APPENDIX 11

ILLUMINATION TECHNICAL MEMORANDUM

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TO: Arash Olia, Ph.D., P.Eng. (Town of Caledon) **RVA:** 195072.13

FROM: Mario A. Watson, P.Eng. (R.V. Anderson)

DATE: June 21, 2021

SUBJECT: Columbia Way Class EA – Lighting Recommendations

1.0 BACKGROUND

R. V. Anderson Associates Limited (RVA) is pleased to submit our lighting recommendations based on our pedestrian, roadway, and intersection Illumination analysis along Columbia Way from Regional Road 50 to Forest Gate, in the Town of Caledon.

1.1 Pedestrian Lighting

The purpose of this study was to determine if the existing Pedestrian level light fixtures (i.e., Ped Lights) would have provided adequate light levels along the proposed Multi-Use Path (i.e., MUP), and meet the minimum requirements outlined in IESNA RP-8-18 (i.e., RP-8) guidelines. Recommendations if the existing Ped Lights can remain in their current locations were to be provided based on the illumination analysis and proposed road and MUP works.

1.2 Roadway Lighting

Continuous roadway lighting only exists between Regional Road 50 and Kingsview Drive. Illumination between Mount Hope Road and Caledon-King Townline exists only at the intersections. The purpose of this study was to determine if the existing roadway network warranted additional continuous lighting.

1.3 Intersection Lighting.

There are currently four (4) intersections in the study area, one is currently signalized, two are unsignalized, and one is proposed to be modified to a roundabout configuration. The purpose of this study was to determine if the existing lighting is sufficient for the revised road configuration.

2.0 APPROACH AND METHODOLOGY

The photometric analysis was carried out following the current industry approved design standards, guidelines, and practices:

- **ANSI/IES RP-8-18 (RP-8)** – RP-8 was used as a guideline to verify the minimum levels of illumination required for the continuous roadways, intersections, and MUP. This recommended practice determines the minimum levels of illumination required based on the type of study area, road classification, and pedestrian activity level. The pedestrian activity level is determined based on the anticipated volume of pedestrians in a single block (or 200-m segment) for the highest one-hour nighttime sample period.
- **International Dark-Sky Association (IDA)** – RP-8 promotes the use of Dark-Sky compliant fixtures as part of the IDA practices. This initiative was established to mitigate or eliminate the adverse impact of lighting on the views of the darkened nighttime sky. It should also be noted with regards to light trespass, current industry practices promote minimum to zero light spill on to adjacent properties.
- **Transportation Association of Canada (TAC)** – TAC standards and tables were used to complete the Warrant Analysis to determine if additional continuous lighting was required.

3.0 PEDESTRIAN LIGHTING

An analysis was completed for the following:

- MUP along Columbia Way from Regional Road 50 to Forest Gate.

3.1 Assumptions

The lighting analysis was carried out based on assumptions made for the following:

- Pedestrian Conflict Level.
- Pedestrian Light Fixture.

3.1.1 Pedestrian Conflict Level

RP-8 recommended values for walk paths are based on the volume of pedestrians during the nighttime hours, and the density of residential dwelling units per acre. The area of concern is

identified as a *Low Pedestrian Activity Area* and *Medium Density Residential*. Based on this criteria, RP-8 Table 16-3 was used for the analysis.

Table 16-3. Recommended Values for Low Pedestrian Activity Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_{avg} (lux/fc)	$E_{v,min}$ (lux/fc)	E_{avg}/E_{min}*
Rural/Semi-Rural Areas	2/0.2	1/0.1	10.0
Low Density Residential (*2 or fewer dwelling units per acre*)	3/0.3	1/0.1	6.0
Medium Density Residential (*2.1 to 6.0 dwelling units per acre*)	4/0.4	1/0.1	4.0

Table Notes:

E_{avg}: Minimum maintained average horizontal illuminance at pavement

E_{min}: Minimum horizontal illuminance at pavement

$E_{v,min}$: Minimum vertical illuminance at 1.5m above the pavement in both directions and parallel to the main pedestrian flow.

Pedestrian Only areas apply to areas such as sidewalks.

* Horizontal only

3.1.2 Pedestrian Light Fixture

The following luminaire information would be required to complete a photometric analysis: Fixture Manufacturer/Model, Wattage, Light Distribution Type, Simulated Arm Reach (i.e., distance from pole to centre of light emission), and Simulated Mounting Height (i.e., distance from finished grade to centre of light emission).

Circuit Loading Schedules shown on available electrical As-Built plans show the existing luminaire wattages are 50W. A field visit was conducted to measure the Arm Reach and Mounting Height. These values averaged to approx. 0.6m and 5.7m, respectively.

It should be noted that no exact information was available to determine the Manufacturer, Model, or Light Distribution type for the existing fixtures.

RVA contacted the following lighting suppliers directly to identify the existing fixtures: Eaton, Acuity, and CREE. It was determined that the existing fixtures mostly resemble the CREE LEDway Street Light. There was no information available for order history and as such, a catalogue number was unavailable.

The following distribution types are available for this fixture: 1S, 2M, 2S, 3M, 4M, and 5M. Standard lighting practice for roadways and walk paths would typically only use Types 2 and

3 light distributions. For this recommendation, types 2M, 2S, and 3M were used for the analysis. The closest configured .ies files with respect to wattage were for 51W:

- **Type 2M**: STR-LWY-2M-**-03-E-UL-525-40K (525mA) CONFIGURED FROM STR-LWY-2M-**-06-E-UL-700-40K or BXSL*206E-UD7 (700mA)
- **Type 2S**: STR-LWY-2S-**-03-E-UL-525-40K (525mA) CONFIGURED FROM STR-LWY-2S-XX-06-E-UL-SV-700-40K-XXX or BXSL0F06E-UD7
- **Type 3M**: STR-LWY-3M-**-03-E-UL-525-40K (525mA) CONFIGURED FROM STR-LWY-3M-XX-06-E-UL-SV-700-40K-XXX or BXSL0306E-UD7

3.2 Minimum Requirements

Based on the Assumptions established, RP-8 recommends an Illuminance calculation method to be completed.

The criteria to be met for the MUP as per RP-8 Table 16-3 in Section 3.1.1 of are:

- An average horizontal illuminance level greater than or equal to 4.0 lux.
- An average to minimum horizontal illuminance ratio less than or equal to 4.0.
- *As vertical illuminance is only measured in the design phase, a quantitative analysis was not completed*.

3.3 Analysis

Based on the proposed MUP location, a majority of the existing 37 Ped Lights were in conflict and would require re-location. The analysis was completed to determine the optimal spacing for the re-located poles required to meet RP-8 requirements.

Results for the Pedestrian Light Analysis can be found in Appendix A of this document.

With reference to the results of the analysis, the MUP was split into 4 segments:

- Segment 1 – Regional Road 50 to Kingsview Drive (approx. 211m)
- Segment 2 – Kingsview Drive to Westchester Boulevard (approx. 900m)
- Segment 3 – Westchester Boulevard to Mount Hope Road (approx. 289m)
- Segment 4 – Mount Hope Road to Forest Gate Avenue (approx. 233m)

Spacing between existing Ped Lights varies between 45m – 50m. The analysis was completed with a spacing of 30m, 35m, 40m, 45m, and 50m.

- 30m spacing requires a minimum of 57 Ped Lights
- 35m spacing requires a minimum of 49 Ped Lights
- 40m spacing requires a minimum of 43 Ped Lights
- 45m spacing requires a minimum of 39 Ped Lights
- 50m spacing requires a minimum of 35 Ped Lights

4.0 ROADWAY LIGHTING

A warrant analysis was completed for all midblock segments to determine if continuous roadway lighting was warranted. With reference to the results, segments were broken into:

- Segment 1 – Regional Road 50 to Kingsview Drive
- Segment 2 – Kingsview Drive to Mount Hope Road
- Segment 3 – Mount Hope Road to Forest Gate Avenue

A warrant analysis was completed for two (2) intersections within the urbanized scope of area. Intersections were denoted as:

- Intersection 1 – Columbia Way @ Kingsview Drive
- Intersection 2 – Columbia Way @ Westchester Boulevard
- Intersection 3 – Columbia Way @ Mount Hope Road
- Intersection 4 – Columbia Way @ Forest Gate Avenue

All completed Warrant Analysis can be found in Appendix B of this document.

4.1 Assumptions and Design Criteria

Full Illumination is always warranted for signalized intersections and roundabouts. Intersection 1 is currently a signalized intersection, and as such will require full illumination. Intersection 3 is proposed to be modified to a roundabout, and as such will require full illumination.

For Intersection 1, it is assumed that the traffic signal infrastructure will need to be adjusted to suit the proposed urbanization. A photometric analysis will need to be performed during the relocation design stage, to ensure the revised joint traffic signal / light poles meet the minimum requirements for Full Illumination.

For Intersection 3, a photometric analysis will need to be performed to meet the minimum illumination requirements as per RP-8 guidelines at the detailed stage of the roundabout design.

For all other scenarios, Full Illumination is warranted where a total point-score of 240 or more points is achieved. Partial or delineation lighting may be considered at intersections with a point-score greater than or equal to 120 points, but less than 240 points.

Further assumptions were made for the following:

- Pedestrian Conflict Level.
- Pedestrian Light Fixture.

4.1.1 Roadway Pedestrian Conflict Level

RP-8 recommended values for intersections are based on the warrant condition, road classification and pedestrian activity level classification. The area of concern is identified as a *Collector/Local* (i.e., Columbia Way / Side Street), and *Low Pedestrian Activity Area*.

4.1.2 Roadway Light Fixtures

The following luminaire information would be required to complete a photometric analysis: Fixture Manufacturer/Model, Wattage, Light Distribution Type, Simulated Arm Reach (i.e., distance from pole to centre of light emission), and Simulated Mounting Height (i.e., distance from finished grade to centre of light emission).

A field visit was conducted to measure the Arm Reach and Mounting Heights for each intersection fixture. Wattage sticker in the field was available showing 73W and 110W fixtures being used along Columbia Way at the intersections.

It should be noted that no exact information was available to determine the Manufacturer, Model, or Light Distribution type for the existing fixtures.

Based on the field visit and the Town of Caledon accepted luminaires, it was determined that the intersection fixtures were the CREE XSPLG Series.

The following distribution types were available for this fixture: 2LG, 2ME, 3ME, and 4ME. Standard lighting practice for roadways and walk paths would typically only use Types 2 and 3 light distributions. For this recommendation, types 2LG, 2ME, and 3ME were used for the analysis. Only one .ies file was available for the CREE XSPLG Series for each distribution type (i.e., 135W). This was configured to simulate 73W and 110W:

- **Type 2LG**: XSPLG-D-HT-2LG-18L-40K7-Ux-SV-N_CONFIGURED
- **Type 2ME**: XSPLG-D-HT-2ME-18L-40K7-Ux-SV-N_CONFIGURED
- **Type 3ME**: XSPLG-D-HT-3ME-18L-40K7-Ux-SV-N_CONFIGURED

4.2 Minimum Requirements

Based on the Assumptions established, RP-8 recommends an Illuminance calculation method to be completed.

RP-8 Table 12-1 is used for *Full Intersection lighting*.

Table 12-1. Pavement Illuminance Criteria for Full Intersection Lighting (lux/fc).

Illuminance for Intersections				
Functional Classification	Pedestrian Activity Level Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34/3.2	26/2.4	18/1.7	3.0
Major/Collector	29/2.7	22/2.0	15/1.4	3.0
Major/Local	26/2.4	20/1.9	13/1.2	3.0
Collector/Collector	24/2.2	18/1.7	12/1.1	4.0
Collector/Local	21/2.0	16/1.5	10/0.9	4.0
Local/Local	18/1.7	14/1.3	8/0.7	6.0

RP-8 Table 12-2 is used for *Partial Intersection lighting*.

Table 12-2. Pavement Illuminance Criteria for Partial (Isolated) Intersection Lighting.

Road Classification	Pavement Classification			Uniformity Ratio
	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{mIn}
Major	6/0.6	9/0.8	8/0.7	3.0
Collector	4/0.4	6/0.6	5/0.5	4.0
Local	3/0.3	4/0.4	4/0.4	6.0

4.3 Analysis

Intersection 2 has a point-score of **133** and Intersection 4 has a point-score of **58**. Based on this warrant analysis, it is recommended that Intersection 2 maintains the minimum illumination requirements as per RP-8 guidelines for Partial Intersection Illumination. Intersection 4 has a point-score below the minimum warrant condition.

Based on the proposed Intersection configuration, an analysis was completed with the existing pole locations. Results shown below:

Road Classification	Collector / Local	
Ped Conflict	Low	
Eavg	6.0 lux	**Partial**
Eavg/min	4.0	
Eavg	10.0 lux	**Full**
Eavg/min	4.0	

Intersection	Distribution Type	Avg Level	Avg/Min Level
Intersection 2	2L	**1.7 lux**	**16.8**
Intersection 2	2M	**4.6 lux**	**23.0**
Intersection 2	3M	**3.8 lux**	**9.6**
Intersection 4	2L	**1.9 lux**	**18.7**
Intersection 4	2M	**3.4 lux**	**8.4**
Intersection 4	3M	**2.4 lux**	4.0

5.0 FINDINGS

5.1 Pedestrian Lighting

Based on the analysis in Section 3.3:

- All simulated average horizontal illumination levels, E_{avg}, were compliant with the minimum RP-8 requirements of 4.0 lux for Ped Light spacing of 30m, 35m, 40m, 45m, and 50m.
- All simulated horizontal uniformity ratios, E_{avg}/E_{min}, were non-compliant with the maximum RP-8 requirements of 4.0 for Ped Light spacing of 40m, 45m, and 50m. The horizontal uniformity ratios, E_{avg}/E_{min}, results were non-compliant for the 2S distribution type at a 35m spacing.
- All simulated horizontal uniformity ratios, E_{avg}/E_{min}, were compliant with the maximum RP-8 requirements of 4.0 for Ped Light spacing of 30m.

5.2 Continuous Roadway Lighting

Based on the Warrant Analysis in Appendix B, neither Segments 1, 2, nor 3 warranted continuous roadway lighting. Segment 2 was marginally below the Warranting Condition and should be re-assessed at the time of detailed design.

5.3 Intersection Lighting

Based on the analysis in Section 4.3:

- All simulated average horizontal illumination levels, E_{avg}, were non-compliant with the minimum RP-8 requirements of 6.0 lux for Distribution Types 2LG, 2ME, and 3ME.
- All simulated horizontal uniformity ratios, E_{avg}/E_{min}, were non-compliant with the maximum RP-8 requirements of 4.0 for Distribution Types 2LG, 2ME, and 3ME.

6.0 LIGHTING RECOMMENDATIONS

6.1 Pedestrian Lighting Recommendations

With the understanding that the distribution type is unknown, it is recommended that a 30m spacing be used for the Ped lights. It should also be noted that a closer spacing increases the vertical illuminance level.

Based on the analysis, 30m spacing requires a minimum of 57 Ped Lights. Assuming all 37 existing Ped lights and poles are in good condition, an additional 20 Ped lights would be required to meet the minimum requirements outlined in RP-8.

6.2 Continuous Roadway Lighting Recommendations

Neither Segments 1, 2, nor 3 warranted continuous roadway lighting. Segment 2 (*Kingsview Drive to Mount Hope Road*) was marginally below the Warranting Condition and should be re-assessed at the time of detailed design.

6.3 Intersection Lighting Recommendations

Intersection 1 (*Columbia Way @ Kingsview Drive*) and Intersection 3 (*Columbia Way @ Mount Hope Road*) will require an upgrade to the existing illumination system. A photometric analysis will need to be performed at the detailed design stage to meet minimum requirements as per RP-8 requirements.

For Intersection 2 (*Columbia Way @ Westchester Boulevard*), it is recommended that the lighting at the intersection be upgraded in compliance with the minimum RP-8 requirements for Partial Intersection Illumination levels.

For Intersection 4 (*Columbia Way @ Forest Gate Avenue*), it is recommended that another warrant analysis be performed at the time of detailed design to determine if the warranting condition changes. Based on the current warrant condition, the existing Delineation lighting at the intersection may remain to mark the location of the intersection.

CLOSING

Thank you for providing us with the opportunity to undertake this study. If there is any query related to this report, please feel free to contact the undersigned at 289-348-1234 ext. 4217 or by email as noted below.

Yours very truly,

R.V. ANDERSON ASSOCIATES LIMITED

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APPENDIX A – PEDESTRIAN LIGHTING ANALYSIS

Segment	Spacing	MUP Length	Wattage	Dist. Type	Min. Lights	Avg Level	Avg/Min Levels
Segment 1	30 m	211 m	51 W	2M	8 Lights	9.8 lux	2.2
Segment 1	30 m	211 m	51 W	2S	8 Lights	10.3 lux	2.9
Segment 1	30 m	211 m	51 W	3M	8 Lights	6.7 lux	2.3
Segment 2	30 m	900 m	51 W	2M	31 Lights	9.8 lux	2.2
Segment 2	30 m	900 m	51 W	2S	31 Lights	10.3 lux	2.9
Segment 2	30 m	900 m	51 W	3M	31 Lights	6.7 lux	2.3
Segment 3	30 m	289 m	51 W	2M	10 Lights	9.8 lux	2.2
Segment 3	30 m	289 m	51 W	2S	10 Lights	10.3 lux	2.9
Segment 3	30 m	289 m	51 W	3M	10 Lights	6.7 lux	2.3
Segment 4	30 m	233 m	51 W	2M	8 Lights	9.8 lux	2.2
Segment 4	30 m	233 m	51 W	2S	8 Lights	10.3 lux	2.9
Segment 4	30 m	233 m	51 W	3M	8 Lights	6.7 lux	2.3
Segment 1	35 m	211 m	51 W	2M	7 Lights	8.4 lux	3.5
Segment 1	35 m	211 m	51 W	2S	7 Lights	9.1 lux	**4.6**
Segment 1	35 m	211 m	51 W	3M	7 Lights	5.8 lux	3.5
Segment 2	35 m	900 m	51 W	2M	26 Lights	8.4 lux	3.5
Segment 2	35 m	900 m	51 W	2S	26 Lights	9.1 lux	**4.6**
Segment 2	35 m	900 m	51 W	3M	26 Lights	5.8 lux	3.5
Segment 3	35 m	289 m	51 W	2M	9 Lights	8.4 lux	3.5
Segment 3	35 m	289 m	51 W	2S	9 Lights	9.1 lux	**4.6**
Segment 3	35 m	289 m	51 W	3M	9 Lights	5.8 lux	3.5
Segment 4	35 m	233 m	51 W	2M	7 Lights	8.4 lux	3.5
Segment 4	35 m	233 m	51 W	2S	7 Lights	9.1 lux	**4.6**
Segment 4	35 m	233 m	51 W	3M	7 Lights	5.8 lux	3.5
Segment 1	40 m	211 m	51 W	2M	6 Lights	7.3 lux	**5.3**
Segment 1	40 m	211 m	51 W	2S	6 Lights	8.3 lux	**7.2**
Segment 1	40 m	211 m	51 W	3M	6 Lights	5.1 lux	**5.4**
Segment 2	40 m	900 m	51 W	2M	23 Lights	7.3 lux	**5.3**
Segment 2	40 m	900 m	51 W	2S	23 Lights	8.3 lux	**7.2**
Segment 2	40 m	900 m	51 W	3M	23 Lights	5.1 lux	**5.4**
Segment 3	40 m	289 m	51 W	2M	8 Lights	7.3 lux	**5.3**
Segment 3	40 m	289 m	51 W	2S	8 Lights	8.3 lux	**7.2**
Segment 3	40 m	289 m	51 W	3M	8 Lights	5.1 lux	**5.4**
Segment 4	40 m	233 m	51 W	2M	6 Lights	7.3 lux	**5.3**
Segment 4	40 m	233 m	51 W	2S	6 Lights	8.3 lux	**7.2**
Segment 4	40 m	233 m	51 W	3M	6 Lights	5.1 lux	**5.4**
Segment 1	45 m	211 m	51 W	2M	5 Lights	6.4 lux	**7.8**
Segment 1	45 m	211 m	51 W	2S	5 Lights	6.4 lux	**7.8**
Segment 1	45 m	211 m	51 W	3M	5 Lights	4.6 lux	**8.2**
Segment 2	45 m	900 m	51 W	2M	21 Lights	6.4 lux	**7.8**
Segment 2	45 m	900 m	51 W	2S	21 Lights	6.4 lux	**7.8**
Segment 2	45 m	900 m	51 W	3M	21 Lights	4.6 lux	**8.2**
Segment 3	45 m	289 m	51 W	2M	7 Lights	6.4 lux	**7.8**
Segment 3	45 m	289 m	51 W	2S	7 Lights	6.4 lux	**7.8**
Segment 3	45 m	289 m	51 W	3M	7 Lights	4.6 lux	**8.2**
Segment 4	45 m	233 m	51 W	2M	6 Lights	6.4 lux	**7.8**
Segment 4	45 m	233 m	51 W	2S	6 Lights	6.4 lux	**7.8**
Segment 4	45 m	233 m	51 W	3M	6 Lights	4.6 lux	**8.2**

Segment 1	50 m	211 m	51 W	2M	5 Lights	5.6 lux	**11.2**
Segment 1	50 m	211 m	51 W	2S	5 Lights	6.9 lux	**18.1**
Segment 1	50 m	211 m	51 W	3M	5 Lights	6.9 lux	**18.1**
Segment 2	50 m	900 m	51 W	2M	19 Lights	5.6 lux	**11.2**
Segment 2	50 m	900 m	51 W	2S	19 Lights	6.9 lux	**18.1**
Segment 2	50 m	900 m	51 W	3M	19 Lights	6.9 lux	**18.1**
Segment 3	50 m	289 m	51 W	2M	6 Lights	5.6 lux	**11.2**
Segment 3	50 m	289 m	51 W	2S	6 Lights	6.9 lux	**18.1**
Segment 3	50 m	289 m	51 W	3M	6 Lights	6.9 lux	**18.1**
Segment 4	50 m	233 m	51 W	2M	5 Lights	5.6 lux	**11.2**
Segment 4	50 m	233 m	51 W	2S	5 Lights	6.9 lux	**18.1**
Segment 4	50 m	233 m	51 W	3M	5 Lights	6.9 lux	**18.1**

APPENDIX B – WARRANT ANALYSIS

Continuous Roadway – Segment 1 – Regional Road 50 to Kingsview Drive

Segment 1 – Regional Road 50 to Kingsview Drive

Item No.	Classification Factor	Rating Factor 'R'					Weight 'W'	Enter 'R' Here	Score 'R' x 'W'	
		1	2	3	4	5				
	Geometric Factors (See Note 6)									
1	Number of Lanes	≤ 4	5	6	7	≥ 8	0.15	1	0.15	
2	Lane Width (m)	> 3.6	3.4 to 3.6	3.2 to 3.4	3.0 to 3.2	< 3.0	0.35	1	0.35	
3	Median Openings/km	< 2.5 or 1-Way	2.5 to 5.0	5.0 to 7.2	7.2 to 9.0	> 9.0 or No Median	1.40	5	7.00	
4	Driveways and Entrances/km	< 20	20 to 40	40 to 60	60 to 80	> 80	1.40	1	1.40	
5	Horizontal Curve Radius(m)	> 600	450 to 600	225 to 450	175 to 225	< 175 to 225	5.90	1	5.90	
6	Verical Grades (%)	<3	3 to 4	4 to 5	5 to 7	>7	0.35	1	0.35	
7	Sight Distance (m)	>210	150 to 210	90 to 150	60 to 90	< 60	0.15	1	0.15	
8	Parking	Prohibited	Loading	Off Peak	One Side	Both Sides	0.10	1	0.10	
								Subtotal Geometric Factors	15.40	**G**
	Operational Factors									
9	Signalized Intersections (%)	80 to 100	70 to 80	60 to 70	50 to 60	0 to 50	0.15	5	0.75	
10	Left Turn Lane	All Major Intersections or 1-Way	Substantial Number of Major Intersections	Most Major Intersections	Half of Major Intersections	Infrequent Number of TWTL (See Notes 1 & 3)	0.70	1	0.70	
11	Median Width (m)	> 10	6 to 10	3 to 6	1.2 to 3	0 to 1.2	0.35	5	1.75	
12	Operating or Posted Speed (km/h) (See Note 5)	≤ 40	50	60	70	≥ 80	0.60	4	2.40	
13	Pedestrian Activity Level (See Note 2)			Low	Medium	High	3.15	3	9.45	
								Subtotal Operational Factors	15.05	**O**
	Environmental Factors									
14	Percentage of Development Adjacent to Road (%) (See Note 4)	nil	nil to 30	30 to 60	60 to 90	> 90	0.15	5	0.75	
15	Area Classification	Rural	Industrial	Residential	Commercial	Downtown	0.15	3	0.45	
16	Distance from Development to Roadway (m) (See Note 4)	> 60	45 to 60	30 to 45	15 to 30	< 15	0.15	5	0.75	
17	Ambient (off Roadway) Lighting	Nil	Sparse	Moderate	Distracting	Intense	1.38	3	4.14	
18	Raised Curb Median	None	Continuous	At All Intersections (100%)	At Most Intersections (51% to 99%)	At Few Intersections (≤ 50%) (See Note 7)	0.35	2	0.70	
								Subtotal Environmental Factors	6.79	**E**
	Collision Factors									
19	Night-to-Day Collision Ratio	< 1.0	1.0 to 1.2	1.2 to 1.5	1.5 to 2.0	> 2.0 (See Note 1)	5.55	1	5.55	
								Subtotal Collision Factors	5.55	**A**
								G + O + E + A = Total Warranting Points	42.79	
								Warranting Condition	**60.00**	
								Subtotal Collision Factors	**-17.21**	**D**

Notes:

1 Lighting Warranted
2 Pedestrian/Cyclist Activity Level (Refer to 9.1.3 - Pedestrian/Cyclist Related Definitions)
3 Two-Way Left Turn Lane
4 Development Defined as Commercial, Industrial or Residential Buildings
5 85th Percentile Night Speed Should Be Used if Available, Otherwise Posted Speed Shall be Used
6 Worst Case Geometric Factors for a Segment of Roadway Shall Apply
7 Also Includes Isolated Medians (Non-Continuous) Between Intersections

Continuous Roadway – Segment 2 – Kingsview Drive to Mount Hope Road

Segment 2 – Kingsview Drive to Mount Hope Road

Item No.	Classification Factor	Rating Factor 'R'					Weight 'W'	Enter 'R' Here	Score 'R' x 'W'	
		1	2	3	4	5				
	Geometric Factors (See Note 6)									
1	Number of Lanes	≤ 4	5	6	7	≥ 8	0.15	1	0.15	
2	Lane Width (m)	> 3.6	3.4 to 3.6	3.2 to 3.4	3.0 to 3.2	< 3.0	0.35	1	0.35	
3	Median Openings/km	< 2.5 or 1-Way	2.5 to 5.0	5.0 to 7.2	7.2 to 9.0	> 9.0 or No Median	1.40	5	7.00	
4	Driveways and Entrances/km	< 20	20 to 40	40 to 60	60 to 80	> 80	1.40	1	1.40	
5	Horizontal Curve Radius(m)	> 600	450 to 600	225 to 450	175 to 225	< 175 to 225	5.90	3	17.70	
6	Verical Grades (%)	<3	3 to 4	4 to 5	5 to 7	>7	0.35	1	0.35	
7	Sight Distance (m)	>210	150 to 210	90 to 150	60 to 90	< 60	0.15	1	0.15	
8	Parking	Prohibited	Loading	Off Peak	One Side	Both Sides	0.10	1	0.10	
								Subtotal Geometric Factors	27.20	**G**
	Operational Factors									
9	Signalized Intersections (%)	80 to 100	70 to 80	60 to 70	50 to 60	0 to 50	0.15	5	0.75	
10	Left Turn Lane	All Major Intersections or 1-Way	Substantial Number of Major Intersections	Most Major Intersections	Half of Major Intersections	Infrequent Number of TWTL (See Notes 1 & 3)	0.70	1	0.70	
11	Median Width (m)	> 10	6 to 10	3 to 6	1.2 to 3	0 to 1.2	0.35	5	1.75	
12	Operating or Posted Speed (km/h) (See Note 5)	≤ 40	50	60	70	≥ 80	0.60	5	3.00	
13	Pedestrian Activity Level (See Note 2)			Low	Medium	High	3.15	3	9.45	
								Subtotal Operational Factors	15.65	**O**
	Environmental Factors									
14	Percentage of Development Adjacent to Road (%) (See Note 4)	nil	nil to 30	30 to 60	60 to 90	> 90	0.15	5	0.75	
15	Area Classification	Rural	Industrial	Residential	Commercial	Downtown	0.15	3	0.45	
16	Distance from Development to Roadway (m) (See Note 4)	> 60	45 to 60	30 to 45	15 to 30	< 15	0.15	5	0.75	
17	Ambient (off Roadway) Lighting	Nil	Sparse	Moderate	Distracting	Intense	1.38	3	4.14	
18	Raised Curb Median	None	Continuous	At All Intersections (100%)	At Most Intersections (51% to 99%)	At Few Intersections (≤ 50%) (See Note 7)	0.35	2	0.70	
								Subtotal Environmental Factors	6.79	**E**
	Collision Factors									
19	Night-to-Day Collision Ratio	< 1.0	1.0 to 1.2	1.2 to 1.5	1.5 to 2.0	> 2.0 (See Note 1)	5.55	1	5.55	
								Subtotal Collision Factors	5.55	**A**
								G + O + E + A = Total Warranting Points	55.19	
								Warranting Condition	**60.00**	
								Subtotal Collision Factors	-4.81	**D**

Notes:

1 Lighting Warranted
2 Pedestrian/Cyclist Activity Level (Refer to 9.1.3 - Pedestrian/Cyclist Related Definitions)
3 Two-Way Left Turn Lane
4 Development Defined as Commercial, Industrial or Residential Buildings
5 85th Percentile Night Speed Should Be Used if Available, Otherwise Posted Speed Shall be Used
6 Worst Case Geometric Factors for a Segment of Roadway Shall Apply
7 Also Includes Isolated Medians (Non-Continuous) Between Intersections

Continuous Roadway – Segment 3 – Mount Hope Road to Forest Gate Avenue

Segment 3 – Mount Hope Road to Forest Gate Avenue

Item No.	Classification Factor	Rating Factor 'R'					Weight 'W'	Enter 'R' Here	Score 'R' x 'W'	
		1	2	3	4	5				
	Geometric Factors (See Note 6)									
1	Number of Lanes	≤ 4	5	6	7	≥ 8	0.15	1	0.15	
2	Lane Width (m)	> 3.6	3.4 to 3.6	3.2 to 3.4	3.0 to 3.2	< 3.0	0.35	1	0.35	
3	Median Openings/km	< 2.5 or 1-Way	2.5 to 5.0	5.0 to 7.2	7.2 to 9.0	> 9.0 or No Median	1.40	5	7.00	
4	Driveways and Entrances/km	< 20	20 to 40	40 to 60	60 to 80	> 80	1.40	1	1.40	
5	Horizontal Curve Radius(m)	> 600	450 to 600	225 to 450	175 to 225	< 175 to 225	5.90	1	5.90	
6	Verical Grades (%)	<3	3 to 4	4 to 5	5 to 7	>7	0.35	1	0.35	
7	Sight Distance (m)	>210	150 to 210	90 to 150	60 to 90	< 60	0.15	1	0.15	
8	Parking	Prohibited	Loading	Off Peak	One Side	Both Sides	0.10	1	0.10	
								Subtotal Geometric Factors	15.40	**G**
	Operational Factors									
9	Signalized Intersections (%)	80 to 100	70 to 80	60 to 70	50 to 60	0 to 50	0.15	5	0.75	
10	Left Turn Lane	All Major Intersections or 1-Way	Substantial Number of Major Intersections	Most Major Intersections	Half of Major Intersections	Infrequent Number of TWTL (See Notes 1 & 3)	0.70	1	0.70	
11	Median Width (m)	> 10	6 to 10	3 to 6	1.2 to 3	0 to 1.2	0.35	5	1.75	
12	Operating or Posted Speed (km/h) (See Note 5)	≤ 40	50	60	70	≥ 80	0.60	4	2.40	
13	Pedestrian Activity Level (See Note 2)			Low	Medium	High	3.15	3	9.45	
								Subtotal Operational Factors	15.05	**O**
	Environmental Factors									
14	Percentage of Development Adjacent to Road (%) (See Note 4)	nil	nil to 30	30 to 60	60 to 90	> 90	0.15	5	0.75	
15	Area Classification	Rural	Industrial	Residential	Commercial	Downtown	0.15	3	0.45	
16	Distance from Development to Roadway (m) (See Note 4)	> 60	45 to 60	30 to 45	15 to 30	< 15	0.15	5	0.75	
17	Ambient (off Roadway) Lighting	Nil	Sparse	Moderate	Distracting	Intense	1.38	3	4.14	
18	Raised Curb Median	None	Continuous	At All Intersections (100%)	At Most Intersections (51% to 99%)	At Few Intersections (≤ 50%) (See Note 7)	0.35	2	0.70	
								Subtotal Environmental Factors	6.79	**E**
	Collision Factors									
19	Night-to-Day Collision Ratio	< 1.0	1.0 to 1.2	1.2 to 1.5	1.5 to 2.0	> 2.0 (See Note 1)	5.55	1	5.55	
								Subtotal Collision Factors	5.55	**A**
								G + O + E + A = Total Warranting Points	42.79	
								Warranting Condition	**60.00**	
								Subtotal Collision Factors	**-17.21**	**D**

Notes:

1 Lighting Warranted
2 Pedestrian/Cyclist Activity Level (Refer to 9.1.3 - Pedestrian/Cyclist Related Definitions)
3 Two-Way Left Turn Lane
4 Development Defined as Commercial, Industrial or Residential Buildings
5 85th Percentile Night Speed Should Be Used if Available, Otherwise Posted Speed Shall be Used
6 Worst Case Geometric Factors for a Segment of Roadway Shall Apply
7 Also Includes Isolated Medians (Non-Continuous) Between Intersections

Intersection 2 – Colombia Way @ Westchester Boulevard

Intersection 2 - Columbia Way @ Westchester Boulevard

Item No.	Classification Factor	Rating Factor 'R' 0	1	2	3	4	Weight Subcategory (If Applicable)	Weight 'W'	Enter 'R' Here	Score 'R' x 'W'	
	Geometric Factors (G)										
1	Channelization	None	Right and/or Left Turn Lanes on Minor Approach Only	Right Turn Lane(s) Only on Major Leg(s)	Left Turn Lane(s) on Major Leg(s)	Left and Right Turn Lanes on All Legs	Raised and Operating Speed Less than 70 km/h on at Least One Channelized Approach or	15	0	0	Only **ONE** 'R' Value Is To Be Entered for These Three Rows!
							Raised and Operating Speed Less than 70 km/h or More on at Least One Channelized Approach or	20	0	0	
							Painted Only	5	0	0	
2	Approach Sight Distance on the Most Constrained Approach (Relative to Recommended Minimum Intersection Sight Distance)	100% or More	75% to 99%	50% to 74%	25% to 49%	< 25%		10	3	30	
3	Horizontal Curvature (Radius) at or Immediately Before Intersection on Any Leg for Posted Speed Limit of:										
	110 km/hr or Above:	Tangent	> 1800 m	1150 to 1800 m	750 to 1150 m	< 750 m		5	2	10	
	90 to 100 km/hr :	Tangent	> 1400 m	950 to 1400 m	600 to 950 m	< 600 m					
	70 to 80 km/hr :	Tangent	> 950 m	550 to 950 m	340 to 550 m	< 340 m					
	60 km/hr or Below:	Tangent	> 575 m	320 to 575 m	190 to 320 m	< 190 m					
4	Angle of Intersection or Offset Intersection	90 Degree Angle	80 or 100 Degree Angle	--	70 or 110 Degree Angle	< 70 ot > 110 Degree or Offset Intersection		5	0	0	
5	Downhill Approach Grades at or Immediately Before Intersection on Any Leg	< 3.0%	3.1 to 3.9% and Meets Design Guidelines for Type and Speed of Road	4.0 to 4.9% and Meets Design Guidelines for Type and Speed of Road	5.0 to 5.9% and Meets Design Guidelines for Type and Speed of Road	> 7.0% OR Exceeds Design Guidelines for Type and Speed of Road		3	0	0	
6	Vertical Grades (%)	--	3	4	5	6 or more		3	1	3	
									Subtotal Geometric Factors	43	G
	Operational Factors (O)										
	If the Intersection is signalized, Illumination is Warranted										
	If the Intersection is NOT Signalized, Points should be Calculated on the Basis of EITHER the AADT Factor or the Signalization Warrant Factor.										
7	Either AADT (2-Way) (See Note 1):										
	On Major Road and	< 1000	1000 to 2000	2000 to 3000	3000 to 5000	> 5000		10	0	0	Only **ONE** 'R' Value Is To Be Entered for These Two Rows!
	On Minor Road	< 500	500 to 1000	1000 to 1500	1500 to 2000	> 2000		20	0	0	
	or Signalization Warrant (See Note 1)	Intersection Not Signalized and Volume-Based Signal Warrant is Less than 20% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 20% to 40% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 40% to 60% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 60% to 80% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is Over 80% Satisfied		30	1	30	
8	Regular Nighttime Hourly Pedestrian Volume (See Note 2)	No Pedestrians	Up to 10	10 to 30	30 to 50	Over 50		10	1	10	
9	Intersecting Roadway Classifications	No Primary Road Involved	Primary/Rural Major, Primary/Rural Minor, or Primary/Designated Community Access	Primary / Secondary	Primary / Primary	Intersection Includes Divided Highway		5	2	10	
10	Operating Speed or Posted Speed Limit on Major Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	3	15	
11	Operating Speed or Posted Speed Limit on Minor Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	0	0	
									Subtotal Operational Factors	65	O
	Environmental Factors (E)										
12	Lighted Development Within 150 m Radius of Intersection	--	In One Quadrant	In Two Quadrants	In Three Quadrants	In Four Quadrants		5	2	10	
									Subtotal Environmental Factors	10	E
	Collision Factors (A)										
13	Average Annual Nighttime Collision Frequency (See Note 4) or Rate over Last Three Year (Only Collisions Potentially Attributable to Inadequate Lighting)	0 Collisions per Year	1 Collision Per Year	--	3 or More Collisions Per Year OR At Least 1.5 Collisions per Million Entering Vehicles per Year and an Average Ratio of All Night-to-Day Collisions of at Least 1.5		1 or 2 Collisions per Year	15	1	15	Only **ONE** 'R' Value Is To Be Entered for These Two Rows!
							3 or More Collisions per Year or Rate ≥ 1.5 Collisions/MEV	30	0	0	
									Subtotal Collision Factors	15	A
									G + O + E + A = Total Warranting Points	133	
									Warranting Condition (Partial or Delineation Lighting)	120	
									Subtotal Collision Factors	13	D
									Warranting Condition (Full Illumination)	240	
									Subtotal Collision Factors	-107	D

Notes:

1 If the intersection is not signalized, the user should choose EITHER the AADT factor OR the signalization factor. The points from either factor, but not both factors, may be used for warrant point calculations.

2 The number of certain typesof vulnerable pedestrians should be factored to reflect their increased need for visibility.
The number of child pedestrians (ages 12 nd under) should be multiplied by two, and the number of senior pedestrians (age 65 and over) should be mulitplied by 1.5.

3 85th Percentile Night Speed Should Be Used if Available, Otherwise Posted Speed Shall be Used.

4 Reported collisions, rounded to the nearest number.

Intersection 4 – Columbia Way @ Forest Gate Avenue

Intersection 3 - Columbia Way @ Forest Gate Avenue

Item No.	Classification Factor	Rating Factor 'R' 0	1	2	3	4	Weight Subcategory (If Applicable)	Weight 'W'	Enter 'R' Here	Score 'R' x 'W'	
	Geometric Factors (G)										
1	Channelization	None	Right and/or Left Turn Lanes on Minor Approach Only	Right Turn Lane(s) Only on Major Leg(s)	Left Turn Lane(s) on Major Leg(s)	Left and Right Turn Lanes on All Legs	Raised and Operating Speed Less than 70 km/h on at Least One Channelized Approach or	15	0	0	Only **ONE** 'R' Value Is To Be Entered for These Three Rows!
							Raised and Operating Speed Less than 70 km/h or More on at Least One Channelized Approach or	20	0	0	
							Painted Only	5	0	0	
2	Approach Sight Distance on the Most Constrained Approach (Relative to Recommended Minimum Intersection Sight Distance)	100% or More	75% to 99%	50% to 74%	25% to 49%	< 25%		10	0	0	
3	Horizontal Curvature (Radius) at or Immediately Before Intersection on Any Leg for Posted Speed Limit of:										
	110 km/hr or Above:	Tangent	> 1800 m	1150 to 1800 m	750 to 1150 m	< 750 m		5	0	0	
	90 to 100 km/hr :	Tangent	> 1400 m	950 to 1400 m	600 to 950 m	< 600 m					
	70 to 80 km/hr :	Tangent	> 950 m	550 to 950 m	340 to 550 m	< 340 m					
	60 km/hr or Below:	Tangent	> 575 m	320 to 575 m	190 to 320 m	< 190 m					
4	Angle of Intersection or Offset Intersection	90 Degree Angle	80 or 100 Degree Angle	--	70 or 110 Degree Angle	< 70 ot > 110 Degree or Offset Intersection		5	0	0	
5	Downhill Approach Grades at or Immediately Before Intersection on Any Leg	< 3.0%	3.1 to 3.9% and Meets Design Guidelines for Type and Speed of Road	4.0 to 4.9% and Meets Design Guidelines for Type and Speed of Road	5.0 to 5.9% and Meets Design Guidelines for Type and Speed of Road	> 7.0% OR Exceeds Design Guidelines for Type and Speed of Road		3	0	0	
6	Vertical Grades (%)	--	3	4	5	6 or more		3	1	3	
								Subtotal Geometric Factors		3	G
	Operational Factors (O)										
	If the Intersection is signalized, Illumination is Warranted										
	If the Intersection is NOT Signalized, Points should be Calculated on the Basis of EITHER the AADT Factor or the Signalization Warrant Factor.										
7	Either AADT (2-Way) (See Note 1):										
	On Major Road and	< 1000	1000 to 2000	2000 to 3000	3000 to 5000	> 5000		10	0	0	Only **ONE** 'R' Value Is To Be Entered for These Two Rows!
	On Minor Road	< 500	500 to 1000	1000 to 1500	1500 to 2000	> 2000		20	0	0	
	or Signalization Warrant (See Note 1)	Intersection Not Signalized and Volume-Based Signal Warrant is Less than 20% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 20% to 40% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 40% to 60% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 60% to 80% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is Over 80% Satisfied		30	0	0	
8	Regular Nighttime Hourly Pedestrian Volume (See Note 2)	No Pedestrians	Up to 10	10 to 30	30 to 50	Over 50		10	1	10	
9	Intersecting Roadway Classifications	No Primary Road Involved	Primary/Rural Major, Primary/Rural Minor, or Primary/Designated Community Access	Primary / Secondary	Primary / Primary	Intersection Includes Divided Highway		5	2	10	
10	Operating Speed or Posted Speed Limit on Major Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	2	10	
11	Operating Speed or Posted Speed Limit on Minor Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	0	0	
								Subtotal Operational Factors		30	O
	Environmental Factors (E)										
12	Lighted Development Within 150 m Radius of Intersection	--	In One Quadrant	In Two Quadrants	In Three Quadrants	In Four Quadrants		5	2	10	
								Subtotal Environmental Factors		10	E
	Collision Factors (A)										
13	Average Annual Nighttime Collision Frequency (See Note 4) or Rate over Last Three Year (Only Collisions Potentially Attributable to Inadequate Lighting)	0 Collisions per Year	1 Collision Per Year	--	3 or More Collisions Per Year OR At Least 1.5 Collisions per Million Entering Vehicles per Year and an Average Ratio of All Night-to-Day Collisions of at Least 1.5		1 or 2 Collisions per Year	15	1	15	Only **ONE** 'R' Value Is To Be Entered for These Two Rows!
							3 or More Collisions per Year or Rate ≥ 1.5 Collisions/MEV	30	0	0	
								Subtotal Collision Factors		15	A
								G + O + E + A = Total Warranting Points		58	
								Warranting Condition (Partial or Delineation Lighting)		120	
								Subtotal Collision Factors		-62	D
								Warranting Condition (Full Illumination)		240	
								Subtotal Collision Factors		-182	D

Notes:

1 If the intersection is not signalized, the user should choose EITHER the AADT factor OR the signalization factor. The points from either factor, but not both factors, may be used for warrant point calculations.

2 The number of certain typesof vulnerable pedestrians should be factored to reflect their increased need for visibility.
The number of child pedestrians (ages 12 nd under) should be multiplied by two, and the number of senior pedestrians (age 65 and over) should be mulitplied by 1.5.

3 85th Percentile Night Speed Should Be Used if Available, Otherwise Posted Speed Shall be Used.

4 Reported collisions, rounded to the nearest number.