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Appendix F:
Drainage and Stormwater Management Report

MEMO

TO	:	FILE
FROM	:	Mohi Mohamed, EIT, CIMA+
VERIFIED BY	:	Phil Campbell, P.Eng., Steve Overend, P.Eng. CIMA+
DATE	:	March 18, 2022
PROJECT NAME	:	B000917 City of Windsor, University Avenue & Victoria Avenue EA
SUBJECT	:	**Drainage Assessment**

1. INTRODUCTION AND SITE LOCATION

The City of Windsor has initiated a study to evaluate the existing roadway elements along the University Avenue and Victoria Avenue corridors and consider active transportation improvements within the right-of-ways to provide facilities for all roadway users. The purpose of this memorandum is to review the generalities of the site with respect to existing stormwater/drainage facilities and provide comment on the stormwater/drainage considerations of the proposed improvements including identifying areas of issue/opportunity.

The site is located within the northern part of the City of Windsor. University Avenue from Huron Church Road to McDougall Street is the second East-West arterial road south of the Detroit River serving traffic flows and providing access to residential, commercial and institutional uses. Similarly, Victoria Avenue from Chatham Street West to Park Street West is a collector road.

The section of University Avenue and Victoria Avenue proposed for study is approximately 3.5km in length and is primarily divided into seven distinct zones (described in section 4). University Avenue is situated within the urban area of the City of Windsor and has a mix of Low-rise Residential buildings and Neighbourhood Residential Living Area with an institutional establishment (University of Windsor) towards the west limit on the north and south sides of the roadway. Victoria Avenue and the eastern portion of University Avenue are situated in the urban commercial area of the City of Windsor. The adjacent land uses vary throughout the University Avenue and Victoria Avenue corridors to include residential, commercial and institutional.

The background information utilized by CIMA to develop the understanding of the Site's location was attained from City of Windsor Official Plan (2016) and Schedules.

2. EXISTING CONDITION

In conjunction with the background information available at the time of this memorandum, the following outlines the generalities of the site's existing condition.

University Avenue within the project limit is primarily an urban road way with a mix of undivided sections and in some locations, a centre turning lane. At the western limit of the study area, University Avenue is a two-lane roadway with two parking lanes and two bike lanes. University Avenue expands to a four-lane roadway with two parking lanes and two bike lanes at Partington Avenue continuing to Crawford Avenue then decreases to a two-lane roadway with two parking lanes, two bike lanes and a centre turning lane to Bruce Avenue. At Bruce Avenue the two bike lanes are terminated. University Avenue continues as a two-lane roadway with two parking lanes until reaching the site's east boundary at McDougall Street.

Similarly, Victoria Avenue is an urban cross section roadway containing a two-lane roadway with two angled parking lanes north of University Avenue. South of University Avenue, Victoria Avenue is a three-lane one-way (south bound) roadway with one angled parking lane and one parallel parking lane.

Generally, University Avenue and Victoria Avenue have defined and organized drainage patterns which are directed towards the urbanized roadways and subsequently to existing sewer systems. Impervious areas covering a range of 63% to 100% on multiple zones.

3. PROPOSED CONDITION – ISSUES/OPPORTUNITIES

As part of the road re-organization; University Avenue and Victoria Avenue right-of-ways will be re-organized by road dieting or widening to achieve systemic improvements to incorporate active transportation facilities for all users of a variety of ages, abilities and modes.

Below is a summary of the stormwater/drainage related issues/opportunities associated with re-organizing the right-of-ways.

- It is understood all roadways will be re-urbanized with new curb and gutter to suit the new roadway and active transportation facilities. Relocation or replacement of catchbasins will be required throughout the corridor to suit the revised curb locations and elevations. Curb and Gutter provides organized, defined and low maintenance roadway drainage patterns.
- Re-urbanization with implementation of perforated subdrains provides an organized means of providing sub drainage to roadway granular base/subbase.
- The new horizontal alignment of curbs should consider the existing and proposed underground storm sewers/utilities to avoid conflicts.
- The new vertical alignment of curbs are anticipated to largely resemble the existing condition. Low points should be avoided wherever possible and curb profiles should maintain a minimum of 0.5% slope gradient and maintain major system patterns.
- Roadway narrowing without re-profiling the roadway will likely result in slightly flattened boulevards, which may require boulevard area drains at specific/isolated areas.
- At localized areas, the flat gradient of the existing boulevards on the north side of University Avenue will pose challenges to establish positive overland drainage to the roadway and will likely require localized inlets. These inlets will be shallow and at low slope to ensure drainage to the existing sewer if feasible.

With optimizing the right-of-ways, University Avenue and Victoria Avenue will be renewed with transportation improvements including sidewalks, on street cycling facilities or cycle tracks. At this time of preparing this memorandum, three (3) alternative approaches to active transportation are being considered.

Below is a summary of each Alternative and the stormwater/drainage related issues/opportunities associated with each alternative.

3.1. Alternative 1 – Protected Bicycle Lanes

- The transformation of the protected bicycle lanes will involve removal of many impervious boulevard areas (Zones 2, 3, 4, 5, 6 & 7) and addition of planting strips, hence an opportunity to encourage infiltration and groundwater recharge.
- To achieve an increased aspect of stormwater management within the corridor, large width planting strips/boulevard areas should be considered as potential locations for localized at grade/below grade LID stormwater facilities.
- A minimum cross slope of 2% is recommended to ensure positive transverse drainage within right-of-way limit.
- Elevated medians shall not impede transverse and longitudinal surface runoff, consider at grade solutions to facilitate drainage i.e. (curb cuts/interruptions, perforated precast curbs or pre-fabricated curb inserts).
- Elevated medians present maintenance challenge i.e. (snow plows and street sweepers), hence prone to blocking drainage.
- A comparative of Alternative 1 to the existing conditions' impervious area and associated run-off is provided below.

3.2. Alternative 2 – Buffered Bicycle Lanes

- The revision of two (2) 1.5m wide on-street bike lanes will generally mimic the configuration and drainage properties of the existing roadway conditions.
- Uniformly paved road cross-sections allowing monolithic drainage by minimizing runoff obstacles and reducing gutter spread and subsequently reducing localized drainage impediments.
- Utilize LID facilities where possible i.e. (curb extensions or bioretention cell) to encourage infiltration and groundwater recharge.
- All active transportation facilities behind curbs to be at grade and positively sloped towards roadway/curb, directing all drainage towards the roadway in keeping with the conventional urban cross section objectives.
- Within roadways all travelled lanes to be positively sloped towards curb.
- A comparative of Alternative 2 to the existing conditions' impervious area and associated run-off is provided below.

3.3. Alternative 3 – Cycle Tracks

- The addition of two (2) 2.0m wide bicycle lanes on boulevards will largely present similar drainage properties to Alternative 1.
- A comparative to Alternative 3 to the existing conditions' impervious area and associated run-off is provided below.

4. IMPERVIOUSNESS AND RUN-OFF

The tables below generally summarize the imperviousness and run-off of the existing site condition, as well as the three active transportation alternatives considered for optimizing the right-of-ways.

To approximate the potential change in impervious area and run-off associated with the improvements, the site has been sectioned into seven (7) distinct zones, as follows:

- Zone 1 is identified as the West Limit on University Avenue West from Huron Church Road to California Avenue. An approximate total length of 433 meters with a typical right-of-way of 30.7m.
- Zone 2 is identified as University Avenue West from California Avenue to Salter Avenue. An approximate total length of 1608 meters with a typical right-of-way of 30.2 meters.
- Zone 3 is identified as University Avenue West from Salter Avenue to Victoria Avenue. An approximate total length of 638 meters with a typical right-of-way of 19.8 meters.
- Zone 4 is identified as University Avenue West from Victoria Avenue to Freedom Way. An approximate total length of 266 meters with a typical right-of-way of 19.5 meters.
- Zone 5 is identified as University Avenue East from Freedom Way to the East Limit on McDougall Street. An approximate total length of 335 meters with a typical right-of-way of 20.0 meters.
- Zone 6 is identified as Victoria Avenue from University Avenue West to the North Limit on Chatham Street West. An approximate total length of 81 meters with a typical right-of-way of 27.0 meters.
- Zone 7 is identified as Victoria Avenue from University Avenue West to the South Limit on Park Street West. An approximate total length of 141 meters with a typical right-of-way of 27.4 meters.

For a high level estimation of impervious areas within proposed boulevards, 50% of the total boulevards area has been considered as a permeable hard surface (i.e. interlocking paver system, grass concrete and turf) with the remainder being grassed areas.

To approximate the site's existing and proposed flows related to the optimization of the right-of-ways, the Rational Method (Q=2.8QiA) with an initial estimated 1:5 year intensity (i) of 108mm/hr (time of concentration = 10 minutes) was utilized in keeping with Windsor Essex Region Stormwater Management Standards Manual (2018).

Existing Conditions

Total % Impervious Area				Sidewalks			Grassed Boulevards and Medians			Impervious Boulevards			Curbs and Gutters			Parking Lanes			Bicycle Lanes			Travel Lanes			TOTAL
	Typical ROW (m)	Length (m)	Existing	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	l/s
Zone 1	30.7	433	63.2%	0.17	0.95	49.78	0.49	0.20	29.51	0.00	0.95	0.00	0.04	0.95	12.45	0.19	0.95	54.76	0.13	0.95	37.34	0.30	0.95	87.12	271.0
Zone 2	30.2	1608	91.7%	0.57	0.95	163.31	0.46	0.20	27.48	0.20	0.95	57.00	0.16	0.95	46.22	0.75	0.95	214.15	0.47	0.95	135.58	2.31	0.95	664.01	1307.7
Zone 3	19.8	638	99.2%	0.39	0.95	112.78	0.00	0.20	0.00	0.00	0.95	0.00	0.06	0.95	18.34	0.28	0.95	81.60	0.00	0.95	0.00	0.53	0.95	151.29	364.0
Zone 4	19.5	266	100.0%	0.24	0.95	68.81	0.00	0.20	0.00	0.00	0.95	0.00	0.03	0.95	7.65	0.00	0.95	0.00	0.00	0.95	0.00	0.27	0.95	76.46	152.9
Zone 5	20.0	335	79.0%	0.19	0.95	55.85	0.15	0.20	9.09	0.04	0.95	11.55	0.03	0.95	9.63	0.00	0.95	0.00	0.00	0.95	0.00	0.26	0.95	75.11	161.2
Zone 6	27.0	81	100.0%	0.06	0.95	16.76	0.00	0.20	0.00	0.00	0.95	0.00	0.01	0.95	2.33	0.10	0.95	28.87	0.00	0.95	0.00	0.05	0.95	14.90	62.9
Zone 7	27.4	141	100.0%	0.10	0.95	28.37	0.00	0.20	0.00	0.03	0.95	9.73	0.01	0.95	4.05	0.11	0.95	32.42	0.00	0.95	0.00	0.13	0.95	36.47	111.0

Alternative 1 - Protected Bicycle Lanes

Total % Impervious Area				Sidewalks			Grassed Boulevards and Medians			Permeable Surface Boulevards			Curbs, Gutters and Medians			Parking Lanes			Bicycle Lanes			Bus and Drive Lanes			TOTAL
	Typical ROW (m)	Length (m)	Existing	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	l/s
Zone 1	30.7	433	69.7%	0.13	0.95	37.34	0.01	0.20	0.40	0.01	0.70	1.38	0.11	0.95	31.11	0.22	0.95	62.23	0.16	0.95	44.80	0.32	0.95	90.85	268.1
Zone 2	30.2	1608	65.9%	0.48	0.95	138.66	0.03	0.20	1.65	0.03	0.70	5.79	0.16	0.95	46.22	0.80	0.95	231.09	0.58	0.95	166.39	1.17	0.95	337.40	927.2
Zone 3	19.8	638	75.3%	0.19	0.95	55.01	0.01	0.20	0.48	0.01	0.70	1.67	0.06	0.95	18.34	0.00	0.95	0.00	0.23	0.95	66.02	0.47	0.95	133.87	275.4
Zone 4	19.5	266	76.4%	0.08	0.95	22.94	0.00	0.20	0.19	0.00	0.70	0.66	0.03	0.95	7.65	0.00	0.95	0.00	0.10	0.95	27.52	0.19	0.95	55.81	114.8
Zone 5	20.0	335	74.5%	0.10	0.95	28.89	0.00	0.20	0.26	0.00	0.70	0.90	0.03	0.95	9.63	0.00	0.95	0.00	0.12	0.95	34.66	0.24	0.95	70.29	144.6
Zone 6	27.0	81	64.4%	0.02	0.95	6.98	0.00	0.20	0.09	0.00	0.70	0.30	0.01	0.95	2.33	0.04	0.95	11.64	0.03	0.95	8.38	0.06	0.95	17.00	46.7
Zone 6 & Flex Boulevard	27.0	81	54.1%	0.02	0.95	6.98	0.00	0.20	0.11	0.00	0.70	0.39	0.01	0.95	2.33	0.00	0.95	0.00	0.03	0.95	8.38	0.06	0.95	17.00	35.2
Zone 7	27.4	141	48.4%	0.04	0.95	12.16	0.00	0.20	0.22	0.00	0.70	0.77	0.01	0.95	2.03	0.04	0.95	10.13	0.05	0.95	14.59	0.05	0.95	14.79	54.7
Zone 7 & Flex Boulevard	27.4	141	39.2%	0.04	0.95	12.16	0.00	0.20	0.26	0.00	0.70	0.90	0.01	0.95	2.03	0.00	0.95	0.00	0.05	0.95	14.59	0.05	0.95	14.79	44.7

Alternative 2 - Buffered Bicycle Lanes

Total % Impervious Area				Sidewalks			Grassed Boulevards and Medians			Permeable Surface Boulevards			Curbs, Gutters, Medians and Buffers			Parking Lanes			Bicycle Lanes			Bus and Drive Lanes			TOTAL
	Typical ROW (m)	Length (m)	Existing	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	l/s
Zone 1	30.7	433	62.9%	0.13	0.95	37.34	0.01	0.20	0.48	0.01	0.70	1.70	0.04	0.95	12.45	0.22	0.95	62.23	0.16	0.95	44.80	0.32	0.95	90.85	249.9
Zone 2	30.2	1608	63.9%	0.48	0.95	138.66	0.03	0.20	1.75	0.03	0.70	6.13	0.16	0.95	46.22	0.80	0.95	231.09	0.48	0.95	138.66	1.17	0.95	337.40	899.9
Zone 3	19.8	638	72.2%	0.19	0.95	55.01	0.01	0.20	0.53	0.01	0.70	1.87	0.06	0.95	18.34	0.00	0.95	0.00	0.19	0.95	55.01	0.47	0.95	133.87	264.6
Zone 4	19.5	266	73.3%	0.08	0.95	22.94	0.00	0.20	0.21	0.00	0.70	0.75	0.03	0.95	7.65	0.00	0.95	0.00	0.08	0.95	22.94	0.19	0.95	55.81	110.3
Zone 5	20.0	335	71.5%	0.10	0.95	28.89	0.00	0.20	0.29	0.00	0.70	1.01	0.03	0.95	9.63	0.00	0.95	0.00	0.10	0.95	28.89	0.24	0.95	70.29	139.0
Zone 6	27.0	81	71.5%	0.02	0.95	6.98	0.00	0.20	0.07	0.00	0.70	0.24	0.01	0.95	2.33	0.04	0.95	11.64	0.02	0.95	6.98	0.06	0.95	17.00	45.2
Zone 6 & Flex Boulevard	27.0	81	53.0%	0.02	0.95	6.98	0.00	0.20	0.11	0.00	0.70	0.40	0.01	0.95	2.33	0.00	0.95	0.00	0.02	0.95	6.98	0.06	0.95	17.00	33.8
Zone 7	27.4	141	46.2%	0.04	0.95	12.16	0.00	0.20	0.23	0.00	0.70	0.80	0.01	0.95	2.03	0.04	0.95	10.13	0.04	0.95	12.16	0.05	0.95	14.79	52.3
Zone 7 & Flex Boulevard	27.4	141	37.0%	0.04	0.95	12.16	0.00	0.20	0.27	0.00	0.70	0.94	0.01	0.95	2.03	0.00	0.95	0.00	0.04	0.95	12.16	0.05	0.95	14.79	42.3

Alternative 3 - Cycle Tracks

Total % Impervious Area				Sidewalks			Grassed Boulevards and Medians			Permeable Surface Boulevards			Curbs, Gutters, Medians and Buffers			Parking Lanes			Bicycle Lanes			Bus and Drive Lanes			TOTAL
	Typical ROW (m)	Length (m)	Existing	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	Area ha	C	Q=2.8(CiA) l/s	l/s
Zone 1	30.7	433	63.7%	0.13	0.95	37.34	0.01	0.20	0.47	0.01	0.70	1.66	0.01	0.95	3.11	0.22	0.95	62.23	0.17	0.95	49.78	0.32	0.95	90.85	245.4
Zone 2	30.2	1608	64.7%	0.48	0.95	138.66	0.03	0.20	1.71	0.03	0.70	5.99	0.04	0.95	11.55	0.80	0.95	231.09	0.64	0.95	184.88	1.17	0.95	337.40	911.3
Zone 3	19.8	638	74.7%	0.19	0.95	55.01	0.01	0.20	0.49	0.01	0.70	1.70	0.03	0.95	9.17	0.00	0.95	0.00	0.26	0.95	73.35	0.47	0.95	133.87	273.6
Zone 4	19.5	266	75.9%	0.08	0.95	22.94	0.00	0.20	0.19	0.00	0.70	0.68	0.01	0.95	3.82	0.00	0.95	0.00	0.11	0.95	30.58	0.19	0.95	55.81	114.0
Zone 5	20.0	335	72.8%	0.10	0.95	28.89	0.00	0.20	0.28	0.00	0.70	0.96	0.01	0.95	2.41	0.00	0.95	0.00	0.13	0.95	38.52	0.24	0.95	70.29	141.3
Zone 6	27.0	81	73.3%	0.02	0.95	6.98	0.00	0.20	0.07	0.00	0.70	0.23	0.00	0.95	1.16	0.04	0.95	11.64	0.03	0.95	9.31	0.06	0.95	17.00	46.4
Zone 6 & Flex Boulevard	27.0	81	54.8%	0.02	0.95	6.98	0.00	0.20	0.11	0.00	0.70	0.39	0.00	0.95	1.16	0.00	0.95	0.00	0.03	0.95	9.31	0.06	0.95	17.00	35.0
Zone 7	27.4	141	48.9%	0.04	0.95	12.16	0.00	0.20	0.22	0.00	0.70	0.76	0.00	0.95	1.01	0.04	0.95	10.13	0.06	0.95	16.21	0.05	0.95	14.79	55.3
Zone 7 & Flex Boulevard	27.4	141	39.8%	0.04	0.95	12.16	0.00	0.20	0.26	0.00	0.70	0.90	0.00	0.95	1.01	0.00	0.95	0.00	0.06	0.95	16.21	0.05	0.95	14.79	45.3

The proposed optimization of the right-of-ways and active transportation improvements will result in less impervious area. Using a weighted average approach results in a decrease in impervious area of 21%, 25% and 23% for Alternatives 1, 2 and 3 respectively. As a result, a decrease in surface runoff compared to existing conditions for Alternatives 1, 2 and 3 can be expected. It should be noted the entirety of the impervious area/run-off reduction is not anticipated to be realized by one specific stormwater system or receiver, as it is anticipated that there are multiple systems throughout the study area.

5. REVIEW OF THE PREFERRED RECOMMENDED ALTERNATIVE

Following the Class EA Process, the selected alternative cross-sections were subjected to a preliminary evaluation process which resulted in the selection of the preferred recommended alternative (Alternative 3 – cycle tracks) as presented in Figure 1.

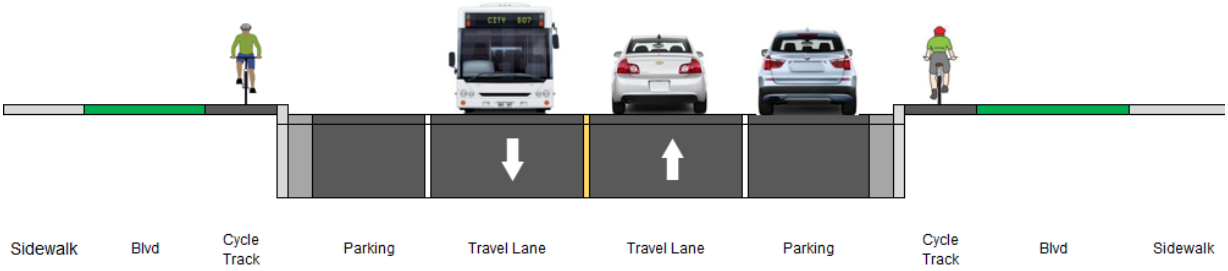

Figure 1 Cycle Track (One-way)

In February 2021, City Staff provided the following comments regarding the location of the proposed cycle track (preferred alternative):

- The cycle track is preferred to be behind the boulevard in all instances throughout the project and not against the curb area.
- This provides an area for snow storage during the winter months from both the road and the cycle tracks.
- Additionally, as mentioned in the report, it poses a hazard to both cyclists and pedestrians exiting and entering vehicles.
- Relocation of the cycle track is preferred. Hydro relocation is acceptable for a project of this scope and scale.

The requested changes to the cross-sections are presented in the following figures.

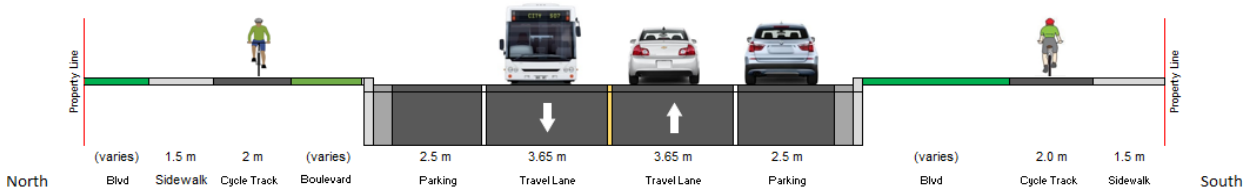

Figure 2 University Avenue – Zone 1

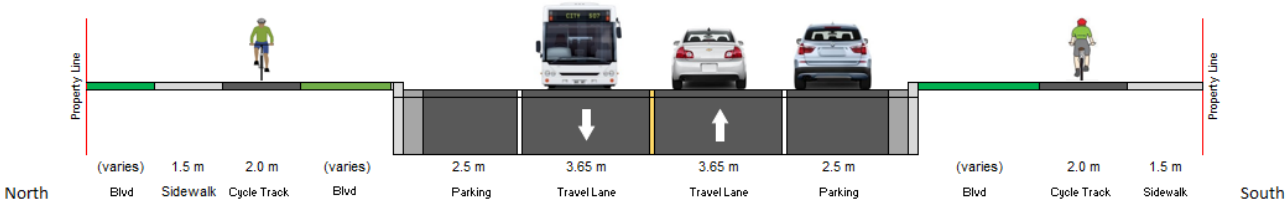

Figure 3 University Avenue – Zone 2

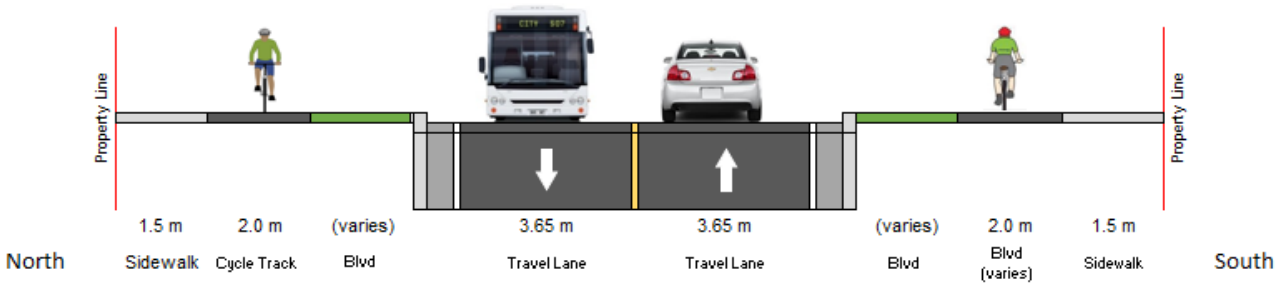

Figure 4 University Avenue – Zone 3

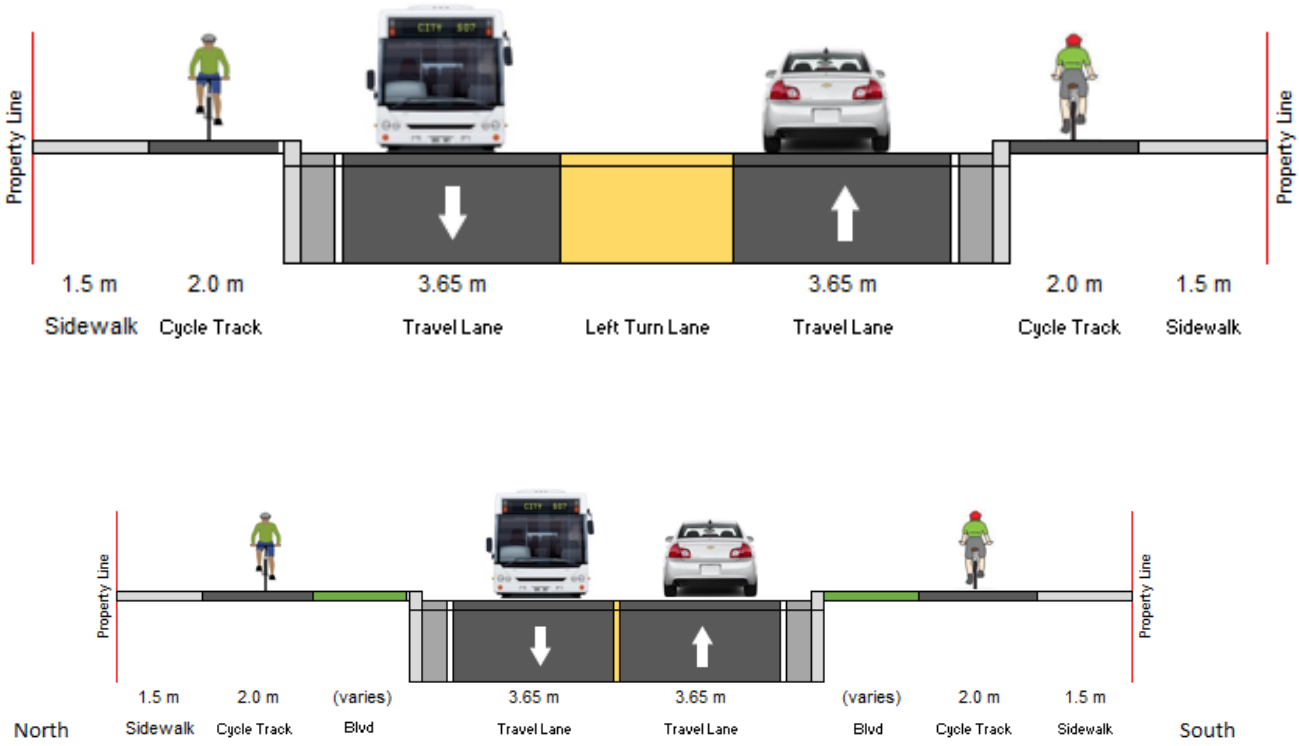

Figure 5 University Avenue – Zone 4

Figure 6 University Avenue – Zone 5

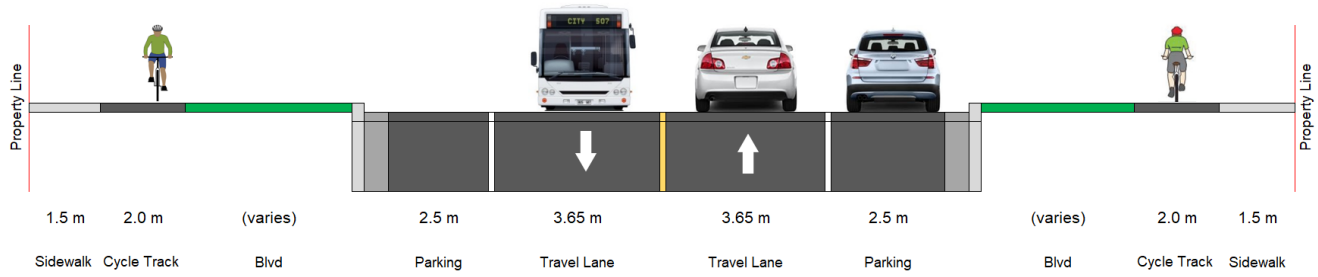

Figure 7 Victoria Avenue – Zone 6

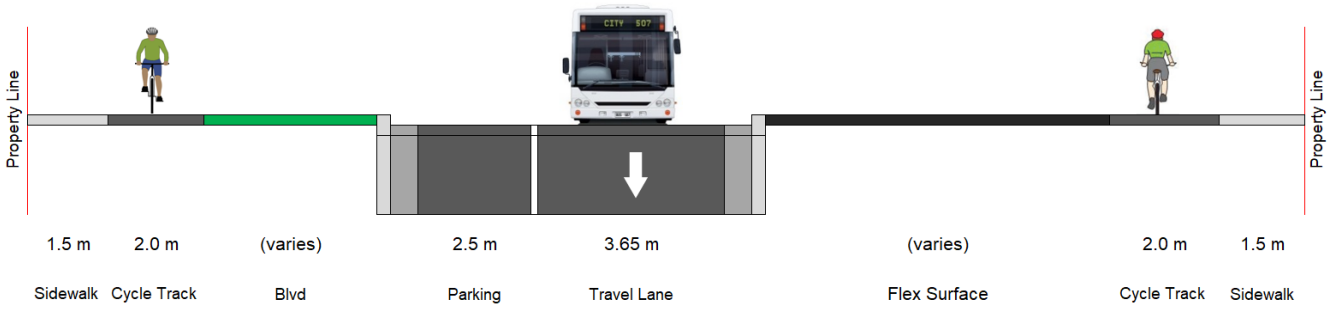

Figure 8 Victoria Avenue – Zone 7

Changes to the location of the proposed cycle track will not affect the impervious area identified for Alternative 3. As such, the projected decrease in impervious area of 23% is still consistent with the results presented in Section 4 of this report. Once again, it should be noted the entirety of the impervious area/run-off reduction is not anticipated to be realized by one specific stormwater system or receiver, as it is anticipated that there are multiple systems throughout the study area.