University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

East Mall Redesign between Agronomy Road and W16th Avenue

Prepared by: Deepinder Bajwa, Ray Han, Johnson Hu, Thomson Mai, Bastien Moy, Kyle Tam

Prepared for:

Course Code: CIVL 446

University of British Columbia

Date: 16 April 2021

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Executive Summary

Our team has been retained by UBC Social Economic Development Studies (UBC SEEDS) to redesign East Mall between Stadium Road and Agronomy Road in attempt to better accommodate sustainable transportation modes. The corridor's current conditions do not accommodate the high amount of pick-up/drop-off traffic during the evenings, and do not promote sustainable modes of transportation.

This report will provide and in-depth review for the detailed design of the transportation, structural, municipal, and environmental disciplines. Our recommended concept involves shifting the existing median East to separate vehicle travel lanes and bike lanes, reconfiguring the intersection of Thunderbird Boulevard and East Mall and upgrading the existing signal, and widening the segment from Thunderbird Boulevard to Agronomy Road to accommodate a new bi-directional bike lane. This design will improve the safety of cyclists, provide an abundance of green space for pedestrians, and reduce conflicts between vehicles and cyclists at drop-off pick-up zones while retaining parking for residents and users of the nearby facilities.

An assessment of the existing utilities was conducted to identify impacts on the existing utility networks. The proposed reconfiguration is not expected to affect the system demands the water distribution and sanitary sewer systems. A stormwater management strategy has been developed on site, and the final corridor reduces the captured stormwater volumes within the project area. Specifications for the new permeable concrete cycling lanes and sidewalks have been developed, including an aggregate reservoir base to detain major storm flows for natural infiltration into the subgrade.

The new pedestrian canopy consists of W200x31 section profiles for the columns and cantilevers with tempered glass panels mounted as the decking. The structure is 66.86-metres in length and will be constructed along the South side of Agronomy Road.

The greenspace consists of the plantation of several new tree species to further improve the aesthetic of the corridor. Additionally, the greenspace has a community garden composed of various flowers to encourage people to gather and enjoy the surrounding landscape hence building the community.

Estimated budget for the proposed solution will be $5,163,449 which includes labour, materials, operation & maintenance and a 15% contingency. Construction work will begin on May 2021 with a completion date of December 2021 with a duration of around 9 months.

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1. INTRODUCTION

Our team has been retained by UBC Social Ecological Economic Development Studies (SEEDS) to redesign East Mall between Stadium Road and Agronomy Road. This section will introduce the project site and the project scope. Our team member contributions are provided below.

Table 1: Team member contributions to the Design Report

Team Member	Contributions To	Review and Edited By
Johnson Hu	• Report formatter and editor • Detailed design and analysis of pedestrian canopy • Canopy drawings • Canopy construction specifications	• Final Design Report • Municipal design and calculations • Cost estimate and schedule • Greenspace design
Bastien Moy	• Design Objectives and Key Issues • Road Configuration • Roadway design • Signage plan	• Final Design Report • Risk analysis • Existing and future traffic condition analysis • Greenway design
Ray Han	• Utilities review • Utilities design and calculations • Drawing formatting • Utilities drawings • Service life maintenance plan • Cross-section drawings	• Final Design Report • Detailed design and analysis of pedestrian canopy • Cost estimate and schedule • Road configuration
Kyle Tam	• Cost estimate & schedule • Risk Analysis • Revised plan view drawings • Traffic Management Plan Drawings • Plan view details	• Final Design Report • Utilities design • Synchro modelling • Stakeholder engagement
Deepinder Bajwa	• Stakeholder engagement • Service life maintenance plan • Greenway design	• Final Design Report • Canopy site preparation requirements • Construction sequencing • Traffic management plan
Thomson Mai	• Existing traffic condition analysis • Future traffic volume growths • Synchro modelling • Greenway design	• Final Design Report • Final drawing package • Signage plan • Service life maintenance plan

1.1. Site Overview

Located on the University Endowment Lands, East Mall runs parallel to Westbrook Mall and is an important point of access for the UBC campus and bears a high volume of traffic on a day-to-day basis. It is a wide road with a large median strip separating single travel lanes. From 16th Avenue to Agronomy Road, East Mall contains two shuttle bus stops, a street bike lane, and a generous amount of curb side parking that also serves as a pick-up/drop-off zone to numerous sports fields and recreation centres. The current design poses several issues including speeding, cyclist safety, overdemand for curb side parking, pedestrian crossing safety, and lack of usable green space. Figure 1 and Figure 2 below show the current conditions and project site location.

Figure 1: East Mall

Figure 2: Project Location

1.2. Project Scope

The scope of work for this project consists of client required objectives as identified below. This report will address each objective and provide some insight on the design process, including calculations, technical drawings, and construction specifications. A summary of the major components of this project are:

1. Upgrade the existing East Mall corridor to promote sustainable modes of transportation and incorporate traffic calming measures to reduce travel speeds
2. Improve liveability along the corridor by reducing the possibility of vehicle conflicts with pick-up/drop-offs, pedestrians, and cyclists
3. Minimize impacts to the existing utility networks and prepare a stormwater management strategy aligned with UBC's sustainability initiatives

4. Incorporate a pedestrian canopy along Agronomy Road that prioritizes comfort, safety, campus aesthetics, and cost

5. Prepare a Class A cost estimate and detailed construction schedule

1.3. Stakeholder Management

A stakeholder study has been completed to ensure the project accounts for all requirements. Our team identified the relevant stakeholders, developing a consulting plan, and reviewing feedback. Table 2 outlines the relevant stakeholders and their importance to the project.

Table 2: Stakeholder Identification

Stakeholder	Association to the project
UBC Social, Ecological, Economic Development Studies (SEEDS)	The client
UBC Students, Faculty, and Staff	Primary users of the corridor and pedestrian canopy
Ministry of Transportation and Infrastructure	Governs transportation policies within BC
TransLink	Provides transit services along and nearby the corridor
UBC Water & Energy Services	Major utility owners within the corridor
Musqueam First Nations	Are the traditional, ancestral habitants of the territory
UBC Neighbourhood Association	Residents that live near the construction project
UBC Properties Trust	Manage the lands adjacent to the corridor

The feedback provided by the stakeholders was critical to establishing an effective final design. Contact has been established with each of the stakeholder to gather information regarding their issues and concerns. Based on the feedback our team received from stakeholders, our team is confident that the project will receive full support during construction. We will continue to reach out to our identified stakeholders before, during and after construction and address any issues that arise.

2. KEY DESIGN COMPONENTS

During the design phase of this project, our team utilized a number of engineering standards, specifications, and software. The table below outlines them organized by project discipline.

Table 3: Standards, Specifications, and Software used during design

Discipline	Standard / Code Used	Software Packages Used
Transportation	• BC Active Transportation Design Guide • TAC Geometric Design Guide for Canadian Roads • City of Vancouver Engineering Design Manual	• Synchro 10 • AutoCAD • Civil 3D
Structural	• CSA A23.3-14 • CSA S16-19 • NBC 2015	• S-Frame • S-Steel • AutoCAD
Utilities	• City of Vancouver Engineering Design Manual • City of Surrey Design • UBC Integrated Stormwater Management Plan • UBC Utilities Technical Guidelines • UNHSC Design Specifications for Porous Asphalt Pavement and Infiltration Beds	• Civil 3D
Greenspace	• UBC Exterior Improvements Technical Guidelines	• Bluebeam Revu
Construction	• BC Traffic Management Manual for Work on Roadways 2015	• AutoCAD • Bluebeam Revu

2.1. DESIGN CONCEPT

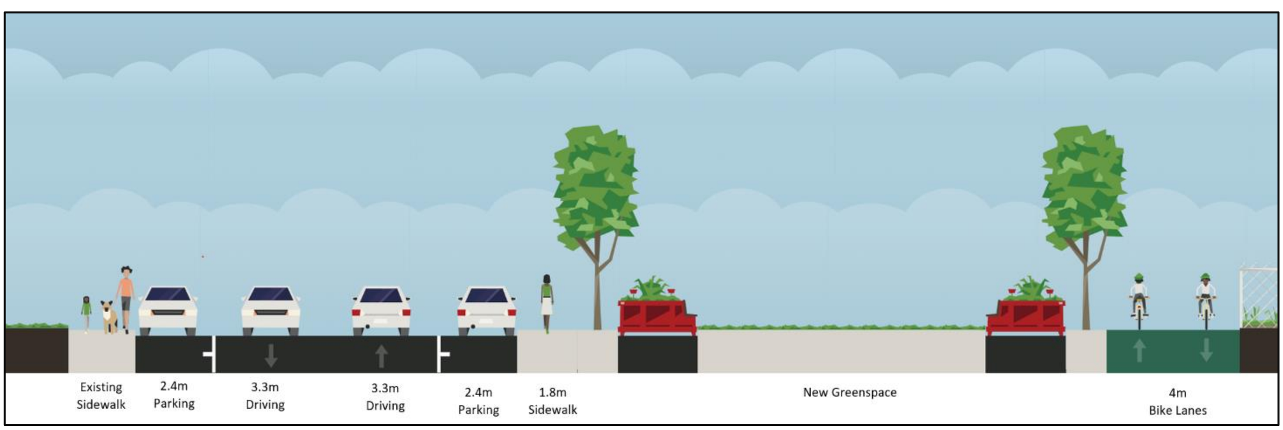

Figure 3: Streetmix cross section of our East Mall Design

Our redesign of East Mall features a full reconstruction of the boulevard. The main feature of this configuration is the shifting of the existing median to the east side of East Mall and moving all the vehicle travel lanes to the west side. Additionally, new traffic calming measures will also be implemented along East Mall to reduce the speed of traffic. This new location of the median will improve the safety of pedestrians and cyclists as it creates a natural separation from the vehicular traffic. Improved access to this area also adds a variety of land use options, and will function as a greenspace featuring new landscaping and space for community garden boxes or public art. A new pedestrian canopy will also be constructed along Agronomy Road and provide shelter for bystanders. A stormwater management strategy has also been prepared centred around the use of permeable pavement for new cycling paths and sidewalks.

Table 4: Summary of design objectives and features

Discipline	Design Objective	Design Feature
Transportation	• Encourage use of active transportation modes • Reduce speeding along East Mall • Reduce vehicle – cyclist conflicts at pick - up drop – off zones • Retain ease of access for current residents	• New 4.0m bi-directional greenway • Reduced travel lane widths • Dedicated drop off pick zones with no parking at any time • Retains parking on both sides of the road
Structural	• Encourage walking along Agronomy Rd. by implementing a pedestrian canopy • Comfortable and safe to use • Cost considerations • Fit with campus architecture	• Spans the full width of sidewalk • Design was inspired from existing UBC bus loop to fit campus architecture • All structural components are the same size and thickness in order to save cost
Utilities	• Ensure post-development demands on UBC utility networks are within pre-development levels • Capture and keep stormwater on-site wherever possible	• Reduce travel lane widths and introduce permeable concrete sidewalks and cycling lanes • Provide stormwater detention reservoir in aggregate base of permeable concrete
Greenspace	• Encourages active modes of transportation • Creates a barrier from vehicle traffic increasing safety of users • Minimize demand on UBC distribution networks and capture stormwater on-site	• Planation of new tree species long median • Community gardens at various points throughout median • Use absorbent topsoil in landscaped areas to promote infiltration
Construction	• Minimize disturbances to surrounding residents	• Existing utilities will remain in place and in-service during construction

3. Transportation Design

This section will describe the design considerations relating to the roadway including roadway dimensions, intersections upgrades, and signage plans.

3.1. Roadway Design

Roadway design was done in accordance with the Geometric Design Guide for Canadian Roads, written by the Transportation Association of Canada (TAC), Engineering Design Manual from the City of Vancouver, as well as the British Columbia Active Transportation Design Guide. Key requirements include: all roadways to have a minimum crossfall of 2.0%, minimum vehicle travel lane width must be 3.25m or greater, grade of proposed alignment must not exceed 10%, and minimum sidewalk widths of 1.8m. Other factors considered in the detailed design include sightline requirements, driver comfort for sag and crest curves, as well as signal timing plans for the proposed signal upgrades at the intersection of East Mall and Thunderbird Boulevard. Software packages utilized in roadway design include AutoCAD and Civil 3D, and intersection analysis and timing plans were done with the aid of Synchro 6. Traffic signs were designed in accordance to the Manual of Traffic Signs and Pavement Markings from the British Columbia Ministry of Transportation and Highways.

3.1.1. Roadway Cross Sections

Roadway cross sections for the newly designed East Mall segment must meet the requirements set out in section 410 in the TAC Geometric Design Guide for Canadian roads. In the proposed design, travel lane widths are set to be 3.30m wide, which satisfies the 3.25m minimum lane width for road segments with a design speed between 50km/h to 70km/h. Roadway crossfall in the design is 2.5%, which satisfies the TAC requirement of having a crossfall of 2% or greater, which is needed in order to provide adequate drainage for the road surface. 2.5% crossfall was chosen in consideration with the climate of the area which experiences high amounts of annual precipitation, and the higher crossfall will assist in facilitating drainage. Existing parking is retained in the new design with 2.4m parking lanes on both sides of the road. 2.4m was chosen to balance the goal of keeping vehicle speeds down on the segment by reducing the amount of space available to drivers, while providing enough room for parked vehicles. Sidewalk widths for the new segment are designed to be a minimum of 1.8m throughout the segment. 1.8m provides enough space for pedestrians to feel comfortable, safe, and allows for movement in both directions. A good sidewalk network is vital in encouraging more users to choose active transportation modes such as walking or cycling. Lastly, the multiuse pathway in the design is 4.0m, surpassing the required 2.7m as required by the British Columbia Active Transportation Guide (BCATG). A wide facility provides users more space to travel on the corridor and encourages more users to make trips with modes like cycling, walking, skateboarding, and rollerblading safely and comfortably. Having good a greenway network is also beneficial for the UBC campus as it allows for better accessibility for the future Stadium development, which is projected to add thousands of units of occupancy.

Table 5: TAC Geometric Design Guide – Roadway Width Requirements

Design Speed (km/h)	Lane Width(1) (m)		Unpaved(1) Shoulder (m)	Normal X-Fall (m/m)	Fill Slope(2)
	ADTT>15(3)	ADTT<15(3)			
80 - 90	3.6	3.5	0.5	0.02	2:1
50 - 60 - 70(5)	3.5	3.25(4)	0.5	0.02	2:1
30 -40(5)	3.25(4)	3.25(4)	0.5	0.02	2:1

3.1.2. Roadway Profile

The roadway profile was also designed to meet the requirements set out in the TAC Geometric Design Guide. Key requirements for the profile of the roadway include grade requirements and sightline requirements. The roadway profile primarily depends on the existing natural topography of the area, which is mostly flat. Hence the proposed roadway will largely overlap with the existing roadway profile and does not contain large elevation changes, with the biggest grade change at 4%, which is below the 10% maximum grade requirement outlined in the TAC Geometric Design Guide. When designing the roadway profile, sightline distances were also taken into consideration in order to satisfy the 65m sight distance for a roadway with a design speed of 50km/h. The length of the crests and sags were also calculated in accordance with best practices currently used in North America. Crest and sag lengths are important to rider comfort as well as stopping distances. Sample calculations can be found in the attached Appendix C. The figure below showcases the roadway profile of the proposed design.

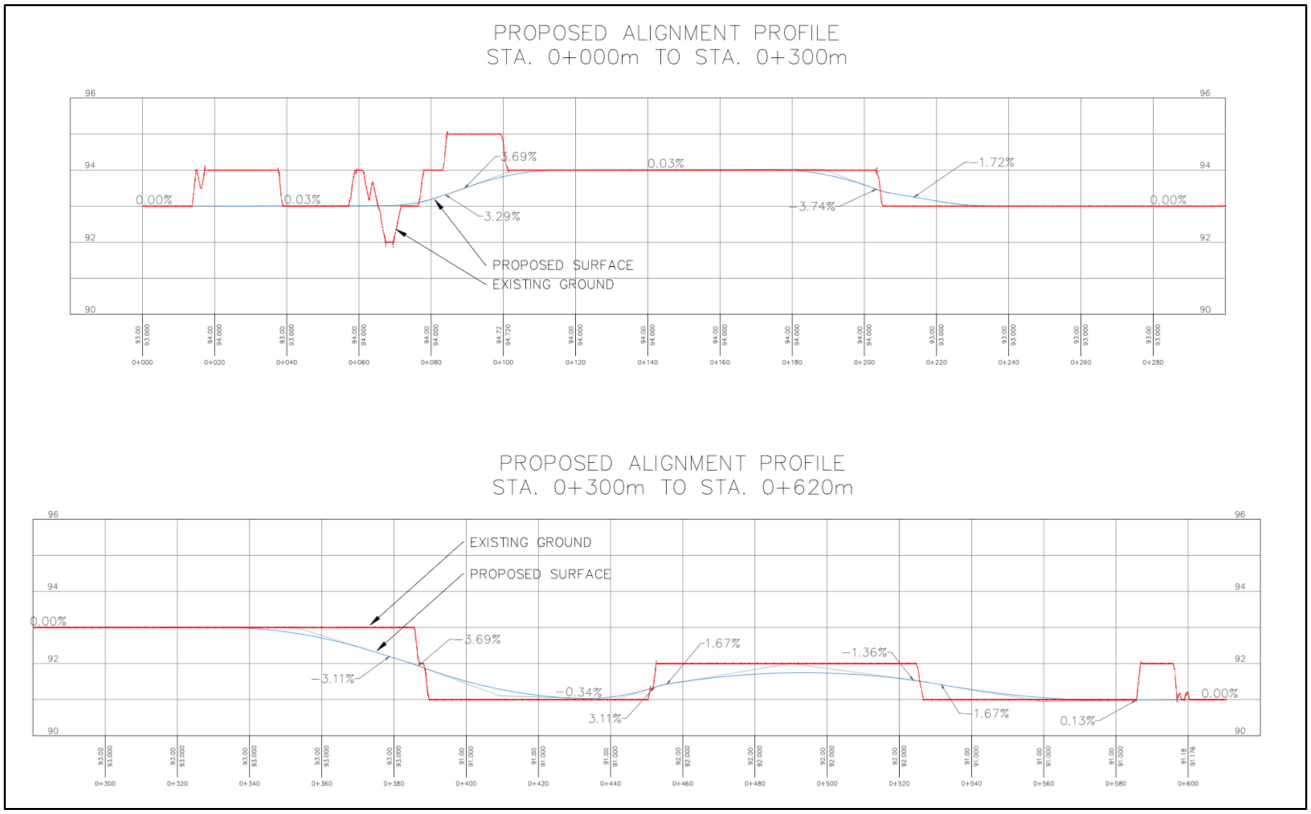

Figure 4: Roadway Profile of Proposed Design

3.2. Thunderbird Boulevard and East Mall

East Mall runs parallel to Westbrook Mall and Marine Drive and is one of the few roads that run North-South on the UBC Campus, providing key connections to locations such as the Health Sciences Parkade and Thunderbird Stadium. A traffic analysis on the intersection of Thunderbird Boulevard and East Mall will be provided in detail throughout this section.

3.2.1. Existing Conditions and Issues

Currently, the intersection of Thunderbird Boulevard and East Mall is controlled by an existing pre-timed signal. The intersection services around 800 vehicles in the AM peak period and around 1150 vehicles in the PM peak. A majority of the vehicle traffic in the AM period are vehicles heading northbound into the campus, while in the PM period most vehicles are heading south and leaving the campus. The existing configuration is as follows: The South, West, and North approaches all have one receiving and departing lane, while the East approach has one receiving lane and two departing lanes, one dedicated to a left turn movement and the other for through and right movements. The intersection also sees high pedestrian volumes, with around 300 crossings in both the AM peak and PM peak periods. Cyclist volumes should also be accounted, as there are around 130 cyclists in both the AM and PM peak periods. The following figure shows the vehicle volumes serviced by the intersection:

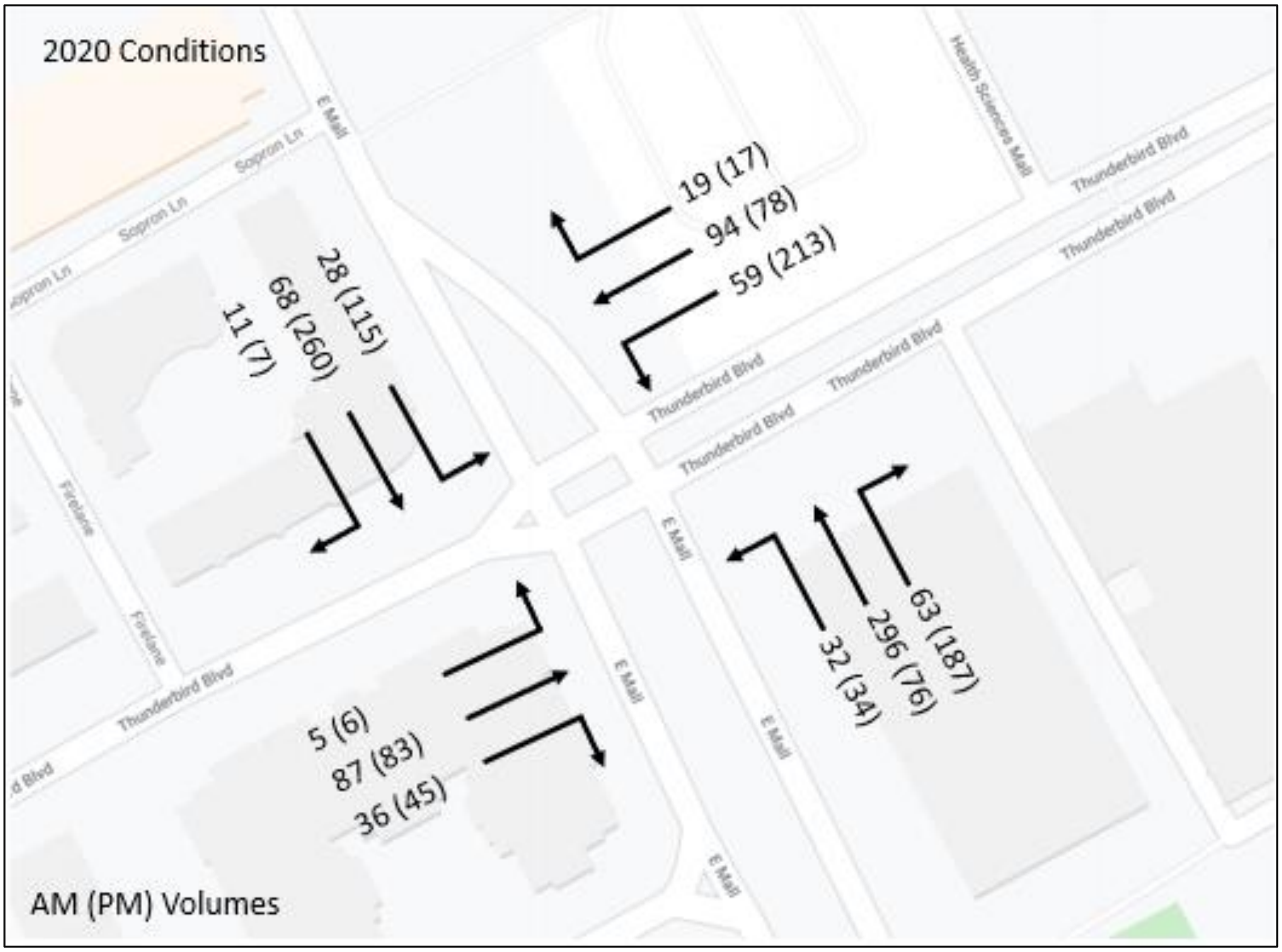

Figure 5: Existing Vehicle Volumes at intersection of Thunderbird Boulevard and East Mall

As shown in Figure 5, there are many vehicles making the westbound-left movement in the PM peak period, and the current traffic signal is not capable of providing a protected left turn movement for those motorists and is a bottleneck in the system.

3.2.2. Proposed Design Changes at Thunderbird Blvd and East Mall

To better facilitate pedestrian and cyclist movements, it is proposed that vehicle travel lanes on the North approach to be moved to the west side of East Mall, allowing the existing northbound lane to be converted into a dedicated bi-direction bicycle lane with bollards acting as a barrier to vehicle traffic. The goal behind this design is to prioritize active transportation modes and provide additional capacity for cyclists and pedestrians. Having dedicated conflict paint will provide users of the greenway a safer experience crossing the intersection by making drivers more aware. A bi-directional bicycle lane makes full use of the existing road space and encourages drivers to slow down due to having less buffer space. The proposed design also includes a full signal upgrade on the intersection to allow for protected westbound left turn movements in the PM peak period to alleviate total intersection delays. To accommodate this, induction loops are to be installed on the westbound left turning bay on the East approach. Section 3.2.3 will discuss the rationale behind this upgrade and provide additional analysis and justification. The figure below highlights the proposed changes to the intersection.

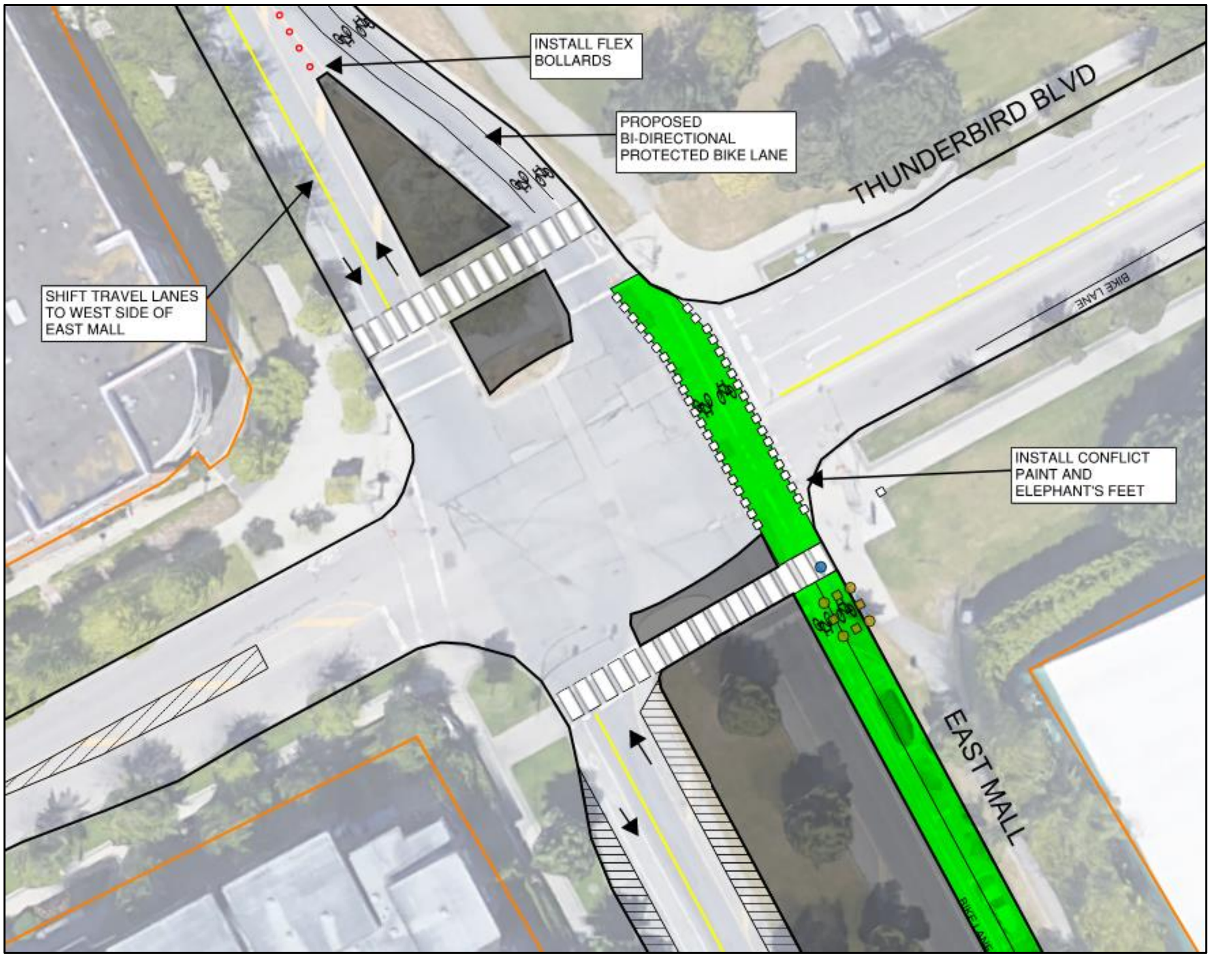

Figure 6: Proposed Design at Thunderbird Boulevard and East Mall

3.2.3. Synchro Analysis

Intersection performance analysis at Thunderbird Boulevard and East Mall was performed using Synchro. The performance of the intersection with the addition of a protected westbound left movement was compared to the existing conditions. The results from the Synchro model showed that in the AM peak period, having a protected westbound left phase decreased the performance of the intersection due to the low volumes. Therefore, it is recommended that the AM peak period retain its current timing configuration. However, in the PM peak period, having a dedicated phase for vehicles making the westbound left movement decreases the delay from an estimated 43 seconds to 22 seconds while maintaining the same overall intersection delay. The results from the Synchro analysis are shown in the table below. A sample Synchro report can be found in Appendix I.

Table 6: Intersection LOS and delays with Existing and Upgraded Signal

	Intersection LOS				Intersection Delays			
	Existing Signal	Upgraded Signal		Existing Signal		Upgraded Signal		
Movement	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
EBL	B	B	B	B	18.5	11.3	16.4	18.1
EBT	B	B	B	B	18.5	11.3	16.4	18.1
EBR	B	B	B	B	18.5	11.3	16.4	18.1
WBL	B	D	A	C	19.2	43.2	9.7	22.3
WBT	B	B	B	A	19.1	11.8	10.0	8.9
WBR	B	B	C	A	19.1	11.8	10.0	8.9
NBL	B	B	C	B	16.3	11.6	27.1	14.6
NBT	B	B	C	B	16.3	11.6	27.1	14.6
NBR	B	B	C	B	16.3	11.6	27.1	14.6
SBL	A	C	B	C	7.5	21.1	12.8	30.1
SBT	A	C	B	C	7.5	21.1	12.8	30.1
SBR	A	C	B	C	7.5	21.1	12.8	30.1
Overall	B	C	B	C	16.3	21.6	19.9	21.6

3.3. Agronomy Road and East Mall

The intersection of Agronomy Road and East Mall is north of Thunderbird Boulevard and is the next intersection for users heading north on East Mall after passing Thunderbird Boulevard. This section will highlight the challenges currently posed on the intersection and the proposed changes to tackle these challenges.

3.3.1. Existing Conditions

Unlike the intersection at Thunderbird Boulevard, the intersection of Agronomy Road is much narrower and supports larger volumes of pedestrian activity due to its proximity to the UBC Centre for Advance Wood Processing and nearby businesses such as the Starbucks at the southeast corner of the intersection. For this report, vehicle volumes on the intersection are assumed to be lower than the intersection of Thunderbird Boulevard due to pedestrian activity as count data was not available at the time of the study.

3.3.2. Proposed Changes

Sticking with the goal of improving active transportation along the corridor, improvements at the intersection of Agronomy Road and East Mall include installing conflict paint and elephant's feet to help facilitate crossing of cyclists and continuing the bi-directional protected bicycle lane originating from Thunderbird Boulevard. The bi-directional bicycle lane is set to terminate at the Agronomy, but the conflict paint markings will allow cyclists to continue northbound on East Mall and provide southbound cyclists a safe connection onto the greenway. The figure below shows the proposed changes at the intersection.

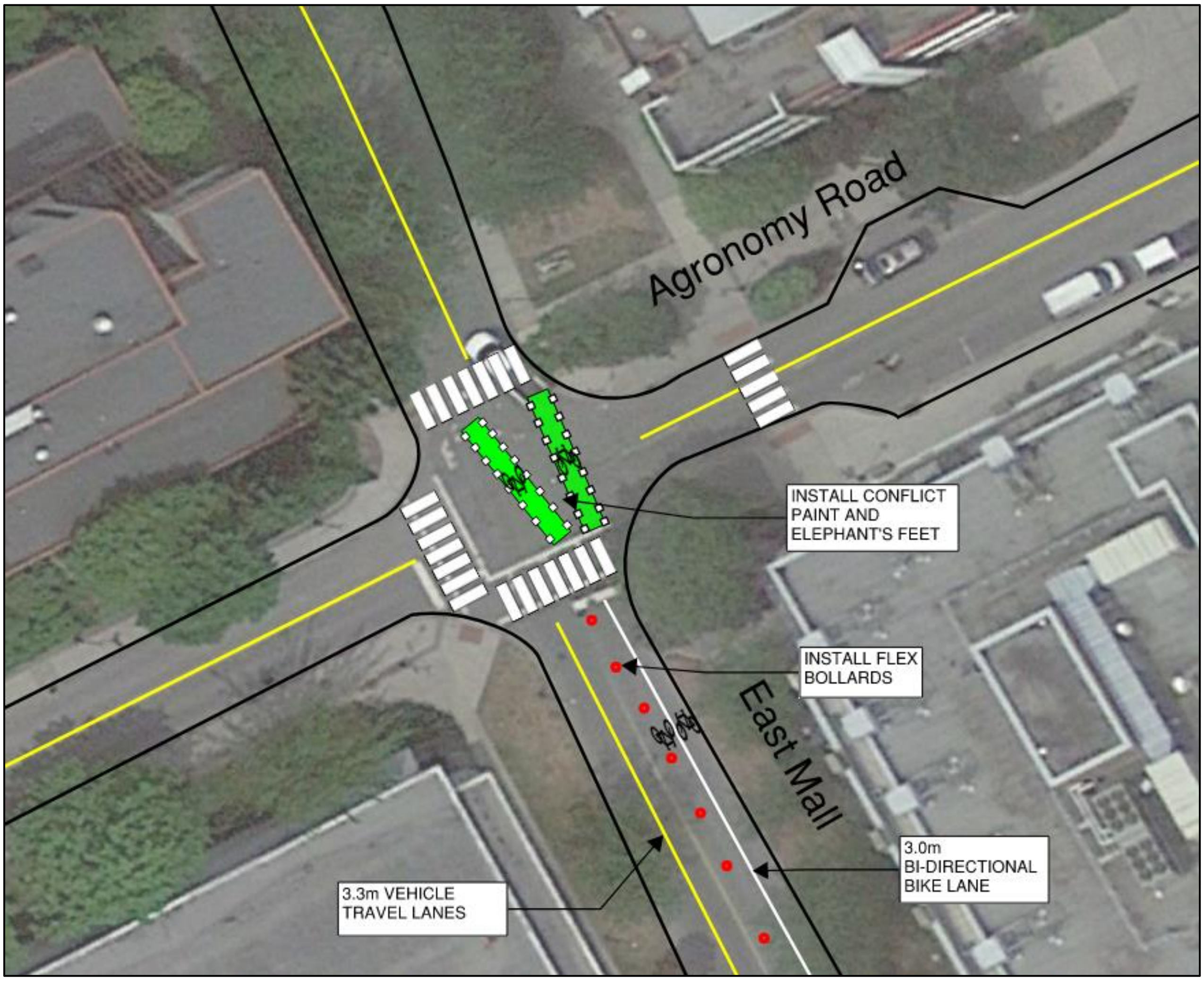

Figure 7: Proposed Changes at the Intersection of Agronomy Road and East Mall

3.4. Signage Plan

The signage plan was designed in accordance with the Manual of Standard Traffic Signs & Pavement Markings from the British Columbia Ministry of Transportation and Highways. Many of the new proposed traffic signs are due to the greenway shifting the travel lanes to the east side of the boulevard. Due to the future Stadium Neighbourhood changes, two zebra crosswalks will be added to facilitate anticipated foot traffic growth on the south end. Additional time-limited parking spots will follow the current design, indicated by white paint. The proposed signage plan can be found in Appendix A.

4. STRUCTURAL CANOPY DESIGN

The detailed structural design and analysis of the proposed pedestrian canopy is outlined in this section. The canopy structure will be made up of wide flange steel beams and columns with tempered glass panels. The structure will be constructed on the south side of Agronomy Road, due to the existing awnings and trees/shrubs on the north side the north side that would obstruct the proposed canopy. As shown in Figure 8 below, the canopy will have one 12.73-metre section and one 54.13-metre section separated by the parking lot driveway. The total length of the structure will be 66.86-metres.

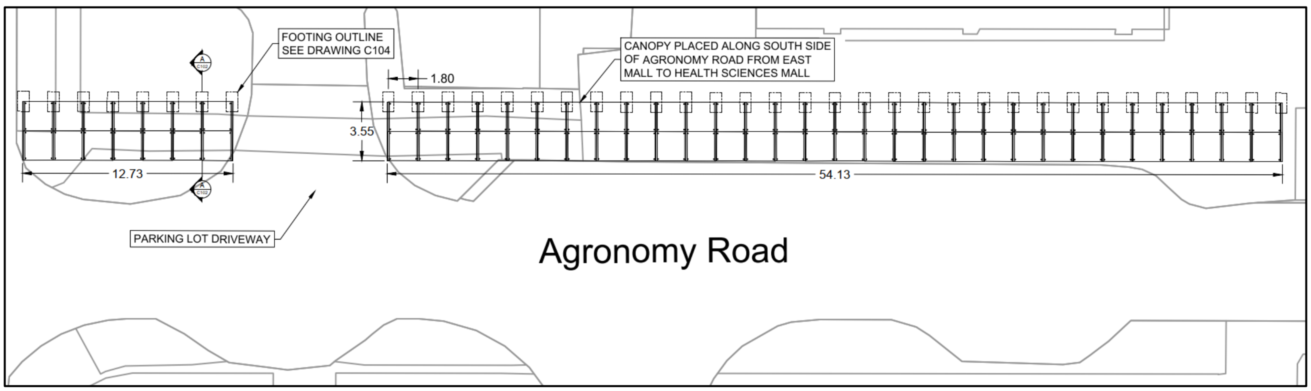

Figure 8: Pedestrian canopy plan

The detailed design process consists of sizing the main structural members, designing the connections, and sizing the foundations. Technical drawings and specifications for the canopy can be found in Appendix A.

4.1. DESIGN LOADINGS

The loading on the structure was determined in accordance with NBC 2015 and consists of dead, snow, and wind loads. Live loads and earthquake loads were not included in this analysis. The considered loads will determine the member sizes and connection detail based on Ultimate Limit States or Serviceability Limit States. Since the canopy structure will not have live loading, the design of the members and connections will be governed by serviceability requirements. A summary of loads is given below:

Table 7: Summary of load combinations used for analysis

Case	NBC 2015 Load Combination	Load on Cantilever [kN/m]	Load on Column [kN]
1	1.4D	1.06	5.85
2	1.25D + 1.0S or 0.4W	2.42	10.54
3	**1.25D + 1.5S + 0.4W**	**3.59**	**14.75**
4	1.25D + 1.4W + 0.5S	3.19	13.31
Serv.	**1.0D + 1.0S + 1.0W**	**3.31**	**13.37**

4.1.1. Snow Load

Snow loading for the structure were determined in accordance with NBC 2015 Clause 4.1.6. NBC specified a 1.8-kPa 1-in-50-year ground snow load for the Vancouver City Hall region. The importance factor for this structure was assumed to be 1.0. The final snow load to be used for analysis was 1.64-kPa. Further detailed calculations can be found in Appendix D.

4.1.2. Wind Load

Wind loading for the structure was determined in accordance with NBC 2015 Clause 4.1.7. The external and internal pressure cases were calculated, and both resulted in a wind uplift of 1.20kPa. The reference velocity pressure used was 0.45-kPa for the Vancouver City Hall region and the assumed importance factor was 1.0. Further detailed calculations can be found in Appendix D.

4.2. Structural Analysis

The analysis completed on the structure consisted of a typical section (ie. cantilever and column) with fixed joints and supports. Loads from the previous section were applied as shown in Figure 8 below. The snow load was applied with global projected coordinate system, wind load was applied in the local coordinate system, and dead load was applied with global coordinate system. The analysis model is shown in Figure 9.

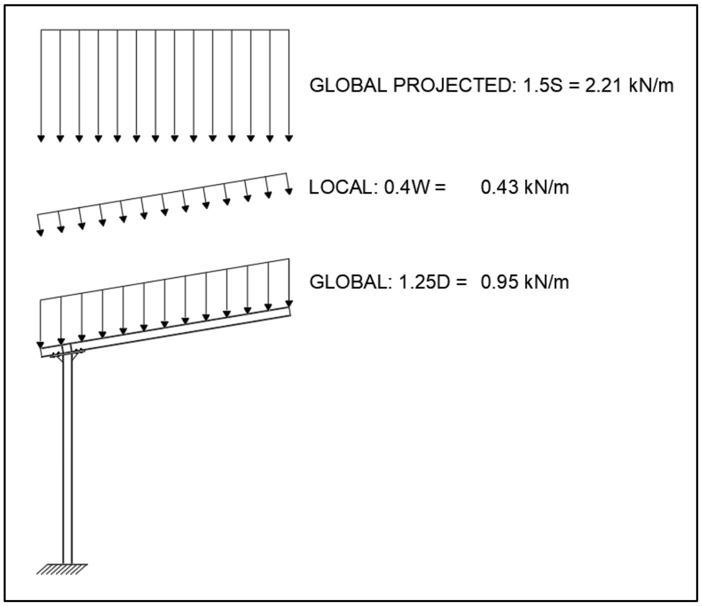

Figure 9: Loads inputted into S-Frame

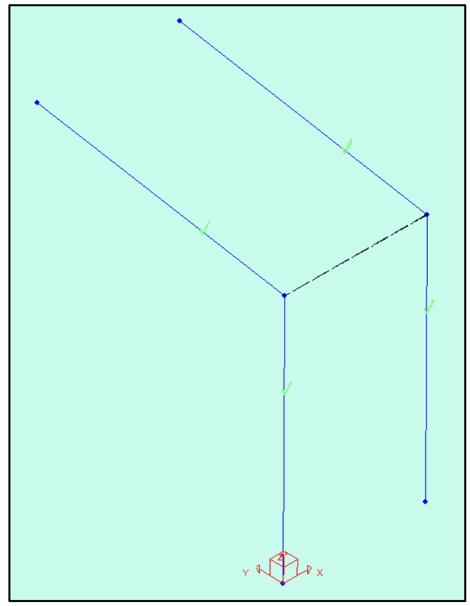

Figure 10: S-Frame analysis model

All ultimate limit states requirements as specified by NBC 2015 were met. See Appendix D for the code checks from S-Frame. The wide flange section that resulted from serviceability limit states was a W200x31 section profile. The deflection at the outer edge of the cantilever beam due to the serviceability load combinations was 33mm. A L/120 deflection requirement results in a maximum displacement of 30mm. As a result, a standard 10-millimetre thick, 100-millimetre-high stiffener plate will be added on both sides of the top and bottom connection. See Appendix A for detail drawings.

4.3. Connection Design

The top and bottom connections as identified in Figure 9 above will be a fixed moment end plate design with similar hex bolt layouts. The end plates will be welded to the column using a fillet weld 6-millimetres thick all around the wide flange section. Three checks on the connection capacities due to internal bending transfers were completed. The prying force on the end plate, yielding of the end plate, and strength of the welds were all passed for both connections. See Appendix A for connection details and Appendix D for calculations.

4.4. Footing Design

The plan dimensions of the footing were initially determined based on the soil type obtained from the Piteau Geotechnical Report. The specified soil type was dense sand with a soil bearing capacity of 150-kPa (based on NBC 2015 Table 9.4.4.1). The resulting plan dimensions are 0.7-meters wide by 1.2-meters long. The depth of the footing was found based on the required overturning resistance of the canopy loads. A depth of

1.3-meters was found to be sufficient to resist the overturning moment. See Appendix A for connection details and Appendix D for calculations.

4.5. Construction Considerations

A construction plan was developed in accordance with NBC 2015. Since the location of the pedestrian canopy will be in a relatively high traffic area, construction fencing, and barricades will adhere to Clause 8.2.1 of NBC 2015 during weekdays. Construction of the canopy shall occur inside an enclosed area with at least 2.0-meters of distance between any adjacent pedestrian areas. Additionally, excavations for the canopy footing shall be kept clear of water to prevent soil and water contamination, and necessary shoring or bracing shall be installed. Proper pedestrian and vehicular traffic management should be implemented as necessary and construction waste materials should be disposed of appropriately.

5. Utilities Design

The following section details the municipal utilities engineering design including the water, sanitary, and stormwater network components.

5.1. Existing Utilities

An initial assessment of the existing utilities has been conducted, based on information provided by the client. While a PDF displaying a plan view of the underground utilities was provided by UBC Seeds, titled UtiilityMasterMap2019, it is not up to date nor high enough resolution to determine accurate alignments and dimensions. As-built drawings for the project area were not available, and so no detailed location and depth information could be found. Figure 11 below shows a snippet of the master utility map. Utility relocations and diversions do not fall under the original scope, and so were not considered for this project. Further, certain utilities are likely to fall under different ownership groups such as FortisBC, and the decision to conduct realignment ultimately does not fall under the project teams' control. The proposed design is generally limited to the road surface and does not introduce any major underground elements that would require the current alignments to be moved. However, an analysis of the water, sanitary, and stormwater systems was conducted to determine if upsizing will be required and can be found in the subsequent report sections.

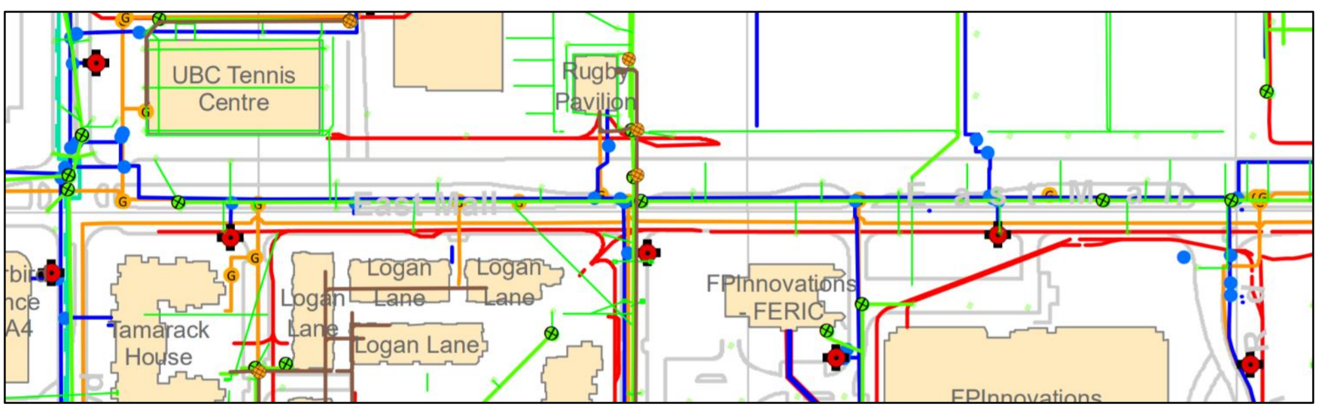

Figure 11: Existing underground utilities

5.1.1. Utilities Design

The following table summarizes the existing utilities identified based on available resources, as well as approximate dimensions, typical depths of cover, and key comments:

Table 8: Existing Utility Summary

Utility	Dimensions (mm)	Typical Depth of Cover (mm)	Comments
Communications	400 x 600	600	• Not shown on master utilities plan, but identified by UBC SEEDS • Likely third-party owned
Electrical	400 x 600	600	• Not shown on master utilities plan, but identified by UBC SEEDS • Likely third-party owned
Natural Gas	∅ 50 to ∅ 100	600	• Service connections not shown • Likely third-party owned
Water	∅ 200 to ∅ 250	900	• Likely to be small diameter • Service connections not shown
District Energy (Water)	Unknown	Unknown	• Not shown on master utilities plan, but identified on UBC Energy publications • Located along Thunderbird Boulevard • High-temperature pressurized main
Sanitary	∅ 200 to ∅ 450	1500 to 3000	• Manholes, service connections, and cleanout information not available • No distinction made between gravity and pressurized mains
Storm	∅ 300 to ∅ 900	1500 to 3000	• Likely to be large diameter mains along East Mall • Manhole and service connection information not available

While the communications and electrical duct banks were not shown on the plan view sheet, typical construction practice is to install close to the surface and underneath the main roadway or sidewalk. Based on an inspection of the project area, most buildings directly facing East Mall are only reachable by mains along the corridor and so must have service connections not shown in the mastery utility map. Service connections are generally installed perpendicular to the main utility with less depth of cover. Other major infrastructure components like manholes are visibly present in the project area, though they are not indicated in the utility map.

5.1.2. Construction Considerations

Based on the City of Vancouver's Engineering Design Guides, the geotechnical requirements for bus lanes call for a minimum of 50mm of surface mix, 180mm of base of mix, 150mm of 19mm crushed granular base, and 300mm of 17mm crushed granular base for a total excavation depth of 680mm beneath the road surface. Communications, electrical, and natural gas conduits will fall directly in the excavation zone and water mains are likely to be encountered where over excavation is required. Information on the district energy system is not available but is likely to have similar specifications as the water mains. Based on the estimated depth of cover, sanitary and storm mains are unlikely to be encountered during construction. However, service connections to adjacent properties are generally found at shallower depths and could be located in the excavation area. Sanitary and storm sewer manholes also fall within the reconfiguration area, though are identifiable prior to construction. As such, safety during construction is the primary concern, and our team has outlined considerations in the General Notes of the drawing package and the Construction Specifications including the following key requirements:

- The Contractor will perform a detailed utility locate to confirm the alignments and depths of existing utilities prior to commencing construction
- Hand excavation will be required within 300mm of any pressurized utilities
- The Consultant will be contacted prior to any construction work requiring the removal or shutdown of an existing utility

5.2. Water and Sanitary

UBC owns and operates both the water distribution and sanitary sewer networks on campus. Both have been identified within the East Mall corridor, as well as the Academic District Energy System which intersects along Thunderbird Boulevard. Sheets W101 and S101 in the drawing package provide plan-view drawings of these systems, as well as construction comments and notes. The focus of this project is a road reconfiguration for East Mall and does not introduce any new developments to the project area that need to be serviced by the existing water or sanitary networks. As such, the post-development demands on these underground utilities will be unchanged from the pre-development demand. A survey of the existing hydrants was conducted, and no relocation will be required for the final design. No improvements will be required, and thus the emphasis will be to maintain service and minimize disturbances during the construction phase.

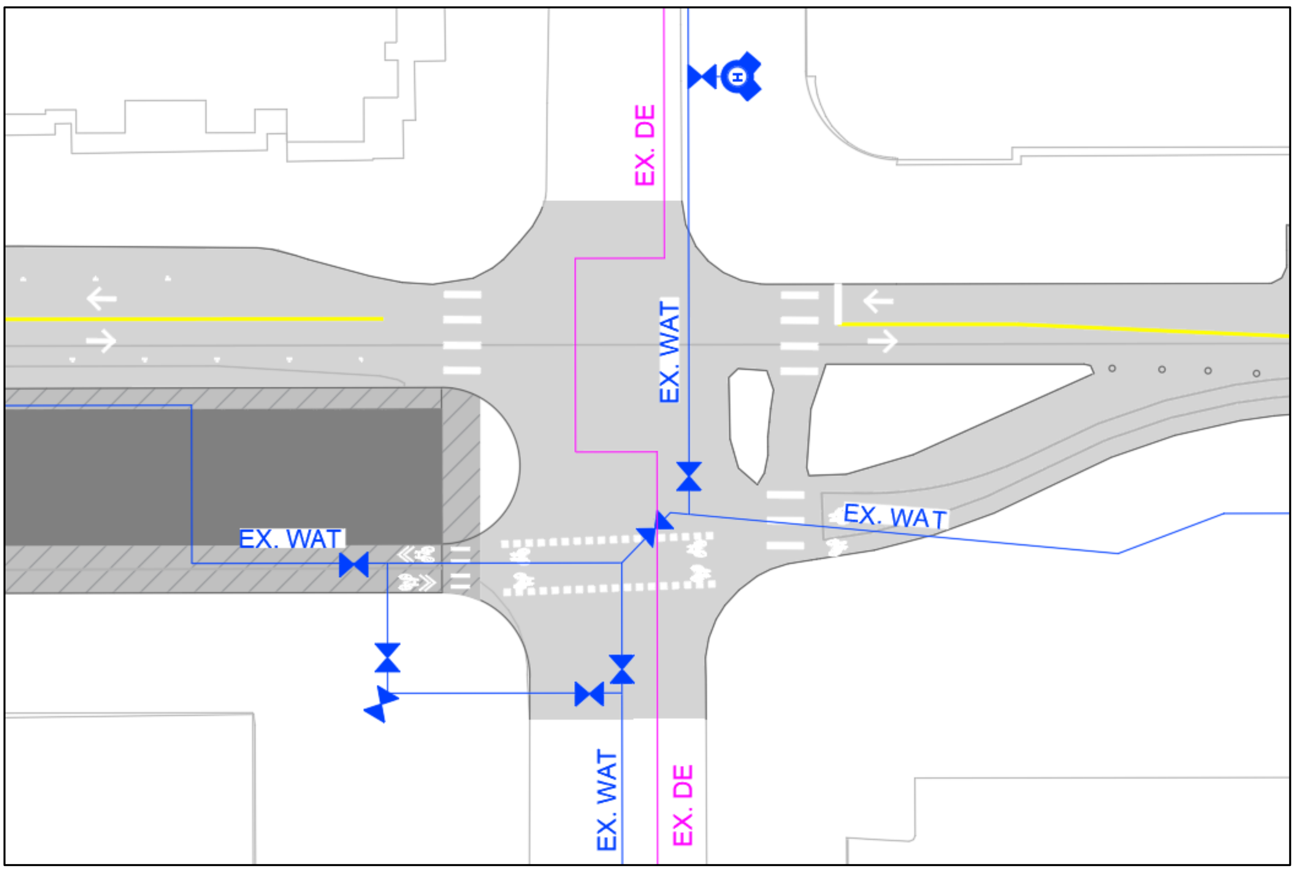

Figure 12: Water Utilities Map at Thunderbird Blvd. and East Mall

In addition to the previously identified construction considerations, stub lengths and pipe loops have also been identified in the water distribution system. Flow can often become stagnant in these areas, and potentially lead to health concerns if the system is not adequately maintained. UBC will be contacted to determine if these sections should be removed or grouted. Hydrants, manholes, and other ground-level infrastructure should remain in place during construction. Service should not be stopped without first getting approval from both the Consultant as well as UBC. Without further information, the sanitary and district energy mains should both be considered to be pressurized and treated as high-risk. Excavation should be done by hand around the mains to avoid potentially damaging them.

5.3. Stormwater

Ensuring that UBC's sustainability initiatives were met was one of the main design objectives, and proper stormwater management plays a critical role in this. The existing corridor has a paved roadway with a shared bicycle lane and an adjacent sidewalk drained through catch basins along the curb line. Rainfall is then directed into the stormwater sewer system, which is owned and operated by UBC. From Thunderbird Blvd. to Agronomy, runoff is directed into the University's Western catchment and out through a creek adjacent to Wreck Beach. South of Thunderbird, runoff is directed along into the University's 16th Avenue Catchment area and the majority drains out within Pacific Spirit Park. While a detailed control plan is not required based on UBC's technical guidelines, the following section outlines the management philosophy for the site.

5.3.1. Management

Throughout the design process, our team minimized runoff and the amount of impermeable area introduced wherever possible. Decreasing the travel lane widths and specifying permeable pavement for the new sidewalks and bicycle paths are two key features of the new corridor that reduces the impermeable area. These impermeable surfaces are associated with the fast runoff response in the system and reducing the tributary area that drains into pipe network reduces the total runoff volume and by extension reduces the peak flow entering the system. The capture method for the roadway has remained the same as before, with both directions sloped towards the adjacent gutter line. According to the City of Surrey's Design criteria, catch basins should serve a maximum catchment area of $500m^2$. With a typical road width of 12.2m, catch basins will be spaced every 35m including a factor of safety. However, this spacing is actually less than what is currently being provided by the existing catch basins. Furthermore, as the stormwater main does not need to be upsized, removing the existing basin leads then installing new ones is redundant and adds unnecessary construction complexity. As a result, catch basins on the roadway will be relocated to follow the new curb line and the leads will be adjusted to suit. Existing basins should be reused wherever possible as long as they are in adequate condition to reduce construction waste.

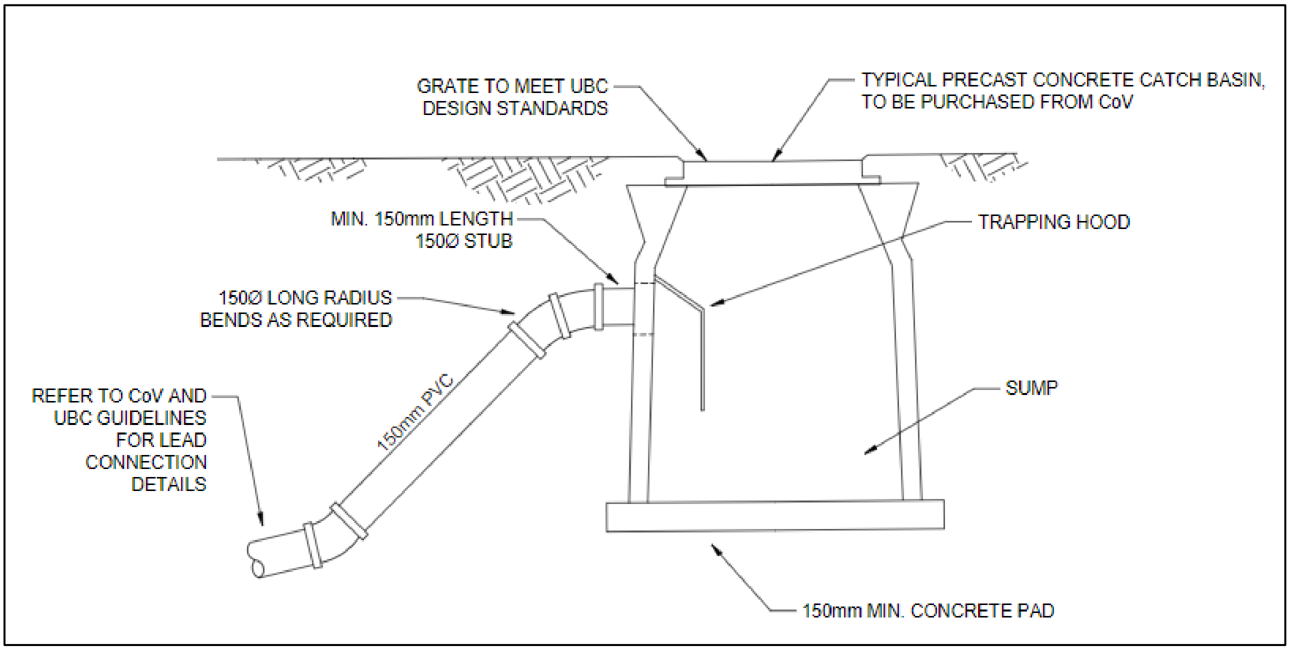

Figure 13: Typical Catch Basin

Landscaped areas like the greenway do not drain into UBC's system, and precipitation is expected to percolate into the groundwater. In accordance with UBC's technical guidelines, the greenspace will also feature a 450mm layer of absorbent topsoil to promote infiltration. More extensive gardening and planting on the proposed greenspace helps to improve stormwater quality by acting as a filter prior to percolation. Similarly, the permeable concrete also allows stormwater to be kept on site instead of captured into the sewer system and conveyed away. From the Integrated Stormwater Management Plan, UBC's preferred implementation strategy is to use detention to capture flooding. As such, the permeable concrete was also designed to have A base aggregate reservoir capable of storing a major storm event. Drawing D101 shows a plan view of the stormwater utilities in the project area, including landscaped and permeable areas.

5.3.2. Permeable Concrete

Permeable concrete is still a relatively developing field, and there are currently no widely accepted standards. The design for the permeable concrete was developed based on best practices and guidelines from the City of Vancouver, National Ready Mixed Concrete Association, UNH Stormwater Centre, and Flood Testing Labs. Layer depths were determined based on the capacity required to store a 10-year 24-hour duration intensity storm, assuming no infiltration into the subgrade. The final design offers 95.2mm of storage compared to an expected 67.2mm of precipitation. This contingency can help to detain excess rainfall from the adjacent landscaped areas and prevent ponding in extreme events. Detailed calculations are available in Appendix E.

Table 9 summarizes the target construction specifications for the permeable concrete, and Figure 14 below illustrates the required layers for construction:

Table 9: Permeable Concrete Specifications

Specification	**Requirement**
28 Day Compressive Strength	20 MPa
Infiltration Rate	8600 mm/hr
Void Space	15%
Unit Weight	1500 kg/m^3 to 2000 kg/m^3
Slump	15cm to 18cm

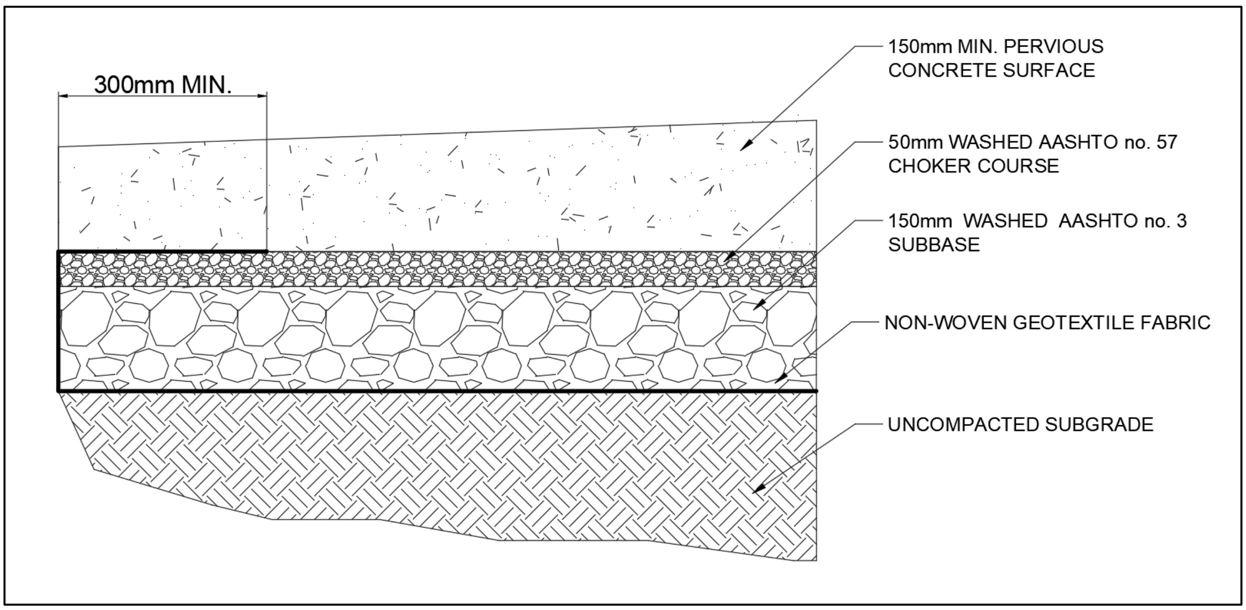

Figure 14: Required permeable concrete layers

A detailed mix design was considered to be outside of the scope of the project, and the Contractor will be expected to develop a final mix design meeting the above specifications. Due to differences in load response, permeable concrete requires slightly different procedures than conventional concrete. Detailed specifications are provided in the Construction Specifications, but the following key points are identified:

- Conventional strength tests are not recommended as compaction is highly variable in cylinder tests for permeable concrete. Instead, a void-density curve should be established for the final mix-design and used for quality assurance during construction
- Concrete should be moistened then covered for curing within 20 minutes of initial placement and compaction

- A minimum of two panel tests should be conducted on site according to ACI 522.1-13 to establish acceptable ranges for hardened concrete
- Three cores will be tested every 75 m^3 poured to verify infiltration rate, dimensions, and average hardened density are within values obtained from the test panels in accordance with ASTM C1754

6. Greenspace

The final design includes a multi-purpose green space separating the travel lanes and the cycling path. One of the primary objectives is to encourage use active and sustainable modes of transportation. This new greenspace encourages provides a place for people to gather and enjoy the surrounding landscape, thereby improving the sense of community and health of residents. The landscape architecture design for this area was based on UBC's sustainability recommendations and past examples of integrated spaces like the Arbutus Greenway.

The final greenspace design involves the transplanting the existing maple trees and the planting of 4 new trees at each crossing to further improve on the aesthetic of the corridor. The four new trees to be planted are the Saucer Magnolia, Weeping Cherry, Eastern Redbud, and Red Oak. Additionally, the greenspace features a community garden consisting of several different species of plants at various locations of the median. A summary of the plants utilized in the final design is summarized in the figures below.

Figure 15: Hydrangeas (gardeningknowhow.com)

Figure 16: Rudbeckia (oscseeds.com)

Figure 17: Fountain Grass (gardeningknowhow.com)

Figure 18: Mearlow Sage (americanmeadows.com)

Figure 19: Tulips (americanmeadows.com)

The overall layout and locations of the various components of the greenspace is shown in Figure 20 and 21 below. Figure 20 displays the greenspace plan from Thunderbird Blvd to Eagles Dr, and Figure 21 displays Eagles Dr. to Stadium Rd.

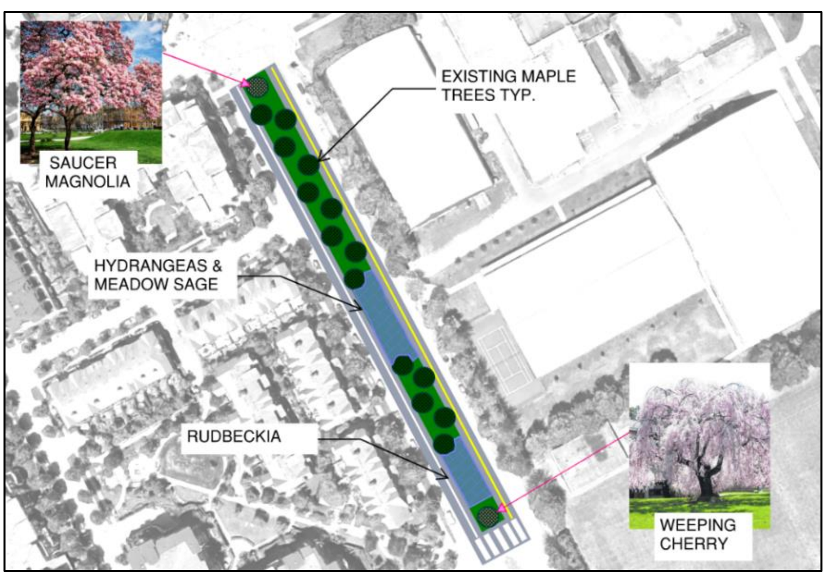

Figure 20: Greenspace Plan from Thunderbird Blvd to Eagles Dr.

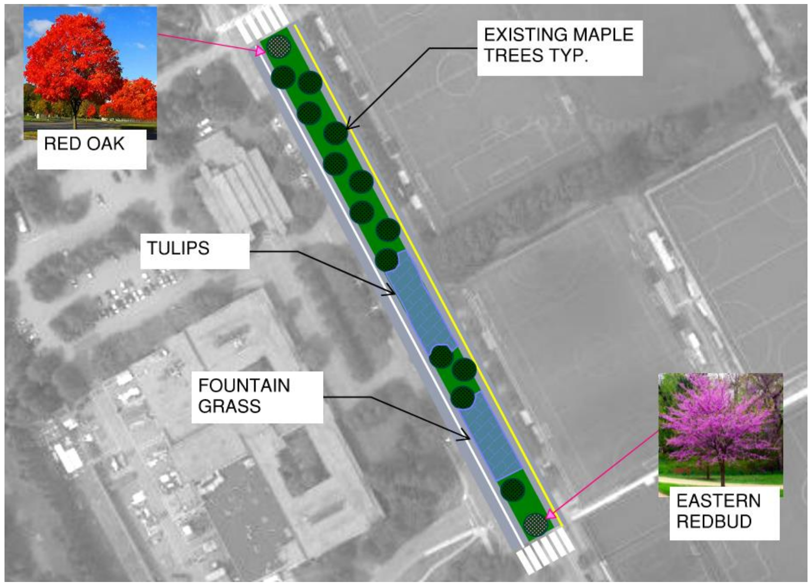

Figure 21: Greenspace Plan from Eagles Dr. to Stadium Rd.

Construction requirements for the greenspace include the following:

Construction for the greenspace is expected to be done in accordance with the UBC Exterior Improvements Technical Guidelines. In conjunction with current best practices the following key requirements have been identified:

- Where possible, existing trees along the current median are expected to be transplanted to their new proposed locations
- Newly planted and transplanted trees must be spaced apart according to their mature canopy spread
- Erosion control devices such as silt fencing shall be installed to prevent siltation and/or erosion within the tree protection zone
- Ensure that soil texture, fertility and drainage at the new planting site by laying composted bark mulch and absorbent topsoil
- Soil should be tested prior to installation to ensure acidity and nutrient composition is adequate for the specified plants

7. Construction Management

This section will provide information regarding construction sequencing, anticipated issues during construction, the construction schedule, and our traffic management plan.

7.1. Sequencing

To mitigate disruptions to the overall network, construction activity has been sequenced into five sections, each relating to a specific portion of East Mall. The bulk of the work has also been further divided into three phases. Figure 22 details the scope of each specific sequence. For full breakdown of tasks and timelines, refer to Section 7.3. Materials and equipment rentals will be procured at the start of each section. Reviews will be undertaken at the end of each activity, with an audit at project turnover.

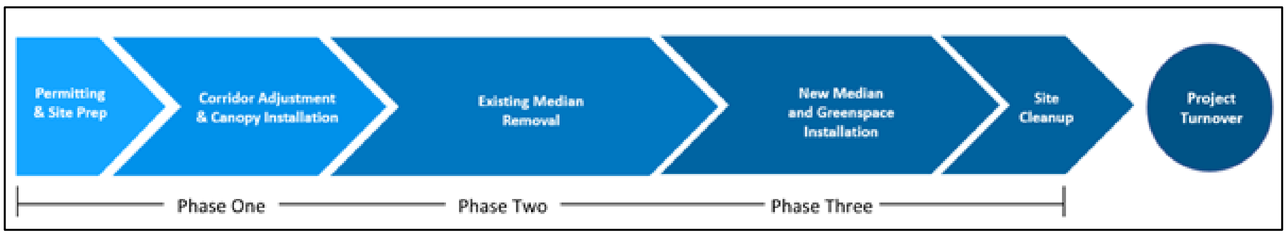

Figure 22: Construction phases and sequencing

7.2. Anticipated issues

A detailed risk assessment was conducted to outline potential setbacks during construction. Table 10 provided below presents several key hazards identified, along with their likelihood of occurrence and impact to the project. A more detailed description of the hazards is also provided in this section. Refer to Appendix H for the risk register in its entirety.

Table 10: Risk analysis of construction method

Risk	Likelihood	Impact
Design changes	Low	High
On-site incidents	Moderate	Moderate
Interrupting Buried Utilities	Low	High
Traffic Delays	Moderate	Moderate
Damage during tree transplant	Moderate	Low

Design changes

Due to continuous stakeholder engagement, there is potential for varying magnitudes of design changes. Unforeseen site conditions might also require change orders during construction. A substantial change could greatly impact the traffic and stormwater analysis, resulting in schedule delays and cost revisions. To mitigate this, site constraints will be clearly communicated to stakeholders and contractors. Our team will also address issues case by case to mitigate design changes.

On site incidents

This hazard includes both worker and pedestrian accidents on site. Due to the sheer number of days worked, it was deemed a moderately probable occurrence. Impacts would vary depending on the incident. To mitigate this, procedures will be developed with worker safety at the forefront. A daily hazard assessment of the site must be conducted prior to start of work by the supervisor. Routine site inspections will be conducted to ensure WorkSafeBC compliance. Equipment will only be operated by qualified personnel. Adequate signage and fencing will block off public spaces and minimize contact with pedestrians.

Interrupting Buried Utilities

Due to the limited information regarding buried utilities, there is potential for accidental contact during construction work. Depending on the affected system, the impact can range from moderate to high. Mitigation will require detailed confirmation of pipe depths at areas with substantial earthwork. Amount of excavation has also been optimized in the design. Hand digging will also be done when in proximity to known utility locations. Given the new development proposed at Stadium Road, it is likely utility owners may already have upgrade works planned. In this case, construction could be coordinated so that the upgrade works can happen in conjunction with the road reconstruction to minimize disruption to the community.

Traffic Delays

Congestion induced by site work will limit access and result in project delays. As such, the East Mall corridor must be able to shoulder a majority of the usual volumes despite construction. Traffic delays were classified as a moderate probability; it will be lowered through the phasing of construction work. Mitigation will consist of the provided Traffic Management Plan and ensuring clear communication with contractors. A bulk of the work is also schedule for the summer with lower volumes. Equipment transport will also occur outside of peak hours when possible.

Damage to trees

With 47 existing trees requiring uplift, there is a moderate probability of damage during the process. To mitigate this, work will be done in accordance with the Tree Protection Guidelines outlined in the UBC Vancouver Campus Plan Part 3: Design Guidelines (2014).

7.3. Construction Schedule

Commencing May 3rd, 2021, construction duration was estimated at around nine months, completing on December 16th, 2021. Workdays were taken as Monday to Friday, eight-hour days with statutory holidays off. A schedule summary is provided in Table 11. For a full task breakdown and Gantt chart, refer to Appendix G.

Table 11: Key construction dates

Activity	Start (2021)	End (2021)
Site Preparation	May 3rd	May 7th
Phase 1 Construction	May 10th	June 11th
Canopy Installation	June 14th	July 23rd
Phase 2 Construction	June 14th	September 2nd
Phase 3 Construction	September 2nd	December 6th
Site Clean-up	December 7th	December 16th

To prevent congestion along East Mall, construction was sectioned into chronological phases. Figure 23 below presents the scope for each phase. Phase one includes the Thunderbird & East Mall intersection upgrades along with roadwork north to Agronomy Road and the pedestrian canopy. Canopy installation will begin mid-June with to minimize roadway disruption. The structure will be complete and inspected by August, allow for immediate use during the fall months. The remaining work along East Mall is divided into two phases. Phase two details the median removal while phase three is dedicated to the new median and greenspace installation. Dividing the work allows traffic to be shifted onto the open lane with capacity for two lane flow. Meeting the usual capacity is essential as phase three will extend into the 2021 winter semester. Temporary parking and traffic control measures will be required.

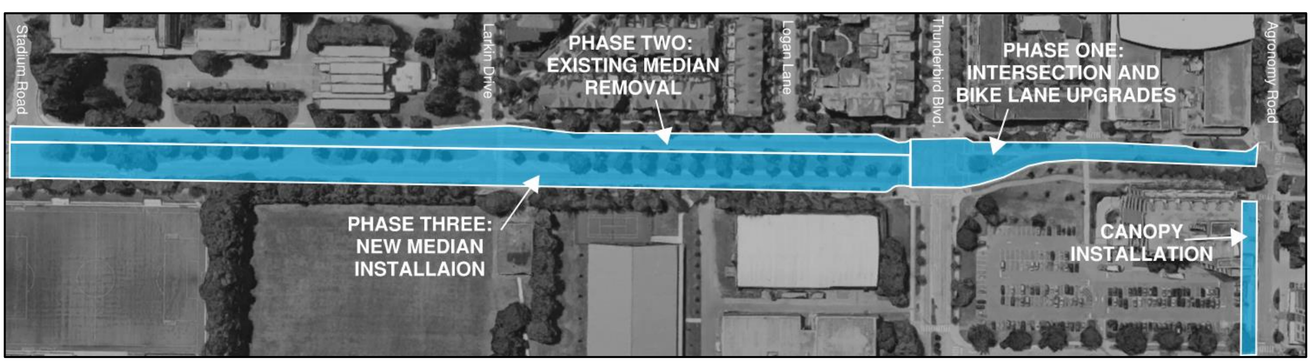

Figure 23: Construction phases

7.4. Traffic Management Plan

Under project classifications set out by the Ministry of Transportation and Infrastructure, the redesign falls under Category 2: moderate impacts on the travelling public and involves some complexity. As such, a full traffic control plan will be required. The figures below provide our management plan for all phases of the project. Temporary signage codes are derived from the BC Traffic Management Manual for Work on Roadways (2016)

7.4.1. Phase 1

Work zones will be divided into halves of road. The first half will require the closing of the southbound lane. While work is in progress, the adjacent lane will allow for two-way traffic flow, with a total width of 18ft. Traffic flow operators and temporary 15 mph speed limit signs will be posted at appropriate intervals to regulate traffic. Figure 17 details the first half of phase one and the required signage and personal on site.

Occurring synchronously with phase 1 is the construction of the pedestrian canopy. To prevent congestion, equipment and operational vehicles will detour down Agronomy and Health Science Mal into the highlighted alleyway. The southern sidewalk of Agronomy will be closed with pedestrian demand relocated to the north.

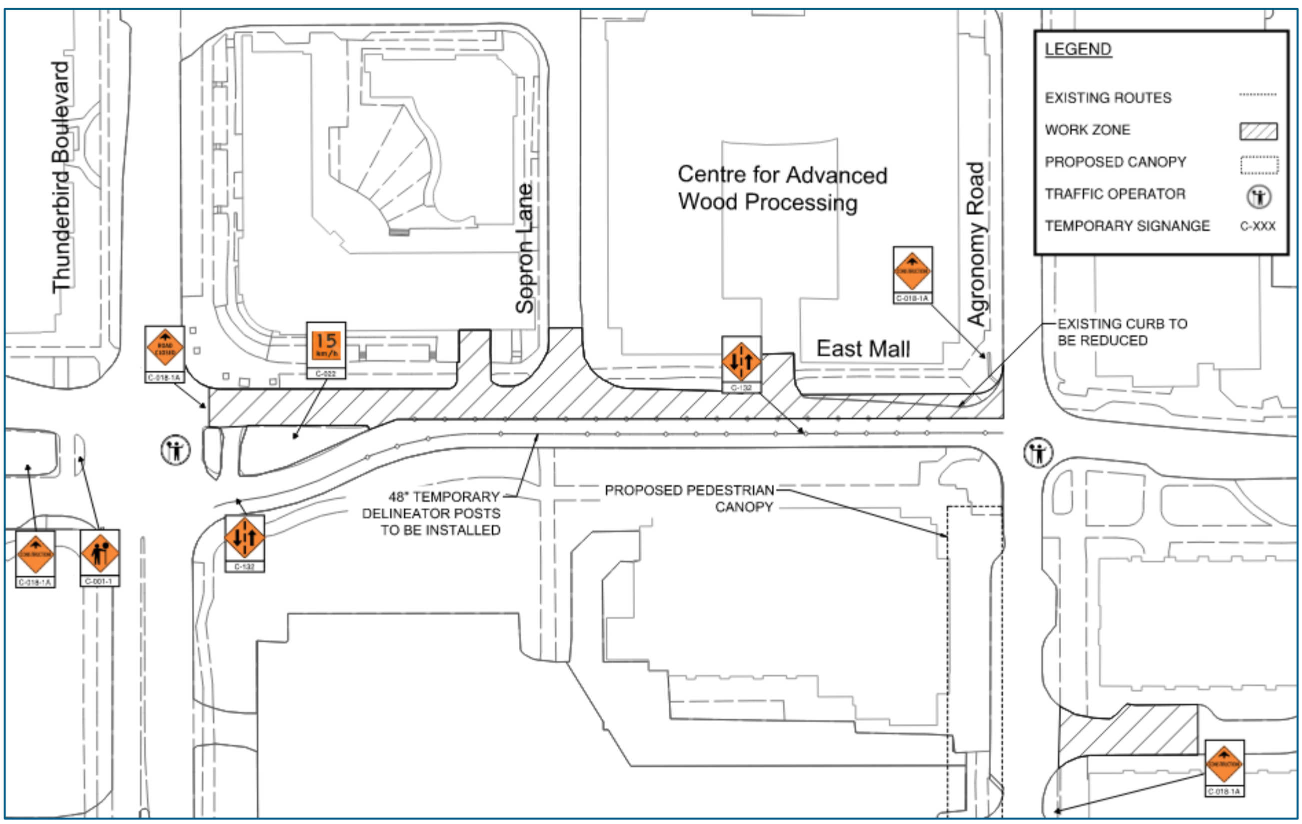

Figure 24: Phase 1 traffic management plan

7.4.2. Phase 2

Existing median removal headlines phase two which will require work on the southbound lane of East Mall. The wide roadway easily allows for two-way traffic flows on the adjacent lane. Parking will be restricted to meet demands. Adequate signage and pylons will be placed alongside traffic flow operators. Figure 18 below details the phase two configuration. A temporary 15 mph vehicle speed limit will be imposed for pedestrian and worker safety.

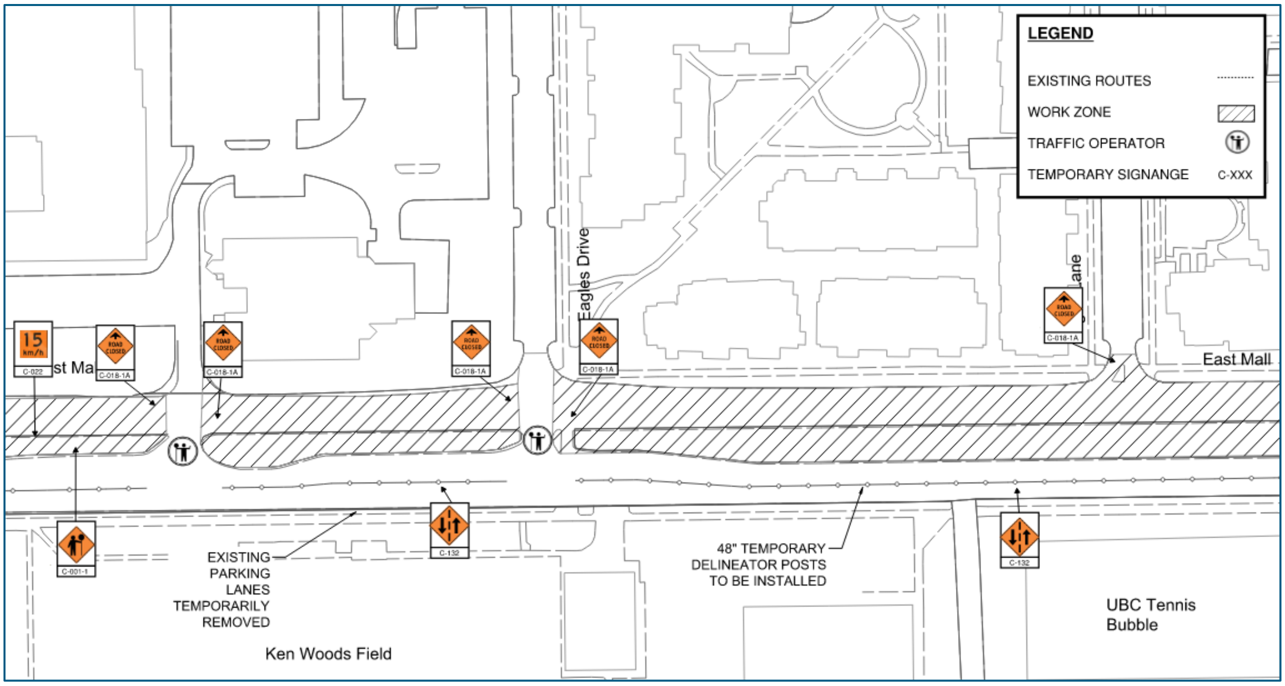

Figure 25: Phase 2 traffic management plan

7.4.3. Phase 3

Phase three will require the closing of the northbound lane, with the volume shifted on the finished southbound lane. Similar to phase two, a temporary no parking limit on the southbound lane will be enacted to meet capacity. A 15-mph vehicle speed limited will also be imposed for worker and pedestrian safety.

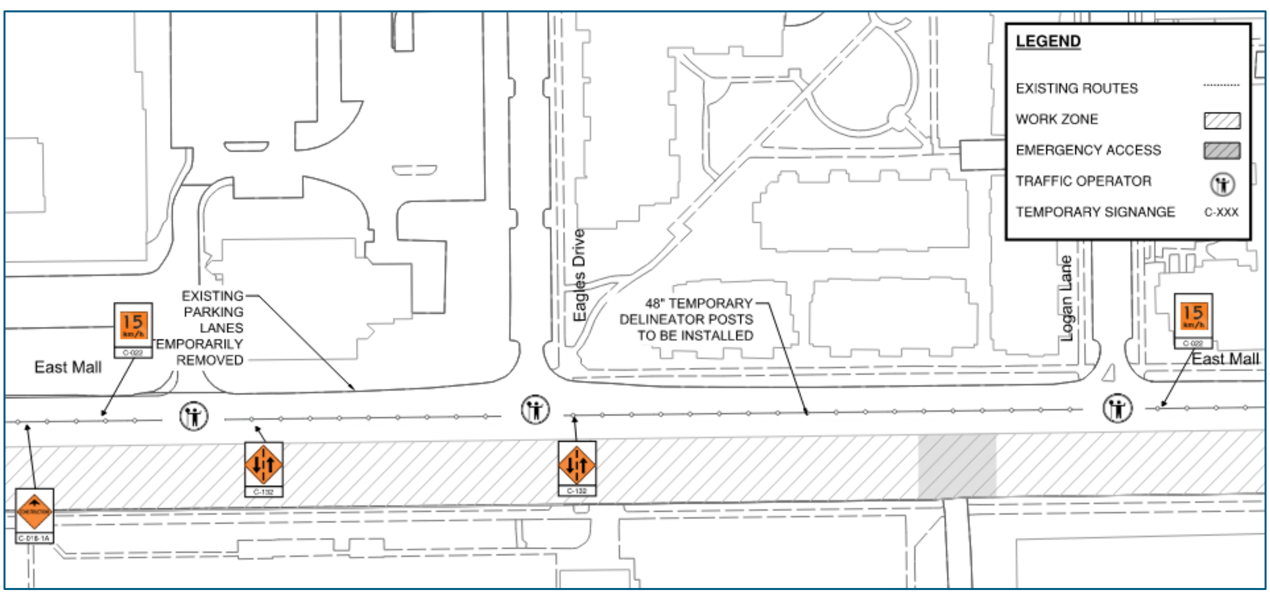

Figure 26: Phase 3 traffic management plan

8. COST ESTIMATE

The total project is estimated to cost $5,163,449, with an annual operations & maintenance cost of $23,500. A high-level cost breakdown is provided in Table 12. To account for potential uncertainty during construction, a 15% contingency has been assigned to overall costs. For the full detailed Class A Cost Estimate, refer to Appendix F. Unit cost for specific materials has been derived from cost guides from different locales and times. As such, RSMeans Cost Indices were used to normalize costs when applicable.

Table 12: Cost Summary

Design		**$179,600**
	Development	$179,600
Construction		**$3,826,224**
	General Permitting	$28,100
	On-Site Personnel	$324,000
	General Construction	$450,000
	Site Preparation	$690,730
	Road Replacement	$797,875
	Median Installation	$131,725
	Bike Lanes & Sidewalks	$118,025
	Stormwater Facilities	$100,000
	Greenspace	$646,650
	Permanent Traffic Controls	$177,035
	Structural	$188,084
	End of Construction	$174,000
Maintenance & Operations		**$23,500**
Contingency (15%)		**$604,399**
	Total Cost	$4,610,222
	PST (7%)	$322,716
	GST (5%)	$230,511
	Total Cost + Tax	**$5,163,449**

9. Service Life Maintenance Plan

This section will outline the potential maintenance concerns associated with the new roadway, canopy, utility, and greenspace upgrades. The items below are only common issues and therefore not exhaustive. Additional issues may arise throughout the lifecycle of the project.

9.1. Transportation

The main component of the road requiring maintenance is the asphalt. The asphalt road in our final design has a design life of 18 years, after which the road will require repaving. However, to achieve this design life maintaining the driving surface and other roadside upkeep is required. The road maintenance plan consists of the following:

Table 13: Maintenance summary and frequency for roadway

Activity	Maintenance Frequency
Crack sealing	As required with annual inspections
Snow and ice control	As required seasonally
Pothole patching	As required with annual inspections
Signage repair	As required with annual inspections
Pavement marking repair	As required with annual inspections

Effective road maintenance addresses damage early. Preventive maintenance for the road will be performance based. This approach maximizes the service life and reduces long term costs of the project.

9.2. Structural

The hot dip galvanized steel canopy has a design life of 70 years. Hot dip galvanized steel structures provide long-term durability. The main concern for the steel canopy is corrosion due to it being located outdoors in a wet climate. That is why a zinc coating was selected since it would be able to provide the proper protection. A Hot Dip Galvanized coating is known for its durability and low maintenance; therefore, the maintenance plan is not overly involved and consists of the following:

Table 14: Maintenance frequency and summary for canopy

Activity	Frequency
Inspect and repair damaged welds	As required with annual inspections
Repair corrosion on the steel by brushing off any rust with a hard plastic bristle brush and repainting with Zingalu spray	As required with semi-annual inspections

9.3. UTILITIES

No new utility mains are installed as part of this project, and so the service life of the existing mains should be unchanged. New catch basins are specified to replace the existing, and the lifespan of a typical precast concrete catch basin including its service lead is estimated to be around 75 years. The on-site utilities do not require any special servicing plans, and the following suggestions are made on the basis of UBC's Technical Guidelines to preserve utility lifespan:

Table 15: Maintenance summary and frequency for utilities

Activity	Maintenance Frequency
CCTV inspection of underground utility services shall be conducted every 5 years to identify potential leaks, root intrusion, among other damage in accordance with UBC Technical Guidelines Section 33 82 01	Once every 5 years
Sewers should be flushed in accordance with UBC Technical Guidelines Section 33 01 30.41	Yearly
Clear out catch basin sumps and surrounding grate area	Twice a year or whenever ponding is observed
Vacuum permeable concrete areas with regenerative vacuum sweeper	Yearly or whenever ponding is observed

9.4. GREENSPACE

The greenspace including its plants and trees all have an indefinite design life and should not require replacement as long proper care and maintenance is provided. Maintenance services are necessary to ensure that the landscape is healthy and looking good. The maintenance plan for the greenspace is the most intensive and consists of the following:

Table 16: Maintenance summary and frequency for greenspace

Activity	Maintenance Frequency
Standard lawn care of the land surrounding the garden including lawn mowing and other techniques to maintain the overall appearance of the garden itself	Bi-weekly during necessary seasons
Watering of all trees and plants along the greenspace	Daily
Renewing mulch to protect roots and soil moisture	Bi-weekly
Lawn fertilization and pest control	Annually
Tree and shrub insect treatments	As required with annual inspections
Leaf removal and trimming	Annually
Aeration and over seeding of the grass	Annually

10. REFERENCES

Documents and Articles

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Ministry of Transportation and Infrastructure. "*British Columbia Active Transportation Design Guide 2019 Edition*". https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/traffic-engineering-safety/active-transportation-design-guide

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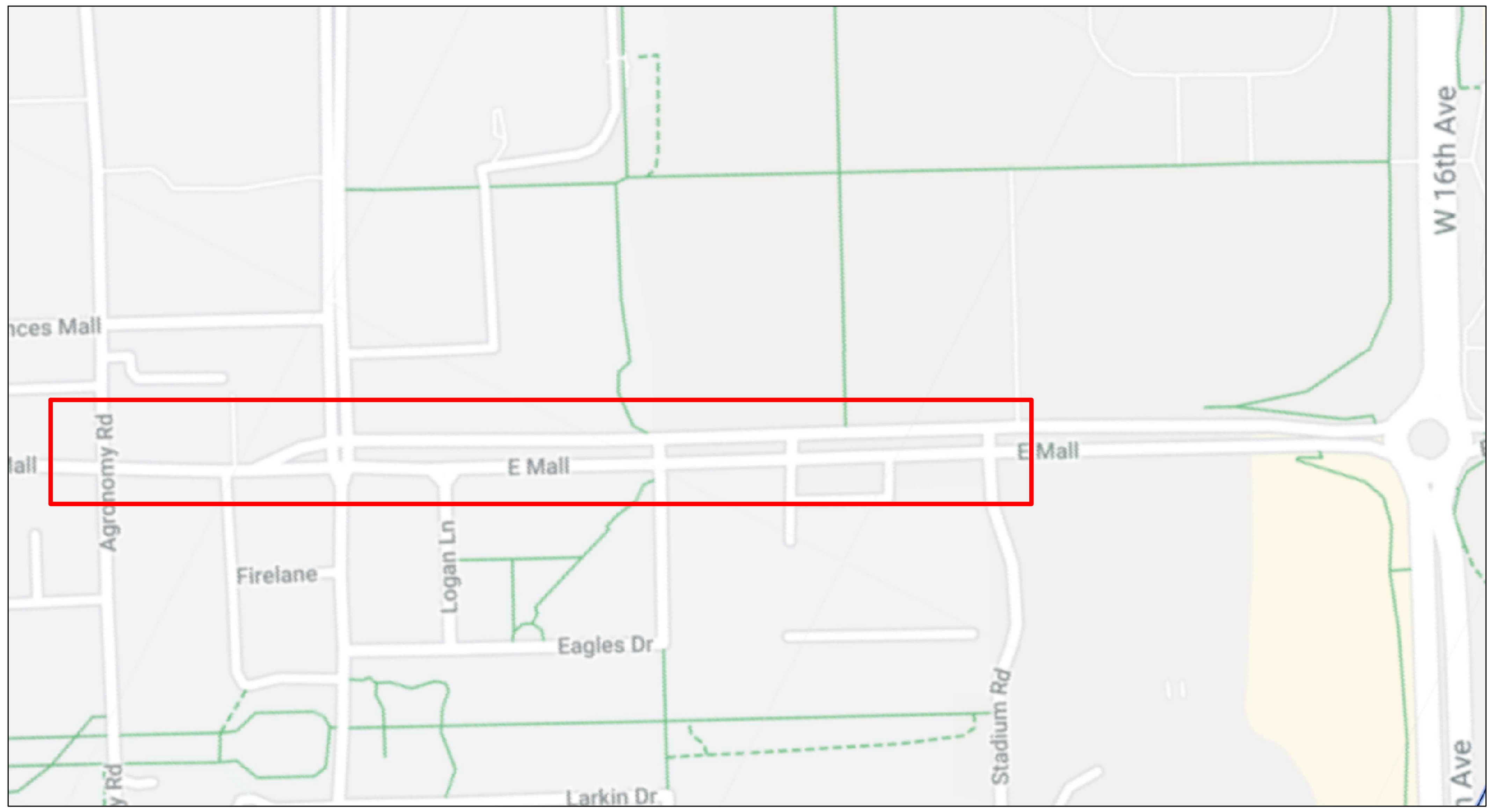
APPENDIX A – ISSUED FOR CONSTRUCTION DRAWINGS

EAST MALL RECONFIGURATION

UBC ENDOWMENT LANDS
VANCOUVER BC

ISSUED FOR CONSTRUCTION



DRAWING INDEX:

GENERAL:
G101 Existing Site Overview
G102 Notes

TRANSPORTATION:
R101 Roadway Plan View (Sheet 1 of 3)
R102 Roadway Plan View (Sheet 2 of 3)
R103 Roadway Plan View (Sheet 3 of 3)
R104 Roadway Cross-Section (Sheet 1 of 3)
R105 Roadway Cross-Section (Sheet 2 of 3)
R106 Roadway Cross-Section (Sheet 3 of 3)
R107 Roadway Profile
R108 Roadway Details
R109 Signage Plan (Sheet 1 of 2)
R110 Signage Plan (Sheet 2 of 2)

STRUCTURAL:
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C102 Canopy Typical Cross-Section
C103 Canopy Connection Details (Sheet 1 of 2)
C104 Canopy Connection Details (Sheet 2 of 2)

UTILITIES:
W101 Utilities Plan - Water
S101 Utilities Plan - Sanitary
D101 Utilities Plan - Stormwater
D102 Stormwater Details
U101 Utilities Cross-Sections (Sheet 1 of 2)
U102 Utilities Cross-Sections (Sheet 2 of 2)

NOTES:

1. 2017 Orthophotos taken by McElhanney retrieved from UBC Abacus Library

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	EXISTING SITE OVERVIEW	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

CONSULTANT

UBC sustainability

CLIENT

The University of British Columbia

6250 Applied Science Ln
Vancouver, BC V6T 1Z4

EAST MALL REDESIGN

Existing Site Overview

SEAL

SCALE: 1:500

DESIGNED RH

DRAWN RH

REVIEWED TM

DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. G101

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 15 2021 – 1:37pm D:\D Drive Documents\School Archive\2020\CIVL 445\445-General.dwg/G101 Ray

1. GENERAL

1.1 WHERE APPLICABLE, ALL CONSTRUCTION PROCEDURES, ACTIVITIES & MATERIALS ARE TO BE IN ACCORDANCE WITH:

- 1.1.1 THE LATEST EDITION OF MUNICIPAL AUTHORITY'S BY-LAWS;
- 1.1.2 THE LATEST EDITION OF B.C. BUILDING CODE;
- 1.1.3 THE MASTER MUNICIPAL CONSTRUCTION DOCUMENT AND STANDARD DETAIL DRAWINGS (MMCD) LATEST EDITION (PLATINUM EDITION), AS ADOPTED;
- 1.1.4 THE MINISTRY OF ENVIRONMENT AND/OR FEDERAL DEPARTMENT OF FISHERIES AND OCEANS OR THE MINISTRY OF WATER, LANDS AND AIR PROTECTION REQUIREMENTS;
- 1.1.5 THE MINISTRY OF TRANSPORTATION & INFRASTRUCTURE "BC TRAFFIC CONTROL MANUAL FOR WORK ON ROADWAYS" LATEST EDITION;
- 1.1.6 THE WORKERS' COMPENSATION ACT – OCCUPATIONAL HEALTH AND SAFETY REGULATIONS – LATEST EDITION;

1.2 ALL DIMENSIONS ARE SHOWN IN METRES, ELEVATIONS ARE GEODETIC AND SHOWN IN METRES, AND PIPE SIZES IN MILLIMETRES UNLESS OTHERWISE NOTED.

1.3 DRAWINGS ARE NOT TO BE SCALED.

1.4 REFER TO LEGAL PLANS FOR SITE DIMENSIONS AND TO ARCHITECTURAL SITE PLANS FOR BUILDING AND PARKING LOT DIMENSIONS.

1.5 THE CONTRACTOR MUST ENSURE ALL REQUIRED PERMITS AND LICENSES ARE ACQUIRED.

1.6 THE CONTRACTOR SHALL CONFIRM WITH GROUP 9 THAT THEY ARE WORKING FROM THE "ISSUED FOR CONSTRUCTION" (I.F.C.) CIVIL DRAWINGS PRIOR TO STARTING CONSTRUCTION. THE DRAWING MUST BE STAMPED "ISSUED FOR CONSTRUCTION" BY GROUP 9. ALL CONSTRUCTION WORKS INSTALLED PRIOR TO THE I.F.C. DATE ARE DONE AT CONTRACTORS OWN RISK.

1.7 THE CONTRACTOR MUST CONTACT GROUP 9 TO SCHEDULE A PRE-CONSTRUCTION MEETING.

1.8 THE CONTRACTOR SHALL PHOTOGRAPH ANY EXISTING FEATURES TO BE DISTURBED INCLUDING ITEMS OUTSIDE OF THE CONSTRAUCTION AREA THAT MAY BE AT RISK OF DAMAGES OR AFFECTED BY CONSTRUCTION.

1.9 GROUP 9 IS TO BE GIVEN A MINIMUM 24 HOURS NOTICE FOR ANY CONSTRUCTION INSPECTION.

1.10 ALL CONSTRUCTION TO BE COMPLETED TO THE SATISFACTION OF THE ENGINEER.

1.11 ANY CHANGE TO THE DESIGN MUST BE APPROVED IN WRITING BY GROUP 9. FAILURE TO NOTIFY GROUP 9 IN ADVANCE OF CHANGES MAY RESULT IN REJECTION OF WORK, SCHEDULE DELAYS AND OR EXTRA COSTS.

1.12 MAINTAIN A MINIMUM COVER OVER ALL SERVICES OF 1.0 m FOR WATERMAINS, STORM, AND SANITARY AND 900 mm FOR ELECTRICAL DUCTS.

1.13 ALL DRAWING DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER PRIOR TO INSTALLATION.

1.14 THE CONTRACTOR MUST HAVE AN UP TO DATE HEALTH AND SAFETY PLAN ACCEPTABLE TO THE PROJECT ENGINEER BEFORE COMMENCING WORK. ALL WORKS ON SITE SHOULD CONFORM TO THE PROVISIONS IN THE PLAN CONSISTENT WITH THE REGULATIONS UNDER THE WORKER'S COMPENSATION ACT AND THE HAZARDOUS PRODUCTS ACT.

1.15 ALL MATERIALS USED ON THIS PROJECT SHALL BE LEAD FREE.

2. EROSION AND SEDIMENT CONTROL MEASURES

2.1 PRIOR TO THE COMMENCEMENT OF ANY GROUND DISTURBANCE, CONTRACTOR IS TO REVIEW, EVALUATE AND IMPLEMENT EROSION SEDIMENT CONTROL (ESC) METHODS AS REQUIRED AND DIRECTED BY ALL APPLICABLE AUTHORITIES GOVERNING THE PROJECT'S LOCATION. CONTRACTOR IS TO FOLLOW THE MUNICIPAL AUTHORITY'S STORM WATER CONTROL BYLAWS.

2.2 ALL REQUIRED ESC PERMITS APPLICATIONS AND APPLICABLE COSTS ARE THE CONTRACTOR'S RESPONSIBILITY.

2.3 THE CONTRACTOR'S PRECONSTRUCTION SITE REVIEW FOR THEIR ESC PLAN IS TO IDENTIFY ITEMS SUCH AS, STORM WATER RUN-OFF LOCATIONS, CATCHMENT AREAS AND AFFECTED DOWNSTREAM AREAS, WITH DOCUMENTATION TO SATISFY ALL REQUIREMENTS OF THE APPLICABLE AUTHORITY.

2.4 THE CONTRACTOR IS TO INSTALL APPROPRIATE AND FUNCTIONAL ESC METHODS AND MAINTAIN, TEST AND ADJUST OR CHANGE THE CONTROLS TO MEET THE EVOLVING REQUIREMENTS OF THE SITE'S STORM FLOW CONDITIONS AT NO EXTRA COST TO THE PROJECT. CHANGES TO THE METHODS OF CONTROLS REQUIRED ARE TO BE COMMUNICATED TO THE ENGINEER.

2.5 THE CONTRACTOR SHALL BE RESPONSIBLE TO ENSURE THAT SEDIMENT LADEN WATER DOES NOT LEAVE THE SITE EITHER OVERLAND OR PIPED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL DRAINAGE DURING CONSTRUCTION AND SHALL PREVENT SURFACE RUNOFF FROM FLOWING ONTO NEIGHBORING PROPERTIES.

2.6 STORM CATCH BASINS TO HAVE APPROPRIATE FILTERING MECHANISM INSTALLED TO PROHIBIT ENTRANCE OF SEDIMENT INTO THE MUNICIPALITY'S STORM SEWERS DURING CONSTRUCTION. FILTERING MECHANISM IS TO BE MAINTAINED UNTIL RESTORATION HAS BEEN COMPLETED.

2.7 CONSTRUCTION ACCESS TO THE SITE SHALL BE LIMITED TO THE APPROVED CONSTRUCTION ENTRANCES PER THE MUNICIPALITY. THE CONTRACTOR SHALL BE RESPONSIBLE TO KEEP THE MUNICIPALITY'S ROADS CLEAN TO THE SATISFACTION OF THE MUNICIPALITY. IN THE EVENT THAT THE MUNICIPALITY SENDS OUT THEIR STREET SWEEPERS AND CHARGES THE OWNER, THE COSTS TO THE OWNER FOR STREET CLEANING WILL BE CHARGED TO THE CONTRACTOR AND DEDUCTED FROM PROGRESS CLAIMS. THE CONTRACTOR SHALL TAKE APPROPRIATE MEASURES TO KEEP THE DUST TO LEVELS ACCEPTABLE TO THE MUNICIPALITY AND THE PUBLIC.

2.8 THE CONTRACTOR'S ESC PLAN SHOWING MANAGEMENT AND MAINTENANCE DETAILS IS TO BE REVIEWED BY THE ENGINEER PRIOR TO COMMENCEMENT OF CONSTRUCTION.

2.9 THE COST OF ALL EROSION AND SEDIMENT CONTROL MEASURES INCLUDING FILTERING MECHANISMS, MAINTENANCE, REMOVAL, STREET CLEANING DUST CONTROL AND ANY CORRECTIVE REQUIREMENTS SHALL BE INCLUDED IN THE CONTRACTOR'S PRICE WITH NO ADDITIONAL COST TO THE CONTRACT.

3. UTILITY LINES, - GRADES AND MEASURES

3.1 THE INFORMATION OF EXISTING UTILITIES HAS BEEN COMPILED FROM THE MUNICIPALITY'S RECORD DRAWINGS AND A TOPOGRAPHICAL SURVEY AND IS NOT NECESSARILY ACCURATE OR COMPLETE. PRIOR TO STARTING CONSTRUCTION, THE CONTRACTOR SHALL INVESTIGATE THE WORK AREA TO CONFIRM THE LOCATION AND ELEVATION OF ALL EXISTING UTILITIES. CONTRACTOR IS TO NOTIFY GROUP 9 IMMEDIATELY IF THERE ARE ANY CONFLICTS OR DISCREPANCIES.

3.2 THE CONTRACTOR SHALL EXPOSE ALL EXISTING SERVICES AND PRESERVE AND PROTECT THEM FROM DAMAGE PRIOR TO AND DURING THE WORK. THE CONTRACTOR SHALL OBTAIN FROM THE OWNERS OF THE EXISTING UTILITIES (INCLUDED BUT NOT LIMITED TO, HYDRO, TEL, GAS AND CABLE) UPDATED INFORMATION ON THE LOCATION OF UNDERGROUND SERVICES WITHIN THE CONTRACT AREA.

3.3 NOTIFY ALL APPLICABLE UTILITIES INCLUDING MUNICIPAL WATER & SEWER, A MINIMUM OF 72 HOURS PRIOR TO CONSTRUCTION COMMENCMENT FOR LOCATES.

3.4 ALL WORK SHALL BE CONSTRUCTED TO THE LINES AND GRADES GIVEN ON THE DESIGN DRAWINGS USING MATERIALS DESIGNATED ON THE DRAWINGS AND OR IN THE MUNICIPALITY'S SPECIFICATIONS AND STANDARDS.

3.5 IF, AS A RESULT OF CONDITIONS ENCOUNTERED DURING CONSTRUCTION, IT BECOMES NECESSARY TO CHANGE ANY ALIGNMENT OR GRADE, THE OWNER RESERVES THE RIGHT TO MAKE SUCH CHANGES AS, IN THE OPINION OF THE ENGINEER, MAY BE CONSIDERED NECESSARY OR DESIRABLE. DIRECTIVES WILL BE ISSUED BY THE CONSULTANTS IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

3.6 SURFACE – STAMPING USING 75mm TALL STICKS "D, S OR W". SERVICES INSTALLED TO PROPERYT LINES ARE TO BE PERMANETLY MARKED OR STAMPED IN THE

4. MATERIALS TESTING

4.1 TRENCHING AND PIPE/SEWER CONSTRUCTION

- 4.1.1 ALL TRENCH BEDDING MATERIAL SHALL CONFORM TO THE MMCD G4 SPECIFICATIONS.
- 4.1.2 ALL STORM AND SANITARY SEWERS ARE TO BE TESTED AND CLEANED BY POWER FLUSHING AS PER THE MUNICIPALITY'S STANDARD SPECIFICATIONS AND AS PER MMCD STANDARD PROCEDURES.
- 4.1.3 ALL STORM AND SANITARY SEWERS ARE TO BE VIDEO REVIEWED AS PER MMCD. COPIES OR THE REPORT SHOWING POSITIVE COMPLIANCE OF THE SEWER LINES ARE TO BE SUPPLIED TO GROUP 9 PRIOR TO REQUESTING SUBSTANTIAL COMPLETION.

4.2 ROADWORKS, DRIVEWAYS & CONCRETE WORKS

- 4.2.1 THE CONTRACTOR WILL BE RESPONSIBLE TO ARRANGE THE TESTING OF GRANULAR, ASPHALT AND CONCRETE MATERIALS AND COMPACTION TO DEMONSTRATE CONFORMITY TO THE GEOTECHNICAL CONSULTANT'S REQUIREMENTS.
- 4.2.2 WHEREVER PIPES ARE PASSING THROUGH UNCOMPACTED FILL AREAS, THE BEDDING TRENCH SHALL BE EXCAVATED TO THE UNDISTURBED GROUND LEVEL AND BACKFILLED WITH GRANULAR MATERIAL COMPACTED TO 95% STANDARD PROCTOR DENSITY.
- 4.2.3 STRUCTURAL FILLS SHALL EXTEND BEYOND THE EDGES OF NEW CURBS AND SIDEWALKS TO A MINIMUM 500mm, PLUS SLOPE AT 2H:1V FROM TOP OF SUBGRADE ELEVATION TO NON ORGANIC SOIL, WHERE APPLICABLE.
- 4.2.4 MINIMUM GRAVEL DRIVEWAY RESTORATION TO BE 70mm OF SIMILAR ORIGINAL MATERIAL.
- 4.2.5 CONTRACTOR TO EMPLOY THE SERVICES OF:
  - 4.2.5.1 CERTIFIED GEOTECHNICAL TESTING AGENCY
    - a. TO TEST AT REGULAR INTERVALS, DURING EXCAVATION PROCEDURES AS DIRECTED BY THE CERTIFYING AGENCY.
    - b. PROVIDE COPIES OF ALL POSITIVE TEST RESULTS TO GROUP 9 ON AN ON-GOING BASIS.
  - 4.2.5.2 GEOTECHNICAL ENGINEER TO APPROVE AND CERTIFY:
    - a. TRENCH BEDDING, RESTORATION MATERIALS AND COMPACTION
    - b. SUBGRADE, BASE GRAVELS AND ASPHALT MATERIALS
    - c. ENSURE EXCAVATION RESTORATION IS DONE TO REQUIRED STANDARDS
    - d. AND OTHER TESTING AS DEEMED REQUIRED BY THE GEOTECHNICAL ENGINEER
    - e. PREPARE AND SIGN REPORTS CERTIFYING THE ROAD'S INTEGRITY – WITH COPY PROVIDED TO GROUP 9.
- 4.2.6 TESTING SHOULD AT A MINIMUM BE CARRIED OUT AS FOLLOWS:
  - 4.2.6.1 GRANULAR BACKFILL MATERIAL OVER SANITARY, STORM, WATER WORKS – ONE PROCTOR DENSITY TEST PER 100m.
  - 4.2.6.2 ROAD SUB-GRADE – ONE PROCTOR DENSITY TEST PER 500m~U2.
  - 4.2.6.3 ROAD BASE AND SUB-BASE – ONE PROCTOR DENSITY TEST PER 500m~U2.
  - 4.2.6.4 ASPHALT TESTING – ONE MARSHALL STABILITY TEST PER 4000m~U2~u PER LAYER AND 5 CORE SAMPLES.
  - 4.2.6.5 CURB AND GUTTER – ONE SET OF CONCRETE CYLINDER TESTS PER 400m OF CURB AND GUTTER.
- 4.2.7 COSTS FOR TESTING WOULD BE INCLUDED IN THE CONTRACTOR'S PRICE WITH NO ADDITIONAL COST TO THE CONTRACT.

4.3 PAVEMENT

- 4.3.1 REINSTATE PAVED MUNICIPALITY'S ROADWAY, DRIVEWAYS & PARKING AREAS AS PER MMCD G5 SPECIFICATIONS WITH A MINIMUM DEPTH OF
  - 4.3.1.1 300mm OF 75 mm MINUS GRAVEL SUB-BASE COMPACTED TO 95% MODIFIED PROCTOR,
  - 4.3.1.2 100mm OF 20mm CRUSHED GRAVEL BASE COMPACTED TO 95% MODIFIED PROCTOR,
  - 4.3.1.3 40 mm ASPHALT – BASE COURSE,
  - 4.3.1.4 35 mm ASPHALT – SURFACE COURSE.
- 4.3.2 ASPHALTIC CONCRETE, IMPORTED BASE AND SUBBASE MATERIAL SHALL CONFORM TO THE GRADATION, SPECIFICATIONS AND COMPACTION SET OUT IN THE MASTER MUNICIPAL SPECIFICATIONS.
- 4.3.3 THE FINAL LIFT OF ASPHALT WILL BE PLACED ONE YEAR SUBSEQUENT TO THE PLACEMENT OF THE FIRST LIFT OR AT TIME AS APPROVED BY THE PROJECT ENGINEER.

4.4 WATERMAINS & WATER SYSTEMS

- 4.3.1 THE CONTRACTOR SHALL PROVIDE GROUP 9 WITH PROOF OF, LEAKAGE TESTING, CHLORINATION TESTING AND FLUSHING FOR THE NEW WATER MAINS AND SERVICES TO ALL STANDARDS OUTLINED IN THE MUNICIPALITY'S STANDARD SPECIFICATIONS, AND TO AWWA STANDARDS. HEAVILY CHLORINATED WATER SHALL BE DISPOSED OF IN A MANNER APPROVED BY THE MUNICIPALITY.

5. STORM AND SANITARY SEWER

5.1 ALL EXISTING STORM AND SANITARY SEWERS AND ASSOCIATED INFRASTRUCTURE SHOULD REMAIN IN PLACE AND IN SERVICE DURING CONSTRUCTION

- 5.2.1 IF SERVICE MUST BE STOPPED OR SEWERS MUST BE MOVED, THE CONTRACTOR MUST FIRST CONTACT THE ENGINEER AND SEEK THE APPROVAL OF UBC'S WATER & ENERGY SERVICES

5.2 ALL TRENCHING TO BE IN ACCORDANCE WITH THE WORKERS COMPENSATION ACT – OCCUPATIONAL HEALTH AND SAFETY REGULATIONS.

5.3 PER THE MUNICIPALITY'S STANDARD DRAWINGS & UNLESS OTHERWISE NOTED,

- 5.3.1 ALL STORM AND SANITARY MAINS SHALL BE CSA APPROVED SDR 35, PVC,
- 5.3.2 STORM AND SANITARY SERVICE CONNECTIONS BE CSA APPROVED SDR 28 PVC, USING PRE-FABRICATED WYES,
- 5.3.3 STORM AND SANITARY SEWER AND SERVICE CONNECTIONS TO BE FITTED WITH RUBBER GASKET JOINTS ON-SITE & OFF SITE TO BUILDING CONNECTIONS.
- 5.3.4 STORM AND SANITARY SEWERS AND SERVICES TO HAVE 1.5 m MINIMUM COVER AND BE CONSTRUCTED IN ACCORDANCE WITH THE OCCUPATIONAL HEALTH AND SAFETY ACT.
- 5.3.5 EXACT LOCATION OF SANITARY SERVICE CONNECTIONS TO BE RECORDED, AT TIME OF CONSTRUCTION, ON AS-BUILT RECORDS DRAWINGS MAINTAINED AT THE SITE OFFICE.

5.4 CATCH BASINS SHOULD BE REUSED IF NO VISUAL DAMAGE OR LEAKS ARE OBSERVED, OTHERWISE:

- 5.4.1 SHALL BE PRECAST REINFORCED CONCRETE WITH A MINIMUM INSIDE DIAMETER OF 600 mm.
- 5.4.2 SURFACE GRATE DESIGN SHOULD MATCH UBC DESIGN GUIDELINES, OR PURCHASED DIRECTLY FROM UBC

5.5 NEW CATCH BASIN LEADS SHOULD REUSE CONNECTIONS TO THE EXISTING SEWER MAIN WHERE POSSIBLE

- 5.4.1 ALL SINGLE CATCH BASIN LEADS SHALL BE MINIMUM 150 mm PVC SDR-35.
- 5.4.2 DOUBLE CATCH BASIN LEADS ARE TO BE 200mm PVC SDR-35.
- 5.4.3 HAVE LEADS AT A MINIMUM GRADE 2.0% UNLESS OTHERWISE SPECIFICALLY NOTED ON THE DRAWINGS.

6. WATERWORKS

6.1 ALL WATER MAINS AND HYDRANTS SHOULD STAY IN PLACE AND IN SERVICE DURING CONSTRUCTION

6.2 THE INVERT OF A WATER MAIN SHALL BE AT LEAST 500 MM ABOVE THE CROWN OF A STORM OR SANITARY SEWER.

6.3 THE MINIMUM HORIZONTAL CLEARANCE BETWEEN A WATER MAIN AND A STORM OR SANITARY SEWER SHALL BE 3.0m UNLESS THE SEWER MAIN IS INSTALLED IN A CARRIER PIPE.

6.4 WHERE THE ABOVE NOTED CLEARANCES, ARE NOT POSSIBLE, APPROVAL IS REQUIRED FROM THE FRASER HEALTH AUTHORITY AND THE MUNICIPALITY'S ENGINEERING DIRECTOR. THE FOLLOWING MEASURES ARE TO BE TAKEN IN ACCORDANCE TO MINISTRY OF HEALTH REQUIREMENTS.

- 6.4.1 WHEN THE WATER MAIN IS CLOSER THAN 500 MM TO A STORM OR SANITARY SEWER BUT ABOVE THE STORM OR SANITARY SEWER, THE WATER MAIN MUST BE LAID IN SUCH A MANNER THAT CROSSING IS MADE MIDWAY BETWEEN JOINTS ON A FULL LENGTH OF WATER MAIN. THE WATER MAIN JOINTS ARE TO BE WRAPPED WITH HEAT SHRINK PLASTIC OR PACKED WITH COMPOUND AND WRAPPED WITH TAPE OVER A LENGTH EXTENDING 3.0 M ON EITHER SIDE OF THE SEWER MAIN.
- 6.4.2 WHEN THE WATER MAIN IS BENEATH THE SEWER, THERE SHALL BE A MINIMUM 300 MM VERTICAL SEPARATION. THE CROSSING SHALL BE MADE MIDWAY ON A FULL LENGTH OF WATER MAIN PIPE. THE WATER MAIN JOINTS ARE TO BE WRAPPED WITH HEAT SHRINK PLASTIC OR PACKED WITH COMPOUND AND WRAPPED WITH TAPE OVER A LENGTH EXTENDING 3.0 M ON EITHER SIDE OF THE SEWER MAIN.
- 6.4.3 WHEN 3.0 M HORIZONTAL SEPARATION IS UNATTAINABLE, ALL WATER MAIN JOINTS ARE TO BE WRAPPED WITH HEAT SHRINK PLASTIC OR PACKED WITH COMPOUND AND WRAPPED WITH TAPE.

6.5 ALL WATER MAINS SHOULD BE DUCTILE IRON CONFORMING TO AWWA C151 UNLESS OTHER SPECIFIED

7. ROADWORKS AND PARKING

7.1 AFTER ALL SERVICES HAVE BEEN INSTALLED, THE CONTRACTOR SHALL RE-COMPACT THE SUBGRADE IN PAVED AND CONCRETE AREAS TO THE SATISFACTION OF THE GEOTECHNICAL ENGINEER.

7.2 ANY SOFT SPOTS IN THE SUBGRADE ARE TO BE EXCAVATED OUT AND REPLACED WITH SUITABLE MATERIAL COMPACTED TO THE SATISFACTION OF THE GEOTECHNICAL ENGINEER.

7.3 THE CONTRACTOR SHALL SUPPLY, PLACE AND COMPACT THE SUBGRADE, SUBBASE, BASE MATERIAL AND ASPHALTIC CONCRETE AS PER THE PAVEMENT DESIGN STRUCTURE. ALSO SEE TESTING NOTES.

7.4 GROUP 9 IS TO BE GIVEN A MINIMUM 24 HOURS NOTICE TO INSPECT THE PAVEMENT BASE PREPARATION PRIOR TO PAVING AND THE FORMS OR STRING LINE FOR THE CONCRETE CURB AND SIDEWALK PRIOR TO POURING CONCRETE.

7.5 ALL RIM ELEVATIONS SHOWN ON DETAIL DRAWINGS ARE TO FINAL LIFT ELEVATION. ALL CATCH BASINS, CBMHS AND VALVE BOXES ARE REQUIRE TO BE SET TO 25mm MINIMUM BELOW FINISHED ASPHALT GRADE ELEVATION) AND SET TO MATCH GRADE AND CROSS-FALL OF THE ROAD.

7.6 THE FINAL LIFT OF MUNICIPAL ROADS ASPHALT WILL BE PLACED ONE YEAR SUBSEQUENT TO THE PLACEMENT OF THE FIRST LIFT OR AT TIME AS APPROVED BY THE PROJECT ENGINEER.

7.7 CONTRACTOR IS TO ADJUST ALL CATCH BASINS, CBMHS AND VALVE BOXES ETC. TO FINAL FINISHED ELEVATIONS PRIOR TO 2ND ASPHALT LIFT INSTALLATION UNLESS APPROVED BY ENGINEER PRIOR TO 1ST LIFT'S INSTALLATION.

7.8 THE ASPHALTIC CONCRETE SHALL CONFORM TO THE GRADATION, SPECIFICATIONS AND COMPACTION SET OUT IN THE MASTER MUNICIPAL SPECIFICATIONS (MMCD).

8. CLEARING AND RESTORATION NOTES

8.1 CONTRACTOR SHALL RESTORE AREAS DISTURBED BY CONSTRUCTION TO THE ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF GROUP 9 AND THE MUNICIPALITY.

8.2 REINSTATEMENT OF PUBLIC ROAD – SEE MATERIALS TESTING NOTES.

8.3 ALL GRASSED AREAS DISTURBED DURING CONSTRUCTION SHALL BE RESTORED WITH 50mm TOPSOIL AND SOD OR HYDROMULCHED. MAINTAIN UNTIL ESTABLISHED.

8.4 IDENTIFY ANY TREES TO BE REMOVED AND OBTAIN A MUNICIPAL TREE CUTTING PERMIT AND ENGINEERING APPROVAL PRIOR TO CUTTING.

8.5 ALL TREES TO BE REMOVED ARE TO BE HAND DUG UNLESS APPROVAL FOR THE USE OF MECHANICAL EQUIPMENT IS OBTAINED.

8.6 IF INSTALLATION OF SERVICING REQUIRES PARTIAL REMOVAL OF FENCING, ALL WORK TO BE PERFORMED BY HAND AND RESTORED TO EXISTING OR BETTER CONDITION.

9. PAVEMENT MARKINGS & LINE PAINTING

9.1 SURFACE LINE PAINTING FOR ROADWAY TRAFFIC LANE DELINEATION IS TO BE DONE IN A TIMELY MANNER WITH PUBLIC SAFETY AS THE FIRST CONSIDERATION AND AS APPROVED BY THE MUNICIPALITY'S ENGINEER.

9.2 THE WORK INCLUDES PAINTING ALL PARKING LOT LINES, HANDICAP STALL SYMBOLS, NO PARKING, AND CROSS HATCHING ETC. ACCORDING TO THE ARCHITECTURAL SITE PLANS AND/OR CIVIL DRAWINGS.

9.3 ALL PAVEMENT MARKINGS SHALL BE PLACED IN ACCORDANCE WITH THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA. THE DEVELOPER IS RESPONSIBLE FOR SUPPLYING AND INSTALLING ALL THE PERMANENT AND TEMPORARY PAVEMENT MARKINGS OF THE MATERIAL TYPE AS SPECIFIED BY THE ENGINEERING DIRECTOR. THE CITY REQUIRES ALL PAVEMENT MARKINGS TO BE THERMOPLASTIC.

10. TRAFFIC CONTROL, SIGNAGE, WARNINGS AND BARRIERS

10.1 THE CONTRACTOR MUST GET APPROVAL FROM THE MUNICIPALITY FOR A TRAFFIC MANAGEMENT PLAN FOR WORKS ON MUNICIPALITY'S STREETS. THE PLAN MUST BE SIGNED AND SEALED BY A PROFESSIONAL ENGINEER OF THE PROVINCE OF B.C.

10.2 THE CONTRACTOR SHALL AT CONTRACTOR'S OWN EXPENSE, SUPPLY AND MAINTAIN ALL REQUISITE BARRIERS, FENCES, WARNING SIGNS OR OTHER PRECAUTIONS TO PROTECT THE WORKERS AND GENERAL PUBLIC FROM ACCIDENT OR INJURY. ALL EXCAVATIONS SHOULD BE FILLED BY THE END OF THE WORKDAY. ANY EXCAVATIONS LEFT OPEN SHALL BE SECURELY FENCED OFF.

10.3 ALL TRAFFIC CONTROL AND SIGNAGE TO BE IN ACCORDANCE WITH M.O.T.I. REQUIREMENTS.

10.4 MAINTAIN A MINIMUM OF ONE LANE OF TRAFFIC FLOW THROUGHOUT DURATION OF PROJECT. LANE CLOSURE PERMITS ARE REQUIRED AND ARE THE CONTRACTOR'S RESPONSIBILITY.

10.5 THE ON-SITE CONTRACTOR MUST BE ABLE TO DEMONSTRATE THAT THEY HAVE PERMISSION FROM THE MUNICIPALITY TO WORK ON ADJACENT MUNICIPALITY'S STREETS.

10.6 THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING A SAFE ROUTE FOR PEDESTRIANS WHILE CONSTRUCTION IS IN PROGRESS DURING DAYLIGHT HOURS AND THE SITE TO BE MADE SAFE AS PER STANDARDS FOR NON WORK HOURS.

10.7 SHOULD ANY OF THE CONTRACTOR'S WORK CAUSE INTERFERENCE WITH ANY EXISTING PUBLIC ROAD OR PEDESTRIAN ACCESS, THE CONTRACTOR SHALL PROVIDE AND MAINTAIN SUCH SIGNS, LIGHTS, BARRIERS, FLAG PEOPLE ETC. AS MAY BE REQUIRED FOR PUBLIC CONVENIENCE AND SAFETY IN ACCORDANCE WITH MUNICIPALITY'S REQUIREMENTS.

11. SURVEYING & AS-BUILTS – CONTRACTOR'S OBLIGATIONS

11.1 THE CONTRACTOR IS RESPONSIBLE FOR ALL SURVEYING FOR CONSTRUCTION OF THE WORKS. PROPERTY CORNER PINS MUST BE PRESERVED BY THE CONTRACTOR. IF THEY ARE REMOVED, THE CONTRACTOR WILL HAVE TO REPLACE THEM AT THEIR COST BY A QUALIFIED LEGAL SURVEYOR.

11.2 FINAL MEASUREMENTS FOR AS BUILTS AND QUANTITIES FOR PAYMENT WILL BE CARRIED OUT BY THE CONTRACT ADMINISTRATOR AT THE END OF THE CONTRACT PERIOD. GROUP 9 WILL CARRY OUT AN AS BUILT SURVEY OF ALL WORKS TO CONFIRM CONFORMANCE TO THE DRAWINGS.

11.3 CONTRACTOR IS TO MAINTAIN AN ON-SITE WRITTEN RECORD OF INSTALLED PIPE MATERIALS, LOCATIONS AND ELEVATIONS OF INTERSECTION POINTS AND SERVICE CONNECTIONS. CROSSING LOCATIONS AND ELEVATION OF EXISTING UTILITIES IS ALSO TO BE RECORDED.

11.4 CONTRACTOR IS TO REVISE ALL GENERAL NOTES AND DETAILED DRAWINGS PAGES AS FOLLOWS:

- 11.4.1 THOSE ITEMS THAT WERE COMPLIED WITH: CHANGE THE NOTE TO PAST TENSE.
- 11.4.2 IF THE NOTE WAS NOT COMPLIED WITH: PROVIDE A NOTE DETAILING THE "REASON" FOR AND WHO AUTHORIZED THE CHANGES.
- 11.4.3 MAKE NOTE IF THE ITEM IS "NOT APPLICABLE" OR "IRRELEVANT".

11.5 CONTRACTOR TO CONFIRM THAT ALL NUMERICAL INFORMATION ON THE DRAWINGS HAS BEEN COMPLIED WITH PRIOR TO THE CHECK BEING CARRIED OUT BY THE GROUP 9 SURVEYOR. KNOWN CHANGES TO THE NUMERICAL INFORMATION IS TO BE REFLECTED ON THE CONTRACTORS RECORD DRAWINGS.

11.6 A CONTRACTOR CERTIFIED COPY OF THE ON-SITE RECORD DOCUMENTS IS TO BE PROVIDED TO GROUP 9 FOR FINAL RECORD DRAWING CREATION.

12. CONCRETE

12.1 ALL CONCRETE SHALL CONFORM TO CSA STANDARD A23.1 (LATEST EDITION) HAVING A MINIMUM COMPRESSIVE STRENGTH AS SHOWN BELOW (UNLESS NOTED OTHERWISE).

12.2 ALL CAST-IN-PLACE CONCRETE SHALL CONFORM TO THE LATEST EDITION OF CSA STANDARD A23.1, "CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION".

12.3 SUBMIT CONCRETE MIX DESIGN TO ENGINEER PRIOR TO PRODUCTION. NO WATER SHALL BE ADDED TO THE CONCRETE AT THE SITE.

12.4 SUBMIT PLACING DRAWINGS AND BAR LISTS FOR ALL REINFORCING STEEL TO RSIO MANUAL SUFFICIENTLY DETAILED AND DIMENSIONED TO PERMIT PLACING OF ALL REINFORCING WITHOUT REFERENCE TO DESIGN DRAWINGS.

12.5 THE OWNER WILL EMPLOY A TESTING COMPANY TO CONDUCT STRENGTH, SLUMP, MATERIAL AND AIR ENTRAINED TESTS ONCE FOR EVERY DAY CONCRETE IS POURED. STRENGTH TEST SHALL INCLUDE THREE CYLINDERS, ONE TESTED AT 7 DAYS AND TWO TESTED AT 28 DAYS IN ACCORDANCE WITH CAN3-A23.2. SLUMP AND AIR CONTENT TESTS SHALL CONSIST OF ONE SAMPLE EACH IN ACCORDANCE WITH CAN3-23. 1 AND CAN3-A23.2.

12.6 ALL CONCRETE THAT WILL BE EXPOSED TO WEATHER SHALL HAVE A 5 TO 7% AIR ENTRAINMENT AT TIME OF PLACING.

12.7 BULL FLOAT CONCRETE SURFACES AND PROVIDE A LIGHT TROWEL FINISH TO PRODUCE A SMOOTH NON-SLIP SURFACE FREE FROM RIDGES, VOIDS AND MACHINE MARKS. EXTERIOR CONCRETE WALKING SURFACES SHALL HAVE A LIGHT BROOM FINISH TO CREATE A NON-SLIP SURFACE. PROVIDE ROUGH SURFACE AT COLD JOINTS.

12.8 KEEP CONTINUOUSLY MOIST ALL EXPOSED NON-FORMED SURFACES FOR A MINIMUM OF SEVEN CONSECUTIVE DAYS AFTER PLACEMENT OF CONCRETE UNLESS NOTED OTHERWISE.

12.9 ALL EXPOSED CONCRETE EDGES ARE TO HAVE A THREE-QUARTER INCH (3/4") CHAMFER UNLESS NOTED OTHERWISE.

12.10 WHERE NEW CONCRETE IS TO BE PLACED AGAINST EXISTING CONCRETE, EXISTING CONCRETE MUST BE THOROUGHLY CLEANED TO REMOVE OIL, GREASE AND DIRT AND BE SURFACE 'CHIPPED' A MINIMUM OF ONE-HALF (1/2) INCH PRIOR TO PLACEMENT OF NEW CONCRETE UNLESS NOTED OTHERWISE ON DRAWINGS. APPLICATION OF AN APPROVED BONDING AGENT SHALL BE APPLIED AT ALL INTERFACES BETWEEN NEW AND OLD CONCRETE.

12.11 VIBRATE ALL CONCRETE. ENSURE ALL CONCRETE IS DENSE, FREE OF HONEY COMBING, AND THAT NO SEGREGATION OCCURS.

12.12 THE ABOVE DO NOT APPLY TOWARDS PERMEABLE CONCRETE AREAS

13. STRUCTURAL STEEL

13.1 ALL WORK SHALL CONFORM TO CSA STANDARD S16 (LATEST EDITION) "LIMIT STATES DESIGN OF STEEL STRUCTURES". CONTRACTOR TO FABRICATE TO APPROVED SHOP DWGS. ONLY.

13.2 STRUCTURAL BOLTS TO BE ASTM-A325-02 SPECIFICATION FOR STRUCTURAL BOLTS. HEAT TREATED 120/105 KSI MIN. TENSILE STRENGTH. COMPLETE WITH HARDENED WASHERS AND HEAVY HEX NUTS.

13.3 ALL ANCHOR RODS TO ASTM-F1554 GRADE 36. ALL ANCHOR RODS TO BE HOT-DIP GALVANIZED.

13.4 ALL WELDING TO BE DONE BY A CONTRACTOR CERTIFIED BY THE CANADIAN WELDING BUREAU TO THE REQUIREMENTS OF CSA-W47. 1-03 CERTIFICATION OF COMPANIES FOR FUSION WELDING OF STEEL STRUCTURES, DIVISION 1 OR 2. CONTRACTOR TO SUBMIT CURRENT CWB LETTER OF VALIDATION TO ENGINEER PRIOR TO PROCEEDING WITH ANY STEELWORK.

13.5 ALL ELECTRODES SHALL BE E49XX CONFORMING TO CSA STANDARD W48.

13.6 ALL WELDING TO BE METAL-ARC TO CSA-W59-M1989-WELDED STEEL CONSTRUCTION. (METAL-ARC WELDING). ALL WELDS SHALL BE CONTINUOUS UNLESS NOTED. MINIMUM SIZE OF FILLET WELD TO BE 6mm OR AS REQ'D BY MATERIAL THICKNESS OR PARTS JOINED.

13.7 DO NOT PAINT CONNECTION SURFACES OR SURFACES TO BE WELDED.

12.8 CLEAN, PRIME AND FINISH PAINT ALL NEW STEEL WORK AS PER THE FOLLOWING:

- 13.8.1 SHOP CLEAN ALL STEEL ACCORDING TO STEEL STRUCTURAL PAINTING COUNCIL SURFACE PREPARATION No. 6, "COMMERCIAL BLAST CLEANING", OR PREPARATION No.3 "POWER WIRE BRUSH CLEANING"
- 13.8.2 SAME DAY AS CLEANED, APPLY ONE SHOP COAT OF DEVGUARD #4160 GREY OXIDE RUST INHIBITIVE PRIMER TO A DRY FILM THICKNESS OF 2.0 TO 2.4 MILS.
- 13.8.3 FOR EXPOSED STEEL IN THE SHOP, APPLY TWO FINISH COATS OF DEVGUARD ALKYD SEMI-GLOSS ENAMEL #4306 SERIES, 1.5 TO 2 MILS DRY FILM THICKNESS, COLOURS BY OWNER.
- 13.8.4 AFTER ERECTION, CLEAN ALL SURFACES. TOUCH-UP ANY DAMAGED OR UNPAINTED AREAS WITH PRIMER AND TWO FINISH COATS.

13.9 BEAM END CONNECTION DETAILS SHOWN ON THESE DRAWINGS ARE INTENDED TO SERVE AS A GUIDE IT IS THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL FINAL DIMENSIONS.

13.10 THE OWNER WILL EMPLOY A QUALIFIED PERSON TO INSPECT THE CONNECTIONS, INCLUDING BOLT TENSION AND WELDING, IN ACCORDANCE WITH CSA S16-01 SECTIONS 23 AND 30.

Apr 16 2021 – 3:30pm D:\D Drive Documents\School Archive\2020\CIVL 445\445-General-v2.dwg/G102 Ray

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	GENERAL NOTES	TM

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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CLIENT

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6250 Applied Science Ln
Vancouver, BC V6T 1Z4

EAST MALL REDESIGN

General Notes

SEAL

SCALE: N.T.S.

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED TM

DRAWN TM

REVIEWED BM

DWG. NO. G102

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

NOTES:
1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE
2. FOR ROADWAY CROSS-SECTIONS, REFER TO DRAWINGS R104-105
3. FOR ROADWAY PROFILES, REFER TO DRAWINGS R106-107
4. FOR TYPICAL MEDIAN CURB RAMP AND RAISED CROSSWALK DETAILS, REFER TO DRAWING R-108
5. EXISTING SIDEWALKS DENOTED BY DASHED LINE, TO BE LEFT AS IS UNLESS STATED OTHERWISE

Ken

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	04/16/2021	Roadway Plan View (Sheet 1 of 3)	KT

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN
Roadway Plan View Drawings (Sheet 1 of 3)

SEAL

SCALE: 1:200
DESIGNED KT
DRAWN KT
REVIEWED TM

DATE (YYYY.MM.DD)
04/16/2021

DWG. NO. R101
REV. 1

Apr 15 2021 – 8:31pm C:\Users\Kyle\OneDrive\4th year Civil\Term 2\Civil 446\Capstone\PLAN\EM446.dwg\R1 Kyle

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE
2. FOR ROADWAY CROSS-SECTIONS, REFER TO DRAWINGS R104-105
3. FOR ROADWAY PROFILES, REFER TO DRAWINGS R106-107
4. FOR TYPICAL MEDIAN CURB RAMP AND RAISED CROSSWALK DETAILS, REFER TO DRAWING R-108
5. EXISTING SIDEWALKS DENOTED BY DASHED LINE, TO BE LEFT AS IS UNLESS STATED OTHERWISE

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	04/16/2021	Roadway Plan View (Sheet 2 of 3)	KT

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Roadway Plan View (Sheet 2 of 3)

SEAL

SCALE: 1:400

DESIGNED

DRAWN KT

REVIEWED TM

DATE (YYYY.MM.DD) 04/16/2021

DWG. NO. R102

REV. 1

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE
2. FOR ROADWAY CROSS-SECTIONS, REFER TO DRAWINGS R104-105
3. FOR ROADWAY PROFILES, REFER TO DRAWINGS R106-107
4. FOR TYPICAL MEDIAN CURB RAMP AND RAISED CROSSWALK DETAILS, REFER TO DRAWING R-108
5. FOR TO DRAWINGS C101-C104 FOR CANOPY DRAWINGS
6. EXISTING SIDEWALKS DENOTED BY DASHED LINE, TO BE LEFT AS IS UNLESS STATED OTHERWISE

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	04/16/2021	Roadway Plan View (Sheet 3 of 3)	KT

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS–CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS–CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN
Roadway Plan View (Sheet 3 of 3)

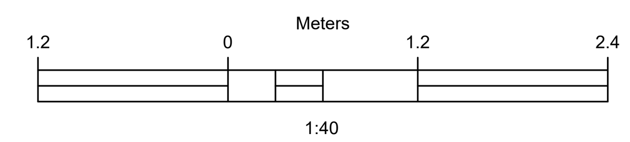
SEAL

SCALE: 1:275
DESIGNED KT
DRAWN KT
REVIEWED TM

DATE (YYYY.MM.DD) 04/16/2021
DWG. NO. R103
REV. 1

PRODUCED BY AN AUTODESK STUDENT VERSION

TYPICAL CROSS-SECTION A



LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3	2021/04/16	IFC Cross-Sections	RH
2	2021/03/04	Updated Design Cross-Sections	RH
1	2020/12/03	Preliminary Design Cross-Sections	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Roadway Cross-Sections (Sheet 1 of 3)

SEAL

SCALE: 1:40

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED RH

DRAWN RH

REVIEWED TM

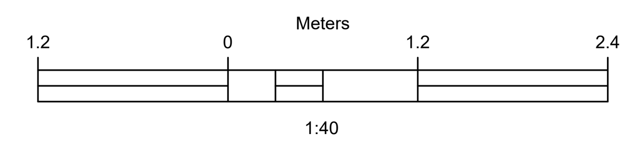
DWG. NO. R104

REV. 3

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 - 2:30pm D:\D Drive Documents\School Archive\2020\CIVL 445\445-Sections.dwg/R104 Ray

BUS STOP AND GREENWAY CROSSING
CROSS-SECTION B



LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3	2021/04/16	IFC Cross-Sections	RH
2	2021/03/04	Updated Design Cross-Sections	RH
1	2020/12/03	Preliminary Design Cross-Sections	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS–CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS–CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Roadway Cross-Sections (Sheet 2 of 3)

SEAL

SCALE: 1:40

DESIGNED RH

DRAWN RH

REVIEWED TM

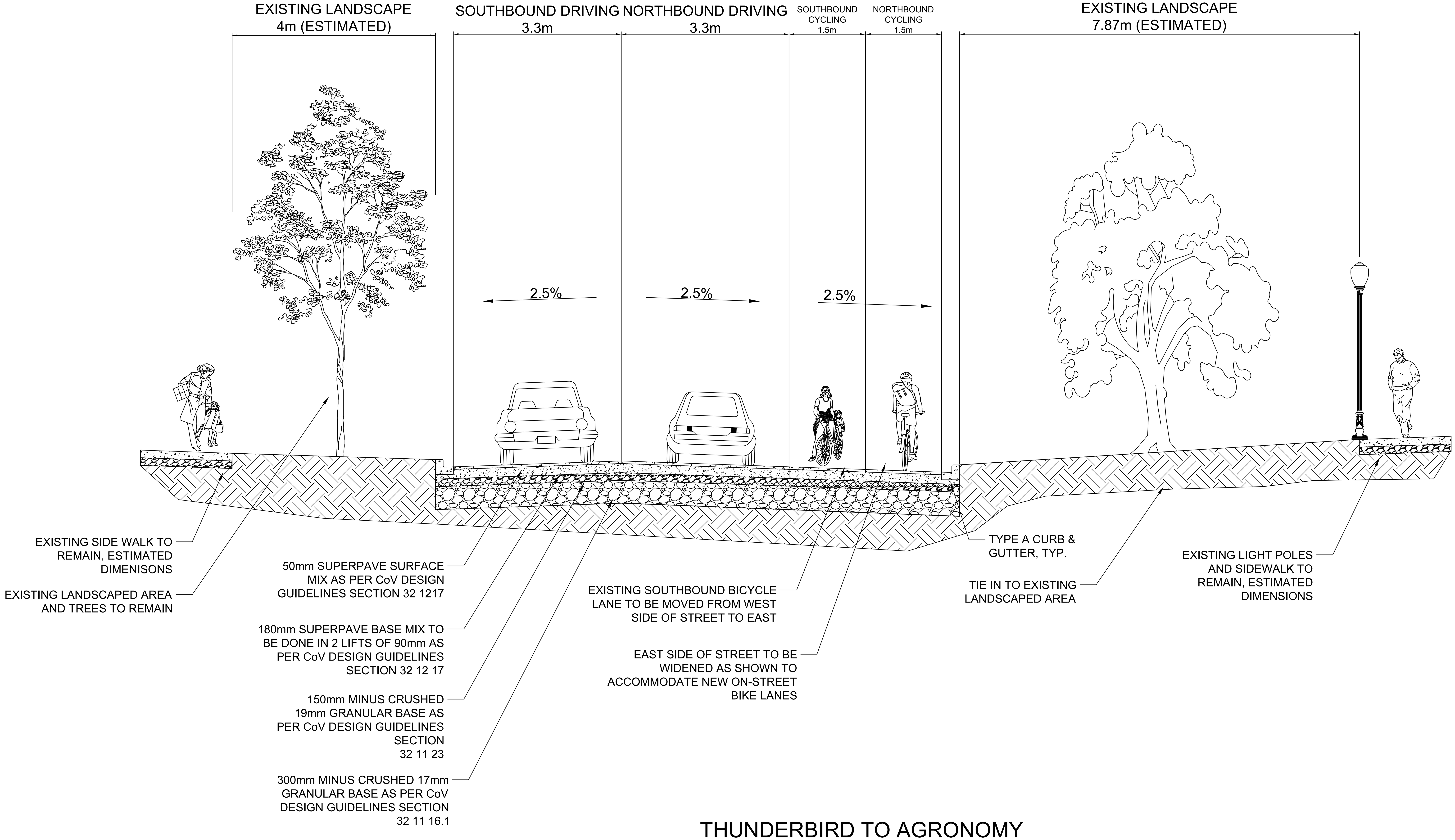
DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. R105

REV. 3

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 2:29pm D:\D Drive Documents\School Archive\2020\CIVL 445\445–Sections.dwg/R105 Ray



THUNDERBIRD TO AGRONOMY
CROSS-SECTION C

Meters
1.2 0 1.2 2.4
1:40

LEGAL DESCRIPTION			
SURVEY BENCHMARK			
REV.	DATE	DESCRIPTION	BY
5			
4			
3	2021/04/16	IFC Cross-Sections	RH
2	2021/03/04	Updated Design Cross-Sections	RH
1	2020/12/03	Preliminary Design Cross-Sections	RH

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EAST MALL REDESIGN
Roadway Cross-Sections (Sheet 3 of 3)

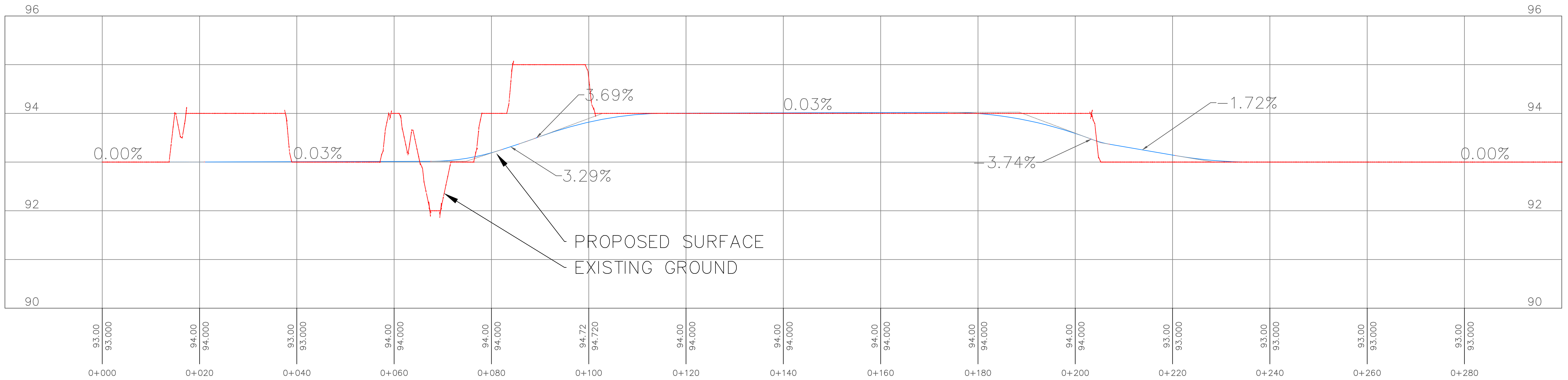
SEAL

SCALE: 1:40	DATE (YYYY.MM.DD) 2021/04/16
DESIGNED RH	
DRAWN RH	DWG. NO. R106
REVIEWED TM	REV. 3

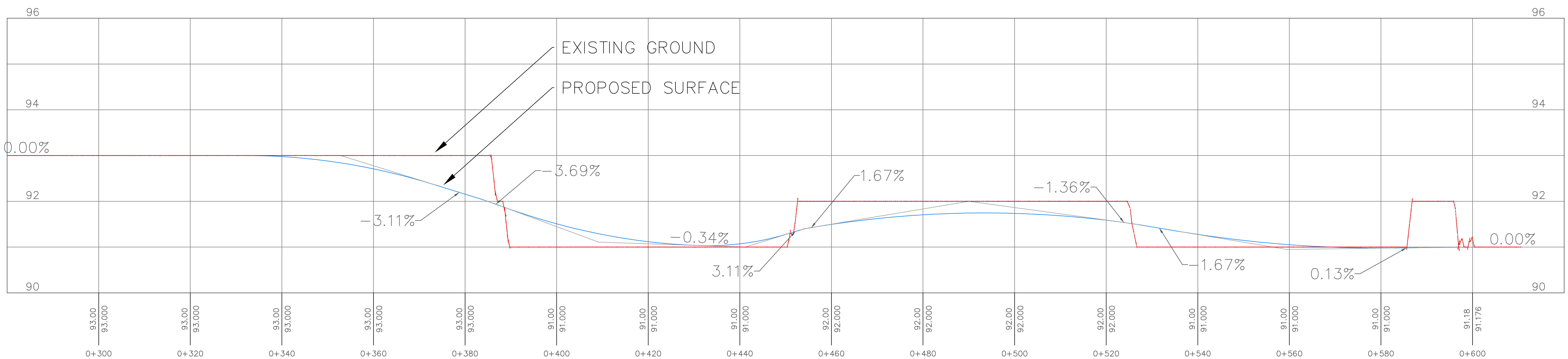
DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 2:29pm D:\D Drive Documents\School Archive\2020\CIVL 445\445–Sections.dwg/R106 Ray

PROPOSED ALIGNMENT PROFILE
STA. 0+000m TO STA. 0+300m



PROPOSED ALIGNMENT PROFILE
STA. 0+300m TO STA. 0+620m



LEGAL DESCRIPTION			
SURVEY BENCHMARK			
REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	ROADWAY PROFILE	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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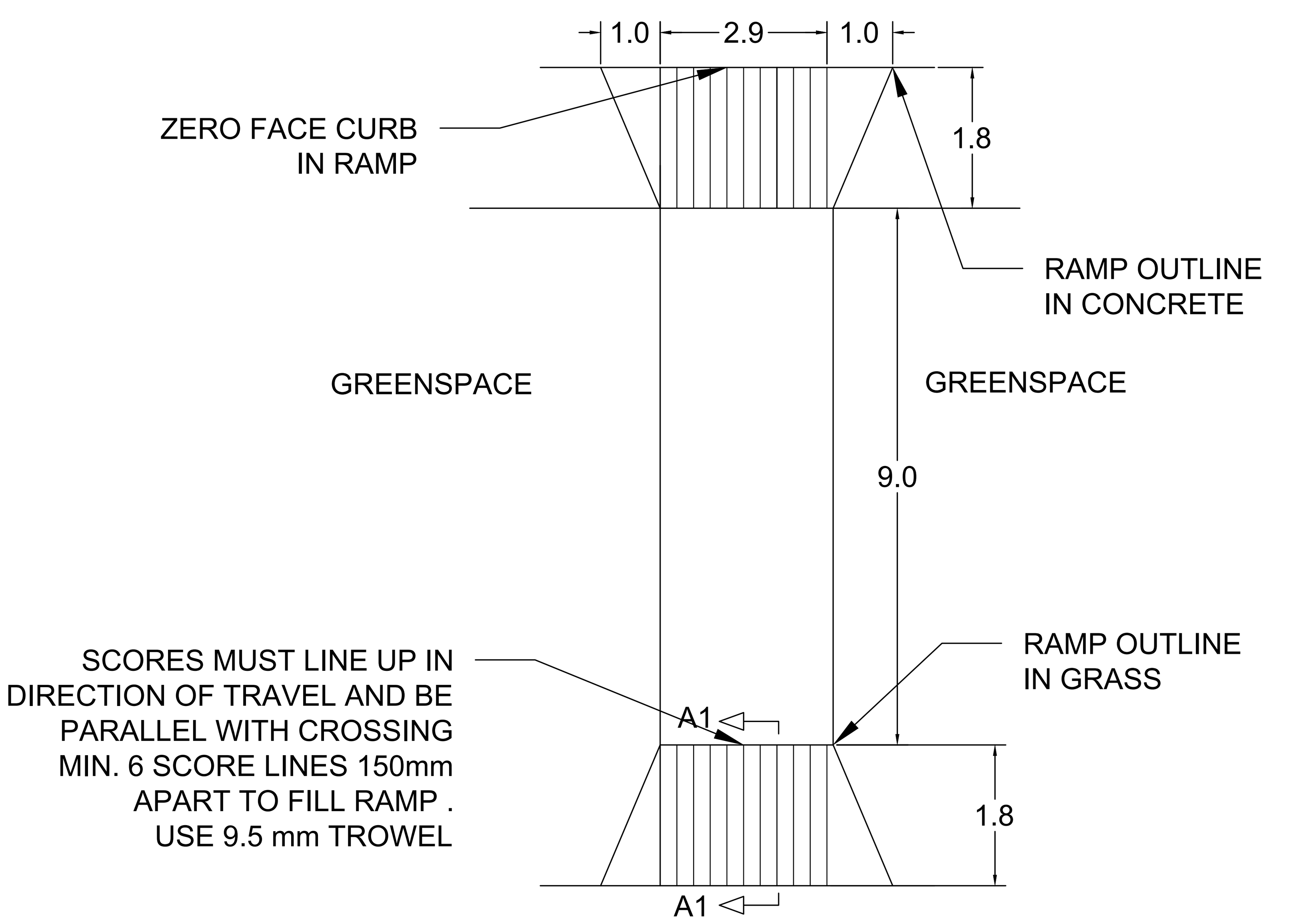
EAST MALL REDESIGN

Roadway Profile

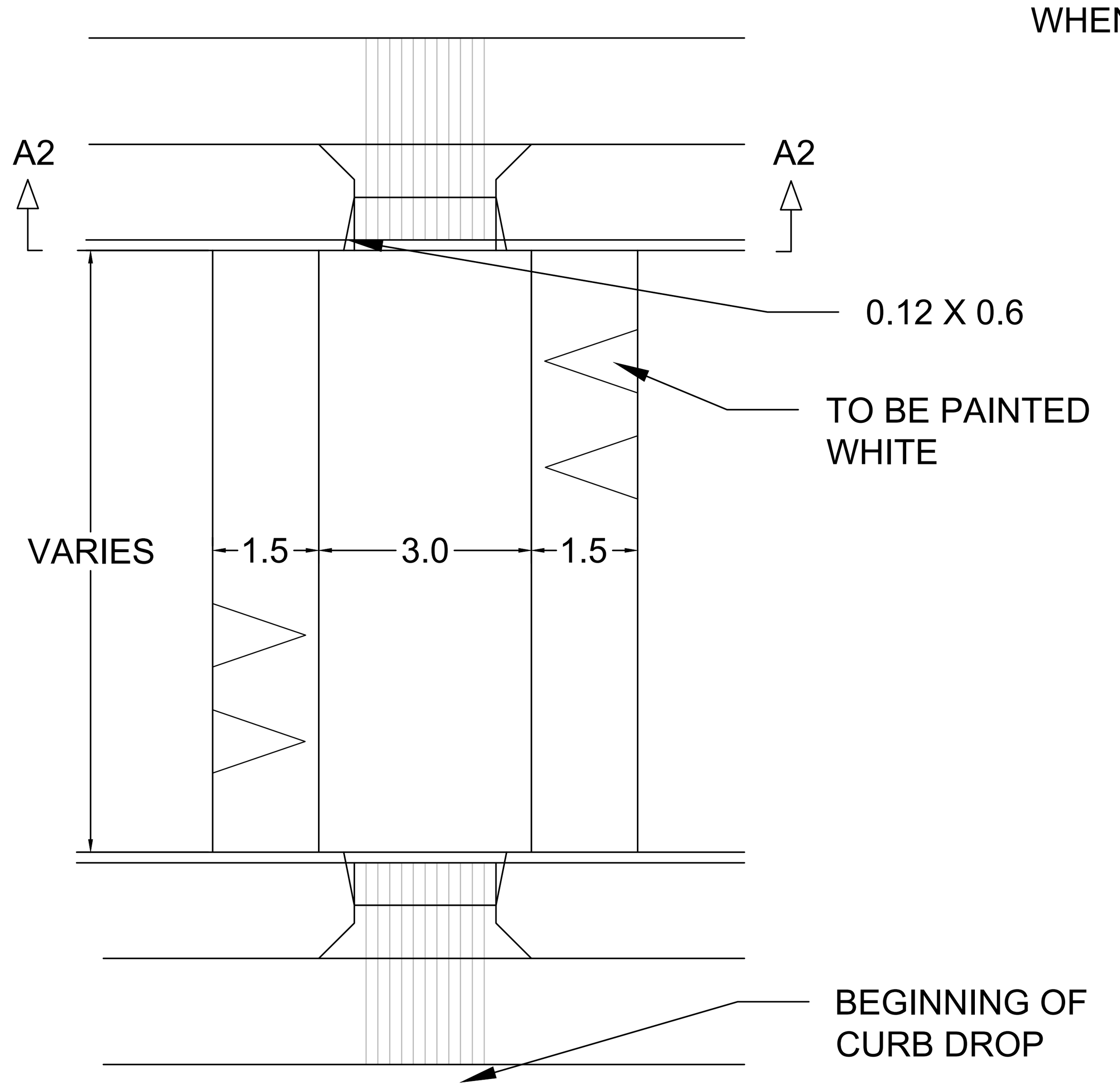
SEAL

SCALE: N.T.S.	DATE (YYYY.MM.DD) 2021/04/16
DESIGNED TM	
DRAWN TM	DWG. NO. R107
REVIEWED BM	REV. 1

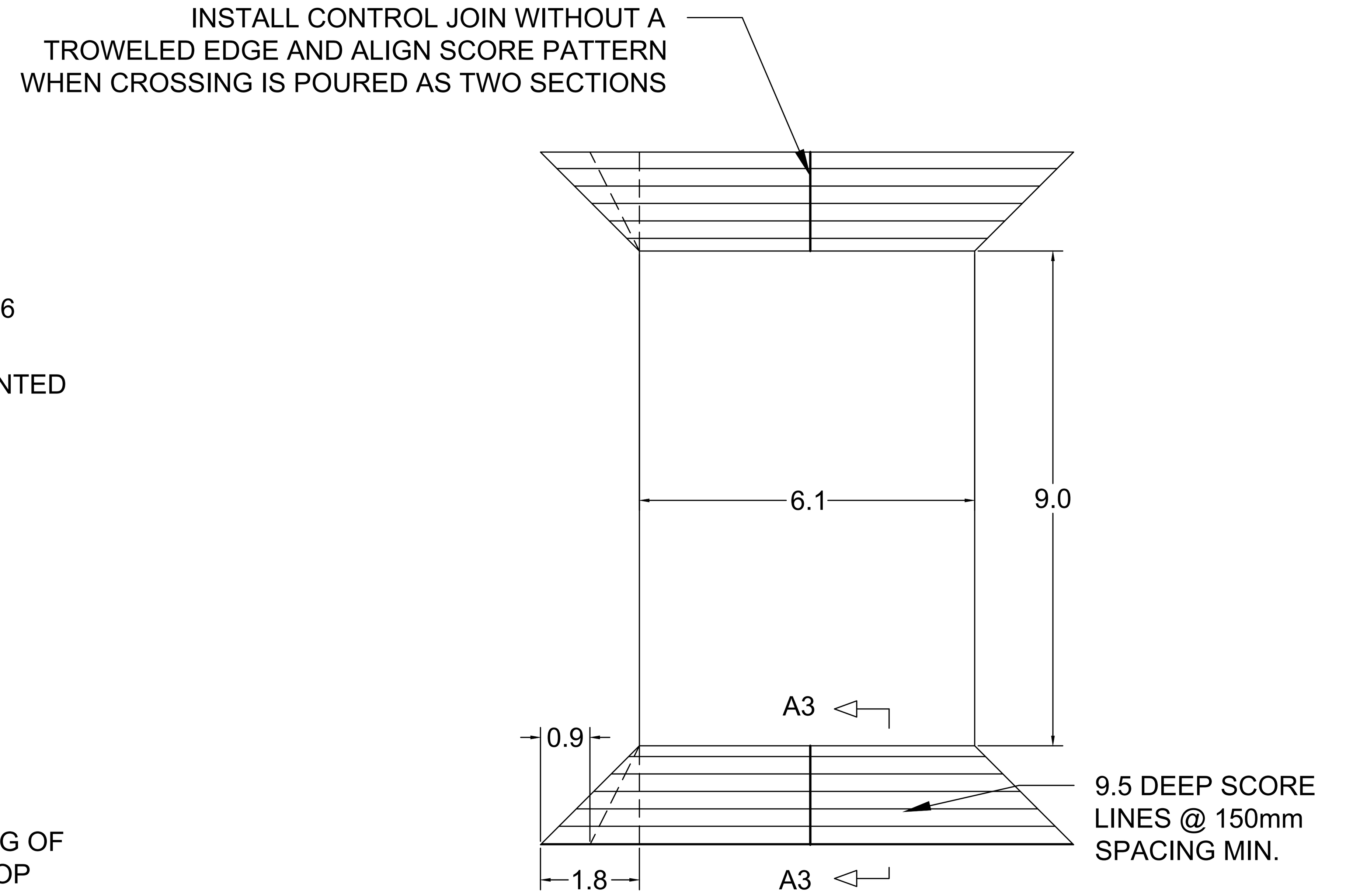
DESTROY ALL PRINTS BEARING PREVIOUS NUMBER



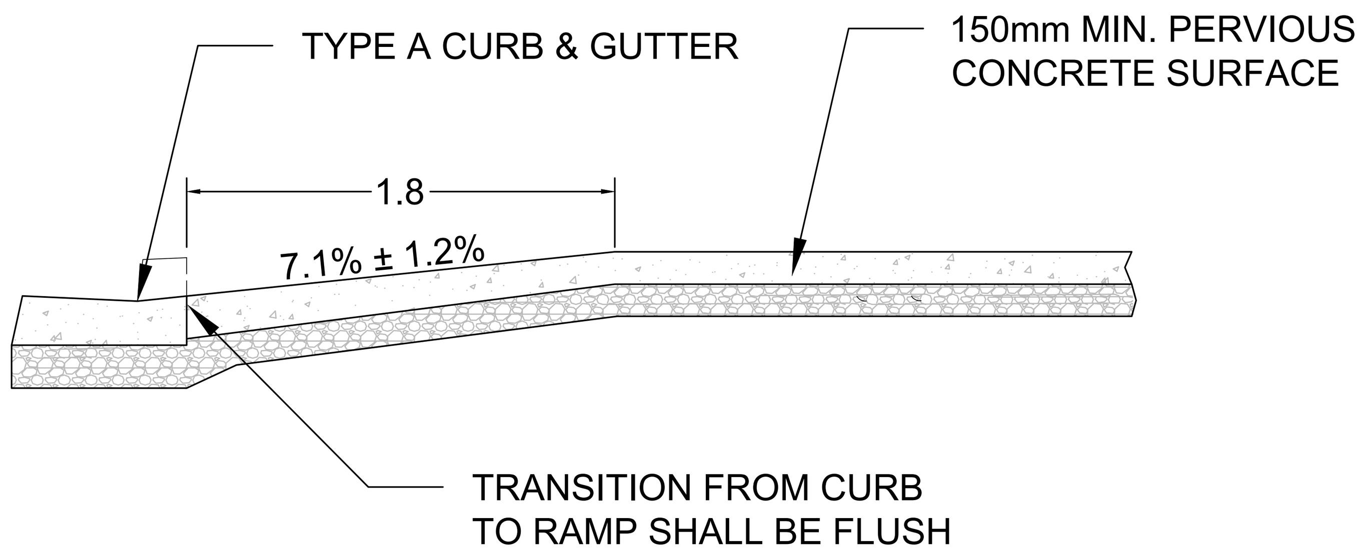
DETAIL 1: MEDIAN CURB RAMPS



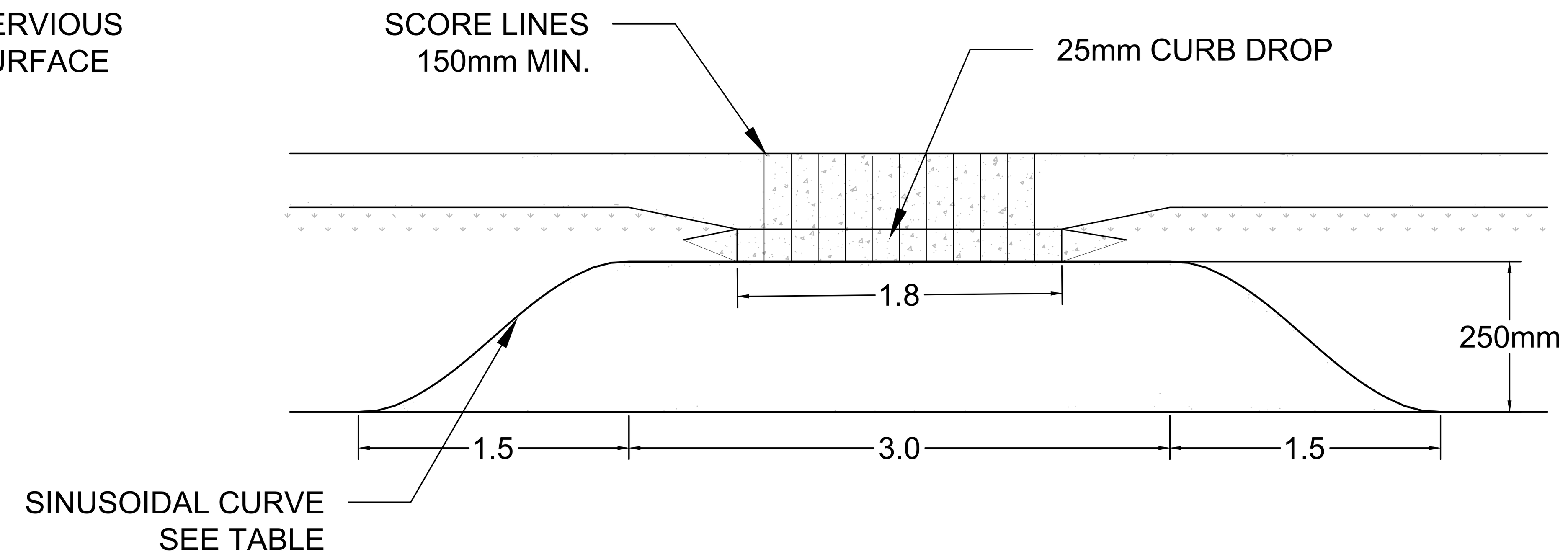
DETAIL 2: RAISED CROSSWALK



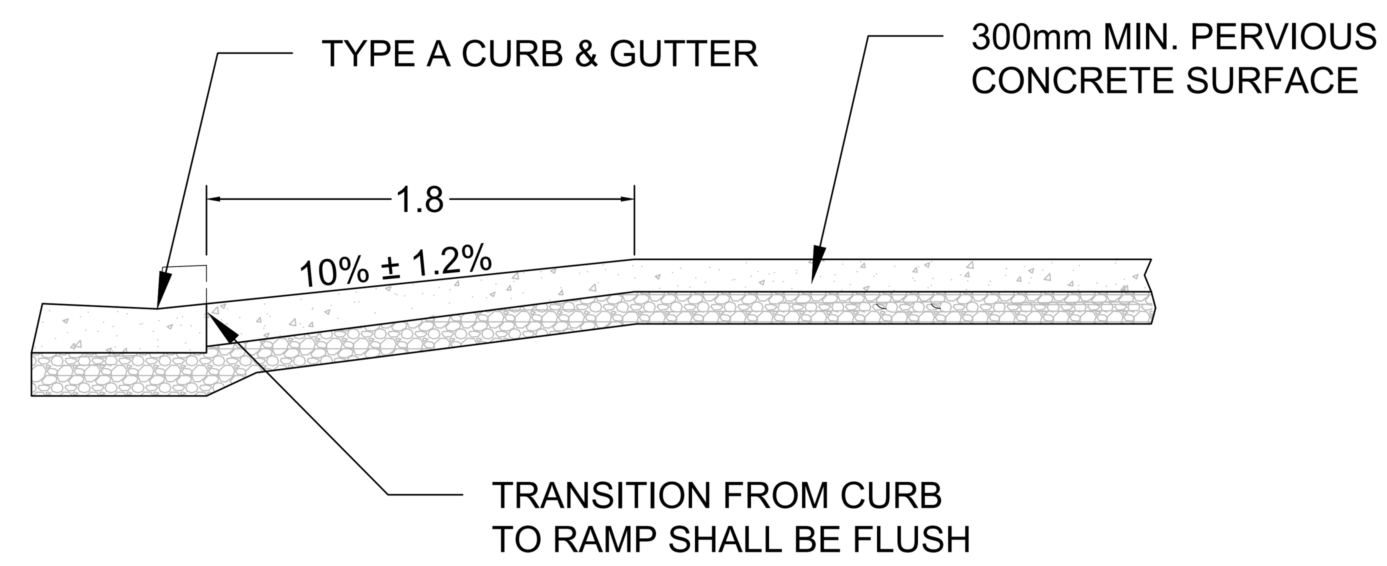
DETAIL C: EMERGENCY ACCESS DRIVEWAY CROSSING



SECTION A1-A1
MEDIAN CURB RAMP



SECTION A2-A2
RAISED CROSSWALK



SECTION A3-A3
EMERGENCY ACCESS DRIVEWAY CROSSING

NOTES:

1. ALL DIMENSIONS ARE IN METERS UNLESS STATED OTHERWISE
2. REFER TO DRAWING R101-103 FOR GENERAL PLAN VIEW
3. REFER TO DRAWING D102 FOR DETAILED SUBGRADE MATERIAL
4. REFER TO CoV CONSTRUCTION SPECIFICATIONS FOR FULL DETAILS
5. CONTRACTOR TO CONFIRM CROSSING LAYOUT IS APPROVED BY CITY INSPECTORS PRIOR TO POURING

SINUSOIDAL SPEED DEVELOPMENT HUMP

DISTANCE (m)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
FINISHED HEIGHT (mm)	1	5	12	21	31	43	56	69	82	94	104	113	120	124	125

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	Roadway Detail	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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CLIENT

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Vancouver, BC V6T 1Z4

EAST MALL REDESIGN
Roadway Details

SEAL

SCALE: N.T.S
DATE (YYYY.MM.DD) 2021/04/16
DESIGNED KT
DRAWN KT
REVIEWED TM
DWG. NO. R108
REV. 1

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	SIGNAGE PLAN (1 of 2)	BM

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS–CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS–CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Signage Plan (1 of 2)

SEAL

SCALE: 1:300

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED BM

DRAWN BM

REVIEWED KT

DWG. NO. R109

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 2:40pm C:\Users\basti\AppData\Local\Temp\AcPublish_23796\SIGNAGE2.dwg/R101 basti

NOTES:

1. REFER TO DRAWING R109 FOR DETAIL A
2. REFER TO DRAWING C101 FOR CANOPY DETAILS

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	SIGNAGE PLAN (2 of 2)	BM

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Signage Plan (2 of 2)

SEAL

SCALE: 1:300

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED BM

DRAWN BM

REVIEWED KT

DWG. NO. R110

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 - 2:40pm C:\Users\basti\AppData\Local\Temp\AcPublish_23796\SIGNAGE2.dwg/R102 basti

LEGAL DESCRIPTION			
SURVEY BENCHMARK			
REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	CANOPY PLAN - FOR CONSTRUCTION	JH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS–CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS–CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Canopy Plan View

SEAL

SCALE: 1:100

DESIGNED JH

DRAWN JH

REVIEWED TM

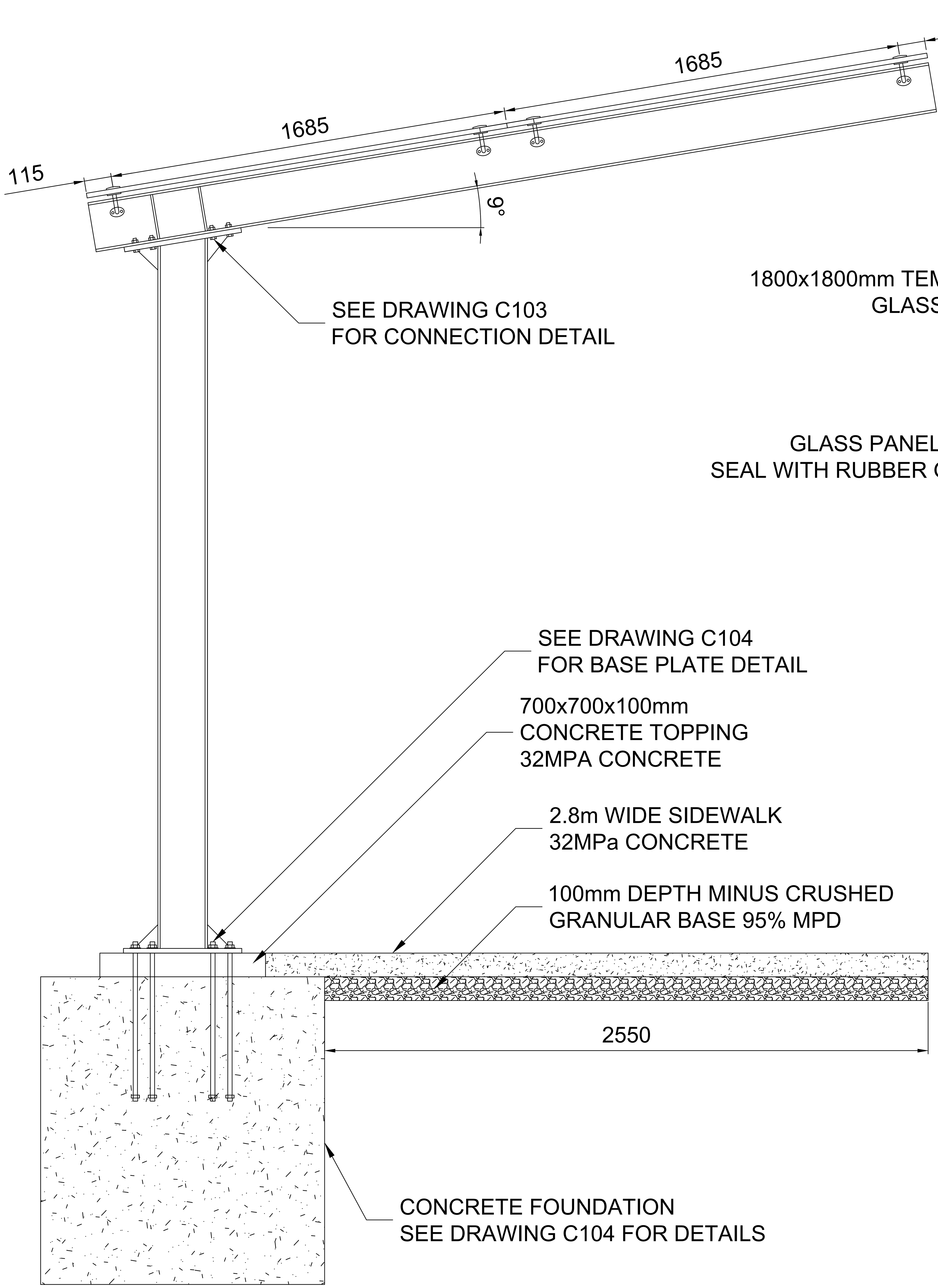
DATE (YYYY.MM.DD) 2021/04/16

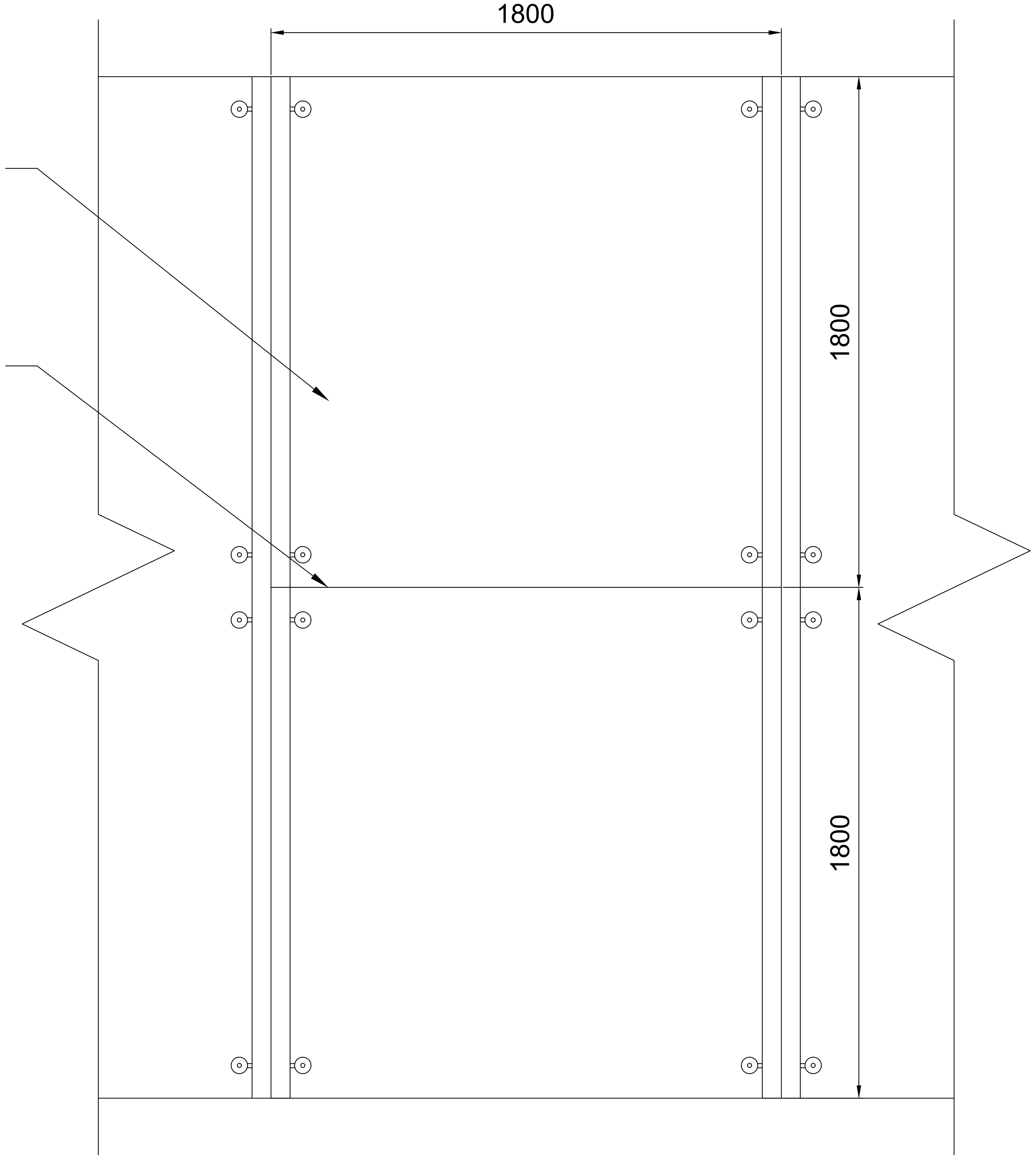
DWG. NO. C101

REV. 1

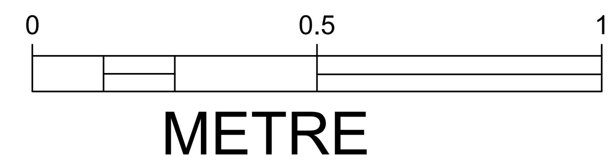
DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 3:47pm C:\Users\8571\Google Drive\UBC-4 Semester 1\CIVL 445 Capstone\Drawings\Detailed Design Drawings\Detailed Canopy Drawings.dwg/C101 8571)





PLAN VIEW TYPICAL
SECTION



LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	CANOPY TYPICAL CROSS SECTION - FOR CONSTRUCTION	JH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS–CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS–CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

CANOPY TYPICAL CROSS-SECTION

SEAL

SCALE: 1:11

DESIGNED JH

DRAWN JH

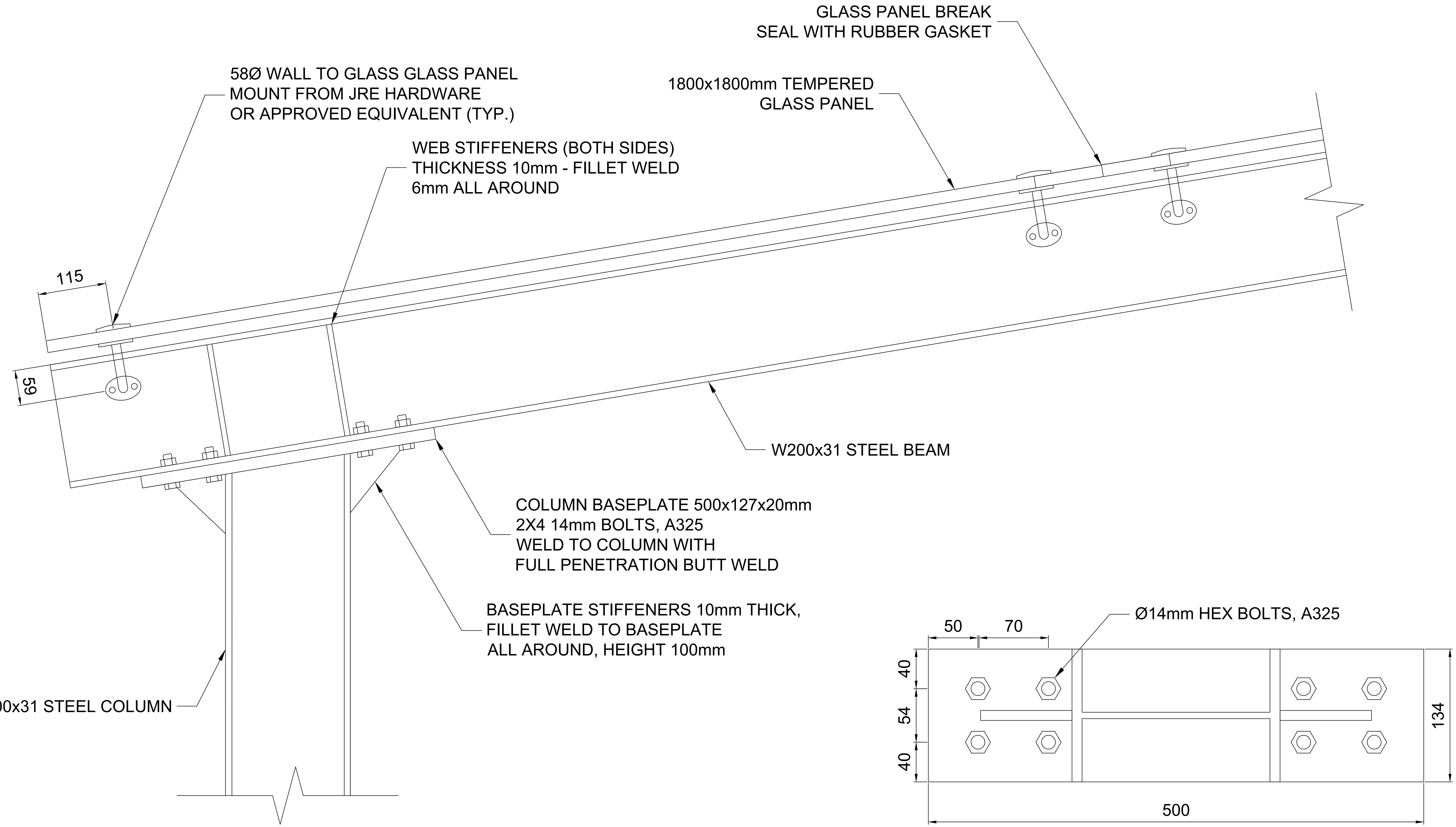
REVIEWED DB

DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. C102

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER



COLUMN TO BEAM
CONNECTION DETAIL 1:5

COLUMN END PLATE
DETAIL 1:2

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2			
1	2021/04/16	CANOPY COLUMN TO CANTILEVER DETAIL - FOR CONSTRUCTION	JH

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CONSULTANT

UBC sustainability

CLIENT

The University of British Columbia

6250 Applied Science Ln
Vancouver, BC V6T 1Z4

EAST MALL REDESIGN

CANOPY CONNECTION DETAILS (Sheet 1 of 2)

SEAL

SCALE: 1:5

DESIGNED JH

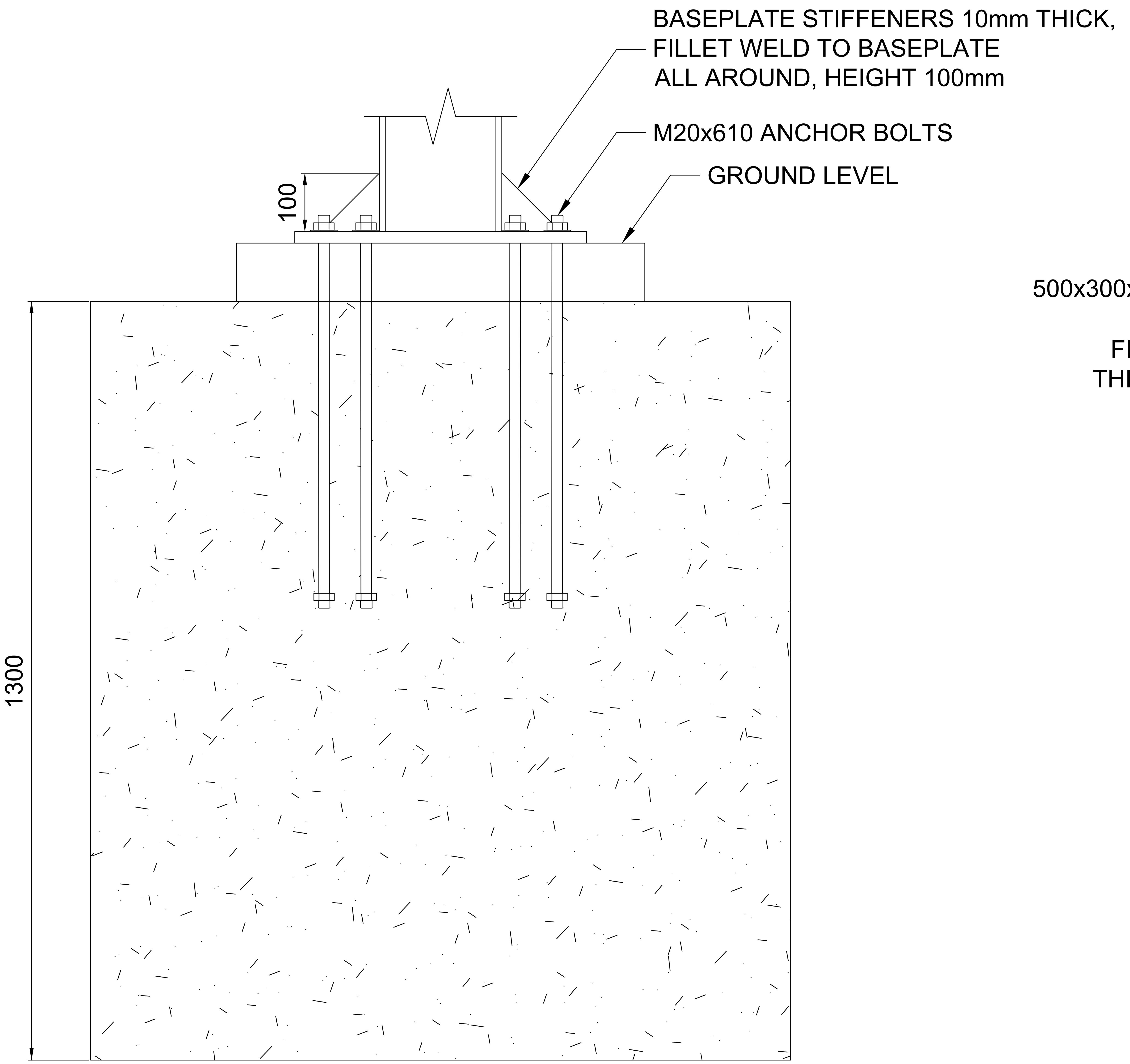
DRAWN JH

REVIEWED DB

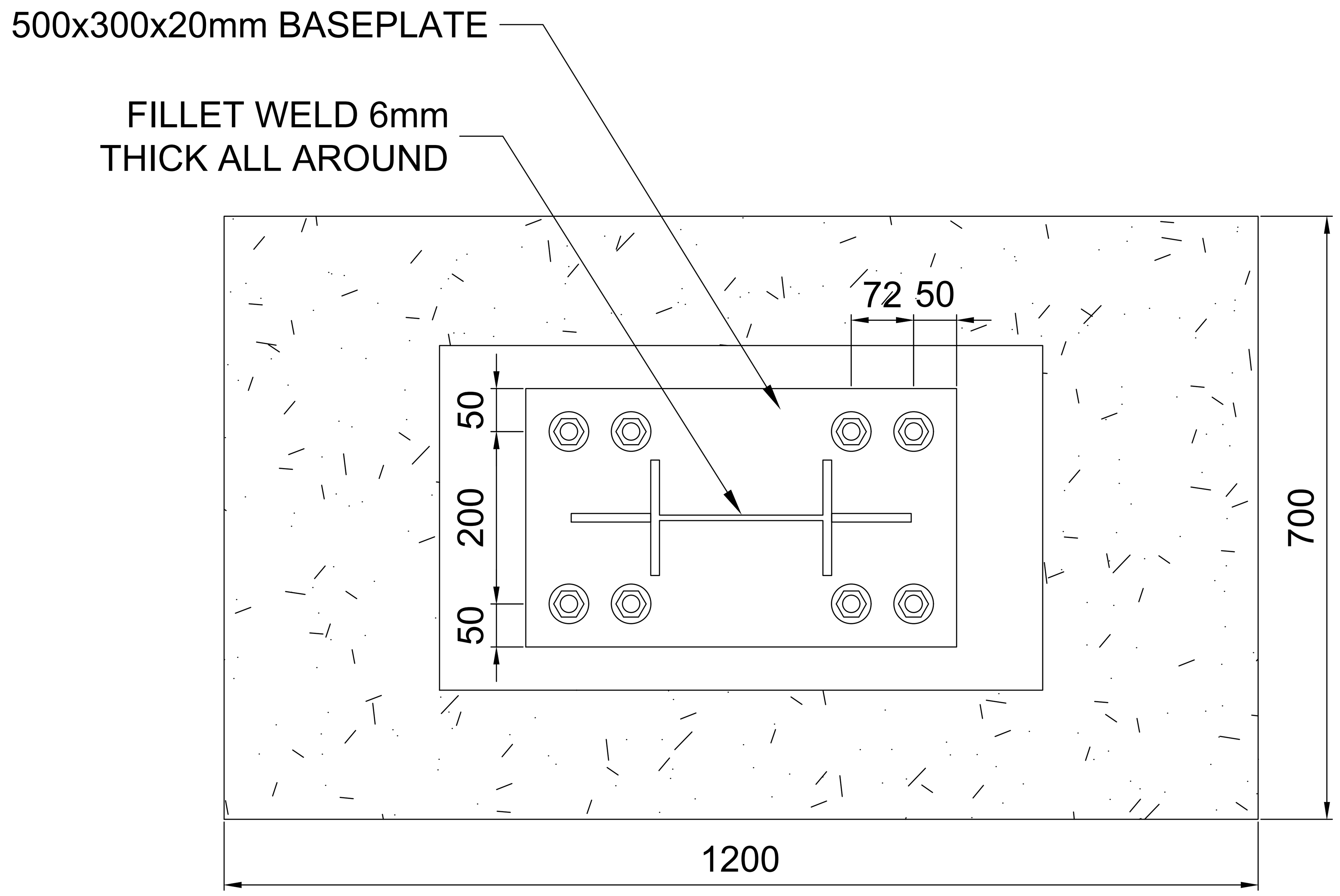
DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. C103

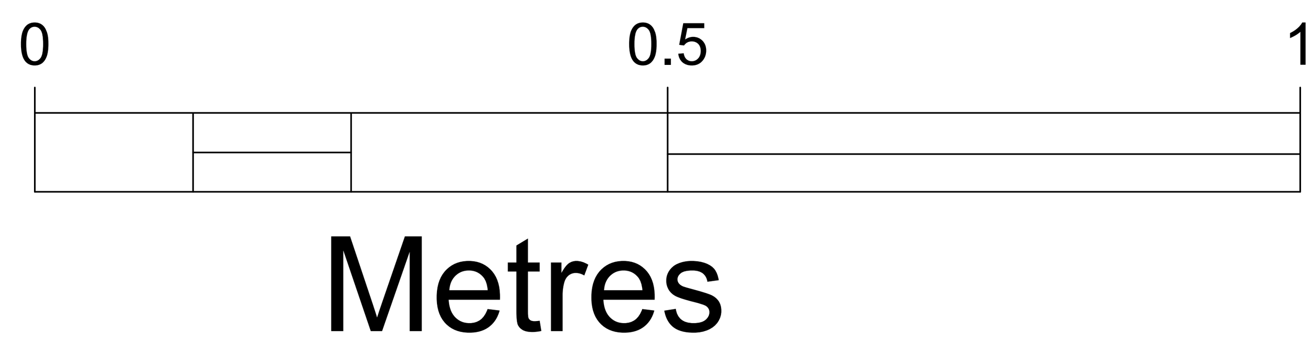
REV. 1



COLUMN TO FOOTING CONNECTION DETAIL 1:5



COLUMN BASEPLATE DETAIL 1:5



LEGAL DESCRIPTION			
SURVEY BENCHMARK			
REV.	DATE	DESCRIPTION	BY
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2			
1	2021/04/16	CANOPY COLUMN TO FOOTING DETAIL - FOR CONSTRUCTION	JH

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EAST MALL REDESIGN

CANOPY CONNECTION DETAILS (Sheet 2 of 2)

SEAL

SCALE: 1:40	DATE (YYYY.MM.DD) 2021/04/16
DESIGNED JH	
DRAWN JH	DWG. NO. C104
REVIEWED DB	REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 3:48pm C:\Users\8571\Google Drive\UBC-4 Semester 2\CIVL 446 Capstone\Detailed Design Drawings\Canopy Design – Detailed.dwg/C104 Lower Connection Detail 8571)

NOTES:

1. ALIGNMENTS AND LOCATIONS SHOWN ARE APPROXIMATE, ESTIMATED BASED ON MASTER UTILITY MAP PROVIDED BY UBC
2. CONTRACTOR TO PERFORM UTILITY LOCATES PRIOR TO CONSTRUCTION
3. PERFORM HAND-DIGGING METHODS WHEN EXCAVATING CLOSE TO UTILITIES
4. SERVICE SHOULD BE MAINTAINED THROUGHOUT CONSTRUCTION

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
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2			
1	2021/04/16	UTILITIES PLAN - WATER	RH

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EAST MALL REDESIGN

Utilities Plan- Water

SEAL

SCALE: 1:500

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED RH

DRAWN RH

REVIEWED TM

DWG. NO. W101

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 15, 2021 – 11:30am D:\D Drive Documents\School Archive\2020\CIVL 445\445-Water.dwg/W101 Roy

NOTES:

1. ALIGNMENTS AND LOCATIONS SHOWN ARE APPROXIMATE, ESTIMATED BASED ON MASTER UTILITY MAP PROVIDED BY UBC
2. CONTRACTOR TO PERFORM UTILITY LOCATES PRIOR TO CONSTRUCTION
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LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
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2			
1	2021/04/16	UTILITIES PLAN - SANITARY	RH

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EAST MALL REDESIGN

Utilities Plan - Sanitary

SEAL

SCALE: 1:500

DESIGNED RH

DRAWN RH

REVIEWED TM

DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. S101

REV. 1

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

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3. PERFORM HAND-DIGGING METHODS WHEN EXCAVATING CLOSE TO UTILITIES
4. SERVICE SHOULD BE MAINTAINED THROUGHOUT CONSTRUCTION

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2	2021/04/16	UTILITIES PLAN - STORMWATER	RH
1	2021/03/04	STORMWATER DESIGN PLAN	RH

"BY SEALING AND SIGNING THIS DRAWING, I CERTIFY THAT THE INFORMATION CONTAINED IN THESE DRAWINGS ACCURATELY REFLECTS THE ORIGINAL DESIGN, ADDENDA, CHANGE ORDERS AND MATERIAL DESIGN CHANGES MADE DURING CONSTRUCTION AND FIELD REVIEWED BY ME, OR MY REPRESENTATIVE, AND THAT THE AS-CONSTRUCTED WORKS SUBSTANTIALLY COMPLY WITH THE ORIGINAL DESIGN INTENT, HOWEVER, I DO NOT ACCEPT RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE AS-CONSTRUCTED INFORMATION SUPPLIED BY OTHERS CONTAINED IN THESE DRAWINGS."

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EAST MALL REDESIGN

Utilities Plan - Stormwater

SEAL

SCALE: 1:500

DESIGNED RH

DRAWN RH

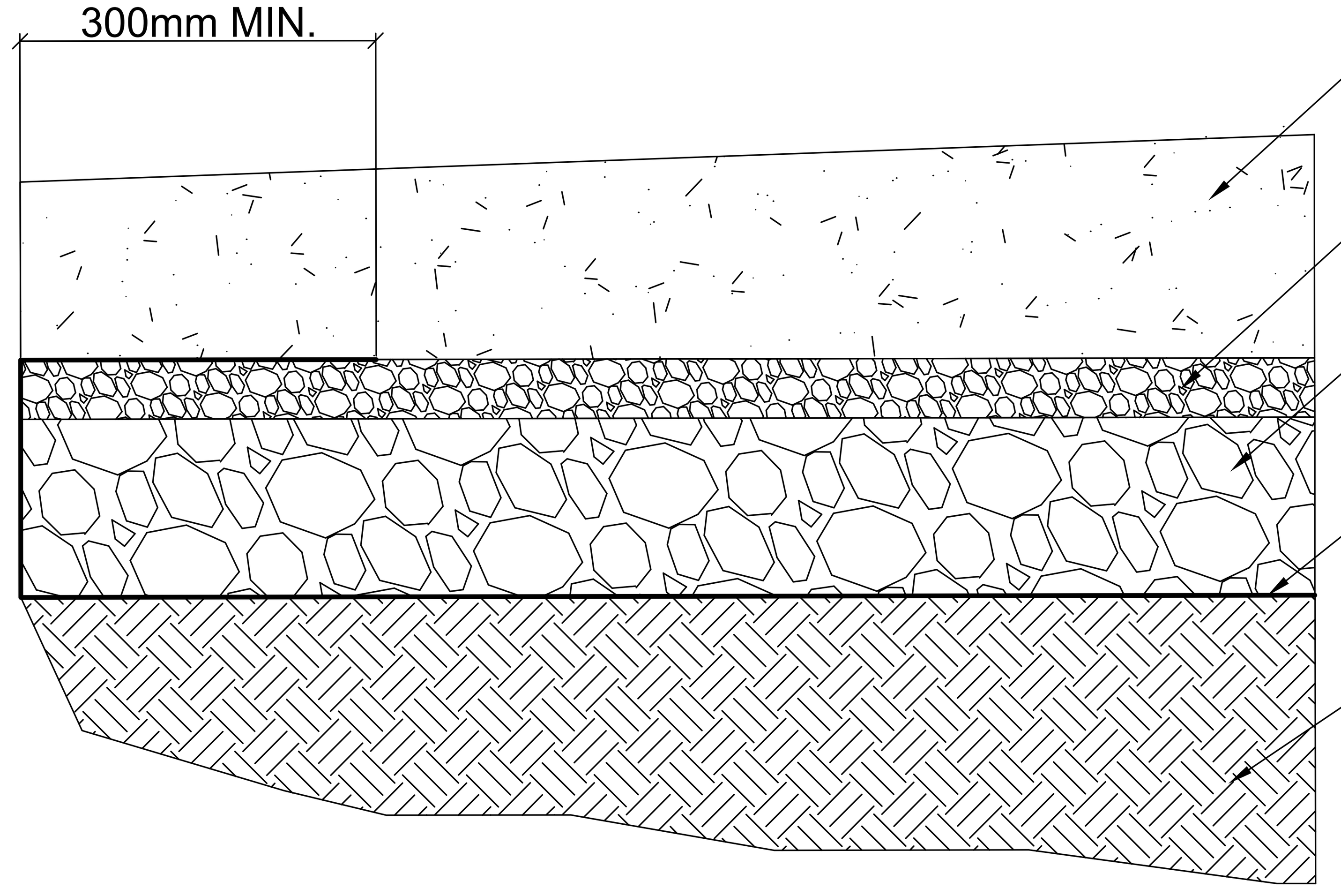
REVIEWED TM

DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. D101

REV. 2

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER



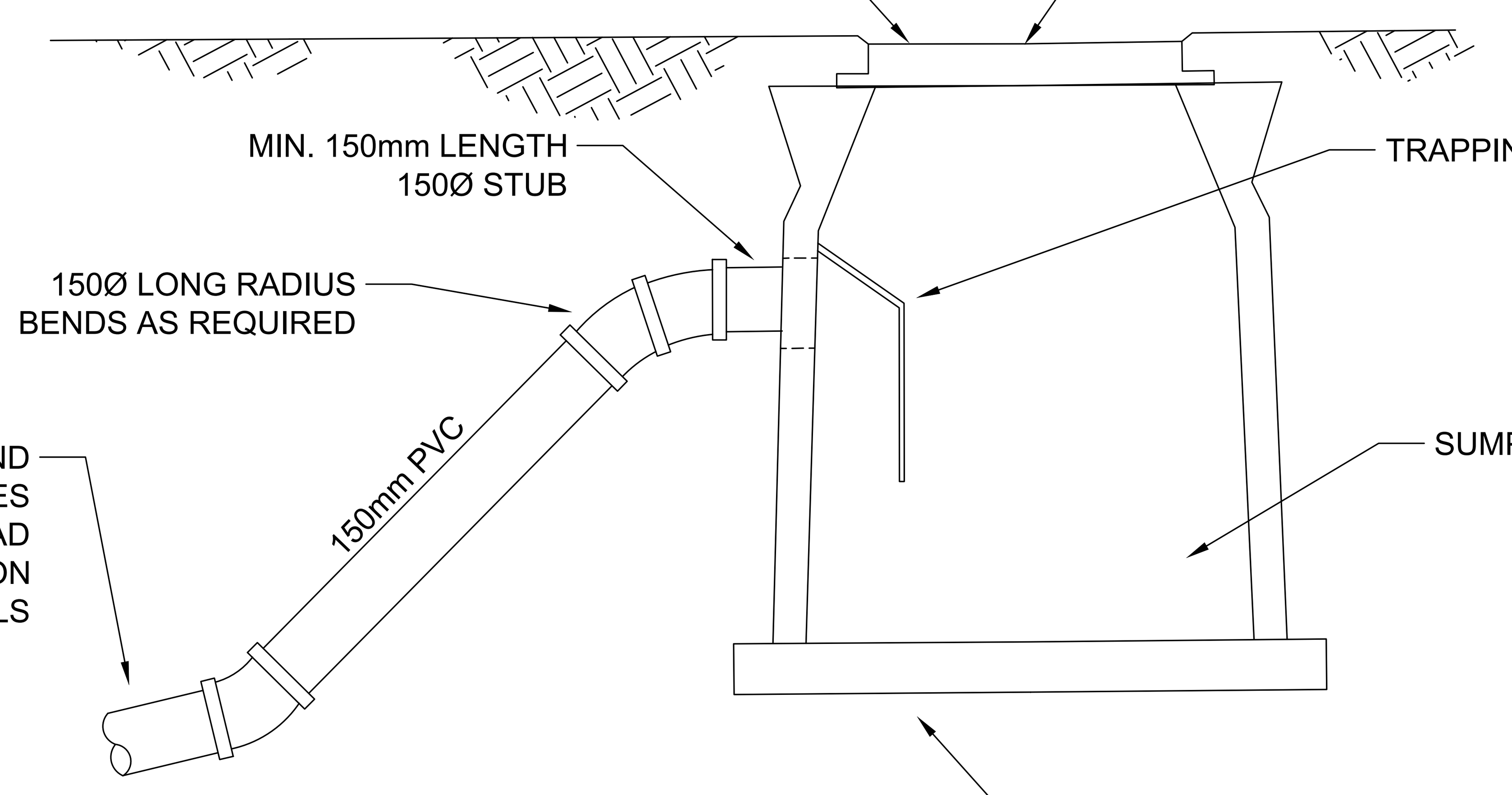
PERMEABLE PAVEMENT DETAIL

NOTES

1. REFER TO CONSTRUCTION SPECIFICATIONS FOR COMPREHENSIVE INSTALLATION AND TESTING REQUIREMENTS
2. PERMEABLE CONCRETE MIX SHALL BE TESTED DAILY BEFORE FIRST POUR TO VERIFY SLUMP IS WITHIN 15cm TO 18cm AND FRESH UNIT WEIGHT IS WITHIN 80kg/m3 OF TARGET
3. ENSURE 95% PROCTOR COMPACTION WITHIN SUBBASE AND ADEQUATE MOISTURE PRIOR TO POURING PERMEABLE SURFACE MIX
4. PERMEABLE CONCRETE SURFACE TO BE CONSOLIDATED USING STEEL ROLLER
5. FINISHED SURFACE TO BE MISTED AND COVERED WITH PLASTIC SHEET FOR MINIMUM OF 7 DAYS WITHIN 20 MINUTES OF PLACEMENT

PERMEABLE CONCRETE SPECIFICATIONS

1. 18MPa 28-DAY COMPRESSIVE STRENGTH
2. 8600mm/hr INFILTRATION RATE
3. 15cm TO 18cm SLUMP
4. VOID-DENSITY CURVE TO BE PREDETERMINED THROUGH LAB TESTING



TYPICAL CATCHBASIN DETAIL

NOTES

1. REFER TO CoV STANDARD CONSTRUCTION DOCUMENTS FOR DETAILED INSTALLATION REQUIREMENTS
2. ALTERNATIVE PRECAST CONCRETE CATCHBASIN MEETING MMCD REQUIREMENTS MAY BE USED IF PRE-APPROVED BY DESIGN ENGINEER
3. TRAPPING HOOD CAN BE PURCHASED AND INSTALLED SEPARATELY
4. EXISTING CATCH BASINS FROM ROAD RESTORATION TO BE REUSED WHEREVER POSSIBLE
5. ENSURE GRATE IS ALIGNED WITH FLOW DIRECTION

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2	2021/04/16	Stormwater Design Details - IFC	RH
1	2021/03/04	Stormwater Design Details	RH

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EAST MALL REDESIGN

STORMWATER DESIGN DETAILS

SEAL

SCALE: N.T.S.

DATE (YYYY.MM.DD) 2021/04/16

DESIGNED RH

DRAWN RH

REVIEWED TM

DWG. NO. D102

REV. 2

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 14 2021 - 8:09pm D:\D Drive Documents\School Archive\2020\CIVL 445\445-Storm.dwg/D102 Roy

TYPICAL UTILITY CROSS-SECTION
THUNDERBIRD TO STADIUM

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2	2021/04/16	IFC Utility Cross-Section	RH
1	2021/03/04	Initial Utility Cross-Section	RH

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EAST MALL REDESIGN

Utility Cross-Sections (Sheet 1 of 2)

SEAL

SCALE: 1:40

DESIGNED RH

DRAWN RH

REVIEWED TM

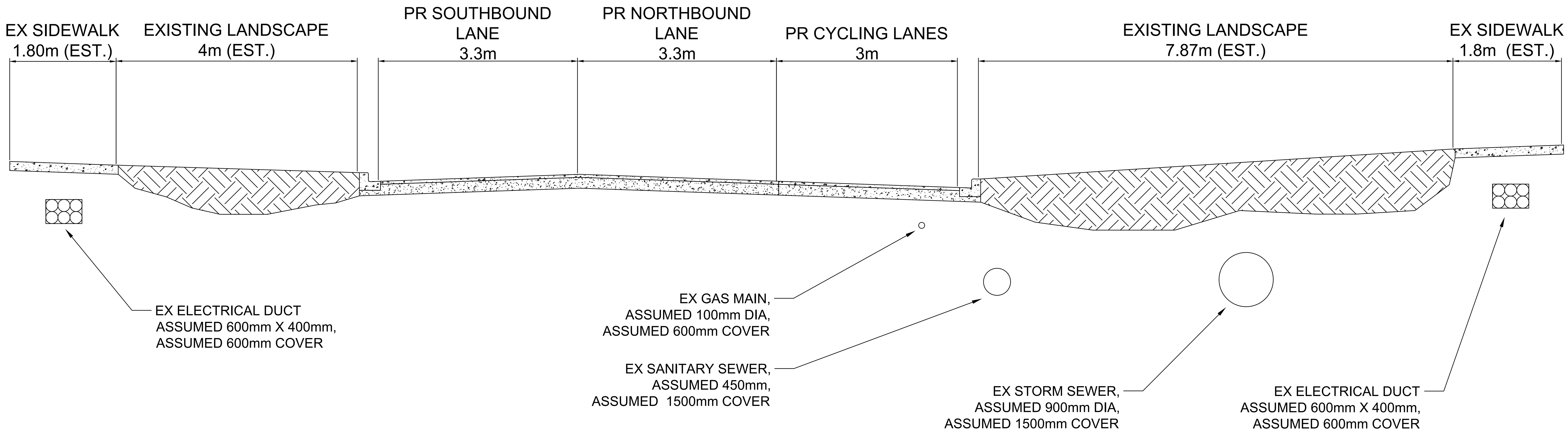
DATE (YYYY.MM.DD) 2021/04/16

DWG. NO. U101

REV. 2

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

Apr 16 2021 – 2:27pm D:\D Drive Documents\School Archive\2020\CIVL 445\445–Sections.dwg/U101 Roy



TYPICAL UTILITY CROSS-SECTION
AGRONOMY TO THUNERBIRD

LEGAL DESCRIPTION

SURVEY BENCHMARK

REV.	DATE	DESCRIPTION	BY
5			
4			
3			
2	2021/04/16	IFC Utility Cross-Section	RH
1	2021/03/04	Initial Utility Cross-Section	RH

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EAST MALL REDESIGN

Utility Cross-Sections (Sheet 2 of 2)

SEAL

SCALE: 1:40

DESIGNED RH

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DWG. NO. U102

REV. 2

DESTROY ALL PRINTS BEARING PREVIOUS NUMBER

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APPENDIX B – CONSTRUCTION SPECIFICATIONS

ROADWAY

Part 1 General

1. **Related Sections**
    a. Roadway Drawings
    b. Detailed Design Report
2. **References**
    a. Transportation Association of Canada Geometric Design Guide for Canadian Roads
    b. British Columbia Active Transportation Guide
    c. City of Vancouver Design Manual
3. **Design Criteria**
    a. **General**. Review and submit documents required to construct the work for accuracy, completeness, and compliance with the contract for approval by the Owner's Representative (OR). Documents submitted without evidence of Contractor approval may be returned for resubmission. Time for approval starts over when documents are returned for revision or if additional information is requested by the OR. Do not perform work related to submitted documents or drawings before approval of the OR. Obtain written approval before changing or deviating from the approved drawings.
    b. Typical surfacing, as per City of Vancouver Design Guidelines, shall include the following:
        i. 50mm Superpave surface mix
        ii. 180mm Superpave base mix implemented in two lifts
        iii. 150mm minus crushed, 19mm granular base
    c. Typical surfacing for bike lane:
        i. 50mm porous concrete surface mix
        ii. 150mm crushed base implemented in two lifts
    d. Maximum grade of 2.5% in travel lanes
4. **Execution**
    a. Verify that rough-in utilities are in proper location.
    b. Verify that road surfaces are ready to receive work.
5. **Materials**
    a. **Material sources**
        i. Material source must be government-approved sources unless otherwise approved
    b. **Handling and Storing Material**
        i. Handle and store material to preserve its quality and fitness for the work
        ii. Use only approved portions of the right-of-way for storing material or equipment, do not use private property for storage without written permission
        iii. Provide security for stored material
    c. Aggregate Gradation shall be determined in accordance with ASTM C117 (Wash Test)
    d. Any Aggregate supplied must not rut when proof rolled with a truck having a 9 tonne single axle dual tire or 17 tonne tandem axle group with dual tires with a tire pressure of 600 kPa.
    e. Water for compaction or dust control shall be incidental to the bid price for the granular material.
6. **Acceptance of Work**
    a. **Conformity with Contract Requirements**

i. Perform work to the lines, grades, cross-sections, dimensions shown in the contract
ii. Unless specific contract tolerances are noted, established manufacturing tolerances will be accepted for standard manufactured items
iii. The owner may inspect, sample, or test work before final acceptance of the project.

CANTILEVERED WALKWAY COVER

Part 1 General

1. **RELATED SECTIONS**
    a. Structural Drawings
    b. Detailed Design Report
2. **REFERENCES**
    a. National Building Code of Canada 2015
    b. British Columbia Building Code 2018
    c. American Society for Testing and Materials International (ASTM)
    d. Canadian Standards Association (CSA International)
3. **DESIGN CRITERIA**
    a. Beam and column depths are shown on the drawings. Adjust beam and column material thicknesses and spacings, as required by the design criteria. Use greater or lesser beam and column depths only if approved by the Consultant.
    b. For beam and columns, conform to the minimum design thicknesses, 95% of the design thickness as limited by CSA-S136
    c. Maximum flexural deflections under specified live shall conform to the following:
        i. Beam and column, L/120.
    d. Wall Assembly:
        i. Refer to Structural Drawings for deflection requirements for, wind loads, tolerances, drift requirements and other design parameters.
        ii. Design to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
        iii. Design to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
4. **QUALITY ASSURANCE**
    a. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of sun controls that are similar to those indicated for this Project in material, design, and intent.
        i. Welding Standards: As follows:
            1. Structural Welding Code—Steel
        ii. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. SMACNA Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

Part 2 Products

1. **FRAMING MATERIALS**
    a. Framing Materials: Cold-rolled steel, with metallic coating, minimum coating thickness Z180 (G60). Minimum 18 gauge.
2. **ACCESSORIES**

   a. Stiffener Plates: Formed sheet steel, thickness determined by performance requirements specified.

3. **FASTENERS**
   a. Bolts, Nuts and Washers: ASTM A307 or ASTM A325, hot dip galvanized to minimum requirements of CSSBI.
   b. Anchorage Devices: Drilled expansion bolts, screws with sleeves.
4. **FABRICATION**
   a. Fabricate assemblies of formed sections of sizes and profiles required.
   b. Provide cut-outs centered in webs of members to accommodate services and though-the knockout style bridging.
   c. Fit, reinforce, and brace framing members to suit design requirements.
   d. Fit and assemble in largest practical sections for delivery to site, ready for installation.
   e. Do welding to CSA S136, as applicable.

Part 3 Installation and Execution

1. **PREPARATION**
   a. Coordinate Installation Drawings, diagrams, templates, instructions, and directions for anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
2. **ERECTION**
   a. Canopies are to be installed according to approved shop drawings and plans.
   b. The entire structure shall be installed straight, true, and plumb according to standard construction procedures.
   c. Canopies shall be installed minimal slope to allow water flow from top of canopy to draining columns and eliminate ponding.
   d. All joints, corners, and connections shall be tight and clean.
   e. All exposed fasteners are to be painted to match the canopy color.
   f. Decking is to be aligned and secured to aluminum frame structure.
3. **COLUMN FOUNDATION**
   a. Styrofoam blockouts shall be provided by the canopy manufacturer and installed by the General Contractor into the concrete foundation.
   b. General Contractor shall pour the required concrete foundation size around the Styrofoam blockouts provided by the manufacturer.
   c. Canopy installer is to remove the Styrofoam after the foundation has cured, set column in cavity, and fill with minimum 2000 psi grout to level of finished concrete slab.
4. **CLEANING**
   a. All canopy surfaces exposed are to be cleaned after installation is complete.
   b. Surplus materials and debris shall be removed from the jobsite after installation is complete.

END OF SECTION

SANITARY, STORMWATER, WATER UTILITIES

Part 1 General

1. **RELATED SECTIONS**
    a. Utilities Drawings
    b. Detailed Design Report
2. **REFERENCES**
    a. City of Vancouver Engineering Design Manual
    b. City of Surrey Design Criteria Manual
    c. UBC Integrated Stormwater Management Plan
    d. American Society for Testing and Materials International (ASTM)
    e. American Concrete Institute (ACI)
    f. American Water Works Associations (AWWA)
    g. Master Municipal Construction Documents (MMCD)

Part 2 Products

1. **STORMWATER AND GRAVITY FED SANITARY MAINS AND CONNECTIONS**
    a. PVC, class SDR for pipes under 150mm and SDR 35 for pipes in diameter up to 600mm
    b. Concrete (reinforced C76 required for all pipes 600mm in diameter and larger)
    c. Water
2. **WATERMAINS AND CONNECTIONS**
    a. Class 50 ductile iron pipe in accordance with AWWA, cement mortar lined to AWWA C104 and coated with 1mm thick asphalt coating or approved equivalent
    b. Type K copper pipes with brazed joints up to 75mm for connections up to 75mm
    c. Single rubber gasket Tyton joints in accordance with AWWA C111 for push-on bell and spigot type joints or approved equivalent
    d. Flat faced flanged joints in accordance with AWWA C110
    e. Fittings to be ductile iron in accordance with AWWA C110 along with pressure rating of 2415 kPa
    f. Minimum design pressure for piping is 1210 kPa
3. **SANITARY FORCEMAINS**
    a. PVC, Class C900 for mains under 300mm diameter and C905 for any larger mains
4. **ACCESSORIES**
    a. Ductile iron gate valves in accordance with AWWA C509 with flanged or hub ends
    b. Nelson-type circular valve boxes manufactured by Terminal City of Dobney foundry
    c. 150mm diameter Terminal City type C-71-P hydrants, tested to 2070 kPa hydrostatic pressure in accordance with AWWA C502
    d. Concrete catch basins to be purchased from City of Vancouver, including trapping hoods and typical sump
5. **PIPE BEDDING AND SURROUND MATERIALS**
    a. 19mm minus, MMS type 1, cleaned, granular pipe bedding with minimum bottom thickness of 100mm, 300mm top thickness, 225mm minimum side thickness
    b. Use native backfill wherever possible under paved areas
    c. Imported bedding must be approved by UBC Energy & Water Services prior to use

Part 3 Execution

1. **GENERAL**
    b. Existing utility mains should be left in place during construction unless explicit direction is provided by the Consultant or UBC Water & Energy Services
    c. Existing ground-level infrastructure including fire hydrants, manholes, cleanouts, and inspection chambers should be left in place during construction unless explicit direction is provided by the Consultant or UBC Water & Energy Services
    d. Relocated catch basins should be reused wherever possible as long as visual inspection suggests adequate quality. If any leakage is observed from catch basin, existing catch basin should be discarded, and new basin used as specified
2. **PREPARATION AND TRENCHING**
    a. Site preparation to follow details outlined in MMCD Section 02666
    b. Trenching to follow details outlined in City of Vancouver Construction Specifications Section 31 23 01
3. **INSTALLATION**
    a. Maintain 3m horizontal clearance between parallel sanitary sewer or storm sewer mains and water mains. If existing clearance is less, or if approved by UBC Water & Energy Services, installation should follow details in MMCD Design Guideline Manual Section 1.4 and Vancouver Coastal Health's Water Supply System Construction Permit Guidelines and Application. Water main joints should be wrapped in shrink plastic or petroleum tape in accordance with AWWA C217, C214, and C209
    b. Maintain 750mm clearance between water mains and other utility services, and 3m clearance to building foundations
    c. Prior to covering, pipe and bedding should be inspected by UBC Energy & Water Services. Contractor shall provide written notification to both the Utilities Engineer and Head Plumber with a minimum of 24 hours' notice
    d. Contractor shall be responsible for maintaining detailed records of pipe sizes and inverts to be provided to UBC's Records Manager, Infrastructure Development, and Mechanical Utilities Engineer in accordance with Section 01 78 39 of UBC's Project Record Documents Technical Guidelines
    e. Upon completion of pipe laying, pipes should be surrounded and covered with specified backfill. Joints and fittings should be exposed until field testing is complete
    f. Backfill and pipe surround should be compacted to at least 95% Modified Proctor Density
4. **FLUSHING AND TESTING**
    a. Cleaning, flushing, and pressure testing to be conducted by Contractor
    b. Engineer should be notified within 24 hours of and present for proposed test
    c. Contractor shall apply for UBC Hydrant Use Permit prior to using water supplied from UBC fire hydrants for cleaning and flushing
    d. Pressure and leakage testing for PVC piping to AWWA M23 standards, HDPE piping to AWWA M55 standards, with no leakage allowed and pressures not exceeding CSA B137.3

END OF SECTION

PERMEABLE CONCRETE

Part 1 General

1. **RELATED SECTIONS**
    a. Permeable Concrete Detail Drawing
    b. Detailed Design Report
2. **REFERENCES**
    a. City of Vancouver Engineering Design Manual
    b. UBC Integrated Stormwater Management Plan
    c. American Society for Testing and Materials International (ASTM)
    d. American Concrete Institute (ACI)
    e. American Association of State Highway and Transportation Officials
    f. National Ready Mixed Concrete Association
    g. UNHSC Design Specifications for Porous Asphalt Pavement and Infiltration Beds
    h. Flood Testing Labs

Part 2 Products

1. **Specifications**
    a. Final concrete mix must adhere to the following property requirements as determined through lab testing in accordance with ACI standards:

Property	**Specification**
28-Day Compressive Strength	20 MPa
Infiltration Rate	8600 mm/hr
Void Space	15%
Unit Weight	1500 kg/m^3 to 2000 kg/m^3
Slump	15cm to 18cm

    b. Contractor to develop target void-density curve for final mix design for use during field testing
2. **Materials**
    a. Contractor to develop mix design meeting specifications outlined above and seek approval from Engineer prior to construction
    b. Calcium chloride is not permitted in any form in mix
    c. Material Source must be government-approved unless specified with grading and density following those outlined in Drawing D102
    d. Filter geotextiles shall meet requirements outlined in AASHTO M288 for Class 2

Part 3 Execution

5. **PRE-INSTALLATION**
    a. A minimum of two panel tests to be conducted on site on native material in accordance with ACI 522.1-13. Panels must have minimum area of 225 sq. ft, with width and thickness outlined in construction drawings.
    b. Dimensions and density of hardened cores must be recorded to establish acceptable reference points for quality assurance purposes
6. **SUBBASE AND SUBGRADE PREPARATION**

a. Do not compact subgrade beyond 90% of theoretical density to maintain void spaces
b. Subgrade should be cleaned prior to installation
c. Moisten subgrade and ensure no free-standing water is visible prior to placement

7. INSTALLATION

a. Mix must be completely discharged within one hour of initial mixing and visually inspected for consistency and even aggregate coating
b. Placement shall be done in a continuous pour into conventional formwork with mechanical screeds used and strike offs done 20 mm above formwork
c. Consolidate concrete using steel roller within 15 minutes of placement
d. Control joints shall be placed every 6m in with a depth of ¼ of the slab thickness
e. Moisten concrete surface with water then cover with plastic sheeting within 20 minutes of initial placement
f. Plastic cover should be held down and remain in place for a minimum of 7 days or until core tests are completed.
g. Formwork shall be left in place for a minimum of 28 days unless otherwise directed

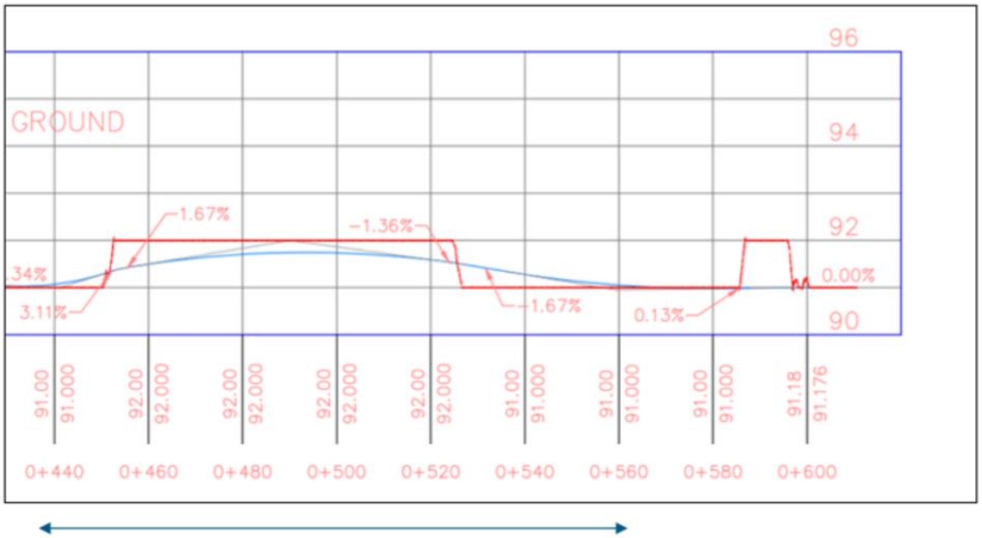
8. INSPECTION AND TESTING

a. Three core samples will be tested for every 75 m^3 poured on-site. The average density of these cores must be within 5% of the density determined from the test panel cores, thickness within 19mm, and average length within -10mm and 38mm of design values in accordance with ASTM C1754
b. Infiltration testing will be conducted in accordance with ASTM C1701

END OF SECTION

APPENDIX C – SAMPLE TRANSPORTATION CALCULATIONS

Road Crest Curve Calculations



Length: Approx. 130m

Example curve: Crest curve at Station = 0 + 500

Elevation of highest point = ~91.75m

Length of crest curve = ~130m

Calculations shown below.

CREST CURVE CALCULATION				
S (Sight Distance)	=	(50/3.6)*2.5+((50/3.6)^2/(2*0.3*9.81)		67.49511 m
		Assume S < L		
L (Length of Vertical Curve)	=	(AS^2)/(100*(sqrt(2*H1)+sqrt(2*H2))^2		33.80774 m
		S > L		
L (Length of Vertical Curve)	=	2S - (200*(sqrt(H1)+sqrt(H2))^2)/A		129.0009 m
			>>	**Use 130 m**
Station VPC	=	Station VPI - L/2 = 0 + 500 - 65		0 + 435
Station VPT	=	Station VPI + L/2 = 0+500 - 65		0 + 565
Elevation VPC	=	Elevation VPI - G(L/2) = 91.75 - 0.0167*65		91.1645 m
Elevation VPC	=	Elevation VPI - G(L/2) = 91.75 - 0.0136*65		91.366 m
Location of High Point	=	(g1*L)/(g2-g1) = (1.67*130)/(3)		72.36667 m
			>>	**Use 75 m**
		0 + 435 + 75	=	0 + 510
Elevation of High Point	=	90.66 + 0.0167*75 + ((-0.03*75^2)/(2*130)) +		**91.76796 m**

APPENDIX D – STRUCTURAL CALCULATIONS

A DIMENSIONS

Length of Roof	3.6	m	
Col to Col	1.8	m	
Cover Length	3.16	m	
Column Height	3.07	m	
Length of Section	2.6	m	
Reference height	3.5519	m	
Maximum height	3.8414	m	
Cantilever Trib A	3.24	m2	half of roof

B SNOW

Is	1	Normal Importance				
Ss	1.8	Vancouver City Hall				
Cb	0.8					
>lc	2.353846154		70	Cb = 0.8		
>>w	1.8					
Cw	1					
Cs	1					
Ca	1					
Sr	0.2					
S	1.64	kPa	Load on	Cantilever	1.476	kN/m
				Column	5.3136	kN

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

C WIND

Iw	1						
q	0.45						
Ce	0.7		Cei	0.7			
>(h/10)^0.2	0.9						
>0.7*(h/12)^0.3	0.7						
Ct	1		Cgi	1.999962112			
Cg	2		>Vo	19.6560216	m3		
Cp	-0.5		>A	37.32156	m2		
>H/D	1.067055556		Cpi	-0.7			
Wext	-0.315	kPa	Wint	-0.88198329	kPa	Wsum	-1.196983292 kPa

$$p_i = I_W q C_{ei} C_t C_{gi} C_{pi}$$

Load on	Cantilever	-1.077285	kN/m
	Column	-3.8782259	kN

D DEAD

Cantilever Section	W200x31		Column Section	W200x31		W200x31
A	4000	mm2	A	4000	mm2	
rx	88.6	mm	rx	88.6	mm	
ry	32	mm	ry	32	mm	

Cross Section			**Densities**		**Loads**	
Steel Column	0.01228	m3	8050	kg/m3	0.9697577	kN
Cantilever	0.004	m2	8050	kg/m3	0.315882	kN/m
Glass Panels	0.02	m	2500	kg/m3	0.4905	kN/m2
>Glass Length	3.2	m				
>Glass Thickness	0.02	m				
			Load on	Cantilever	0.757332	kN/m
				Column	4.1810318	kN

E Load Combinations

Summary of Loads	Cantilever		Column	
Snow	1.48	kN/m	5.31	kN
Wind	1.08	kN/m	3.88	kN
Dead	0.76	kN/m	4.18	kN

		Cantilver		Column		Servicibility	Cantilver	Column
1	1.4D	1.06	kN/m	5.85	kN	1.0*D+1.0*S+1.0*W	3.31	13.37
2	1.25D+1.0S or 0.4W	2.42	kN/m	10.54	kN			
3	1.25D+1.5S+0.4W	3.59	kN/m	14.75	kN			
4	1.25D+1.4W+0.5S	3.19	kN/m	13.31	kN	1.25D	0.946665	
5	1.0D			4.18	kN	1.5S	2.214	
						0.4W	-0.430913985	
	Mf	17.93	kNm	11.64				
	Vf	11.35	kN	N/A				

F FLEXURE

CANTILEVER	W200x31					COLUMN	W200x31				
E	200000	MPa				E	200000	MPa			
G	76923.07692	MPa				G	76923.07692	MPa			
J	119000	mm4				J	119000	mm4			
Iy	4100000	mm4				Iy	4100000	mm4			
bel	134	mm				bel	134	mm			
t	10.2	mm				t	10.2	mm			
Cw	40900000000	mm6				Cw	40900000000	mm6			
zx	335000	mm3				zx	335000	mm3			
sx	299000	mm3				sx	299000	mm3			
Phi	0.9					Phi	0.9				
bel/t	6.57		<	7.750576015	Class 1	bel/t	6.57		<	7.750576015	Class 1
			<	9.086882225	Class 2				<	9.086882225	Class 2
			<	12.82853961	Class 3				<	12.82853961	Class 3
delta_max	54.5921141	mm				delta_max	54.5921141	mm			
My	94.185	kNm				My	94.185	kNm			
0.67*My	63.10395	kNm				0.67*My	63.10395	kNm			
Mu	286.7470112		>	63.10		Mu	286.7470112		>	63.10	
>w2	2.425913739	kNm				>w2	2.425913739	kNm			
>>M1	0.79	10.08677	kNm			>>M1	0.79	10.08677	kNm		
>>M2	1.58	4.483008889	kNm			>>M2	1.58	4.483008889	kNm		
>>M3	2.37	1.120752222	kNm			>>M3	2.37	1.120752222	kNm		
>>Mmax	0	17.93203556	kNm			>>Mmax	0	17.93203556	kNm		
Mr = Mu<0.67Mp	258.0723101	kNm				Mr = Mu<0.67Mp	258.0723101	kNm			
Mr = Mu>0.67Mp	**88.51621342**	**kNm**	> Mf			**Mr = Mu>0.67Mp**	**88.51621342**	**kNm**	> Mf		

G MOMENT END PLATE CONNECTION DESIGN

PRYING ACTION

Equilibrium

Mf	17.93	kNm			
Lever Arm 1	0.2	m			
Lever Arm 2	0.1288	m			
F	109.0756421	kN			
Tf1	70.89916735	kN	65% of Load		
Tf2	38.17647472	kN	35% of Load		
Nom. Area Bolt	155	mm2			
Stress in Bolt 1	457.4139829	MPa	<	Fub =	825
Stress in Bolt 2	246.2998369	MPa	<	Fub =	825

14mm A325 Bolts

Fub	825	MPa
Tr (Bolt)	76.725	kN

END PLATE YIELDING

Mf	17.93	kNm			
End Plate Length	0.5	mm			
Lever Arm	0.125	mm			
Equivalent Force	143.4562844	kN			
End Plate Thickness	10	mm			
End Plate Width	127	mm			
End Plate Area	1270	mm2			
F	112.9577043	MPa	<	fy =	400.05
Tr (End Plate)	400.05	MPa			

WELD STRENGTH

Mf	17.93	kNm				
Lever Arm	0.06	m				
Tf	298.8672593	kN		<	Vr =	337.16777
Vr	337.1677659	kN				
>Phi_w	0.67					
>Aw	1077.468	mm2				
>>Weld Leg	6	mm				
>>Weld Length	254	mm				
>Xu	490	MPa				
>Theta	90	deg				
Mw	1					

H FOOTING DESIGN

OVERTURNING MOMENT DESIGN

f'c	25	MPa				
q_Allowable	150	kPa	Dense Sand			
Total P	34.34	kN				
A_req	0.228933333	m2				
b_req	0.478469783	m				
use A	0.8	m2				
use a	0.666666667					
use b	1.2	m				
Fb	11050	kN				
>A1	0.09	m2				
>A2	0.8	m2				
Vc	1064.7	kN				
Depth of Footing	1.3					
Volume of Footing	1.04					
Weight of Footing	6.993913333	kN				
Overturning Mom.	17.93	kNm		<	Mr =	18.845032
Overturning Resis.	18.84503181	kNm				

PLAN

FOOTING a

b

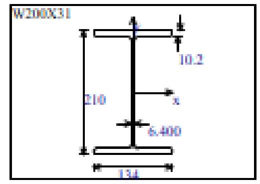
MOMENT BASEPLATE CONNECTION DESIGN

Mf	17.93	kNm				
Lever Arm 1	0.2	m				
Lever Arm 2	0.1288	m				
F per bolt	109.0756421	kN	2 Bolts			
Tf1	70.89916735	kN	65% of Load			
Tf2	38.17647472	kN	35% of Load			
Nom. Area Bolt	315	mm2				
Stress in Bolt 1	225.0767217	MPa		<	Fub =	825
Stress in Bolt 2	121.1951579	MPa		<	Fub =	825
Anchor Bolt Size	20	mm				
Fub	825	MPa				
Tr (Bolt)	155.925	kN				
Development Ld	576	mm				

>use 610mm (24") anchor bolts

,	***Code Details*** Project: DetailedCanopyDesign Structure: Filename: Detailed Canopy Design.TEL Engineer: Johnson Hu	Page: 1 Date:2021-04-15

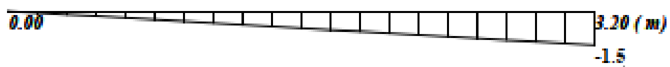
Member: 1 S-FRAME Section is W200X31
Member is part of group: SECTION 1
Note: Neglecting: axial<1.0 kN, shear<1.0 kN, moment<1.0 kNm
Note: Member in braced frame(s).



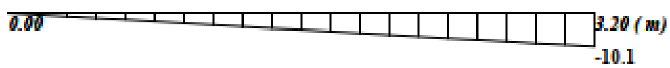
Load Case 1 (Bending + Compression)

Section classification (f_y=350 MPa):	Section Class =	1	Clause 11
Governing geometrical slenderness ratio **k_x=1.00; k_y=1.00; k_xL/r_x=36.2;**	$\frac{k_x L/r_x}{200} = \frac{100}{200}$ =	**0.500**	**Clause 10.4.2.1**
Axial Load - (kN)			
Factored Compressive Resistance Check n=1.34; λy=1.33	$\frac{C_f}{C_{ry}} = \frac{C_f}{\phi A F_y (1+\lambda^{2n})^{-1/n}} = \frac{C_f}{\phi A\ (148\ \text{MPa})} = \frac{1}{534}$ =	0.003	Clause 13.3.1.1
Strong Axis Shear - (kN)			
Strong axis shear strength check A_w= 1344 mm^2;	$\frac{V_{fx}}{\phi A_w F_s} = \frac{V_{fx}}{\phi A_w 0.66 F_y} = \frac{10}{279}$ =	0.036	Clause 13.4.1.1(a)(i)
Strong Axis Moment - (kN-m)			
Bending Stability Check L_u=3.20 m; ω_2=2.426;	$\frac{M_{fx}}{M_{rx}} = \frac{16}{106}$ =	0.153	Clause 13.6.1(a)
Axial Compression and Bending cross-sectional Strength Check ω_{1x}=1.00; U_{1x}=1.00;	$\frac{C_f}{\phi A F_y} + \frac{0.85\ U_{1x} M_{fx}}{\phi Z_x F_y}$ =	0.131	Clause 13.8.2(a)
Axial Compression and Bending overall member Strength Check ω_{1x}=1.00; U_{1x}=1.00;	$\frac{C_f}{C_{rx}} + \frac{0.85\ U_{1x} M_{fx}}{\phi Z_x F_y}$ =	0.132	Clause 13.8.2(b)
Axial Compression and Bending lateral torsional buckling strength check ω_{1x}=1.00; U_{1x}=1.00;	$\frac{C_f}{C_{ry}} + \frac{0.85\ U_{1x} M_{fx}}{M_{rx}}$ =	0.133	Clause 13.8.2(c)

Axial Load - (kN)



Strong Axis Shear - (kN)



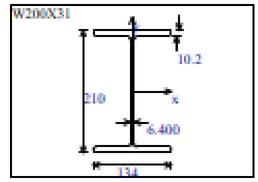
Strong Axis Moment - (kN-m)

Design Code: CAN/CSA S16-19
Steel Table : Canadian (CISC)
Analysis Program: S-FRAME (Linear static analysis)
ACADEMIC VERSION NOT FOR COMMERCIAL USE

S-STEEL
Version 2020.2.10

	Code Details Project: DetailedCanopyDesign Structure: Filename: Detailed Canopy Design.TEL Engineer: Johnson Hu	Page: 1 Date:2021-04-15

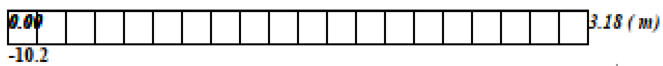
Member: 2 S-FRAME Section is W200X31
Member is part of group: SECTION 1
Note: Neglecting: axial<1.0 kN, shear<1.0 kN, moment<1.0 kNm
Note: Member in braced frame(s). *Angle Gamma is 90.0 degrees*



Load Case 1 (Bending + Compression)

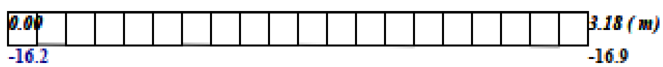
Section classification (f_y=350 MPa): Section Class =	1	Clause 11
Governing geometrical slenderness ratio **k_x=1.00; k_y=1.00; k_xL/r_x=35.9;** $\frac{k_y L/r_y}{200} = \frac{99}{200}$ =	**0.497**	**Clause 10.4.2.1**

Axial Load - (kN)



Factored Compressive Resistance Check n=1.34; λy=1.32 $\frac{C_f}{C_{ry}} = \frac{C_f}{\phi A F_y (1+\lambda^{2n})^{-1/n}} = \frac{C_f}{\phi A\ (150\ \text{MPa})} = \frac{10}{539}$ =	0.019	Clause 13.3.1.1

Strong Axis Moment - (kN-m)



Bending Stability Check L_u=3.18 m; ω_2=1.020; $\frac{M_{fx}}{M_{rx}} = \frac{17}{88}$ =	0.192	Clause 13.6.1(a)
Axial Compression and Bending cross-sectional Strength Check ω_{1x}=0.98; U_{1x}=1.00; $\frac{C_f}{\phi A F_y} + \frac{0.85\ U_{1x} M_{fx}}{\phi Z_x F_y}$ =	0.144	Clause 13.8.2(a)
Axial Compression and Bending overall member Strength Check ω_{1x}=0.98; U_{1x}=0.98; $\frac{C_f}{C_{rx}} + \frac{0.85\ U_{1x} M_{fx}}{\phi Z_x F_y}$ =	0.143	Clause 13.8.2(b)
Axial Compression and Bending lateral torsional buckling strength check ω_{1x}=0.98; U_{1x}=1.00; $\frac{C_f}{C_{ry}} + \frac{0.85\ U_{1x} M_{fx}}{M_{rx}}$ =	0.182	Clause 13.8.2(c)

Design Code: CAN/CSA S16-19
Steel Table : Canadian (CISC)
Analysis Program: S-FRAME (Linear static analysis)
ACADEMIC VERSION NOT FOR COMMERCIAL USE

S-STEEL
Version 2020.2.10

APPENDIX E – STORMWATER CALCULATIONS

Permeable Concrete Storage Depth Calculations

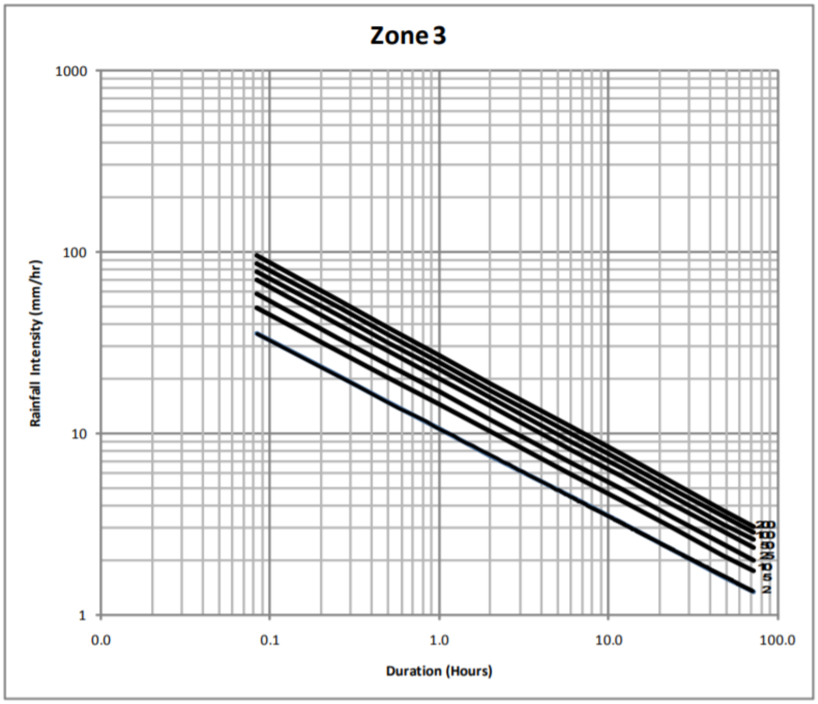


Figure 27: IDF Curve for UBC

$10 - year, \quad 24 - hour\ Storm\ Intensity = 2.8mm/hr$

$Total\ Precipitation\ = i * d\ = 2.8 * 24 = 67.2mm$

$Storage\ in\ Concrete\ Layer = Min.Depth * Void\ Space = 150mm * 15\% = 22.5mm$

$$Min.\ Depth\ of\ Reservoir\ Base = \frac{Total\ Precipitation - Storage\ in\ Concrete\ Layer}{Void\ Space} = \frac{67.2mm - 22.5mm}{35\%}$$

$$= 128mm, \quad Round\ up\ to\ 200mm\ for\ contingency$$

$50mm\ minimum\ depth\ for\ choker\ course, so\ 200mm - 50mm = 150mm\ depth\ for\ reservoir\ course$

Layer	Void Space (%)	Depth (mm)	Storage (mm)
Permeable Concrete	15	150	22.5
Reservoir	35	200	70
Total		350	92.5
Precipitation			67.2

APPENDIX F – CLASS A COST ESTIMATE

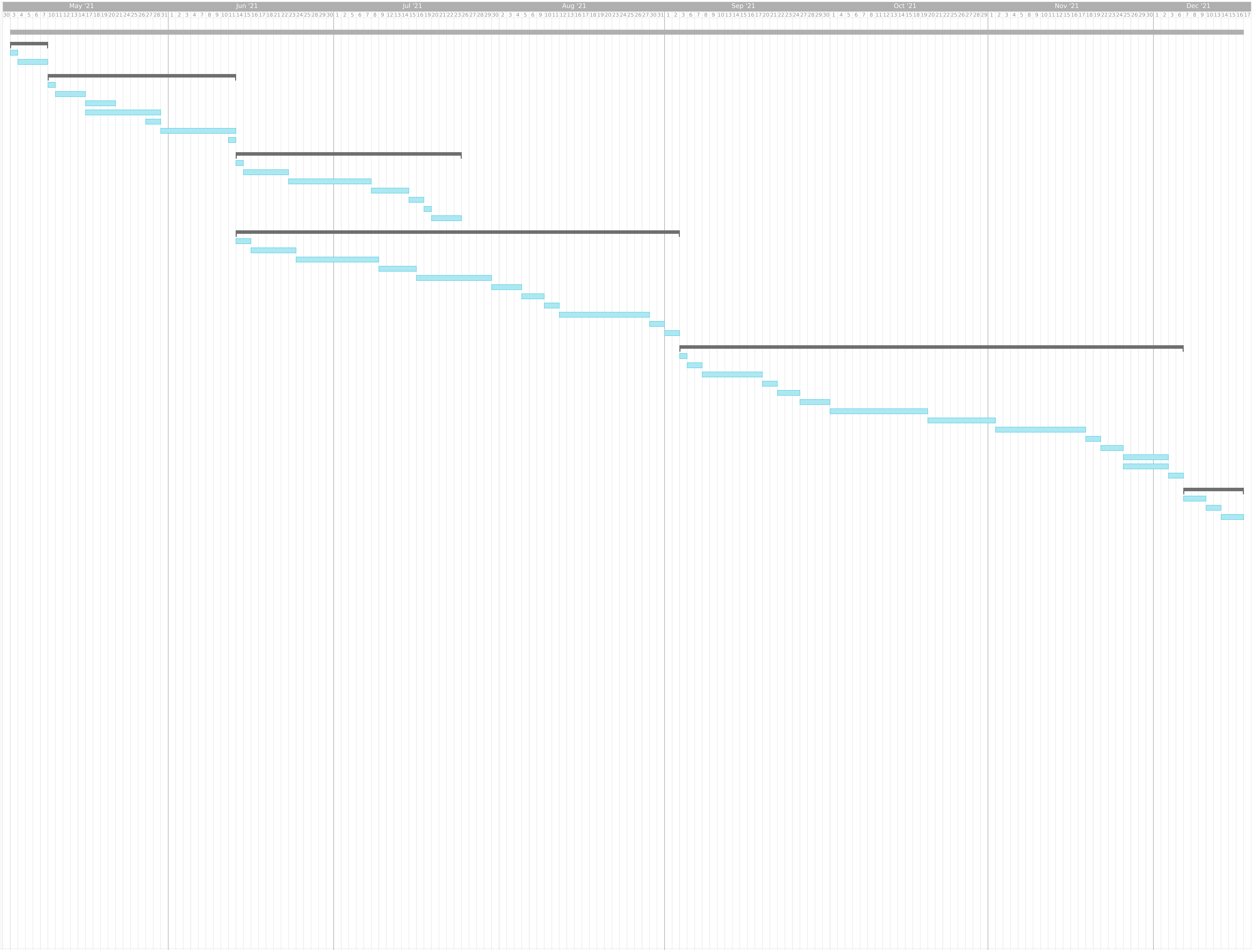
Description	Quantity	Unit	Pricing		Total Cost
			Cost per Unit	Sub Cost	
DESIGN					**$179,600**
Development					$179,600
Conceptual Design	1	LS	$39,600	$39,600	
Preliminary Design	1	LS	$45,000	$45,000	
Detailed Design	1	LS	$80,000	$80,000	
Drawings	1	LS	$15,000	$15,000	
CONSTRUCTION					**$3,826,224**
General Permitting					$28,100
Development Permit	1	LS	$10,000	$10,000	
Building Permit	1	LS	$5,000	$5,000	
Streets & Landscape Permit	1	LS	$2,500	$2,500	
Utilities Permit	1	LS	$10,600	$10,600	
On-Site Personnel					$324,000
Senior Field Engineer	1200	hrs	$135	$162,000	
Senior Technician	1200	hrs	$135	$162,000	
Construction					$450,000
Implement Traffic Management Plan	1	LS.	$150,000	$150,000	
Equipment Rentals	1	LS.	$250,000	$250,000	
Erosion & Sediment Control	1	LS.	$50,000	$50,000	
Site Preparation					$690,730
Site Mobilization	1	LS	$25,000	$25,000	
Clearing and Grubbing	2,840	m^2	$10	$28,400	
Top Soil Removal	2,840	m^3	$12	$34,080	
Removal of Concrete Median - Saw Cut	2,840	m^3	$75	$213,000	
Asphalt Pavement Removal - Saw Cut	11,150	m^2	$5	$55,750	
Existing Subgrade Removal	11,150	m^2	$30	$334,500	
Subgrade Preparation	11,150	m^2	$5	$55,750	
Road Repavement					$797,875
50mm Superpave Mix	85,000	ft^2	$3	$255,000	
180 mm Superpave Mix	85,000	ft^2	$5	$425,000	
150mm Minus Crushed 19mm Granular Base	1,500	ton	$30	$45,000	
300mm Minus Crushed 17 mm Granular Base	1,500	ton	$30	$45,000	
Site Grading	11,150	m^2	$3	$27,875	
Median Insallation					$131,725
152 mm Concrete Curb	860	m	$50	$43,000	
Curb Ramp	84	ft	$250	$21,000	
Soil Backfill	4,515	m^2	$15	$67,725	
Bike Lane & Sidewalks					$118,025
150mm Pervious Concrete Mix	3,499	m^2	$25.00	$87,475	
50mm Washed AASHTO no.57 Choker Course	500	ton	$25.00	$12,500	
150mm Washed AASHTO no.3 Subbase	500	ton	$25.00	$12,500	
Non-woven Geotextile Fabric	37,000.000	ft^2	$0.15	$5,550	
Stormwater Facilities					$100,000
Catch Basins	40	ea.	$2,500	$100,000	
Greenspace					$646,650
450mm Absorbent Topsoil Layer	2,030	m^3	$30	$60,900	
Mulch	20,000	ft^3	$3	$60,000	
Existing Tree Transplant	1	LS.	$300,000	$300,000	
Community Garden	1	LS.	$150,000	$150,000	
Saucer Magnolia	1	ea.	$8,000	$8,000	
Weeping Cherry	1	ea.	$9,250	$9,250	
Eastern Redbud	1	ea.	$7,500	$7,500	
Red Oak	1	ea.	$9,000	$9,000	
Grass Sod	20,000	ft^2	$0.85	$17,000	
Light Fixtures	1	LS.	$25,000	$25,000	
32" Flex Bollard - Emergency Access	5	ea.	$500	$2,500	

Permanent Traffic Controls					$177,035
New Signange Implementation	1	LS.	$150,000	$150,000	
Raised Crosswalks	2	ea.	$7,000	$14,000	
Signal Upgrades	1	LS.	$4,000	$4,000	
Skid resistant conflict paint (Bike Crossing/Lane)	1,345	ft^2	$6	$8,070	
Elephants Feet (Bike Crossing)	74	m	$0	$15	
48" In-Ground Post	25	ea.	$38	$950	
Structural					$188,084
W200x31 Beam	124.00	m	$106	$13,144	
W200x31 Column	140.00	m	$106	$14,840	
500x300x20mm Column Base Plate	39	ea.	$100	$3,900	
14mm Hex Bolts	312	ea.	$5	$1,560	
20mm Anchor Bolts	312	ea.	$5	$1,560	
500x134x20mm Column End Plate	39	ea.	$750	$29,250	
Concrete Fill	45	m^3	$300	$13,500	
Zingalu Coating	1	LS	$750	$750	
20mm Tempered Glass Panel	226	m^2	$250	$56,500	
Glass Mounts	234	ea.	$120	$28,080	
Installation and Welding	1	LS.	$25,000	$25,000	
End of Construction					$174,000
Site Cleanup	1	LS	$20,000	$20,000	
General Landscaping	1	LS	$50,000	$50,000	
Lane & Parking Painting	800	m	$5	$4,000	
Waste Removal & Recycling	1	LS	$100,000	$100,000	
OPERATION & MAINTENANCE					**$23,500**
Maintenance					$23,500
Greenspace Upkeep	1	yrs	$12,000	$12,000	
Signal Operation & Maintenance	1	yrs	$4,000	$4,000	
Corridor Operation & Maintenance	1	yrs	$7,500	$7,500	
Canopy Maintenance	1	yrs	$2,000	$2,000	
Stormwater Facilities Maintenance	1	yrs	$1,000	$1,000	
CONTINGENCY (15%)					**$604,399**
				Pre-tax cost	**$4,610,222**
				PST (7%)	**$322,716**
				GST (5%)	**$230,511**
				Post-tax cost	**$5,163,449**

APPENDIX G – CONSTRUCTION SCHEDULE

East Mall Redesign

Task	start	end
Site Preparation	**05/03/21**	**05/07/21**
Bus Stop Relocation	05/03	05/03
Clearing & Grubbing	05/04	05/07
Phase 1 Construction	**05/10/21**	**06/11/21**
Site Mobilization	05/10	05/10
Signal Upgrade	05/11	05/14
Topsoil Removal	05/17	05/20
Asphalt Pavement Removal	05/17	05/28
East Mall Curb Reduction	05/27	05/28
Road & Bike Lane Paving	05/31	06/11
Lane Painting & Site Cleanup	06/11	06/11
Canopy Installation	**06/14/21**	**07/23/21**
Site Mobilization	06/14	06/14
Footing Installation	06/15	06/22
Erect Canopy Frame	06/23	07/07
Install Canopy Cover	07/08	07/14
Backfill	07/15	07/16
Inspection	07/19	07/19
Site Cleanup	07/20	07/23
Phase 2 Construction	**06/14/21**	**09/02/21**
Site Mobilization	06/14	06/15
Topsoil Removal	06/16	06/23
Tree Uplift	06/24	07/08
Median Removal	07/09	07/15
Asphalt Pavement Removal	07/16	07/29
Catch Basin Installation	07/30	08/04
Manhole Realignment	08/05	08/09
Subgrade Preparation	08/10	08/11
Road Repaving	08/12	08/27
Raised Crosswalk Installation	08/30	08/31
Lane Painting & Site Cleanup	09/01	09/02
Phase 3 Construction	**09/03/21**	**12/06/21**
Site Mobilization	09/03	09/03
Topsoil Removal	09/06	09/07
Asphalt Pavement Removal	09/08	09/17
Subgrade Preparation	09/20	09/21
Catch Basin Installation	09/22	09/24
Manhole Realignment	09/27	09/30
Road Repaving	10/01	10/19
Casting Median Curb	10/20	11/01
Casting Pervious Pavement	11/02	11/17
Soil Backfill & Mulching	11/18	11/19
Existing Tree Relocation	11/22	11/24
Greenspace Amenities Addition	11/25	12/02
Raised Crosswalk Installation	11/25	12/02
Lane Painting & Site Cleanup	12/03	12/06
Site Cleanup	**12/07/21**	**12/16/21**
Final Landscaping	12/07	12/09
Waste Removal & Recycling	12/10	12/13
Site Demobilization	12/14	12/16



APPENDIX H – RISK REGISTER

Risk	Project Phase	Likelihood	Impact	Mitigation Strategy
Significant design changes	Design	Low	High	Ensure clarity when communicating with contractors and that all specifications and requirements are understood
Inaccurate cost estimate	Design	Low	High	Continually refine costs estimates and minimize major design changes throughout the project
Delays in obtaining permits	Design	Low	Moderate	Ensure all necessary documents and fees are included in application process
Schedule delays	Design	Moderate	Moderate	Have clear schedule specifications and confirm design with contractors before the start of major work
On-site incidents	Construction	Moderate	Moderate	Ensure equipment is only operated by qualified personnel. Implement adequate signage and minimize contact with pedestrians
Interrupting Buried Utilities	Construction	Low	High	Conduct One-Calls prior to digging and contractor to confirm utility depths. Hand-digging will be used when in proximity to utilities
Traffic Delays	Construction	Moderate	Moderate	Ensure Traffic Management Plan is understood and relayed to all contractors. Equipment transport will be done outside of peak hours
Damage during tree transplant	Construction	Moderate	Low	Ensure all tree work is done in accordance to UBC Tree Protection Guidelines
Contaminated or unsuitable soil	Construction	Moderate	Moderate	Contractor to conduct adequate geotechnical studies. Contaminated soils will be removed and disposed of and replaced with new soil
Concrete Plastic Shrinkage	Construction	Moderate	Low	Ensure concrete curing specifications are conveyed to relevant contractors
COVID 19 - Restrictions	Construction	Moderate	High	Contractors and on-site workers to follow all B.C. and WorkSafeBC COVID-19 protocols relevant to on-site work
Extreme weather	Construction	Low	High	Ensure on-site work and equipment are adequately stored when inclement weather is predicted
Site Vandalism	Construction	Low	Moderate	Ensure all on-site work and equipment are adequately stored and protected after hours
Noise Complaints	Construction	Moderate	Low	Ensure noise sensitive work is done outside of the morning and evening periods

APPENDIX I – SYNCHRO ANALYSIS

Thunderbird Boulevard at East Mall – 2020 AM

Lanes, Volumes, Timings
3: Int
2020-12-01

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (m)	0.0		0.0	50.0		0.0	0.0		0.0	0.0		0.0
Storage Lanes	0		0	1		0	0		0	0		0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	15.0	15.0		15.0	15.0		15.0	15.0		15.0	15.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor		0.95		0.85	0.99			0.97			0.98	
Frt		0.970			0.982			0.946			0.980	
Flt Protected		0.997		0.950				0.997			0.987	
Satd. Flow (prot)	0	1713	0	1770	1811	0	0	1716	0	0	1774	0
Flt Permitted		0.982		0.643				0.980			0.836	
Satd. Flow (perm)	0	1682	0	1022	1811	0	0	1680	0	0	1498	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		30			14			72			19	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		108.8			143.4			126.2			127.5	
Travel Time (s)		7.8			10.3			9.1			9.2	
Volume (vph)	5	87	36	59	94	19	32	296	187	28	68	11
Confl. Peds. (#/hr)	53		170	170		53	54		25	25		54
Peak Hour Factor	0.42	0.62	0.82	0.87	0.53	0.79	0.89	0.89	0.77	0.78	0.85	0.55
Adj. Flow (vph)	12	140	44	68	177	24	36	333	243	36	80	20
Lane Group Flow (vph)	0	196	0	68	201	0	0	612	0	0	136	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phases	4	4		8	8		2	2		6	6	
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	29.0	29.0		29.0	29.0		23.0	23.0		23.0	23.0	
Total Split (s)	29.0	29.0	0.0	29.0	29.0	0.0	31.0	31.0	0.0	31.0	31.0	0.0
Total Split (%)	48.3%	48.3%	0.0%	48.3%	48.3%	0.0%	51.7%	51.7%	0.0%	51.7%	51.7%	0.0%
Maximum Green (s)	25.0	25.0		25.0	25.0		27.0	27.0		27.0	27.0	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		Max	Max		Max	Max	
Walk Time (s)	14.0	14.0		14.0	14.0		8.0	8.0		8.0	8.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	30	30		30	30		10	10		10	10	
Act Effct Green (s)		12.1		12.2	12.2			33.0			33.0	
Actuated g/C Ratio		0.23		0.23	0.23			0.65			0.65	
v/c Ratio		0.48		0.29	0.47			0.55			0.14	
Control Delay		16.0		16.5	16.9			10.0			6.1	
Queue Delay		0.0		0.0	0.0			0.0			0.0	

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Lanes, Volumes, Timings
3: Int
2020-12-01

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Total Delay		16.0		16.5	16.9			10.0			6.1	
LOS		B		B	B			B			A	
Approach Delay		16.0			16.8			10.0			6.1	
Approach LOS		B			B			B			A	

Intersection Summary
Area Type: Other
Cycle Length: 60
Actuated Cycle Length: 50.7
Natural Cycle: 60
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.55
Intersection Signal Delay: 12.1 Intersection LOS: B
Intersection Capacity Utilization 68.7% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 3: Int

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