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 this 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 the data is not appropriate.

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. 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. It must be noted that the data varied not only by year but also by lane, by direction and by air temperature recorded at the time data was collected. The yearly values we have used in this memo are representative of the averages of the data, by year. Individual test results varied above and below the average yearly values.

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.

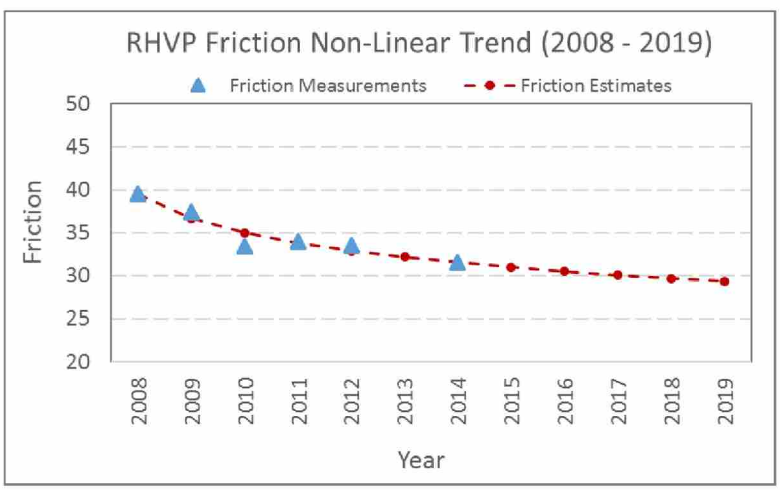

Figure 1 – RHVP Friction Non-Linear Trend – Graph

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

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

Overall, the results show that average friction levels have dropped over time. We again highlight that individual testing values varied by lane, by direction and by temperature.

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

Traffic volume is known to impact friction values. The data provided did not include traffic volumes. Changes in volumes over time, and their impact on friction values, is unknown.

It is also normal for pavement friction values to reduce during the lifecycle of a road and that 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 we note that our regression analysis does not directly model normal life cycle pavement friction degradation.

Lastly, the results determined for 2019 are estimates based on extrapolation of an identified trend. Longer term extrapolation of data will be less accurate than estimates done over a shorter term. The magnitude of uncertainty in results increases 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 reported the Tradewind testing results. Those results 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. Again, we note that the testing protocols from Tradewinds and from the MTO testing have not been compared, so the comparison of the friction values should also be viewed with caution.

The MTO data provided was only 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 any difference in friction values that may exist 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 design parameters are being provided in the field.

The friction values measured by the MTO from 2008 through 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 equal to the stopping distance design value used in a 100 km/h design speed (f=0.29). The value is above the lateral friction value used in the road design for 100 km/h horizontal curves (f=0.12).

Based on the variance in the MTO test data by lane and by direction, we anticipate that some areas of the RHVP in 2019 have friction values that are lower than the stopping distance design value used in a 100 km/h design speed (f=0.29).

We recommend that additional testing be undertaken of the current condition of the pavement. In-field friction testing will confirm the current pavement friction values and allow validation of the extrapolated 2019 results.

Undertaking friction testing prior to repaving will also provide a baseline for evaluation of changes to pavement friction levels following the resurfacing. ~~When undertaking testing, i~~It should be noted that our review of the MTO data showed statistical correlation with air temperature at the times friction testing was undertaken. Therefore, ~~Air~~ air temperature at the time of testing should be considered when undertaking comparisons of the friction testing results from 2019 completed before and after repaving to ensure accurate interpretation.

Our extrapolated 2019 average friction values show numbers that are estimated to be equal to 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 the less-safe conditions identified on the RHVP. The recent lowering of the speed limit for portions of the RHVP adds to those countermeasures.

We have reviewed the recommendations in our 2015 report in light of the MTO friction testing data from 2008 to 2014. Our report had recommended pavement friction testing. MTO data provides clarity on the issue of friction being a contributing factor in collisions. We had also identified countermeasures that targeted elements that interact with pavement friction, specifically speed.

Given that resurfacing is now planned in 2019 and that action will directly address pavement friction conditions, we have no changes to our 2015 recommendations.

Brian J. Malone, P.Eng.

Commented [SS1]: If you need a partner in crime, you can include my name as well. For reasons that you know, I am not insisting though.