

University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

UBC East Mall Redesign Detailed Design Report

Prepared by: Yubo Jin, Lingjin Lyu, Yufeng Qiu, Liang Wang, Haolun Wu, Simin Ye

Prepared for:

Course Code: CIVL 446

University of British Columbia

Date: 16 April 2021

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Executive Summary

Per requested by UBC SEEDS Sustainability Program, a redesign on the East Mall segment between Agronomy Road and W 16th Avenue is prompted to achieve two goals: 1) Address current traffic issues such as speeding, lack of safety for pedestrians and cyclists, insufficient supply of temporary parking, etc.; 2) Improve the surrounding area with betterment such as tie-in with the Thunderbird Stadium Neighborhood, weather protection at Agronomy Road, greenspace increment and etc.

The final detailed design is developed based on the preliminary design, with new features added. The final report includes design key components, design criteria, construction and maintenance plan, detailed cost estimate, construction schedule as well as the IFC drawings package and construction specification. Different modelling softwares such as Excel, AutoCAD and Synchro were applied to visualize the design components and analyze the design outcome.

An updated class-B cost estimate is conducted, with the total of 14 main tasks defined in the detailed stage broken down into 35 subtasks. The project is estimated to be \$11,432,982 CAD. The estimated cost covers permitting fee, construction cost, direct operation cost and maintenance cost. Based on estimated project schedule, actual construction will start on May 1st, 2021, and will attain substantial completion by Aug 22nd, 2021.

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1.0 Introduction

The objective of the East Mall redesign project is to increase transportation safety and, enhance the green infrastructures, and reduce speeding issues. This report is to present the detailed design regarding the East Mall Redesign Project. Design of each component is to comply with applicable design guidelines, subjected to the City of Vancouver By-law and relevant City of Vancouver Construction Standard of Specification. Components details are designed to the element extent, with supplement drawings for illustration.

2.0 Key Components and Design Criteria

East mall redesign target is a 1km roadway from 16th Avenue intersection to agronomy road intersection. The road comprises five main intersections and 4 roadway sections. The different rearrangements of each roadway component are aiming to fit into the existing land uses and optimize the safety, comfortability and traffic conditions. The design key components include:

- Roadway Realignment
- Stormwater Management
- Traffic Management
- Traffic Signage & Pavement Marking Rearrangement
- Canopy Design at Agronomy Road Intersection
- Underground Utility

2.1 Roadway Realignment

Based on the existing road right-of-way layout, the road is divided into four designed

sections as listed below:

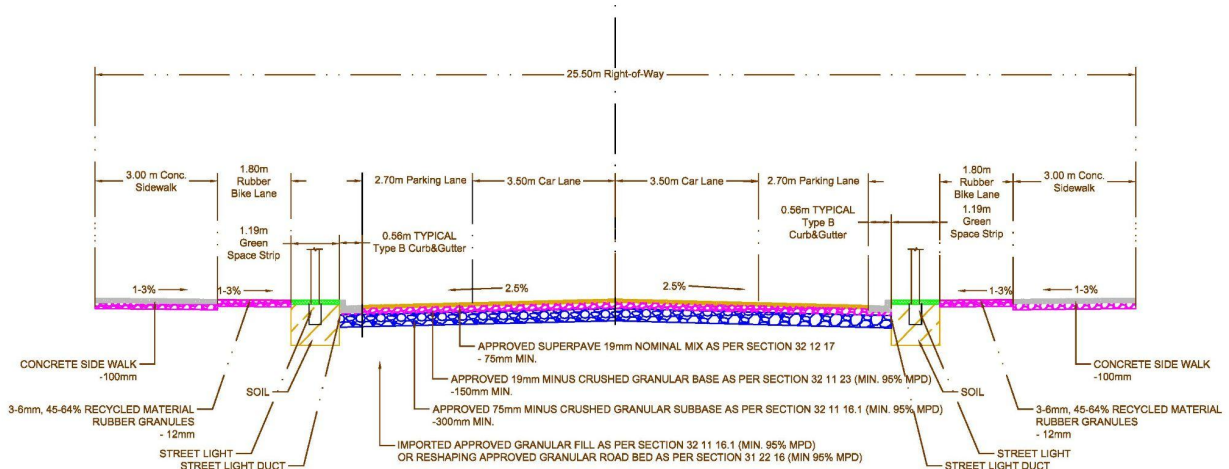
	Road Section	Length (m)	Existing Road Right-of-Way Average Width (m)	Proposed Road Right-of-Way Average Width (m)
Section 1	16th Ave. to Stadium Rd	300	40	25 (as required)
Section 2	Stadium Rd to Eagle Drive	230	40	42
Section 3	Eagle Drive to Thunderbird Blvd	220	40	42
Section 4	Thunderbird Blvd to Agronomy Rd	160	25	25

Table 1. Summary of Designed Road Sections

Each section has a specific roadway arrangement plan in accordance to its property lines and the existing street zones. The major adjustment of road alignment happens on road section 1, the proposed design removes the existing road median and narrows the entire road right-of-way from 40m to 25m in order to maximize the space for the future stadium neighbourhood and . Though the road gets narrowed, we keep the 2.7m multi-use parking

areas on both sides to support the high demand of the drop-off and pick up activity. As road section 1 has Thunderbird stadium on the west side and the UBC baseball field on the east side, lots of entertaining and social events are held in this area frequently, so this section is classified as the area of high pedestrian activity (including temporary special events or seasonal), the desirable sidewalk space of 3.0 m is designed on both sides of the road to provide people with the spacious and comfortable pedestrian through zone to get access to the sports field. And the new alignment of road section 1 will tie in with road section 2 from the stadium road intersection. Different from the existing street zone arrangement, except the south bound of road section 4, all the road sections will replace the existing asphalt bike lane by the rubber bike lane which will be paved above the curb and separated from the parking lanes or car lanes by the curb and green space. This new bike lane is classified as the protected bike lane with the highest comfortability which is protected from motor vehicles by curbs and planters. This new design further improves the safety and riding experience of cyclists as well as the safety of drop-off activities. As for the unchanged road section 4, the bike bollards will be installed to separate the bike lane and the car lane.

The road design has 5 main road elements which include car and parking lane, bike lane, sidewalk, green space and curb ramp. The design strictly follows the City of Vancouver Construction Specification, Standard Detail Drawing and Design Manual. The typical cross section of road section 1 is shown as follows, see Figure 1 for all the road cross section views.



**TYPICAL SECTION VIEW - 16th AVE. TO STADIUM ROAD
Sta.1 - Sta.167.1 & Sta. 211 - Sta. 275**

Figure 1. Typical Roadway Cross Section

2.1.1 Car and Parking Lanes

2.5% slope from curb to crown with 3 layers of material: a) 75mm surface layer: 19mm superpave hot-mix asphalt concrete paving. b) 150mm second layer: 19mm minus combined crushed granular base. c) 300mm third layer: 75mm minus crushed tailings granular subbase.

2.1.2 Rubber Bike Lane

With min. 2.0 % cross slope from curb to side with 3 layers of material: (a) 12mm surface layer: 3-6mm recycled rubber granules. (b) 150mm granular base: 19 minus combined crushed granular based. c) 300mm third layer: 75mm minus crushed tailings granular subbase.

2.1.3 Sidewalk

1.0% - 3.0% cross slope rising from gutter to the side with two layers of material: (a) 100mm Surface layer: CIP hand-formed concrete (min. 32MPa at 28 days) with a 6mm x 25mm sawcut joint on the surface. c) 150mm Second layer: 19mm minus combined crushed granular base. Type B Curb and Gutter are selected for the design.

2.1.4 Green Space

City approved topsoil products include: on-site topsoil, imported topsoil and manufactured topsoil with the min. depth of 450mm is suggested, and the designed depth of the topsoil and the rock pit for the rain garden area will be specified in Section 2.4.1.1.

City approved seed mix shall be applied. Comparing seed with sod, as the root systems of seed usually grow more efficiently when the grass matures, we choose seeding over sodding turf for the long term quality consideration instead of . In addition, seeding is about 20 times cheaper than sodding.

Trees are relocated to assigned locations with 8m - 10m average spacing, 15m³ soil volume/tree, and min. 0.3 distance from the back of the curb. The root barriers and the 50mm mulch with 0.5m radius coverage will be placed for each of the tree pits.

2.1.5 Curb Ramp

Apply double curb ramp for intersections and lane curb ramp for laneways with 7.1% ± 1.2% ramp slope. Score lines shall be in direction of travel and parallel with crossing with min. 6 lines and be 150mm apart.

2.2 Traffic Management

The traffic management design aims to prioritize the travel efficiency of transit, walking, cyclists over personal vehicles and reduce vehicle speed before intersection and ensure pedestrian safety.

2.2.1 Intersection Components

On each intersection, street name signs, PTZ cameras, advance warning signs and illuminated crosswalk wings should be provided

2.2.2 LED Traffic Signal Light

According to ITE standard, the traffic signal shall have a light center length of 62mm, 595 rated initial lumens, operating over the temperature zone from minus 40 °F to plus 165 °F. The design will keep the existing four traffic signal lights on the Thunderbird and East Mall intersection but change the phase time to accommodate future growth traffic volume and improve traffic efficiency.

2.2.3 Detector Loops

Detector loops shall be installed in the final base lift of asphalt. Loop junction boxes and stub conduits are to be placed in a manner that the loop tails will not cut through or cross any specialty road surface treatments.

2.2.4 Pedestrian Controlled Yellow Flash Light

A 450mm bi-modal LED display with countdown display pedestrian signal light shall be installed on each side of the intersection of Stadium Road, Eagle Drive and East Mall. A yellow polycarbonate backboard with 75mm border of yellow prismatic retro-reflective sheeting should

be provided on each pedestrian signal. A concrete base is buried on the ground to connect conduits and wires. An aluminum pedestrian use signal will be mounted on the pole which holds the LED signal light. There are totally four LED signal lights installed.

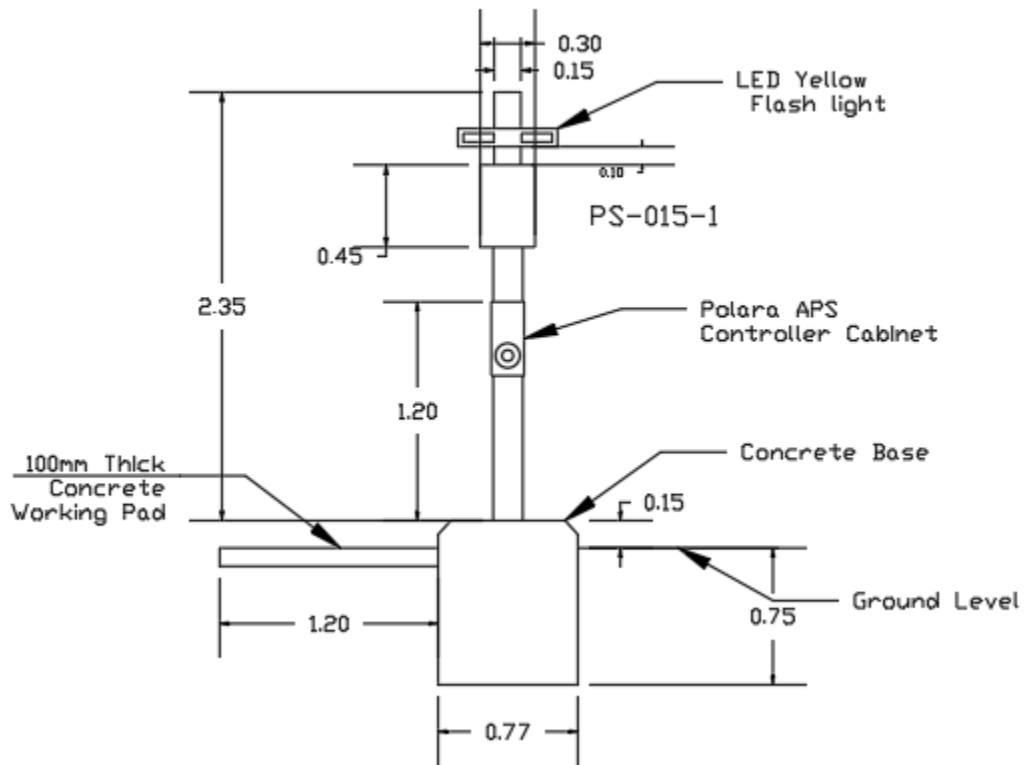


Figure 2. Pedestrian Controlled Yellow Flash Light

2.2.5 Traffic Sign

2 speed limit signs, 18 pedestrian cross signs, 1 do not enter sign are installed on the East Mall shown on the plan view.

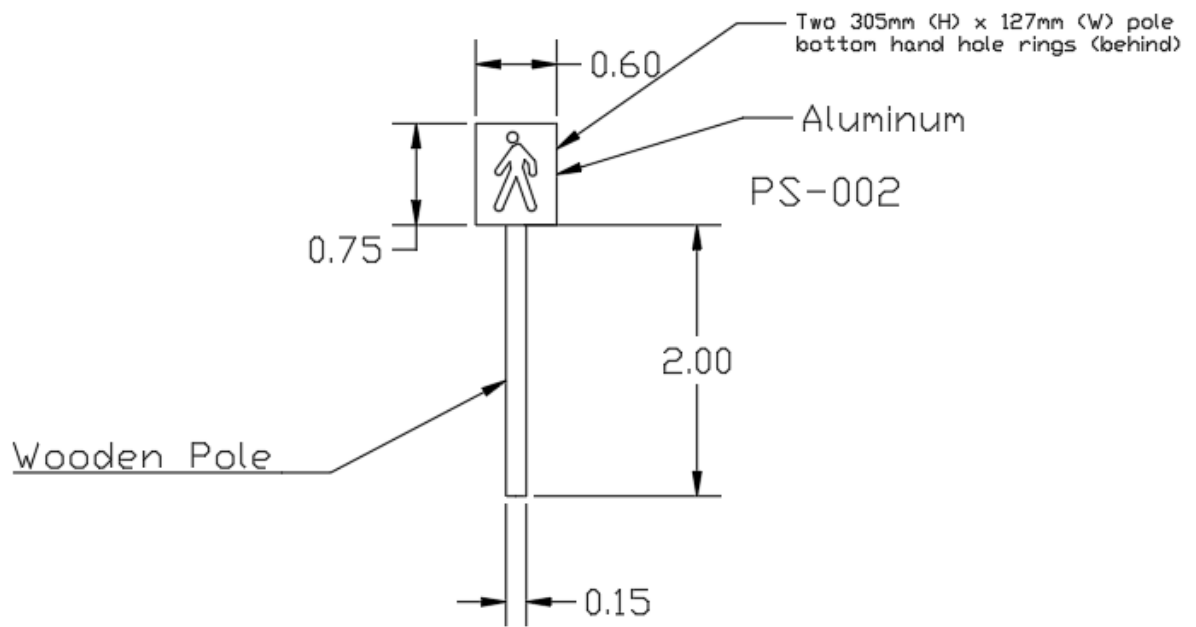


Figure 3. Pedestrian Cross Sign

2.3 Sidewalk Canopy

The proposed canopy structure will be installed along both sides of the sidewalks along Agronomy Road in between East Mall and Health Science Mall to provide a temporary shelter to keep the traveling pedestrians from getting wet during the rainy or snowy seasons. Due to sidewalk constraint, canopies on eastbound and westbound are designed with different dimensions. Dimension of the canopies are as follow:

- Westbound - 4.5m x 90m, clear height 2.5m
- Eastbound - 8.1m x 46m, clear height 2.5m;

Schematic layout of the canopies is shown in Figure 4 and virtual visuals are shown in Figure 5 and Figure 6.

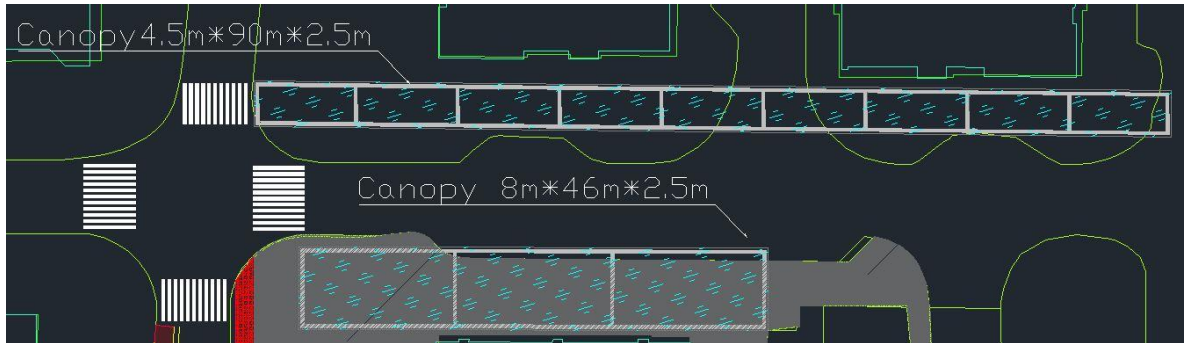


Figure 4. Plan Layout of Canopies along Agronomy Road

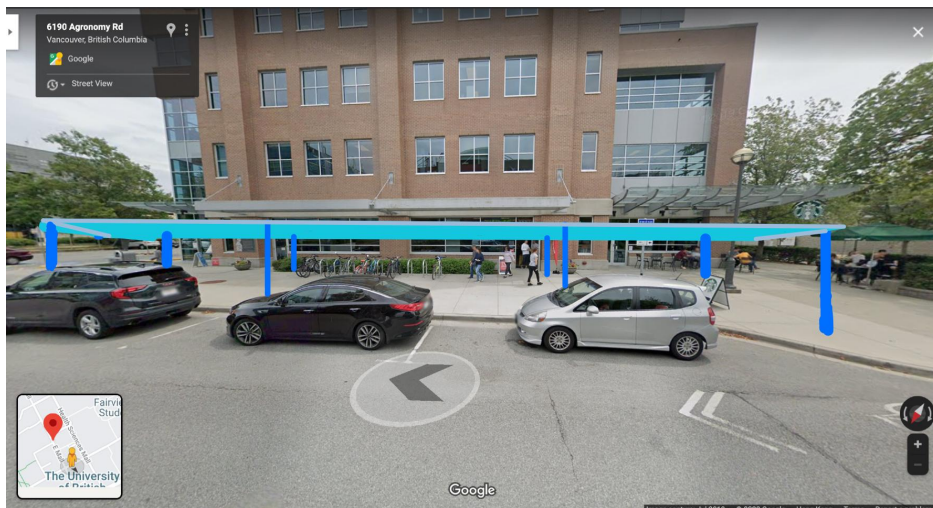


Figure 5. Westbound Canopy

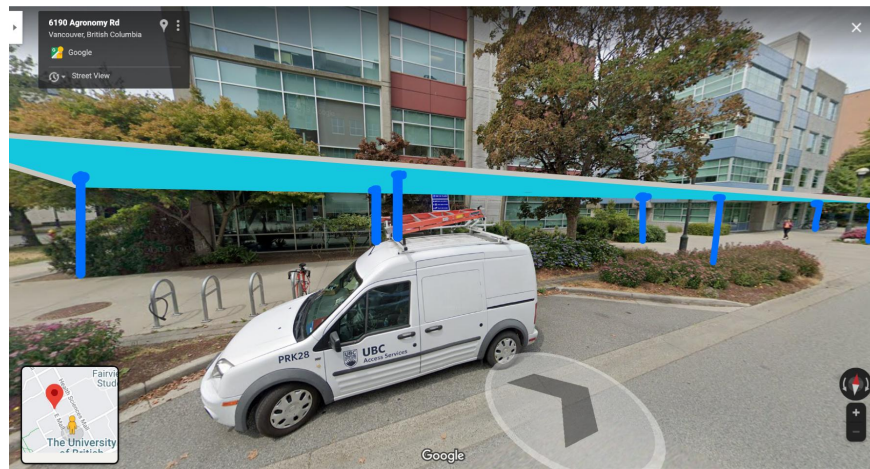


Figure 6. Eastbound Canopy

Components of the canopy structure are as follow:

- Top cover of the canopy is composed of reinforced glazing panels. Glazing product adopted is Pilkington **Planar™**. Dimension of the glazing is to comply with the dimension of the canopies. These Glazings are frameless. Bolted to the Stainless Steel 4-arm spider fitting at four corners, each piece of glazing is structurally secured, while providing maximum transparent area. Design Loads will be provided to Pilkington to determine the strength and thickness of the glazings. Gap between glazings is 5 mm, which is caulked with rubber sealant to ensure the top is integrated and water-leak free.
- Structural timber columns are the main support. Columns are spaced 4000mm on the long span. Typical column is 241mm by 241mm Glulam PLUS. Each column has the bottom pre-bolted with 4 bolt holes of 22mm diameter. A vertical rectangular groove of at least 500mm from the bottom of column is cut for T-shape knife plate insert. Actual location of bolt holes and groove should be adjusted to match the geometry of the knife plates.
- Wood Struts are anchored to the columns as lateral bracings if necessary.
- LVL beams are sized ½ inch by ¾ inch. Beams are placed along the long span of the canopy, setting on top of the columns. Beams are secured to the columns with L-angle steel and bolted.
- Wood members are shop fabricated and assembled on-site. Fire-resistant coating is applied on all wood members.
- 200mm aluminum gutters are installed along the long span on both sides of the canopies. Slope of the gutter is 2%. Additional aluminum flashing is attached to the gutter, and

lapped under the glazing in case of water overflowing. PVC pipe is used for gutter drain, and the pipes are anchored along the columns with U-shape plates.

Typical cross section view of the canopy on Agronomy Road Westbound is shown in the below Figure 7.

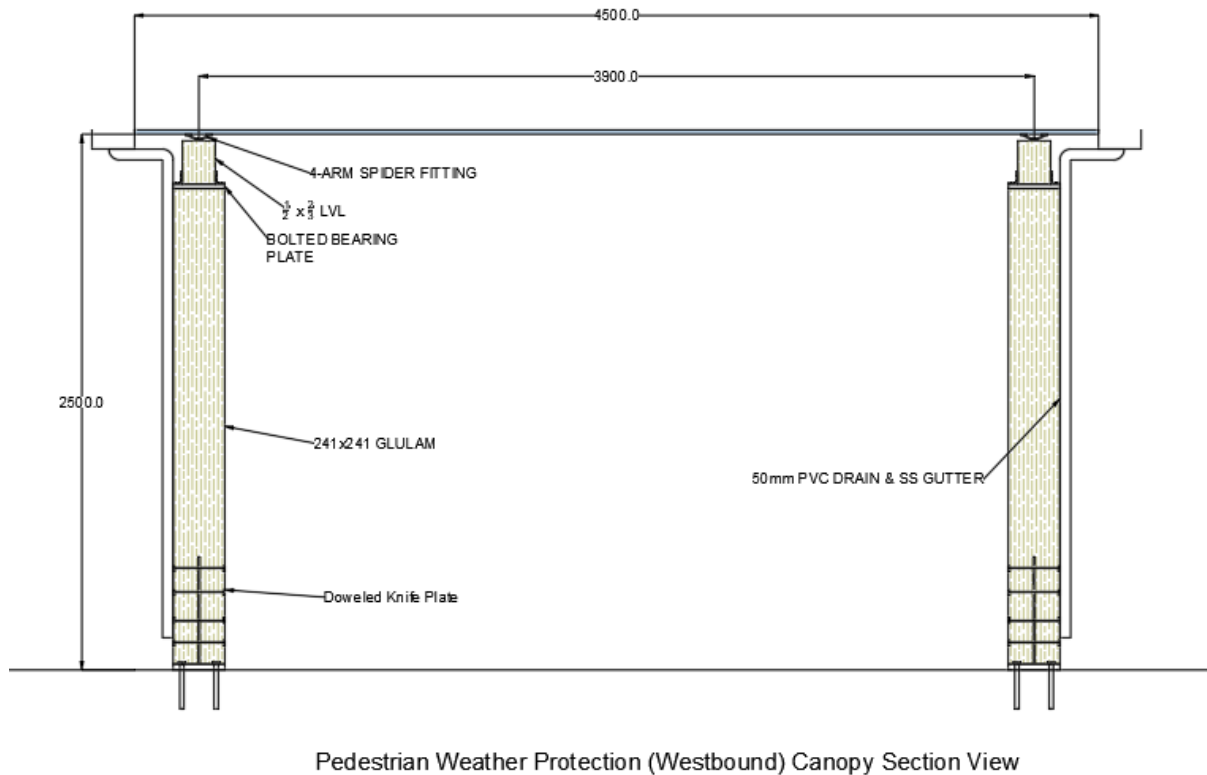


Figure 7. Pedestrian Weather Protection (Westbound) Canopy Section View

2.4 Stormwater Management - Utilization of Green Space

Depending on each green section's width and the availability of storm mains underneath, one of two different stormwater management plans is implemented. The two plans include tree planting and rain garden. A rain garden does not require underdrain and will be used in the wider green

spaces to capture enough surface runoffs. While on some sections with much narrower green areas less than 1m wide, planting trees is a good choice.

2.4.1 Tree planting

Tree planting is implemented in the 1m or less than 1m wide green spaces, which are listed below. The number of trees for each section is calculated based on the section length and specified tree spacing.

Table 2. Tree Planting in Different Location

Green space location	Green space width	Tree type & spacing	Number of trees
16th AVE. TO STADIUM ROAD Sta.1 - Sta.167.1 & Sta. 211 - Sta. 275	0.54m	Eastern Redbud / 7m	33
STADIUM ROAD to Eagle Drive Sta. 310 - Sta. 318	1m each on two sides	Eastern Redbud / 7m	2
STADIUM ROAD to Eagle Drive Sta. 345 - Sta. 429 & Sta. 450 - Sta. 461	1m each on two sides	Eastern Redbud / 7m	28
Eagle Drive to Thunderbird Rd Sta. 535 - Sta. 736	1m each on both sides	Eastern Redbud / 7m	30
Thunderbird Rd to Agronomy Rd Sta. 754 - Sta. 900	1m	Eastern Redbud / 7m	21

2.4.2 Rain Garden

Rain gardens are considered where spacious green spaces are present. Rain gardens are designed to mimic the natural water cycle. Rainwater is soaked into the soil and then recharges groundwater for eventual uptake and use by plants. Therefore, no undertrain or external pipe connections are required. Other design factors such as the garden shape and size, soil mix and location are considered.

Proposed rain garden areas vary in different widths from 1.2m to 5.64m, depending on where they are located along East Mall. The following table 3 specifies key components of the proposed rain gardens at each road section including rain garden width, topsoil depth, rockpit dimensions and other relevant parameters. All rain gardens are designed to effectively capture rainfall runoff from impervious areas such as the sidewalk and rubber bike lanes. Please note that each rain garden also consists of 0.2-0.3m gravel transition buffer width on both sides to separate it from adjacent the sidewalk and bike lane.

Table 3: Summary of Rain Garden Areas with Key Design Components

Road Section	Total length(m)	Rain garden width (m)	Topsoil depth(m)	Rockpit width (m)	Rockpit depth (m)	
16th AVE. TO STADIUM Rd.	Sta.1 - Sta.167.1 & Sta. 211 - Sta. 275					
	GS in width: 1.2m	230.1	1.2	0.1	0.8	0.2
	GS in width: 2.9m	230.1	2.9	0.05	1	0.1
	Sta.169 - Sta. 210 & Sta. 275 - Sta. 289					

	GS in width: 3.24m	55	3.24	0.05	1	0.1
	GS in width: 5.64m	55	5.64	0.05	3	0.1
	GS in width: 1.2m	55	1.2	0.05	0.5	0.3
STADIUM	Sta. 310 - Sta. 318					
ROAD to Eagle	GS in width: 1.5m	8	1.5	0.1	1	0.2
Dr.	Sta. 345 - Sta. 429 & Sta. 450 - Sta. 461					
	GS in width: 1.5m	95	1.5	0.15	1	0.3
Eagle Drive to	Sta. 535 - Sta. 580, Sta. 580 - Sta. 720, Sta. 720 - Sta. 736					
Thunderbird	GS in width: 1.5m	201	1.5	0.15	1	0.3
Bldv.	Sta. 754 - Sta. 784, Sta. 784 - Sta. 810, Sta. 810 - Sta. 862					
Thunderbird	GS in width: 2.0m (left)	108	2	0.1	1.5	0.1
Bldv. to	Sta. 754 - Sta. 784, Sta. 784 - Sta. 810					
Agronomy Rd	GS in width: 3m (right)	56	3	0.05	2	0.2
	Sta. 862 - Sta. 900					
	GS in width: 2m	38	2	0.2	1.5	0.2
	Sta. 810 - Sta. 862, Sta. 862 - Sta. 900					
	GS in width: 3.5 m	90	3.5	0.1	2.5	0.1

2.4.3 Road Source Control

Nowadays, intensive rainfall events have happened more frequently due to climate change. In urban areas, overland flow can accumulate over rooftops, driveways and sidewalks, which can cause damages due to flooding and water ponding within settlement. In order to minimize these potential impacts, excess runoff needs to be properly and efficiently discharged into the storm system. In Figure 8 below, existing storm mains are shown in bright green lines, which will remain in the system. However, due to the road re-alignments, there are adjustments to be made on locations of manholes & catch basins. The figure below shows approximate new locations of manholes in black and catch basins in purple. Elevations of each manhole are obtained to determine the overflow direction through Google Earth data. Elevation is the highest at M11(at 96m) and lowest at M1 (at 86m), which determines the runoff flows towards M1. As per City of Vancouver Engineering Design Manual, the catch basin connection leader shall be no more than 30m. The exact distance between catch basin and manhole can be found in the plan views of the road section in Appendix A. The cross-section views of the manhole and catch basin are shown below in Figure 9 & Figure 10.

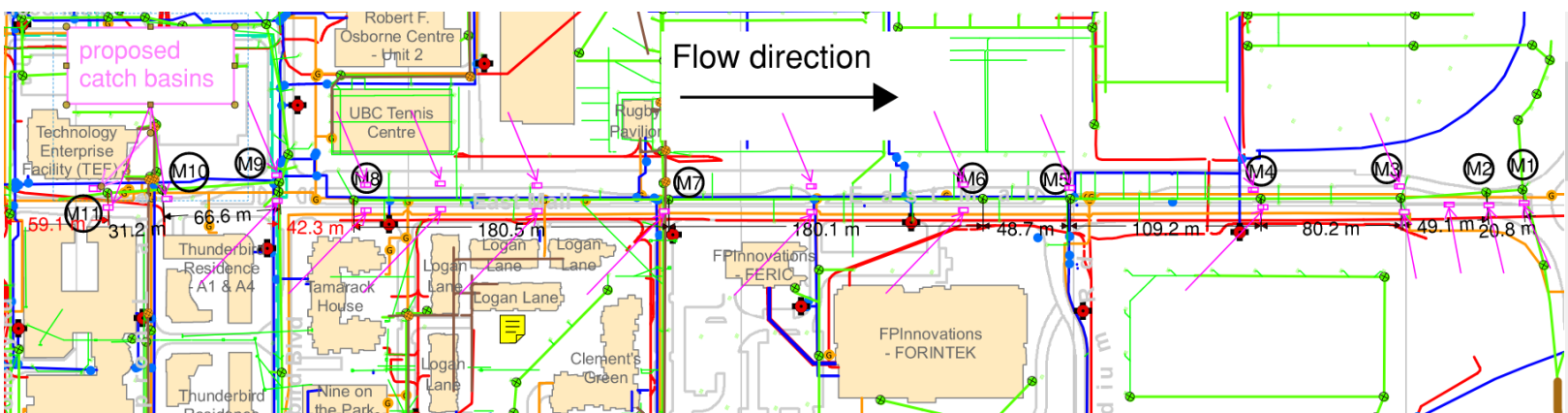


Figure 8. UBC Utility Map along East Mall with manholes and proposed catch basins

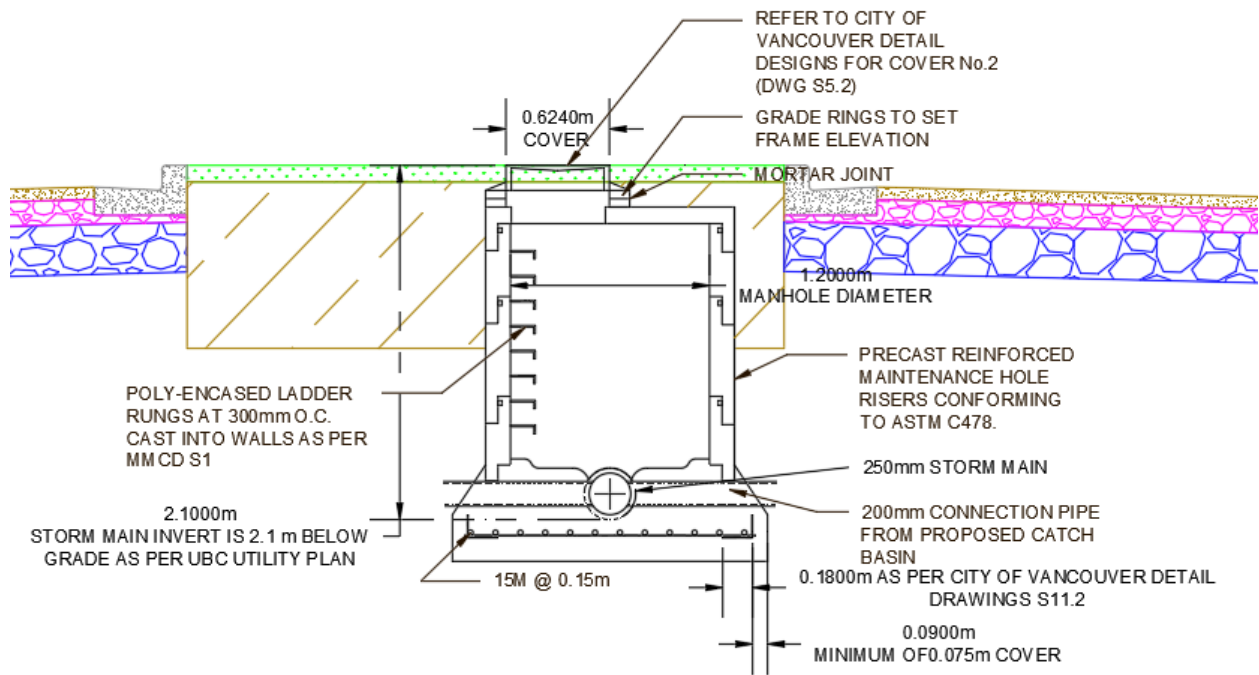


Figure 9. Cross-section View of a Manhole on Road Surface

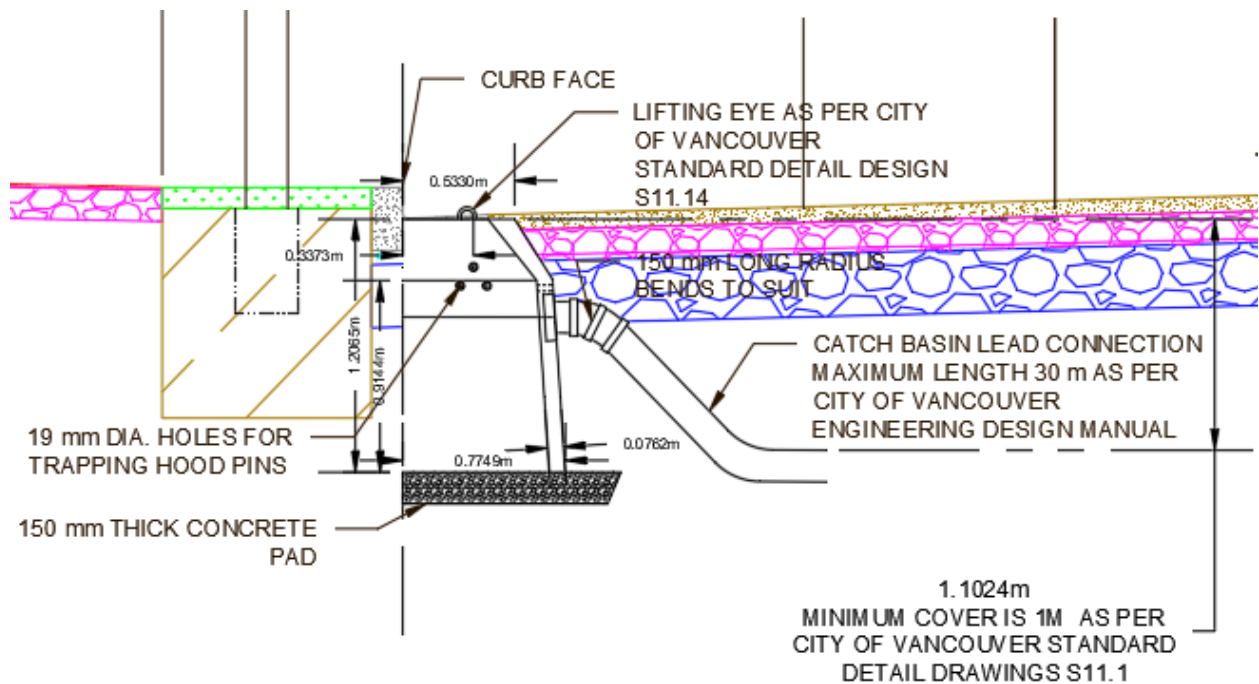


Figure 10. Cross-section View of a Catch Basin

2.5 Utility

For underground utility, MLH has followed the UBC Technical Guidelines. Due to the lack of accurate locations of the underground pipelines, Utility Master Map 2019 and Underground Utilities within UBC are referred. Most of the pipelines will remain unchanged based on the fact that these underground utilities are located under sidewalks, which would not affect construction of roadways. On the east side of East Mall, a 500 mm water main and a 250 mm storm sewer is located below our new sidewalk .

For the west side of the East Mall, the water supply pipes and storm sewer shall be located the same as the east side of East Mall. Also, the electrical line is located at 650mm deep. The natural gas mains are buried 200mm deeper than its origin place for safety purpose and ease for maintenance.

3.0 Design Criteria & Technical Consideration

3.1 Roadway Design Criteria

For the roadway design, pavement design influences the roadway overall lifespan, maintenance requirements, driveability. The pavement shall strictly follow the design

criteria outlined by City of Vancouver.

As the project is to realign the existing roadway, the pavement follows the original pavement design as well as the City of Vancouver Construction Specification. Pavement component thicknesses are equal or greater than the requirements of Local/Residential (Light Duty) Streets and Lanes as shown in Table 4. The design life for the East Mall roadway is 30 years.

Table 4. Asphalt Pavement Structures - Local/Residential (Light Duty) Streets and Lanes

(Source from City of Vancouver Design Manual Table 8-21)

Pavement Layers	Thickness
AC Surface Course	35mm
AC Lower Course	40mm
Granular Base	150mm
Granular Sub Base	300mm

3.2 Traffic Design Criteria

3.2.1 Speed Control

To determine the speed limit for vehicles, criteria including delay ratio and pedestrian safety average travel time for each vehicle should be considered. Because the maximum speed limit in British Columbia is 50km/hr, the analysis will mainly focus on 40km/hr and 50km/hr.

By considering the criteria discussed above, a 50km/hr speed limit is applied throughout the East Mall Road, and bumpers are applied 50m away from each intersection to help ensure pedestrian crossing safety.

3.2.2 Traffic Signal Phases

The traffic control of Thunderbird and East Mall intersection will be signal control and the other intersection will be pedestrian push button yellow flash light control.

The signal phase time is optimized for travel efficiency based on a model result on Synchro.

Morning Peak hour:

The actuated control type is applied to the intersection in the morning peak hour.

- Vehicle Green time:
 - Left turn at Westbound along Thunderbird Road: 4s
 - Westbound(Thunderbird Road): 25s
 - Eastbound(Thunderbird Road): 17s, 25s for call with no left turn at opposite direction
 - Northbound & SouthBound(East Mall): 27s

- Pedestrian Green time:
 - Westbound & Eastbound north side: 17s
 - Westbound & Eastbound south side: 25s
 - Northbound & Eastbound: 27s

Afternoon peak hour:

The actuated signal control is applied to the intersection in the afternoon peak hour.

- Vehicle Green time:
 - Left turn at Westbound along Thunderbird Road: 11s
 - Westbound(Thunderbird Road): 32s
 - Eastbound(Thunderbird Road): 17s, 20s for call with no left turn at opposite direction
 - Northbound & SouthBound(East Mall): 20s
- Pedestrian Green time:
 - Westbound & Eastbound north side: 17s
 - Westbound & Eastbound south side: 32s
 - Northbound & Eastbound: 20s

Regular hours:

The Signal control type is applied to the intersection in the morning peak hour.

- Vehicle Green time:
 - Left turn at Westbound along Thunderbird Road: 6s
 - Westbound(Thunderbird Road): 16s
 - Eastbound(Thunderbird Road): 26s
 - Northbound & SouthBound(East Mall): 16s

- Pedestrian Green time:
 - Westbound & Eastbound north side: 17s
 - Westbound & Eastbound south side: 35s
 - Northbound & Eastbound: 27s

The traffic and pedestrian volume will grow by 7.76% in ten years. The change will not affect any traffic design applied now.

3.2.3 Traffic and Pedestrian Volume Analysis

In this report, the traffic and pedestrian volume analysis will only focus on the future ten years and the growth rate will be 0.75% per year according to UBC SEEDS engineer's suggestion.

3.3 Canopy Design Criteria

Design of canopy structure is to conform with applicable design guidelines.

3.3.1 Design Load

Design load complies with BC Building Code 2018 (BCBC2018) Division B, Section 4.1.3 and Section 4.1.6. As the canopies are exterior, with no other items expected to sit on top of the structure, they are considered only subjected to rain load, snow load and wind load. Section statement is shown in Figure 11 below.

4.1.6.2. Specified Snow Load

(See Note A-4.1.6.2.)

1) The specified load, S, due to snow and associated rain accumulation on a roof or any other *building* surface subject to snow accumulation shall be calculated using the formula

$$S = I_s [S_s (C_b C_w C_s C_a + S_r)]$$

where

I_s = importance factor for snow load as provided in Table 4.1.6.2.-A,

S_s = 1-in-50-year ground snow load, in kPa, determined in accordance with Subsection 1.1.3.,

C_b = basic roof snow load factor in Sentence (2),

C_w = wind exposure factor in Sentences (3) and (4),

C_s = slope factor in Sentences (5), (6) and (7),

C_a = accumulation factor in Sentence (8), and

S_r = 1-in-50-year associated rain load, in kPa, determined in accordance with Subsection 1.1.3., but not greater than $S_s(C_b C_w C_s C_a)$.

Table 4.1.6.2.-A
Importance Factor for Snow Load, I_s
 Forming Part of Sentence 4.1.6.2.(1)

Importance Category	Importance Factor, I_s	
	ULS	SLS
Low	0.8	0.9
Normal	1	0.9
High	1.15	0.9
Post-disaster	1.25	0.9

Figure 11. BCBC 2018 Division B Section 4.1.6.2

According to Section 4.1.6.2, the specified weather load associated with snow and rain is derived, and design factored stress is calculated to be 0.196 kPa. This is the stress incurred by 1 in 50 years snow precipitation in Vancouver. For canopy structure capacity, LVL beam bending capacity dominates. While the shear force from design load is derived to be 0.784 kNm, LVL beam capacity is 18.13 kNm, giving a factor of safety of 23. In the case of extreme heavy snowfall, the structure can resist an amount equivalent to consecutive 20 days of snow accumulation. Given that snow melts and is directed out from the gutter, this extreme scenario can barely happen.

3.3.2 Structural Elements

The following design guidelines provide basis for element material and dimension selection:

- Design of wood members conforms with BCBC 2018 Division B, Section 4.3.1, CSA-O86, “Engineering Design in Wood” and CSA-0177, “Qualification Code for Manufacturers of Structural Glued-Laminated Timber”.
- Design of steel connections conforms with CSA-S16 “Design of Steel Structure”.
- Design of gutter conforms with CAN/CSA S157/S157.1, “Strength Design in Aluminum/Commentary on CSA S157-05, Strength Design in Aluminum”.
- Design of glazing panels conforms with CAN/CGSB12.20-M, “Structural Design of Glass for Buildings”.

3.4 Storm Management Design Criteria

3.4.1 Tree planting

Tree planting is used on most of the narrower green spaces in this project, of which width usually ranges from 1m to 3m. A complete guidance on Street Tree is provided by the City of Vancouver. A few key design requirements and constraints in the guidance are extracted from City of Vancouver Street Tree Guidelines Year 2011 revision:

- Tree size selected: Small or Columnar (Global Maple, Eastern Redbud, Columnar Norway Maple,etc...)
- Spacing: 6-10m
- Constraints: minimum distance 1.8m away from driveways, minimum 1.5m away from electrical trolley poles

3.4.2 Rain garden design

Design of the rain garden is to conform with applicable design guidelines.

Simplified rainfall capture method was used to calculate total capture volume by each rain garden. A volumetric reduction criteria of 72% of a 2-year, 24-hour rainfall event was applied to determine total rainfall in mm. Based on the current IDF curve shown below, a 2-year 24 hour rainfall event has a PPT of 54.41 mm. Therefore the design uses a total rainfall of 39.18mm to estimate input volume for each rain garden. The captured volume, which is designed to be larger than the input volume, includes evaporation volume, infiltration volume, topsoil volume and rockpit captured volume. The evaporation rate and infiltration rate are set at 1mm/hour and 1.5mm/ day as per City of Vancouver Engineering Design manual. Detail calculations are provided in the Appendix.

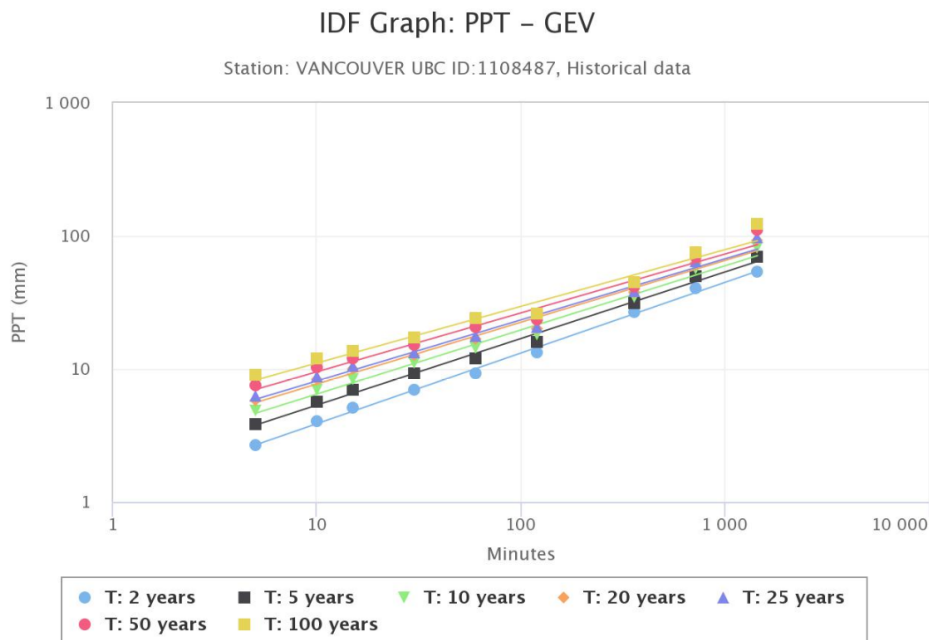


Figure 12. IDF Curve at Vancouver UBC

3.4.3 Road Source Control

3.4.3.1 Catch basin design

The design of Catch basin complies with City of Vancouver Engineering Design Manual Section 5.4.4.

Table 5. Catch Basin Catchment Areas and Spacing

Table 5-15: Catchbasin Catchment Areas and Spacing

Type	Catchment Area / Spacing		
	Minimum	Preferred	Maximum
Typical Catchbasin Catchment Area			
New / Reconstructed Roads up to 4% Grade	350m ²	500m ²	600m ²
New / Reconstructed Roads over 4% Grade	250m ²	400m ²	500m ²
Rehabilitation Projects ⁽¹⁾	250m ²	500m ²	750m ²
Typical Catchbasin Spacing			
All roads	60m	-	150m
Notes:			
1) Match or reduce the catchment area from existing for rehabilitation projects when possible.			
2) Catchbasin catchment area governs in the event the maximum catchment area produces a spacing requirement below minimum spacing.			

Based on the requirements provided in the Table 5 above, the number of catchment between two consecutive manholes can be calculated by dividing the road area by preferred catchment area.

The following Table 6 provides the number of catch basins required between manholes.

Table 6. Catch basin design along East Mall

From	To	Road Grade	Road Length	Road Area(m ²)	Preferred catchment area	Number of catch basin required
M11	M10	0	31.2	514.17	500	2
M10	M9	0	66.6	271.44	500	1
M8	M7	0.55%	180.5	621.81	500	2
M7	M6	1.11%	180.1	3014.35	500	7
M6	M5	2.05%	48.7	1746.97	500	4
M5	M4	0.92%	109.2	472.39	500	1
M4	M3	1.25%	80.2	1354.08	500	3
M3	M2	4.07%	49.1	994.48	400	3
M2	M1	4.81%	20.8	608.84	400	2
M9	-	0		579.42	500	2
					total	27

In section 5.4.4.3 of the City of Vancouver Engineering Design Manual, specific requirements of catch basin connection lead are given as follow:

- New single catch basin leads shall have a minimum diameter of 150mm.
- Leads are typically installed at a depth of 1.5m.
- No catch basin lead shall exceed 30m in length as measured horizontally between the main sewers and the catchbasin unless maintenance holes are provided.

The detail design of the catch basin as shown in Appendix A has met above-mentioned criterias.

3.4.3.2 Manhole Design

The design of Manhole complies with City of Vancouver Engineering Design Manual Section 4.4.3.

The existing storm sewer pipes are 250mm Dia., which corresponds to a minimum 1050mm manhole in Table 7. Our team selected a 1200mm manhole which satisfies the requirement.

Other design factors including dimensions of riser, cover, rungs are considered based on Standard Detail Drawings Storm & Sanitary Sewers S 1.1.

Table 7. Minimum Manhole Sizes in Section 4.4.3.3 of City of Vancouver Engineering Design Manual

Table 4-5: Minimum Maintenance Hole Sizes

Pipe Diameter (mm)	Minimum Maintenance Hole Barrel Diameter (mm)
150 - 450	1050
525 - 675	1200
750 - 1050	1350
1200	1500
1350 - 1500	1800
1650 - 2100	2400

The BC CL-625 vehicle shall be used for loading designs, recognizing that the BC design vehicle includes higher axle load ratings than the CAN/CSA design vehicle.

4.0 Standards and Software Package

4.1 Synchro

The traffic condition of East Mall Street after the redesign is simulated by using Computer Software Synchro. By inputting traffic information such as intersection layout, daily average vehicle volume and signal phase timing into the Synchro, the total delay, optimal signal phase

windows and heat maps etc can be obtained and the result will be used to help analyze the traffic condition.

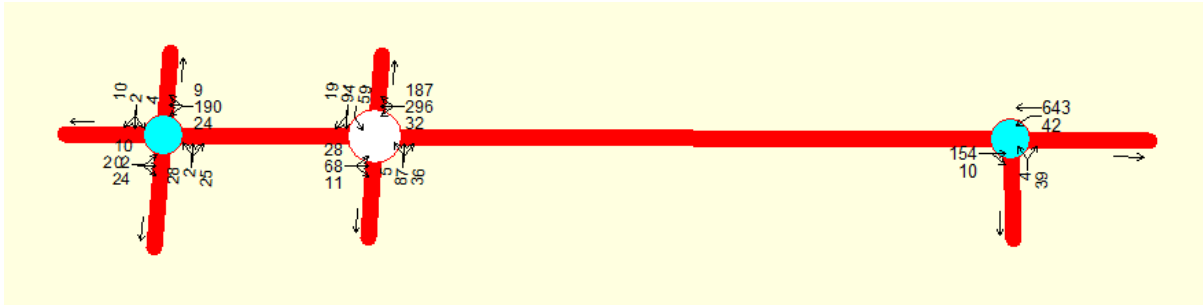


Figure 13. The Traffic Condition of East Mall Street After Redesign.

After considering the delay ratio, fuel consumption and travel time on different scenarios on each intersection, traffic control on the intersection of Thunderbird and East Mall is set to be different on different time zones, and the other intersection will have pedestrian push button control. Protected left-turn phase will not be provided.

Time phase	Control type	Delay ratio	Fuel consumption (Litre/vehicle)	Travel time (mins/Vehicle)
Morning PH	Actuated	0.382	0.114	0.887
Afternoon PH	Actuated	0.491	0.107	1.245
Regular hour	Signal	0.671	0.120	1.443

Morning Peak hour:

Table 8. Morning Peak Hour Signal Type Comparison

	Delay ratio	Fuel consumption	Travel time	Overall Benefits

		(Litre/vehicle)	(mins/vehicle)	
Actuated	0.382	0.114	0.887	
Signal controlled	0.375	0.123	0.938	
Percent difference	-1.83%	+7.89%	+5.75%	11.81%

Afternoon peak hour:

Table 9. Afternoon Peak Hour Signal Type Comparison

	Delay ratio	Fuel consumption (Litre/vehicle)	Travel time (mins/vehicle)	Overall Benefits
Actuated	0.491	0.107	1.245	
Signal controlled	0.490	0.139	1.10	
Percent difference	-0.20%	29.9%	-11.6%	18.1%

Regular hours:

Table 10. Regular Hour Signal Type Comparison

	Delay ratio	Fuel consumption(Litre/vehicle)	Travel time(mins/vehicle)	Overall Benefits
Actuated	0.671	0.120	1.443	
Signal controlled	0.436	0.110	0.857	
Percent difference	-35.02%	-8.33%	-40.61%	-83.96%

5.0 Draft Plan of Construction Work

5.1 Construction Sequence

A conventional top-down planning approach for construction processes, with which large scale works, such as existing roadway milling, excavation and paving, are performed first, following with detailed works to be addressed. A simplified workflow is illustrated below.



Figure 14. General Workflow of Road Construction

The East Mall project has been divided into 4 sections as mentioned, the designed roadway will be constructed section by section, Prior to excavation, the site shall be cleared and surveyed by the designated surveyors, the proposed storm drain inlets, manholes, centerline of the

right-of-way, face of curbing, elevations etc. shall be staked out by field markers. With the permission from the owner, the contractor shall move in their equipment and set the material stockpiles at the designated location (See Appendix A). The excavation will take place after the asphalt cold milling, the roadway excavation activities include the removal of the roadway, granular base and subbase until the proposed subgrade depth is reached. The relocation of the storm drain system shall be completed and backfilled during the excavation phase. Contractor shall design the temporary detour plan to maintain the traffic during the excavation phase. When the proposed subgrade depth is reached, the 150mm thick 19mm minus crushed granular base and 300mm thick 75mm minus crushed granular sub base shall be placed to where the existing roadway gets removed with the proper grading and compaction application. The traffic can be allowed to enter the paved areas immediately after the last rolling of the base course.

The pavement removal of the curb side will take place after the greenspace removal, utility relocation. The removal activity involves sawcutting the existing edge of pavement on both sides of the road, removing the entire existing concrete curb and gutter, concrete pavement surface and the granular base material, Placing 150mm thick 19mm minus crushed granular base and 100mm thick concrete pavement to the designed location. the installation of Type B curb and gutter inside of the edge of the surface course and tie-in the curb surface with the road surface. The existing rain leaders which are affected or damaged by the construction will be replaced and extended through the face of the curb. Design depth of topsoil, rockpits will be placed at the designated spots, the water valves/meters elevation and location might be adjusted based on the newly installed topsoil. Trees shall be replanted at designated locations, All topsoil areas and tree pit

areas shall be seeded and mulched. In the end, tie in the concrete driveways with the asphalt roadway.

5.2 Site Setup

Project Boundary is the East Mall segment between Agronomy Road and West 16th Avenue. Fencing will be set along the boundary line. The orphan land between Stadium Road and West 16th Avenue can be deployed for construction preparation use and locate temporary site huts, material laydown areas, material and equipment storage areas and site vehicle parking. Land deployment will be negotiated with the Ministry of Transportation and Infrastructure.



Figure 15. Designated land deployed for site preparation

Entrance to the site will be at the roundabout at West 16th Avenue. Heavy vehicles coming from West 16th Avenue shall follow the roundabout and enter East Mall. Traffic control is to be implemented at the intersection to direct normal vehicles. Traffic control crews are to be at the four entrances of the roundabout to provide stop signals to normal vehicles whenever site vehicles are incoming.

5.3 Anticipated Issues

The following issues associated with construction are considered and solutions are proposed accordingly.

- **Noise Control:** As scope of the construction is in proximity with many sports fields and communities along East Mall, construction noise will inevitably affect neighbors. According to City of Vancouver Noise Control By-law 6555, street construction time is limited between 7:00 a.m. to 8:00 p.m. on weekdays, and between 10:00 a.m. to 8:00 p.m. on weekends, including holidays. In this project, construction time will follow the City Bylaw since surrounding areas are mostly sports fields and users are less susceptible to noise. For the East Mall Segment between Logan Ln. to Agronomy Road, where office buildings and residence are more dense, notification of construction noise will be given to building users one week ahead. As street construction noise mainly derives from operation of heavy machines, noise control is only needed during heavy machine operation. Wherever a heavy machine is in operation, temporary noise barrier walls will be set by the site boundary to mitigate construction noise.
- **Dust Control:** Similar to noise control, wherever dust spread is to occur, notification will be given to surrounding building users one week ahead. Dust Barrier Zipwall should

encase the area with heavy dust, and industrial dust collectors will be provided to minimize dust spread.

- Traffic Detour: East Mall segment subjected to construction connects Agronomy Road and W 16th Avenue. Vehicles intending to travel across should be rerouted to WestBrook Mall. During the construction phase, traffic control is to be implemented at the two entrances to the East Mall segment. Temporary fence gate will be set. Given that the roundabout at W 16 Avenue and East Mall intersection has a large traffic flow, construction caution, speed control signages and reroute billboard are set at the entrance of the roundabout to notify drivers. Traffic control crews are to be at the entrances of the roundabout to guide vehicles.

6.0 Cost Estimate

The cost estimation encompasses the construction of the East Mall redesign on the East Mall in between Agronomy Rd. and W. 16th Avenue. The total cost of the project is \$11,432,982 including 15% contingency (see *Table 10*), with details outlined in Appendix C: Cost Estimation. This estimate was determined by precedent examples of similar projects, permitting regulations by law of British Columbia, as well as RSMeans data.

East Mall Redesign Cost Estimation			
Material Cost (\$)	Labour Cost (\$)	Equipment Cost (\$)	Incidental Costs (\$)
8956837.584	636160	273814.48	74911.41283

Total Cost + 15% Contingency (\$)	11432982
--	----------

Table 11. East Mall Cost Estimation

7.0 Schedule

The project starts from May 1st, 2021 as required, and ends on Aug 22nd when the last task of East Mall construction, painting and signage installation finishes, which lasts 114 days. Project schedule is divided into three parts: intersection, roadway and sidewalk, since their tasks are mostly independent.

As for the intersection, only canopies will be installed there, and the installation is splitted to 6 small tasks with one day duration for each of the tasks. A detailed schedule is shown in the figure below, and the arrows between tasks represent the dependent relationship. The total duration for this part is 5 days.

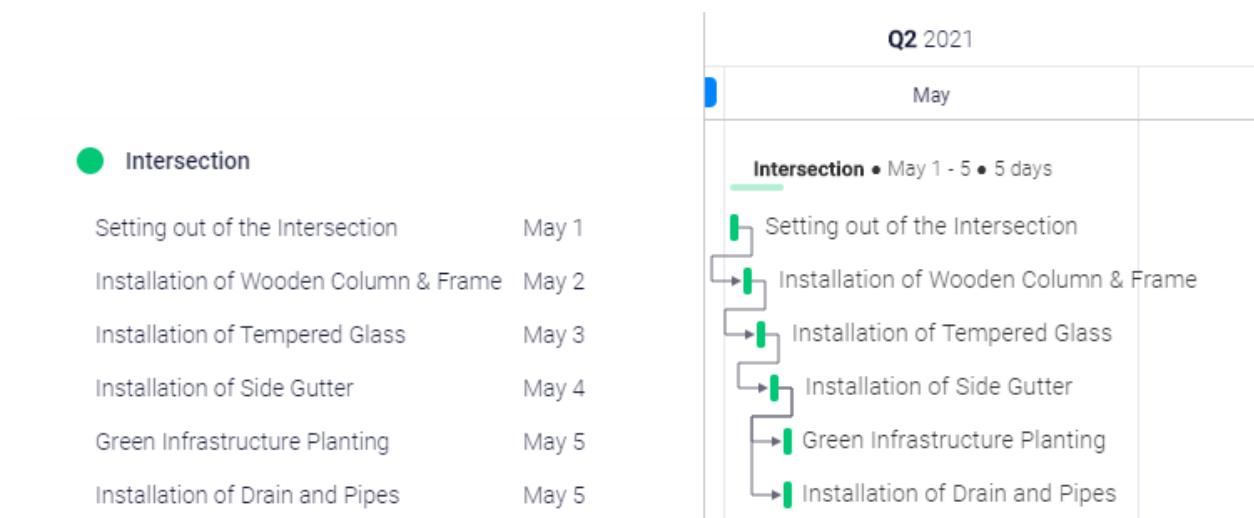


Figure 16. Intersection Construction Schedule

The duration of the roadway is the longest among the three. Starting with setting out, the part has 20 tasks and most of them take around a week. The total duration is 114 days.

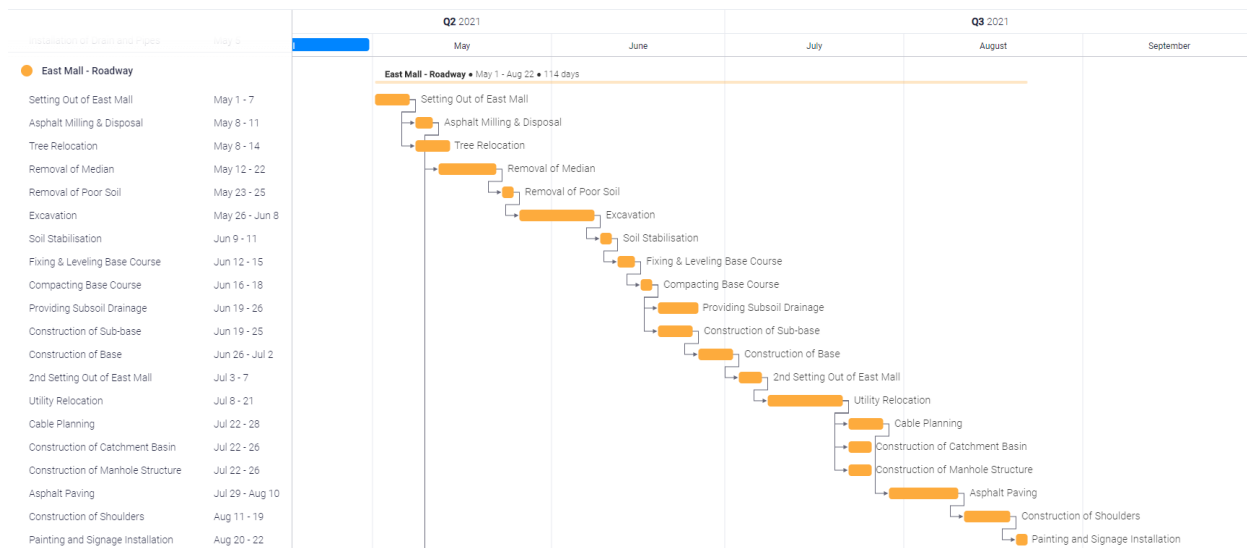


Figure 17. Roadway Construction Schedule

The construction of the sidewalk starts after the asphalt milling finishes, and ends when the planting completes. The total duration is 40 days.

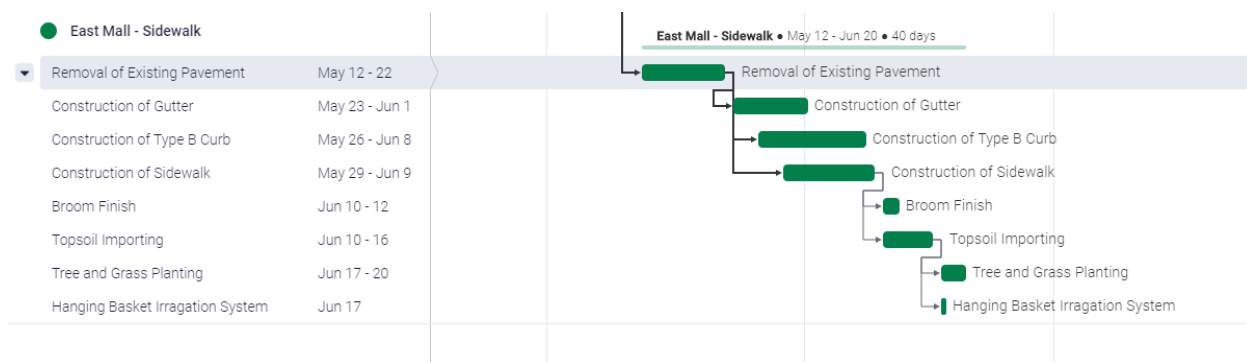


Figure 18. Sidewalk Construction Schedule

8.0 Maintenance Plan

The road maintenance plan of the East Mall redesign project could be split into 3 categories, namely, routine, periodic, and emergency (see, Table 11). The routine maintenance mainly focuses on the daily inspection of the pavement, gutter, sodding conditions, intersection canopy design, and drainage, etc. Moreover, the routine maintenance activities require both labour and equipment to provide works and adequate quality under cost-effective manners. The result of this maintenance will be reported weekly, and then analyzed for monthly periodic roadway and intersection maintenance. Whereas the emergency maintenance basically comprises works to restore the sections and related facilities to the normal operating conditions after damages.

Table 12. Typical Types of Maintenance

Type of Maintenance	Tasks of East Mall Redesign Section	Task of Intersection-Canopy Design Section
Routine	Clearing of pavement	Clearing and safety check of tempered glass
	Mowing and maintenance of plants	
	Repair of traffic signs and road markings	Green infrastructure check
	Shoulder grading	Paint cover of wooden frame check
	Pothole patching and crack sealing	
Repair of cut and fill slopes		
Periodic	Regraveling	Repairing the wooden frame
	Resealing/surface dressing	Repairing the tempered glass
	Overlay	Replantation of the green infrastructures
	Maintenance of traffic signs and road markings	Recoating the wooden frame
Emergency	Removal of debris or obstacles from natural causes	Site lockdown and structural analysis and safety check
	Repair of damage caused by traffic accidents	Wooden frame or tempered glass replacement

8.1 Road Maintenance Quality Control

The maintenance quality of the East Mall road section depends on the well-organized supervision. The supervising department of MHL is responsible for maintenance of road and road facilities for the East Mall redesigned section, implement the maintenance plan, and supervise the controlled quality of the progress. The maintenance costs should be reimbursed according to the actual implemented maintenance cost estimation. Besides, the government and

regulatory authorities of East Mall should carry out a policy of road improvement to reduce potential damage that could happen on the East Mall redesigned project.

8.2 Canopy Intersection Maintenance Quality Control

The main maintenance focuses of the intersection design are the canopy and green infrastructures. It requires the same well-organized supervision from the regulatory authorities and the MHL company. The maintenance plan shall include the daily routine check towards the wooden frame and glass cover of the canopy and the green infrastructures along the canopy. Also, the routine maintenance plan should be reported and analyzed for the periodic maintenance of the design, like repairing of the wooden frame, replantation of the green infrastructures, and recoating of the frame structures. As for emergency cases, the intersection shall be locked down for safety reasons, and apply maintenance plans corresponding to the site situation.

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Appendix A - IFC Drawing Package



THE UNIVERSITY OF BRITISH COLUMBIA

CLIENT: THE UNIVERSITY OF BRITISH COLUMBIA
2329 West Mall
Vancouver, BC Canada V6T 1Z4

PROJECT: UBC EAST MALL REDESIGN

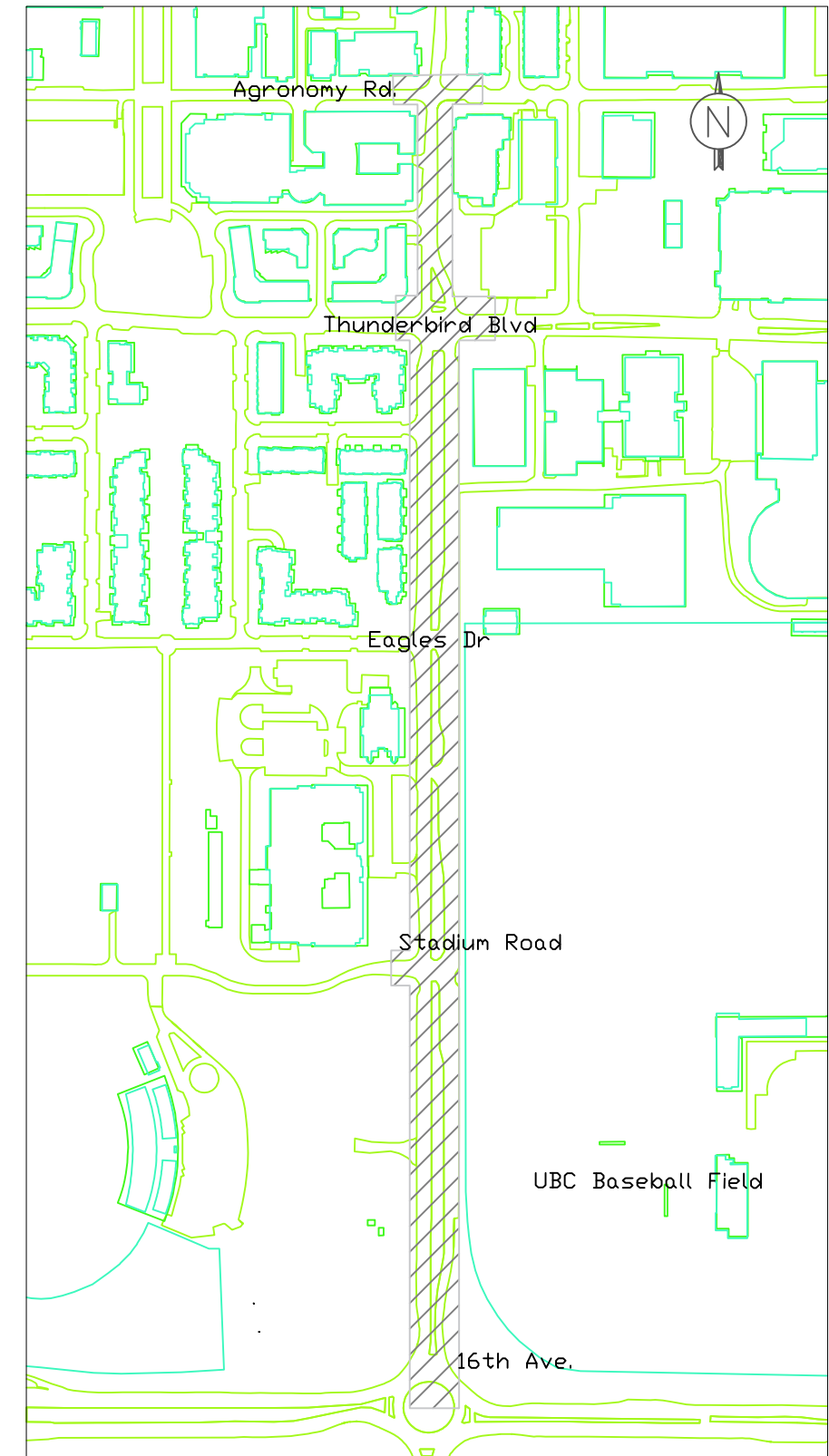
MLH CONSULTANTS

ENGINEERING DESIGN AND PLANNING SERVICES

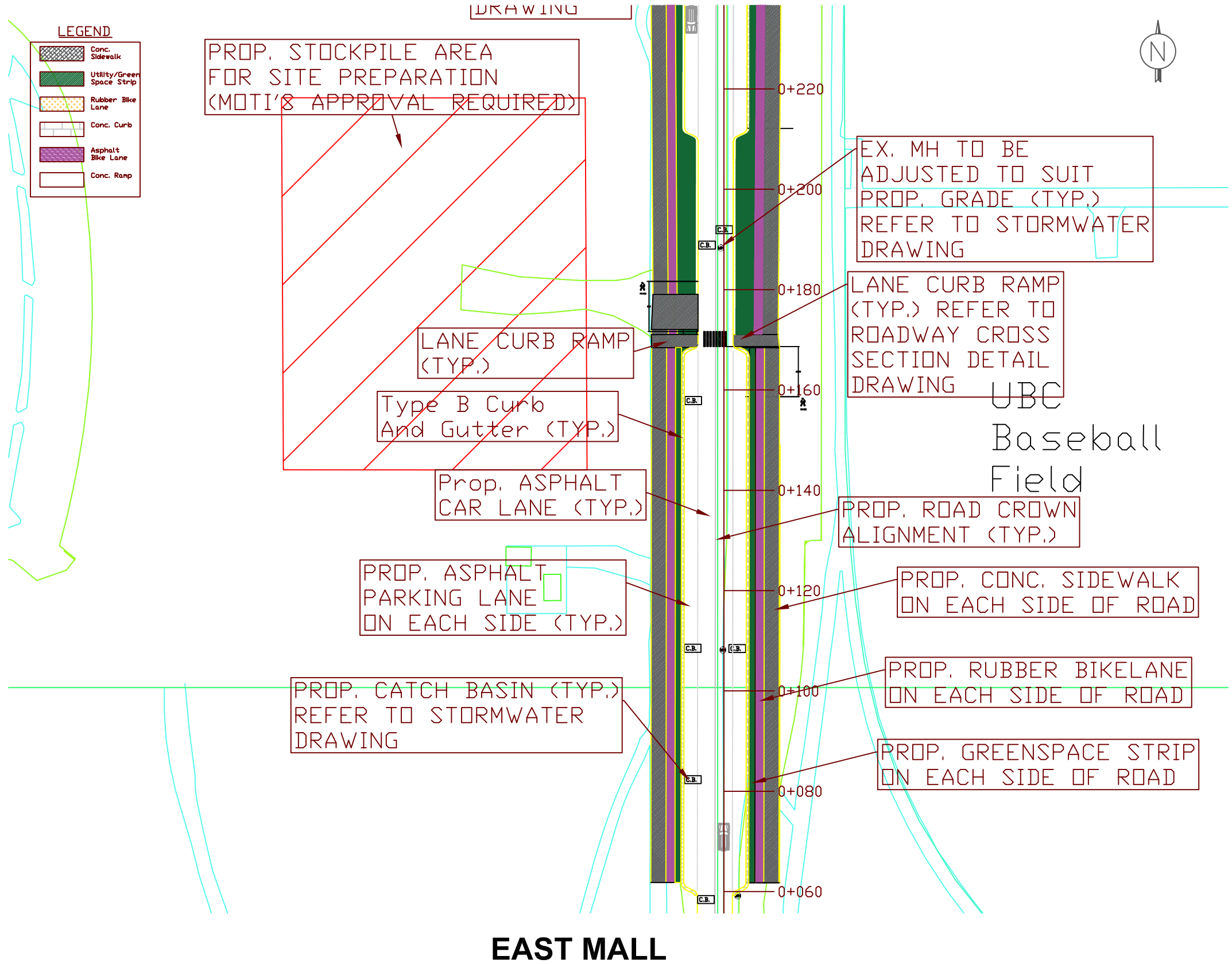
2002 - 6250 Applied Science Lane, Vancouver, BC, Canada V6T 1Z4

Tel: (778) 929-3521, Email: general@MLH.com

DRAWING INDEX		
DRAWING NO.	DRAWING TYPE	DESCRIPTION
RW-01	ROADWORK	STA. 0+060 TO STA. 0+220
RW-02	ROADWORK	STA. 0+220 TO STA. 0+380
RW-03	ROADWORK	STA. 0+380 TO STA. 0+540
RW-04	ROADWORK	STA. 0+540 TO STA. 0+700
RW-05	ROADWORK	STA. 0+700 TO STA. 0+860
RW-06	ROADWORK	STA. 0+860 TO STA. 0+920
IS-01	INTERSECTION	STADIUM RD AND EAST MALL INTERSECTION
IS-02	INTERSECTION	EAGLE DR AND EAST MALL INTERSECTION
IS-03	INTERSECTION	THUNDERBIRD BLVD AND EAST MALL INTERSECTION
CS-01	CROSS SECTION	16TH AVE. TO STADIUM RD
CS-02	CROSS SECTION	STADIUM RD. TO EAGLE DR
CS-03	CROSS SECTION	EAGLE DR. TO THUNDERBIRD BLVD PART 1
CS-04	CROSS SECTION	EAGLE DR. TO THUNDERBIRD BLVD PART 2
CS-05	CROSS SECTION	THUNDERBIRD BLVD TO AGRONOMY RD PART 1
CS-06	CROSS SECTION	THUNDERBIRD BLVD TO AGRONOMY RD PART 2
CAN-01	STRUCTURE	WESTBOUND CANOPY SECTION VIEW
CAN-02	STRUCTURE	EASTBOUND CANOPY SECTION VIEW
CAN-03	STRUCTURE	CANOPY ELEVATION VIEW
CAN-04	STRUCTURE	COLUMN DETAIL
CAN-05	STRUCTURE	COLUMN DETAIL
SW-01	STORM DRAINAGE	STANDARD CATCH BASIN CROSS SECTION VIEW
SW-02	STORM DRAINAGE	MANHOLE STRUCTURE CROSS SECTION VIEW



SITE LOCATION PLAN
scale: 1:1000



PROP. STOCKPILE AREA FOR SITE PREPARATION (MOTI'S APPROVAL REQUIRED)

EX. MH TO BE ADJUSTED TO SUIT PROP. GRADE (TYP.) REFER TO STORMWATER DRAWING

LANE CURB RAMP (TYP.) REFER TO ROADWAY CROSS SECTION DETAIL DRAWING

LANE CURB RAMP (TYP.)

Type B Curb And Gutter (TYP.)

Prop. ASPHALT CAR LANE (TYP.)

PROP. ROAD CROWN ALIGNMENT (TYP.)

PROP. ASPHALT PARKING LANE ON EACH SIDE (TYP.)

PROP. CONC. SIDEWALK ON EACH SIDE OF ROAD

PROP. CATCH BASIN (TYP.) REFER TO STORMWATER DRAWING

PROP. RUBBER BIKE LANE ON EACH SIDE OF ROAD

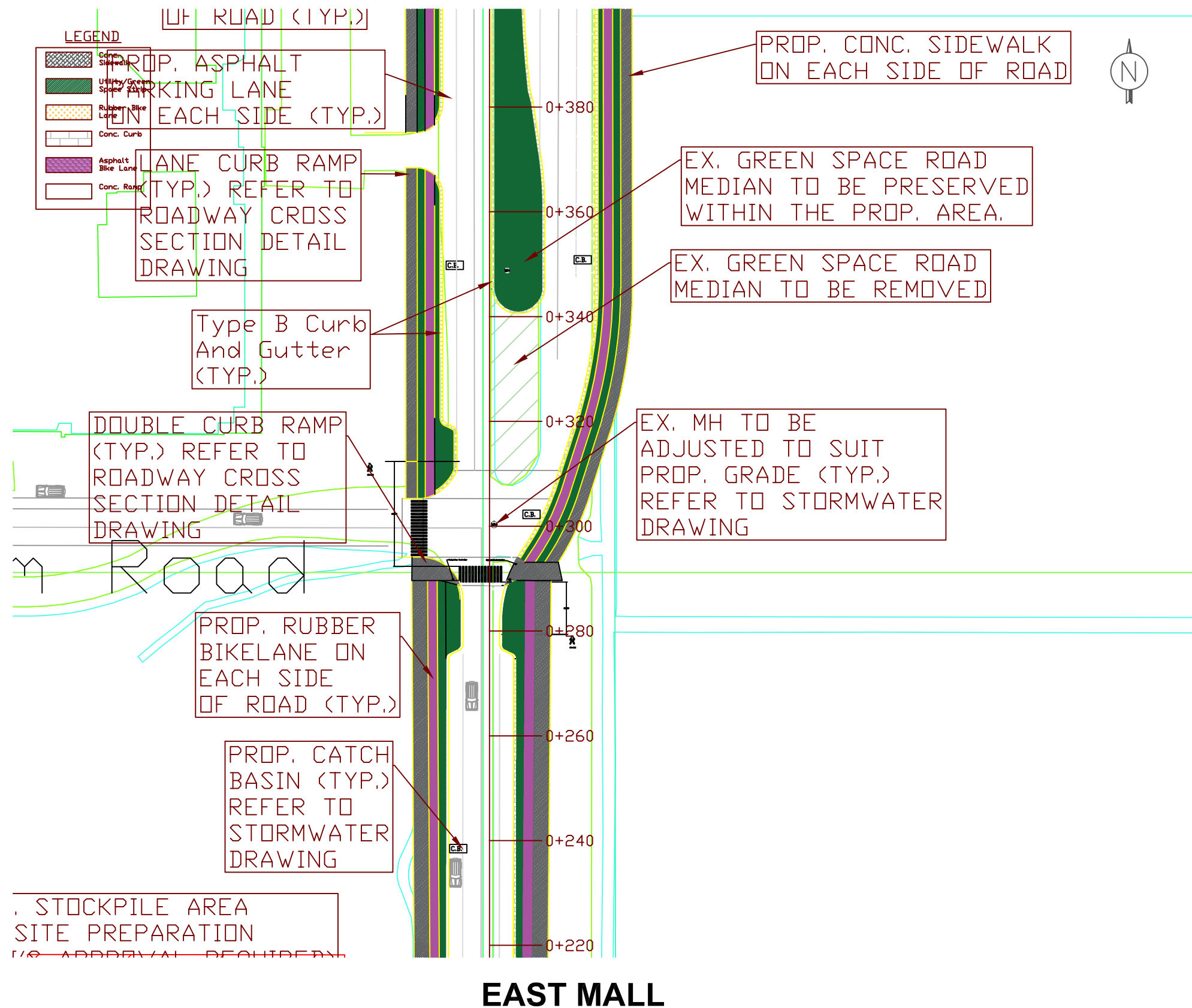
PROP. GREENSPACE STRIP ON EACH SIDE OF ROAD

- NOTE:**
1. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED ROADWAY PAVING PLAN.
 2. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED LANE CURB RAMP DESIGN.
 3. REFER TO TRAFFIC MANAGEMENT DRAWING FOR PROPOSED ARRANGEMENT OF ROADWAY PAVEMENT MARKING, SIGNAGE AND SIGNALS.
 4. REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCHBASIN, SOURCE CONTROL PLAN.

UBC
Baseball
Field

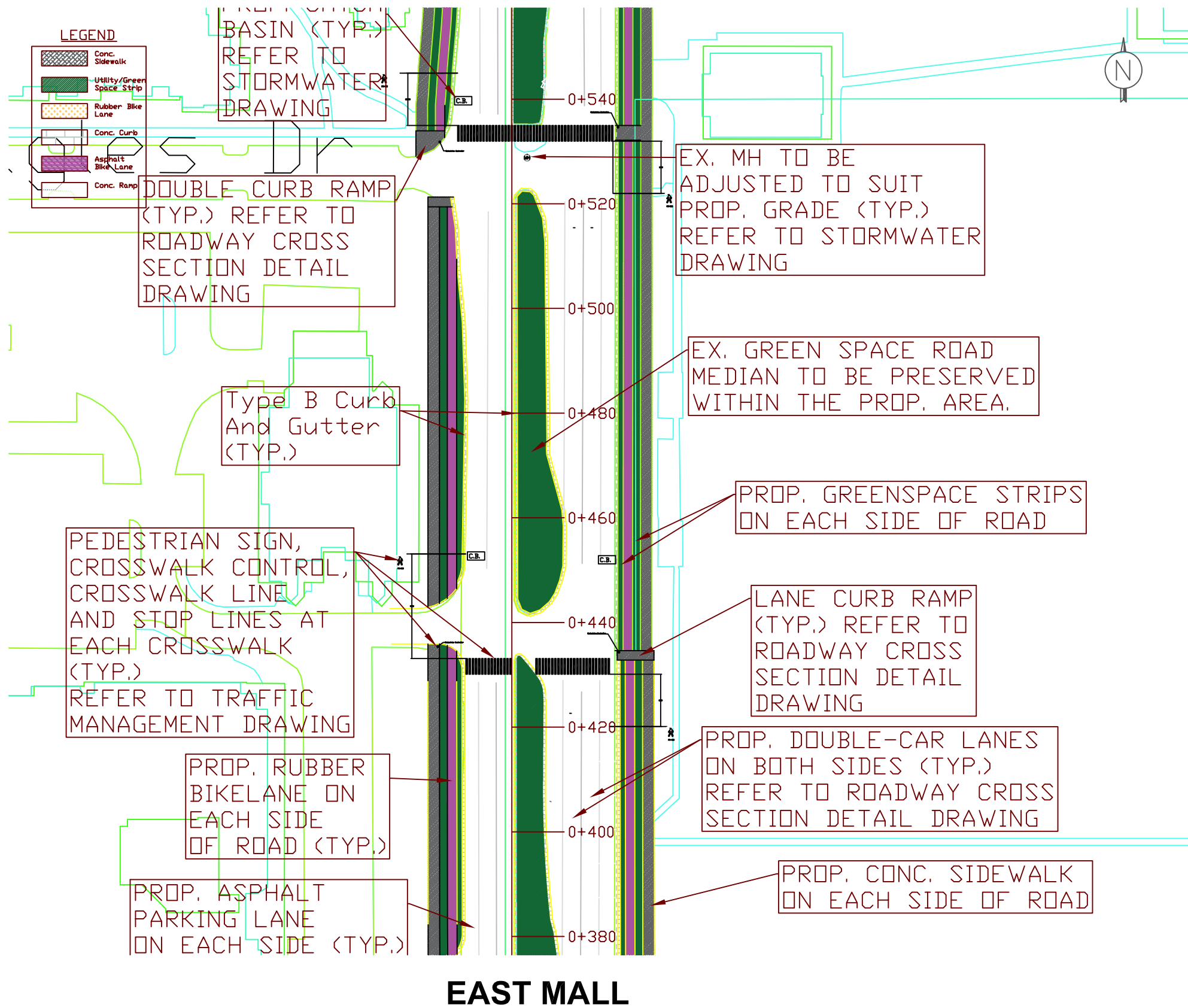
EAST MALL

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY PLAN STA 0+060 to STA 0+220	DESIGNED LW	DRAWING TYPE ROADWORK	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		DRAWING NUMBER RW-01
CONSULTANT MLH Consultants Ltd.		REVIEWED HW		



- NOTE:**
- REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED ROADWAY PAVING PLAN.
 - REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED DOUBLE CURB RAMP AND LANE CURB RAMP DESIGN.
 - REFER TO TRAFFIC MANAGEMENT DRAWING FOR PROPOSED ARRANGEMENT OF ROADWAY PAVEMENT MARKING, SIGNAGE AND SIGNALS.
 - REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCH BASIN, SOURCE CONTROL PLAN.
 - DESIGNED ROADWAY SHALL TIE IN WITH THE EXISTING INFRASTRUCTURES AT THE ROAD INTERSECTION.
 - PROPOSED REMOVAL AREA OF EXISTING GREEN SPACE ROAD MEDIAN SHALL BE REPLACED BY ASPHALT PAVEMENT AND TIED IN WITH THE DESIGNED CAR LANES.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY PLAN STA 0+220 to STA 0+380	DESIGNED LW	DRAWING TYPE ROADWORK	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		SEAL
CONSULTANT MLH Consultants Ltd.		REVIEWED HW	DRAWING NUMBER RW-02	



- NOTE:**
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 2. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED DOUBLE CURB RAMP AND LANE CURB RAMP DESIGN.
 3. REFER TO TRAFFIC MANAGEMENT DRAWING FOR PROPOSED ARRANGEMENT OF ROADWAY PAVEMENT MARKING, SIGNAGE AND SIGNALS.
 4. REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCH BASIN, SOURCE CONTROL PLAN.
 5. DESIGNED ROADWAY SHALL TIE IN WITH THE EXISTING INFRASTRUCTURES AT THE ROAD INTERSECTION.

CLIENT
UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

CONSULTANT
MLH Consultants Ltd.

TITLE
UBC EAST MALL REDESIGN ROADWAY PLAN
STA 0+380 to STA 0+540

DESIGNED
LW

DRAFTED
YQ

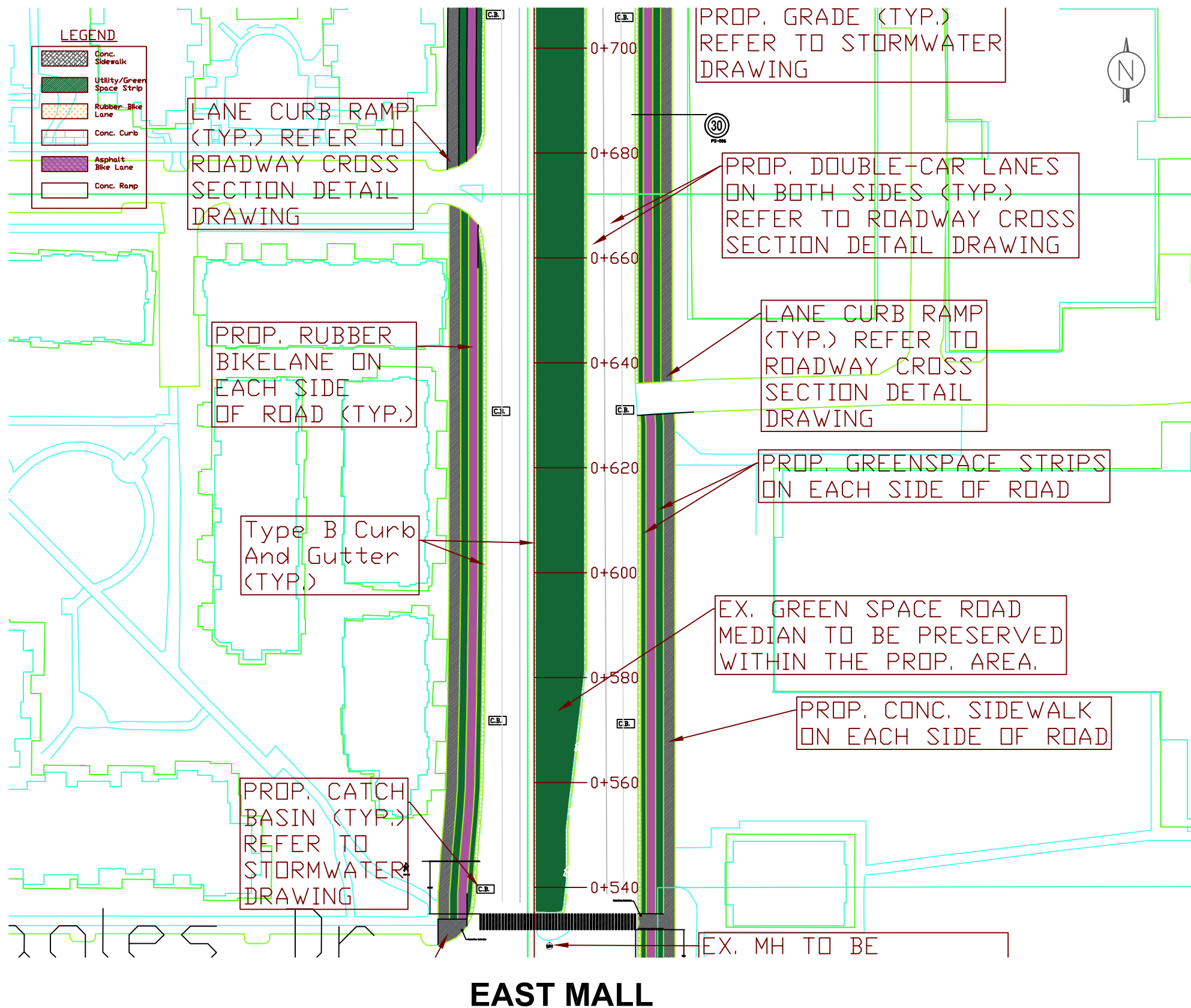
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HW

DRAWING TYPE
ROADWORK

DRAWING NUMBER
RW-03

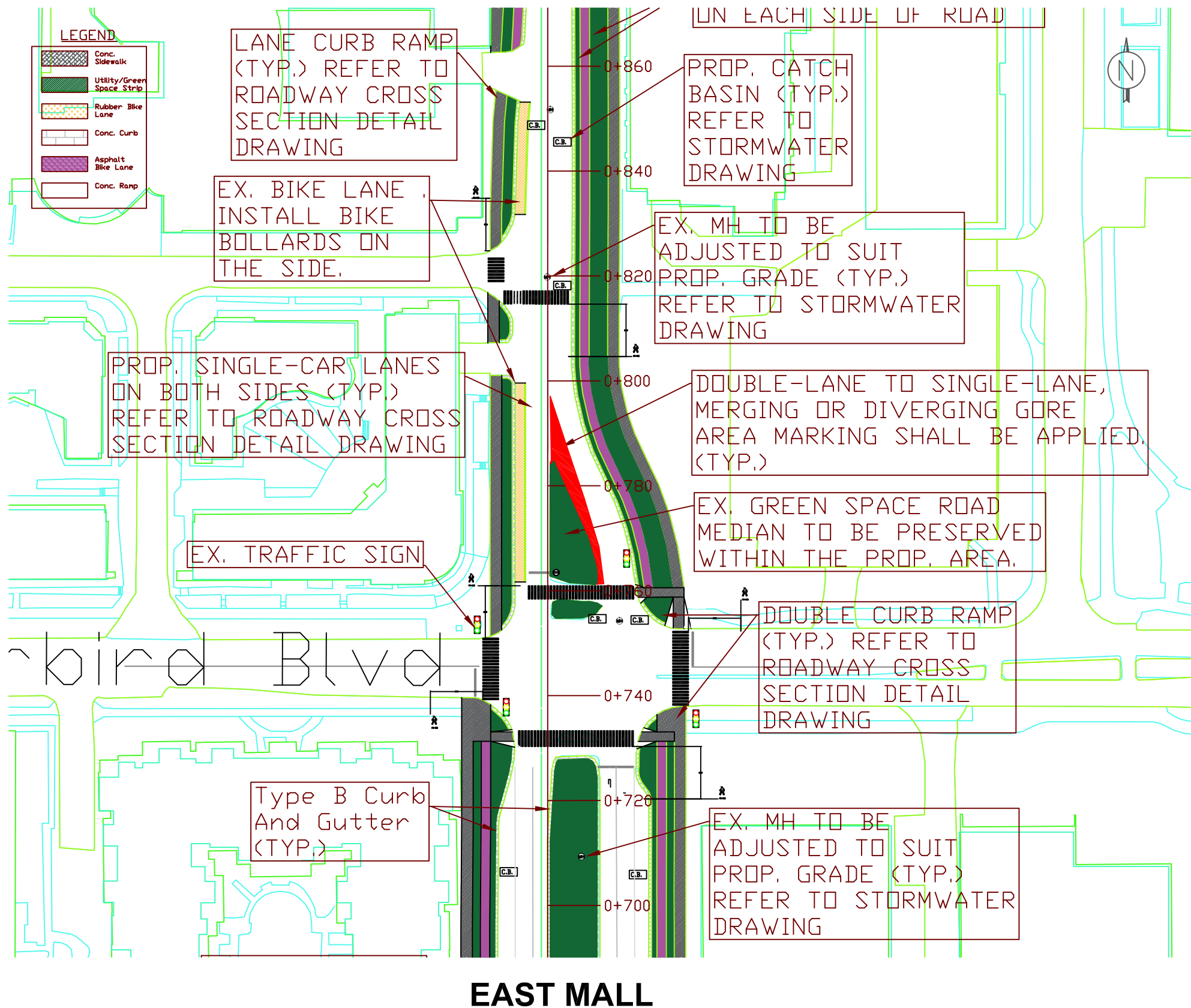
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2021.04.15

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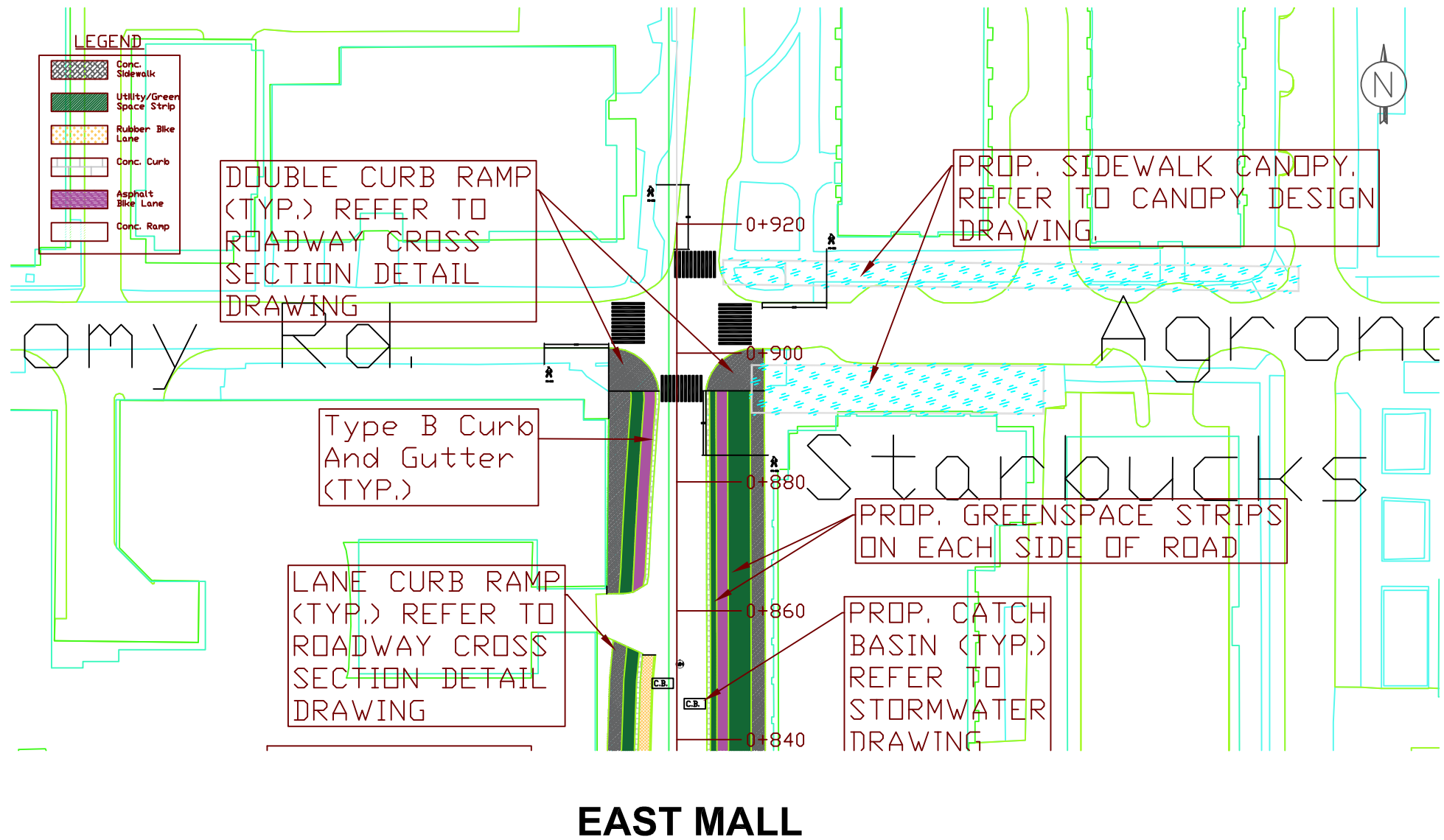
- NOTE:**
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 2. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED DOUBLE CURB RAMP AND LANE CURB RAMP DESIGN.
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 4. REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCH BASIN, SOURCE CONTROL PLAN.
 5. DESIGNED ROADWAY SHALL TIE IN WITH THE EXISTING INFRASTRUCTURES AT THE ROAD INTERSECTION.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY PLAN STA 0+540 to STA 0+700	DESIGNED LW	DRAWING TYPE ROADWORK	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		SEAL
CONSULTANT MLH Consultants Ltd.		REVIEWED HW	DRAWING NUMBER RW-04	



- NOTE:**
- REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED ROADWAY PAVING PLAN.
 - REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED DOUBLE CURB RAMP AND LANE CURB RAMP DESIGN.
 - REFER TO TRAFFIC MANAGEMENT DRAWING FOR PROPOSED ARRANGEMENT OF ROADWAY PAVEMENT MARKING, SIGNAGE AND SIGNALS.
 - REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCH BASIN, SOURCE CONTROL PLAN.
 - DESIGNED ROADWAY SHALL TIE IN WITH THE EXISTING INFRASTRUCTURES AT THE ROAD INTERSECTION.
 - TIE IN THE PROPOSED RUBBER BIKE LANE WITH THE EXISTING BIKE LANE FROM STA. 0+830. BIKE BOLLARDS SHALL BE INSTALLED ALONG THE EXISTING BIKE LANE

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY PLAN STA 0+700 to STA 0+860	DESIGNED LW	DRAWING TYPE ROADWORK	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		SEAL
CONSULTANT MLH Consultants Ltd.		REVIEWED HW	DRAWING NUMBER RW-05	









NOTE:

1. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED ROADWAY PAVING PLAN.
2. REFER TO CROSS SECTION DETAIL DRAWING FOR PROPOSED DOUBLE CURB RAMP AND LANE CURB RAMP DESIGN.
3. REFER TO TRAFFIC MANAGEMENT DRAWING FOR PROPOSED ARRANGEMENT OF ROADWAY PAVEMENT MARKING, SIGNAGE AND SIGNALS.
4. REFER TO STORMWATER DRAWING FOR PROPOSED MANHOLE, CATCH BASIN, SOURCE CONTROL PLAN.
5. DESIGNED ROADWAY SHALL TIE IN WITH THE EXISTING INFRASTRUCTURES AT THE ROAD INTERSECTION.
6. TIE IN THE PROPOSED RUBBER BIKE LANE WITH THE EXISTING BIKE LANE FROM STA. 0+830. BIKE BOLLARDS SHALL BE INSTALLED ALONG THE EXISTING BIKE LANE

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY PLAN STA 0+860 to STA 0+920	DESIGNED LW	DRAWING TYPE ROADWORK	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		SEAL
CONSULTANT MLH Consultants Ltd.		REVIEWED HW	DRAWING NUMBER RW-06	

LEGEND

	Conc. Sidewalk
	Utility/Green Space Strip
	Rubber Blue Lane
	Conc. Curb
	Asphalt Blue Lane
	Conc. Ramp

 Pedestrian Crossing Sign

Pedestrian Crossing

Pedestrian Controller

Top of Drop

Bottom of Drop

C.B.

MH

Client:
UBC Social Ecological Economic
Development
Studies (SEEDS) Sustainability
Program

Title:
UBC EAST MALL REDESIGN
ROADWAY INTERSECTION PLAN

Drawn By:
YQ

Drawing Type:
INTERSECTION

Date:
2021.04.16

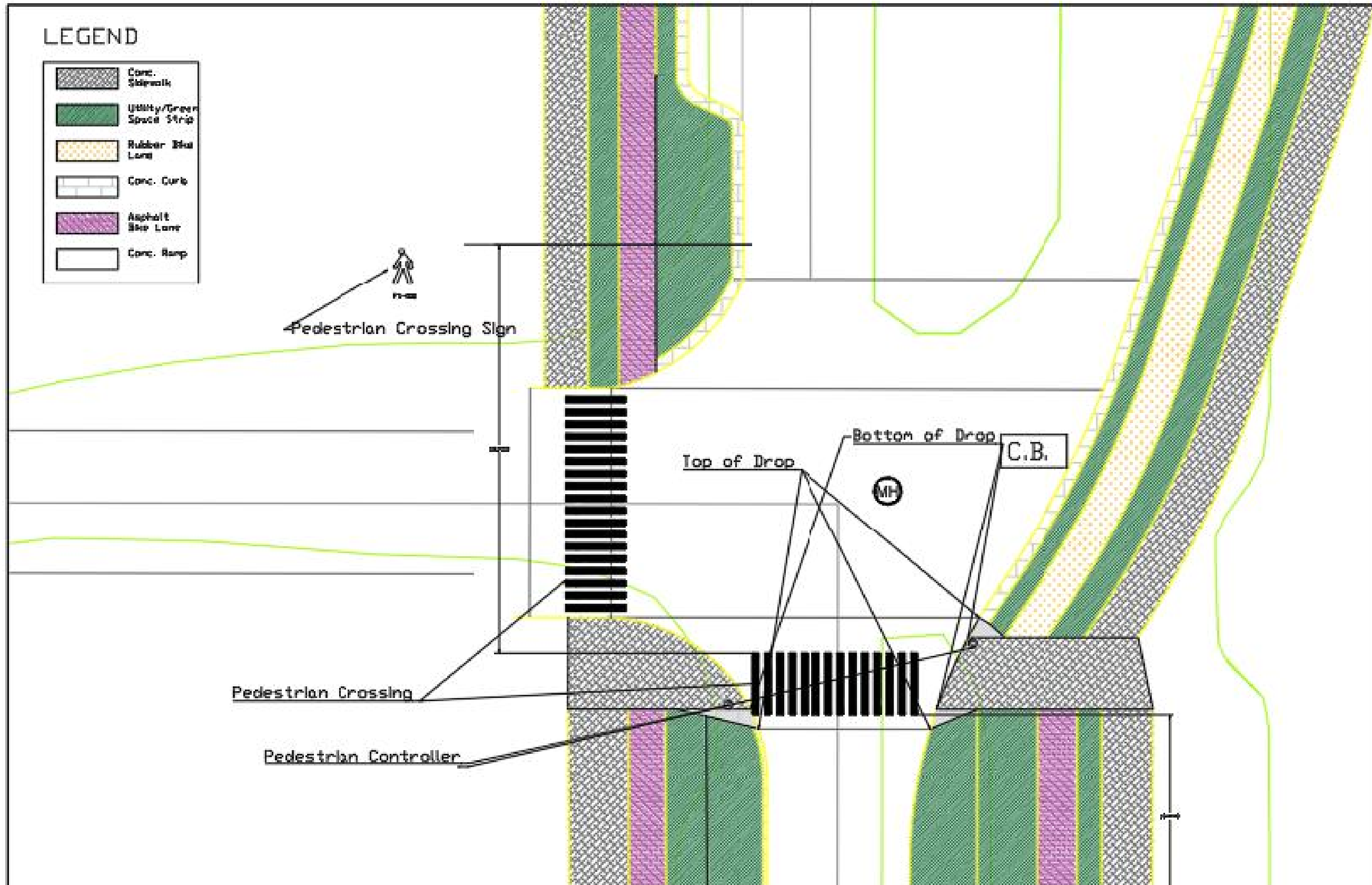
Reviewed By:
YQ

Drawing number:
IS-01







Title:
MLH Consultants
Ltd.

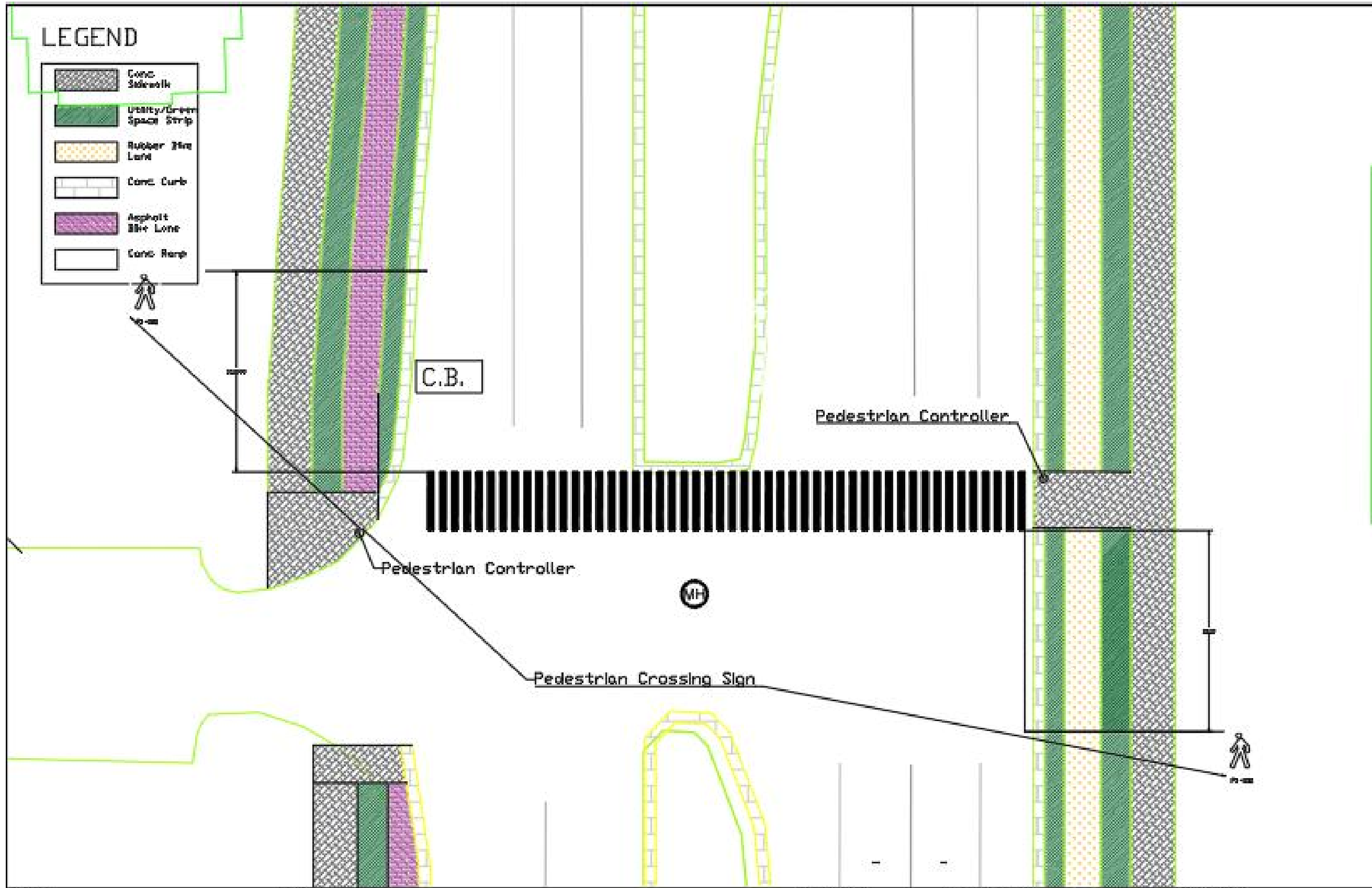
Title:
Stadium Road and East Mall
Intersection

Designed By:
LW



LEGEND

-  Conc. Sidewalk
-  Utility/Green Space Strip
-  Rubber Tire Lane
-  Conc. Curb
-  Asphalt Bike Lane
-  Conc. Ramp



Client:
 UBC Social Ecological Economic
 Development
 Studies (SEEDS) Sustainability
 Program

Title:
 UBC EAST MALL REDESIGN
 ROADWAY INTERSECTION PLAN

Drawn By:
 YQ

Drawing Type:
 INTERSECTION

Date:
 2021.04.16

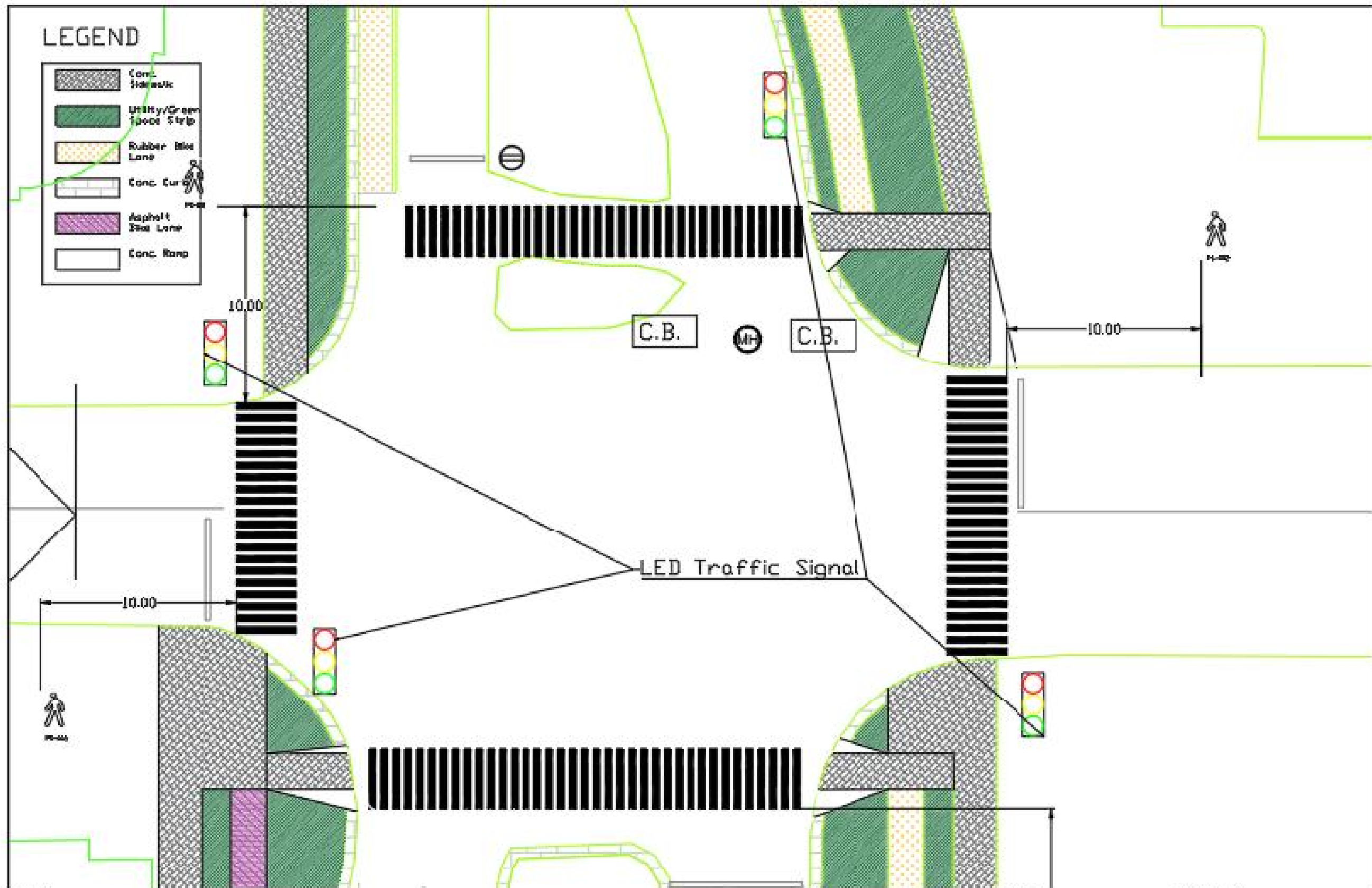
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 MLH Consultants
 Ltd.

Title:
 Eagle Drive and East Mall
 Intersection

Reviewed By:
 YQ

Drawing number:
 IS-02

Designed By:
 LW



Client:
 UBC Social Ecological Economic
 Development
 Studies (SEEDS) Sustainability
 Program

Title:
 MLH Consultants
 Ltd.

Title:
 UBC EAST MALL REDESIGN
 ROADWAY INTERSECTION PLAN

Thunderbird Blvd and East Mall
 Intersection

Drawn By:
 YQ

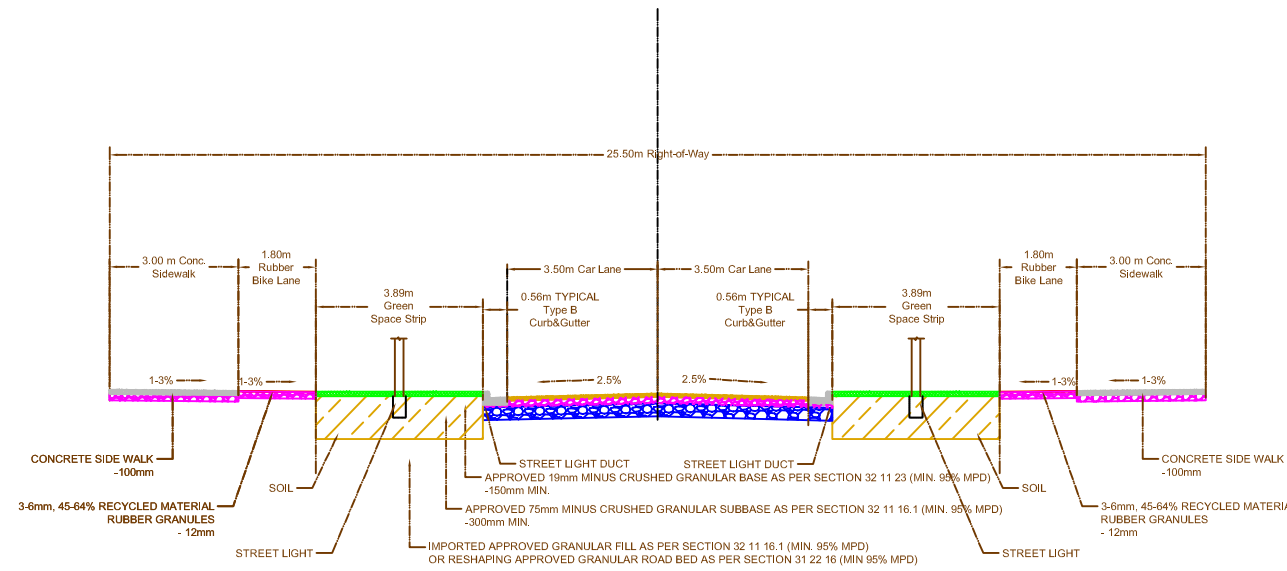
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Designed By:
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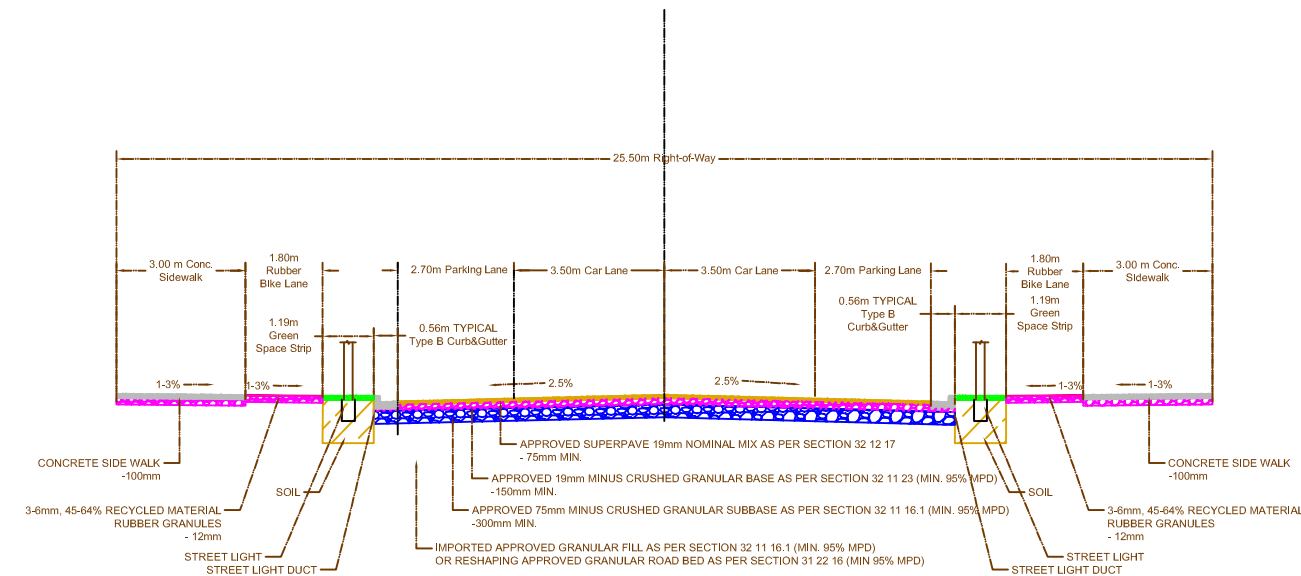
Drawing Type:
 INTERSECTION

Drawing number:
 IS-03

Date:
 2021.04.16



TYPICAL SECTION VIEW - 16th AVE. TO STADIUM ROAD
Sta.1 - Sta.167.1 & Sta. 211 - Sta. 275

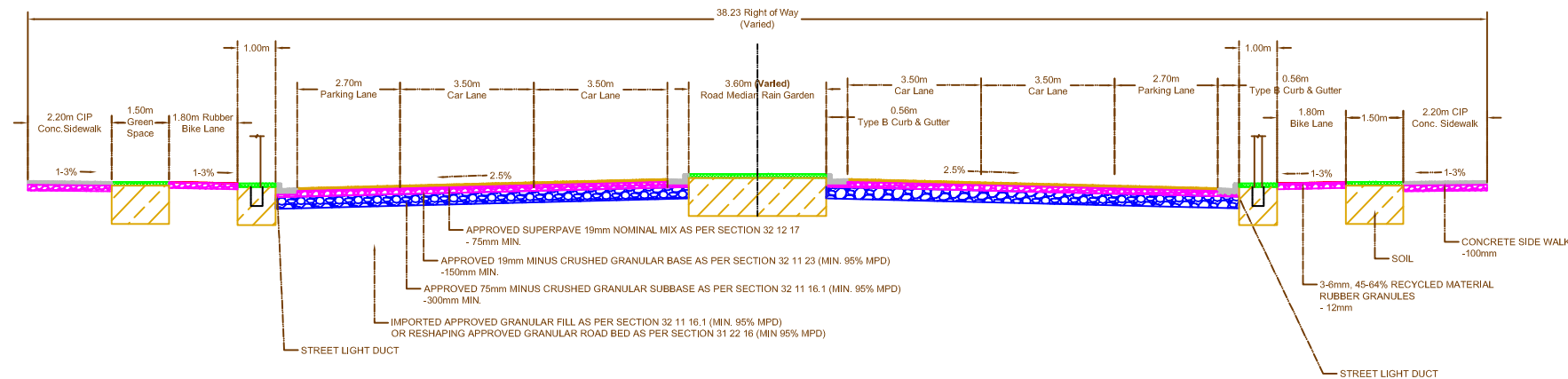


TYPICAL SECTION VIEW - 16th AVE. TO STADIUM ROAD
Sta.1 - Sta.167.1 & Sta. 211 - Sta. 275

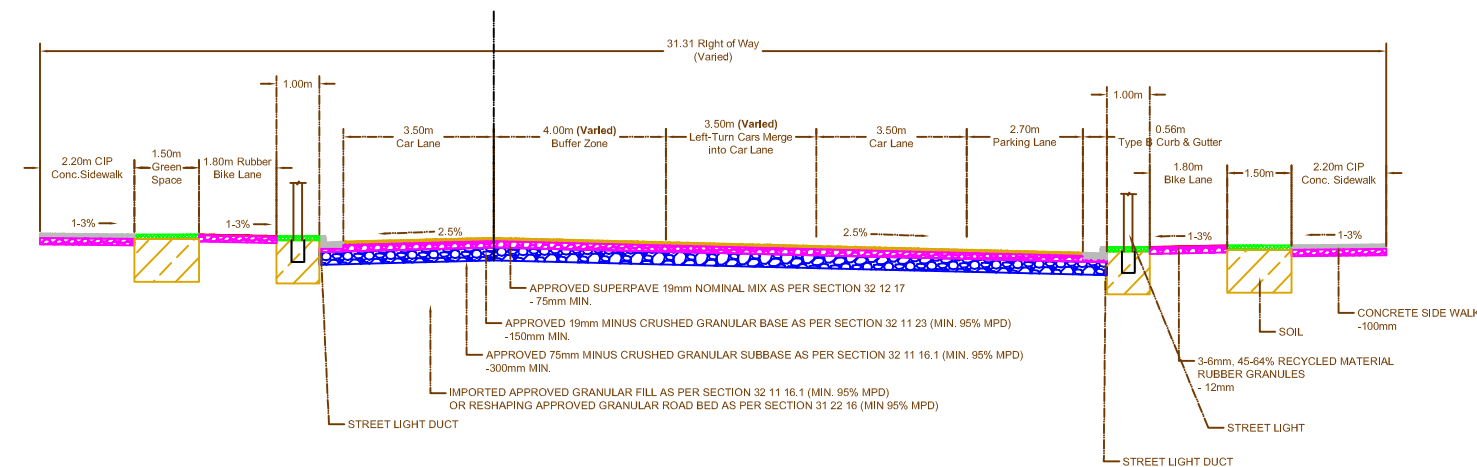
TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
-75mm MIN.
2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
4. IMPORTED APPROVED GRANULAR FILL AS PER SECTION 32 11 16.1 (MIN 95% MPD) OR RESHAPING APPROVED GRANULAR ROAD BED AS PER SECTION 31 22 16 (MIN 95% MPD)
5. TYPE B CURB & GUTTER (TYP.)
6. 32 MPa CONCRETE SIDEWALK PAVEMENT
- 100mmMIN.
7. PROP. STREET/PEDESTRIAN LIGHTS RELOCATION.
8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL 16TH AVENUE TO STADIUM ROAD TYPICAL CROSS SECTION	DESIGNED LW	DRAWING TYPE CROSS SECTIONS	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		DRAWING NUMBER CS-01
CONSULTANT MLH Consultants Ltd.		REVIEWED HW		



TYPICAL SECTION VIEW - STADIUM ROAD to Eagle Drive
Sta. 345 - Sta. 429 & Sta. 450 - Sta. 461

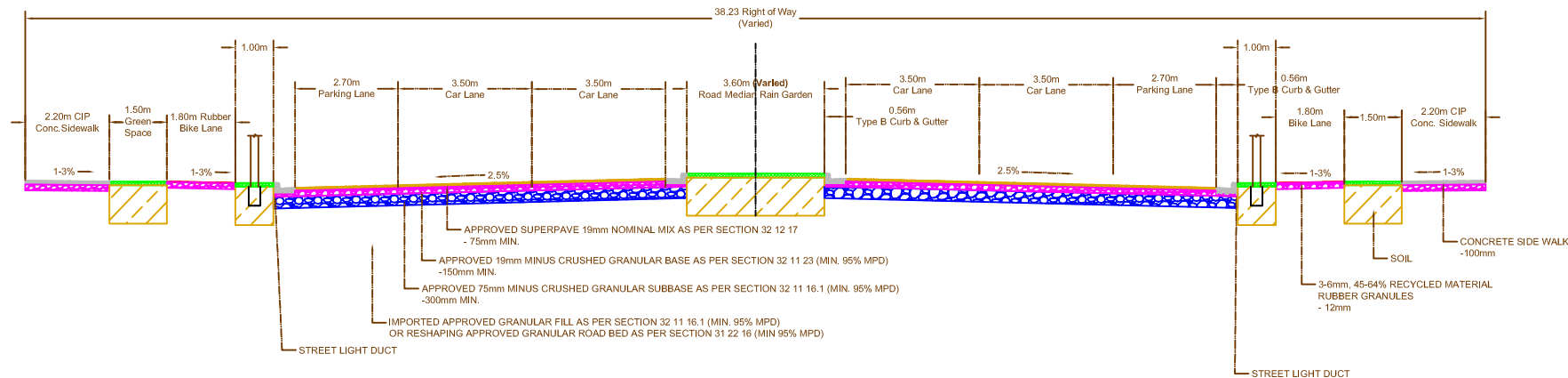


TYPICAL SECTION VIEW - STADIUM ROAD to Eagle Drive
Sta. 310 - Sta. 318

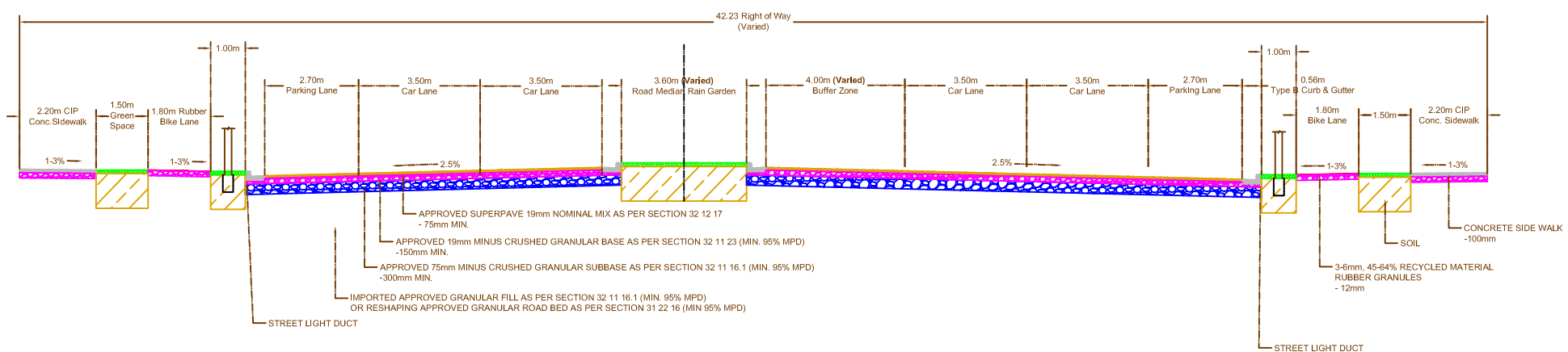
TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
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2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
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- 100mmMIN.
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8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL STADIUM ROAD TO EAGLE DRIVE TYPICAL CROSS SECTION	DESIGNED LW	DRAWING TYPE CROSS SECTIONS	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		DRAWING NUMBER CS-02
CONSULTANT MLH Consultants Ltd.		REVIEWED HW		



TYPICAL SECTION VIEW - Eagle Drive to Thunderbird Rd
Sta. 580 - Sta. 720



TYPICAL SECTION VIEW - Eagle Drive to Thunderbird Rd
Sta. 535 - Sta. 580

TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
-75mm MIN.
2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
4. IMPORTED APPROVED GRANULAR FILL AS PER SECTION 32 11 16.1 (MIN 95% MPD) OR RESHAPING APPROVED GRANULAR ROAD BED AS PER SECTION 31 22 16 (MIN 95% MPD)
5. TYPE B CURB & GUTTER (TYP.)
6. 32 MPa CONCRETE SIDEWALK PAVEMENT
- 100mmMIN.
7. PROP. STREET/PEDESTRIAN LIGHTS RELOCATION.
8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

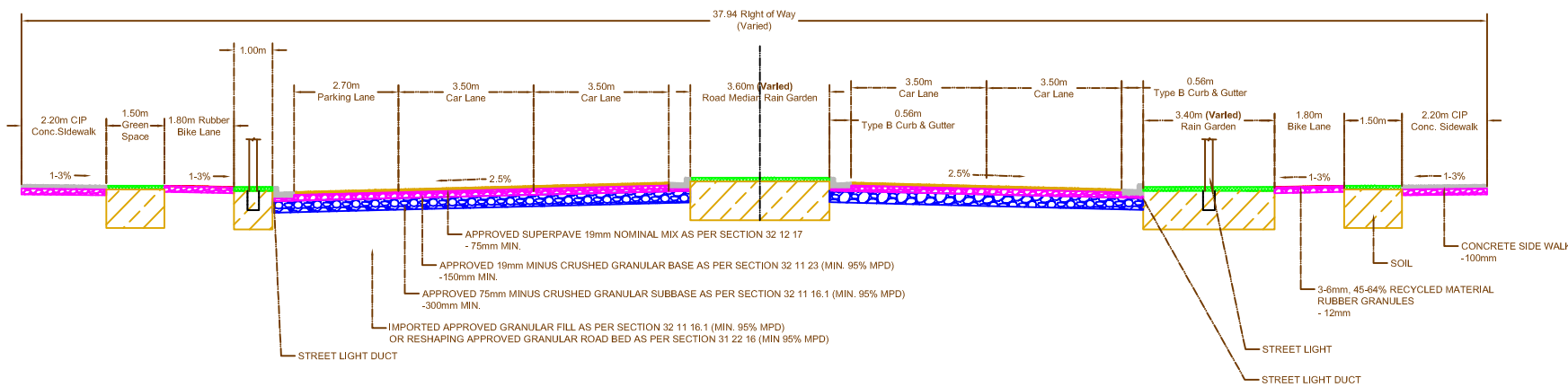
CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program
CONSULTANT MLH Consultants Ltd.

TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL EAGLE DRIVE TO THUNDERBIRD BLVD TYPICAL CROSS SECTION PART 1
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DESIGNED LW
DRAFTED YQ
REVIEWED HW

DRAWING TYPE CROSS SECTIONS
DRAWING NUMBER CS-03

DATE (YYYY.MM.DD) 2021.04.15
SEAL

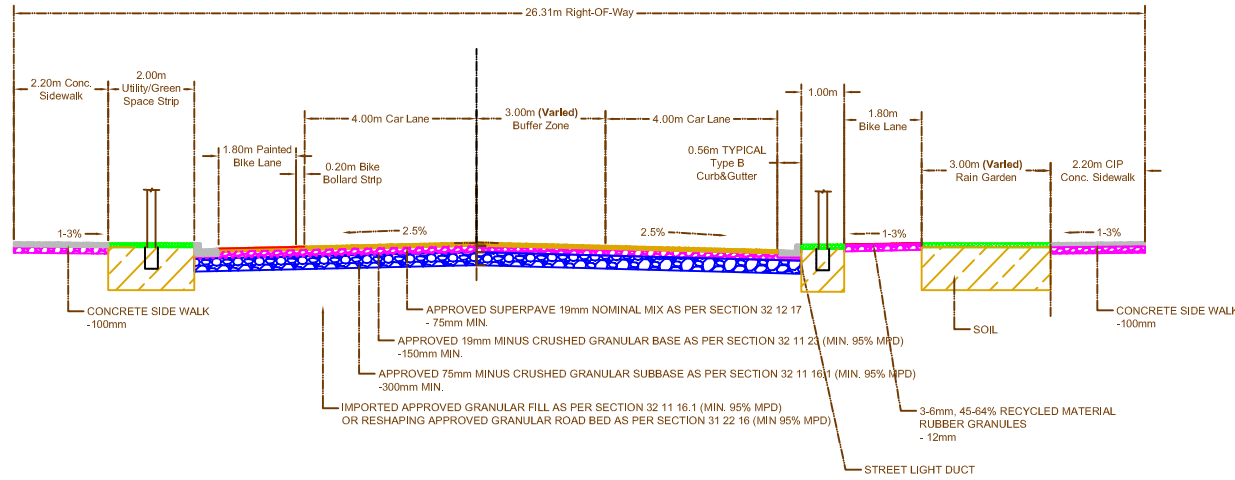


TYPICAL SECTION VIEW - Eagle Drive to Thunderbird Rd
Sta. 720 - Sta. 736

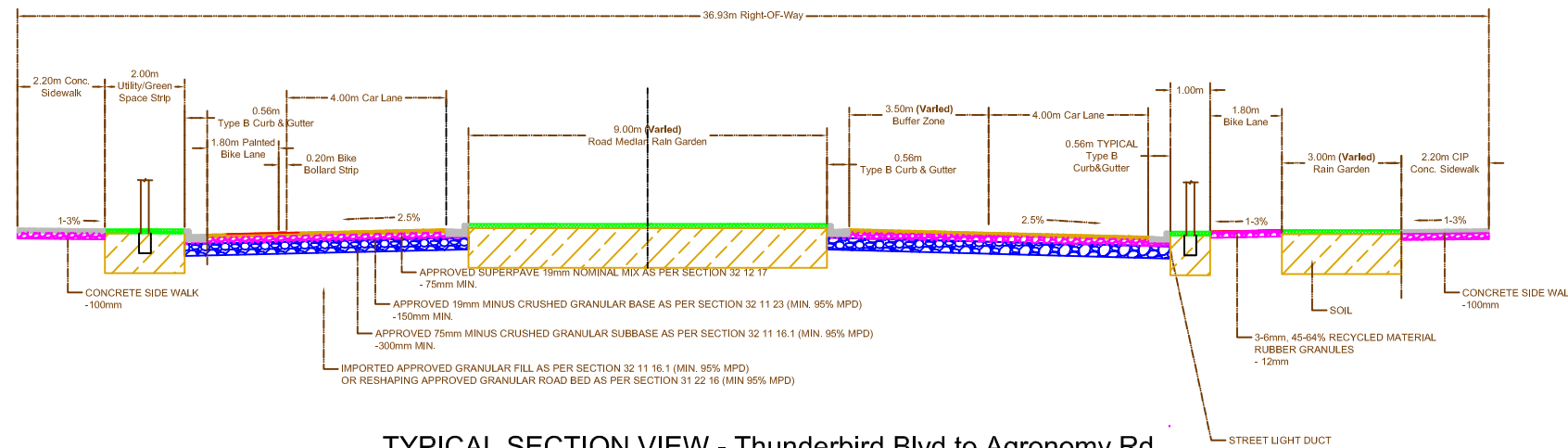
TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
-75mm MIN.
2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
4. IMPORTED APPROVED GRANULAR FILL AS PER SECTION 32 11 16.1 (MIN 95% MPD) OR RESHAPING APPROVED GRANULAR ROAD BED AS PER SECTION 31 22 16 (MIN 95% MPD)
5. TYPE B CURB & GUTTER (TYP.)
6. 32 MPa CONCRETE SIDEWALK PAVEMENT
- 100mmMIN.
7. PROP. STREET/PEDESTRIAN LIGHTS RELOCATION.
8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL EAGLE DRIVE TO THUNDERBIRD BLVD TYPICAL CROSS SECTION PART 2	DESIGNED LW	DRAWING TYPE CROSS SECTIONS	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ	DRAWING NUMBER CS-04	SEAL
CONSULTANT MLH Consultants Ltd.		REVIEWED HW		



TYPICAL SECTION VIEW - Thunderbird Blvd to Agronomy Rd
Sta. 784 - Sta. 810



TYPICAL SECTION VIEW - Thunderbird Blvd to Agronomy Rd
Sta. 754 - Sta. 784

TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
-75mm MIN.
2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
4. IMPORTED APPROVED GRANULAR FILL AS PER SECTION 32 11 16.1 (MIN 95% MPD) OR RESHAPING APPROVED GRANULAR ROAD BED AS PER SECTION 31 22 16 (MIN 95% MPD)
5. TYPE B CURB & GUTTER (TYP.)
6. 32 MPa CONCRETE SIDEWALK PAVEMENT
- 100mmMIN.
7. PROP. STREET/PEDESTRIAN LIGHTS RELOCATION.
8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

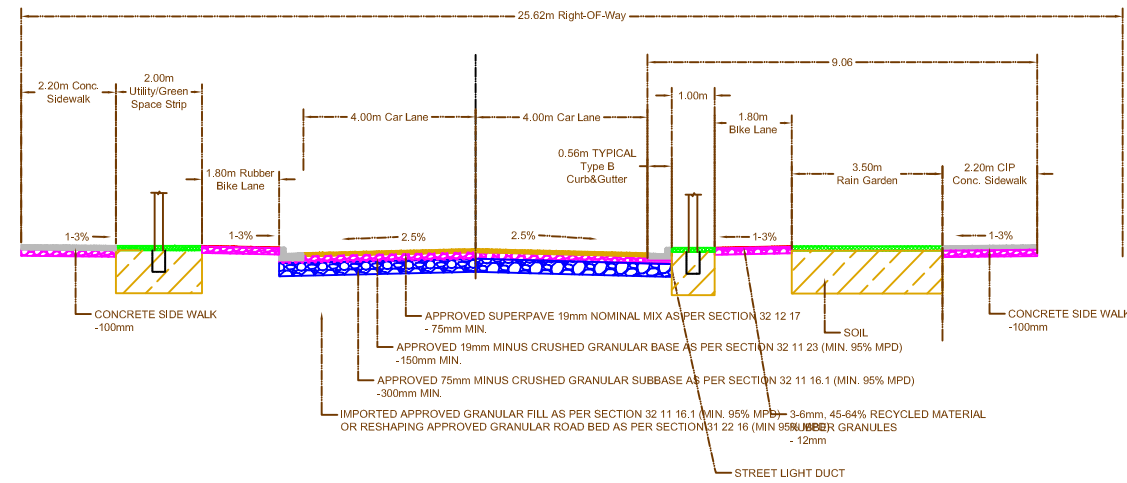
CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program
CONSULTANT MLH Consultants Ltd.

TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL THUNDERBIRD BLVD TO AGRONOMY ROAD TYPICAL CROSS SECTION PART 1
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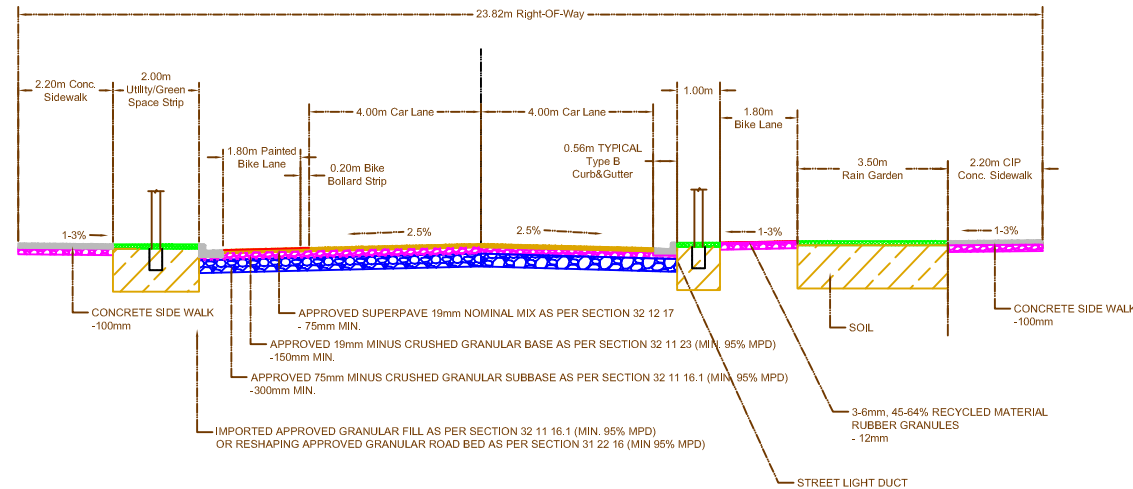
DESIGNED LW
DRAFTED YQ
REVIEWED HW

DRAWING TYPE CROSS SECTIONS
DRAWING NUMBER CS-05

DATE (YYYY.MM.DD) 2021.04.15
SEAL



TYPICAL SECTION VIEW - Thunderbird Blvd to Agronomy Rd
Sta. 862 to Sta. 900

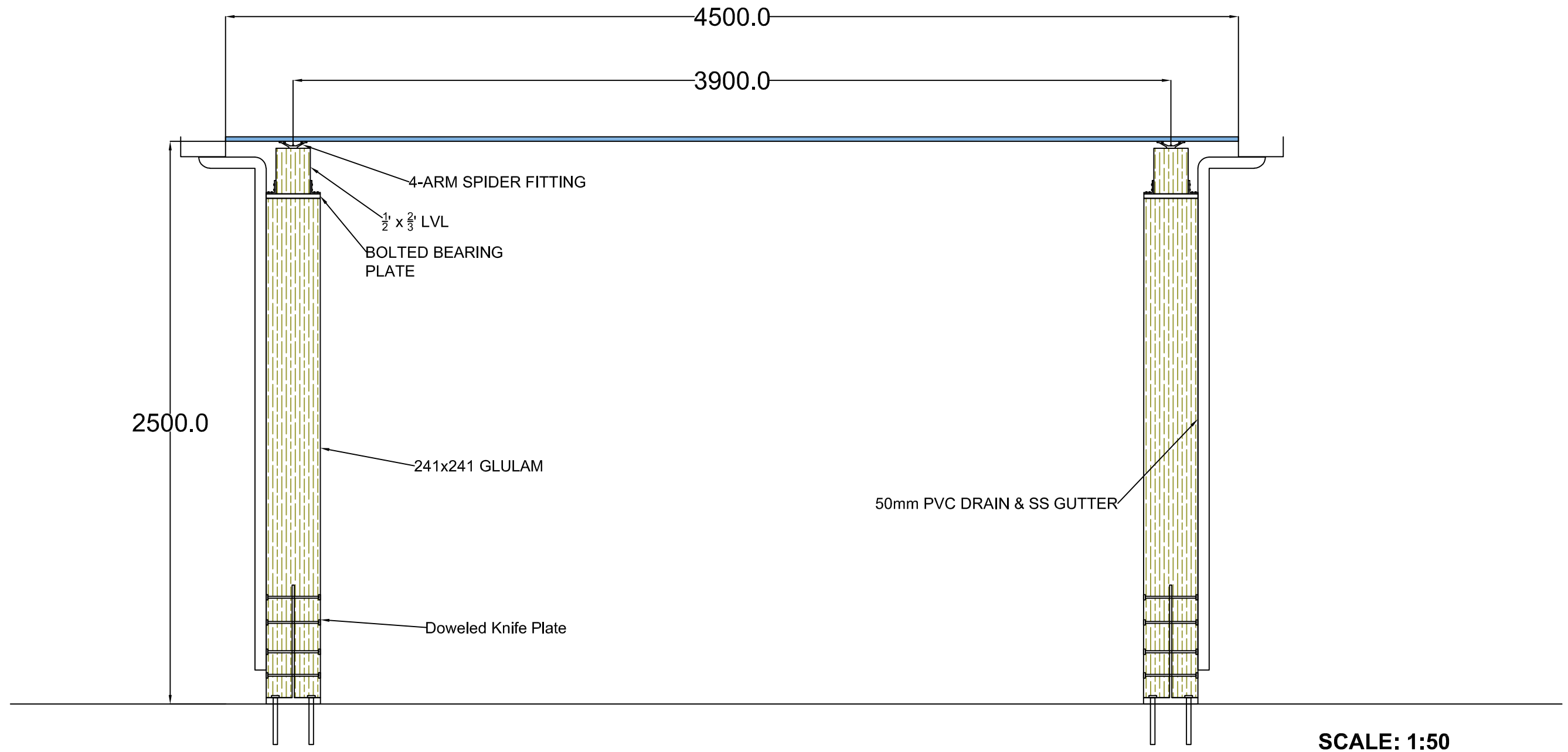


TYPICAL SECTION VIEW - Thunderbird Blvd to Agronomy Rd
Sta. 810 - Sta. 862

TYPICAL ROAD STRUCTURE FOR EAST MALL:

1. APPROVED SUPERPAVE 19mm NOMINAL MIX AS PER SECTION 3212 17
-75mm MIN.
2. APPROVED 19mm MINUS CRUSHED GRANULAR BASE AS PER SECTION 32 11 23 (MIN. 95% MPD)
-150mmMIN.
3. APPROVED 75mm MINUS CRUSHED GRANULAR SUBBASE AS PER SECTION 32 11 16.1 (MIN. 95% MPD)
-300mmMIN.
4. IMPORTED APPROVED GRANULAR FILL AS PER SECTION 32 11 16.1 (MIN 95% MPD) OR RESHAPING APPROVED GRANULAR ROAD BED AS PER SECTION 31 22 16 (MIN 95% MPD)
5. TYPE B CURB & GUTTER (TYP.)
6. 32 MPa CONCRETE SIDEWALK PAVEMENT
- 100mmMIN.
7. PROP. STREET/PEDESTRIAN LIGHTS RELOCATION.
8. STREET DUCT
9. PROP. BIKE BOLLARDS
10. GREEN SPACE AREA, ACTUAL SIZE SHALL REFER TO ROADWAY PLAN DRAWING.
11. TOPSOIL AND ROCKPIT DESIGN DEPTHS SHALL REFER TO SOURCE CONTROL PLAN.
12. RECYCLED RUBBER BIKE LANE.

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE UBC EAST MALL REDESIGN ROADWAY CROSS SECTION DETAIL THUNDERBIRD BLVD TO AGRONOMY ROAD TYPICAL CROSS SECTION PART 2	DESIGNED LW	DRAWING TYPE CROSS SECTIONS	DATE (YYYY.MM.DD) 2021.04.15
		DRAFTED YQ		DRAWING NUMBER CS-06
CONSULTANT MLH Consultants Ltd.		REVIEWED HW		



CLIENT
**UBC Social Ecological Economic Development
 Studies (SEEDS) Sustainability Program**

CONSULTANT
MLH Consultants Ltd.

TITLE
**PEDESTRIAN WEATHER PROTECTION
 (WESTBOUND) CANOPY SECTION VIEW**

DESIGNED
HW

DRAFTED
HW

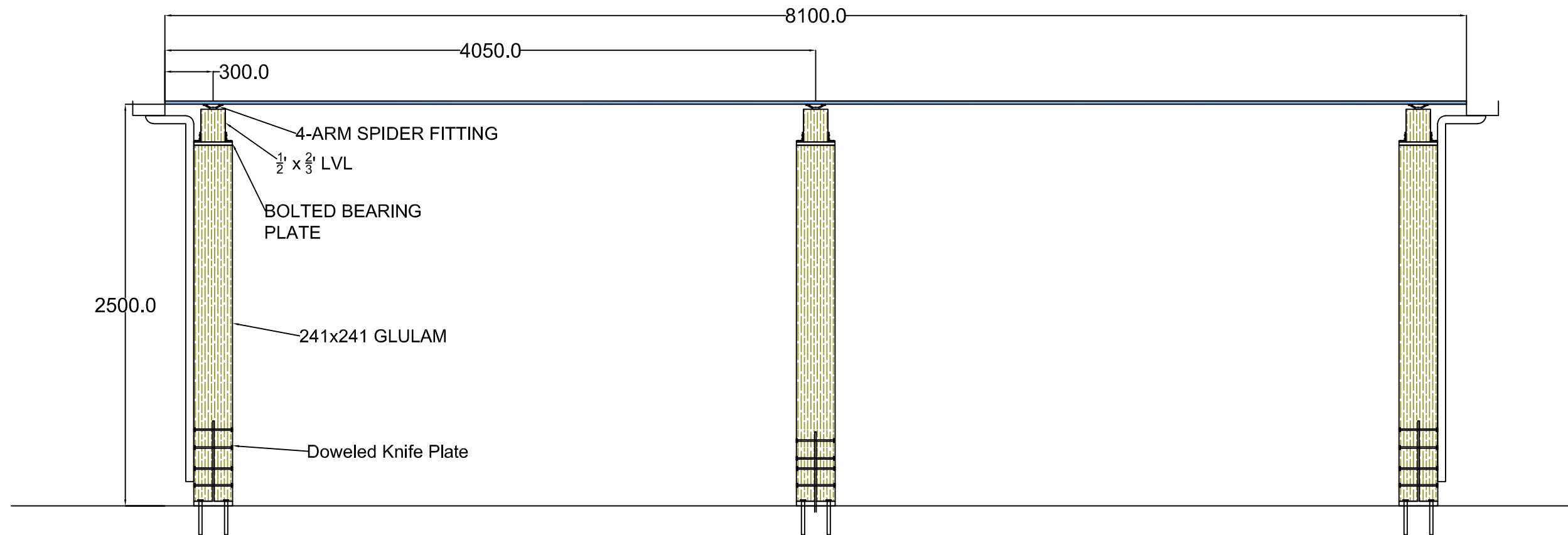
REVIEWED
LW

DRAWING TYPE
STRUCTURE

DRAWING NUMBER
CAN-01

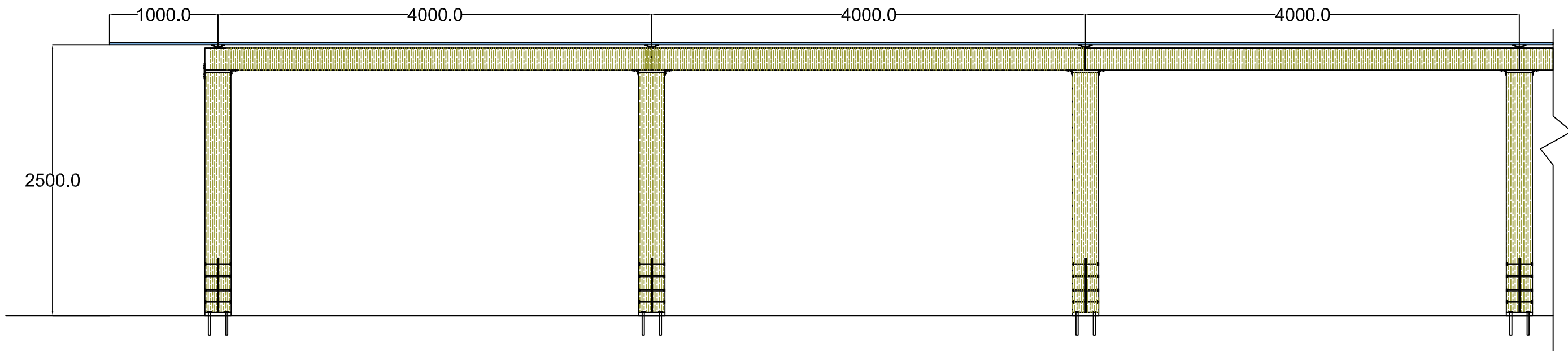
DATE (YYYY.MM.DD)
2021.04.15

SEAL



SCALE: 1:75

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE PEDESTRIAN WEATHER PROTECTION (EASTBOUND) CANOPY SECTION VIEW	DESIGNED HW	DRAWING TYPE STRUCTURE	DATE (YYYY.MM.DD) 2021.04.15
CONSULTANT MLH Consultants Ltd.		DRAFTED HW		DRAWING NUMBER CAN-02
		REVIEWED LW		



SCALE: 1:100

CLIENT
**UBC Social Ecological Economic Development
 Studies (SEEDS) Sustainability Program**

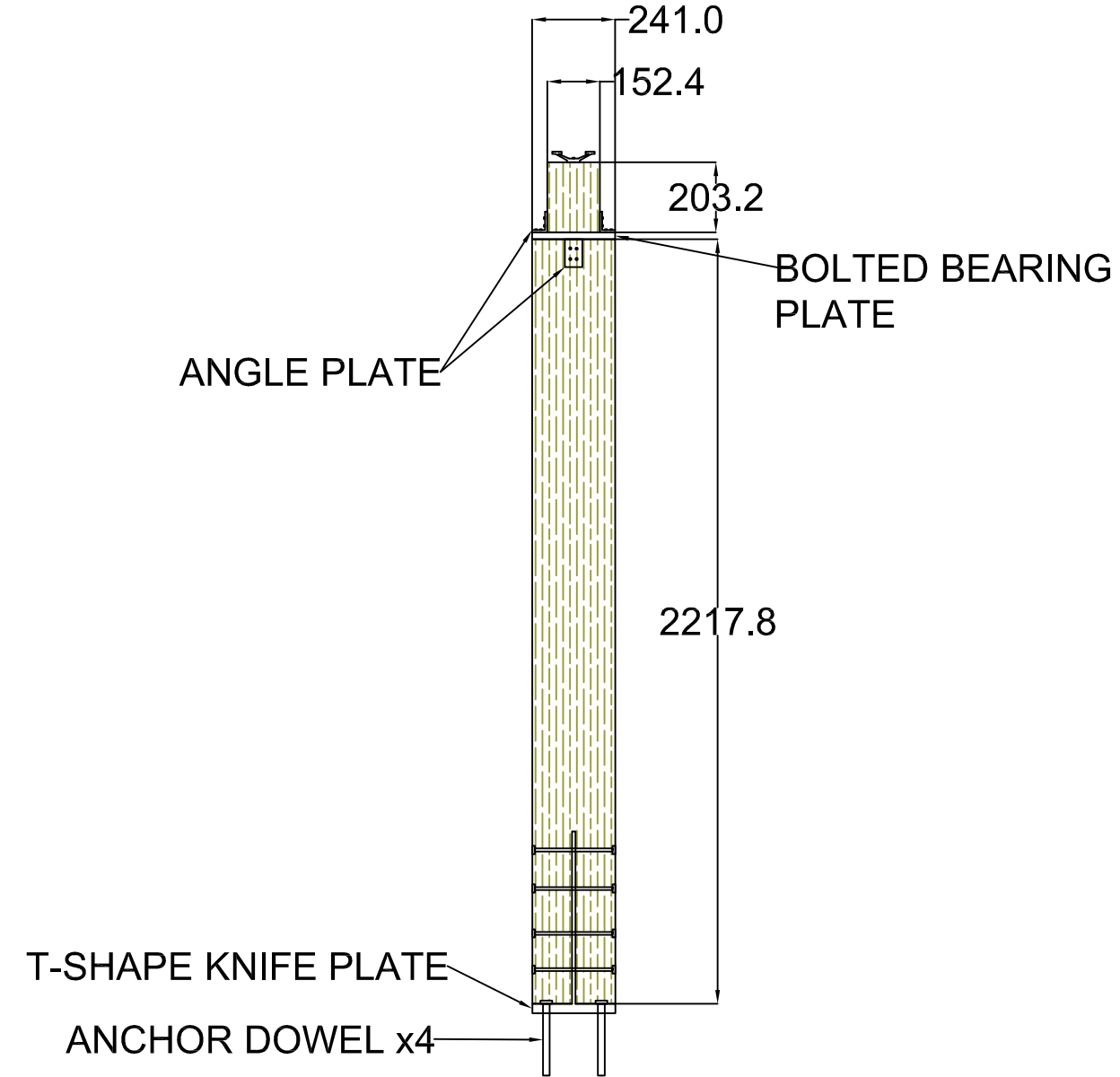
CONSULTANT
MLH Consultants Ltd.

TITLE
**PEDESTRIAN WEATHER PROTECTION
 ELEVATION VIEW**

DESIGNED
HW
 DRAFTED
HW
 REVIEWED
LW

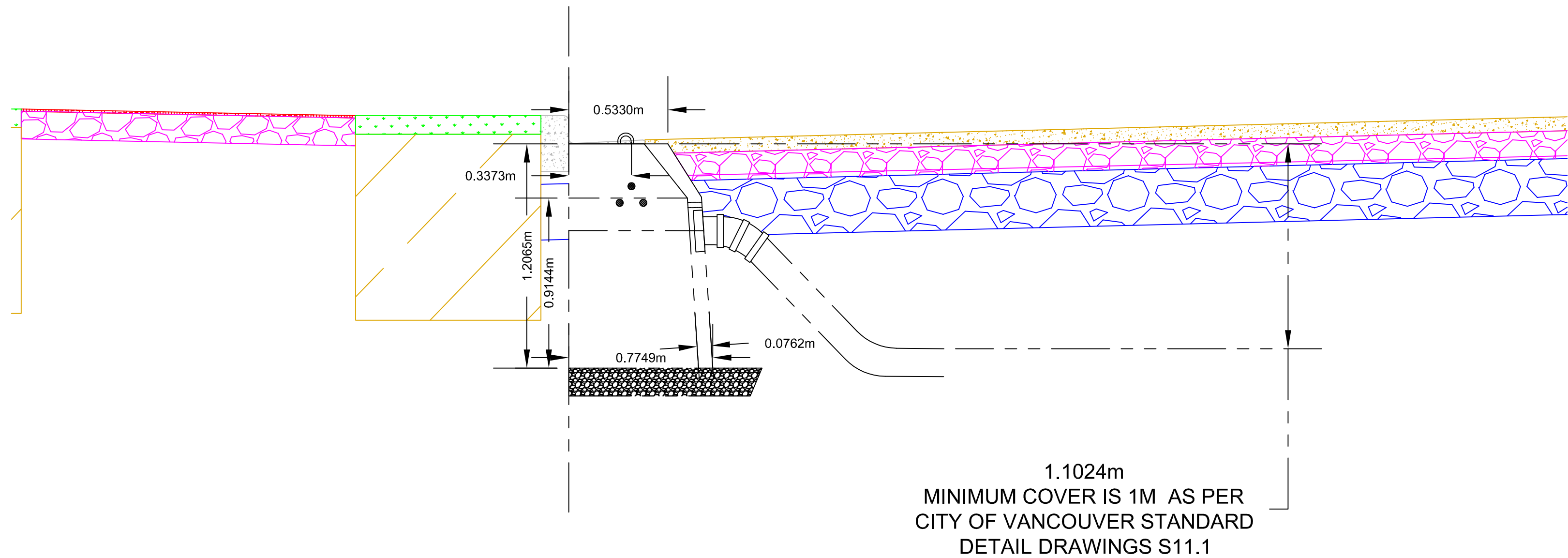
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CAN-03

DATE (YYYY.MM.DD)
2021.04.15
 SEAL



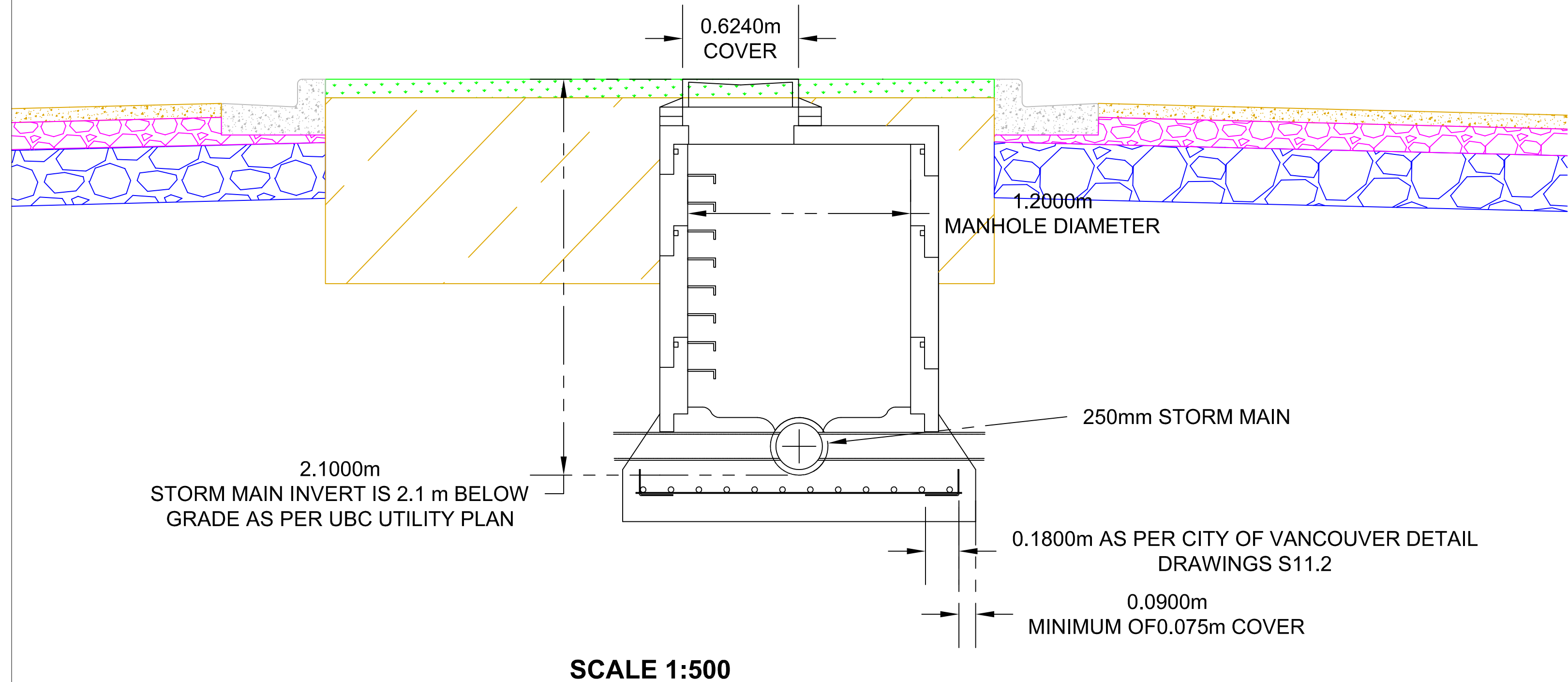
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CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE <h2 style="text-align: center;">COLUMN DETAIL</h2>	DESIGNED HW	DRAWING TYPE STRUCTURE	DATE (YYYY.MM.DD) 2021.04.15
CONSULTANT MLH Consultants Ltd.		DRAFTED HW	DRAWING NUMBER CAN-04	SEAL
		REVIEWED LW		



SCALE 1:500

CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program	TITLE STANDARD CATCH BASIN CROSS SECTION VIEW	DESIGNED SY	DRAWING TYPE STORM DRAINAGE	DATE (YYYY.MM.DD) 2021.04.15
CONSULTANT MLH Consultants Ltd.		DRAFTED SY	DRAWING NUMBER SW-01	SEAL
		REVIEWED LL		



CLIENT UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program
CONSULTANT MLH Consultants Ltd.

TITLE MANHOLE STRUCTURE CROSS SECTION VIEW
--

DESIGNED SY
DRAFTED SY
REVIEWED LL

DRAWING TYPE STORM DRAINAGE
DRAWING NUMBER SW-02

DATE (YYYY.MM.DD) 2021.04.15
SEAL

Appendix B - Construction Specification

The roadway realignment is described in the report and is to be performed in accordance with requirements contained in the specification. The work shall consist of:

- Supplying and installing the required materials listed below in accordance to the drawings and specifications.

REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or the latest revision at the date of tender advertisement.

References

- Section 03 30 20 City of Vancouver Construction Specification Supplementary Specification
- Section 03 30 53 City of Vancouver Construction Specification Supplementary Specification
- Section 32 05 17 City of Vancouver Construction Specification Supplementary Specification
- Section 01 57 01 City of Vancouver Construction Specification Supplementary Specification
- Section 33 40 01 City of Vancouver Construction Specification Supplementary Specification
- Section 33 44 01 City of Vancouver Construction Specification Supplementary Specification
- Section 32 05 17 City of Vancouver Construction Specification Supplementary Specification
- Section 32 91 21 City of Vancouver Construction Specification Supplementary Specification
- G5.6 City of Vancouver Standard Detail Drawing

1.0 GENERAL

2.0 PRODUCTS

2.1 Materials

Concrete mixes shall conform to Section 03 30 53 Cast-in-Place Concrete

3.0 EXECUTION

3.1 Formwork

At lanes, crossings and other similar locations, formwork shall be left in place until the concrete has attained sufficient strength to bear traffic loads without edge damage. Sufficient strength generally means minimum 20MPa in concrete strength unless otherwise allowed by the City Engineer.

3.2 Driveway Crossings and Wheel Chair Ramps

- Wheel Chair Ramps:

.1 Ramps shall land wheelchair and other users safely in the crosswalk and in the desired direction of travel.

.2 The ramp and the directional score lines shall lead into the crosswalk, lining up with the ramp across the Street and be parallel with the crossing or marked crosswalk. The directional score lines are intended to aid the visually impaired pedestrian across the Street and shall be constructed for maximum detection.

- Double Curb Ramp

Minimum 1.0m full curb is required between the two ramps as per Standard Detail Drawing C8.1. Double curb ramps are preferred, and shall be implemented whenever possible, over large single curb ramps as described in 3.7.4 of this Section.

- Laneways Lane Curb Ramp

The ramp and the directional score lines shall line up with the ramp across the lane and be parallel with the crossing as per Standard Detail Drawing C9.1.

3.3 Control Joints

Walks 1.5m, 1.8m, and 2.0m in width shall be marked off in panels 1.5m, 1.8m, or 2.0m long respectively unless otherwise directed by the City Engineer. Control joints to control and minimize cracking shall be installed to the satisfaction of the City Engineer. The scoring pattern of the sidewalk is governed by the distance between features such as tree pits and water valve boxes. Keep the scoring pattern as square as possible for the sidewalk panels.

Whenever there is a sidewalk feature, such as a tree pit or water valve box, presented, the scoring pattern must follow through from the main sidewalk scoring pattern. A cut is generally spaced between two adjacent sidewalk panels as long as it provides balanced scoring pattern between features.

3.4 Isolation Joints

Carefully fit, cut, and mark the sidewalk around all features such as water valve boxes, lamp standards, poles, and hydrants to prevent cracking of the slabs, to the satisfaction of the City Engineer.

3.5 Finishing

Cutting and marking tools shall have a cutting edge not less than 25mm in depth and the edge of the panel shall be rounded to a 6mm radius. Trowel edge to be as close to flush as possible with broom finish. The broom finish shall extend to the edge of the panel.

Finished curb and gutter shall have a smooth and uniform surface, true to line, grade, and section and shall be free from voids, sags, bumps, or other irregularities to the satisfaction of the City Engineer.

All control joints are to be sawcut only (no trowel marks) and shall be done 24 hours after the pour to avoid any cracking.

All score lines are to be trowelled only.

3.6 Special Effects

At Street intersections, the cast year shall be stamped in the surface of the sidewalk as directed by the City Engineer. The necessary template figures will be available from the Contract Administrator.

Old historical sidewalk stamp markings 1950 or older have special value to the City and are required to be saved and kept in place. The Contract Administrator must be contacted and consulted prior to the demolition and removal of the sidewalk containing the markings.

3.7 Protection

Protect freshly finished concrete from dust, rain or frost by using tarpaulins or other suitable protective coverings after final set. Keep clear of the finished surface.

3.17 Acceptance

Any portion marked or damaged by vandalism, rain, frost, equipment, traffic, or other, to be replaced at the Contractor's cost.

The Contractor shall be responsible for any damage to existing concrete walks, curbs, and gutters at their Site or any damages at adjacent sites, and shall make all necessary repairs, at their cost, to any damage caused from their construction activities to the satisfaction of the City Engineer.

END OF SECTION 03 30 20

1.0 GENERAL

1.3 Approvals

The Contractor shall be responsible to provide samples to the Contract Administrator.

2.0 PRODUCTS

2.2 Native Material

Granular native material may be used only with the express written permission of the City Engineer, and provided it can be compacted to the requirement stated in Section 31 23 01 Excavating, Trenching and Backfilling. All costs for Quality Control testing of granular native materials shall be covered by the Contractor.

The City Engineer may require analytical laboratory confirmation that the native materials meet the applicable BC Ministry of Environment land use standards (residential or industrial) as well as the requirements in this section - 2.2 Native Material.

2.9 Crushed Granular Sub-Base

75mm Minus Crushed Tailings - City of Vancouver Aggregate #13:

This material shall be a well-graded, 75mm minus, 100% crushed-quarried material of uniform quality suitable for use in fills and road subbase lifts. It shall consist of durable particles capable of withstanding the effects of handling, spreading and compacting without degrading, resulting in the production of deleterious fines. The grading limits shall be:

Sieve Designation	Percent Passing
75.0mm	100
19.0mm	40 - 50
4.75mm (No. 4)	20 - 35
75µm (No. 200)	2 - 8

2.10 Granular Base

19mm Minus Combined Crushed Aggregate Fill (Mulch) - City of Vancouver Aggregate #9:

This material shall be of uniform quality, crushed to size as necessary, and consisting of sound, tough, durable, mechanically crushed fragments. A minimum 60% of particles by mass of the portion retained on a 9.5mm sieve shall have at least one freshly fractured face. The grading limits shall be:

Sieve Designation	Percent Passing
19.0mm	100
12.5mm	61 - 95
9.5mm	45 - 85
4.75mm (No.4)	35 - 60
2.36mm (No. 8)	26 - 47
1.18mm (No. 16)	20 - 39
600µm (No. 30)	13 - 29
300µm (No. 50)	8 - 21
150µm (No. 100)	5 - 15
75µm (No. 200)	2 - 8

This is a high quality granular fill and may be used up to the bottom of the asphalt or concrete surface.

END OF SECTION 32 05 17

CONSTRUCTION
SPECIFICATION

SUPERPAVE HOT-MIX ASPHALT CONCRETE PAVING

SECTION 32 12 17

2.0 PRODUCTS

1.0 GENERAL

The selection, application and approval of each Superpave mix is entirely at the discretion of the City Engineer.

2.1 Materials

19mm Nominal Maximum Aggregate Size Mix is recommended for the project. The City Engineer will consider the use of this mix for base or course only on an individual project basis. The City Engineers decision will be final.

The asphalt shall conform to all the requirements on this Section 32 05 17 Superpave Hot-Mix Asphalt Concrete Paving.

3.0 EXECUTION

3.1 Plant and Mixing Requirements

Permissible variation in aggregate gradation from the job mix (percent of total mass) shall be as follows:

Gradation	Tolerance
Passing 4.75mm and Larger Sieves	±5%
Passing 2.36mm to 0.6mm	±4%
Passing 0.6mm to 0.3mm	±3%
Passing 0.3mm to 0.15mm	±2%
Passing 0.15mm to 0.075mm	±1.5%

Permissible variation of asphalt cement from job mix shall be 0.25%

3.2 Equipment

Vibratory rollers may only be used with precaution to ensure there will be no damage done to nearby structures and utilities, or cause unreasonable discomfort to nearby residents.

While compaction standards as set forth in Section 31 23 01 Excavating, Trenching and Backfilling and Section 32 12 17 Superpave Hot-Mix Asphalt Concrete Paving must always be met, extreme care must be taken around cast iron water mains as additional costs may be incurred by the Contractor if the repair of leaking / damaged water mains becomes necessary.

3.5 Placing

Upon arrival, it shall be immediately put in place in a uniform lift without any segregation. Segregation within asphalt will not be accepted.

The grade and camber shall be smooth and true, and conform to the grade and camber of the existing surface, where applicable. All excess asphalt shall be removed by sweeping.

Provide the best possible seamless joints by raking of finer materials to fill in all the gaps directly adjacent to the joints, leaving a flush finish between old and new asphalt. A non-flush grade between existing and new surface is cause for rejection. Refer to Standard Detail Drawing G5.6 for compliance requirements.

3.6 Compaction

Roll asphalt continuously to meet the following requirements:

- 9.5mm nominal maximum aggregate size mix: 92 to 96% MTD.
- 12.5mm nominal maximum aggregate size mix: 92 to 96% MTD.
- 19mm nominal maximum aggregate size mix: 93 to 96% MTD.

Maximum Theoretical Density (MTD) of each mix shall be determined in accordance with AASHTO T209 or ASTM D2041. Final compaction level of the finished pavement shall be determined by core samples. The Contractor will be required to provide core density verification data upon request by the City Engineer.

A minimum of three cores shall be obtained from random locations as selected by the City Engineer. No more than one individual test result shall be more than 1.0% below or 2.0% above the specified range as indicated above, and the average test results of the cores must be within the specified range. The Contractor may be allowed to extract one additional core near the original failed area with the consent of the City Engineer. New average will be calculated with the new core result replacing the original failed data. Failing to comply constitutes immediate rejection.

The Contractor shall use smaller approved power compactors or tampers in areas around Maintenance Holes, poles, or other structures which are inaccessible to a roller, to the satisfaction of the City Engineer.

END OF SECTION 32 12 17

CONSTRUCTION
SPECIFICATION

TOPSOIL AND FINISH GRADING

SECTION 32 91 21

2.0 PRODUCTS

2.10 Growing Medium

Growing Medium shall conform to all the requirements in this section 32 91 21

3.0 EXECUTION

3.4 Placing Growing Medium

The growing medium shall be moderately compacted (e.g. 90% density) with a slight crown to account for near-term settlement.

Boulevard soil shall be placed at a minimum depth of 300mm in turf areas. A minimum depth of 450mm shall be placed in planted areas of the boulevard.

Underground utilities and conduits shall maintain their required minimum granular cover as specified by the utility. In these areas, at least 150mm of boulevard growing medium shall be

placed over the granular cover (300mm preferred); the thickness shall be as per the Contract Documents.

3.5 Applying Fertilizers

Add fertilizers to bring growing medium fertility within ranges set out in this Section, and as recommended by testing of the growing medium.

3.6 Finished Grading

The desired crossfall through a grass or planted boulevard to the curb is 4%; the allowable crossfall of a grass or planted boulevard shall be between 2% and 6% or as otherwise approved by the City Engineer. If there is settlement in the boulevard during the two-year Warranty Period, the areas must be re-graded / top-dressed to prevent trips (settlements over 6mm), particularly at the edge of curb and edge of sidewalk.

END OF SECTION 32 91 21

CONSTRUCTION
SPECIFICATION

Seeding

SECTION 32 92 20

2.0 PRODUCTS

2.1 Grass Seed

The seed mix shall be a premium grade suitable for high-traffic areas and offer good wear and drought tolerance. The mix shall include turf-type Perennial Ryegrass, turf-type Kentucky Bluegrass, and turf-type Red Fescue (including Chewing's and Creeping Fescues).

END OF SECTION 32 92 20

1.0 GENERAL

1.1 Electrical Energy Supply

The Contractor shall coil and install wire markers indicating signal phase on conductors out of the weather head. Utility companies shall complete electrical service connections.

1.2 Inspection

Required field tests are to be confirmed with the City Engineer, including, but not limited to:

- Concrete testing.
- Flashing out of traffic signal wiring.
- Arc flash test results.
- Pole fabrication test reports.
- Powder coat test reports. Set-up testing and commissioning reports may also be required for, but not limited to:
 - Traffic controllers.
 - Cameras.
 - UPS.

2.0 PRODUCTS

2.1 General

All products supplied to be new, and in accordance with the Contract Documents. All products must bear evidence of either a mark or a label of a certification agency accredited by CSA or have an approved label issued by the BC Safety Authority.

All products shall be in accordance with the Approved Materials and Products List which may be shown on the Drawings. Where the list is not on the Drawings, contact the Contract Administrator for a current list.

2.2 Poles and Anchor Bolts

Poles shall have galvanized and powder coat finish. Colour is specific to the area. Contact the City Engineer for a specific RAL colour number for the given area.

Pole bottom hand hole rings shall be 305mm (H) x 127mm (W) with a cover of 346mm (H) x 171mm (W).

2.3 Conductors and Cables Delete

Single Conductors: 600V, conductor size (AWG) as noted on the Drawings, stranded copper type with RW90 polyethylene insulation, to conform to CSA C22.2 No. 38, 90°C, and colour coded as per CEC or, in the case of signal wiring, as per Standard Detail Drawing E7.13.

2.4 Conductor Connectors

Wire connectors in underground boxes shall be silicone-filled wire nuts or approved waterproof method of split bolts for bigger wire sizes.

2.11 Service Panels
Typical service panels, kiosks and cabinets are defined on Standard Detail Drawings E7.7 to E7.9C. Kiosks and cabinets shall be fabricated. The specific panel, kiosk or cabinet and internal breakers, contactors, transformer and metering shall be defined on the Contract Drawings.

Kiosks and cabinets shall have a powder coat finish. Colour is specific to the area (contact the City Engineer for specific RAL colour number for the given area).

2.5 Traffic and Pedestrian Signals

Traffic signal heads shall be polycarbonate and pedestrian signal heads shall be aluminum and conform to the latest TAC and ITE standards and specifications. Housing and visor colour shall be yellow. Tunnel or cowl visor shall be provided as defined. Each pedestrian signal head shall be designed for a 450mm bi-modal LED display with countdown display. All primary and tertiary signal heads shall have yellow polycarbonate backboards with 75mm border of yellow prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or Approved Equal).

Fire signal heads shall have special yellow backboards as shown on Standard Detail Drawing E5.17. All fire signal backboards shall have a 75mm border of white prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or Approved Equal).

2.6 Signal Mounting Hardware

Refer to Standard Detail Drawings E5.2 and E5.9A to E5.9B for signal mounting hardware.

2.7 Pedestrian / Cyclist Pushbuttons

Where noted on the Drawings, pedestrian push buttons shall be Polara APS type.

Cyclist push buttons shall have white background and black raised characters. Button mechanism is to be raised style with mounting fully external to the pole (recessed button will not be accepted).

2.8 Luminaires

All luminaires shall be LED.

2.9 Illuminated Crosswalk Signs

Crosswalk internal illumination and downlight shall be LED.

2.10 Powder Coat Finish

Powder coat colours (RAL number) shall be specified on the Drawings.

2.11 Advance Warning Signs

Advance warning signs shall have illustration details in yellow prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or Approved Equal). Signal heads shall be 200mm, or 300mm if determined necessary, yellow aluminum or polycarbonate with amber LED's and cowl visors.

2.12 Emergency Vehicle Preemption

The Contractor shall install, as required by the Drawings, emergency vehicle preemption on signal pole arms as per manufacturer's instructions and as directed by the City Engineer. The Contractor shall also provide all required aiming, testing and commissioning of this equipment required for correct operation.

2.13 PTZ Cameras

The Contractor shall install, as required by the Drawings, PTZ Cameras on signal pole arms or other suitable locations as per manufacturer's instructions and as directed by the City Engineer. The Contractor shall also provide all required aiming, testing and commissioning of this equipment required for correct operation. The City's Electrical department and IT department will be required for final commissioning of equipment.

2.14 Street Name Signs

Street name, restriction, mandatory, or other specified signs shall be safety cabled to the pole arm using 2.4mm galvanized steel aircraft cable or galvanized safety chain (5mm galvanized regular link grade 30) on both ends of the sign which shall be looped through small holes in the street name sign and fastened at both ends of sign to the signal arm.

2.15 Traffic Controllers

Controllers are supplied by the City.

3.0 EXECUTION

3.1 General

When tying into or upgrading an existing installation, maintain the existing traffic signal(s) in operation at all times. Where the signal operation can't be maintained, the Contractor shall provide traffic control and flagging to meet City requirements and to maintain safe and efficient traffic flow. The City's Electrical Operations shall make all connections and terminations to existing City installations and infrastructure; a minimum of 5 Days advance notice is required.

3.2 Concrete Bases Delete

Refer to Standard Detail Drawings CE1.1 to CE1.7 for poured-in-place concrete base details. All concrete bases shall be poured-in-place type, unless approved by the City Engineer.

Refer to Standard Detail Drawings E2.3 and E2.4 for junction box details.

3.3 Underground Conduit

Minimum cover over conduits shall be 600mm for all street lighting and signal conduits and 900mm for communications conduits. The number of bends in a conduit run shall not exceed 360°. Pull strings shall be tied together inside JB. Main run (backbone) communications conduit shall be concrete-encased in road crossings.

3.4 Pole and Related Equipment

The Contractor shall place specific pole number labels (reflective white decal) on poles after installation as per the Drawings. The Contract Administrator will supply number labels. Pole number shall be placed 45° on pole shafts facing traffic flow for arterial and collector roads and on the front face of pole shafts for residential areas at 1.8m minimum above grade.

3.5 Traffic and Pedestrian Signal Head Mounting

Install signal and pedestrian heads as per Standard Detail Drawings E5.2 and E5.9A to E5.9B.

Traffic signal heads and pedestrian signal heads shall be completely obscured with proper signal head covers designed for the purpose from the time of installation until the system is in operation. Traffic signal head lenses and pedestrian signal head lenses and reflectors shall be cleaned prior to signal start-up.

Primary traffic signal heads shall be minimum 5.0m and maximum 6.0m from the bottom of the primary traffic signal head backboard to the finished road grade below and have galvanized safety cable or chain installed.

Secondary traffic signal heads shall be minimum 2.3m from finished grade to the bottom of the signal head.

Use Traffic Signal Yellow touch-up paint to repair any spots where the original finish is scratched.

Secondary and pedestrian signal head mounting arms at skewed intersections are to be drilled in the field to achieve optimum viewing angles.

Where signal heads are single-point attached to the signal arm with spring cushion type hangers, the back of primary heads shall have a C-channel bolted to the head to attach the safety cable or chain to the signal arm.. Chains shall be bolted to the arm.

3.6 Electrical Service Panel

Refer to Standard Detail Drawing E1.4 for service cabinet concrete base details. Refer to Standard Detail Drawings E7.7 to E7.9C for service panel and cabinet details.

3.7 Wiring

All individual signal head displays on each pole shall be wired separately with single conductors from the junction box nearest the signal pole including a separate neutral; multi-head displays from the pole hand hole including a separate neutral and bond for each signal pole.

Prior to capping or pulling conductors, conduits shall be blown out with compressed air, from both ends, then swabbed out to remove stones, dirt, water and other material which may have entered during installation. All cut ends of conduits shall be trimmed to remove rough edges.

All field wiring terminations shall be installed using a Thomas and Betts Sta-Kon Comfort Crimp™ Terminal Tool or Approved Equal.

Looping of feeder conductors with “T” taps shall not be permitted.

Cables and wires shall have 1.0m of spare length in all junction boxes and 0.3m minimum of spare length out from pole hand hole cover.

3.8 Traffic Controller

Traffic signal cabinet shall be mounted on the concrete base as per Standard Detail Drawing E1.4. Seal conduits in traffic controller base after conductors are installed with approved duct seal.

Approved silicone sealant shall be used between the traffic signal cabinet and concrete base to ensure a weather-tight seal.

Approved duct-seal shall be placed over / in all underground conduits entering the traffic signal cabinet. All unused conduits shall be capped by PVC.

The Contract Administrator will supply one electrical service panel padlock and service panel decal sticker for the Contractor to install.

Traffic signal cabinet interior must be kept dry during inclement weather.

3.9 Detector Loops

Detector loops shall be installed in the final base lift of asphalt when possible and the conductor colours shall conform to the City loop conductor colour chart shown on Standard Detail Drawings E8.2, E8.7 and E8.11 and to the specified off-sets from the final road markings. Loop junction boxes and stub conduits are to be placed in a manner that the loop tails will not cut through or cross any specialty road surface treatments (i.e. bike holding bays, and green or red conflict area treatments).

Loops in adjacent lanes shall be wound in opposite directions (i.e. clockwise and counterclockwise).

Each shielded cable shall have twisted pair conductors and shall run continuously with no splices from the traffic signal cabinet to the junction box. Splices between the detector loop and the shielded cable shall be soldered and connected with 3M DBR/Y-6 silicone-filled splice connectors.

3.10 Advance Warning Signs

Advance warning signs shall be completely covered and secured with burlap sacking from the time they are installed until the system is turned on for full operation. Plastic garbage bags are not acceptable.

3.11 Grounding & Bonding

Additional to the common bonding conductor, all poles shall be connected to a ground plate. Refer to Standard Detail Drawing E7.10 for details; however, the plate shall be located 300mm on the side of the concrete base with native soil separating the base and the ground plate.

3.12 Pole Finish Application

Pole refinishing (touch-up): The Contractor shall clean and wire brush galvanized surfaces, touch up scratches and abrasions with prime coat (General Paint META Prime (vinyl wash)), and apply finish coat of non-alkyds color base paint. Poles must be free from moisture (rain, dew, frost, fog). No pole refinishing shall be undertaken if frost is predicted within 24 hours of the Work.

The standard detail drawings refer to City of Vancouver standard detail drawings

END OF SECTION 03 30 20

SUPPLEMENTARY
SPECIFICATION

Storm Sewer System Environmental Protection

SECTION 01 57 01

1.0 General

1.1 Temporary Erosion and Sediment Controls

1. A truck wheel wash system is required, if necessary, to keep mud, dirt and debris from being tracked onto roads and into the storm sewer system

2. Do not allow construction stormwater runoff to drain on or through areas planned for stormwater infiltration practices.

3. The stormwater infiltration practices, such as permeable pavement, bioretention, and infiltration trenches, shall be constructed last to avoid clogging and damage from construction activity.

END OF SECTION 01 57 01

SUPPLEMENTARY
SPECIFICATION

Storm Sewers

SECTION 33 40 01

2.0 Products

1. Storm sewer service connections to be 150mm minimum diameter; maximum diameter as specified on the Drawings.
2. The following pipe is permitted for gravity and pressure main sewers, connections and fittings. The pipe material and pipe class shall be as per the Drawings

Material	Class	Size	Use	Standard
Concrete	Non-Reinf. Cl. 3	150 - 750mm	Mains	ASTM C14M
Concrete	Reinf. Cl. III, IV, or V	300 - 1650mm	Mains	ASTM C76M
PVC Gravity Sewer Pipe	DR28	150mm	Conn.	CSA B182.2-M ASTM D3034
PVC Gravity Sewer Pipe	DR35	200 - 375mm	Mains / Conn.	CSA B182.2-M ASTM D3034
Vitrified Clay	Extra Strength	150 - 375mm	Mains / Conn.	ASTM C700 ASTM C425
Ductile Iron	Cl. 50, 51, 52	150 - 600mm	Mains / Conn.	AWWA C151 AWWA C104 AWWA C111
Blue Brute PVC Pipe	DR14, 18, 25	150-300mm	Mains	AWWA C900 CSA B137.3

All other materials and sizes require the approval of the City Engineer.

3.0 Execution

1. The minimum vertical separation between sewers that cross shall be 0.3m, unless approved otherwise by the City Engineer.
2. The typical bottom of all trench excavations for pipes, Maintenance Holes, and related structures shall be excavated to a depth of 150mm below the bottom of the pipe or structure and refilled to the required grade and elevation for the full width of the trench as per 3.5 of this Section.
3. Storm and sanitary sewer connections shall be laid side-by side to the same invert at the property line unless otherwise approved or directed by the City Engineer.

END OF SECTION 33 40 01

2.0 Products

1. Catchbasins shall conform to Standard Detail Drawings S11.1 to S11.15. Catchbasins shall be ordered by phoning the City's Central Stores a minimum of six weeks in advance. Catchbasins shall be picked up at the City's Manitoba Works Yard. Coordinate pickup from the Manitoba Works Yard with the Contract Administrator. The City will furnish the catchbasins at no charge to the Contractor, except when the Contractor is working on behalf of a private developer or owner.
2. Gutter inlet grates are normally used; however, curb inlet catchbasins shall be used where specified on the Drawings.
3. Maintenance Hole barrels shall be made with precast concrete sections or poured in place concrete.

END OF SECTION 33 44 01

Appendix C - Cost Estimation

Labour Cost for Intersection Design			
Construction Tasks	Duration (Days)	Number of Crews	Labour Cost 8hr/Day (\$)
Setting out of East Mall & Agronomy Rd. Intersection	4	3	3840
Installation of Wooden Column & Frame	4	8	10240
Installation of Tempered Glass	3	8	7680
Green Infrastructure (Vegetation) Planting of Intersection	2	3	1920
Installation of Drain and Pipes	4	5	6400
Installation Side Gutter	3	5	4800
Sum	20	32	34880

East Mall Roadway Labour Cost				
Construction Tasks	Duration (Days)	Crew Member	Sub-Cost (\$)	Total Cost (\$)
Setting out of East Mall	6	8	15360	601280
Asphalt Milling & Disposal	3	10	9600	
Removal of Median	10	10	32000	
Removal of Poor Soils	2	10	6400	
Tree Relocation	6	10	19200	
Soil Stabilisation	2	8	5120	
Fixing and Leveling Base Course	3	8	7680	
Compacting Base Course	2	10	6400	
Providing Adequate Subsoil Drainage	7	8	17920	
Construction of Sub-base	6	2+6 from the above cell	11520	
Construction of Base	8	2+6 from the above cell	15360	
2nd Setting out of East Mall	4	8	10240	
Cable Planning	6	10	19200	
Construction of Catchment Basin	4	10	12800	
Construction of Manhole Structure	4	20	25600	
Construction of Shoulders (Casting)	8	10	25600	
Asphalt Paving	12	5	19200	
Utility Relocation	13	5	20800	
Excavation	13	10	41600	
Construction of Gutter	7	15	33600	
Construction of Sidewalk	12	15	57600	
Broom Finish	2	10	6400	
Removal of Existing Pavement	10	20	64000	
Topsoil Importing	6	10	19200	
Tree and Grass Planting	3	15	14400	
Handing Basket Irrigation System	1	4	1280	
Construction Type B Curb	13	20	83200	

Materials	Unit	Quantity	Unit Price (\$)	Sub-Cost (\$)	Total Cost (\$)
Tempered Glass	m ²	773	40	30920	42595.6
Wooden Column and Frame	m ³	40	15.7	628	
Green Infrastructure	# Plants	100	5.45	545	
Drainage Pipes	m	170	9.3	1581	
Side Gutter	m	272	32.8	8921.6	

Materials	Unit	Quantity	Unit Price (\$)	Sub-Cost (\$)	Total Cost (\$)
Asphalt milling and offsite disposal	lane*km	3.4	\$110,000.0	\$374,000.0	\$8,914,242.0
Clearing and excavation	Lump Sum	1	\$27,450.0	\$27,450.0	
Off-site desposal	Tonne	41616	\$90.0	\$3,745,440.0	
19mm minus combined crushed granular base	Tonne	10404	\$30.0	\$312,120.0	
75mm minus crushed tailings granular subbase	Tonne	28611	\$20.0	\$572,220.0	
Imported topsoil for restoration - 200mm thick	Square metre	7558.76	\$23.0	\$173,851.5	
Grass seed mix	Square metre	7558.76	\$1.0	\$7,558.8	
Tree relocation, and replanting	Each	63	\$700.0	\$44,100.0	
Root barrier	Each	63	\$500.0	\$31,500.0	
Type B Curb and Gutter	Lineal metre	3000	\$127.3	\$381,900.0	
Remove the existing concrete pavers	Square metre	4500	\$59.2	\$266,400.0	
Concrete sidewalk or walkway including ramps, 100mm thick, c/w	Square metre	3210	\$87.5	\$280,875.0	
Broom finish, sawcut pattern	Square metre	3210	\$140.0	\$449,400.0	
Asphalt paving - 75mm thick	lane*km	3.852	\$137,238.0	\$528,640.8	
Asphalt driveway regrade 150mm thick granular base	Square metre	12326.4	\$43.0	\$530,035.2	
Asphalt driveway regrade 300mm thick granular base	Square metre	12326.4	\$65.0	\$801,216.0	
1.8m recycle rubber material bike lane	Lineal metre	1000	\$88.9	\$88,860.0	
1.8m existing asphalt bike lane painting	Lineal metre	60	\$1.5	\$90.0	
LED Signal lights with pedestrian controller	Each	4	\$1,795.0	\$7,180.0	
Speed Limit Signs with wooden pole	Each	2	\$270.0	\$540.0	
Pedestrian cross signs with wooden pole	Each	18	\$270.0	\$4,860.0	
Do not enter sign with wooden pole	Each	1	\$270.0	\$270.0	
Yellow line	Lineal metre	357	\$3.1	\$1,106.7	
White line	Lineal metre	1812	\$3.1	\$5,617.2	
White dash line	Lineal metre	42.5	\$1.6	\$65.9	
Catch basin connection lead (150 mm dia.)	Linear metre	270	\$27.3	\$7,357.5	
Manhole Base, Frame, Lid and Cover (1200 mm dia.)	Each	11	\$3,000.0	\$33,000.0	
Pre-cast concrete catch basin	Each	27	\$4,050.0	\$109,350.0	
150mm thick precast concrete bed	Cubic meter	3.94	\$133.3	\$525.3	
Prefab Glulam Columns 241x241x2500	Each	68	\$2.1	\$145.5	
Prefab LVL Beams 1/2' x 2/3' x 4000	Per 8 feet	893	\$0.9	\$768.0	
Pilkington Planar Glazing	Square Meter	773	\$150.0	\$115,950.0	
A-36 L Angle 1/2x1/2x1/8	Each	272	\$5.0	\$1,354.6	
drainage pipe	Linear meter	170	\$9.3	\$1,572.5	
side gutter	Linear meter	272	\$32.8	\$8,921.6	

East Mall Equipment Cost				
Construction Tasks	Duration (Days)	Machinery Cost (\$/hr)	Sub-Cost (\$)	Total Cost (\$)
Setting out of East Mall	6	0	0	273814.48
Asphalt Milling & Disposal	3	157.23	3773.52	
Re oval of Median	10	210.44	16835.2	
Removal of Poor Soils	2	210.45	3367.2	
Tree Relocation	6	157.26	7548.48	
Soil Stabilisation	2	183.42	2934.72	
Fixing and Leveling Base Course	3	50.41	1209.84	
Compacting Base Course	2	183.47	2935.52	
Providing Adequate Subsoil Drainage	7	22.78	1275.68	
Construction of Sub-base	6	277.22	13306.56	
Construction of Base	8	277.22	17742.08	
2nd Setting out of East Mall	4	0	0	
Cable Planning	6	133.48	6407.04	
Construction of Catchment Basin	4	277.22	8871.04	
Construction of Manhole Structure	4	52.59	1682.88	
Construction of Shoulders (Casting)	8	202.22	12942.08	
Asphalt Paving	12	256.77	24649.92	
Utility Relocation	13	108.32	11265.28	
Excavation	13	294.47	30624.88	
Construction of Gutter	7	277.22	15524.32	
Construction of Sidewalk	12	277.22	26613.12	
Broom Finish	2	78.72	1259.52	
Removal of Existing Pavement	10	210.45	16836	
Topsoil Importing	6	277.22	13306.56	
Tree and Grass Planting	3	103.45	2482.8	
Handing Basket Irragation System	1	198.67	1589.36	
Construction Type B Curb	13	277.22	28830.88	

Canopy Incidental Cost	
Building Permit Fees (\$)	660.606
Review Fees (\$)	1820
Road Closure Fees (\$)	10,773.00
Annual Maintainance Cost (\$)	500
Total Incidental Fees (\$)	13753.606

East Mall Incidental Cost	
Building Permit Fees (\$)	30590.805
Review Fees (\$)	1820
Road Closure Fees (\$)	10,773.00
Annual Maintenance Cost (\$)	17974.0018
Total Incidental Fees (\$)	61157.8068

Extra Cost					
Component	Unit	Qty	Unit Price	Total / Year	Comments
Roadway	Mile	0.528	345	182.16	Maintenance
Urban Traffic Lights	Each	4	4206	16824	Maintenance+Power
Pedestrian Signal	Each	18	2274	40932	Maintenance+Power
Canopy	Month	12	500	6000	Maintenance+Cleaning
Drainage Pipe	Linear Meter	170	0.7	119	Maintenance+Cleaning