MEMO

TO : Edward Soldo
Director, Transportation Operations and Maintenance
City of Hamilton

FROM : Brian Malone, CIMA+

DATE : February 25, 2019

SUBJECT : Red Hill Valley Parkway - Review of MTO Pavement Friction Data 2008-2014
(CIMA+ File: B000920 / 200)

1. INTRODUCTION

This memorandum details our review of the results of pavement friction testing data for the Red Hill Valley Parkway that had been collected by the MTO starting in 2008 and continuing until 2014. The data provided is for friction testing completed on the RHVP and data was collected for 6 years of the 7 year timespan, the exception being 2013.

In your email of February 17, 2019 you requested that we review the data, undertake an analysis of trends that may exist in the data and determine if an extrapolation of pavement friction values to 2019 can be provided from the data. You also asked if CIMA would recommend that the City undertake friction testing prior to the resurfacing to validate the MTO data and if any of our recommendations from recent reports, including the Feb 4th, 2019 memo, would be impacted by this data.

This data is separate from the friction testing data which was collected in 2013 by Tradewind Scientific. That data was reviewed by CIMA in our memo dated February 4, 2019. The Tradewind data has not been included in our analysis of the MTO friction data. Details of the testing protocol used by MTO were not available and could not be compared to the Tradewind protocol. Without confirmation that testing protocols are the same, merging of data is not appropriate.

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As with the 2013 Tradewind data, CIMA has not previously been provided with this MTO data and it did not form a component of our earlier road safety reviews relating to the RHVP and the LINC.

2. ANALYSIS

The MTO pavement friction data was completed over a period of 7 years, from 2008 to 2014. Six years of data were provided, 2008, 2009, 2010, 2011, 2012, and 2014. No data was provided for 2013.

CIMA examined the data for each year and reviewed it for trends from 2008 to 2014. We determined that there were sufficient data points to undertake trend analysis, and, with considerations noted below, to extrapolate date to 2019

We have summarized data using a single value for each reference year. Results varied not only by year but also by lane, by direction and by air temperature recorded at the time data was collected.

The potential for trends in the data was reviewed using various model alternatives. Linear regression (straight-line projection), was assessed as was non-linear regression. A non-linear (logarithmic) function was found to have the best fit, statistically. The non-linear regression was used for extrapolation of the data to future years, up to 2019. The results are shown graphically in Figure 1 and numerically in Figure 2. In these figures both friction measurements (2008-2014) and friction estimates (2008 – 2019, extrapolated by the fitted model) are presented.

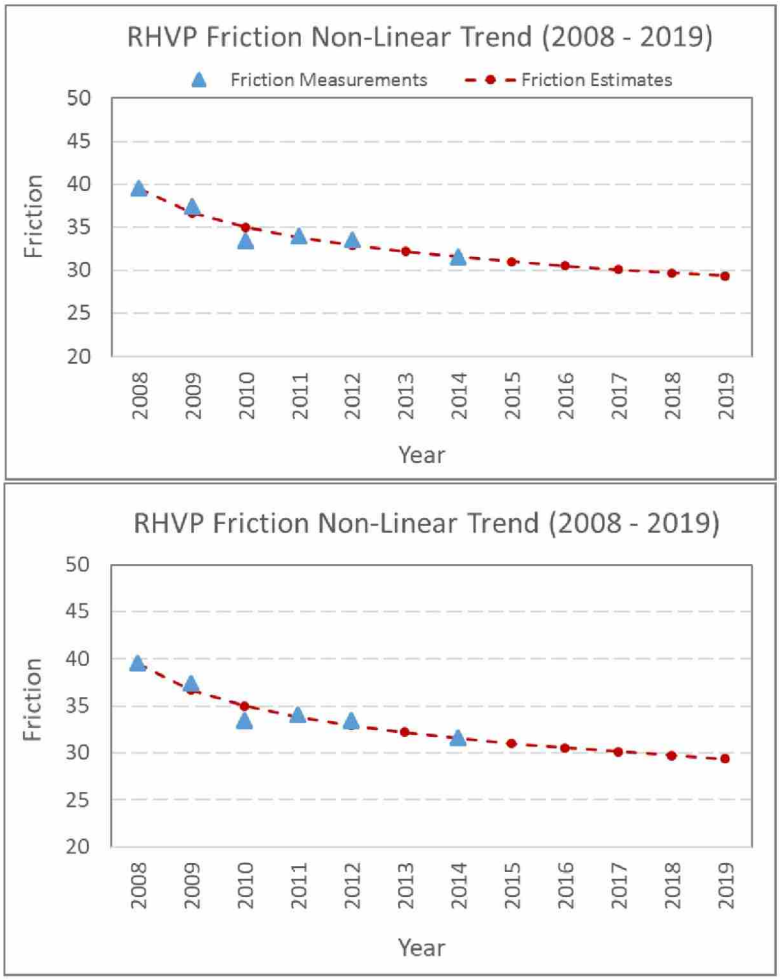

Figure 1 – RHVP Friction Non-Linear Trend – Graph

Year	Friction Measurements	Friction Estimates
2008	39.6	39.5
2009	37.4	36.7
2010	33.4	35.0
2011	34.0	33.8
2012	33.5	32.9
2013		32.2
2014	31.6	31.6
2015		31.0
2016		30.5
2017		30.1
2018		29.7
2019		29.4

Year	Friction
2008	39.6
2009	37.4
2010	33.4
2011	34.0
2012	33.5
2013	
2014	31.6
2015	
2016	
2017	
2018	
2019	29.4

Figure 2 ~~- Figure 1~~ – RHVP Friction Non-Linear Trend – Values

While specific values do vary by lane and direction, overall the results show that friction levels have dropped over time.

We have extrapolated the values to 2019 based on the best fit of the testing data using a non-linear function. However, results must be viewed with caution. Mathematically the 2019 values represent the best fit to the extrapolated 2008 to 2014 measured data, but actual 2019 field-measured values may vary, based on a number of factors.

Traffic volume is known to impact friction values. Data provided did not include traffic volumes. Changes in volumes over time, and their impact on friction values, has not been accounted for.

It is normal for pavement friction values to reduce during the lifecycle of a road and the trend is generally found to be non-linear. While our use of a non-linear function to fit the data may account for this to some degree, the exact profile of degradation is unknown and our regression analysis does not directly model 'normal' life cycle pavement friction degradation.

Lastly, longer term extrapolation of data will be less accurate than estimates done over a shorter term. The magnitude of uncertainty in results will increase as the projection timespan increases.

Based on the extrapolation of data collected from 2008 to 2014, the average pavement friction values in 2019 are estimated to be dropping, to approximately 29 (f=0.29). That value corresponds to the same stopping distance design value used in a 100 km/h design speed, which is f=0.29. The value is above the lateral friction value used in the road design for 100 km/h horizontal curves of f=0.12.

The extrapolated 2019 average friction value is lower that the results reported in the Golder report of January 2014 which indicated measured average friction levels on the RHVP ranging from FN values of 34 to 39, corresponding to (f) values of 0.34 to 0.39.

The MTO data provided was for the RHVP. Data for the LINC was not provided. The 2013 Tradewind study did provide measurements for the LINC which showed values higher than the RHVP. Given the absence of corresponding data from the LINC in the MTO data, we are unable to comment on difference in friction values between the two facilities either in the measured data from 2008 to 2014, or in the extrapolated 2019 values.

3. DISCUSSION

As noted in our February 4th, 2019 memo, pavement friction measurements can be compared to the assumed design values to ensure that the fundamental design parameters have been provided. The friction values measured by the MTO from 2008 to 2014 indicate that the average friction values exceeded the stopping distance design value used in a 100 km/h design speed (f=0.29). The values were also above the lateral friction value used in the road design for 100 km/h horizontal curves (f=0.12).

Extrapolated values for average pavement friction were determined for 2019 using a non-linear function. The extrapolated 2019 average friction value is the same as the stopping distance design value used in a 100 km/h design speed (f=0.29). The value remains above the lateral friction value used in the road design for 100 km/h horizontal curves (f=0.12).

It is not possible to determine friction values by lane and direction for 2019, but it is likely that some areas of the RHVP have friction values that are lower than the stopping distance design value used in a 100 km/h design speed (f=0.29).

Commented [SS1]: This statement is not quite right. Using our model we are able to determine friction values by lane and direction.

We recommend that testing be undertaken. Empirical testing in the field will validate the extrapolated 2019 data results. In-field friction testing will confirm the current pavement friction values. Undertaking friction testing prior to repaving will also provide a baseline for evaluation of changes to pavement friction levels following the resurfacing.

We note that the review of the MTO data showed statistical correlation with air temperature at the time friction testing was undertaken. Air temperature should be considered when undertaking comparisons of the existing conditions in 2019 to previous data and when friction testing is completed following paving operations, to ensure accurate comparisons.

Our extrapolated 2019 average friction values shows numbers that are at the design values. Even if field measurements indicate lower levels, they are an indicator that the road is less-safe, but they do not immediately render the road unsafe.

Lower friction levels result in longer stopping distances. Multiple countermeasures were previously recommended by CIMA and have been implemented to mitigate for these less-safe conditions. The recent lowering of the speed limit for portions of the RHVP adds to countermeasures that directly address pavement friction conditions. No additional changes are recommended at this time.

Commented [SS2]: Shouldn't we rephrase it and say "No additional changes are recommended prior to the upcoming resurfacing."?

Brian J. Malone, P.Eng.