 30. We are in agreement with that.

Q. Okay. And I won't take you to this. This is a different topic in your report, but you make the observation that the grip tester numbers on the RHVP, Red Hill Valley

Parkway, were lower than the LINC. You're aware of course that the LINC was resurfaced in 2011?

A. Yes.

Q. And as a general proposition, you would expect that a newer pavement could generate higher friction results?

A. Correct.

Q. And that would explain the variation or the differential between the friction levels on the LINC and the Red Hill?

A. Well, at least potentially. There may be many other reasons, too, but that could be one of the reasons of course.

Q. Okay. Great. Thank you. Mr. Lewis raised the UK levels with you and we've touched on it a little bit in your report. You say that the UK guidelines can provide a good reference.

First question: You're not aware of whether the UK investigatory levels have ever been applied in Ontario. Right?

A. No.

Q. Okay. And is it fair to say that an investigatory level set by one

jurisdiction does not necessarily suit the conditions or needs of another jurisdiction?

A. Correct.

Q. And so, if a road authority wants to adopt an investigatory level from another jurisdiction, you know, you may want to consider the differences of those conditions between jurisdictions?

A. Correct.

Q. This is not a one-size-fits-all situation?

A. Agree.

Q. Okay. And Mr. Hein, in his report, talks about the Austroads report, which Mr. Lewis had raised with you as well, and I don't think we need to bring it up, but in that report it points out various things that you would want to look at before relying on an investigatory level from another jurisdiction so I just want to see what your thoughts are on it?

A. Sure. Sorry, I thought you were done the question.

Q. I'm going to be a bit more specific. One of the things that you would look at the construction material, so the

availability of aggregates. That would affect the investigatory level?

A. It could.

Q. Climate?

A. Yes.

Q. Right. And another point that the report raises is road management budgets of a particular city. That's also a fair consideration?

A. All of those are valid consideration, I agree.

Q. All right. And budgets themselves are important not just for, you know, looking at investigatory levels, but also with respect of what remedial measures or treatments may be of value at a particular time?

A. Of course.

Q. All right. So, I want to switch topics to the very technical conversion relationship that we have in your report. And, you know, Mr. Lewis brought this up with you. And the conversion is from grip tester results, so GN, to FN90, friction number 90 or at 90 kilometres an hours. Correct?

A. Correct.

Q. And so, the steps that you do, you take, to do the conversion are set out in your report. I may have lost the reference. It's at 2.1.2.3. I'm just trying to locate the actual image number. Bear with me one second.

MR. LEWIS: It's page and image 18 and 19.

MR. CHEN: Thank you, Mr. Lewis.

BY MR. CHEN:

Q. Okay. Perfect. So, you've testified that you have done the conversion in four steps, two equations, two adjustments. Correct?

A. Correct.

Q. I take it there's no reliable formula to use to convert directly from GN to FN. Right? Otherwise, you would have used that instead of a four step approach?

A. That is correct. That's discussed in the Primer and also in Mr. Hein's report. There have been many attempts over the years to do these. And the reason why I used these two in particular is because they are based on significant amount of testing in a wide range

of pavements. A lot of the other corrections are based on wider ranges of friction, so it's very hard to get a good accurate conversion that you could extrapolate. And, again, if you have facilities where you have high values and low value, of course your equation is more comprehensive and that's the reason I chose these two in particular.

Q. Right. But just for the direct conversion to GN to FN, there is no formula out there that will give you any, you know, sort of comfort in the conversion?

A. That's correct. There are many that have been published, including some that we developed in our research group, but I think these two in particular, I felt more confidence with.

Q. Okay. Well, in 2017, there's a paper by, I think, your research department?

A. Yeah.

Q. If we can pull that up, EXP13.

A. That's the one from North Carolina?

Q. Yeah, that's correct.

A. That is correct, yeah.

Q. You know your work very well. If we can go to image 33, just jumping to the conclusion.

A. Yeah. There is an equation there where we had a relationship but we didn't felt that it was very accurate and then we mentioned that when we specify. I think it's a couple pages before that, I believe.

Q. If I can just confirm your conclusion here, Conclusions, then there's the bolded heading, Harmonization/Interconversion of Equipment, and you say:

> "The direct results of the comparison showed that: Comparing the locked-wheel to the GN and SR measurements produced low to moderate correlations (under 50 percent)."

Do you stand by that conclusion?

A. For this particular data

set, I do.

Q. Okay. Great. Thank you. We can bring that down and turn back to image 18 of the report, EXP191.

MR. LEWIS: I'm sorry to interrupt, but I was wondering if that should be made an exhibit?

MR. CHEN: Perfect. Thank you. Thank you, Mr. Lewis.

THE REGISTRAR: Noted as an exhibit.

JUSTICE WILTON-SIEGEL: What's the number, Mr. Registrar?

THE REGISTRAR: 227.

JUSTICE WILTON-SIEGEL: Thank you.

EXHIBIT NO. 227: Paper published by Dr. Flintsch's research department in 2017, EXP13.

BY MR. CHEN:

Q. If we can go back to image 18 when you have a moment, Mr. Registrar, 18 and 19. And in terms of how the conversion goes,

Dr. Flintsch, you take the value that you obtain from the first formula and then you apply it to the next step. Is that right?

A. Correct.

Q. And step one of the conversion is the conversion of the grip number to the SCRIM reading?

A. Correct.

Q. And to do that, you relied on -- there's a cite, Dunford 2010. That's the UK project that you referred to?

A. Correct.

Q. Okay. And you're familiar with that project, I assume?

A. Yes, I am.

Q. So, can we turn up EXP34, page 7.

Dr. Flintsch, so, for this UK project, it was carried out in October 2009. You see that there? I take it that's a yes with the nod?

A. I'm sorry. I didn't understand the question.

Q. No, I was just asking you to confirm that this was when it took place.

A. Okay. Yes, of course.

Q. And for this particular trial, there were 11 grip testers and two SCRIMs. Is that right?

A. I don't remember the numbers, but I assume that's correct.

Q. All right. Well, well come to that, but one of the objectives is to see how the grip tester results, you know, compare with the SCRIM results. Right? That's where you were, kind of, running both machines?

A. Correct.

Q. All right. You were also comparing how various grip tester results compare amongst each other. That was also part of the exercise?

A. I don't remember the details, but I think that's probably correct, yes.

Q. All right. And just as a general matter, when we talk about conversions, is it correct that there are two concepts that are important: Repeatability and reproducibility?

A. That is correct.

Q. And repeatability is the ability for a measurement tool, like the grip

tester, to, kind of, repeat its results. Right?

A. That is correct.

Q. And reproducibility is the ability, you know, for a different measurement to a different grip tester to obtain the same results?

A. Sorry, I lost you a little bit because you broke for a second when you were talking.

Q. Repeatability is the same machine getting the same results. Reproducibility is a different machine getting similar or same result from a different machine?

A. That is correct.

Q. Somewhat of a mouthful, but I think --

A. I know.

Q. -- we're on the same page. All right.

A. So, the questions they use, they are related with the reproducibility of the devices basically.

Q. Right. And you touched on this in your evidence earlier, but the formula that's developed, you know, that's part of this

trial, is derived from the various roads and tracks that were used in this trial?

A. The various sections, yes. There were shorter sections and they have a research facility where they were first done, if I remember correctly.

Q. Right. And can we agree that, you know, none of the sections or the test facilities here replicate the Red Hill Valley Parkway?

A. Well, I couldn't answer that. There may be one that is similar. Truly, I don't remember the details. You may go to the page where they show the sections. I reviewed this report in preparing the Primer, but that was a long time ago now. I don't remember the detail.

Q. Let me just locate the page.

A. One of the good things I've seen in this report was, again, that there was a wide range of different friction values from relatively low to kind of high values.

Q. Okay.

A. That part, I do remember. But if it was an SMA section similar to the one we

are dealing with, I truly don't remember.

Q. That's fair. I'll take you to something more specific.

A. Yeah.

Q. But perhaps something less challenging. I take it we can agree that the grip tester that was used to conduct the Tradewind testing in 2013 was not the same as any of the grip testers that were used in this trial?

A. I agree with that.

Q. Okay.

A. Probably the locked-wheel that was used by MTO wasn't the same one used by ARA later.

Q. Fair enough. I'm just focused on --

A. Yeah, yeah.

Q. -- the formula and how we arrive at the formula.

A. Okay.

Q. And this report, aside from the fact that, you know, there's variations between the grip tester, it also talks about the variations between, you know, operators and tow systems being different. That's all correct?

A. That is correct.

Q. Okay. And so, just looking at some of the results of this project, if we can go to image 18, table 4.4, Dr. Flintsch, titled Average Grip Number Measured on All Road Sections.

A. Can you make it a little bit bigger, that table, please? Okay, perfect.

Q. Thank you, Mr. Registrar. I have to say this is some fascinating stuff. But just looking at row 1, which is a particular section, and then there are letters on the top, A to L, those represent the different grip testers that did the testing. So, if we look at row 1, am I right that the variation that we see in the 11, 10 or 11, grip testers is that it can go as low as 0.46, which is A, and as high as 0.63, which is H?

A. That is correct.

Q. Okay. So, that's a difference of, you know, 46 GN and 63 GN?

A. Yeah. And if I remember correctly, they are highlighted because they identify that they probably had some problems with those measurements, if I remember correctly.

Q. Yeah. I think it was K

where they had to exclude that machine because it was producing results higher than, much higher, than the other grip tester challengers.

And if we can turn to image 21, and I appreciate, Dr. Flintsch, that I'm getting into the details, but I have to understand, you know, how this formula was derived, as I understand it, figure 4.1 shows the results of the study, so they've plotted the results that they have. Do you see that?

A. Correct. Correct.

Q. And so, the grip numbers range from about 0.45 all the way to 0.85 or so. Correct?

A. Correct. And there's one value very low there at about 0.1.

Q. Right.

A. Yeah.

Q. So, the data set that we're dealing with in which this equation was developed is replicated here. Correct?

A. Correct.

Q. All right. And from that data set, we get to the equation at the bottom, SC equals 0.89 times GN. Correct?

A. That is correct. These are, I think, if I remember correctly, is the average for each device, for each section, sorry, from all the devices.

Q. And it says here at the bottom there:

"This conversion should be used with caution."

And I take it that's consistent with the evidence that you gave today with respect to conversions?

A. Correct.

Q. Okay. And if we can go to image or if we could also put up image 12, which is the page before this, so that -- sorry, my mistake. Image 20 and 21.

And you had mentioned before, Dr. Flintsch, that the trial was run on different sections with different types of services. And on the left side of your screen just at the bottom there, that last paragraph, it says:

"Section 3B on the track and all measurements from grip tester K on the track have been

excluded."

Do you see that notation? We can blow up the --

A. Can you repeat that? Where is that? Sorry.

Q. If we can just call out the paragraph, the bottom paragraph, on image 20. So, it's that second line at the end, Dr. Flintsch, section B, 3B?

A. Yeah, that's correct.

Q. I take it you don't know what section 3B is until --

A. No, no. No, I don't.

Q. Okay. So, if we can go --

A. I visit the track once many years ago, but I -- yeah.

Q. I seem to have lost -- image 11. If we just look at the table 2.2 there, section 3B, it says SMA?

A. Mm-hmm.

Q. Right. So, that would be the section that was removed. That data was excluded. Do you agree with that?

A. Yeah.

Q. Okay. We can take that down, Registrar. Thank you very much.

Dr. Flintsch, a different topic. You talk about the impact of temperature on friction measurements in your report?

A. Yes.

Q. And one of the things that you say is that no measurement should be taken for -- sorry?

MR. LEWIS: Sorry to interrupt. Should we mark that as an exhibit?

MR. CHEN: We should.

MR. LEWIS: I do it all the time, so I can't fault you. I'm not sure of the document number, though. The doc ID.

THE REGISTRAR: EXP34, Exhibit 228.

MR. LEWIS: Thank you.

EXHIBIT NO. 228: UK project carried out in October 2009, EXP34.

MR. CHEN: My law clerk is not sitting with me, signalling me to do it, so that's why I'm failing a bit.

BY MR. CHEN:

Q. Dr. Flintsch, just going back to where it was, you talk about the impact of temperature on friction measurements in your report and one of the things you say is that no measurements should be taken when the temperature drops below 0 degrees because water may freeze. Is that correct?

A. That is correct. That was in the Primer, I believe, not that the report that we're discussing now. It's provided as an appendix. I agree, yeah.

Q. Yeah. And I think it's also in your report after you talk about the conversion at --

A. Well, when we talk about the VPN, I said they're not reliable because they are done below 0 degrees, so it is implied there, yes.

Q. And so, just going back to that point, if the water freezes, the values are unreliable?

A. Correct, because you're testing on ice, not on a wet pavement. Yeah.

Q. And in your report, aside from the 0 degrees Celsius that you talk about,

you also talk about your personal recommendation, also the recommendation of AASHTO, that friction testing be conducted with pavement temperatures between 5 degrees Celsius to 50 degrees Celsius. Correct?

A. Yes, that is correct.

Q. And is it fair to say that you would ideally want to avoid friction testing at near freezing temperatures as well, so close to 0?

A. Yeah, because I will be measuring the friction value too high compared to what really we do under regular conditions. The lower the temperature, the higher the value I measure in, so it would be too high when in reality the friction will be lower than that.

Q. Right. But is there not also, you know, if you're close to freezing temperatures, a measure of unreliability in -- go ahead.

A. Well, the recommendation is mostly based on the fact that I don't want to measure a friction higher and it not be in the safe side. What I'm saying is if you test in between 5 and then I don't remember what the other

temperature is, you get the value that is freezing. With the rubber, it starts to get too hard with low temperatures, then the friction value you're measuring is higher than what you're really getting on the road. That's my recommendation. But I know that there's some agencies that do that and they do correct for temperature. So, I wouldn't say they are unreliable. I think this is just a recommendation truly. I don't have a good argument either way.

Q. Right. So, if you were testing in, you know, temperature ranges that are, you know, even below your 5 degrees -- let me just step back. As I understand it, when you're conducting friction testing, you want to be able to control as many variables as you can. Right?

A. Correct.

Q. Right. And so, if the temperatures have been below 0 and slowly rising, for example, are you saying that that's not a range of temperature that would cause you any concern with respect to friction testing?

A. Really, I couldn't say a way or another really. Of course I don't want to test below freezing, as I said before, and I would

need to look at each case in particular before I say, well, I feel good or not about this. I know if you look at most of the standards, they don't have a range of temperatures because we are not sure, but if you ask me about my opinion, I don't see it would be unreliable. And also, we are talking pavement temperature or air temperature? That's another question, because the pavement is typically warmer than the air by a lot of degrees during the day and by a few degrees during night. So, if you're talking about one degree, it's very likely that the water will be freezing on the pavement. If you are talking about minus one degree, I would say probably I wouldn't measure, but I'm not sure -- I don't know, to be frank.

Q. Okay. That's fine. Thank you very much.

A. Thank you.

Q. Just to confirm a separate point, Dr. Flintsch, your report goes into the macrotexture and measurements on the Red Hill. Am I correct that your conclusion on macrotexture is that the macrotexture on the Red Hill was appropriate and acceptable?

A. Correct.

Q. Okay. And turning to your comments on resurfacing and shot blasting, specifically with respect to shot blasting, your view is that shot blasting can be a good short-term solution as it relates to friction. Is that correct?

A. Correct.

Q. Right. And when we say short-term, I take it you mean a short period of time?

A. Correct. As I explained just before this discussion with Ms. Roberts is that you break the aggregate and you expose some of the microtexture and, again, these are small areas that get polished again relatively quickly. Truly, I don't have enough experience to tell you if it's three months or one year or something like this. But I don't think it does provide, based on what I've seen in the literature, like, a five years improvement that will last several years. That's -- I'm quite sure.

Q. And so, you had mentioned that microsurfacing needs, you know, to be done properly. I take it with shot blasting, similarly the effectiveness, if, you know, I understand your

point about the experience, the effectiveness of shot blasting may very well depend on, you know, the asphalt and the aggregate that you're dealing with. Is that fair?

A. That is fair.

Q. And one of the points that Mr. Hein makes in his report, which I think you've read, is that shot blasting sometimes is actually over abrasive and it may actually affect friction detrimentally. Would you agree with that?

A. Truly, I don't know. I haven't seen it, but that doesn't mean that -- truly, what I've seen is that it's used as a treatment to improve friction, so I couldn't tell if it could be detrimental, but it's not unreasonable.

Q. And you conclude in that section of your report that resurfacing is a better and long-term solution. Why is that?

A. Because you're starting with a new surface.

Q. Okay. Fairly straightforward, Dr. Flintsch?

A. Yeah.

Q. And so, obviously with that comes a longer term solution?

A. Exactly.

Q. Right. Okay. And just going back to what Mr. Hein said about shot blasting and it being over abrasive, you don't dispute, I take it, his conclusion that that's a possibility?

A. No.

Q. Okay. And I apologize for jumping back and forth, Dr. Flintsch. I'm just, kind of, going through the notes and making sure that points are covered and I don't want to ask you again.

There is, in your report, references to localized areas with low friction. Do you recall using words to that effect?

A. Yes. I believe it was lower friction, but --

Q. Okay. Well, just to be fair, I think there's lower and also localized elsewhere, but we don't need to go into that.

I take it you've, you know, in your report, indicated there are localized areas with lower friction, which are identified in the

Tradewind report. Do you recall that?

A. Yeah.

Q. And you've reviewed the Tradewind friction data, of course?

A. Yes.

Q. And when I look at those results and compare it to ARA, for example, I see GPS coordinates with the ARA data, as an example, but not the Tradewind. Is that your observation as well?

A. That is correct.

Q. Okay. And without GPS coordinates, you would agree that it's, you know, quite difficult to determine with any precision, you know, where the areas of low friction are, looking at the Tradewind report?

A. Well, yes and no. Of course you won't be able to locate it to the point that you know exactly where they are, but I think since you have the niche at the beginning of the end of the section, it's relatively easy to point with an accuracy. If you have to repair them, you should be able to locate them. I wouldn't have any problem locating them myself.

Q. Okay. So, you're

suggesting that -- and I'm trying to think back to how the Tradewind data looks, but you're going, like, roughly in sections of --

A. Yeah. I'm not talking about -- yeah. You're not talking about fixing five metres of road here, because that would not affect friction, but we're talking about a few hundred metres. That's a little bit different. I don't know if I -- can you hear me?

Q. Yes, I can hear you.

A. Okay. Something happened on the screen. I don't know what. I don't know if I answered your question or not. I'm sorry. I got a little bit distracted.

Q. No. I think we agree that the Tradewind data doesn't provide you with any precision of where, you know, some of the localized areas are, but you're saying that you would, kind of, look at it more broadly. Is that fair?

A. That is correct, yes. And, again, we need to keep in mind that some of those tests were done several years ago with GPRs, not as commonly used as it is now.

Q. Give me one second,

Dr. Flintsch.

A. No problem.

Q. One of the topics that you address in your report is the contributing factors to the wet road collisions?

A. Yes.

Q. And in discussing the ranking of, you know, the potential contributing factors to wet weather collisions on the Red Hill, you confirmed earlier that, you know, it's impossible to rank them because a they're all, you know, interrelated. Is that a fair characterization?

A. That is correct. They're interrelated and, again, the reports change from one crash to another.

Q. Yeah, agreed. And just in terms of the contributing factors, you know, they would include, so we talked about, you know, slipperiness. There's also speeding and curvature. Those are factors as well?

A. Yes, they are.

Q. Right. And you can't say, when you're looking at those factors, that, you know, one factor is contributing more than

another to collisions on the Red Hill. Correct?

A. Correct.

Q. Okay. And that is consistent with what you've said at the outset of your evidence, that -- and I think it's in your Primer -- deficient friction is, you know, seldom the main cause of a crash, but that it could cause or contribute to crashes in the presence of other contributing factors. Is that right?

A. Correct.

Q. And that's because, I take it, the contributing factors, like human error or speeding, they would create an increased friction demand as well? Is that correct?

A. Correct.

Q. All right. And I think one of the points that you raised today that the higher friction values could, you know, avoid the crash or reduce the severity of the crash. Is that correct?

A. Correct.

Q. And so, just looking at it from the other perspective, it's fair to say that, you know, countermeasures or actions that reduce the friction demand could also avoid the

crash or reduce the severity of the crash. Is that correct?

A. Correct. Yes.

Q. All right. And I think you were talking about, you know, friction demand and supply, so we're, kind of, bringing that together.

You're aware and you've read the 2015 CIMA report? You may not have read it all, but you're aware of it?

A. Yes. I had it all because I had to review it carefully, so I did read it. It was while ago, so if you ask me for details, I need to go and look for them.

Q. No, no. I will be staying high level.

A. Okay.

Q. But you understood that the 2015 CIMA report to, you know, discuss the detailed safety review that was done on the Red Hill?

A. Yes.

Q. All right. And so, based on collision analysis, CIMA in that report concluded that a combination of speeding and wet

surface conditions may be contributing to the wet weather collisions on the Red Hill. Does that accord with your recollection?

A. Yes.

Q. And, you know, just considering the conversation we've been having, we can't generalize which one of those factors would be the primary contributor. Correct?

A. I agree.

Q. Okay. So, if a countermeasure were to be deployed that reduces speeding, for example, that, as we discussed, could reduce the demand for friction. Right?

A. Yes.

Q. Okay. And countermeasures like those ones could also, then, reduce or result in a reduction of the number of collisions or reduce the severity of the collision?

A. Yes.

Q. Yes? You're nodding.

A. Yes. I think we all agree on that, yes.

Q. Perfect. Okay. If I can just have a minute to consult.

Mr. Commissioner, I wonder if we could take our afternoon break just to confirm that there's no further questions from our end?

JUSTICE WILTON-SIEGEL: That would be fine. Let's take a five-minute break. Sorry, a 15-minute break, if you want to take the afternoon break. I guess we have plenty of time. It's a quarter to 4:00 now. We'll return at 4:00.

--- Recess taken at 3:43 p.m.

--- Upon resuming at 4:00 p.m.

MR. CHEN: Mr. Commissioner, no further questions from the City. Thank you.

JUSTICE WILTON-SIEGEL: Okay. Thank you, Mr. Chen.

MR. LEWIS: I believe Mr. Bourrier was up next.

MR. BOURRIER: May I proceed, Commissioner?

JUSTICE WILTON-SIEGEL: Yes, please do.

EXAMINATION BY MR. BOURRIER:

Q. Good afternoon, Dr. Flintsch. I'm counsel for the Ministry of Transportation. I have a few questions to ask you about the MTO friction measurements.

A. Good afternoon.

Q. Good afternoon. Registrar, can you please pull up Dr. Flintsch's report at page 5. And, Registrar, if you could call out the figure 1 chart at the top, that would be helpful. Thank you.

Dr. Flintsch, if we look at this chart, which shows the MTO locked-wheel average measurements between 2007 and 2014, would you say that the friction values were starting to stabilize prior to 2014?

A. That's hard to say really because we are missing one in between. It seems that the 2012 are a bit higher than the 2014.

Q. Okay. And I believe this morning your evidence to commission counsel was that when you looked at the grip tester results in 2013, you had thought that that demonstrated that the friction was stabilizing around 2013. Do I have that right?

A. I said, yeah, around 2013 or 2014 really, yes.

Q. And if we look at this chart, we don't have any results for 2013 for the locked-wheel measurements. With that in mind, is

it fair to say that the results were starting to stabilize after the MTO tested in 2012, so sometime after 2012?

A. It could be. I don't have any way of saying really one way or another.

Q. That's fine.

A. Because we don't have any testing after 2014, either.

Q. If you take a look at the results between 2011 and 2014, would you agree with the statement that the friction is decreasing at a much slower rate than the previous years?

A. That is correct.

Q. And if we look at the previous years, specifically 2009 to 2010, would you say that those results show the more rapid decline in friction?

A. Correct.

Q. And if we look at these results just on their own, am I right in saying that they don't tell us anything about the friction demand on the road?

A. That is correct.

Q. Registrar, you can take down this call out.

Commissioner, I'm just going to take one minute to look at my notes.

Those are all my questions. Thank you, Dr. Flintsch.

MR. LEWIS: And Ms. Laurion for Dufferin reserved time, five minutes, but I don't know if she has any questions.

MS. LAURION: We have no questions. Thank you, Commissioner. Thank you, Mr. Lewis.

JUSTICE WILTON-SIEGEL: Okay. Thank you. Mr. Lewis?

MR. LEWIS: I do have a few redirect questions, Commissioner, if I could have your indulgence.

JUSTICE WILTON-SIEGEL: Yes. Please proceed.

FURTHER EXAMINATION BY MR. LEWIS:

Q. Dr. Flintsch, Mr. Chen asked you about the LINC and it having the higher friction levels as disclosed by the Tradewind report and then later the ARA and maybe to a lesser extent the Englobe testing because of the limits on the testing, and you had indicated -- he asked you if the reason for that would be or could

be the more recent resurfacing in 2011 and you said, well, that is one of the potential reasons.

What are the other potential reasons?

A. The material is different and it has just higher friction to start with and throughout the life. I don't know what the terminal value would be, but they could be a different material in the surface truly. I did not look into that.

Q. No, I appreciate you didn't look at it. I'm just asking you to speculate on the reason, so I just wanted to finish the thought. Thank you.

A. Yeah.

Q. In relation to the Dunford paper, which Mr. Chen brought you to and it was about the conversion, and Mr. Chen asked you about the SMA section being removed and the data excluded from the SMA section. Do you recall that?

A. I do.

Q. And do you know why it was removed?

A. No, I don't.

Q. Okay. If we just look back and you see it, and I don't know if this will help you or not, if we could go, Registrar, to EXP34, which is, I think, Exhibit 228, and image 17, if I've got the right one. And then in the middle paragraph above table 4.3, it talks about section 3B being removed. I appreciate you don't have any insight behind -- I assume you don't have any further insight behind it, but it says that they have excluded section 3B and I think it was indicated that was the SMA section. Is that right?

A. That is correct, yes. I do remember that part.

Q. Okay. And it says:

"Because of the physical variability of the surface caused by repeated braking."

What does physical variability mean? Do you know?

A. I think that it's not homogeneous, so you cannot -- that's what I understand, that there are areas maybe with a different condition than others along that length

and maybe there were some cracking or some bleeding or something. Truly, it could be many things. That would be my assumption truly. I don't know.

Q. You're just reading it, as am I?

A. Yeah.

Q. Okay. Thank you. You can take that down. Thank you, Registrar.

Mr. Chen asked you about repeatability and reproducibility in relation to the grip testers. Did you see any issue with reproducibility between the Tradewind and Englobe devices and results?

A. No. They both produced similar results, so -- but at least there wasn't anything obvious that indicated any problems. And, if I may add, you probably will see the same issue with all friction devices. Truly, the measurements are depending on many factors that we discussed in the Primer. Unfortunately, there is variability and I did mention a little bit of that when we were talking about it. The 30 limit, that truly is not an exact number. We know that every measurement has potential variability.

Q. Thank you. Two questions, and then I'm done, about temperature. In one sense, no evidence that the Tradewind testing was done close to 0; however, I just want to make sure I'm clear on your evidence, that you indicated the Tradewind -- if it's close to 0, you would expect the friction number that results to be higher than it would if it was taken at a higher temperature. Right?

A. Correct.

Q. Okay. And last question, and this is -- I just want to make sure I understand it correctly. You said that pavement, the pavement temperature, is usually warmer, especially during the day, than the air temperature. That's the first thing. Is that correct?

A. That is correct.

Q. And then you said, if you're talking about one degree, it's very likely water will be freezing on the pavement. And I'm wondering there, because given that you have described the pavement being warmer than air, are you talking about if the pavement temperature is one degree or if the air temperature is one degree

or something else?

A. No, no. I was talking about the pavement temperature is one degree, I think there's a chance that it may freeze. But if you're talking about air temperature, I think that would be very unlikely. It's just to give you a number. Truly, as I said, I don't even know it's been researched enough to know. We try to avoid measuring at very low temperatures because we don't want to have a value that is not conservative in a way.

Q. Okay. Right, that's higher --

A. That's higher than what we have really under normal -- well, at least under the normal temperature range that we would measure.

Q. Thank you. I have no further questions, Commissioner, so subject to any questions that you have for followup.

JUSTICE WILTON-SIEGEL: I also have no further questions, so I think we're done for the day. I want to thank Dr. Flintsch for his assistance throughout.

THE WITNESS: My pleasure.

JUSTICE WILTON-SIEGEL: You've produced two reports and you've been of great assistance to the inquiry. Thank you very much and we'll adjourn for the day.

--- Whereupon the proceedings adjourned at 4:12 p.m. until Friday, February 17, 2023 at 9:30 a.m.