University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Wesbrook Mall Redesign Phase 4 (Thunderbird Boulevard – W 16th Avenue)

Prepared by: Harman Sandhu, Amarpreet Nijjar, Arshdeep Pandher, Pardeep Khattra, Tarndeep Grewal, Amandeep Natt

Prepared for:

Course Code: CIVL 446

University of British Columbia

Date: 6 April 2022

UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Wesbrook Mall Redesign Phase 4

Harman Sandhu

Amarpreet Nijjar

Arshdeep Pandher

Pardeep Khattra

Tarndeep Grewal

Amandeep Natt

University of British Columbia

CIVL 446

April 6, 2022

Wesbrook Mall Redesign Phase 4

(Thunderbird Boulevard – W 16th Avenue)

Detailed Design Report

April 6, 2022

Client

University of British Columbia - UBC SEEDS (Social Ecological Economic Development Studies) Sustainability Program

Team 9

Executive Summary

Team 9 has been tasked with developing a design for the Wesbrook Mall Redesign Phase 4 Project. The project focuses on improvements for pedestrians, cyclists, and transit services and promotes the transition to these modal services from passenger vehicles.

Stakeholders

To include all parties affected by the design, a stakeholder consultation plan was developed. To gather comments during the design phase, the stakeholder consultation strategy includes in-person meetings, emails, and a website. The identified stakeholders for this project include: UBC Seeds, University of British Columbia, Musqueam People, residents, and businesses, UBC student and staff, Translink, BC Hydro and telecommunication companies, UBC Energy and Water Infrastructure, and commuters.

Design Constraints and Criteria

The owner has also requested that the safety, convenience, and enjoyment of these users be maximized while expenditures are kept to a minimum. The design should also include green infrastructure and mechanisms for retaining on-site stormwater. The customer has requested a pedestrian overpass or underpass near Doug Mitchell Thunderbird Sports Center to expand pedestrian facility alternatives. Design constraints include any regulatory requirements for design aspects and ensuring that all project work is completed within the project schedule.

Design

The design prioritizes mobility for cyclist and transit vehicles, while minimizing impact to existing parking and road usage. Both southbound and northbound would undergo several improvements related to cycling and pedestrian usage. Protected bicycle lanes would be implemented along the entire corridor and the existing sidewalks would be upgraded to ensure safe cyclist and pedestrian travel and crossing. Bus lanes will then be added along non-parking shoulders and additional transit priority measures will also be implemented along the signalized intersection at Thunderbird Blvd. Northbound parking regulations along the residential buildings nearby to the RCMP detachment would be reconfigured to only allow parking during off peak hours. During peak hours the shoulder lane would serve as a transit priority lane further improving transit mobility. On street parking along the southbound direction would also be maintained and short term/drop off parking regulation will be implemented as well. A pedestrian overpass will be implemented near Doug Mitchel Thunderbird Sports Center.

Project Costs

After taking all aspects of the design into account, the project is estimated to cost $6,553,000. Annual maintenance costs were estimated to be $50,000.

Project Timeline

The northbound stage will commence by the end of May 2022 and will finish before the end of June 2022. The southbound stage will then commence and will finish before the end of August 2022. Major overpass work will begin after the completion of the northbound and southbound directions. Construction disruptions due to the overpass work will be significantly less and as a result can be completed during heavy traffic volume periods (September – April).

Table of Contents

List of Figures

List of Tables

1.0 Introduction

1.1 Project Background

Located on the campus of the University of British Columbia (UBC), a request from the UBC SEEDS (Social Ecological Economic Development Studies) Sustainability Program has been presented to develop the detailed design for the revitalization of the existing corridor along Wesbrook Mall.

In partnership with the University Endowment Lands, TransLink, and the Ministry of Transportation and Infrastructure, the Campus and Community Planning team has developed a long-term vision for Wesbrook Mall which focuses on improvements for pedestrians, cyclists, and transit services and promotes the transition to these modal services from passenger vehicles (UBC Campus and Community Planning). Phase 1, 2, and 3 have already been designed and are either constructed or pending construction. Phase 4, which is the last phase of the multi-phase project will be the redesign from Thunderbird Boulevard to 16th Avenue. Figure 1 shows the extent of the project area.

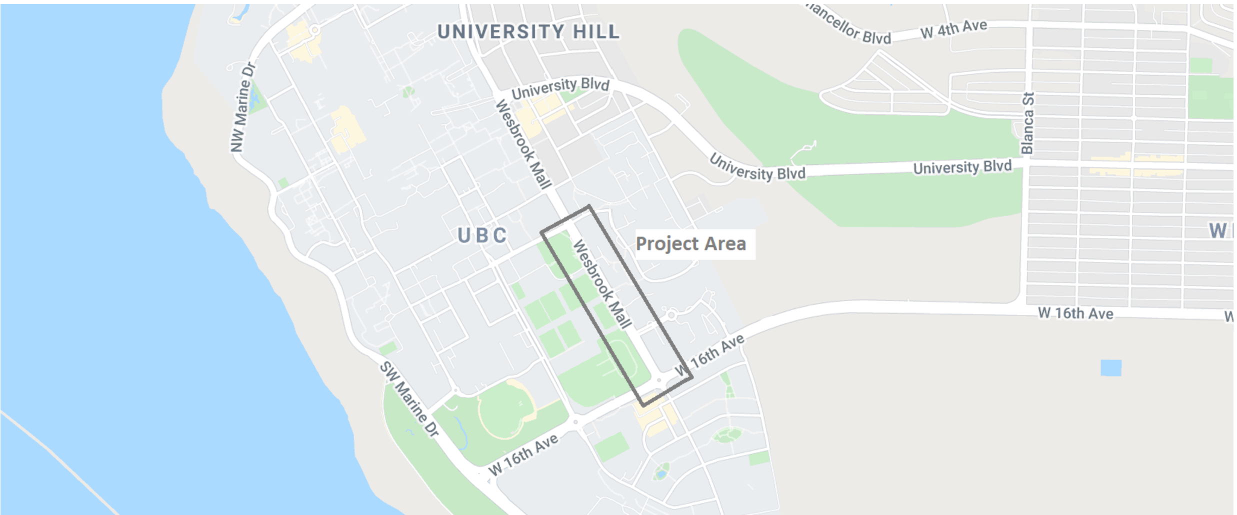


Figure 1 – Map of Project Area

By prioritizing sustainability, function and efficiency, Team 9 will seek to produce an optimal design that incorporates these key factors to produce a desirable outcome that aligns with our client's needs. Team 9 has developed a design of Wesbrook Mall Phase 4 which addresses all details surrounding transportation, safety, community development, and environmental considerations.

1.2 Project Objectives

By utilizing the necessary tools and methods, Team 9 will present a design that satisfies all project constraints, projected cost estimates, and a timeline that fits within a targeted schedule, while also adhering to the appropriate design regulations. The design will also be cognizant towards the needs of all stakeholders involved. UBC SEEDS will be provided the appropriate documentation including drawings, visual models, project schedule, project cost, and any other required deliverables.

The project focuses on reducing congestion along the Wesbrook Mall corridor. Additionally, improving the green infrastructure through the corridor is a key priority; therefore, a redesign that promotes sustainability and environmental stewardship is favored significantly. Also, the new corridor design is focused to reflect the interests of local communities. Street parking is prioritized to support the commonly used areas along the corridor. Finally, a design plan that imposes minimal disruption in the neighborhood is prioritized.

2.0 Team Introduction

SECTION REMOVED IN UBC SEEDS REPORT. SEE CIVL 446 SUBMISSION FOR CONTENT.

2.1 Team Contributions

SECTION REMOVED IN UBC SEEDS REPORT. SEE CIVL 446 SUBMISSION FOR CONTENT.

3.0 Stakeholders

3.1 Stakeholder Consultation Plan

A stakeholder consultation plan was developed to involve all parties affected by the design. The stakeholder consultation plan consists of conducting in person meetings, emails, and a website to gain feedback during the design process. A matrix was developed below to identify the key stakeholders for the project and schedule meetings, the levels of involvement, communication, engagement members, and engagement tools.

Stakeholder	Level of Involvement	Manager	Approach	Tools	Meeting Dates & Notes
UBC SEEDS		Krista Falkner	Consult & Design	Face-to-face & Emails	Bi-weekly from 09/5/2021-Present
University of British Columbia (Organization)		Dr. Lorretta Li/ Dr. Clark Lim	Consult & Design	Face-to-face & Emails	Bi-weekly from 09/5/2021-Present
Musqueam People Chiefs		Traditional Chiefs	Consult & Design	Face-to-face Emails & Information Boards	Consult on 09/18/21, 09/25/21, 10/02/21, 01/28/22

Residents and Businesses		Open to all	Design & Inquiry	Website & Emails	Ongoing via website
UBC Students and Staff		Open to all	Design & Inquiry	Website & Emails	Ongoing via website
Translink		Regional HQ	Consult & Design	Face-to-face & Emails	09/25/21, 01/21/22 By appt.
BC Hydro and Telecommunication Companies		Regional HQ	Consult & Design	Face-to-face & Emails	09/25/21, 01/21/22 By appt.
UBC Energy and Water Infrastructure		Director	Consult & Design	Face-to-face & Emails	09/25/21, 01/21/22 By appt.
Users (commuters, sporting facility)		Open to all	Inquiry	Website & Emails	Ongoing via website

Figure 2 – Stakeholder Engagement Matrix

3.2 Stakeholder Feedback

Each stakeholder was asked a series of questions during the consultation process to gain feedback on the proposed design. Some of the questions asked during the consultation include, but are not limited to, the following:

- What changes would you like to see on the Wesbrook Mall corridor in relation to congestion, transit, and the environment?
- What are your key priorities?
- How would the construction phase negatively impact you or your business?
- How important is the implementation of green infrastructure to you in the Wesbrook Mall Phase 4 Redesign Project?
- What suggestions do you have to improve the current configuration of the Wesbrook Mall corridor?
- Which parking facilities do you use the most along this corridor?
- What did you think of the preliminary design?
- Is there anything you would like to change about the preliminary design for the detailed design?

After stakeholder consultations with the various groups there were several reoccurring suggestions which Team 9 has generalized. They include prioritizing a reduction in congestion, implementing more green infrastructure throughout the corridor, while also minimizing the construction impact on surrounding residents. Also, residents who frequently use the community spaces want to see parking spaces maintained along Wesbrook Mall. Furthermore, cyclists were seeking to have protected bike lanes to increase safety. Finally, the stakeholders were consulted about Team 9's preliminary design prior to the commencement of the detailed design. For example, the queue jump lane for transit was removed as the stakeholder's preferred a more efficient solution to reduce traffic at the intersection.

4.0 Design Criteria and Constraints

4.1 Regulatory Requirements

In terms of regulatory compliance, any municipal and provincial requirements must be followed during design development. These include submitting any applicable design documents related to environmental, structural, geotechnical, and hydrological design. Before construction, the project must have all the relevant construction licenses, traffic control permits, tree permits, excavation permits, follow Translink guidelines and WorkSafeBC regulations. Construction activities must also follow all construction standards and requirements as set forth by the University of British Columbia and other regulatory bodies.

4.2 Design Criteria

Based on the feedback received through client meetings and stakeholders a set of design criteria was developed. The design criteria ensures that transit users, cyclists, and pedestrians are prioritized over vehicular traffic. The owner has also requested to maximize the safety, convenience, and enjoyability for these users while minimizing costs. As mentioned by the stakeholders, the design should also incorporate green infrastructure and make provisions to retain on-site stormwater. To increase pedestrian facility options, the client has asked for a pedestrian overpass or underpass near Doug Mitchell Thunderbird Sports Center. Moreover, to accommodate access to the various sporting facilities, the design should incorporate various types of parking (pick up/drop off, short, and long term). In addition, the design should maximize the parking retention along the residential areas. In general, the design should also prioritize safety of all road users. In terms of environmental considerations, the design must have provisions to retain as many trees as possible, especially along the existing center median.

4.3 Design Constraints

Since the Wesbrook Mall Redesign is a multi-phase development it is imperative that each design phase have continuity in terms of aesthetics and functionality. The owner has also reflected the importance of promoting modal priority in transit, pedestrians, and cyclists to ensure sustainable transportation objectives are being met. In addition, other design constraints that must be followed include meeting any regulatory requirements for design elements and ensuring all project work is inside the project boundaries. Improving safety is a cornerstone constraint in the project as the corridor serves thousands of road users each day.

5.0 Methodology

The Wesbrook Mall corridor is a major arterial road at the University of British Columbia and serves all road users including transit, passenger vehicles, delivery vehicles, cyclists, and pedestrians. An innovative design concept for the project has been developed. The proposed innovative design meets the client's objectives of improving traffic safety, travel efficiency and corridor reliability through Wesbrook Mall. While also increasing capacity, improving the local and commercial travel time, as well as reducing conflicts between commercial vehicles and other traffic users. These objectives were achieved through an extensive and thorough design process which explored several design options and combinations.

5.1 Mobility Considerations

By analyzing current conditions and following the design criteria, a Modal Priority Triangle for the corridor was developed (Figure 3). Pedestrian, cyclist, and transit mode shares were prioritized over personal and commercial vehicles due to the high volume of these users along Wesbrook Mall and the sustainable mobility objectives provided by the client. Therefore, when developing design considerations, maximizing safety, convenience, and enjoyability for these users was focused on the most.

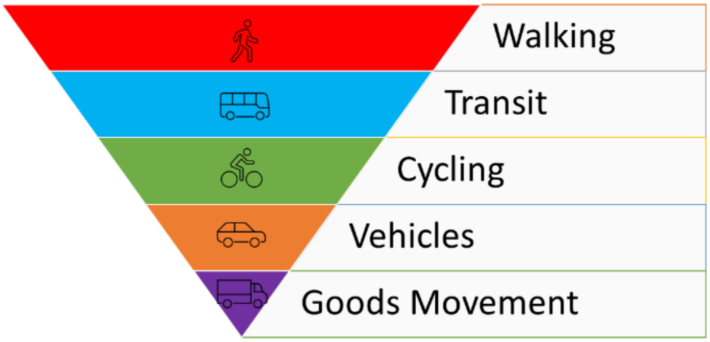


Figure 3 – Modal Priority Triangle for Wesbrook Mall

5.2 Design Development

The Master Municipal Construction Document (MMCD) was used as the primary regulatory document for design specifications. However, in instances where the MMCD was unable to provide adequate information, the Transportation Association of Canada (TAC) and the City of Vancouver's Engineering Design Manual (EDM) were used as secondary regulatory documents. In addition, the MoTI Manual of Standard Traffic Signs & Pavement Markings, Streetlighting Design Manual and TransLink's Bus Infrastructure Design Guidelines were used to develop traffic markings, streetlighting design and bus infrastructure details. Furthermore, to ensure the corridor's mobility objectives are met the Active Transportation Design Guide was consulted. Using these design specification documents and the provided base plan details from the client, the detailed design was developed in Autodesk Civil 3D and AutoCAD. In addition, AutoTurn Pro 11 and Visual Lighting software were used for turning movement and lighting analysis checks. Finally, Synchro 6 was used to develop the signal timing design for the Wesbrook Mall and Thunderbird Blvd intersection.

6.0 Detailed Design

6.1 Design Overview

Team 9's design focuses on maximizing mobility for cyclist and transit vehicles, while minimizing impact to existing parking and road usage. Both southbound and northbound would undergo several improvements related to cycling and pedestrian usage. Protected bicycle lanes would be implemented along the entire corridor and the existing sidewalks would be upgraded to ensure safe cyclist and pedestrian travel and crossing. Bus lanes will then be added along non-parking shoulders and additional transit priority measures will also be implemented along the signalized intersection at Thunderbird Blvd. Northbound parking regulations along the residential buildings nearby to the RCMP detachment would be reconfigured to only allow parking during off peak hours. During peak hours the shoulder lane would serve as a transit priority lane further improving transit mobility. On street parking along the southbound direction would also be maintained and short term/drop off parking regulation will be implemented as well. Figure 4 illustrates the high-level design overview of the facility.

Figure 4 – Design Overview

6.2 Design Specifications

6.2.1 Roadway Facilities

In general, all geometric features in the roadway design were designed using the listed specifications in Table 1.

Table 1 – Roadway Facilities Specifications

Roadway Element	Specification	City of Vancouver's EDM Section
Residential Boulevard – Small Street Trees	1.2 m (Width)	Table 8-4: Boulevard Widths and Materials
Residential Boulevard – Minimum	0.6 m (Width)	Table 8-4: Boulevard Widths and Materials
Bicycle Lane Buffer - Raised Buffer	0.7 m (Width)	Table 8-7: Buffer Widths
Curb Returns – Residential and Commercial	5.5 m (Radius)	Table 8-16: Curb Return Radii
Curb Returns – Lane Access	2.0 m (Radius)	Table 8-16: Curb Return Radii

Curb and Gutter (Type E and Type F)	0.3 m (Offset)	Table 8-15: Curb Types
Crown	2.0 % (Grade)	Table 8-13: Crossfalls

In certain instances, curb return radii were adjusted to improve or restrict turning movements. Drawings R1-955-200, 201, 202, 203, 204 included in Appendix E – Issued for Tender Drawings show detailed geometric features and their corresponding values.

Traffic markings and signage were designed based on the Ministry of Transportation and Infrastructure's Manual of Standard Traffic Signs and Pavement Markings. The City of Vancouver's Engineering Design Manual Section 8.9 Pavement Markings was also used as a supplemental guideline for developing the pavement marking and traffic signage designs. Drawings R1-955-210, 211, 212, 213, 214 included in Appendix E – Issued for Tender Drawings show the various traffic markings and signage.

6.2.2 Typical Cross Sections

In the northbound and southbound direction, the general cross section consists of a sidewalk, boulevard, protected bicycle lane, multiuse curb lanes or dedicated parking lanes, a general driving lane, left turning lane, and a center median. The respective facility widths are listed in Table 2.

Table 2 – Facility Widths

Facility	**Width**	**City of Vancouver's EDM Section**
Sidewalk	1.8 m	Table 8-3: Sidewalk Widths
Protected One-way Bicycle Lane	1.5 m	Table 8-6: Bicycle Facility Widths
Curb Lane	3.3 m	Table 8-11: Lane Widths
Dedicated Parking Lane	2.5 m	Table 8-11: Lane Widths
Transit Lane	3.3 m	Table 8-11: Lane Widths
General Driving Lane	3.0 m	Table 8-11: Lane Widths
Left Turn Lane	3.0 m	Table 8-11: Lane Widths

Figure 5 shows the general northbound and southbound cross sections of the design. Cross-sectional details can be found in drawing R1-955-215 which is included in Appendix E – Issued for Tender Drawings.

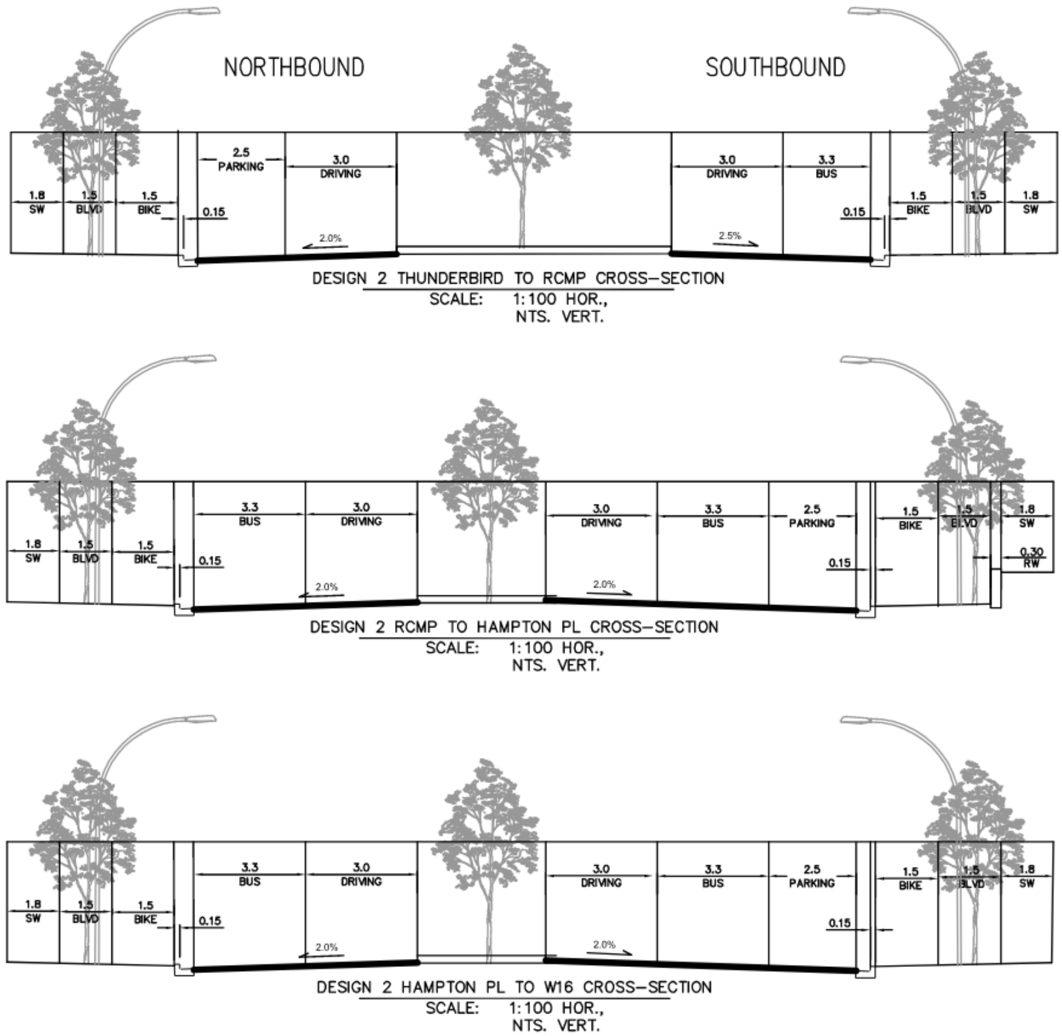


Figure 5 – General Road Cross Sections (Northbound and Southbound)

6.2.4 Pavement Design

The pavement design of the road was designed based on the MMCD with the City of Vancouver's EDM Section 8.11 Pavement Design and Section 8.7 Motor Vehicle Facilities used as supplementary material. The minimum pavement thicknesses for an arterial road are listed in Table 3. The design uses the absolute minimum pavement thickness throughout the corridor.

Table 3 – Minimum Pavement Thickness

Roadway Classification	**Design Values**
Arterial / Industrial Streets (New Infrastructure)	50mm AC Surface Course 150mm AC Lower Course (2x75mm lifts) 150mm Granular Base 300mm Granular Subbase

Road crowning was designed according to MMCD with the City of Vancouver's EDM Section 8.7.3.4 Crossfall used as supplementary material. The design incorporates a crossfall value of 2% for the crowning of the roadway. Details can be found in drawing R1-955-215.

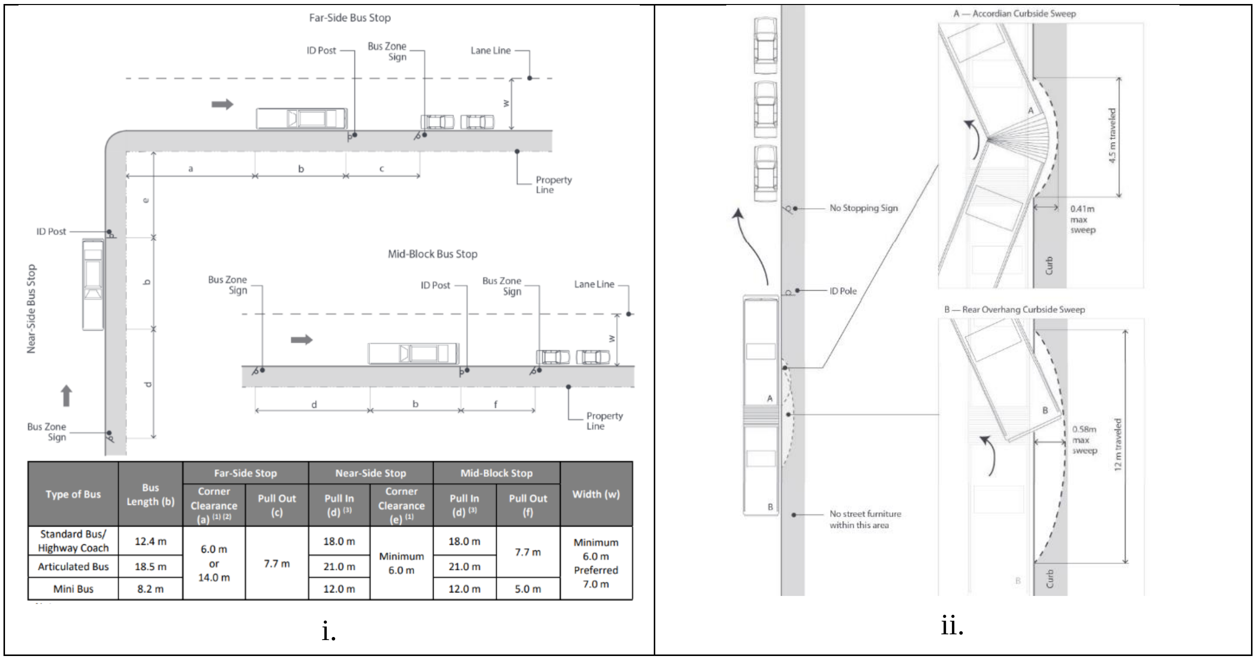
6.2.5 Transit Facilities

Transit facilities were designed according to TransLink's Bus Infrastructure Design Guidelines. To ensure that the design is compatible with TransLink's bus fleet the critical vehicle dimensions shown in Table 4 were used to design any transit facilities.

Table 4 – Transit Vehicle Design Parameters

Design Parameter	Critical Design Value
Maximum Bus Length (Articulated)	18.5 m
Maximum Bus Length (Standard)	12.4 m
Maximum Bus Width	3.1 m
Bus Rear Overhang Sweep	0.6 m
Extrusion from Passenger Side	1.6 m

These design values are significant as they dictate the necessary space requirements for bus stops and transit lanes. The maximum bus length and width values are used to design the length of bus stops and the associated clearance distances (Figure 6 i.). Whereas the Bus Rear Overhang Sweep and Extrusion from Passenger Side values are used to ensure that street furniture (signs, benches) and other road facilities (bicycle lanes, sidewalks) have adequate horizontal clearance from the lateral sweep of a standard and articulated bus (Figure 6 ii.).



Type of Bus	Bus Length (b)	Far-Side Stop: Corner Clearance (a) (1) (2)	Far-Side Stop: Pull Out (c)	Near-Side Stop: Pull In (d) (3)	Near-Side Stop: Corner Clearance (e) (1)	Mid-Block Stop: Pull In (d) (3)	Mid-Block Stop: Pull Out (f)	Width (w)
Standard Bus/ Highway Coach	12.4 m	6.0 m or 14.0 m	7.7 m	18.0 m	Minimum 6.0 m	18.0 m	7.7 m	Minimum 6.0 m Preferred 7.0 m
Articulated Bus	18.5 m			21.0 m		21.0 m		
Mini Bus	8.2 m			12.0 m		12.0 m	5.0 m	

Figure 6 – Transit Facility Design Figures (Bus Infrastructure Design Guidelines)

6.2.6 Parking Facilities

Parking regulations and facilities were designed according to the MMCD with City of Vancouver's EDM Section 8.7.7 General Parking and Curbside Management used as supplementary material. Table 5 shows the required clearances for parking facilities.

Table 5 – Parking Clearances

Facility Parking Restrictions	Required Clearance
Lane Access	2.0 m
Fire Hall (Near Side)	6.0 m
Fire Hall (Far Side)	25.0 m
Fire Hydrant	5.0 m
Crosswalk / Stop Bar	6.0 m
Bus Zone	36 m
Private Driveway	1.5 m

The detailed design also incorporates time regulated curbside parking. Rush Hour Regulations (i.e., No Stopping 7 AM – 9:30 AM, 3 PM – 6 PM) will be implemented (City of Vancouver Design Manual Section 8.7.7 General Parking and Curbside Management). Parking will revert outside of these hours. Traffic parking facilities are detailed in drawing R1-955-210 to R1-955-214.

6.3 Design Principles

6.3.1 Improving Transit Mobility

One of the key goals of the project is to improve transit mobility throughout the corridor. The project area serves five major bus services (25, 33, 49, 480, R4), and on average at least one bus travels along Wesbrook Mall every 5 minutes during peak hours (Transit DB). The design incorporates similar design principles to the previous phase redesign (University Blvd to Thunderbird Blvd). In the southbound direction, a dedicated transit priority lane will be maintained along the entire stretch from Thunderbird Blvd to W 16 St. The proposed redesign maintains this feature as the space allowance in the southbound direction is far greater than in the northbound direction. Furthermore, the existing configuration (Figure 7) has already proven to be successful in reducing transit delays.

Figure 7 – Existing Southbound Lane Configuration

In the northbound direction, the space allowance and adjacent road uses are far more restrictive compared to the southbound. It is important to consider the existing road usages and accesses when designing any transit priority measures.

Beginning near the W 16th roundabout, a dedicated transit lane will be added along the curb to the Royal Canadian Mounted Police (RCMP) detachment driveway. Although the initial stretch of this curb lane will have minimal improvements for reducing transit delays, the dedicated bus lane will accommodate for future congestion increases. Moreover, the dedicated transit lane will immediately improve bus safety as the dedicated lane will reduce the number of conflicts with other road users.

The dedicated transit lane will then switch over to a time regulated shared parking/transit lane after the bus stop (NB Wesbrook Mall at 2900 Block). This shared use lane was incorporated due to the feedback and observations obtained from the initial site investigations and stakeholder feedback. Significant northbound queuing was observed in the early rush hours (7AM – 9AM), whereas a minimal number of vehicles were parked along the existing parking lane. Residential stakeholders also confirmed that most of the parking demand is with overnight parking and during weekends.

Transit vehicles will then merge back into the general traffic lane before the start of the last residential complex. Due to the sensitive parking requirements along this stretch, the design maintains most of the curbside parking. However, due to the signal at Thunderbird Blvd significant queuing can occur which creates delays to transit vehicles. To accommodate this, a dedicated transit lane with enough storage to accommodate at least one articulated bus was implemented. The existing northbound intersection configuration would be reconfigured to accommodate the additional lane. Figure 8 shows the changes to the Thunderbird Blvd intersection. Detailed drawings showing roadworks, drainage, and landscaping can be found in Appendix E – Issued for Tender Drawings.

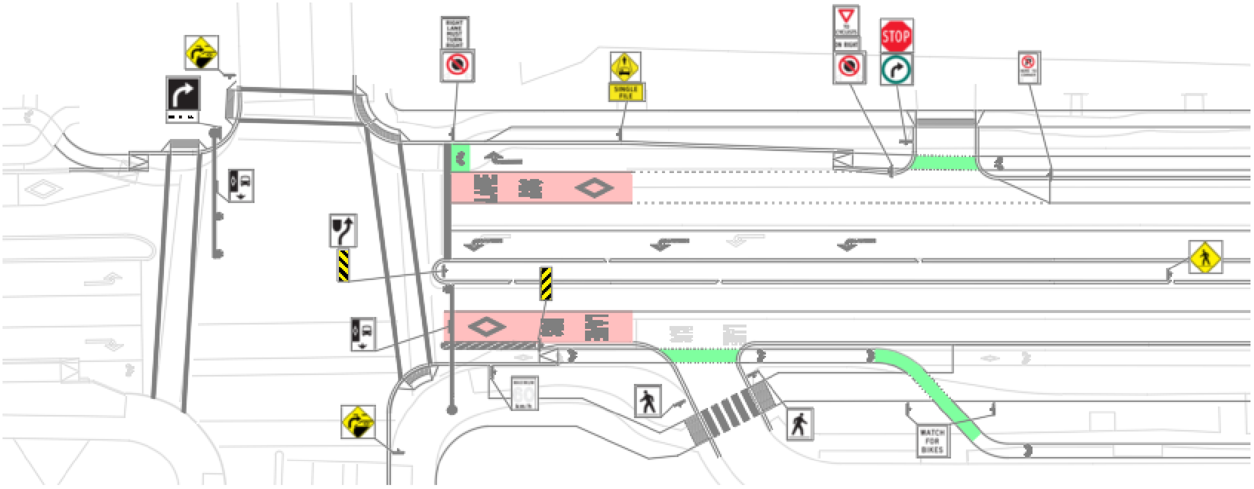


Figure 8 – Intersection Configuration at Thunderbird Blvd

6.3.2 Improving Cyclist and Pedestrian Mobility

Promoting the transition to more sustainable transportation modes such as cycling, and walking are a cornerstone in the design. All sidewalk and cycling facilities are being upgraded to ensure safe and reliable travel. In terms of cycling, the design incorporates protected bicycle lanes which follow alignment of the main roadway. Protected bicycle lanes allow cyclist to safely travel the corridor without interference from other road users. In sections where there is curbside parking, a buffer has been incorporated between the curb and protected lane. This buffer increases safety and ensures there is sufficient space allowance for both road users to use the adjacent facilities.

In instances where there is a bus stop, the bicycle lane crosses over the sidewalk. Similar design philosophy to the previous Wesbrook Mall redesign have been implemented (Figure 9). Bollards, high visibility paint markings, and delineators will be used to ensure there is no conflicts between pedestrians and cyclists. Details of the pedestrian and cyclist infrastructure can be found in drawings R1-955-200 to R1-955-225.

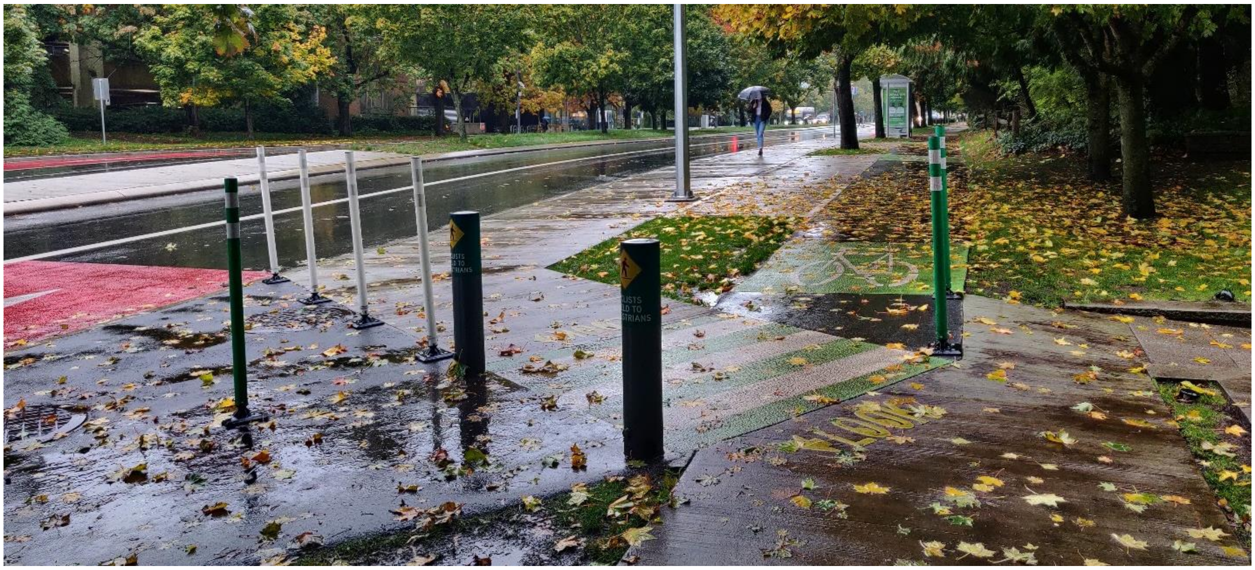


Figure 9 – Sidewalk and Bicycle Lane Interface

During site investigations, it was noted that the existing sidewalk facilities near the sporting facilities are unsafe and needing replacement (Figure 10). Team 9 took this opportunity to introduce an innovative design element which will increase safety, aesthetics, and usability of the space.

Figure 10 – Existing Southbound Sidewalk (Near Sporting Fields)

Stretching between both sporting facility driveways along the southbound direction, the design incorporates a retaining wall to address the sloping boulevard (Figure 11).

Figure 11 – Retaining Wall Location

Both ends of the retaining wall will have a gradual grade to allow easy accessibility to the raised sidewalk facility. In addition to providing a level corridor for pedestrians, the retaining wall will be utilized to showcase community artwork. In addition to ensure accessibility remains to parking users, the lowered area will be converted to a pedestrian facility with functional street furniture. Drawing R1-955-410 included in Appendix E – Issued for Tender Drawings shows the details for the retaining wall.

6.3.4 Minimizing Impact to Existing Road Users

Although the key objectives of the project are to prioritize and promote the transition to sustainable transportation methods, maintaining existing road facilities (parking, driving lanes) for regular passenger vehicles is critical. The design maintains all southbound parking through dedicated curb parking lanes. To improve parking efficiency, certain sections of parking allotment will be adjusted to drop off/pick up, as requested by the owner.

In the northbound direction, the design changes minimally to reduce the parking allowance. Currently there is around 210 m of dedicated curbside parking available along the northbound direction. Team 9's design reduces the dedicated amount to approximately 95 m and converts approximately 100 m to time regulated parking.

These reductions in dedicated parking were warranted based on site investigations and feedback from surrounding residents. In addition, the proximity of Thunderbird Parkade to the existing curbside parking allows users to use the parkade facility as overflow parking if required.

In addition, the design eliminates several merge lanes and adds a dedicated turning lane at Thunderbird Blvd. The merge lanes were removed to increase the center median and corresponding bio swales. The elimination of these merge lanes will not impact traffic as observations during site investigation indicated that road user often negated these lanes and when the lanes were used, they caused confusion with flowing traffic (Figure 12).

Figure 12 – Eliminated Merge Lanes

A dedicated right turn lane was included at Thunderbird Blvd in the northbound direction (Figure 13). This lane was added to separate traffic flow from the general driving lane. By separating turning vehicles, the queue length for through lane is significantly reduced which also allows the bus only lane to be more effective. The dedicated right turn lane will also be shared with cyclists as the configuration allows the design to tie into the existing northern leg of the intersection.

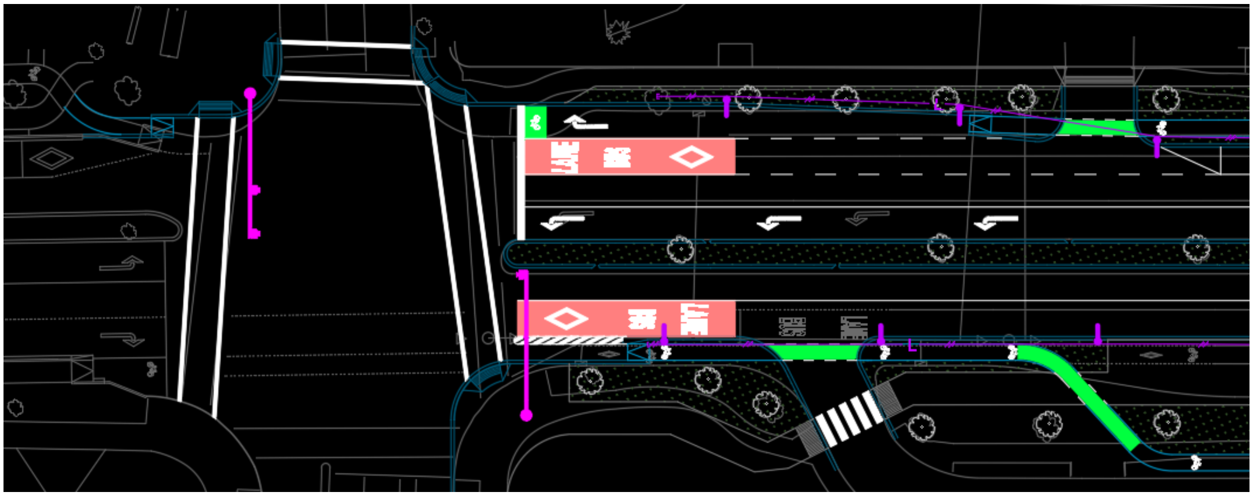


Figure 13 – Redesigned Thunderbird Blvd Intersection

6.4 Safety Considerations

One of the primary goals with the development of the design is to ensure pedestrian and cyclist safety is significantly improved along the corridor. To achieve this, the design implements several pedestrian and cyclist safety measures which included tactile sidewalk letdowns, staggered crosswalks, improved street lighting, crosswalk lights, radar speed boards, and protected bicycle lanes.

6.4.1 Pedestrian Safety

When designing for pedestrian safety, people of all mobility levels were considered including, but not limited to, users with limited mobility (i.e., wheelchair users) and the visually impaired. To accommodate for users with limited mobility, curb ramps are used to allow wheelchair users to enter and exit the crosswalk without issue. Further safety controls for the visually impaired include the placement of tactile sidewalk letdowns before the entrance of each crosswalk (Figure 14).

Figure 14 – Tactile Curb Letdown

Based on the site investigation and consultation with local users, it was found that pedestrians often had trouble crossing the large intersection safely, as it was difficult to predict vehicle patterns on the opposite side of the road as is evident by Figure 15.

Figure 15 – Existing Crosswalk at Wesbrook Mall (Near Hampton Place)

To address these safety concerns, a staggered crosswalk was incorporated. Staggered crosswalks improve safety by allowing pedestrians to focus on one direction of traffic when crossing, while also shortening the time spent in traffic lanes. Figure 16 shows the designed staggered crosswalk near Hampton Place.

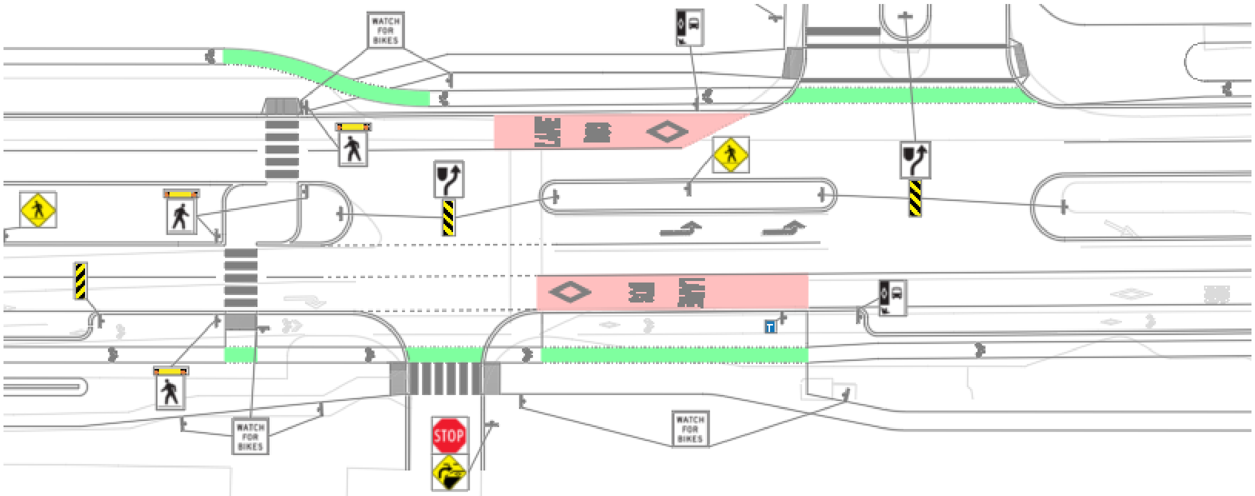


Figure 16 – Staggered Crosswalk Implemented Near Hampton Place

Crosswalk lights are used in conjunction with the staggered crosswalk to provide enhanced pedestrian safety. In addition to upgrading the existing overhead crosswalk light, additional pedestrian-controlled crosswalk lights will be placed on either ends of the crosswalk and in the center median (Figure 17).

Figure 17 – Additional Pedestrian Controlled Traffic Lights and Sign

Other safety additions include implementing radar speed boards before crosswalks. These radar speed boards will show road users their current speed, alerting them if they are speeding and reminding them to slow down. Cyclist safety will be increased within the corridor by implementing protected bike lanes in both directions of traffic. High visibility traffic markings will be used to distinguish any bicycle crossings and crosswalks (Figure 18).

Figure 18 – High Visibility Traffic Markings for Cyclists Crossings

6.5 Stormwater Considerations

During the team's site investigation, it was evident there were issues with major pooling and stormwater detention during significant rainfall events (Figure 19).

Figure 19 – Pooling at Existing RCMP Driveway Access

To address these problems, top inlet dual catch basins will be placed throughout the corridor. Top inlet catch basins will conform to MMCD standard drawing S11. Since the bike path is protected, side inlet catch basins were not necessary, since their primary benefit is cyclist safety. Dual catch basins are used to increase storage which will reduce pooling. Using the City of Vancouver's EDM Section 5 - Storm Drainage System, a layout for the catch basins was created. Section 5.4.4.1 of the Design Manual provides all requirements for where catch basins are necessary. The design includes dual catch basins spaced at a maximum of 60 m apart, or at all major low points. Majority of catch basins will be located at existing locations to minimize extra trench digging and costs. In areas where the catch basins are too close to the main, offset sumps will used (Figure 20). To avoid pooling at intersections and driveway letdowns, a combination of catch basins and bioswales are included (Figure 21). In areas where bioswales cannot be included in the center median, catch basins will be located along the median curb. Lawn basins (as per MMCD standard detail S12) are also included in the boulevard for sidewalk and bicycle lane drainage. For further information on the drainage design, see drawings R1-955-300 to R1-955-305.

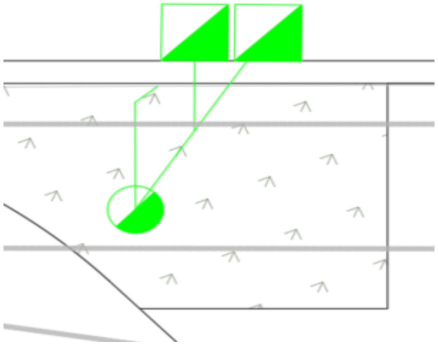


Figure 20 – Pan Catch Basin and Offset Sump

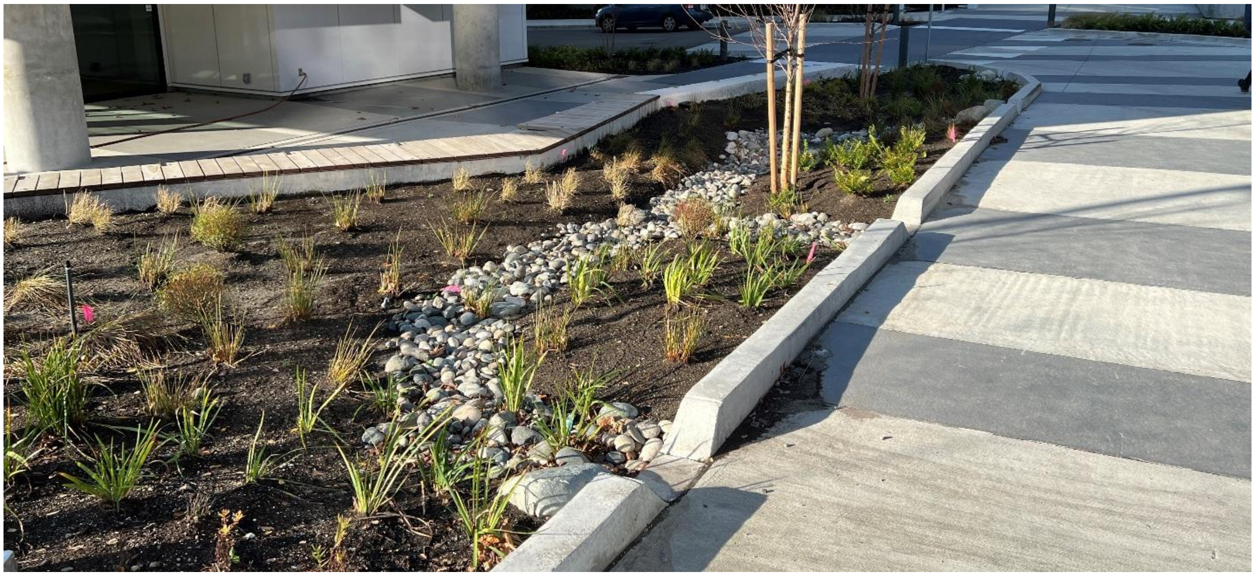


Figure 21 – Bioswale and Curb Drainage System

6.6 Environmental Considerations

There are two main environmental topics which were considered during design development. Since there are many existing trees, it is important to retain as many of them as possible. In doing so, the boulevard area which will provide water for the trees through drainage is maximized. In total, 15 street trees will be removed, majority of which are because of the new retaining wall beside the athletic fields.

In Section 5.7 of the City of Vancouver's Design Manual, examples for green infrastructure are provided. One recommendation was the use of infiltration swales which allow rainwater to directly drain into the soil. 450 m of bioswales were included in both the center medians, and boulevard areas between sidewalks and bike paths. The rainwater will flow into the swales through breaks in the curbs. A perforated pipe is buried deep and connected to an overflow lawn basin in case water cannot be infiltrated at a high enough rate. These lawn basins have an overflow pipe that connects into the city's main as a backup. The criteria and cross-sections can be found in Section 3 of the Metro Vancouver Stormwater Source Control Design Guidelines 2012 (Figure 22). For further information on the bioswale locations and details, see drawings R1-955-300 to R1-955-305.

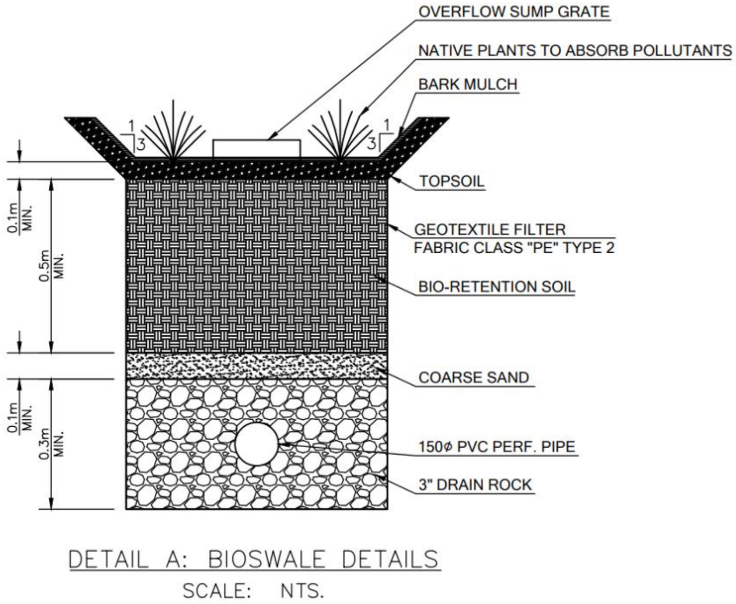


Figure 22 – Infiltration Soil with Reservoir and Subdrain Cross Section

6.7 Overpass Structural Design

6.7.1 Preliminary Sizing and Overall Geometry

The structural design for the pedestrian overpass was created based on site geometry and design criteria obtained from the Transportation Association of Canada (TAC). The pedestrian overpass was intentionally designed using exclusively steel components as it is significantly cheaper than forming concrete columns due to the costs associated with formwork at UBC. The pedestrian overpass consists of four girders, six columns, and a series of beams spaced two meters on center. The overall geometry and beam lengths can be seen in the framing plan (Figure 23), each element was placed based on selected limiting criteria. For example, the design utilizes 65 mm of 45 MPa concrete topping on a 76 mm steel fluted deck and therefore the maximum deck span (distance between beams) was limited to 2.5 meters. Loads on the structure were obtained using the National Building Code of Canada and conservative values of 4.8 kPa and 1.9 kPa were selected for the live and snow loads respectively. The dead loads were simply calculated as the self-weight of the structure. Beams and girders were sized based on the required moment and shear demands of the structural system, the lightest possible beam/girder was then selected using the CISC Handbook of Steel Construction beam selection table. All chosen sections were selected to ensure they were readily available in Canada. The beams and girders were then checked for against the serviceability limit state (L/360) to ensure there was no over-deflection of any member. The beams were selected to be W360x51 and the girders were selected to be W530x66. Columns were selected by checking three ultimate limit states which included local buckling, slenderness, and global capacity of the member. Based on the TAC design criteria the clearance height needs to be a minimum of 5.3 meters, since the girder had a depth of 0.5 meters the column height was selected to be 6 meters. The column was selected to be a W250x49 section. Preliminary calculations of the structural overpass design can be found in Appendix A – Pedestrian Overpass Structural Calculations. Drawings of the overpass can be found in R1-955-500.

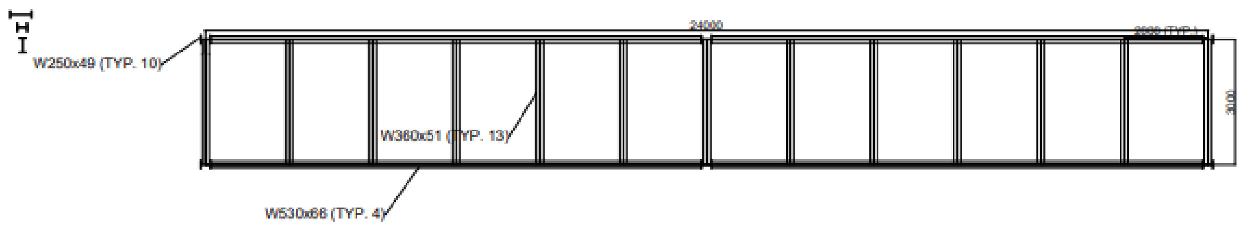


Figure 23 – Overpass Structural Framing Plan

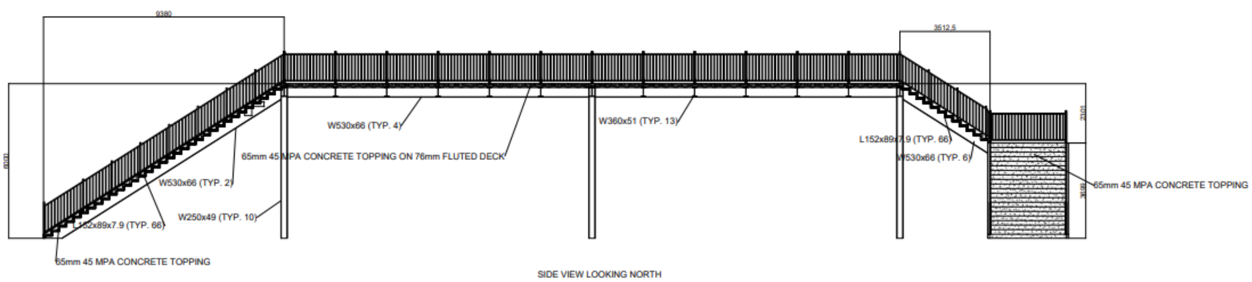


Figure 24 – Overpass Structural Cross Section

6.7.2 Footing Design

A footing design was completed for the overpass to effectively transmit the gravity loads of the structure into the soil below. Based on the geotechnical report provided by the owner it was determined that Wesbrook Mall's soil consists of a strong till layer underneath the site with a unit weight of 21.5 kN/m^3. Furthermore, using the geotechnical report it was found that the groundwater table well below the proposed 0.5 m depth the footing would be placed in. Using this information Team 9 was able to determine the allowable bearing capacity of the soil was 446 kPa. The footing was designed for the critical loading case using two-way shear (punching shear) and checked to ensure it also was able to resist one way shear. A flexure design of the footing was then completed to ensure the footing had sufficient capacity to resist the critical bending moment. The final footing design consisted of a 30 MPa footing with dimensions of 1m x 1m x 0.5m. Furthermore, the footing will utilize 10M bars at 125 mm spacing in both directions. Detailed calculations of the footing can be found in Appendix A – Pedestrian Overpass Structural Calculations and the detailed design can be found in drawing R1-955-500.

6.7.3 Connection Design

Connection designs were completed by Team 9 for all Girder-Column, Beam-Girder, and Beam-Column connections on the overpass. The Beam-Girder and Beam-Column designs were completed as shear connections and the Girder-Column connection was designed as both a moment and shear connection. The shear connections were designed using four critical checks which included bolt shear, bolt bearing, block shear, and shear rupture. Since constructability was a major component to the overpass design all shear connections were designed using the same connection details if possible. Through Team 9's calculations it was found that using two L109x109x9.4 angles with two A325 bolts spaced 75 mm apart would be sufficient to resists the demands of the structure. Furthermore, in the Girder-Column moment connection, Team 9 found that utilizing two 80 mm x 15 mm continuity stiffeners on each side of the column would be sufficient to resist demands. Detailed calculations of the connection can be found in Appendix A – Pedestrian Overpass Structural Calculations and the detailed design can be found in drawing R1-955-500.

6.7.4 Base Plate and Shear Stud Design

To connect the fluted deck to the overpass a shear stud design was carried out by Team 9. The design was completed as a partial shear connection to reduce the number of studs required in the overpass. Through Team 9's calculations it was found that the contractor needs to insert two studs in the first four flutes on either end of the beam and three studs in the middle two flutes for a total of 22 studs per a beam. It was also determined that the 65 mm concrete topping would need to utilize a 45 MPa mix. The base plate design was carried out to ensure that the steel column would distribute the load into the footing adequately as to prevent crushing of the concrete at the base of the column. Through Team 9's calculations it was determined that a 250 mm x 250 mm x 10 mm base plate will be sufficient to adequately distribute the load into the footing. Detailed calculations of the base plate and shear studs can be found in Appendix A – Pedestrian Overpass Structural Calculations and the detailed design can be found in drawing R1-955-500.

6.8 Traffic Signal Design

6.8.1 Introduction

Traffic models are a useful way to recreate traffic conditions in the real world. By simulating traffic flow, macroscopic models can identify key problems and constraints that may arise in the actual facility. For this project, Synchro 6 was used as the traffic model software to design the signal timing. An analysis on the capacity capabilities of the new designed facility was already completed in the preliminary stage. To adequately assess the new signal timing design, two different models were created: the designed facility with projected peak demands and the current signal timing design, and the designed facility with projected peak demands and the new signal timing design. The methodology for creating the two traffic models is explained in 6.8.2 Methodology. 6.8.3 Results discusses the results from the two traffic models whereas the limitations and assumptions of using Synchro 6 are explained in 6.8.4 Limitations and Assumptions of Synchro 6.

6.8.2 Methodology

The configuration used in Traffic Model 1 replicated the designed facility. After a scaled model of the facility was imported into Synchro 6, specific volume and lane parameters were inputted. The first step was to configure the lanes and input volume demands. Using data provided, the average peak hour demand was calculated by averaging the peak AM, peak midday, and peak PM demand volumes for the four sets of data. This average peak hour demand was then adjusted to account for traffic growth in the facility for the next 15-20 years. The UBC Vancouver Transportation Status Report from fall 2019 was used as the primary source to predict traffic growth. This document presents the most recent traffic data UBC has collected and analyzed. It includes information on the changes to traffic patterns to and from UBC from 1997 to 2019. According to Table 2.5: Summary of Average Weekday Traffic Volumes at Screenlines, 1997 vs. 2019, the average weekday traffic volume of W 16th Avenue has increased by 30% over the 22 years. It was mentioned that this largely had to do with pedestrian growth in Wesbrook Village and congestion on other routes. Therefore, a 20% increase in peak traffic demand was assumed at the Westbrook Mall & W 16th Avenue intersection for the next 15-20 years. This was based on the idea that the heavy development near Wesbrook Village will continue and that more busses will be required to pass through the intersection. A similar process was followed at the Wesbrook Mall and Thunderbird Blvd intersection, where an assumption of a 15% increase was used. Next, important lane parameters were inputted into the model. These include lane widths, storage lengths for turning lanes, and lane utilization factors. Lane widths were obtained from the design, whereas the storage length for non-redesigned turning lanes were measured from Google Earth. Details about determining the lane utilization factor can be found in 6.8.4 Limitations and Assumptions of Synchro 6. After the lane parameters were added into the traffic model, other important volume parameters were adjusted, specifically the percentage of heavy vehicles, vehicle speeds, and adjacent parking spaces. The percentage of heavy vehicles used for the model was 7%. This number was obtained from averaging the percentage of heavy vehicles over the four sets of vehicle data provided. The network vehicle speed was set to 50 km/h. After the specific volume and lane parameters, the current signal timing information for the Wesbrook Mall and Thunderbird Blvd was added to the model. This information was provided apart from pedestrian calls per hour, which was assumed to be 40 in all directions. After all the parameters were added into the model, a simulation of the facility was completed in Synchro. The configuration used in Traffic Model 2 is identical to the one used in Traffic Model 1, with the only exception being the signal timing design. Due to the limitations of Synchro 6, the optimization function for the signal timing design resulted in increased congestion in the facility. Therefore, manual optimization was completed by Team 9 to determine the new signal timing design, by focusing on reducing intersection delay and maximum queue length. The final signal timing design used in Traffic Model 2 can be seen in Figure 25 - Final Signal Timing Design (Model 2). There are four phases split over a total cycle length of 100 seconds. The next subsection will explain the results from the two traffic models. The input parameters used for both models can also be found in Appendix B – Traffic Model Information.

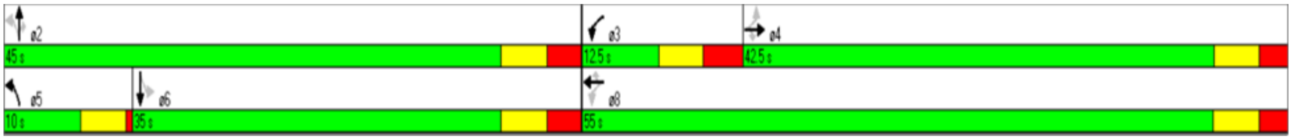


Figure 25 - Final Signal Timing Design (Model 2)

6.8.3 Results

The delay per vehicle diagram for Traffic Model 1 can be seen in Figure 26 - Delay/Vehicle for Traffic Model 1. At initial glance, it is evident that the facility will have enough capacity to meet future peak demands with the current signal timing design. However, when compared to the delay per vehicle diagram for Traffic Model 2 in Figure 27 - Delay/Vehicle for Traffic Model 2, the overall intersection delay decreases significantly. It was found that the intersection delay in Model 2 was 3.8 seconds shorter than Model 1. The signal timing information for Model 1 and 2 can be found in Appendix B – Traffic Model Information.

Figure 26 - Delay/Vehicle for Traffic Model 1

Figure 27 - Delay/Vehicle for Traffic Model 2

6.8.4 Limitations and Assumptions of Synchro 6

Using an older software such as Synchro 6 comes with limitations. Foremost, the software makes it difficult to analyze bus lanes without bus volumes. For this reason, the "bus lanes" in the traffic models were assigned a lane utilization factor of 0.20. This factor takes into consideration the assumption that only 20% of the lane is utilized for traffic flow to account for busses and vehicles entering/ leaving street parking. Another limitation to Synchro 6 is its optimization function. It was found that whenever the software tried to optimize the signal timing for the Wesbrook Mall and Thunderbird Blvd intersection, congestion would easily form in the facility. Therefore, a manual optimization was completed. Team 9 recommends that another traffic model software be used to model the proposed Wesbrook Mall facility due to the limitations and number of assumptions used in Synchro 6.

Other assumptions include setting the adjacent street parking parameter to “no”, as the influence from adjacent street parking was already considered in the lane utilization factor. Due to the limitations of Synchro 6, the software LOS measure of was not considered as an accurate metric of the realistic LOS of the facility and was not considered when completing the signal timing design. Lastly, a walking time of 7 seconds was assumed for all crosswalks in the signalized intersection.

6.9 Lighting Design

Using the Streetlighting Design Manual, and the Visual Lighting software, a lighting design was completed. For an arterial road with high pedestrian traffic, the minimum lighting levels are 17.0 Lux. To meet this level, a type 2, 4k lumens, 124W LED luminaire was used. This provided a lighting level of 19.5 Lux which is adequate to meet roadway lighting in this area. The minimum spacing between the lights will be 15m and the minimum pole height will be 9.1m. The system will tie into the north stub from phase 3, and a stub will be left at the south end for future lighting improvements on 16th Avenue. In total 66 new streetlights will be added to the redesigned facility. See drawings R1-955-600 to R1-955-604 for the Wesbrook Mall lighting design.

6.10 Design Drawings

Appendix E – Issued for Tender Drawings includes Team 9’s design drawings. The design drawings include the road alignment and geometric features, proposed drainage, overpass design, proposed landscaping, and traffic markings and signage.

7.0 Analysis

7.1 Turning Movement Analysis

To validate the geometric design, AutoTurn Pro 11 was used to perform turning movement checks for passenger cars, articulated busses, and firetrucks (Figure 28). According to the City of Vancouver’s Engineering Design Manual Section 8.7.2 Design Vehicles geometric designs of roadways should be sufficient to handle the turning travel envelope of the design vehicles plus a minimum 0.2 m width on both sides. The design vehicles used are listed in Table 6.

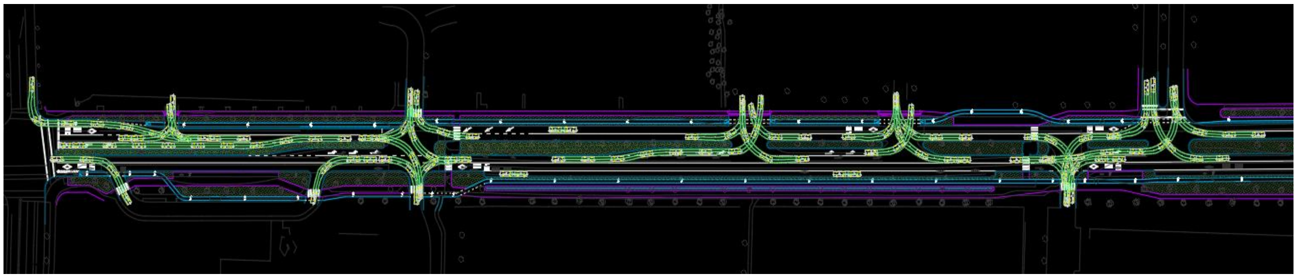
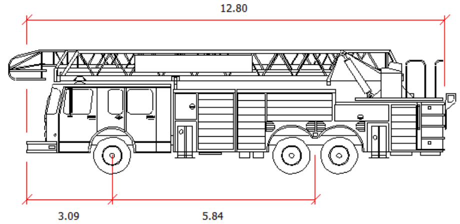
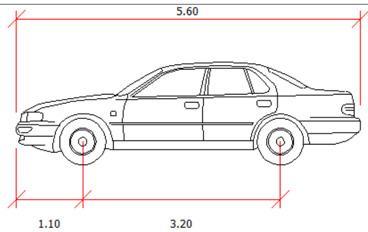
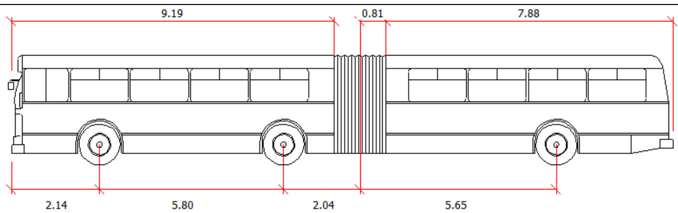


Figure 28 – Turning Movement Analysis for Passenger Cars

The full set of turning movements are included in drawing R1-955-223 which is included in Appendix E – Issued for Tender Drawings.

Table 6 – Design Vehicles

Design Vehicles	Specifications
SU9 (TAC-1984)	
PC (TAC-1984)	
A-BUS (TAX-1999)	

8.0 Construction Details

8.1 Roadworks Construction

Roadwork construction activities will be carried out in accordance with all regulatory standards and requirements. Team 9's Issued for Tender Drawing Package (Appendix E – Issued for Tender Drawings), has been developed to include all necessary details to construct all roadway features. Roadwork construction will begin with removal of existing roadway infrastructure (curbs, sidewalks, and asphalt). Once completed any underground utility work will be conducted alongside any cut and fill placement. New curbs and sidewalks will then be formed according to the design drawings. The general roadway will undergo a full depth pavement restructure, which will involve regrading and compacting new subgrade and roadway subbase. Drawing R1-955-700 details the full depth pavement construction. At the same time, the dedicated bicycle lanes will be constructed according to drawing R1-955-220. Once the substructures are completed, asphalt paving will occur. Landscaping along boulevard and median areas will then be completed. Finally, traffic markings and signage will be installed in accordance with the roadworks drawing package.

8.2 Drainage Construction

All drainage construction shall conform to MMCD standards. To improve constructability, catch basins are mostly located where the existing catch basins are to be removed. This means, only one trench is required to remove the old catch basins and install the new ones.

8.3 Landscape Construction

The landscaping infrastructure shall conform to MMCD standards. During the retaining wall construction, a geotechnical engineer shall be present on site. An arborist must be present during any works in the tree protection areas.

8.4 Pedestrian Overpass Construction

The construction of the overpass will be conducted in accordance with regulatory standards. Since construction speed and constructability are a primary concern, excavation and construction of the footings will be done during off peak hours. To further minimize traffic delays the overpass's main walkway will be constructed off site and welded into place using a portable crane.

9.0 Class A Cost Estimate

Team 9 understands the uncertainty associated with increasing material costs in the lower mainland. Therefore, to minimize the discrepancy between the Class A cost estimate and the actual construction costs, a 15% inflation factor was added to the civil works of the Class A cost estimate. The table below is a breakdown of the Class-A Project Cost Estimate. The costs were split into five categories namely: road & site works, storm systems, erosion & sediment control, pedestrian overpass, and street trees, signage, & pavement markings. Road & site works account for majority of the site works with erosion & sediment control accounting for the least amount. The bulk of the roadworks costs comes from the asphalt structure, curbs and gutters, and sidewalks. The site works include new boulevard areas, removal of any existing materials, and implementation of a retaining wall. Other construction costs come from drainage systems, pedestrian overpass, lighting, signage, line painting, traffic control, and potential erosion and sediment control measures. The cost estimate for civil works was based on City of Langley's standard cost sheet sent by a city engineer. The cost estimate for the overpass was based on current structural steel and labor costs. All prices include materials and labor for this project. Other costs come from project management, permits, preconstruction preparation such as surveying and geotechnical analysis, and a 10% contingency. A detailed cost estimate breakdown is provided in Appendix C – Class A Cost Estimate.

Table 7 – Class-A Project Cost Estimate

Class-A Project Cost Estimate Breakdown	
Road & Site Works	$3,775,000
Storm Systems	$349,000
Erosion & Sediment Control	$173,000
Pedestrian Overpass	$561,000
Street Lighting, Signage & Pavement Markings	$658,000
Sub Total	$5,516,000
Contingency (10%)	$552,000
Project Management	$350,000
Permits	$15,000
Preconstruction	$100,000
Total	**$6,533,000**

10.0 Project Specifications

10.1 Permitting

To begin construction and design implementation on site, all municipal and provincial regulations must be adhered to. Before construction of the Wesbrook Mall Phase 4 Redesign, it is required for any contracting group to possess the necessary building permits, traffic control permits, excavation permits, and have consulted WorkSafeBC before construction of any sort has started.

10.2 Construction Schedule and Milestones

The successful planning and coordination that is required to deliver a project of this scope involves input and commitment from all stakeholders, design engineers, operations, and the construction and commissioning team. An integrated project schedule has been developed which includes procurement, multi trade execution, testing and commissioning, durations, sequences, and constraints.

The construction schedule utilizes a work breakdown structure (WBS) which incorporates permitting, procurement, mobilization, early works, structural, roadworks, utilities, finishing, testing, commissioning, demobilization, and landscaping. Sequencing of construction activities will be developed to maximize concurrent activities while maintaining all workplace safety and construction procedures.

Activity durations have been calculated using input of internal civil, structural, mechanical, electrical, and commissioning personnel ensuring an accurate schedule is being developed. The current schedule can also be adjusted to allow for fast-track construction which can minimize design and construction delays.

The construction schedule also allows for potential delays, by using the float currently assigned to the contractor's construction contingency.

Since Wesbrook Mall is a major arterial road at the University of British Columbia, major construction activities are planned to be completed during non-fall academic terms (May – August). Team 9 anticipates the project to be constructed in three major stages (northbound direction, southbound direction, and overpass). To allow for construction, detours will be designed and implemented. Currently, the detour design shifts both northbound and southbound traffic to the existing southbound lanes. Once construction is completed in the northbound direction, both northbound and southbound traffic will be diverted to the new northbound lanes to allow for the completion of the southbound direction.

The northbound stage will commence by the end of May 2022 and will finish before the end of June 2022. The southbound stage will then commence and will finish before the end of August 2022. Major overpass work will begin after the completion of the northbound and southbound directions. Construction disruptions due to the overpass work will be significantly less and as a result can be completed during heavy traffic volume periods (September – April). The full construction schedule is included in Appendix D – Construction Schedule.

10.3 Risks

Roadway design projects are complex projects which have many stakeholders and project requirements. Several risks associated with the design and construction of Wesbrook Mall have been identified. Poorly defined project scopes and incomplete design details and drawings can lead to lengthy delays and field errors. In addition, unexpected increases in material costs, and availability of materials can cause construction delays. Unexpected risks such as labor shortages, and natural disasters can also greatly affect the project during design and construction. Since the project area is a major corridor at UBC, delays can have large consequences to various stakeholders. As such, it is paramount that mitigation and response strategies are in place at the start of the detailed design and construction phases.

11.0 Service and Maintenance Details

The featured design would require several forms of maintenance on various time frames. While considering wear and use of the roadway, in addition to weather impacts will cause deterioration and potholes. Because of this, patchwork will be required as necessary based on climate and road wear. Additionally, asphalt overlays will be required periodically to refinish the surface of the roadway, by utilizing previously degraded asphalt as a base. In harsher weather climates, snow removal and road salt may likely be required to provide optimal surface conditions. The use of road salt and similar materials has the potential to increase surface and subsurface wear and erosion. Finally, landscaping work along either side of the corridor will be required as necessary.

11.1 Annual Maintenance Cost

The following table highlights the costs required to annually maintain the redesigned corridor on Wesbrook Mall. These values were provided by consultation with industry professionals.

Table 8 – Annual Maintenance Cost

Service	Cost
Asphalt Patchwork	**$5,000**
Asphalt Overlays	**$15,000**
Snow Removal	**$5,000**
Road Salt	**$5,000**
Landscaping	**$10,000**
Overpass	**$10,000**
Total	**$50,000**

References

Wesbrook Mall Redesign Phase 4 Preliminary Design Report. Team 9. (2021, December 3). Retrieved from hardcopy.

Wesbrook Mall. UBC Campus and Community Planning. (2019, March 8). Retrieved from https://planning.ubc.ca/news/wesbrook-mall-gets-facelift.

Consulting Engineers Fee Guideline. ACEC. Retrieved from https://acec-bc.ca/2021/02/2021-consulting-engineers-fee-guideline-now-available.

UBC Vancouver Transportation Status Report Fall 2019. UBC. (2020, March). Retrieved from https://planning.ubc.ca/sites/default/files/2020-05/UBC2019-TransportationStatusReport-Mar5-2020_0.pdf

Metro Vancouver Stormwater Source Control Design Guidelines 2012. Lanark Consultants Ltd. Kerr Wood Leidal Associates Ltd. Goya Ngan. (2012, May). Retrieved from http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012StormwaterSourceControlDesignGuidelines2012.pdf

Translink. http://www.translink.ca

Transit DB. http://www.transitdb.ca

The National Building Code of Canada 2015. (2015). Retrieved from hardcopy.

Handbook of Steel Construction 11th Edition. (2017). Retrieved from hardcopy.

Geometric Design Guide for Canadian Roads. TAC. (2017). Retrieved from hardcopy.

Master Municipal Construction Document. MMCD (2019). Retrieved from hardcopy.

City of Vancouver Engineering Design Manual. (2018). Retrieved from https://bids.vancouver.ca/bidopp/RFA/Documents/PS20181461-CityofVancouver-EngineeringDesignManualFirstEdition2018.PDF

Bus Infrastructure Design Guidelines. Translink. (2018, September). Retrieved from https://www.translink.ca/-/media/translink/documents/plans-and-projects/managing-the-transit-network/bus_infrastructure_design_guidelines-sept_2018.pdf

Manual of Standard Traffic Signs & Pavement Markings. MOTI (2000, September). Retrieved from https://www.atstraffic.ca/wp-content/uploads/2016/08/MoST_PM.pdf

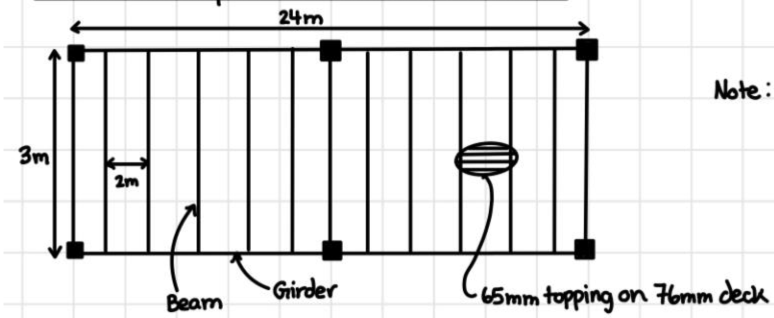
GTA price list. (n.d.). Retrieved February 26, 2022, from http://www.canadabuildingmaterials.com/en-ca/Pages/Products%20and%20Services/GTA-Pricelist.aspx

2022 steel beam costs: Install support beam prices (LVL vs. wood). HomeGuide. (n.d.). Retrieved February 27, 2022, from https://homeguide.com/costs/steel-beam-cost

DeSimone, B. (n.d.). Corrugated steel decking. Corrugated Steel Decking, B Deck. Retrieved February 27, 2022, from https://www.fsindustries.com/more_info/corrugated_steel_decking/corrugated_steel_decking.shtml

Appendix A – Pedestrian Overpass Structural Calculations

Pedestrian Overpass Structural Calculations



Note: Since we are using 65 topping on 76mm deck, the max deck span (Spacing between beams) less than 2.5m

Load Source:

65 topping on 75 deck = 2.14 KPa
Beams (estimate) = 0.3 KPa
Girders (Estimate) = 0.35 KPa
} Total Dead = 3.79 KPa
Finishes/Mechanical/etc. = 1 KPa

Live Load = 4.8 KPa

Snow Load = 1.9 KPa

Factored Load = $1.25D + 1.5L + 1S = 1.25(3.79\,KPa) + 1.5(4.8\,KPa) + (1.9\,KPa) = 13.84\,KPa$

→ Calculate Mf on beam:

$$Mf_{beam} = \frac{Wf_{beam} \cdot \ell^2}{8}$$

Wf_{beam} = (Factored Load)(Tributary Width)

$Wf_{beam} = (13.84\,KPa)(2m) = 27.68\,KN/m$

$$Mf_{beam} = \frac{(27.68\,KN/m)(3m)^2}{8} = 30.14\,KN{\cdot}m$$

→ Using the CISC Beam Selection table choose W360x51 section because it is lighest and readily avaliable

W360x51 → $Mr = 277\,KN{\cdot}m > Mf = 30.14\,KN{\cdot}m$ ∴ passes

→ Check Shear capacity

$$Vf = \frac{Wf\ell}{2} = \frac{(27.68\,KN/m)(3m)}{2} = 42\,KN$$

→ From CISC Beam Selection table a W360x51 Section has a $Vr = 524\,KN$ ∴ $Vr > Vf$ and section passes

→ Check Servicability limit state deflection $< L/360$

$$\Delta = \frac{5WL^4}{384EI} = \frac{5(4.8\,KPa \cdot 2m)(3m)^4(1000)}{(384)(200\times10^6)(141\times10^{-6}\,m^4)} = 0.35mm < L/360 = \frac{3000}{360} = 8.3mm \therefore \text{Passes}$$

→ W360x51 passes all required checks ∴ Size beam to W360x51

→ Add self weight of beam to dead load & check if section still works

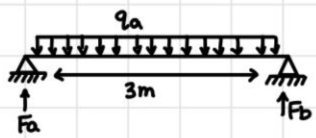
Self weight = 51 kg/m · 9.81 $\frac{m}{s^2}$ = 500 N/m = 0.5 kN/m = 0.25 kPa

→ Since we estimated the beams would be 0.3 kPa in our origonal calculation we know the section will still pass

Design Girders:

→ Calculate M_f of girders

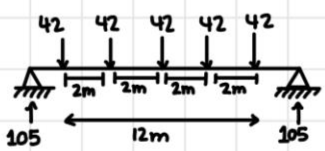
Beams:



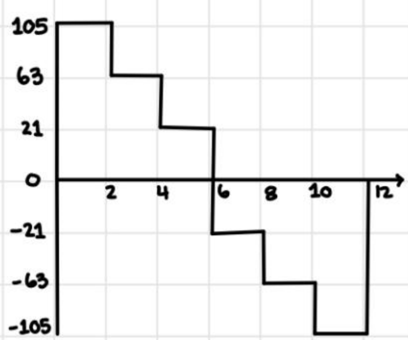
q_a = factored load = 27.68 kN/m

$F_A = F_b = \frac{(27.68\,kN/m)(3m)}{2} = 42\,kN$

Girder:

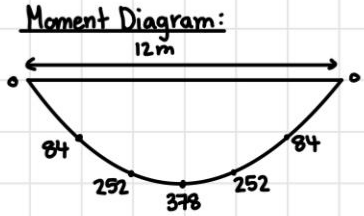


Shear Diagram:



V_f = 105 kN

Moment Diagram:



M_f = 378 kN·m

→ Using the CISC Beam Selection table choose W460x60 section because it is readily avaliable and has sufficient M_r

W530x66 → M_r = 484 kN·m > M_f = 378 kN·m ∴ passes

→ Check Shear capacity

$V_f = 105kN$ (from shear diagram above)

→ From CISC Beam Selection table a W530x66 section has a $V_r = 927\ kN \therefore V_r > V_f$ and section passes

→ Check Servicability limit state deflection < L/360

$$\Delta = \frac{5WL^4}{384EI} = \frac{5(4.8kPa \cdot 1.5m)(12m)^4(1000)}{(384)(200\times10^6)(351\times10^{-6}m^4)} = 27.7mm < L/360 = \frac{12000}{360} = 33.3mm \therefore \text{Passes}$$

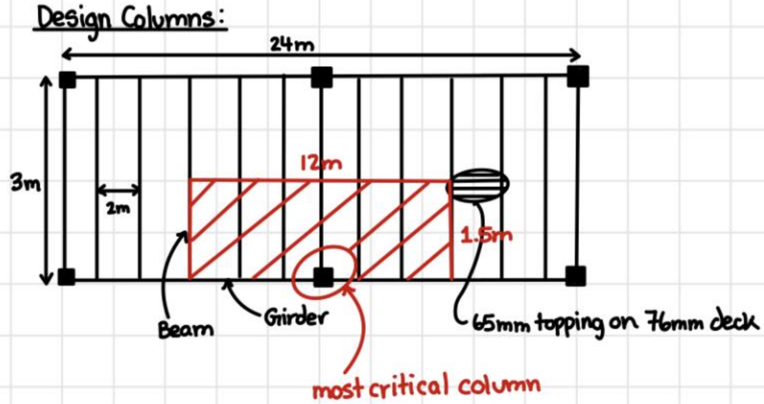
→ W530x66 passes all required checks ∴ Size beam to W530x66

→ Add self weight of beam to dead load & check if section still works

Self weight $= 66\ kg/m \cdot 9.81\frac{m}{s^2} = 650\ N/m = 0.65kN/m \approx 0.35kPa$

→ Since we estimated the beams would be 0.35kPa in our origonal calculation we know the section will still pass

Design Columns:



* Note: From TAC the pedestrian overpass must have a minimum clearance of 5.3m. Our deepest girder is 0.5m ∴ Column height will be 6m.

→ We will design for the most critical column as indicated above

Load Source:

65 topping on 75 deck = 2.14kPa
Beams = 0.3kPa
Girders = 0.35kPa
Column (Estimate) = 0.3kPa
Finishes/Mechanical/etc. = 1kPa

} Total Dead = 4.09kPa

Live Load = 4.8kPa

Snow Load = 1.9kPa

Factored Loads = 1.25(4.09kPa) + 1.5(4.8kPa) + 1.9kPa = 14.21kPa

C_f = (Factored Load)(Tributary Area)

C_f = (14.21kPa)(12m x 1.5m) = 256kN

→ Try W250x49 section with grade 300W

→ Check local buckling

Flange:

$b_{el}/t \le \frac{200}{\sqrt{F_y}}$

$\frac{202/2}{11} \le \frac{200}{\sqrt{300}}$

$9.18 \le 11.5$ ✓

Web:

$\frac{h}{w} \le \frac{670}{\sqrt{F_y}}$

$\frac{247 - 2(11)}{7.4} \le \frac{670}{\sqrt{300}}$

$30.4 \le 38.7$ ✓

∴ Section passes checks

Slenderness Check:

$r_x = 106\text{mm}$

$r_y = 49.2\text{mm}$

$\frac{KL}{r_x} \le 200$ $\qquad$ $\frac{KL}{r_y} \le 200$

$\frac{(1.0)(6000)}{(106)} \le 200$ $\qquad$ $\frac{(1.0)(6000)}{(49.2)} \le 200$

$56.6 \le 200$ ✓ $\qquad$ $122 \le 200$ ✓

∴ passes slenderness checks

Global Capacity Check:

$C_r = \phi A F_y (1+\lambda^{2n})^{-1/n}$

$\lambda = \frac{KL}{r_y}\sqrt{\frac{F_y}{\pi^2 E}} = \frac{(1.0)(6000)}{(49.2)}\sqrt{\frac{300}{\pi^2(200\times10^3)}} = 1.50$

$C_r = (0.9)(6250\text{mm}^2)(300\frac{N}{mm^2})(1+(1.50)^{2(1.34)})^{-1/1.34}$

$C_r = 601.7\text{ kN}$

$C_r = 607.1\text{ kN} > C_f = 256\text{ kN}$ ∴ passes check

W250x49 passes all required checks ∴ Use W250x49 for Columns

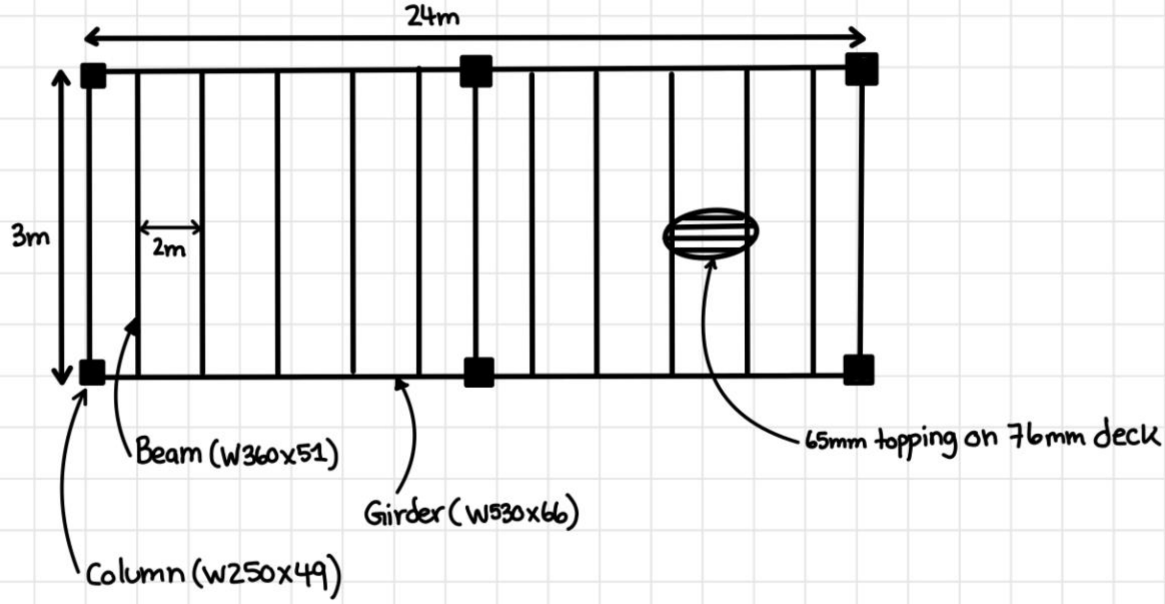
→ Add self weight of beam to dead load & check if section still works

Self weight $= 49\text{ kg/m} \cdot 6\text{m} = 294\text{ kg} \cdot 9.81\frac{m}{s^2} = 2.88\text{ kN}/(12\times1.5) = 0.16\text{ kPa}$

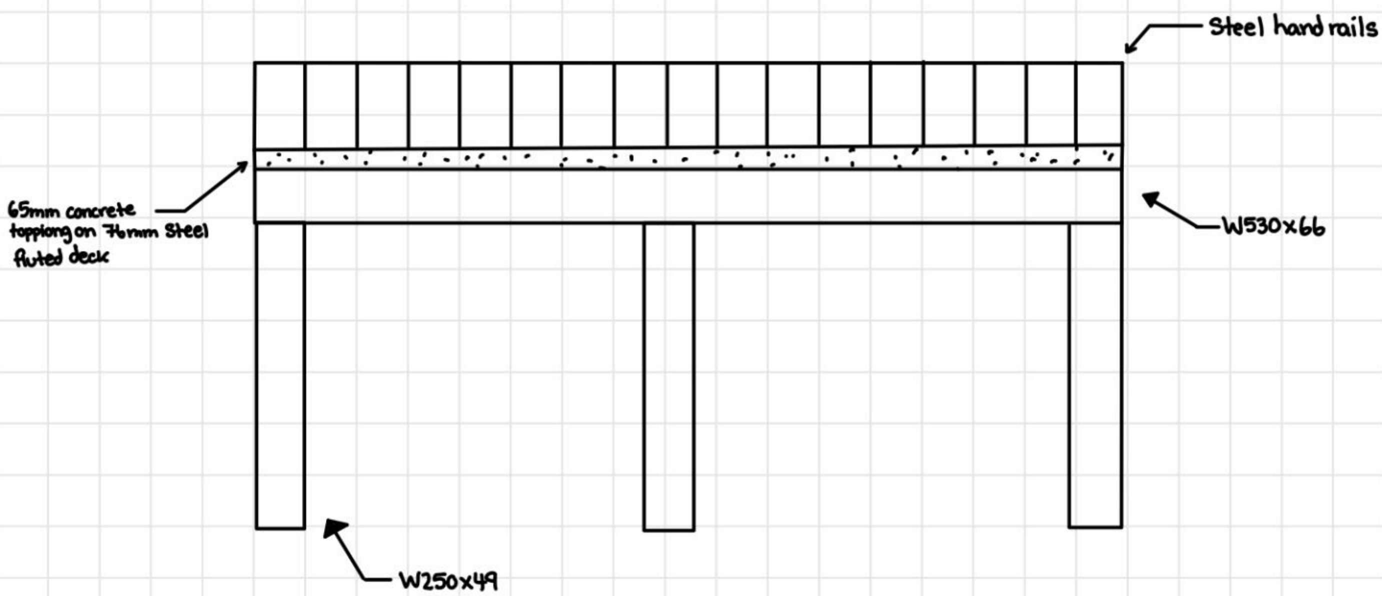
→ Since we estimated the beams would be 0.3kPa in our origonal calculation we know the section will still pass

Layout & Geometry:

Plan View

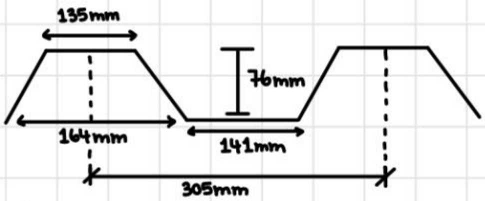


Cross Section:



Shear Stud Design:

Flute Profile:



Slab thickness = 141 mm

$E_c = 4500\sqrt{f'c} = 4500\sqrt{45} = 30186.9 \text{ MPa}$

Beam W360x51 → $A = 6450 mm^2$, $d = 355mm$, $b_f = 171mm$, $t_f = 11.6mm$, $w = 7.2mm$, $F_y = 350MPa$

Design for Partial Shear connection of 55% to reduce studs required

$\alpha = 0.85 - 0.0015(45) = 0.8125$

→ Determine Stud Diameter

$d_{stud} \leq 2.5t_f$

$d_{stud} \leq 2.5(11.6mm)$

$d_{stud} \leq 29mm$ ← more critical case

$b_f = 1.4_{stud} + 20mm$

$d_{stud} \leq \frac{b_f - 20}{1.4}$

$d_{stud} \leq 108mm$

→ Choose $d_{stud} = 22mm$

→ Determine Effective Width

Case 1 = 0.25(3000) = 750mm
Case 2 = 1000mm
} case 1 governs

→ Since we know this is a 55% shear connection the N.A. will be in the steel

$V_h(55\%) = (0.55)\phi A_s F_y \leq \alpha\phi f'_c bt$

$V_h(55\%) = (0.55)(0.9)(6450)(350) \leq (0.8125)(0.65)(45)(750)(65)$

$V_h(55\%) = 1117.5KN \leq 1158.6KN$

$\therefore C_r' = V_h(55\%) = 1117.5KN$

$a = \frac{C_r'}{\alpha_1 \phi_c f'b} < t$

$a = \frac{1117.5KN}{(0.8125)(0.65)(45)(750)} = 62.7mm < 65mm$ ✓

$C_r = \frac{\phi A_s F_y - C_r'}{2} = \frac{(0.9)(6450mm^2)(350N/mm^2) - 1117.5KN}{2}$

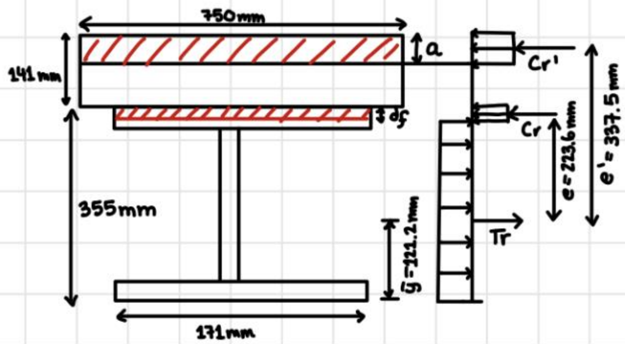
$C_r = 457.1KN$

→ Assume N.A. is within flange of steel

$Cr = \phi b_f d_f F_y$

$d_f = \frac{Cr}{\phi b_f F_y} = \frac{457.1\,kN}{(0.9)(171mm)(350N/mm^2)} = 8.49mm < 11.6mm$ ∴ Assumption correct

$\bar{y} = \frac{\Sigma area \cdot y}{area} = \frac{(6450mm)(355/2) - (8.49)(171)(355 - 8.49/2)}{6450 - (8.49 \cdot 171)} = 127.2mm$



$e = d - \bar{y} - d_f/2 = 355mm - 127.2mm - \frac{8.49mm}{2} = 223.6mm$

$e' = d - \bar{y} + t - a/2 = 355mm - 127.2mm + 141mm - \frac{62.7mm}{2} = 337.5\,mm$

$Mr(55\%) = Cre + Cr'e' = (457.1kN)(\frac{223.6mm}{1000}) + (1117.5kN)(\frac{337.5mm}{1000})$

$Mr(55\%) = 479.4\,kN$

→ Shear Stud Design for ribbed slab

$\frac{wd}{hd} = \frac{141}{76} = 1.86$ ∴ wide profile

$q_{rr} = q_{rs}\left[0.75 + 0.167\left(\frac{wd}{hd} - 1.5\right)\right] \leq q_{rs}$

$q_{rs} = 0.50\,\phi_{sc} A_{sc}\sqrt{f'_c E_c} \leq \phi_{sc} A_{sc} F_u$

$q_{rs} = 0.50(0.80)(\frac{\pi}{4}(22mm)^2)\sqrt{(45)(30186.9)} \leq (0.80)(\frac{\pi}{4}(22)^2)(450)$

$q_{rs} = 177.2kN \leq 136.8kN$ ∴ $q_{rs} = 136.8kN$

$q_{rr} = 136.8kN\left[0.75 + 0.167\left(1.86 - 1.5\right)\right] \leq 136.8kN$

$q_{rr} = 110.8kN$

$n = \frac{Vh}{q_{rr}} = \frac{1117.5kN}{110.8kN} \approx 11$ studs x 2 = 22 total studs required

Number of flutes in beam $= \frac{3000mm}{305mm} = 10$ flutes

Transverse Spacing Requirements $= 4d = 4(22) = 88mm$

$6d_{stud} \leq$ Stud Spacing $\leq 600mm$

Stud Spacing $= \frac{3000mm}{22} = 136.4\ mm$

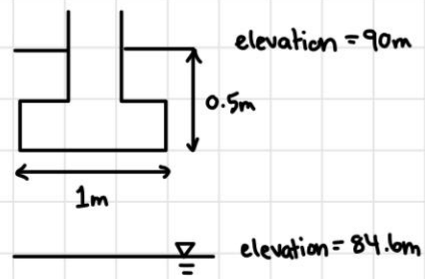
$132\ mm \leq 136\ mm \leq 600\ mm$ $\therefore$ acceptable

Contractor should put 2 studs in each flute in first 4 flutes on either end of beam an and 3 studs in the middle two flutes for total of 22 studs

Footing Soil Capacity:

→ Calculate the q_{ult} of the soil near Wesbrook Mall

→ Based on geotechnical report there is a till layer underneath the site ∴ $\gamma_{till} = 21.5 \text{ KN/m}^3$



$q_{ult} = \sigma'_d N_q + 0.4 \gamma B N_\gamma$

Depth into soil = 0.5m

Assume width of footing, B = 1m

Case 3 since groundwater table is lower than D+B

$\sigma'_d = (\gamma_{till} - u)\text{Depth} = (21.5 \text{KN/m}^3 - 9.81 \text{KN/m}^3)(0.5\text{m}) = 5.85 \text{ KPa}$

$\phi = 35°$ ∴ $N_q = 41.4$, $N_\gamma = 47.3$

$q_{ult} = (5.85 \text{ KN/m}^2)(41.4) + 0.4(21.5 \text{KN/m}^3)(0.5\text{m})(47.4)$

$q_{ult} = 446 \text{ KPa}$

Footing Design:

Unfactored Dead Load = 4.09 KPa x (12 x 1.5) = 74 KN

Live Load = 6.7 KPa x (12 x 1.5) = 120.6 KN

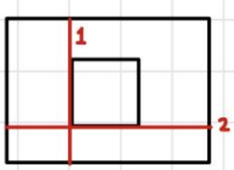
Allowable Bearing Stress = 446 KPa

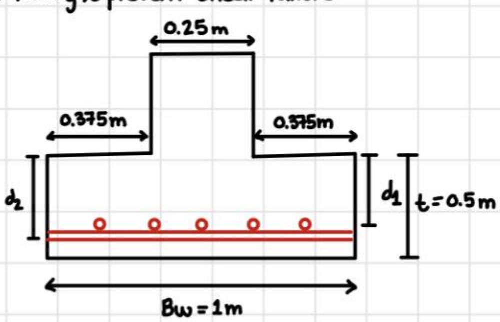
$$\frac{74 \text{KN}}{A} + \frac{120.6 \text{KN}}{A} + 23.5 \frac{\text{KN}}{\text{m}^3}(0.5\text{m}) \leq 446 \text{KPa}$$

$$A = \sqrt{\frac{194.6 \text{KN}}{434.3 \frac{\text{KN}}{\text{m}^2}}} = 0.67\text{m} \quad A \geq 0.67\text{m} \times 0.67\text{m}$$

→ Footing Dimensions = 1.0 m x 1.0 m x 0.5m

→ Determine required depth of footing to prevent shear failure





$d_1 = 500\text{mm} - 75\text{mm} - 10\text{mm} - \frac{10\text{mm}}{2} = 410\text{mm}$

$d_2 = 500\text{mm} - 75\text{mm} - \frac{10\text{mm}}{2} = 420\text{mm}$

$d = \frac{d_1 + d_2}{2} = 415\text{mm}$

One-way Shear Check:

Footing projection = 0.375m ≤ 2(0.415m · 0.9) = 0.747m

0.375m ≤ 0.747m ∴ β = 0.21

$V_r = V_c = \phi_c \beta \sqrt{f'c}\, b_w d_v$

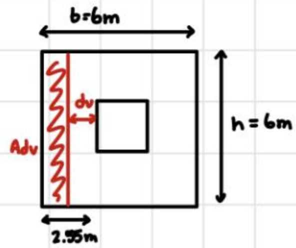
$V_r = (0.65)(0.21)\sqrt{30}\,(1000mm)(0.9 \cdot 415\,mm)$

V_r = 279.2KN

→ Calculate $V_{f\,one\text{-}way}$

$V_f@dv = \frac{P_f}{bh} \cdot A_{dv}$

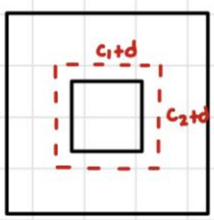
$V_f@dv = \frac{256\,KN}{(1m)^2} \cdot (0.375m - 0.36m)(1m)$



$V_f@dv$ = 3.84KN

V_r = 269.2KN ≥ 3.84 KN ∴ passes

2 way-shear check (Punching Shear):



$c_1+d = c_2+d$ = 250mm + 415mm = 665mm

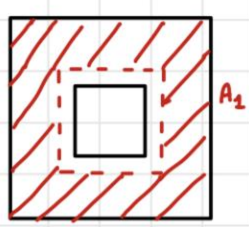
Shear Resistance:

$V_r = V_c = 0.38\phi_c\sqrt{f'c} = 0.38(0.65)\sqrt{30}$ = 1.35MPa

$V_r = v_r \cdot b_o \cdot d = (1.35\frac{N}{mm^2})(665mm \cdot 4)(415\,mm)$ = 1490KN

Calculate Demand V_f

$V_f = \frac{P_f}{bh} \cdot A_1$



$V_f = \frac{256\,KN}{(1m)^2}\,(1m^2 - 0.44m^2)$

V_f = 143.4KN

V_r = 1404KN ≥ V_f = 143.4 KN ∴ passes

Flexural Design – longitudinal steel:

→ Calculate steel for d_1 as it is more critical than d_2

Top steel located at d_1:

$\rho = \frac{A_s}{A_g}$; use 0.2% steel

$0.002 \cdot (1000mm \times 400mm) \le A_s$

$A_s \ge 800mm^2$

use 10M bars ∴ $\# bars = \frac{800\ mm^2}{100mm^2} \approx 8 bars$

$Spacing = \frac{1000mm}{8} \approx 125mm$

→ Use 10M bars @ 125 mm Spacing

→ Calculate Mr (flexural resistance)

Assume reinforcement has yielded ∴ T-C=0

$\phi_s A_s F_y - \alpha_1 \phi_c f'_c \beta_1 C b = 0$

$\beta_1 C = \frac{\phi_s A_s F_y}{\alpha_1 \phi_c f'_c b} = \frac{(0.85)(8 \cdot 100\ mm^2)(400N/mm^2)}{(0.81)(0.65)(30N/mm^2)(1000mm)} = 17.22mm$

$C = 17.22\ mm / 0.90 = 19.13mm$

$C \le 0.64(410mm) = 262.4mm$

c<<<d ∴ assumption was correct and reinforcement has yielded

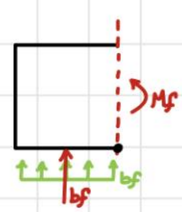
$M_r = \phi_s A_s F_y \cdot (d - \beta_1 C/2)$

$M_r = (0.85)(8 \cdot 100mm^2)(400N/mm^2)(410mm - \frac{17.22mm}{2})$

$M_r = 109.2\ KN \cdot m$

→ Calculate demand Mf

$M_f = \frac{P_f}{bh} \cdot A_1 \cdot \frac{0.375}{2}$



$M_f = \frac{256\ KN}{(1m)^2} \cdot (0.375m \cdot 1m) \cdot \frac{0.375m}{2}$

$M_f = 18KN \cdot m$

$M_r = 109KN \cdot m \ge M_f = 18KN \cdot m$ ∴ passes

→ Check bearing stress at column-footing interface & design dowels

$$F_b = 0.85\phi_c f'_c A_1 \sqrt{\frac{A_2}{A_1}}$$

$$\sqrt{\frac{A_2}{A_1}} \leq 2$$

$$\sqrt{\frac{1\times1}{0.25^2}} \leq 2$$

$$5 \leq 2 \therefore \text{ use } 2$$

$$F_b = 0.85(0.65)(30\,N/mm^2)(250mm)^2(2)$$

$$F_b = 2071.9\,kN$$

$F_b > P_f = 256\,kN$ ∴ provide minimum 4-25M bars

<u>Final Design Summary:</u>

→ 1m x 1m x 0.5m footing

→ 10M @ 125mm Spacing

→ Provide minimum 4-25M bars

→ Use 30 MPa Concrete

Girder - Column Connection Detail:

Diameter of Bolts = 22.2mm

A325 → F_{ub} = 825 MPa

p = 75mm, e = 35mm, Standard guage = 65mm

Girder = W530x66 } Grade 350W } F_u = 450 MPa

Column = W250x49 }

Angle = L102 x 102 x 9.4 (Grade 300w) }

Bolt Shear:

→ Since the bolt diameter & grade are the same, we only have to check **either** the supporting or supported angle legs. This is because the supported angle and column have twice the bolts but only 1 shear plane, whereas the suppourting angle and girder have half the bolts but 2 shear planes. Since both cases are equally critical we only check one.

Shear capacity of one bolt in web:

$V_r = 0.6\,\phi_b\, n\, m\, A_b\, F_{ub}$

$V_r = 0.6(0.8)(1\text{ bolt})(2)(388\text{mm}^2)(825\frac{N}{mm^2})(0.7)$ ← assume threads are in shear plane since not stated

V_r = 215.1 KN/bolt

Bolt Bearing:

Girder web thickness = 8.9mm

Angle thickness = 9.4mm

Column flange thickness = 11mm

→ Since the number of bolts in a vertical line at the girder web and column flange will be the same as well as the bolt diameter, the critical section will be determined by the total thickness of the material in bearing and the forces transferred at each location. Since F_u = 450 MPa for the beam, column, and angle and observing that (1) the column flange thickness is greater than the angle thickness, (2) 2 x angle thickness > web thickness, and (3) force transfer on web is double that of the column flange <u>we only need to check the girder web for bearing</u>.

Bolt Bearing Capacity of one bolt in web:

$B_r = 3\phi_{br} \cdot n \cdot t \cdot d \cdot F_u$

$B_r = 3(0.8)(1\text{ bolt})(8.9\text{mm})(22.2\text{mm})(450\frac{N}{mm^2})$

B_r = 213.4 KN/Bolt

⟶ Bolt Shear Governs

→ Calculate # bolts required

→ $V_f = 105 kN$

$$\#bolts = \frac{105 kN}{215.1 kN/bolt} = 1 \text{ bolt}$$ → use 2 bolts to account for block shear & shear rupture

Block Shear Check:

Since number of bolts and layout is going to be the same for the supporting & supported legs we only need to check one. We also know the column flange & girder web will not fail in this configuration.

Angle - beam block shear check:

$$T_r = \phi_u [U_t A_n F_u + 0.6 A_{gv} (F_y + F_u)/2]$$

$$A_n = \left[65mm - \frac{(22.2+4)}{2}\right](9.4mm) = 487.9mm^2$$

$$A_{gv} = ((75mm) + (35mm))(9.4mm) = 1034mm^2$$

$$T_r = \left[(0.75)\left[0.6 \cdot 487.9mm^2 \cdot 450MPa + 0.6(1034mm^2)\left(\frac{300+450}{2}\right)\right]\right](2)$$

$$T_r = 546.6kN$$

$$T_r = 546.6kN > V_f = 105kN \therefore OK$$

Shear Rupture:

Since number of bolts and layout is going to be the same for the supporting & supported legs we only need to check one. We also know the column flange & girder web will not fail in this configuration.

Angle - beam shear rupture check:

$$A_{gv} = ((75mm) + 2(35mm))(9.4mm) = 1363 mm^2$$

$$T_r = \phi_u \left(0.6 A_{gv} \left(\frac{F_y + F_u}{2}\right)\right)$$

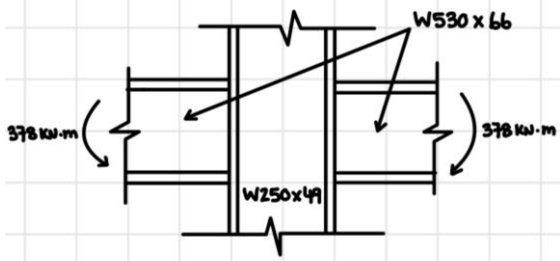
$$T_r = \left[(0.75)(0.6)(1363mm^2)\left(\frac{300+450}{2}\right)\right] \times 2$$ ← double angle

$$T_r = 460kN$$

$$T_r = 460 kN > V_f = 105kN \therefore OK$$

$$\text{Angle length} = (75) + 2(35) = 145mm < d_G - 2t_G = 525 - 2(11.4) = 502.5mm$$

Girder-Column Moment Connection:



Determine Class of Beam:

Flange: $b_{el}/t \le \frac{145}{\sqrt{F_y}}$ $\quad b_{el}/t \le \frac{170}{\sqrt{F_y}}$

$\frac{165/2}{9.8} \le \frac{145}{\sqrt{350}}$ $\quad \frac{165/2}{9.8} \le \frac{170}{\sqrt{350}}$

$8.41 \le 7.75$ ✗ $\quad 8.41 \le 9.09$ ✓ ∴ flange class 2

Web: $\frac{h}{w} \le \frac{1100}{\sqrt{F_y}}$

$\frac{(525 - 2(11.4))}{(8.9)} \le \frac{1100}{\sqrt{350}}$

$56.4 \le 58.8$ ∴ Web class 2

Beam is Class 2

→ $V_b = 0$ ∴ diagonal stiffner & doubler plate

Check Column Bearing Capacity:

Largest Bearing Force $= \frac{378 \text{ kN·m}}{(525/1000)} = 720\text{kN}$

$B_r = \phi_{bi} W_c (t_b + 10t_c) F_{yc}$

$B_r = (0.80)(8.9)(11.4 + 10(11))(350) = 302.5\text{kN}$

Since $B_r < 720\text{kN}$, stiffners are required

$F_{st} = \frac{M_f}{d_b} - B_r = 720\text{kN} - 302.5\text{kN} = 417.5\text{kN}$

$A_{st} \ge \frac{F_{st}}{\phi F_y} = \frac{417.5\text{kN}}{(0.9)(300)} = 1546.3\text{mm}^2$

$(b_{el}/t)_{max} = \frac{170}{\sqrt{300}} = 9.8$ (Class 2)

$\frac{b_b - w_c}{2} = \frac{165 - 8.9}{2} = 78\text{mm}$ → Use $b_{st} = 80$ mm

$t_{st} \ge 80/9.8 = 8.2\text{mm}$ → Use $t_{st} = 15\text{mm}$

Effective $A_{st} = (2b_{st} + W_c - 2K_{1c})t_{st} = [2(80\text{ mm}) + (8.9\text{ mm}) - 2(23\text{mm})](15\text{mm}) = 1843.5\text{ mm}^2$

Effective $A_{st} = 1843.5\text{ mm}^2 > 1546.3\text{mm}$ ∴ OK

→ Check local buckling

$b_{el}/t \leq \frac{170}{\sqrt{F_y}}$

$80/15 \leq \frac{170}{\sqrt{300}}$

$5.3 \leq 9.8 \therefore$ OK

→ Use a 80mm x 15mm stiffner

Check Column flange transverse capacity:

Largest tensile force $= \frac{378 kN \cdot m}{(525/1000)} = 720$ kN

$T_r = 7\phi t_c^2 F_{yc} = 7(0.9)(11.0)^2(350) = 266.8$ kN

$T_r < 625$ kN, stiffner required

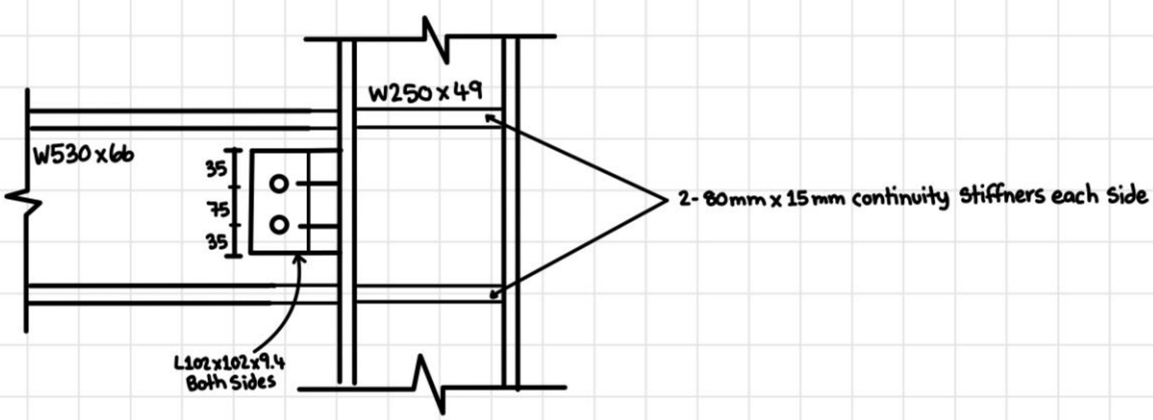
$F_{st} = \frac{M_f}{d_b} - T_r = 720 - 266.8 = 453.2$ kN

$A_{st} \geq \frac{F_{st}}{\phi F_y} = \frac{453.2 kN}{(0.9)(300)} = 1678.5 mm^2$ → Use same $b_{st} = 80$mm as compression flange for consistency & constructability

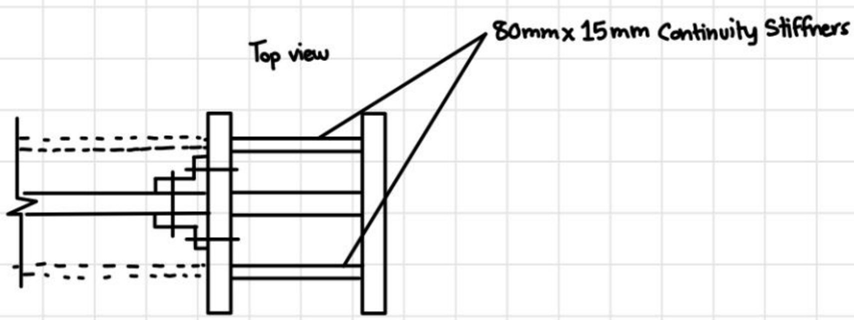
$t_{st} \geq A_{st}/(2b_{st} + W_c - 2K_{1c}) = 1678.5mm^2/(2(80mm) + 8.9mm - 2(23)) = 13.7$ mm → Use $t_{st} = 15$mm for consistency & constructability

Summary of Design:

Side View



Top view



Beam-Girder Connection:

Diameter of Bolts = 22.2mm

A325 → F_{ub} = 825 MPa

p = 75mm, e = 35mm, Standard guage = 65mm

Girder = W530x66 } Grade 350W

Beam = W360x51 }

Angle = L102 x 102 x 9.4 (Grade 300W)

} F_u = 450 MPa

Bolt Shear:

→ Since the bolt diameter & grade are the same, we only have to check either the supporting or supported angle legs. This is because the supported angle and girder have twice the bolts but only 1 shear plane, whereas the suppourting angle and beam have half the bolts but 2 shear planes. Since both cases are equally critical we only check one.

Shear capacity of one bolt in web:

$V_r = 0.6\,\phi_b\, n\, m\, A_b\, F_{ub}$

$V_r = 0.6(0.8)(1\text{ bolt})(2)(388\text{mm}^2)(825\frac{N}{mm^2})(0.7)$ ← assume threads are in shear plane since not stated

$V_r = 215.1\text{ kN/bolt}$

Bolt Bearing:

Beam web thickness = 7.2mm

Angle thickness = 9.4mm

Girder web thickness = 8.9mm

→ Since the number of bolts in a vertical line at the beam web and girder web will be the same as well as the bolt diameter, the critical section will be determined by the total thickness of the material in bearing and the forces transferred at each location. Since F_u = 450 MPa for the beam, girder, and angle and observing that (1) the girder web thickness is greater than the beam web thickness, (2) 2 x angle thickness > beam web thickness, and (3) force transfer on Beam is double that of the girder web we only need to check the beam web for bearing.

Bolt Bearing Capacity of one bolt in web:

$B_r = 3\phi_{br} \cdot n \cdot t \cdot d \cdot F_u$

$B_r = 3(0.8)(1\text{ bolt})(7.2\text{mm})(22.2\text{mm})(450\frac{N}{mm^2})$

$B_r = 172.6\text{ kN/Bolt}$

⟶ Bolt Shear Governs

→ Calculate # bolts required

→ $V_f = 42\,kN$

$$\#\text{bolts} = \frac{42\ kN}{172.6\ kN/bolt} = 1\ bolt$$ ⟶ use 2 bolts to account for block shear & shear rupture

Block Shear Check:

Since number of bolts and layout is going to be the same for the supporting & supported legs we only need to check one. We also know the beam web & girder web will not fail in this configuration.

Angle - beam block shear check:

$$T_r = \phi_u [U_t A_n F_u + 0.6 A_{gv} (F_y + F_u)/2]$$

$$A_n = \left[65mm - \frac{(22.2+4)}{2}\right](9.4mm) = 487.9mm^2$$

$$A_{gv} = ((75mm)+(35mm))(9.4mm) = 1034mm^2$$

$$T_r = \left[(0.75)\left[0.6 \cdot 487.9mm^2 \cdot 450MPa + 0.6(1034mm^2)\left(\frac{300+450}{2}\right)\right]\right](2)$$

$$T_r = 546.6kN$$

$$T_r = 546.6kN > V_f = 42kN \therefore OK$$

Shear Rupture:

Since number of bolts and layout is going to be the same for the supporting & supported legs we only need to check one. We also know the beam web & girder web will not fail in this configuration.

Angle - beam shear rupture check:

$$A_{gv} = ((75mm)+2(35mm))(9.4mm) = 1363\ mm^2$$

$$T_r = \phi_u\left(0.6 A_{gv}\left(\frac{F_y+F_u}{2}\right)\right)$$

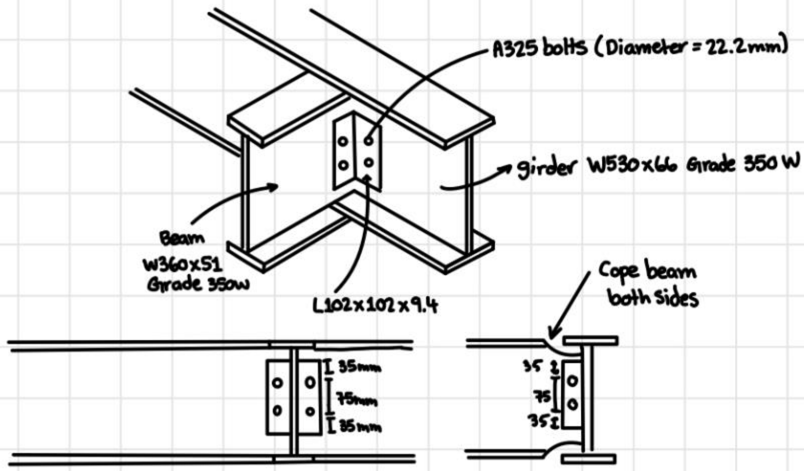
$$T_r = \left[(0.75)(0.6)(1363mm^2)\left(\frac{300+450}{2}\right)\right] \times 2$$ ← double angle

$$T_r = 460kN$$

$$T_r = 460\ kN > V_f = 42kN \therefore OK$$

$$\text{Angle length} = (75)+2(35) = 145mm < d_B - 2t_B = 355 - 2(11.6) = 331.8\,mm$$

Beam-Girder Connection:



Beam - Column Connection:

Diameter of Bolts = 22.2mm

A325 → F_{ub} = 825 MPa

p = 75mm, e = 35mm, Standard guage = 65mm

Column = W250x49 } Grade 350W

Beam = W360x51

Angle = L102x102x9.4 (Grade 300W)

} F_u = 450 MPa

Bolt Shear:

→ Since the bolt diameter & grade are the same, we only have to check either the supporting or supported angle legs. This is because the supported angle and column have twice the bolts but only 1 shear plane, whereas the suppourting angle and beam have half the bolts but 2 shear planes. Since both cases are equally critical we only check one.

Shear capacity of one bolt in web:

$V_r = 0.6\,\phi_b\, n\, m\, A_b\, F_{ub}$

$V_r = 0.6(0.8)(1\text{ bolt})(2)(388\text{mm}^2)(825\frac{N}{mm^2})(0.7)$ ← assume threads are in shear plane since not stated

V_r = 215.1 kN/bolt

Bolt Bearing:

Beam web thickness = 7.2mm

Angle thickness = 9.4mm

Column web thickness = 7.4mm

→ Since the number of bolts in a vertical line at the beam web and column web will be the same as well as the bolt diameter, the critical section will be determined by the total thickness of the material in bearing and the forces transferred at each location. Since F_u = 450 MPa for the beam, column, and angle and observing that (1) the column web thickness is greater than the beam web thickness, (2) 2 x angle thickness > beam web thickness we only need to check the beam web for bearing.

Bolt Bearing Capacity of one bolt in web:

$B_r = 3\phi_{br} \cdot n \cdot t \cdot d \cdot F_u$

$B_r = 3(0.8)(1\text{ bolt})(7.2\text{mm})(22.2\text{mm})(450\frac{N}{mm^2})$

B_r = 172.6 kN/Bolt

⟶ Bolt Shear Governs

→ Calculate # bolts required

→ $V_f = 42 kN$

$$\#bolts = \frac{42 kN}{172.6 kN/bolt} = 1 bolt$$ → use 2 bolts to account for block shear & shear rupture

Block Shear Check:

Since number of bolts and layout is going to be the Same for the supporting & supported legs we only need to check one. We also know the beam web & column web will not fail in this configuration.

Angle - beam block shear check:

$$T_r = \phi_u [U_t A_n F_u + 0.6 A_{gv} (F_y + F_u)/2]$$

$$A_n = [65mm - \frac{(22.2+4)}{2}](9.4mm) = 487.9mm^2$$

$$A_{gv} = ((75mm) + (35mm))(9.4mm) = 1034 mm^2$$

$$T_r = [(0.75)[0.6 \cdot 487.9mm^2 \cdot 450MPa + 0.6(1034mm^2)(\frac{300+450}{2})]](2)$$

$$T_r = 546.6 kN$$

$$T_r = 546.6 kN > V_f = 42 kN \therefore OK$$

Shear Rupture:

Since number of bolts and layout is going to be the Same for the supporting & supported legs we only need to check one. We also know the beam web & column web will not fail in this configuration.

Angle - beam shear rupture check:

$$A_{gv} = ((75mm) + 2(35mm))(9.4mm) = 1363 mm^2$$

$$T_r = \phi_u (0.6 A_{gv} (\frac{F_y + F_u}{2}))$$

$$T_r = [(0.75)(0.6)(1363mm^2)(\frac{300+450}{2})] \times 2$$ ← double angle

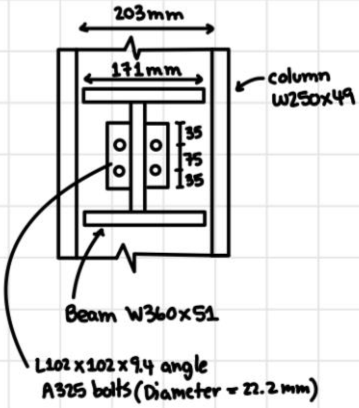
$$T_r = 460 kN$$

$$T_r = 460 kN > V_f = 42 kN \therefore OK$$

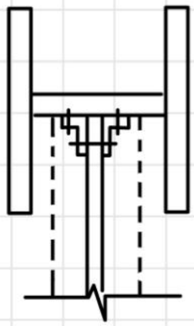
Angle length = $(75) + 2(35) = 145mm < d_B - 2t_B = 355 - 2(11.6) = 331.8 mm$

Beam-Column Connection:

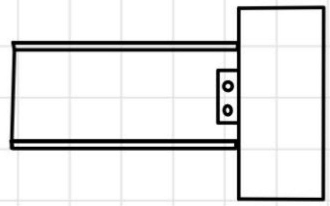
Front View



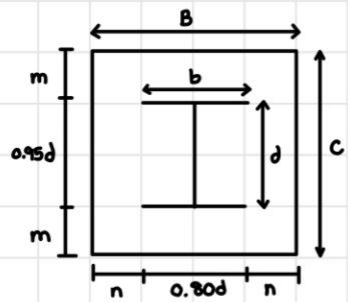
Top View



Side View



Base Plate Design:



Dead Load = 4.09KPa

Live Load = 4.8KPa

Snow Load = 1.9KPa

Factored Loads = 1.25(4.09kPa) + 1.5(4.8KPa) + 1.9KPa = 14.21KPa

Factored Load = (14.21KPa)(12)(1.5) = 256KN

For W250x49, b = 202mm d = 247mm

Area of plate required:

$$Br = 0.85\phi_c f'_c A_1 \cdot \sqrt{\frac{A_2}{A_1}}$$

$$A_1 = \left[\frac{Br}{0.85\phi_c f'_c \sqrt{A_2}}\right]^2$$

$$A_1 = \left[\frac{256\times10^3 N}{(0.85)(0.65)(30\frac{N}{mm^2})\sqrt{650^2}}\right]^2 = 565\ mm^2$$

$$\sqrt{\frac{A_2}{A_1}} \leq 2$$

$$\sqrt{\frac{650^2}{565^2}} \leq 2$$

$1.15 \leq 2$ ✓

$\sqrt{565} = 23.8\ mm$ → choose $A_1 = 250mm \times 250mm$ (smallest plate which will accomdate column)

Determine m and n

$0.95d = 0.95(247mm) = 235mm$

$m = (250 - 247)/2 = 1.5mm$

$0.80b = 0.80(202mm) = 161.6mm$

$n = (250 - 161.6)/2 = 44.2mm$

Calculate thickness of base plate

Since n > m use n = 44.2mm to calculate t_p

$$t_p = n \times \sqrt{\frac{2P_f}{BC\phi F_y}}$$

$$t_p = (44.2mm)\sqrt{\frac{2(256\times10^3 N)}{(250mm\times250mm)(0.9)(300\frac{N}{mm^2})}}$$

$t_p = 7.7mm$

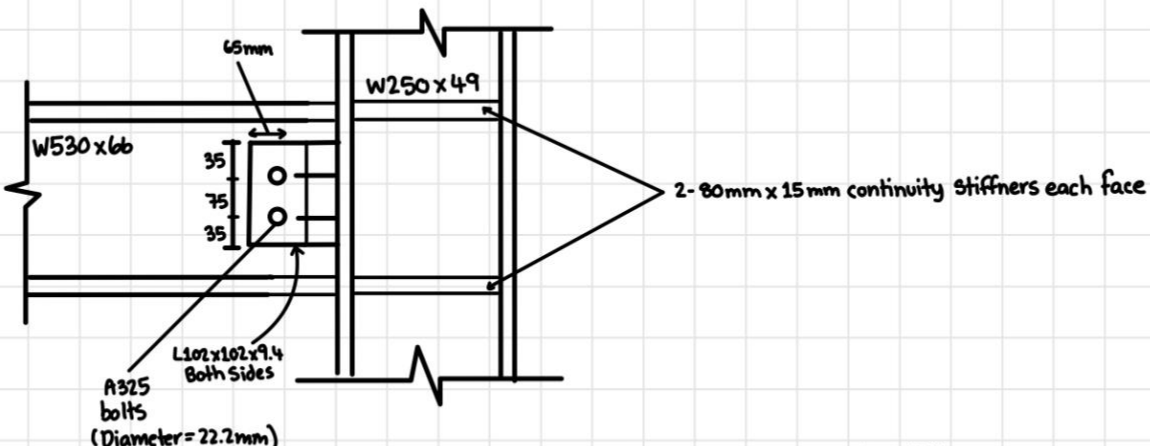
$\frac{n}{5} = \frac{44.2\ mm}{5} = 8.8mm > 7.7mm$ ∴ Use $t_p = 10\ mm$

Use a 250mm X 250mm X 10mm Base Plate

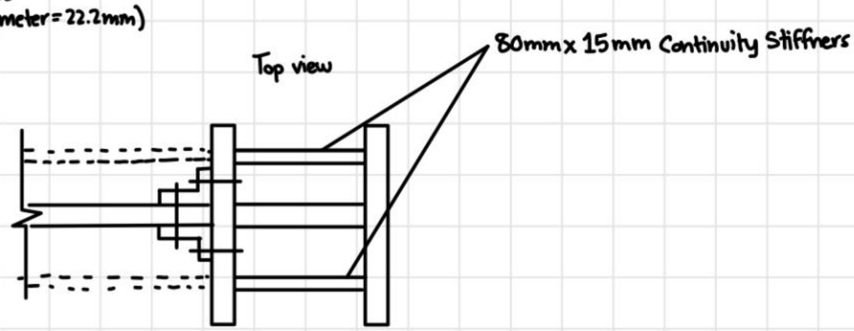
Summary of All Details:

Girder to Column Connection:

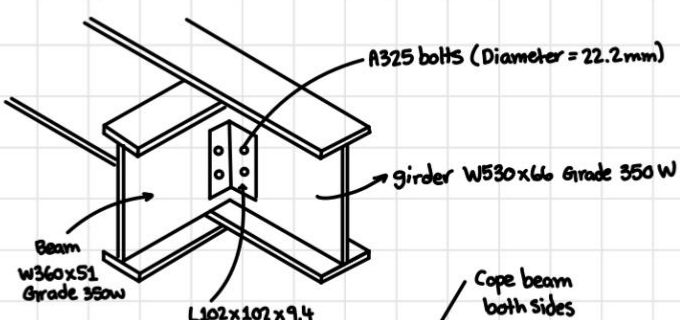
Side View

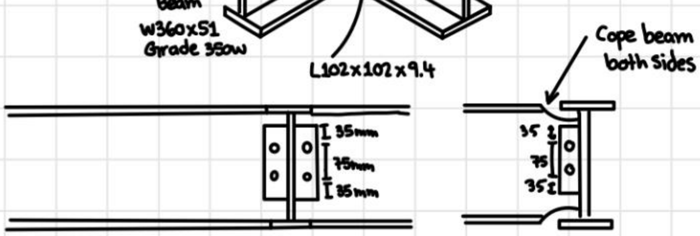


Top view

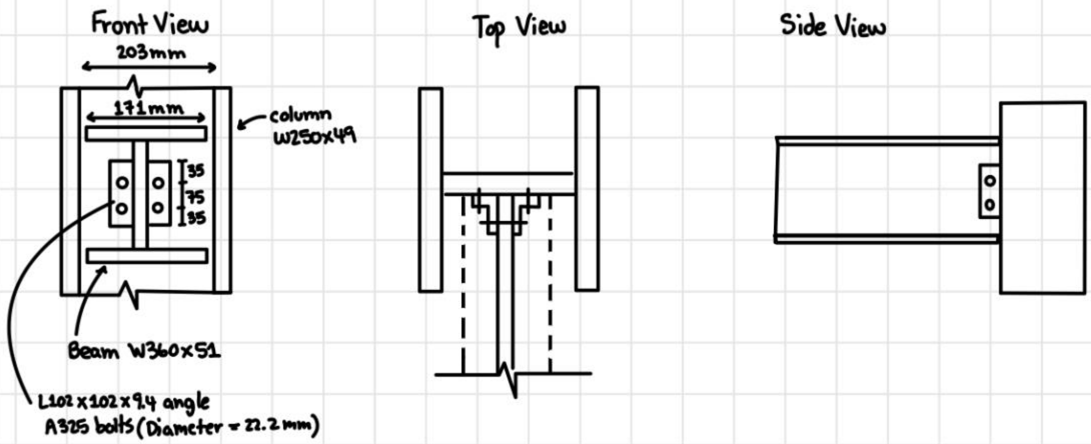


Beam-Girder Connection:

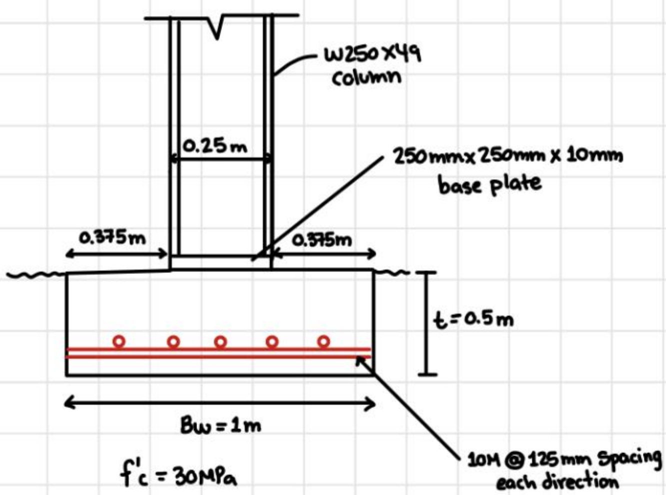




Beam-Column Connection:



Footing Design:



Appendix B – Traffic Model Information

Model 1:

LANE WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)	↰	↑	↱	↰	↑	↱	↰	↑	↱	↰	↱	
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1000	1900	1900	1900	1900	1900	1900
Lane Width (m)	4.2	4.2	4.2	3.2	3.2	3.2	4.2	4.2	4.2	4.2	4.2	3.6
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type	—	Other	—	—	Other	—	—	Other	—	—	Other	—
Storage Length (m)	67.0	—	67.0	120.0	—	0.0	90.0	—	75.0	27.0	—	0.0
Storage Lanes (#)	1	—	1	1	—	—	1	—	1	1	—	—
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	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	0.0	0.0	0.0	—
Turning Speed (km/h)	25	—	15	25	—	15	25	—	15	25	—	15
Right Turn Channelized	—	—	None	—	—	None	—	—	None	—	—	None
Curb Radius (m)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00	1.00	—
Right Turn Factor	1.000	1.000	0.850	1.000	1.000	0.850	1.000	1.000	0.850	1.000	0.946	—
Left Turn Factor (prot)	0.950	1.000	1.000	0.950	1.000	1.000	0.950	1.000	1.000	0.950	1.000	—
Saturated Flow Rate (prot)	1799	1894	1610	1612	1697	152	1799	1894	1610	1799	1792	—
Left Turn Factor (perm)	0.540	1.000	1.000	0.187	1.000	1.000	0.614	1.000	1.000	0.719	1.000	—
Right Ped Bike Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	—
Left Ped Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	—
Saturated Flow Rate (perm)	1023	1894	1610	317	1697	152	1163	1894	1610	1362	1792	—
Right Turn on Red	—	—	Yes	—	—	Yes	—	—	Yes	—	—	Yes
Saturated Flow Rate (RTOR)	0	0	76	0	0	98	0	0	124	0	32	—
Headway Factor	0.92	0.92	0.92	1.06	1.06	1.06	0.92	0.92	0.92	0.92	0.92	1.00

VOLUME WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	39	373	70	171	343	90	162	53	114	86	56	31
Conflicting Peds. (#/hr)	0	—	0	0	—	0	0	—	0	0	—	0
Conflicting Bikes (#/hr)	—	—	0	—	—	0	—	—	0	—	—	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth 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
Heavy Vehicles (%)	7	7	7	7	7	7	7	7	7	7	7	7
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	No	No	No	No	No	No	No	No	No	No	No	No
Parking Maneuvers (#/hr)	—	—	—	—	—	—	—	—	—	—	—	—
Traffic from mid-block (%)	—	0	—	—	0	—	—	0	—	—	0	—
Link OD Volumes	—	—	—	—	WB	—	—	—	—	—	—	—
Adjusted Flow (vph)	42	405	76	186	373	98	176	58	124	93	61	34
Lane Group Flow (vph)	42	405	76	186	373	98	176	58	124	93	95	0

Options >

Controller Type: Pretimed

Cycle Length: 92.5

Actuated C.L.: 92.5

Natural C.L.: 90.0

Max v/c Ratio: 0.80

Int. Delay: 25.1

Int. LOS: C

ICU: 54.7%

ICU LOS: A

Lock Timings

Offset Settings

Offset: 0.0

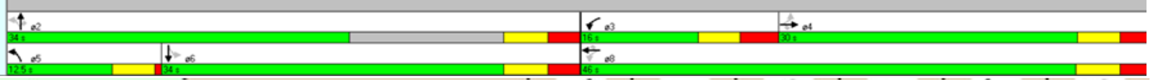
Begin of Green

2 - NBTL

Master

By Phase

TIMING WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	39	373	70	171	343	90	162	53	114	86	56	31	—	—
Turn Type	Perm	—	Perm	pm+pt	—	Perm	pm+pt	—	Perm	Perm	—	—	—	—
Protected Phases		4		3	8		5	2			6	—		
Permitted Phases	4		4	8		8	2		2	6		—	—	—
Detector Phases	4	4	4	3	8	8	5	2	2	6	6	—	—	—
Minimum Initial (s)	10.0	10.0	10.0	6.0	10.0	10.0	6.0	7.0	7.0	7.0	7.0	—	—	—
Minimum Split (s)	28.9	28.9	28.9	12.5	21.9	21.9	12.5	31.3	31.3	33.3	33.3	—	—	—
Total Split (s)	30.0	30.0	30.0	16.0	46.0	46.0	12.5	34.0	34.0	34.0	34.0	—	—	—
Yellow Time (s)	3.5	3.5	3.5	3.4	3.6	3.6	3.5	3.6	3.6	3.6	3.6	—	—	—
All-Red Time (s)	2.3	2.3	2.3	3.1	2.3	2.3	0.5	2.7	2.7	2.7	2.7	—	—	—
Lead/Lag	Lag	Lag	Lag	Lead	—	—	Lead	—	—	Lag	Lag	—	—	—
Allow Lead/Lag Optimize?	Yes	Yes	Yes	Yes	—	—	Yes	—	—	Yes	Yes	—	—	—
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	—	—	—
Actuated Effct. Green (s)	26.0	26.0	26.0	42.0	42.0	42.0	42.5	42.5	42.5	30.0	30.0	—	—	—
Actuated g/C Ratio	0.28	0.28	0.28	0.45	0.45	0.45	0.46	0.46	0.46	0.32	0.32	—	—	—
Volume to Capacity Ratio	0.15	0.76	0.15	0.60	0.48	0.80	0.30	0.07	0.15	0.21	0.16	—	—	—
Control Delay (s)	26.7	41.3	7.1	24.1	20.3	50.0	16.6	14.3	3.3	24.3	16.1	—	—	—
Queue Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—	—	—
Total Delay (s)	26.7	41.3	7.1	24.1	20.3	50.0	16.6	14.3	3.3	24.3	16.1	—	—	—
Level of Service	C	D	A	C	C	D	B	B	A	C	B	—	—	—
Approach Delay (s)	—	35.1	—	—	25.8	—	—	11.6	—	—	20.2	—	—	—
Approach LOS	—	D	—	—	C	—	—	B	—	—	C	—	—	—
Queue Length 50th (m)	5.9	69.3	0.0	20.8	47.3	0.0	19.1	5.9	0.0	12.5	8.2	—	—	—
Queue Length 95th (m)	14.6	#112.1	10.3	35.5	72.9	#117.0	32.6	12.8	9.3	24.9	19.7	—	—	—
Stops (vph)	30	329	13	103	233	20	93	28	13	61	41	—	—	—
Fuel Used (l/hr)	2	23	1	18	35	10	6	2	2	4	3	—	—	—



Options >

Controller Type: Pretimed

Cycle Length: 92.5

Actuated Cycles

90th %:	92.5
70th %:	92.5
50th %:	92.5
30th %:	92.5
10th %:	92.5

Quick Reports:

Green Times

Starts

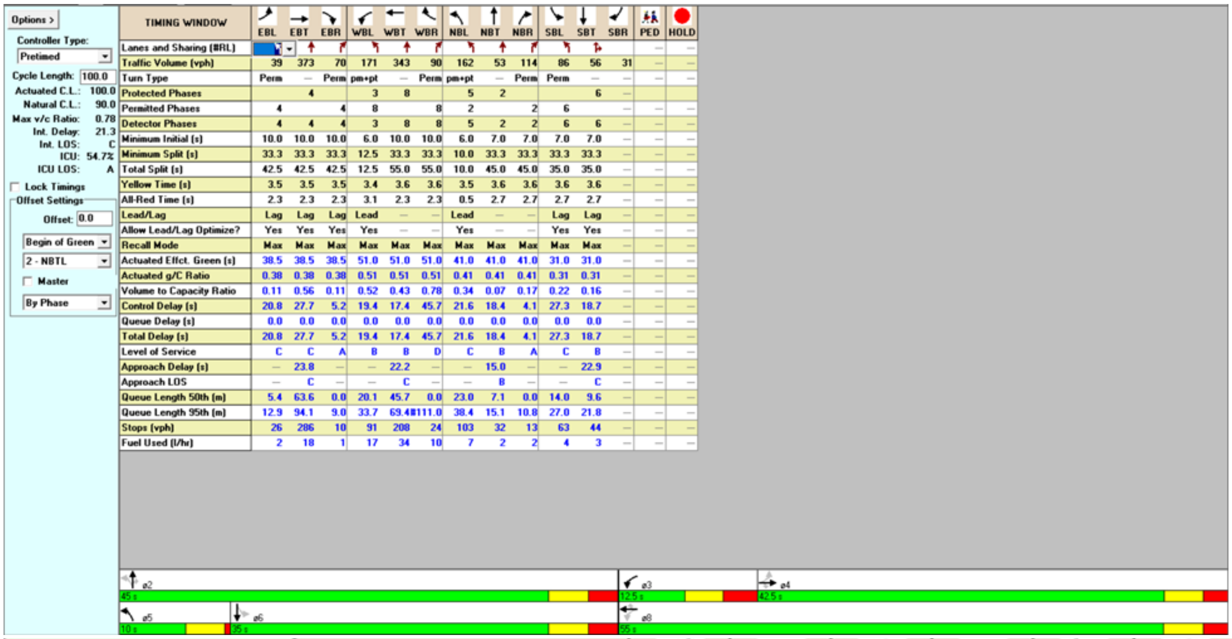
Details

PHASING WINDOW	2-NBTL	3-WBL	4-EBTL	5-NBL	6-SBTL	8-WBTL
Minimum Initial (s)	7.0	6.0	10.0	6.0	7.0	10.0
Minimum Split (s)	31.3	12.5	28.9	12.5	33.3	21.9
Maximum Split (s)	34.0	16.0	30.0	12.5	34.0	46.0
Yellow Time (s)	3.6	3.4	3.5	3.5	3.6	3.6
All-Red Time (s)	2.7	3.1	2.3	0.5	2.7	2.3
Lead/Lag	—	Lead	Lag	Lead	Lag	—
Allow Lead/Lag Optimize?	—	Yes	Yes	Yes	Yes	—
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Minimum Gap (s)	3.0	3.0	3.0	3.0	3.0	3.0
Time Before Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0
Time To Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0
Recall Mode	Max	Max	Max	Max	Max	Max
Pedestrian Phase	Yes	No	Yes	No	Yes	Yes
Walk Time (s)	7.0	—	7.0	—	7.0	7.0
Flash Dont Walk (s)	18.0	—	16.0	—	20.0	9.0
Pedestrian Calls (#/hr)	30	—	30	—	30	30
Dual Entry?	Yes	Yes	Yes	No	Yes	Yes
Inhibit Max?	Yes	Yes	Yes	Yes	Yes	Yes
90th %ile Green Time (s)	40 cd	10 mr	24 mr	9 mr	28 cd	40 mr
70th %ile Green Time (s)	40 cd	10 mr	24 mr	9 mr	28 cd	40 mr
50th %ile Green Time (s)	40 cd	10 mr	24 mr	9 mr	28 cd	40 mr
30th %ile Green Time (s)	40 cd	10 mr	24 mr	9 mr	28 cd	40 mr
10th %ile Green Time (s)	40 cd	10 mr	24 mr	9 mr	28 cd	40 mr

Model 2:

LANE WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1000	1900	1900	1900	1900	1900	1900
Lane Width (m)	4.2	4.2	4.2	3.2	3.2	3.2	4.2	4.2	4.2	4.2	4.2	3.6
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type	—	Other	—	—	Other	—	—	Other	—	—	Other	—
Storage Length (m)	67.0	—	67.0	120.0	—	0.0	90.0	—	75.0	27.0	—	0.0
Storage Lanes (#)	1	—	1	1	—	—	1	—	1	1	—	—
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	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	0.0	0.0	0.0	—
Turning Speed (km/h)	25	—	15	25	—	15	25	—	15	25	—	15
Right Turn Channelized	—	—	None	—	—	None	—	—	None	—	—	None
Curb Radius (m)	—	—	—	—	—	—	—	—	—	—	—	—
Add Lanes (#)	—	—	—	—	—	—	—	—	—	—	—	—
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	0.20	1.00	1.00	1.00	1.00	1.00	—
Right Turn Factor	1.000	1.000	0.850	1.000	1.000	0.850	1.000	1.000	0.850	1.000	0.946	—
Left Turn Factor (prot)	0.950	1.000	1.000	0.950	1.000	1.000	0.950	1.000	1.000	0.950	1.000	—
Saturated Flow Rate (prot)	1799	1894	1610	1612	1697	152	1799	1894	1610	1799	1792	—
Left Turn Factor (perm)	0.540	1.000	1.000	0.304	1.000	1.000	0.616	1.000	1.000	0.719	1.000	—
Right Ped Bike Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	—
Left Ped Factor	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	—
Saturated Flow Rate (perm)	1023	1894	1610	516	1697	152	1167	1894	1610	1362	1792	—
Right Turn on Red	—	—	Yes	—	—	Yes	—	—	Yes	—	—	Yes
Saturated Flow Rate (RTOR)	0	0	76	0	0	98	0	0	124	0	29	—
Headway Factor	0.92	0.92	0.92	1.06	1.06	1.06	0.92	0.92	0.92	0.92	0.92	1.00

VOLUME WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	39	373	70	171	343	90	162	53	114	86	56	31
Conflicting Peds. (#/hr)	0	—	0	0	—	0	0	—	0	0	—	0
Conflicting Bikes (#/hr)	—	—	0	—	—	0	—	—	0	—	—	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth 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
Heavy Vehicles (%)	7	7	7	7	7	7	7	7	7	7	7	7
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	No	No	No	No	No	No	No	No	No	No	No	No
Parking Maneuvers (#/hr)	—	—	—	—	—	—	—	—	—	—	—	—
Traffic from mid-block (%)	—	0	—	—	0	—	—	0	—	—	0	—
Link OD Volumes	—	—	—	—	WB	—	—	—	—	—	—	—
Adjusted Flow (vph)	42	405	76	186	373	98	176	58	124	93	61	34
Lane Group Flow (vph)	42	405	76	186	373	98	176	58	124	93	95	0



Options >

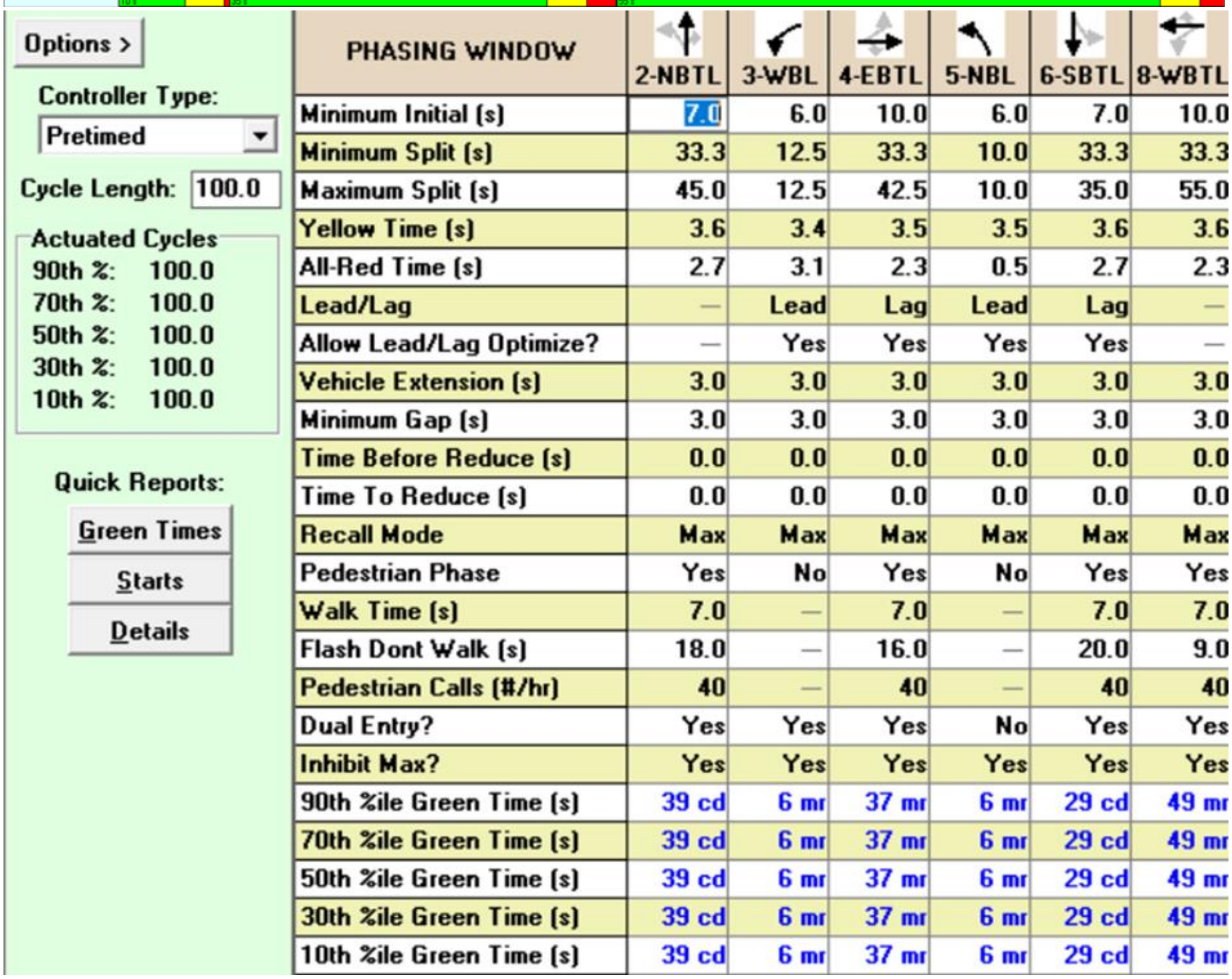
Controller Type: Pretimed

Cycle Length: 100.0
Actuated C.L.: 100.0
Natural C.L.: 90.0
Max v/c Ratio: 0.78
Int. Delay: 21.3
Int. LOS: C
ICU: 54.7%
ICU LOS: A

Lock Timings

Offset Settings
Offset: 0.0
Begin of Green
2 - NBTL
Master
By Phase

TIMING WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	39	373	70	171	343	90	162	53	114	86	56	31	—	—
Turn Type	Perm	—	Perm	pm+pt	—	Perm	pm+pt	—	Perm	Perm	—	—	—	—
Protected Phases		4		3	8		5	2			6	—		
Permitted Phases	4		4	8		8	2		2	6		—	—	—
Detector Phases	4	4	4	3	8	8	5	2	2	6	6	—	—	—
Minimum Initial (s)	10.0	10.0	10.0	6.0	10.0	10.0	6.0	7.0	7.0	7.0	7.0	—	—	—
Minimum Split (s)	33.3	33.3	33.3	12.5	33.3	33.3	10.0	33.3	33.3	33.3	33.3	—	—	—
Total Split (s)	42.5	42.5	42.5	12.5	55.0	55.0	10.0	45.0	45.0	35.0	35.0	—	—	—
Yellow Time (s)	3.5	3.5	3.5	3.4	3.6	3.6	3.5	3.6	3.6	3.6	3.6	—	—	—
All-Red Time (s)	2.3	2.3	2.3	3.1	2.3	2.3	0.5	2.7	2.7	2.7	2.7	—	—	—
Lead/Lag	Lag	Lag	Lag	Lead	—	—	Lead	—	—	Lag	Lag	—	—	—
Allow Lead/Lag Optimize?	Yes	Yes	Yes	Yes	—	—	Yes	—	—	Yes	Yes	—	—	—
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	—	—	—
Actuated Effct. Green (s)	38.5	38.5	38.5	51.0	51.0	51.0	41.0	41.0	41.0	31.0	31.0	—	—	—
Actuated g/C Ratio	0.38	0.38	0.38	0.51	0.51	0.51	0.41	0.41	0.41	0.31	0.31	—	—	—
Volume to Capacity Ratio	0.11	0.56	0.11	0.52	0.43	0.78	0.34	0.07	0.17	0.22	0.16	—	—	—
Control Delay (s)	20.8	27.7	5.2	19.4	17.4	45.7	21.6	18.4	4.1	27.3	18.7	—	—	—
Queue Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—	—	—
Total Delay (s)	20.8	27.7	5.2	19.4	17.4	45.7	21.6	18.4	4.1	27.3	18.7	—	—	—
Level of Service	C	C	A	B	B	D	C	B	A	C	B	—	—	—
Approach Delay (s)	—	23.8	—	—	22.2	—	—	15.0	—	—	22.9	—	—	—
Approach LOS	—	C	—	—	C	—	—	B	—	—	C	—	—	—
Queue Length 50th (m)	5.4	63.6	0.0	20.1	45.7	0.0	23.0	7.1	0.0	14.0	9.6	—	—	—
Queue Length 95th (m)	12.9	94.1	9.0	33.7	69.4	#111.0	38.4	15.1	10.8	27.0	21.8	—	—	—
Stops (vph)	26	286	10	91	208	24	103	32	13	63	44	—	—	—
Fuel Used (l/hr)	2	18	1	17	34	10	7	2	2	4	3	—	—	—



Options >

Controller Type: Pretimed

Cycle Length: 100.0

Actuated Cycles
90th %: 100.0
70th %: 100.0
50th %: 100.0
30th %: 100.0
10th %: 100.0

Quick Reports:
Green Times
Starts
Details

PHASING WINDOW	2-NBTL	3-WBL	4-EBTL	5-NBL	6-SBTL	8-WBTL
Minimum Initial (s)	7.0	6.0	10.0	6.0	7.0	10.0
Minimum Split (s)	33.3	12.5	33.3	10.0	33.3	33.3
Maximum Split (s)	45.0	12.5	42.5	10.0	35.0	55.0
Yellow Time (s)	3.6	3.4	3.5	3.5	3.6	3.6
All-Red Time (s)	2.7	3.1	2.3	0.5	2.7	2.3
Lead/Lag	—	Lead	Lag	Lead	Lag	—
Allow Lead/Lag Optimize?	—	Yes	Yes	Yes	Yes	—
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Minimum Gap (s)	3.0	3.0	3.0	3.0	3.0	3.0
Time Before Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0
Time To Reduce (s)	0.0	0.0	0.0	0.0	0.0	0.0
Recall Mode	Max	Max	Max	Max	Max	Max
Pedestrian Phase	Yes	No	Yes	No	Yes	Yes
Walk Time (s)	7.0	—	7.0	—	7.0	7.0
Flash Dont Walk (s)	18.0	—	16.0	—	20.0	9.0
Pedestrian Calls (#/hr)	40	—	40	—	40	40
Dual Entry?	Yes	Yes	Yes	No	Yes	Yes
Inhibit Max?	Yes	Yes	Yes	Yes	Yes	Yes
90th %ile Green Time (s)	39 cd	6 mr	37 mr	6 mr	29 cd	49 mr
70th %ile Green Time (s)	39 cd	6 mr	37 mr	6 mr	29 cd	49 mr
50th %ile Green Time (s)	39 cd	6 mr	37 mr	6 mr	29 cd	49 mr
30th %ile Green Time (s)	39 cd	6 mr	37 mr	6 mr	29 cd	49 mr
10th %ile Green Time (s)	39 cd	6 mr	37 mr	6 mr	29 cd	49 mr

Appendix C – Class A Cost Estimate

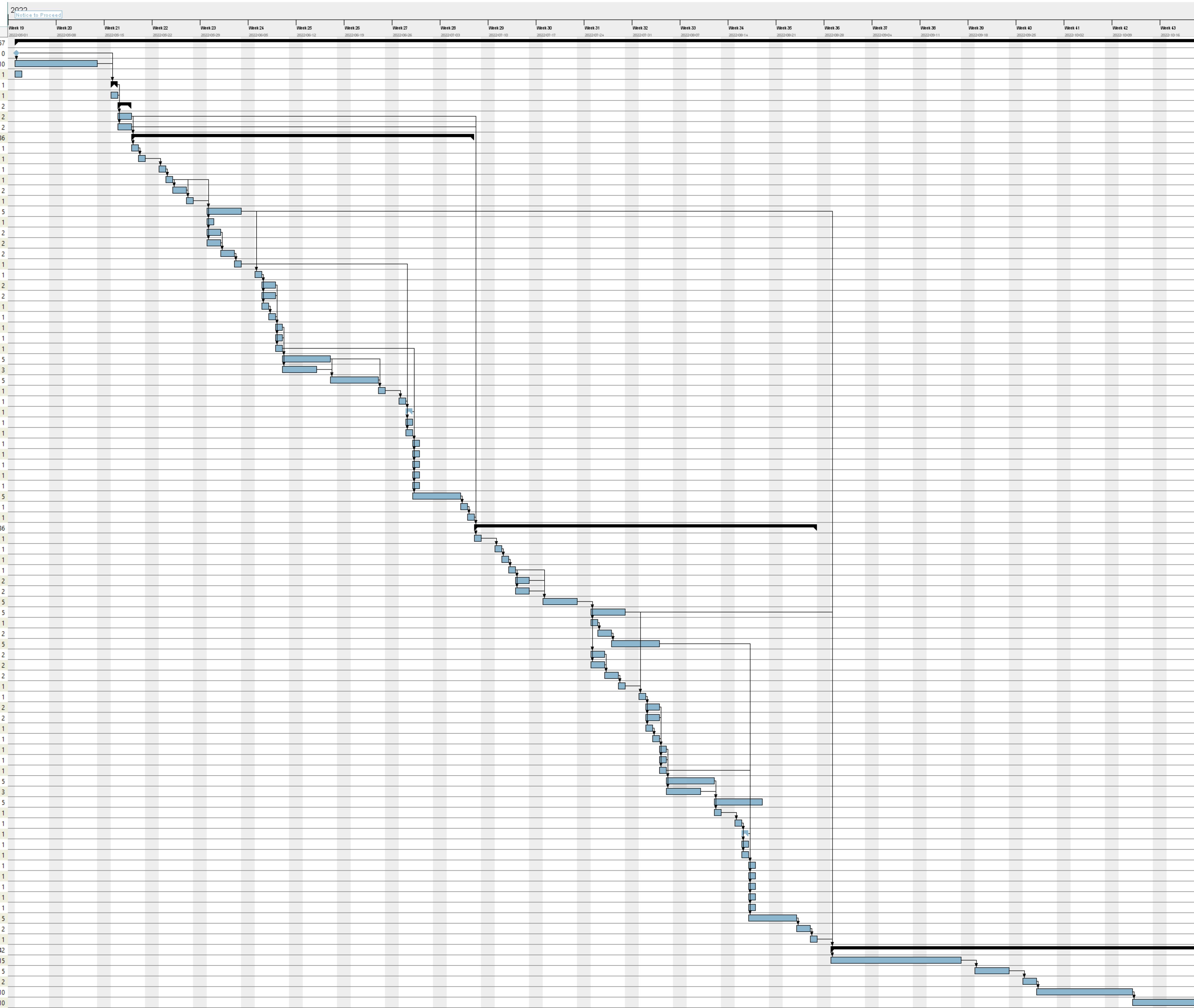
DETAILED COST ESTIMATE

WESBROOK MALL (THUNDERBIRD BLVD - 16TH AVE)
CLASS A CONSTRUCTION COST ESTIMATE

ITEM	DESCRIPTION	UNIT	QUANTITY	INFLATION 0.15	UNIT PRICE		AMOUNT	
1.0	ROAD & SITE WORKS							
	SITE WORKS							
1.01	Clearing and Grubbing	ha	3.2	$25,000	$28,750	$	92,000	32,000.00
	Removals & Dispose							
1.02	Remove and Dispose Pavement	m²	15,910.0	$30	$35	$	548,895	15,910.00
1.03	Remove and Dispose Curbs	m	2,600.0	$20	$23	$	59,800	2,600.00
1.04	Remove and Dispose Sidewalks / Driveways	m²	3,397.0	$25	$29	$	97,664	3,397.00
1.05	Remove and Dispose of Catch Basins	ea.	45.0	$700	$805	$	36,225	45.00
1.06	Tree Removal	ea.	15.0	$1,500	$1,725	$	25,875	15.00
		SUBTOTAL SITE WORKS				$	860,459	
	ROADS							
1.07	Subgrade Preparation including Compaction	m²	17,233.0	$3	$2.9	$	49,545	17,233.00
1.08	Subbase Course (Pit Run Gravel - 300mm depth)	m³	5,169.9	$60	$69.0	$	356,723	5,169.90
1.09	Base Course (Crushed Gravel - 100mm depth)	m³	1,723.3	$70	$80.5	$	138,726	1,723.30
1.10	Curb and Gutter - Concrete Barrier	m	2,659.5	$117	$134.6	$	357,836	2,659.50
1.11	Asphalt Base Course - 50mm	tonne	2,068.0	$130	$149.5	$	309,160	2,067.96
1.12	Tack Coat	m²	17,233.0	$3	$2.9	$	49,545	17,233.00
1.13	Asphalt Top Course/Overlay - 40mm	tonne	1,654.4	$130	$149.5	$	247,328	1,654.37
1.14	Concrete Driveway Letdowns	m²	86.5	$60	$69.0	$	5,969	86.50
1.15	Sidewalk - Concrete c/w Wheel Chair Ramps c/w 100mm Granular Base	m²	5,672.0	$120	$138.0	$	782,736	3,837.00
1.16	Bike Path - Asphalt c/w Wheel Chair Ramps c/w 100mm Granular Base	m²	1,835.0	$50	$57.5	$	105,513	1,835.00
1.17	Lock Block Retaining Wall	m²	240.0	$430	$494.5	$	118,680	240.00
1.18	Traffic Control	ls	1.0	$200,000	$200,000.0	$	200,000	1.00
1.19	Bioswale	m	218.5	$100	$115	$	25,128	218.50
1.20	Boulevard Topsoil (300mm depth)	m³	2,019.8	$32	$37	$	74,327	2,019.75
1.21	Boulevard Sodding	m²	6,732.5	$12	$14	$	92,909	6,732.50
		SUBTOTAL ROADS				$	2,914,122	
	SUB-TOTAL ROAD & SITE WORKS					$	3,774,581	
2.0	STORM SEWERS							
2.01	Catch Basin - 1050mm dia.	ea.	57	$2,000	$2,300	$	131,100	57.00
2.02	Catch Basin Leads - 200mm dia.	m	357	$270	$311	$	110,690	356.50
2.03	Lawn Basin - 600mm dia.	ea.	18	$900	$1,035	$	18,630	18.00
2.04	Lawn Basin Leads - 150mm dia.	m	170	$250	$288	$	48,730	169.50
2.05	Perforated Drain/Gravel/Filter Cloth - 100mm dia.	m	219	$110	$127	$	27,640	218.50
2.06	Offset Sump	ls.	2	$3,000	$3,450	$	6,900	2.00
2.07	Storm Sewer Mainline Video	m	754	$7	$7	$	5,270	753.50
	SUB-TOTAL STORM SEWERS					$	348,960	
3.0	ESC							
3.01	Erosion and Sediment Control	ls.	1	$150,000	$172,500	$	172,500	1.00
	SUB-TOTAL ESC					$	172,500	
4.0	PEDESTRIAN OVERPASS							
4.01	Neat Cut (Excavation)	m³	9	$75	$86	$	780	9.00
4.02	12m-Steel W530x66 Girder	ea.	4	$8,000	$9,200	$	36,800	4.00
4.03	6m-W250x49 Column	ea.	6	$4,000	$4,600	$	27,600	6.00
4.04	3m-W360x51 Beam	ea.	13	$2,000	$2,300	$	29,900	13.00
4.05	76mm Fluted Deck	m²	72	$150	$173	$	12,420	72.00
4.06	65mm 45 Mpa Concrete Topping/Overlay	m³	5	$280	$322	$	1,510	4.68
4.07	10M Rebar + 25M Dowels	ea.	100	$60	$69	$	6,900	100.00
4.08	Connections	ls.	1	$6,000	$6,900	$	6,900	1.00
4.09	Steel Railings	ls.	1	$30,000	$34,500	$	34,500	1.00
4.10	Steel Stairs	ls.	1	$150,000	$172,500	$	172,500	1.00
4.11	30 Mpa Concrete	m³	3	$215	$247	$	740	3.00
4.12	Equipment Rentals	ls.	1	$200,000	$230,000	$	230,000	1.00
	SUB-TOTAL PEDESTRIAN OVERPASS					$	560,550	
5.0	STREET LIGHTING, SIGNAGE & PAVEMENT MARKINGS							
	STREET LIGHTING							
5.01	Replacing Streetlight (9.1m Davit w/ Service Base)	ea.	66.0	$8,000	$9,200.00	$	607,200	66.00
		SUBTOTAL STREET LIGHTING				$	607,200	
	SIGNAGE & PAVEMENT MARKINGS							
5.02	Stop bar (Thermoplastic)	ea.	6.0	$300	$345	$	2,070	6.00
5.03	Line Painting	m	2,240.0	$5	$6	$	12,880	2,240.00
5.04	Road Markings	ls.	1.0	$7,500	$8,625	$	8,625	1.00
5.05	Sign on Post	ea.	83.0	$280	$322	$	26,726	83.00
		SUBTOTAL SIGNAGE & PAVEMENT MARKINGS				$	50,301	
	SUB-TOTAL STREET LIGHTING, SIGNAGE & PAVEMENT MARKINGS					$	657,501	
	TOTAL					$	5,514,092	

Appendix D – Construction Schedule

Name	Begin date	End date	Duration
Construction	2022-05-02	2022-12-06	157
Notice to Proceed	2022-05-02	2022-05-02	0
Permitting Contingency	2022-05-02	2022-05-13	10
Revert Detour	2022-05-02	2022-05-02	1
Mobilization	2022-05-16	2022-05-16	1
Setup Laydown and Site Office	2022-05-16	2022-05-16	1
Early Works	2022-05-17	2022-05-18	2
Survey	2022-05-17	2022-05-18	2
Install Tree Protection	2022-05-17	2022-05-18	2
Northbound	2022-05-19	2022-07-07	36
Temporary Works	2022-05-19	2022-05-19	1
Implement Detours	2022-05-20	2022-05-20	1
Setup Construction Access	2022-05-23	2022-05-23	1
Mobilize Equipment	2022-05-24	2022-05-24	1
Existing Curb Removal	2022-05-25	2022-05-26	2
Excavation	2022-05-27	2022-05-27	1
Overpass Work	2022-05-30	2022-06-03	5
Tree Removal	2022-05-30	2022-05-30	1
Install Utilities	2022-05-30	2022-05-31	2
Install Drainage	2022-05-30	2022-05-31	2
Backfill	2022-06-01	2022-06-02	2
Compaction	2022-06-03	2022-06-03	1
Coarse Grading	2022-06-06	2022-06-06	1
Curb and Gutter Forming	2022-06-07	2022-06-08	2
Sidewalk Forming	2022-06-07	2022-06-08	2
Install Electrical Components	2022-06-07	2022-06-07	1
Install Light Post	2022-06-08	2022-06-08	1
Curb and Gutter Concrete Pour	2022-06-09	2022-06-09	1
Sidewalk Concrete Pour	2022-06-09	2022-06-09	1
Commissioning and Testing	2022-06-09	2022-06-09	1
Curb and Gutter Concrete Curing	2022-06-10	2022-06-16	5
Sidewalk Concrete Curing	2022-06-10	2022-06-14	3
Boulevard	2022-06-17	2022-06-23	5
Fine Grading	2022-06-24	2022-06-24	1
Compaction	2022-06-27	2022-06-27	1
Asphalt Paving	2022-06-28	2022-06-28	1
Road Paving	2022-06-28	2022-06-28	1
Bike Lane Paving	2022-06-28	2022-06-28	1
Line Painting	2022-06-29	2022-06-29	1
Install Signage	2022-06-29	2022-06-29	1
Install Tactile Tiles	2022-06-29	2022-06-29	1
Install Pedestrain Lighting	2022-06-29	2022-06-29	1
Install Overhead Signage	2022-06-29	2022-06-29	1
Landscaping	2022-06-29	2022-07-05	5
Demobilization	2022-07-06	2022-07-06	1
Revert Detour	2022-07-07	2022-07-07	1
Southbound	2022-07-08	2022-08-26	36
Temporary Works	2022-07-08	2022-07-08	1
Implement Detours	2022-07-11	2022-07-11	1
Setup Construction Access	2022-07-12	2022-07-12	1
Mobilize Equipment	2022-07-13	2022-07-13	1
Tree Removal	2022-07-14	2022-07-15	2
Existing Curb Removal	2022-07-14	2022-07-15	2
Excavation	2022-07-18	2022-07-22	5
Overpass Work	2022-07-25	2022-07-29	5
Retaining Wall Forming	2022-07-25	2022-07-25	1
Retaining Wall Concrete Pour	2022-07-26	2022-07-27	2
Retaining Wall Concrete Curing	2022-07-28	2022-08-03	5
Install Utilities	2022-07-25	2022-07-26	2
Install Drainage	2022-07-25	2022-07-26	2
Backfill	2022-07-27	2022-07-28	2
Compaction	2022-07-29	2022-07-29	1
Coarse Grading	2022-08-01	2022-08-01	1
Curb and Gutter Forming	2022-08-02	2022-08-03	2
Sidewalk Forming	2022-08-02	2022-08-03	2
Install Electrical Components	2022-08-02	2022-08-02	1
Install Light Post	2022-08-03	2022-08-03	1
Curb and Gutter Concrete Pour	2022-08-04	2022-08-04	1
Sidewalk Concrete Pour	2022-08-04	2022-08-04	1
Commissioning and Testing	2022-08-04	2022-08-04	1
Curb and Gutter Concrete Curing	2022-08-05	2022-08-11	5
Sidewalk Concrete Curing	2022-08-05	2022-08-09	3
Boulevard	2022-08-12	2022-08-18	5
Fine Grading	2022-08-12	2022-08-12	1
Compaction	2022-08-15	2022-08-15	1
Asphalt Paving	2022-08-16	2022-08-16	1
Road Paving	2022-08-16	2022-08-16	1
Bike Lane Paving	2022-08-16	2022-08-16	1
Line Painting	2022-08-17	2022-08-17	1
Install Signage	2022-08-17	2022-08-17	1
Install Tactile Tiles	2022-08-17	2022-08-17	1
Install Pedestrain Lighting	2022-08-17	2022-08-17	1
Install Overhead Signage	2022-08-17	2022-08-17	1
Landscaping	2022-08-17	2022-08-23	5
Demobilization	2022-08-24	2022-08-25	2
Revert Detour	2022-08-26	2022-08-26	1
Overpass	2022-08-29	2022-10-25	42
Pre Erection Work	2022-08-29	2022-09-16	15
Mobilization	2022-09-19	2022-09-23	5
Erection Work	2022-09-26	2022-09-27	2
Post Erection Work	2022-09-28	2022-10-11	10
Access Work	2022-10-12	2022-10-25	10
Construction Contingency	2022-10-26	2022-12-06	30



Appendix E – Issued for Tender Drawings

WESBROOK MALL PHASE 4 REDESIGN

ISSUED FOR TENDER PACKAGE

ROADWORKS

DRAINAGE

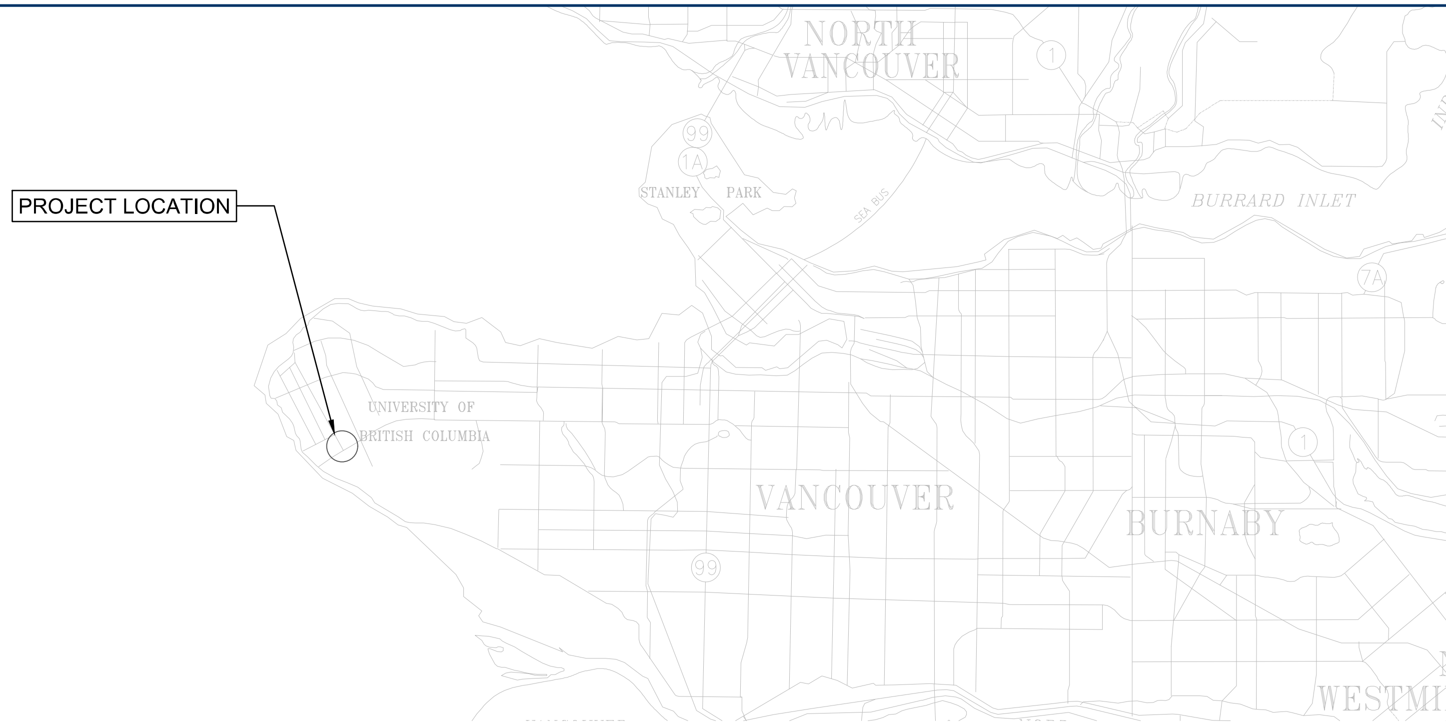
STRUCTURAL

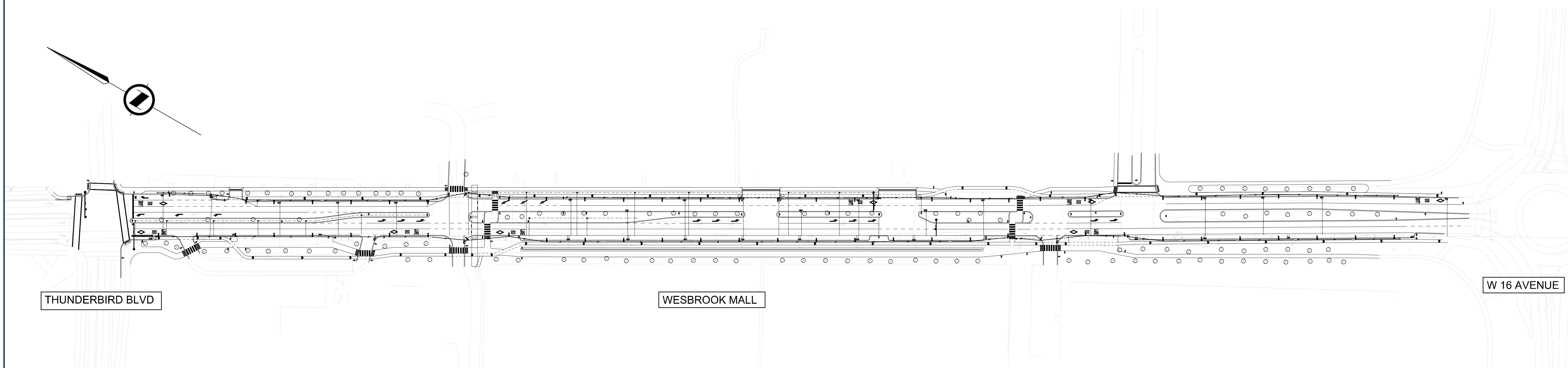
LANDSCAPE

LIGHTING

PAVEMENT

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science





SCALE

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

KEY PLAN

WESBROOK MALL PHASE 4 REDESIGN

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-R02	0

R1-955-R01	COVER
R1-955-R02	KEY PLAN
R1-955-001	DRAWING INDEX
R1-955-200	ROADWORKS
R1-955-201	ROADWORKS
R1-955-202	ROADWORKS
R1-955-203	ROADWORKS
R1-955-204	ROADWORKS
R1-955-210	ROADWORKS - SIGNAGE
R1-955-211	ROADWORKS - SIGNAGE
R1-955-212	ROADWORKS - SIGNAGE
R1-955-213	ROADWORKS - SIGNAGE
R1-955-214	ROADWORKS - SIGNAGE
R1-955-215	ROADWORKS - TYPICAL SECTION
R1-955-220	ROADWORKS - DETAILS
R1-955-221	ROADWORKS - DETAILS
R1-955-222	ROADWORKS - DETAILS
R1-955-223	ROADWORKS - DETAILS
R1-955-224	ROADWORKS - DETAILS
R1-955-225	ROADWORKS - DETAILS
R1-955-300	DRAINAGE
R1-955-301	DRAINAGE
R1-955-302	DRAINAGE
R1-955-303	DRAINAGE
R1-955-304	DRAINAGE
R1-955-305	DRAINAGE NOTES AND DETAILS
R1-955-400	LANDSCAPING
R1-955-401	LANDSCAPING
R1-955-402	LANDSCAPING
R1-955-403	LANDSCAPING
R1-955-404	LANDSCAPING
R1-955-410	RETAINING WALL
R1-955-500	STRUCTURAL
R1-955-600	LIGHTING
R1-955-601	LIGHTING
R1-955-602	LIGHTING
R1-955-603	LIGHTING
R1-955-604	LIGHTING
R1-955-700	PAVEMENT DESIGN

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

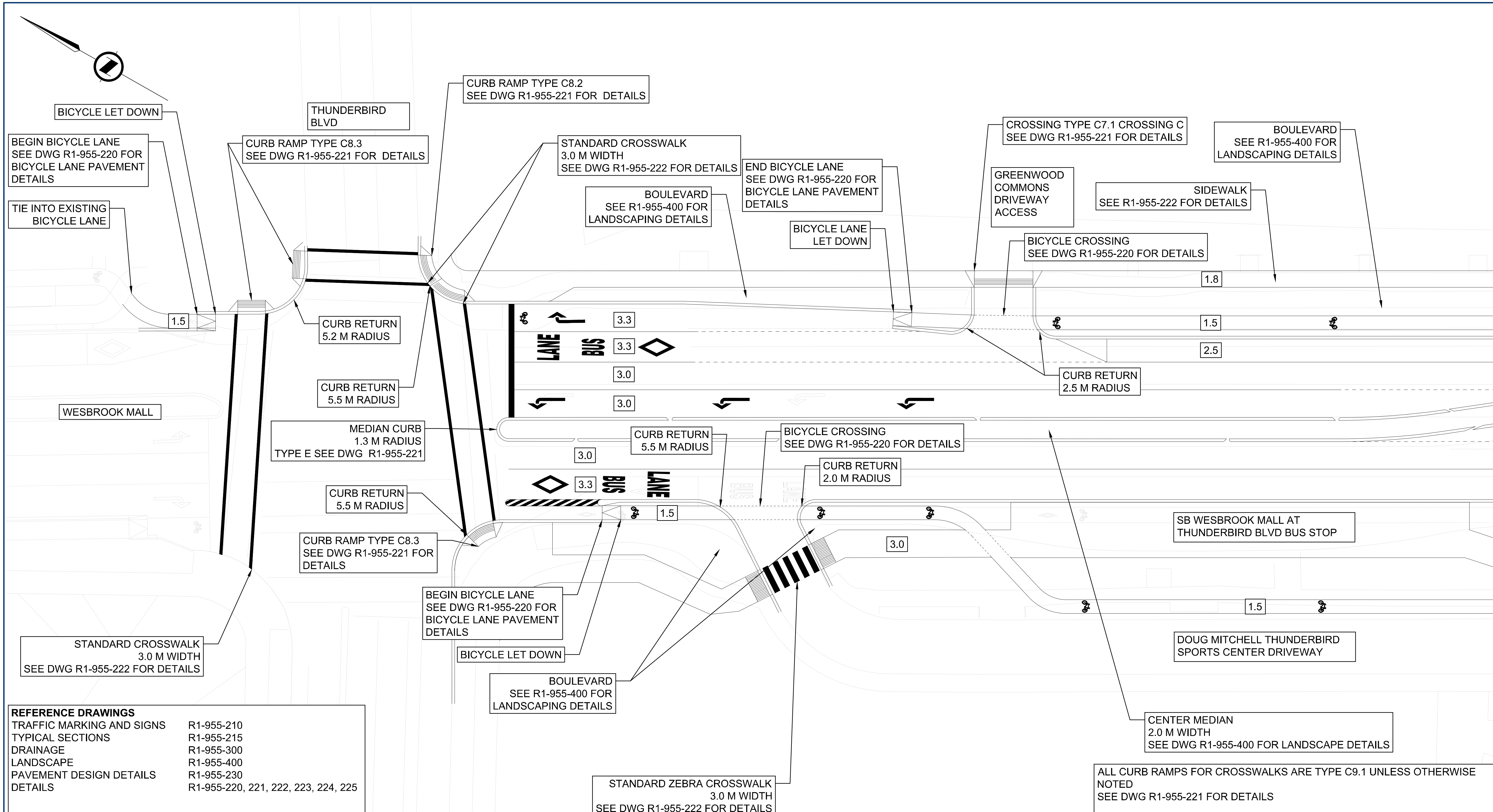
H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

DRAWING INDEX

WESBROOK MALL PHASE 4 REDESIGN

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-001	0



REFERENCE DRAWINGS

TRAFFIC MARKING AND SIGNS	R1-955-210
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-300
LANDSCAPE	R1-955-400
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

ALL CURB RAMPS FOR CROSSWALKS ARE TYPE C9.1 UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

ALL CURB AND GUTTER ARE TYPE F UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

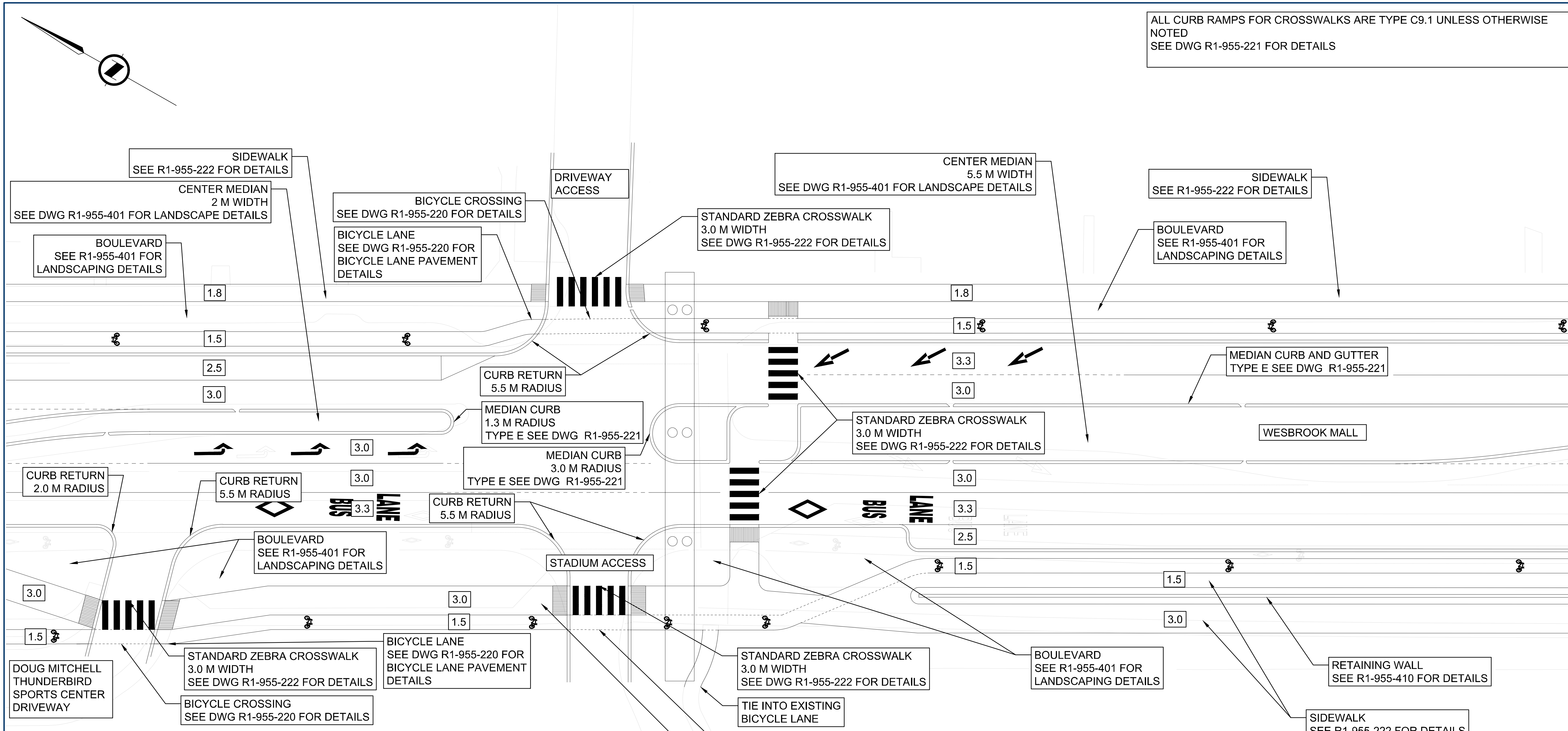
PLAN

WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS

THUNDERBIRD BLVD TO GREENWOOD COMMONS DRIVEWAY ACCESS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-200	0

ALL CURB RAMPS FOR CROSSWALKS ARE TYPE C9.1 UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS



REFERENCE DRAWINGS

TRAFFIC MARKING AND SIGNS	R1-955-211
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-301
LANDSCAPE	R1-955-401
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

REFER TO STRUCTURAL OVERPASS DRAWINGS FOR DETAILS ON PEDESTRIAN OVERPASS
SEE DWG R1-955-500

ALL CURB AND GUTTER ARE TYPE F UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

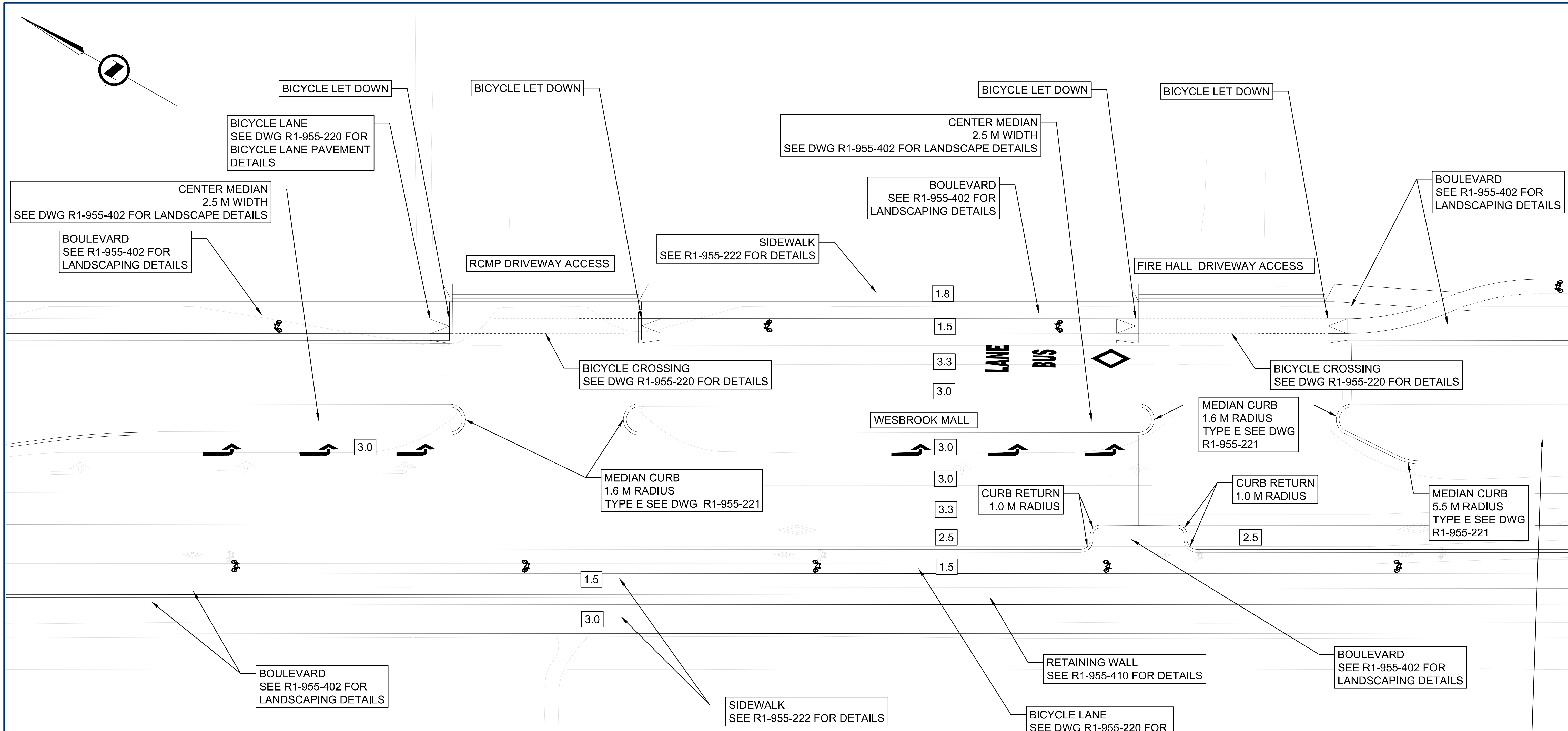
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS

GREENWOOD COMMONS DRIVEWAY ACCESS TO RCMP DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-201	0



REFERENCE DRAWINGS

TRAFFIC MARKING AND SIGNS	R1-955-212
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-302
LANDSCAPE	R1-955-402
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

ALL CURB RAMPS FOR CROSSWALKS ARE TYPE C9.1 UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

ALL CURB AND GUTTER ARE TYPE F UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

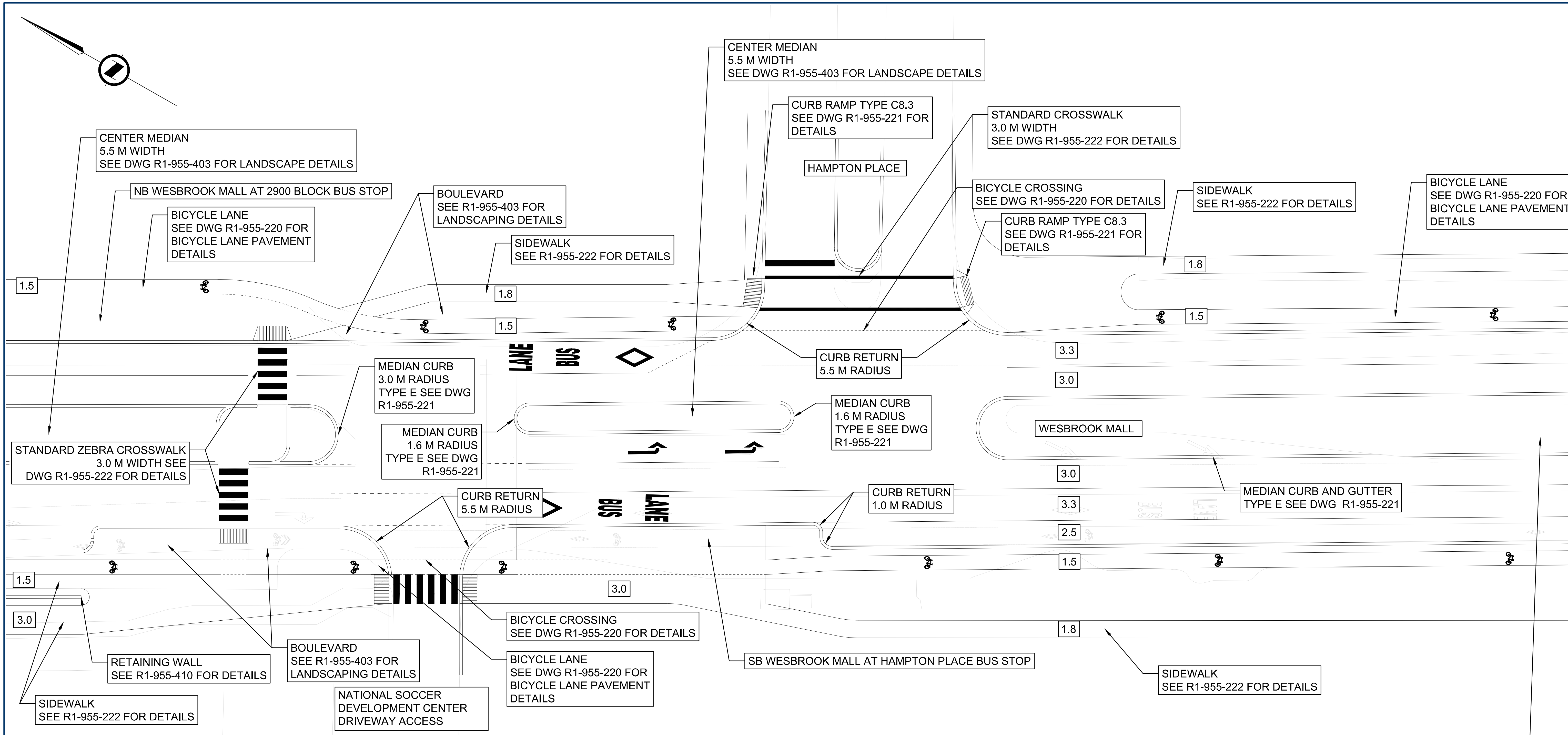
TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

PLAN
WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS
RCMP DRIVEWAY TO FIRE HALL DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-202	0



REFERENCE DRAWINGS

TRAFFIC MARKING AND SIGNS	R1-955-213
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-303
LANDSCAPE	R1-955-403
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

ALL CURB RAMPS FOR CROSSWALKS ARE TYPE C9.1 UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

ALL CURB AND GUTTER ARE TYPE F UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

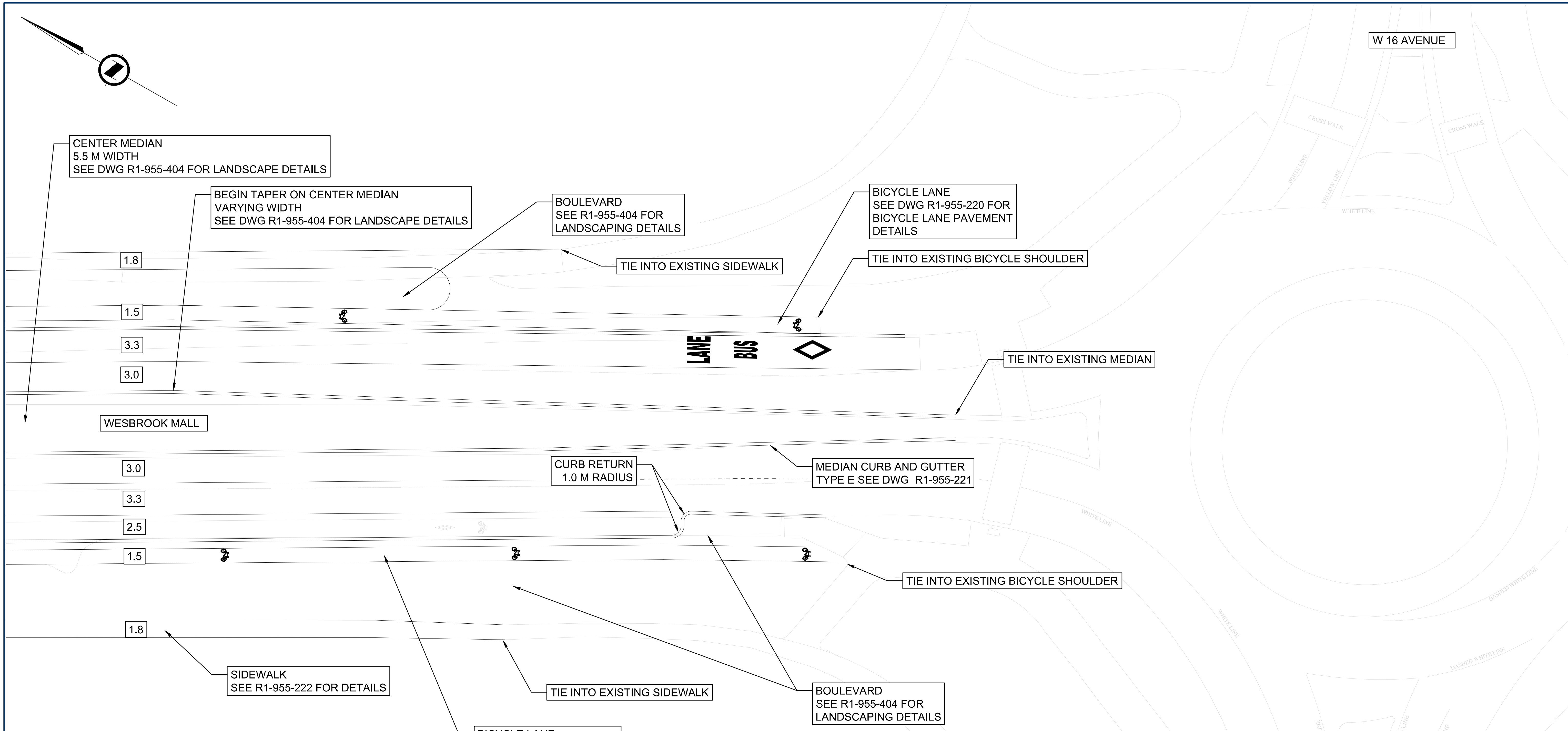
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS

FIRE HALL DRIVEWAY TO HAMPTON PLACE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-203	0



REFERENCE DRAWINGS

TRAFFIC MARKING AND SIGNS	R1-955-214
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-304
LANDSCAPE	R1-955-404
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

ALL CURB RAMPS FOR CROSSWALKS ARE TYPE C9.1 UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

ALL CURB AND GUTTER ARE TYPE F UNLESS OTHERWISE NOTED
SEE DWG R1-955-221 FOR DETAILS

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

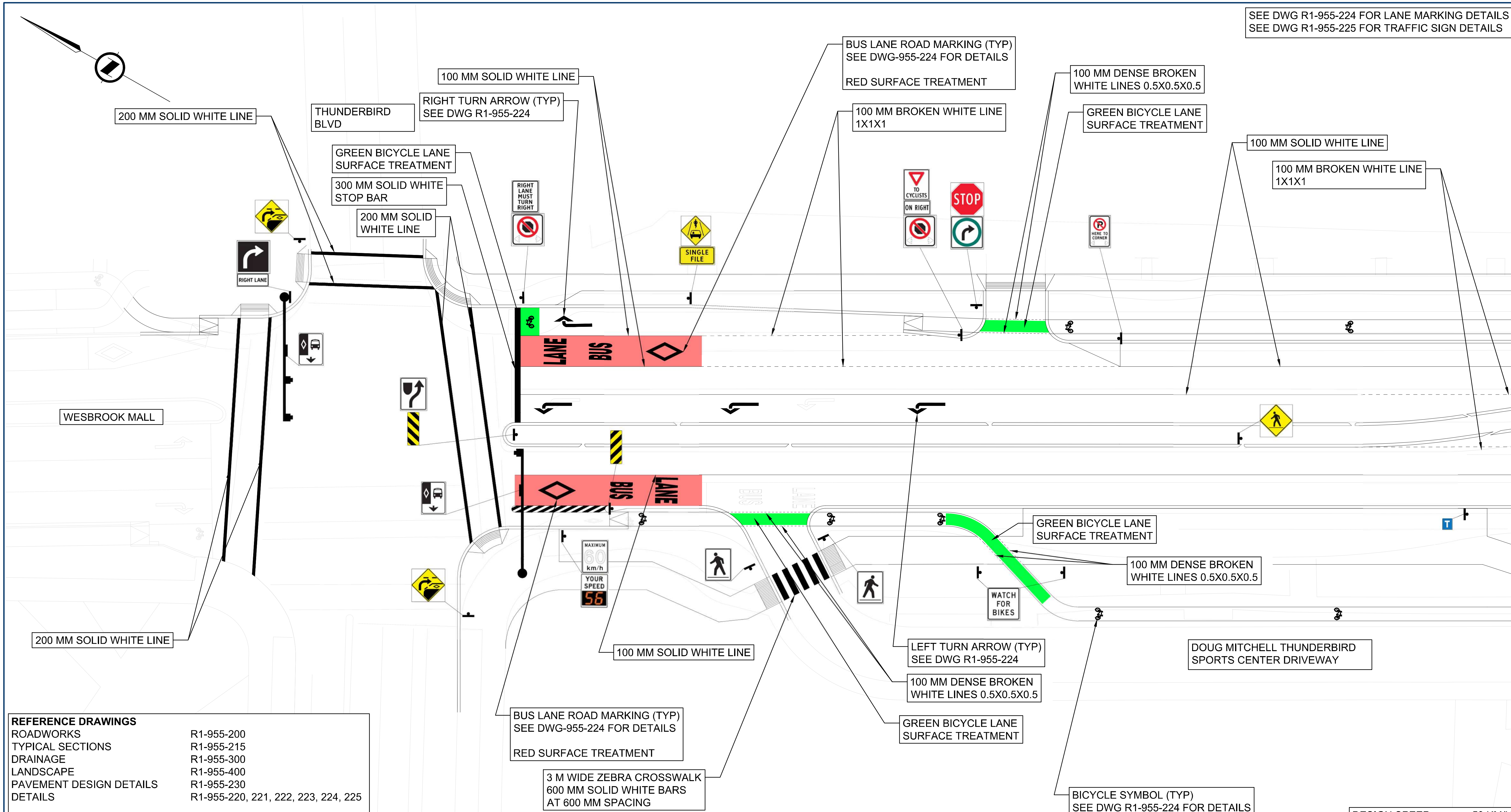
H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS
HAMPTON PLACE TO W 16 AVENUE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-204	0



REFERENCE DRAWINGS

ROADWORKS	R1-955-200
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-300
LANDSCAPE	R1-955-400
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

DESIGN SPEED 50 KM/H

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

DESIGN VEHICLES PC (TAC-1984) SU9 (TAC-1984) B12 (TAC-1984) A-BUS (TAX-1999)
SEE DWG R1-955-223 FOR DETAILS

INSTALLATION OF SIGNING AND PAVEMENT MARKINGS AND MATERIAL USED SHALL BE AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA (MUTCD) AND MOTI MANUAL OF STANDARD TRAFFIC SIGNS AND PAVEMENT MARKINGS.

SCALE 0 5 10 Meters
PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

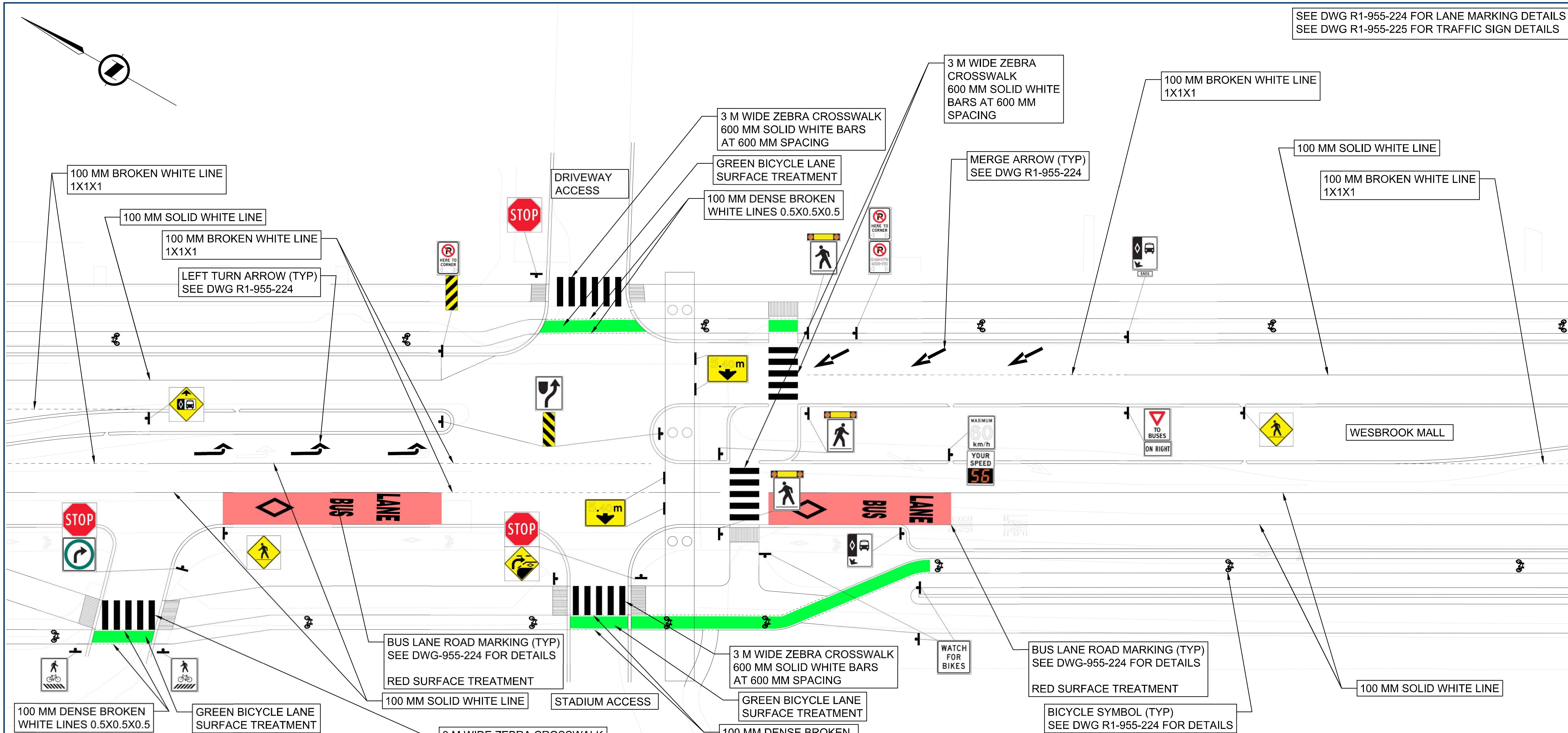
TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN
WESBROOK MALL PHASE 4 REDESIGN - TRAFFIC MARKING AND SIGNS
THUNDERBIRD BLVD TO GREENWOOD COMMONS DRIVEWAY ACCESS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-210	0



REFERENCE DRAWINGS	
ROADWORKS	R1-955-201
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-301
LANDSCAPE	R1-955-401
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

REFER TO STRUCTURAL OVERPASS DRAWINGS FOR DETAILS ON PEDESTRIAN OVERPASS
SEE DWG R1-955-500

DESIGN SPEED 50 KM/H

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

DESIGN VEHICLES PC (TAC-1984) SU9 (TAC-1984) B12 (TAC-1984) A-BUS (TAX-1999)
SEE DWG R1-955-223 FOR DETAILS

INSTALLATION OF SIGNING AND PAVEMENT MARKINGS AND MATERIAL USED SHALL BE AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA (MUTCD) AND MOTI MANUAL OF STANDARD TRAFFIC SIGNS AND PAVEMENT MARKINGS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

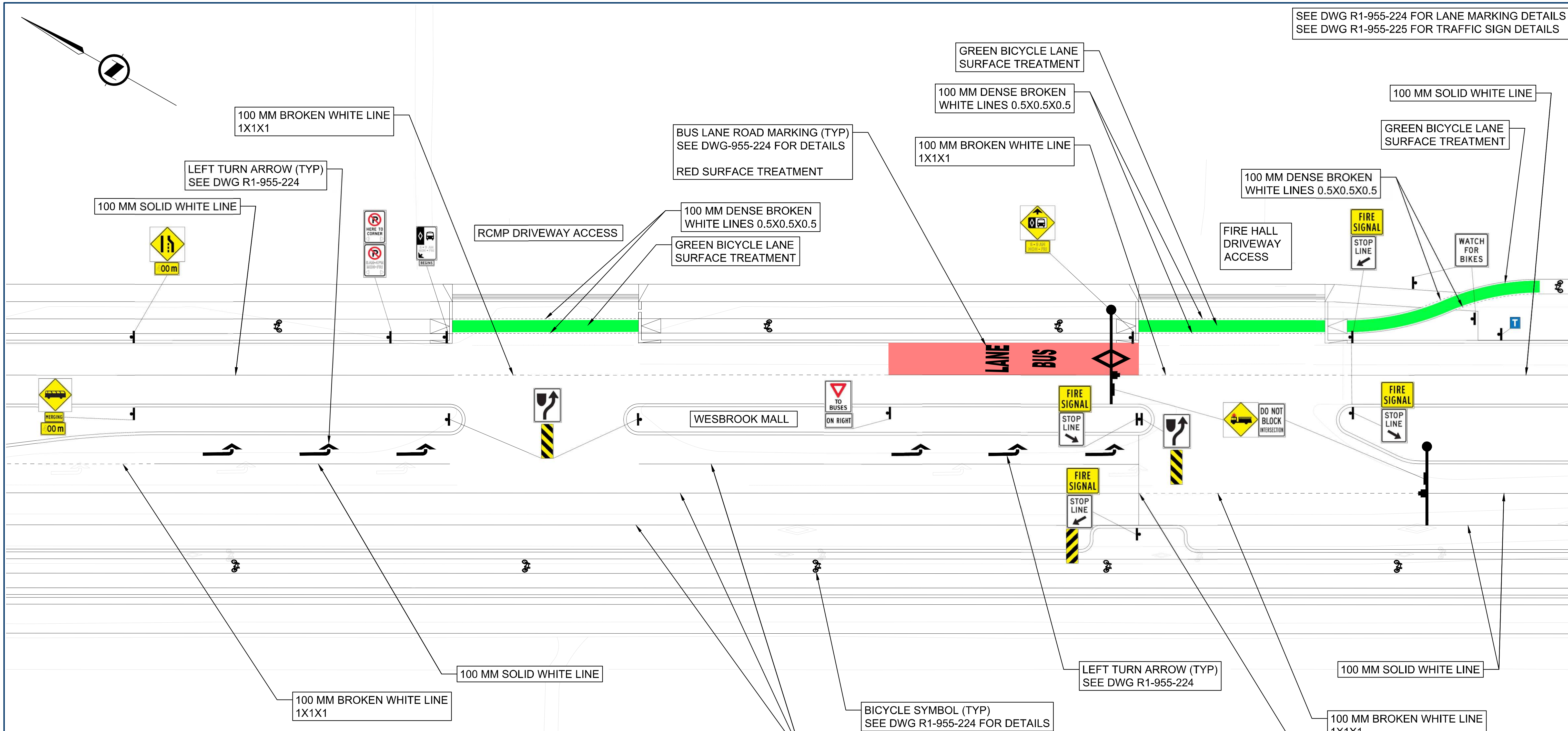
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4 REDESIGN - TRAFFIC MARKING AND SIGNS

GREENWOOD COMMONS DRIVEWAY ACCESS TO RCMP DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-211	0



REFERENCE DRAWINGS	
ROADWORKS	R1-955-202
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-302
LANDSCAPE	R1-955-402
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

DESIGN SPEED 50 KM/H

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

DESIGN VEHICLES PC (TAC-1984) SU9 (TAC-1984) B12 (TAC-1984) A-BUS (TAX-1999)
SEE DWG R1-955-223 FOR DETAILS

INSTALLATION OF SIGNING AND PAVEMENT MARKINGS AND MATERIAL USED SHALL BE AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA (MUTCD) AND MOTI MANUAL OF STANDARD TRAFFIC SIGNS AND PAVEMENT MARKINGS.

SCALE 0 5 10 Meters
PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

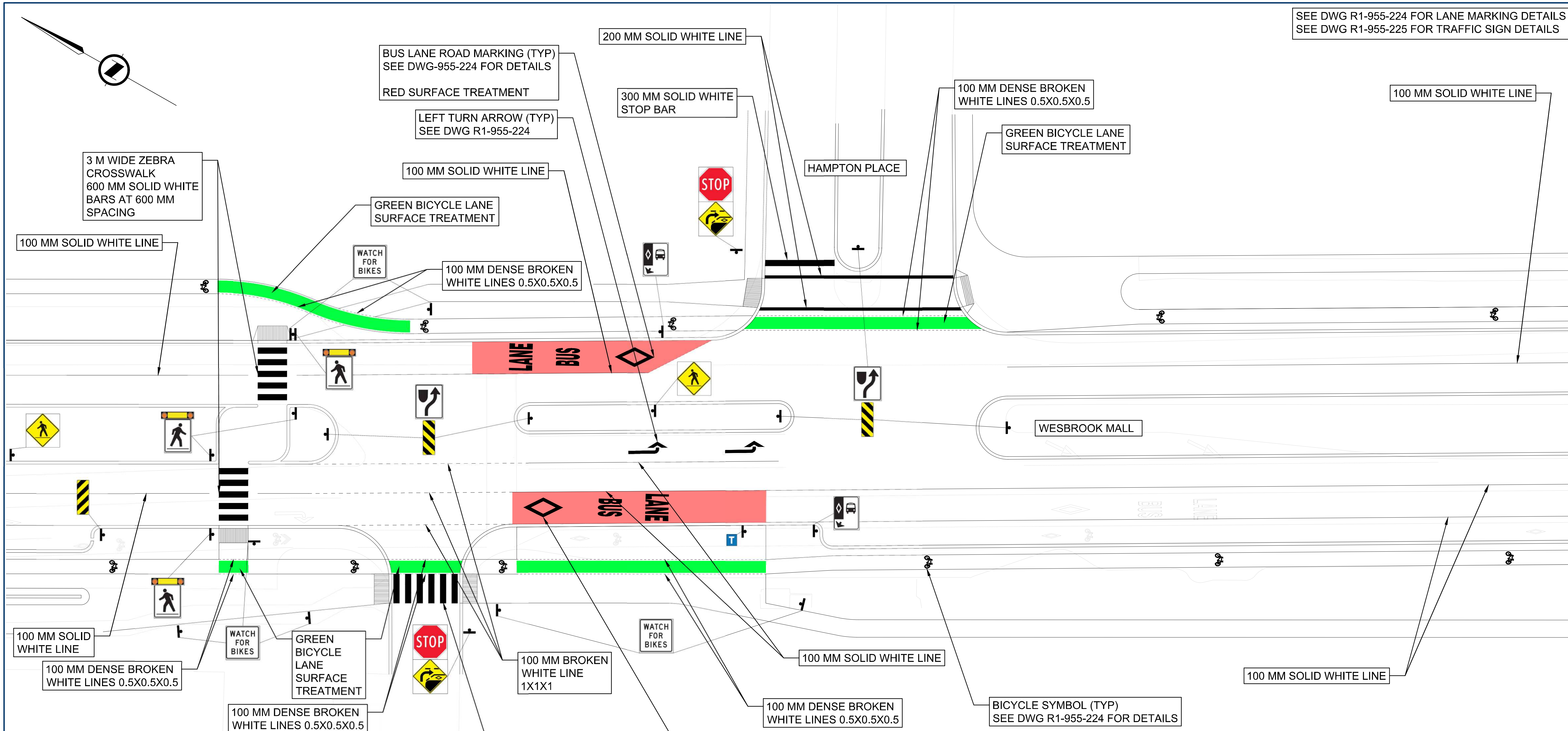
H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4 REDESIGN - TRAFFIC MARKING AND SIGNS
RCMP DRIVEWAY TO FIRE HALL DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-212	0



REFERENCE DRAWINGS	
ROADWORKS	R1-955-203
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-303
LANDSCAPE	R1-955-403
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

DESIGN SPEED 50 KM/H

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

DESIGN VEHICLES PC (TAC-1984) SU9 (TAC-1984) B12 (TAC-1984) A-BUS (TAX-1999)
SEE DWG R1-955-223 FOR DETAILS

INSTALLATION OF SIGNING AND PAVEMENT MARKINGS AND MATERIAL USED SHALL BE AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA (MUTCD) AND MOTI MANUAL OF STANDARD TRAFFIC SIGNS AND PAVEMENT MARKINGS.

SCALE 0 5 10 Meters
PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

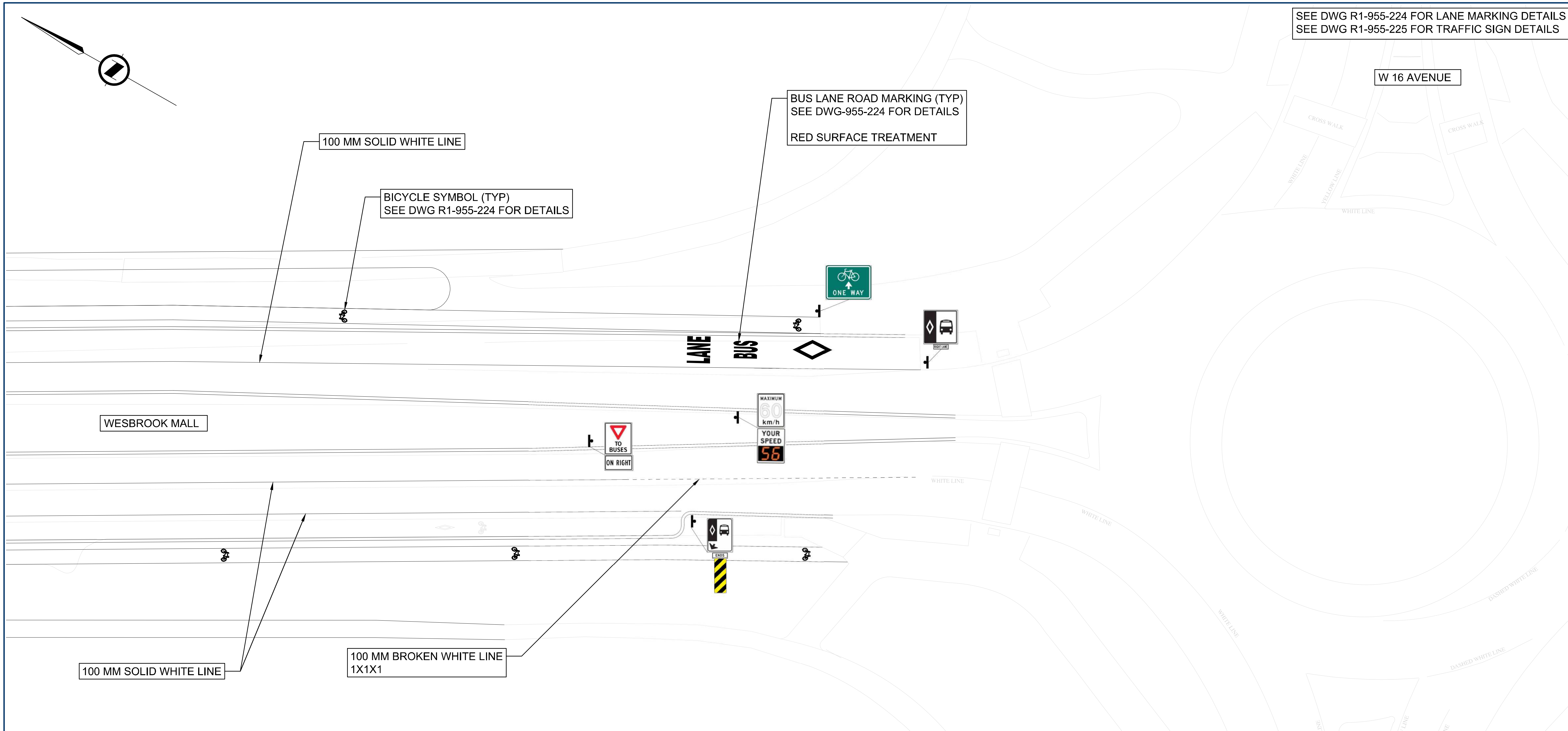
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4 REDESIGN - TRAFFIC MARKING AND SIGNS
FIRE HALL DRIVEWAY TO HAMPTON PLACE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-213	0

SEE DWG R1-955-224 FOR LANE MARKING DETAILS
SEE DWG R1-955-225 FOR TRAFFIC SIGN DETAILS



REFERENCE DRAWINGS

ROADWORKS	R1-955-204
TYPICAL SECTIONS	R1-955-215
DRAINAGE	R1-955-304
LANDSCAPE	R1-955-404
PAVEMENT DESIGN DETAILS	R1-955-230
DETAILS	R1-955-220, 221, 222, 223, 224, 225

DESIGN SPEED 50 KM/H

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

DESIGN VEHICLES PC (TAC-1984) SU9 (TAC-1984) B12 (TAC-1984) A-BUS (TAX-1999)
SEE DWG R1-955-223 FOR DETAILS

INSTALLATION OF SIGNING AND PAVEMENT MARKINGS AND MATERIAL USED SHALL BE AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA (MUTCD) AND MOTI MANUAL OF STANDARD TRAFFIC SIGNS AND PAVEMENT MARKINGS.

SCALE 0 5 10 Meters
PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

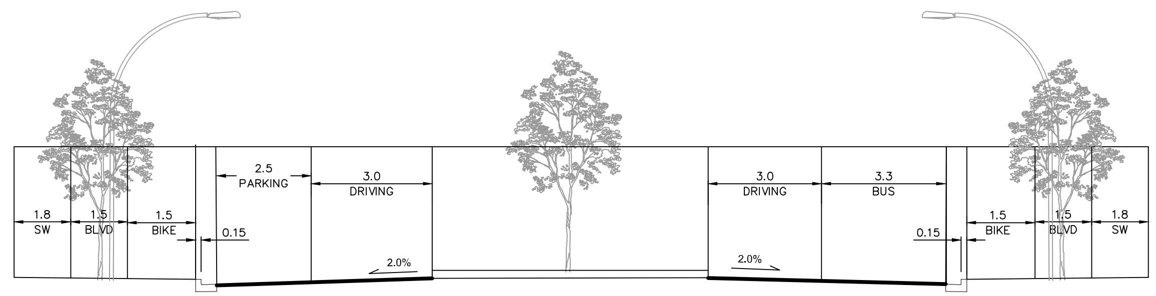
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

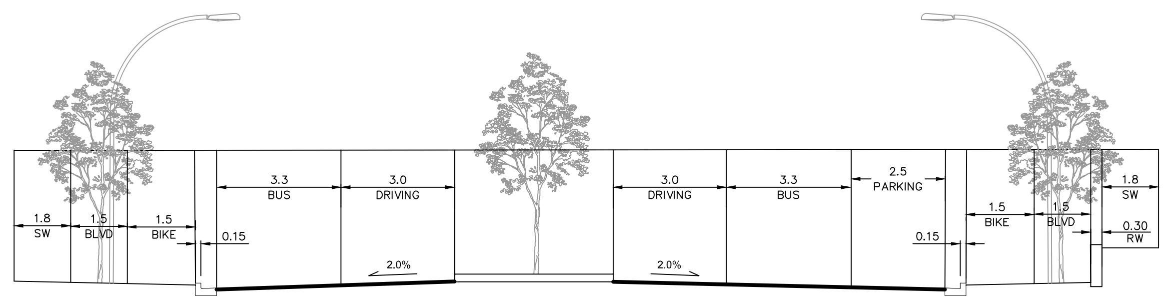
WESBROOK MALL PHASE 4 REDESIGN -
TRAFFIC MARKING AND SIGNS

HAMPTON PLACE TO W 16 AVENUE

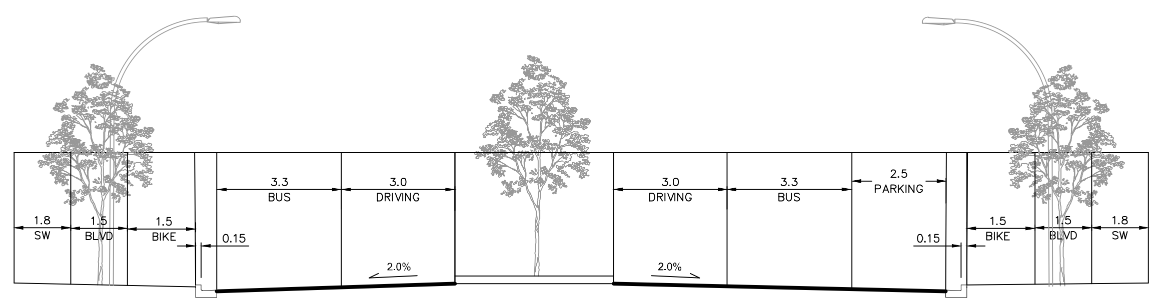
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-214	0



THUNDERBIRD TO RCMP CROSS-SECTION
SCALE: 1:100 HOR.,
NTS. VERT.



RCMP TO HAMPTON PL CROSS-SECTION
SCALE: 1:100 HOR.,
NTS. VERT.



HAMPTON PL TO W 16TH AVE CROSS-SECTION
SCALE: 1:100 HOR.,
NTS. VERT.

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

DETAILS

WESBROOK MALL PHASE 4 REDESIGN -
ROADWORKS

TRAFFIC SIGN DETAILS

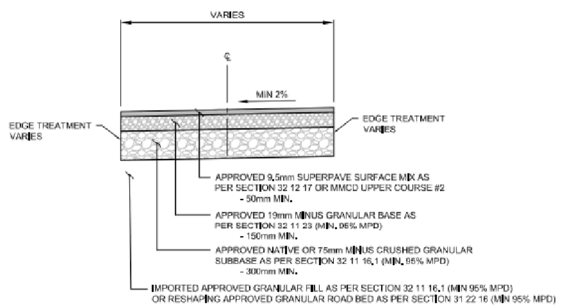
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-215	0

CITY OF VANCOUVER

STANDARD DETAIL DRAWINGS

ENGINEERING SERVICES - VANCOUVER, B.C.

DRAWING No. R3.3



NOTES:

1. FOR SUBGRADE SOIL CLASS SC, ML, OR CL ONLY. OTHER SOIL CLASSES REQUIRE SPECIAL TREATMENT GEOTECHNICAL ENGINEER REQUIRED TO DETERMINE SUBGRADE SOIL CLASSIFICATION.

SCALE: N.T.S.

REV.	REVISION DATE	APPROVED

TYPICAL CROSS SECTION
PROTECTED/RAISED BIKE LANE

ISSUE DATE: SEPTEMBER 2018

APPROVED BY: J. LEE

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

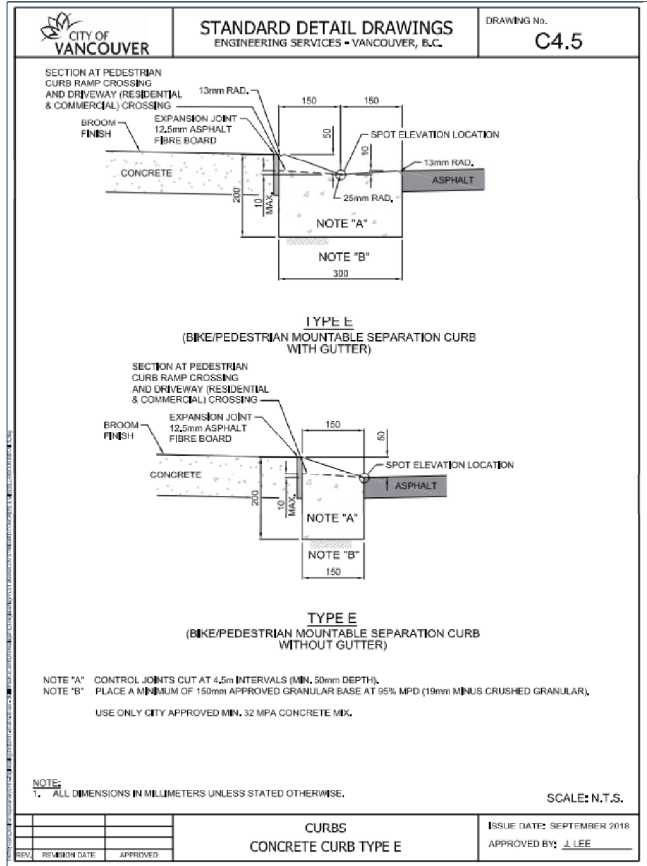
DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

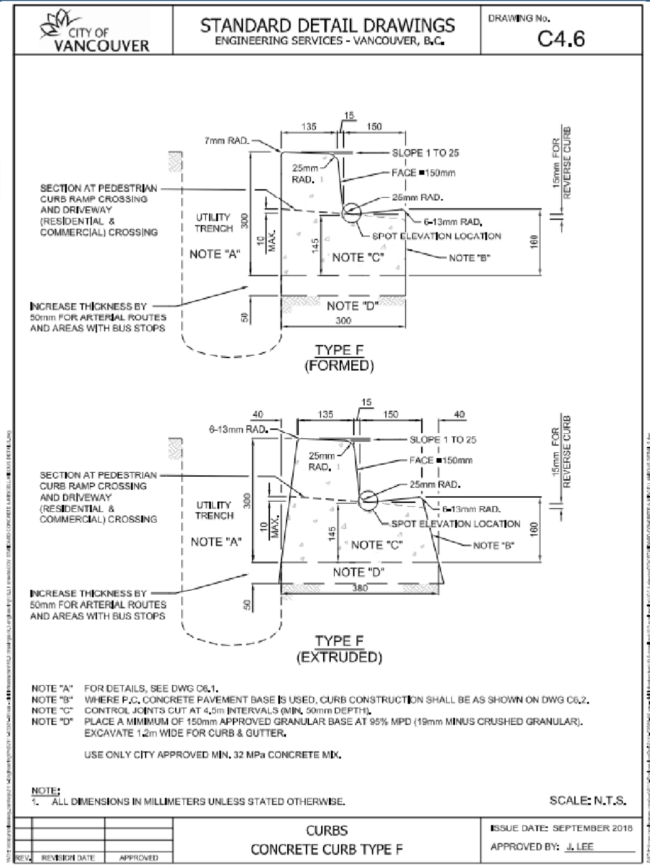
DETAILS

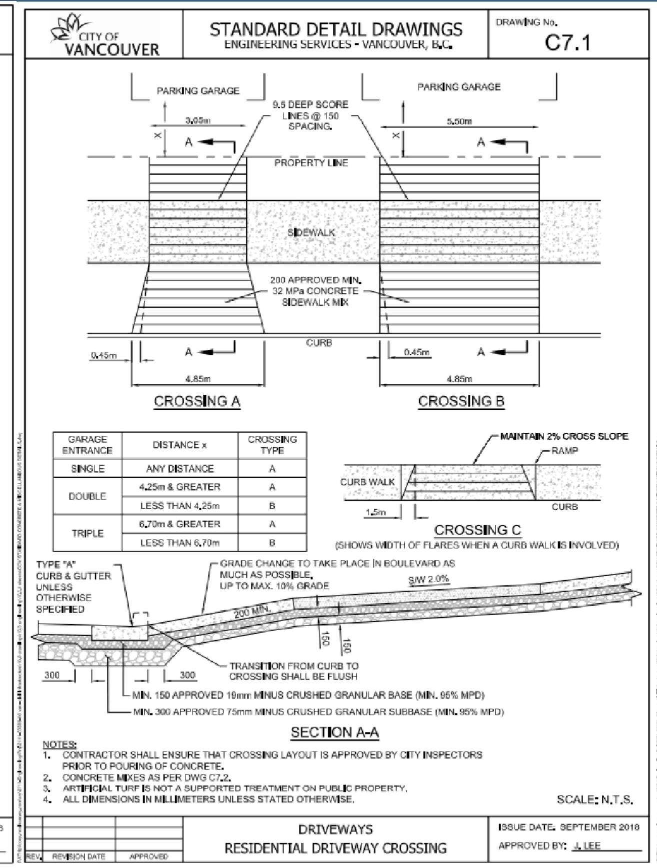
WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS

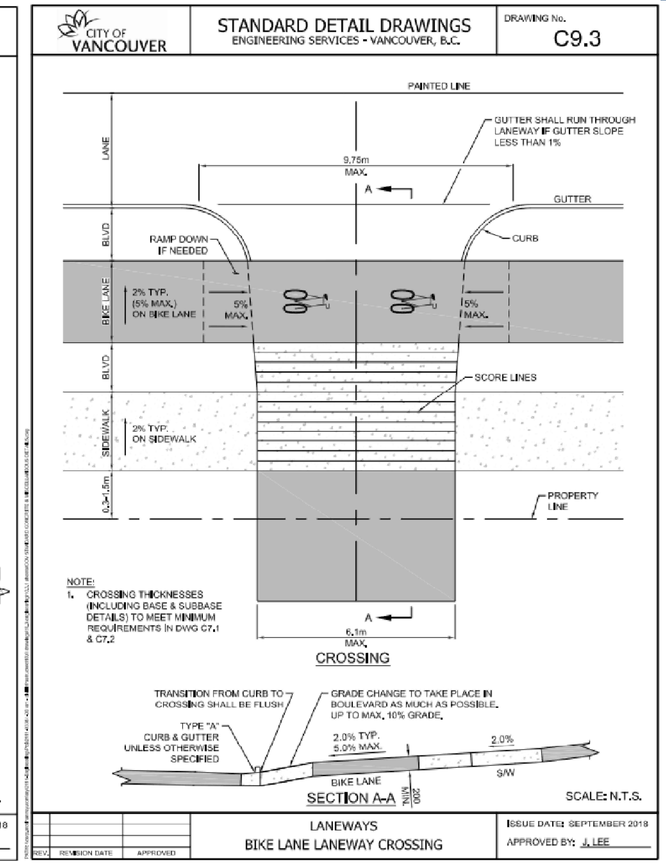
BICYCLE FACILITY DETAILS

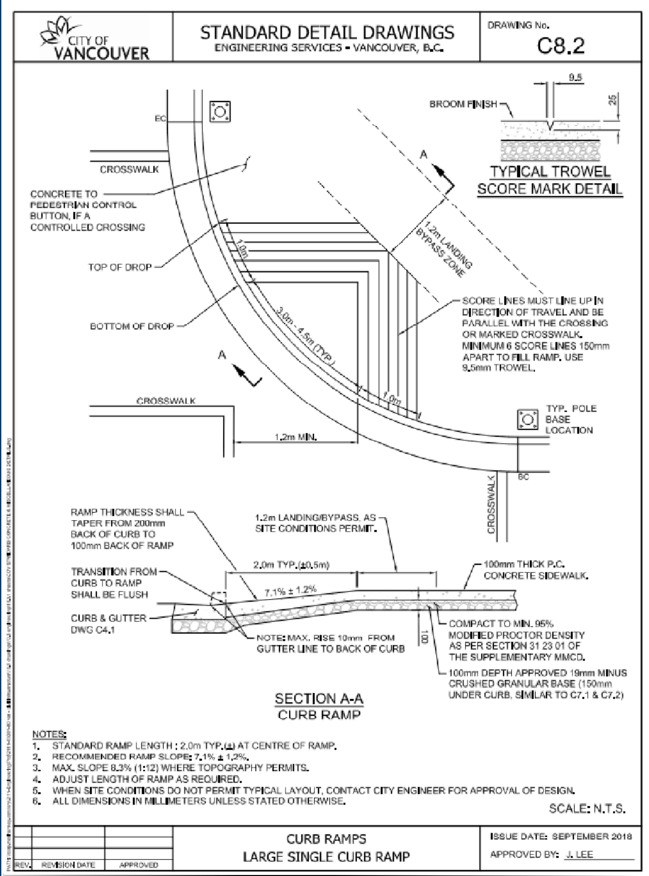
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-220	0

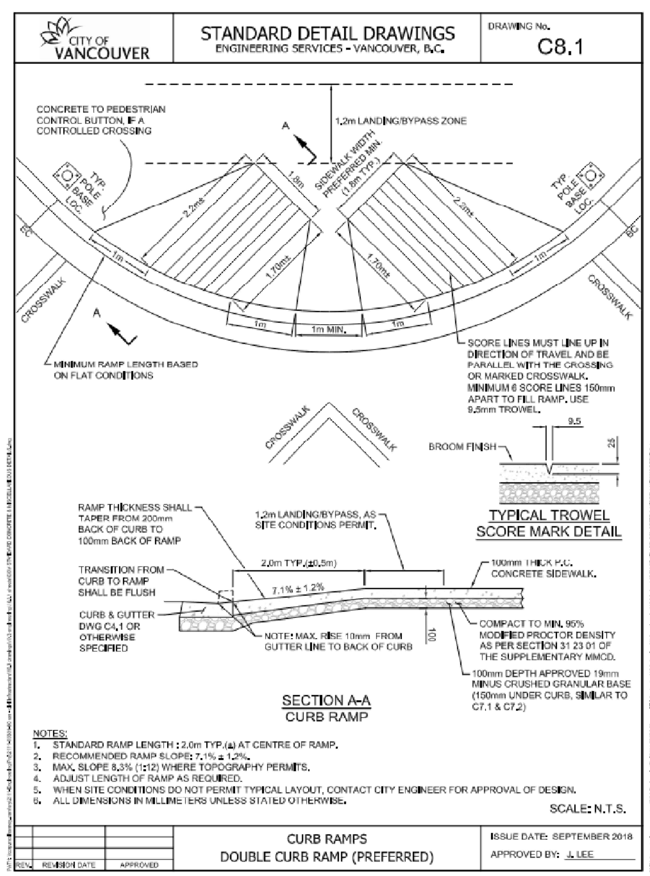


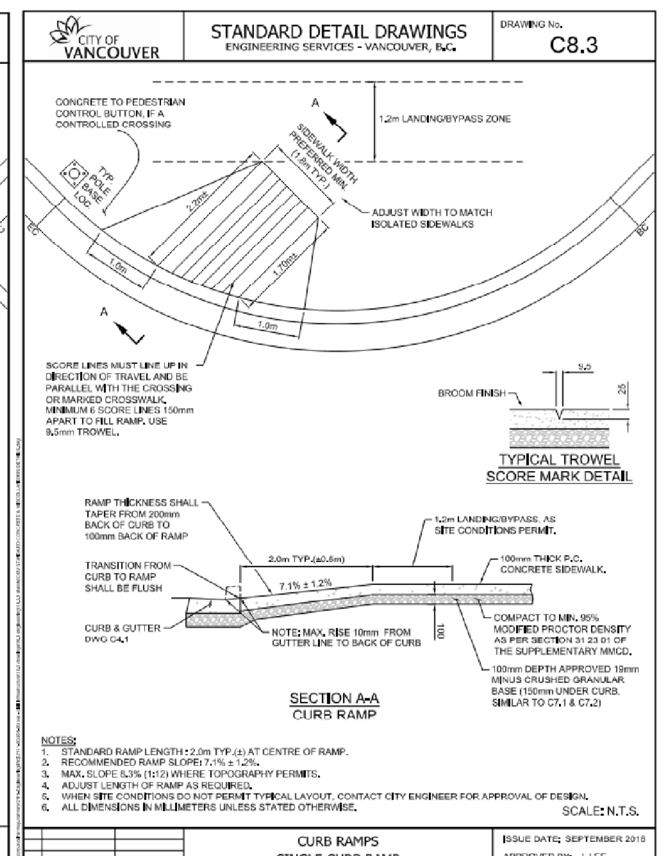


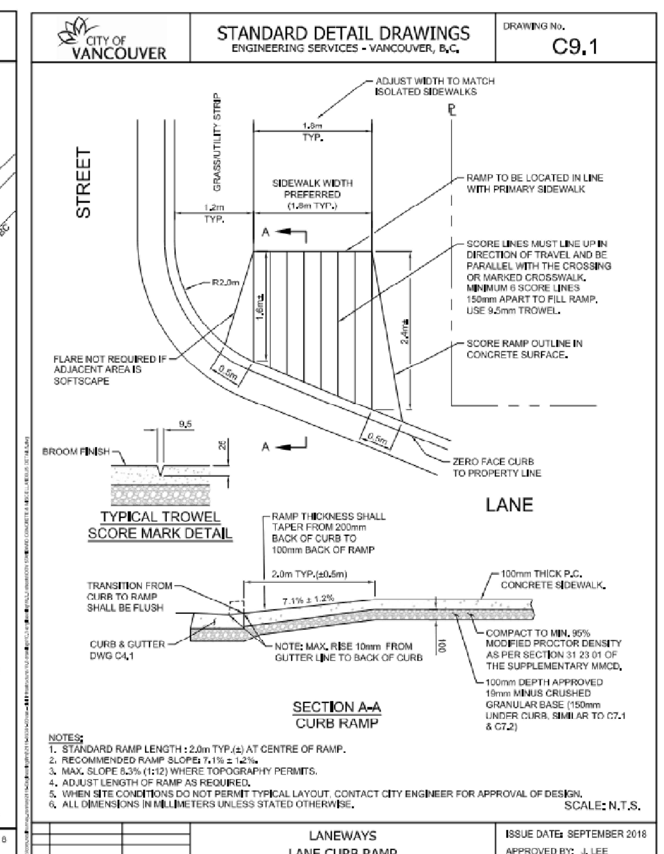












PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

TEAM 9
CIVL 446

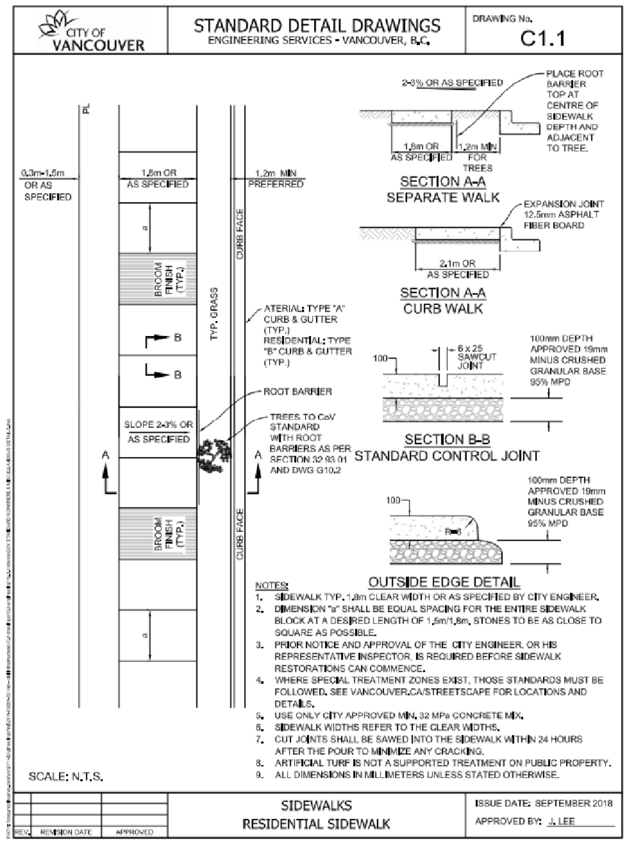
DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

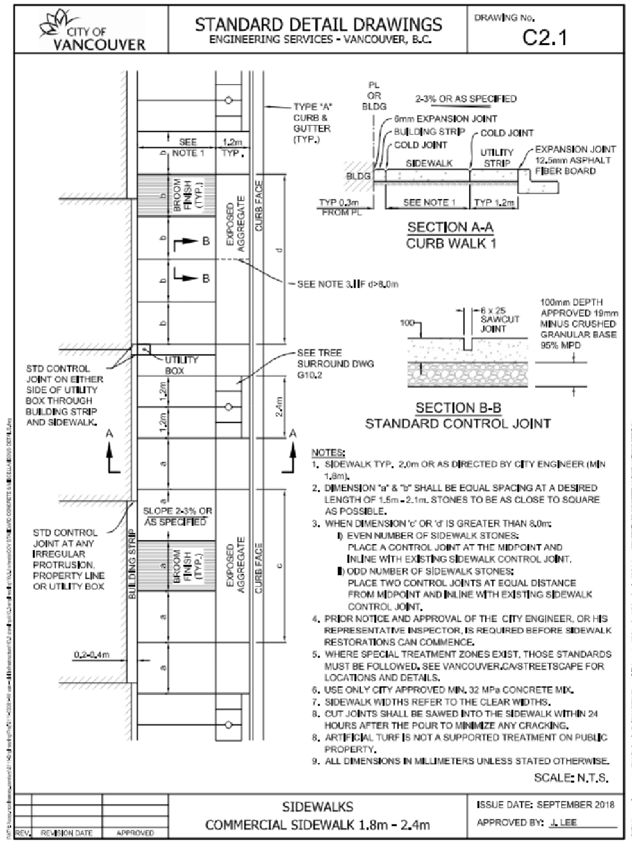
DETAILS

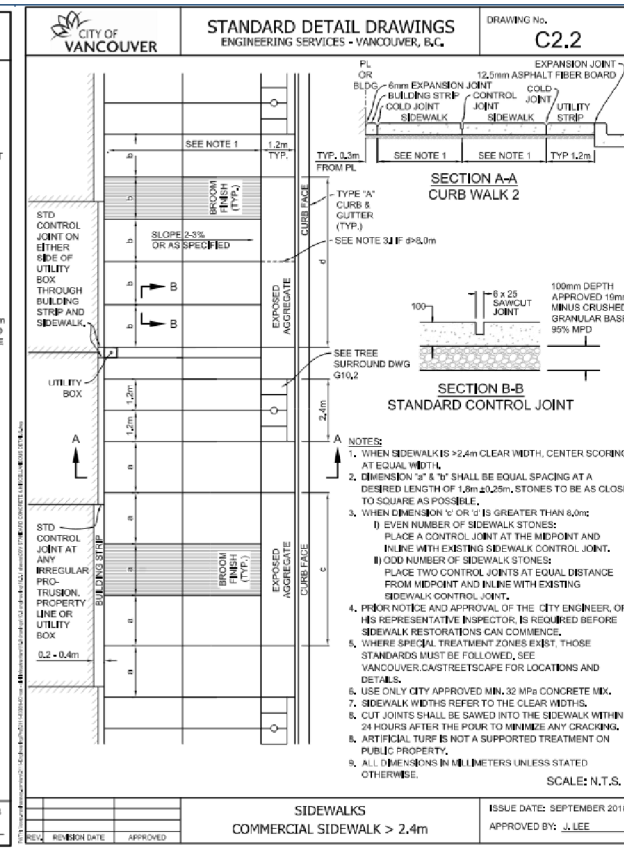
WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS

GEOMETRIC FEATURES

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-221	0







PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

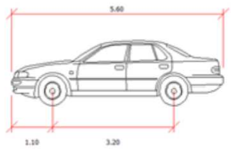
DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

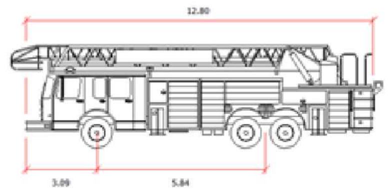
DETAILS

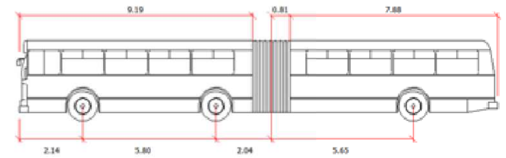
WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS

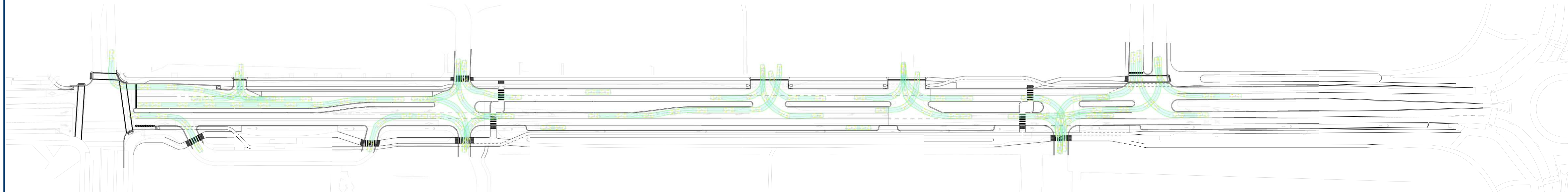
PEDESTRIAN FACILITY DETAILS

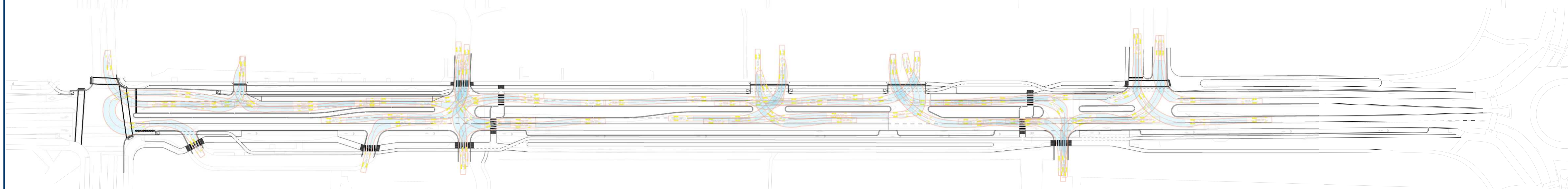
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-222	0

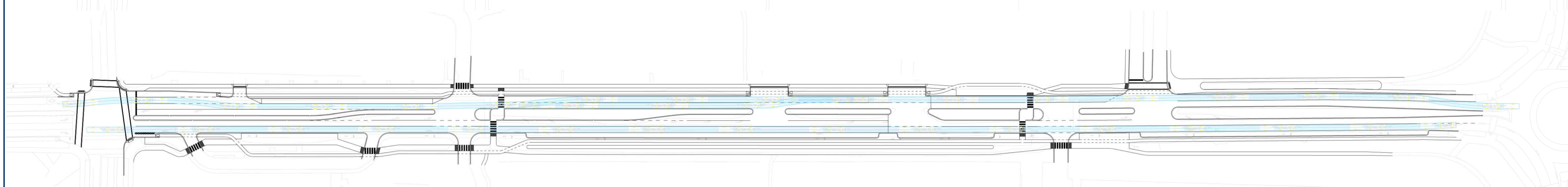

PC (TAC-1984)


SU9 (TAC-1984)


A-BUS (TAX-1999)


PASSENGER CAR TURNING MOVEMENT


FIRE TRUCK TURNING MOVEMENT


ART BUS TURNING MOVEMENT

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

DETAILS

WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS

DESIGN VEHICLE DETAILS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-222	0

CITY OF VANCOUVER — STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No. R8.1

INSTALLATION OF PAVEMENT MARKINGS

TYPE	LINE DIMENSIONS (mm)	COLOR	
		WHITE	YELLOW
SOLID	100	1. EDGELINES ON THE RIGHT 2. LANE LINES PROHIBITING LANE CHANGES	1. EDGELINES ON THE LEFT 2. DIRECTIONAL DIVIDING LINES
BROKEN	100; 3.0m, 6.0m, 3.0m	1. LANE LINES	1. DIRECTIONAL DIVIDING LINES
SHORT BROKEN	100; 1.0m, 1.0m, 1.0m	1. CONTINUITY LINES IN MERGING AND DIVERGING AREAS 2. LEFT TURN BAYS	
DENSE BROKEN	100; 0.5m, 0.5m, 0.5m	1. GUIDE LINES FOR INTERSECTION MOVEMENTS	1. GUIDE LINES FOR INTERSECTION MOVEMENTS
STOP	300	1. STOP LINES	
CROSSWALK	200	1. CROSSWALKS	
ELEPHANT'S FEET	300; 300, 300	1. BIKE CROSSINGS	

NOTE:
1. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

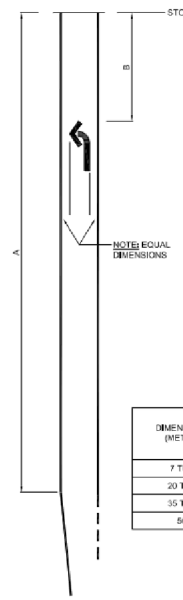
SCALE: N.T.S.

REV. | REVISION DATE | APPROVED

MARKINGS & SIGNAGE
INSTALLATION OF PAVEMENT MARKINGS

ISSUE DATE: SEPTEMBER 2018
APPROVED BY: R. KENNY

CITY OF VANCOUVER — STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No. R8.4



DIMENSION 'A' (METRES)	NUMBER OF ARROWS	DIMENSION 'B'
7 TO 20	1	3m
20 TO 35	2	3m, 18m
35 TO 50	3	3m, 18m, 33m
50 +	4	3m, 18m, 33m, 48m

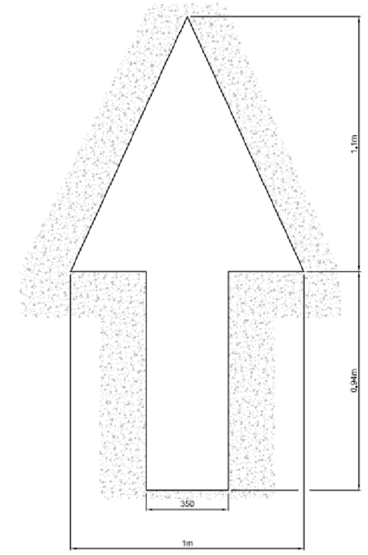
SCALE: N.T.S.

REV. | REVISION DATE | APPROVED

MARKINGS & SIGNAGE
LEFT TURN BAY ARROW INSTALLATION

ISSUE DATE: SEPTEMBER 2018
APPROVED BY: R. KENNY

CITY OF VANCOUVER — STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No. R8.7



NOTE:
1. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

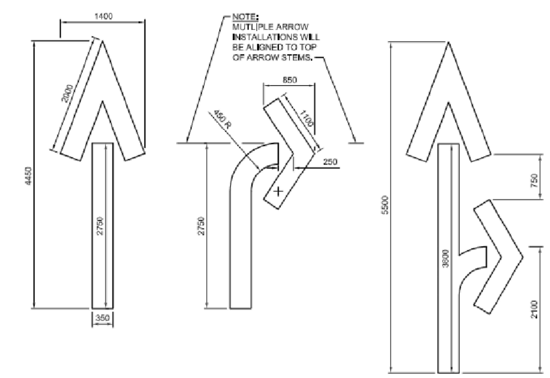
SCALE: N.T.S.

REV. | REVISION DATE | APPROVED

MARKINGS & SIGNAGE
MERGE ARROW

ISSUE DATE: SEPTEMBER 2018
APPROVED BY: R. KENNY

CITY OF VANCOUVER — STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No. R8.5



NOTE:
1. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

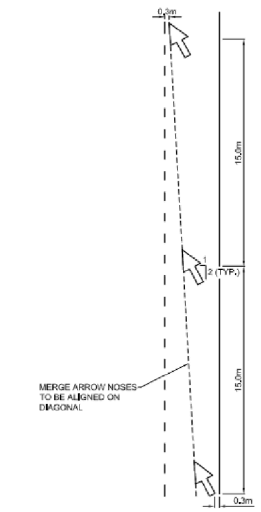
SCALE: N.T.S.

REV. | REVISION DATE | APPROVED

MARKINGS & SIGNAGE
TURN ARROWS

ISSUE DATE: SEPTEMBER 2018
APPROVED BY: R. KENNY

CITY OF VANCOUVER — STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No. R8.6



NOTE:
1. WHEN MORE OR LESS THAN 3 ARROWS ARE REQUIRED, ALL ARROWS ARE TO BE PLACED IN THE CENTER OF THE LANE.

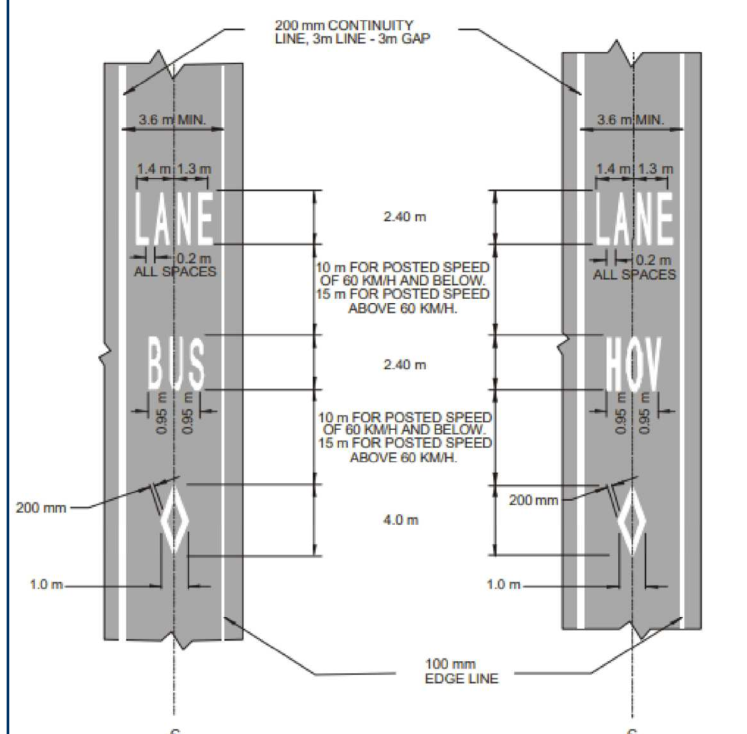
SCALE: N.T.S.

REV. | REVISION DATE | APPROVED

MARKINGS & SIGNAGE
TYPICAL MERGE ARROW PLACEMENT

ISSUE DATE: SEPTEMBER 2018
APPROVED BY: R. KENNY

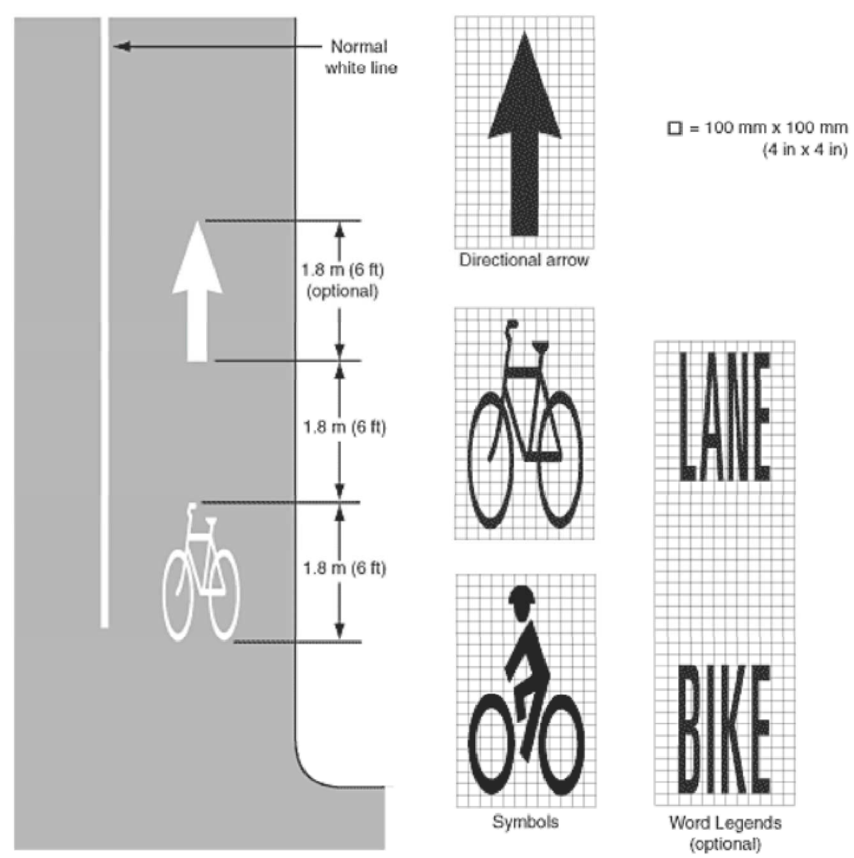
Reserved Lane Markings



NOTE: BUS AND HOV PAVEMENT MARKING SYMBOLS AND WORDED MESSAGES ARE TO BE REPEATED AT 200 m TO 280 m INTERVALS DEPENDING ON THE OVERALL LENGTH AND CONTINUITY OF THE LANE

LETTERING DIMENSIONS SHALL CONFORM WITH TAC STANDARDS AS PER THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA. SEE APPENDIX A-2.

Figure 9C-6. Example of Optional Word and Symbol Pavement Markings for Bicycle Lanes



REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

PLOT DATE 2022-04-06

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

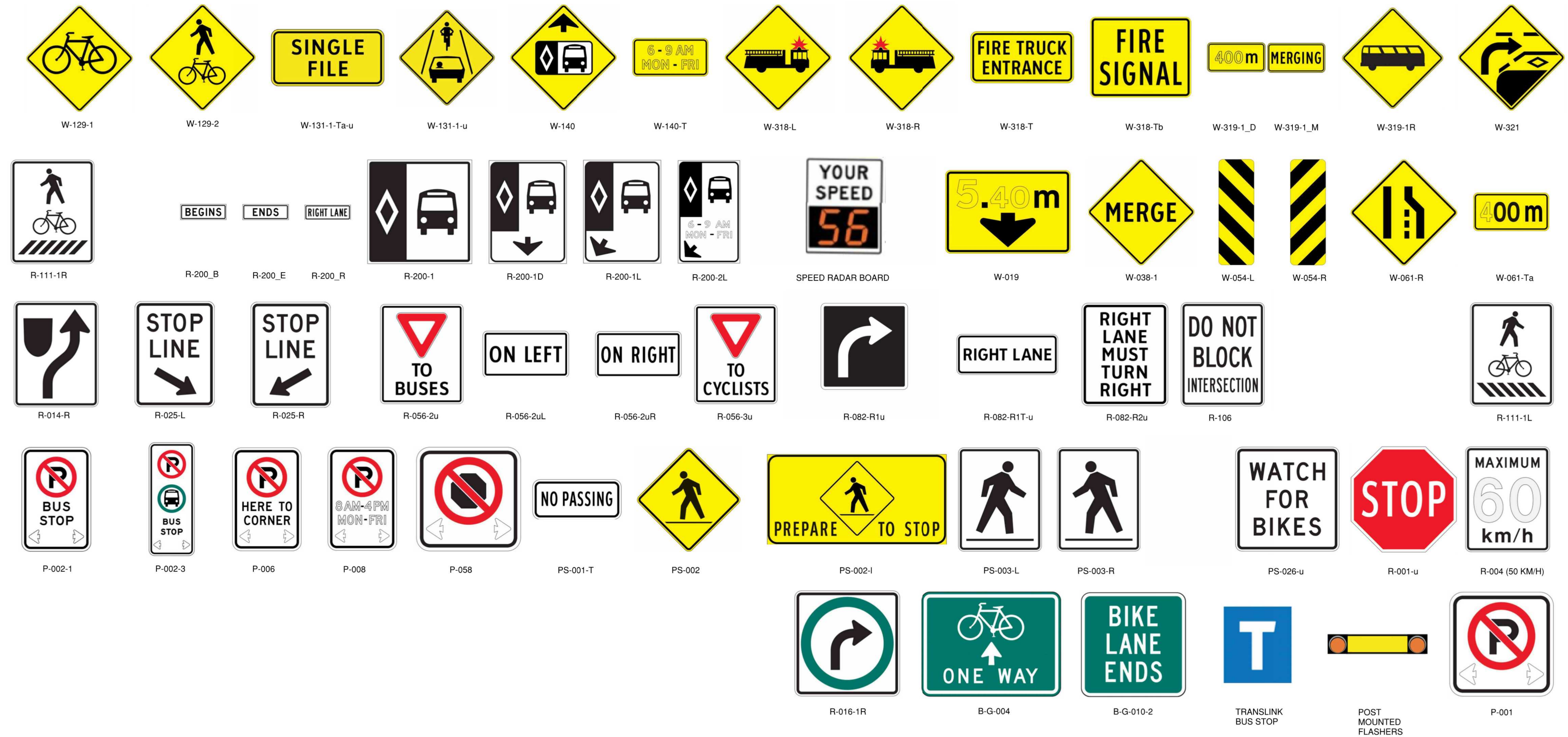
TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

DETAILS
WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS
PAVEMENT MARKING DETAILS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-222	0



PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

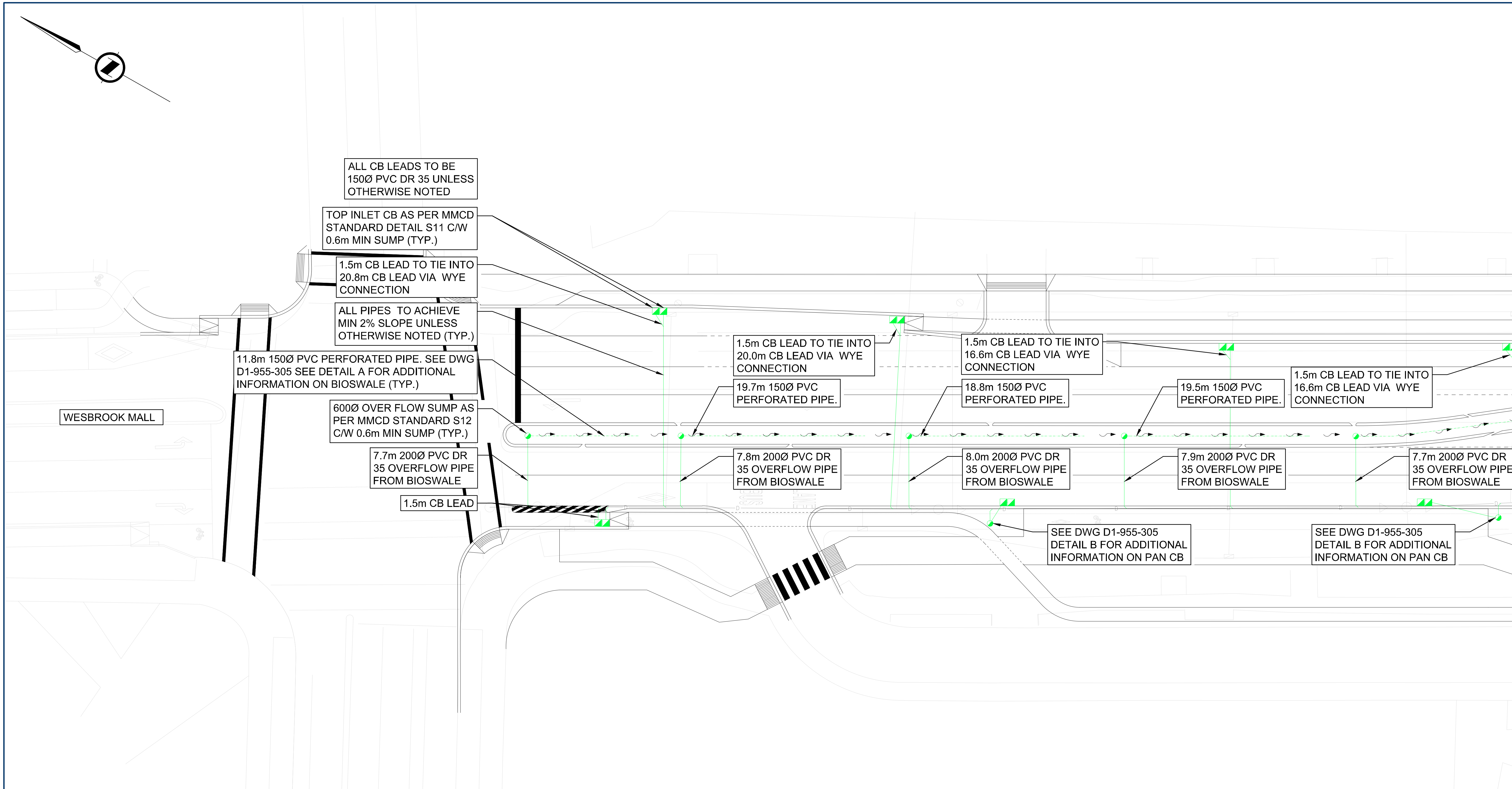
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

DETAILS

WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS

TRAFFIC SIGN DETAILS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-225	0



REFERENCE DRAWINGS	
DETAILS/NOTES	D1-955-305

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

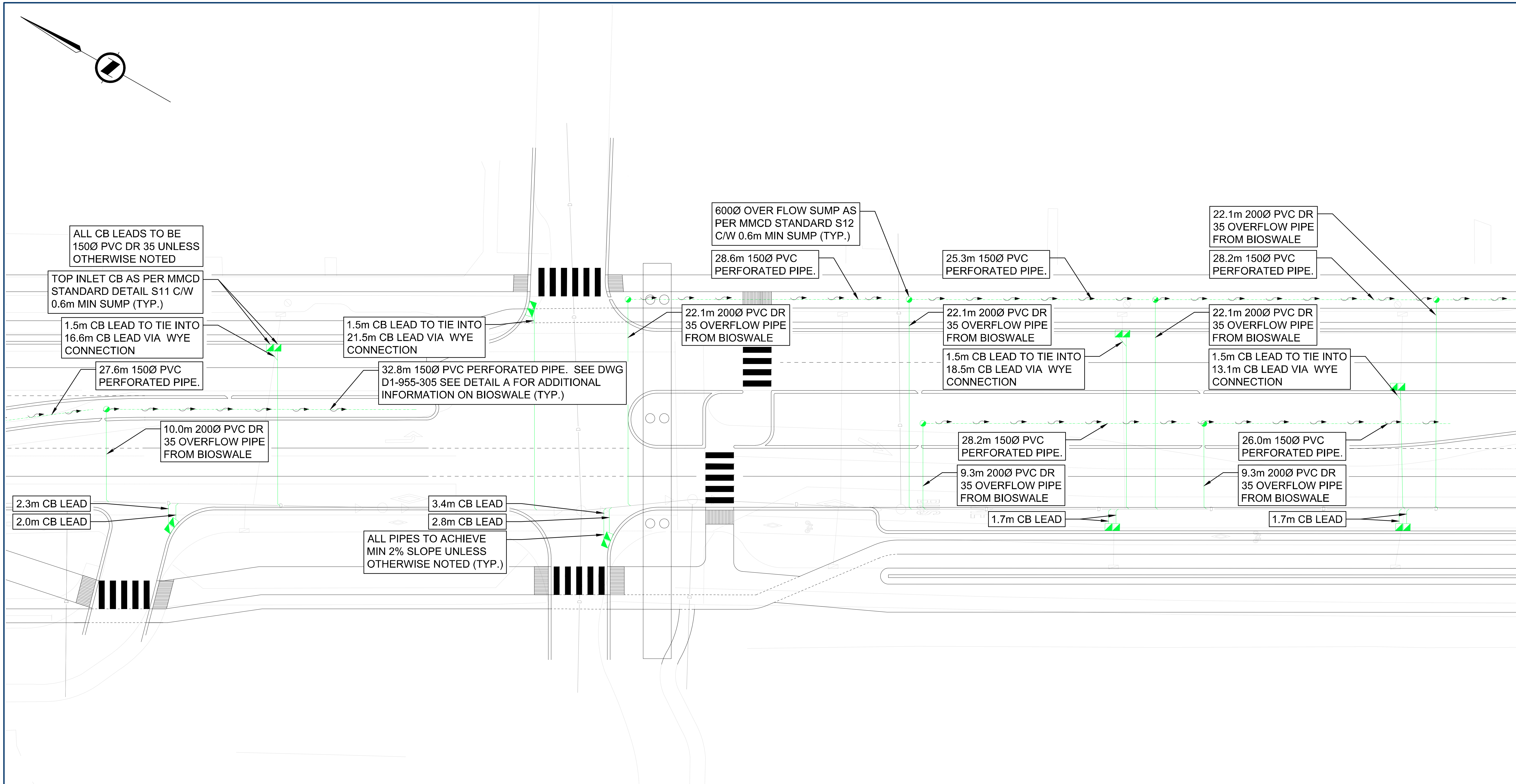
DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - DRAINAGE

THUNDERBIRD BLVD TO GREENWOOD COMMONS DRIVEWAY ACCESS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-300	0



REFERENCE DRAWINGS
DETAILS/NOTES D1-955-305

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

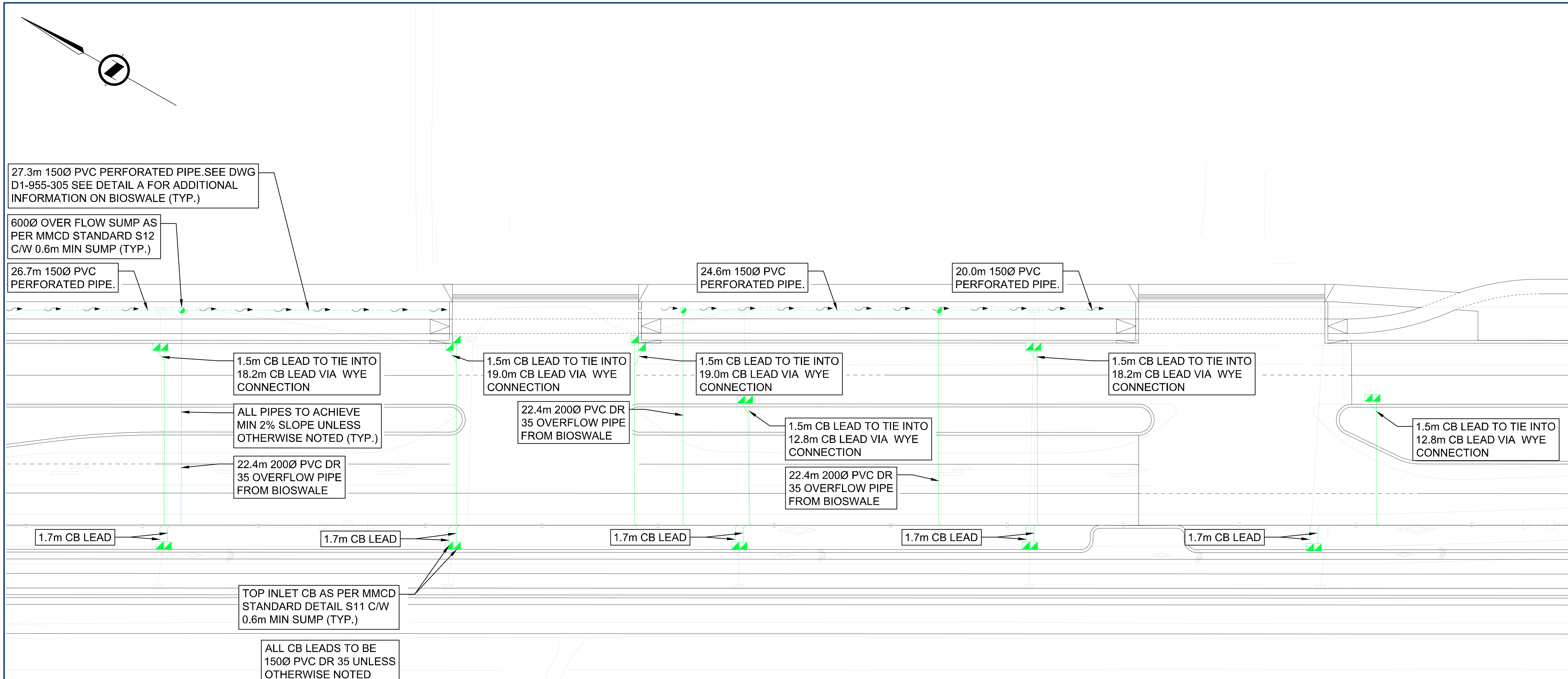
TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN
WESBROOK MALL PHASE 4
REDESIGN - DRAINAGE
GREENWOOD COMMONS DRIVEWAY ACCESS TO RCMP DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-301	0



REFERENCE DRAWINGS
DETAILS/NOTES D1-955-305

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

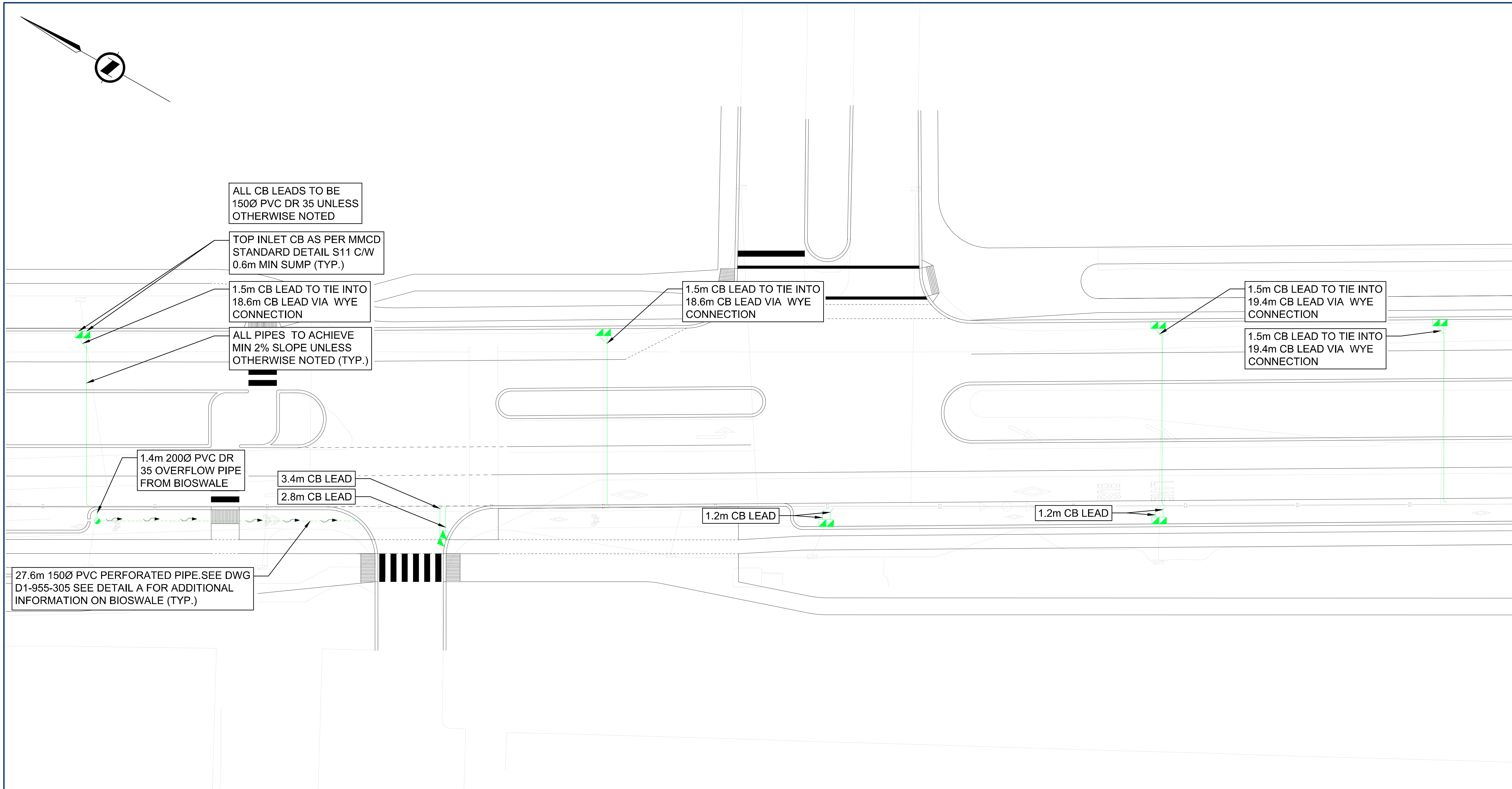
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - DRAINAGE

RCMP DRIVEWAY TO FIRE HALL DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-302	0



REFERENCE DRAWINGS
DETAILS/NOTES D1-955-305

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

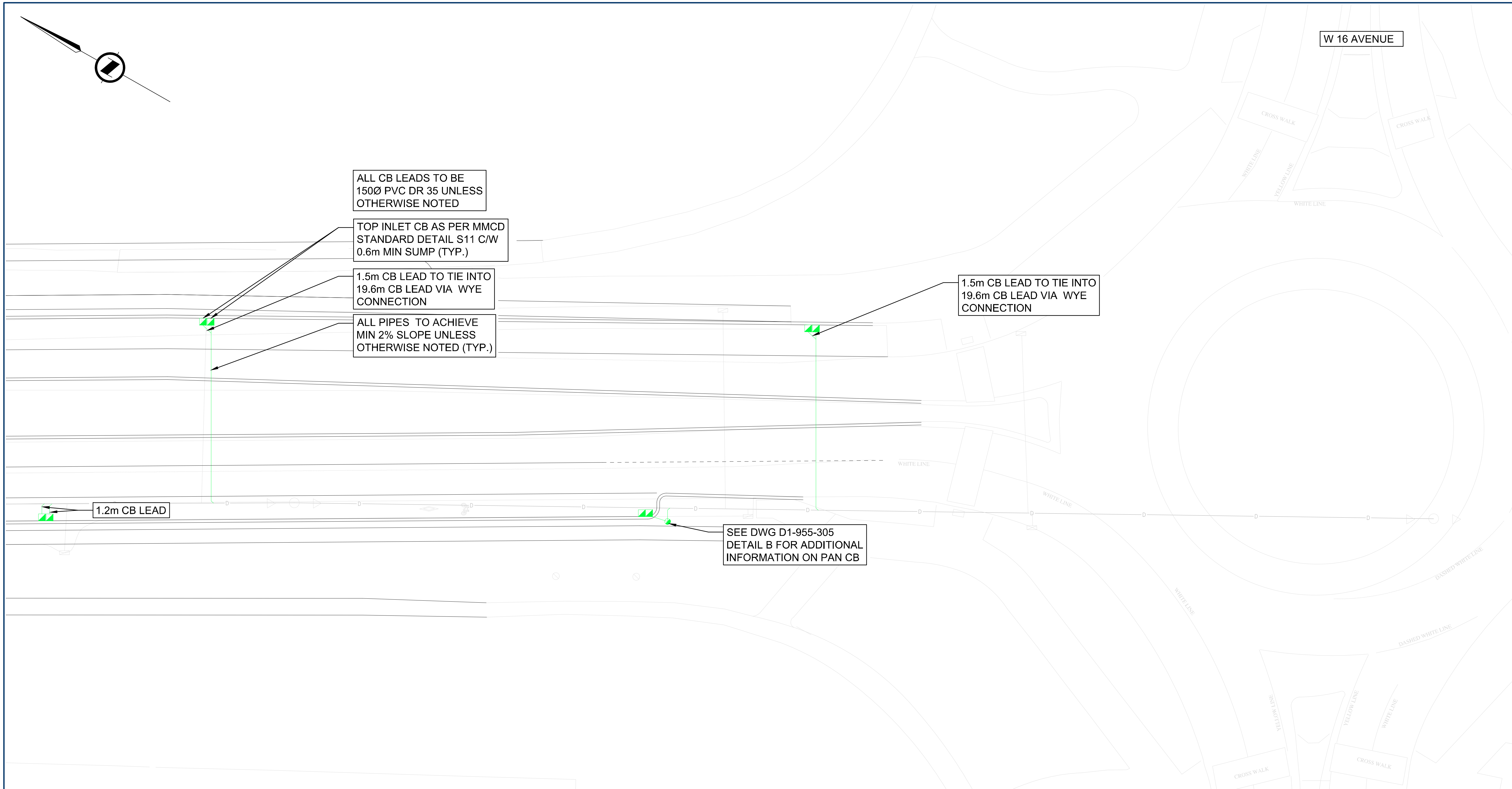
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - DRAINAGE

FIRE HALL DRIVEWAY TO HAMPTON PLACE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-303	0



REFERENCE DRAWINGS
DETAILS/NOTES D1-955-305

INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

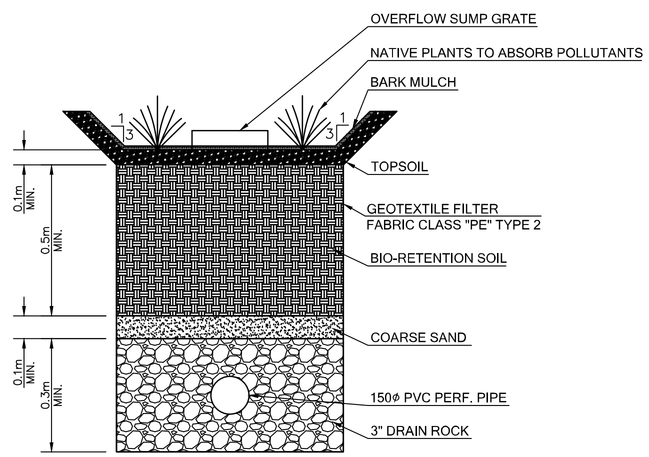
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - DRAINAGE

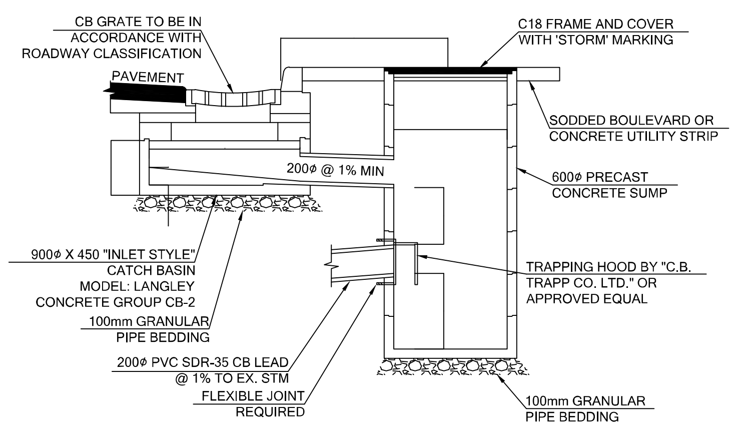
HAMPTON PLACE TO W 16 AVENUE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-304	0



DETAIL A: BIOSWALE DETAILS

SCALE: NTS.



DETAIL B: PAN CATCH BASIN DETAILS

SCALE: NTS.

DRAINAGE LEGEND

(symbol)	PROPOSED TOP INLET CATCH BASIN (MMCD STANDARD DRAWING S11)
(symbol)	PROPOSED 600ϕ LAWN DRAIN (MMCD STANDARD DRAWING S12)
(symbol)	PROPOSED STORM SEWER SERVICE CONNECTION
(symbol)	PROPOSED PERFORATED PIPE
(symbol)	SWALE DENOTING DIRECTION OF FLOW

STORM SEWERS:

1. ALL OFFSITE WORKS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE LATEST EDITIONS OF THE UBC DESIGN CRITERIA MANUAL, THE AND MMCD PLATINUM EDITION", THE MASTER MUNICIPAL CONSTRUCTION DOCUMENTS (MMCD), THE UBC STANDARD CONSTRUCTION DOCUMENTS (GENERAL CONDITIONS, SUPPLEMENTARY SPECIFICATIONS AND SUPPLEMENTARY STANDARD DRAWINGS AND ALL OTHER APPLICABLE MUNICIPAL BYLAWS AND POLICIES, UNLESS NOTED OTHERWISE.
2. THE DEVELOPER SHALL BE RESPONSIBLE FOR CONTACTING ALL PROPERTY OWNERS WHOSE LAND WILL BE AFFECTED BY THE PROPOSED WORKS ONE MONTH IN ADVANCE OF COMMENCEMENT OF CONSTRUCTION. THIS APPLIES PARTICULARLY WHERE WORKS WILL ENCROACH ON PRIVATE LANDS SUCH AS FILL SLOPES FROM RAISED ROADWAYS, INSTALLATION OF INSPECTION CHAMBERS AND CONSTRUCTION OF SANITARY SEWERS IN EASEMENTS. THE DEVELOPER SHALL OBTAIN FROM THE PRIVATE PROPERTY OWNERS WRITTEN PERMISSIONS FOR ANY INCURSIONS ONTO THEIR LANDS AS STATED ABOVE.
3. ELEVATIONS OF EXISTING UNDERGROUND UTILITIES SHALL BE PROVEN IN THE FIELD PRIOR TO COMMENCEMENT OF CONSTRUCTION BY THE DEVELOPER. WHERE THE POSSIBILITY OF DAMAGE TO EXISTING UNDERGROUND UTILITIES MAY BE CAUSED BY NEW CONSTRUCTION SHOWN ON THESE PLANS, SUCH UTILITIES SHALL BE EXPOSED, RAISED/LOWERED, RELOCATED OR, IF NECESSARY, REMOVED BY THE OWNER OF THE UTILITY AT THE DEVELOPERS EXPENSE.
4. ALL CONNECTIONS TO THE EXISTING DRAINAGE SYSTEM ARE TO TO BE CARRIED OUT BY THE CONTRACTOR UNLESS OTHERWISE NOTED.
5. NOTIFY THE UBC 48 HOURS IN ADVANCE OF ANY CONSTRUCTION OR UTILITY RELOCATION.
6. REPORT ANY DISCREPANCIES TO TEAM 9 CONSULTING PRIOR TO CONSTRUCTION.
7. RESTORATION OF EXISTING DRIVEWAYS AND WALKWAYS TO CONFORM TO THE UBC SPECIFICATIONS AND TO THE IMPACTED PROPERTY OWNERS' WRITTEN ACCEPTANCE.
8. ALL MANHOLE AND CATCH BASIN LIDS SHOWN ON CONTRACT DRAWINGS ARE TO FINISHED GRADE ELEVATIONS.
9. ELEVATION OF MANHOLE LID AND CATCH BASIN ON PAVEMENT TO BE SET TO TOP OF BASE COURSE ELEVATION, WHEN THE FINAL LIFT IS LAID (AT A LATER DATE) THE MANHOLE LID AND CATCH BASIN GRATE ARE TO BE RAISED TO FINISHED GRADE AT DEVELOPERS COST.
10. ALL CATCH BASIN LEADS TO BE 150 mm IN DIAMETER AT 2.0% SLOPE MIN. UNLESS OTHERWISE NOTED.
11. OFFSET OF ALL INSPECTION CHAMBERS (IC) TO BE IN ACCORDANCE WITH THE CURRENT UBC STANDARDS.
12. ALL EXISTING ICs AND X–DRAINS ARE TO BE FLUSHED TO ENSURE PROPER WORKING ORDER AND REPLACED IF NECESSARY.
13. MARK ALL CAPPED STUB ENDS WITH STAKE IN ACCORDANCE WITH MMCD.
14. ALL GAS AND WATER CONNECTIONS CROSSING UNDER DITCHES ARE TO BE LOCATED AND ADJUSTED FOR THE STORM SEWER INSTALLATION BEFORE BACKFILLING OF TRENCH AT DEVELOPERS COST.
15. SYMBOL SHOWN THUS INDICATES FLOW DIRECTION
16. BOULEVARDS ARE TO BE CONSTRUCTED TO THE CURRENT EDITION OF THE MASTER MUNICIPAL CONSTRUCTION DOCUMENTS (MMCD) AND CITY OF DELTA STANDARDS UNLESS OTHERWISE SHOWN ON CONTRACT DRAWINGS. BOULEVARDS TO BE SLOPED TO ICs WHERE APPLICABLE.

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

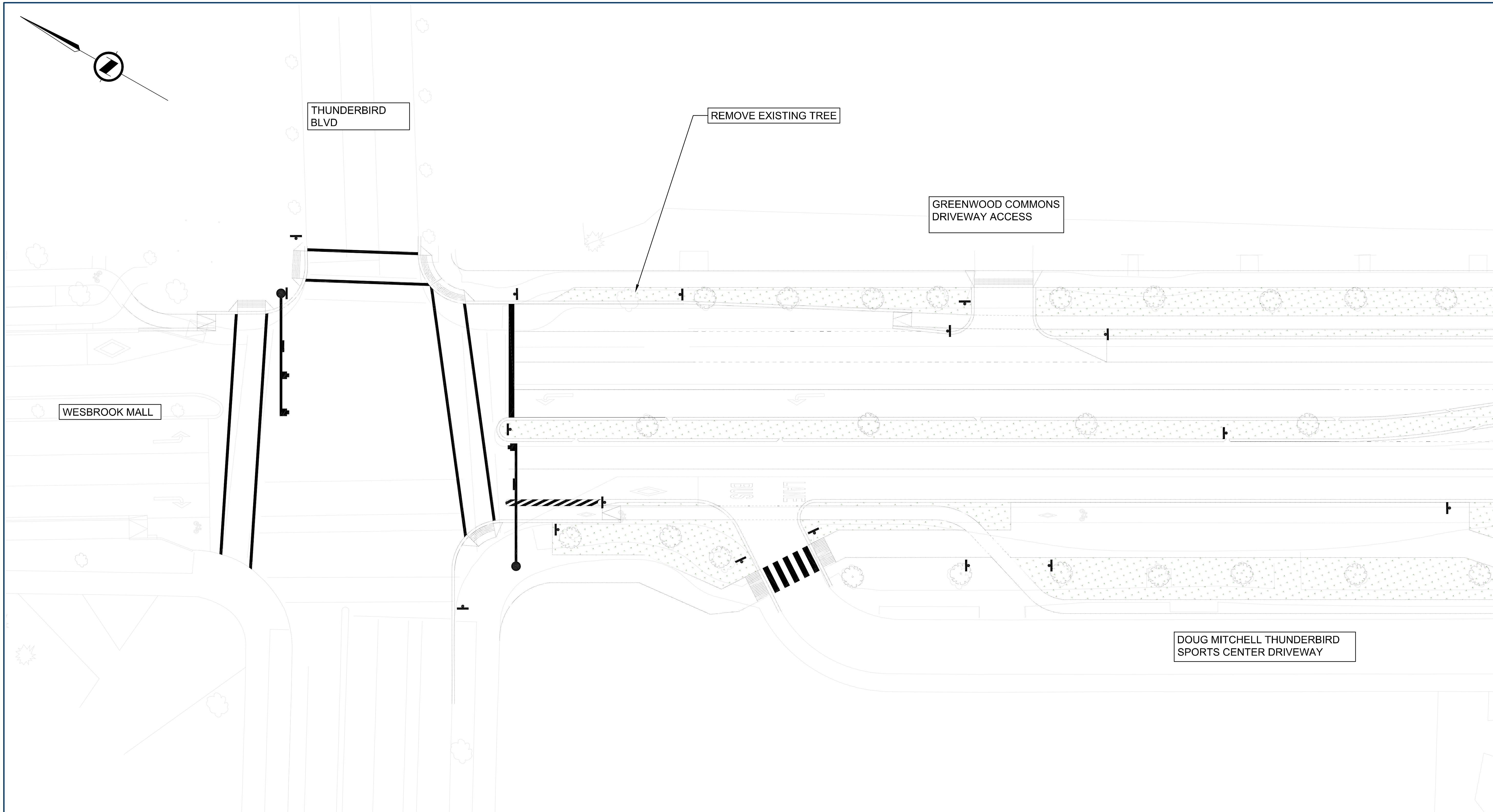
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

NOTES & DETAILS

WESBROOK MALL PHASE 4
REDESIGN - ROADWORKS

HAMPTON PLACE TO W 16 AVENUE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-100	0



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SEE DWG D1-955-305 DETAIL A FOR ADDITIONAL INFORMATION ON BIOSWALE (TYP)

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

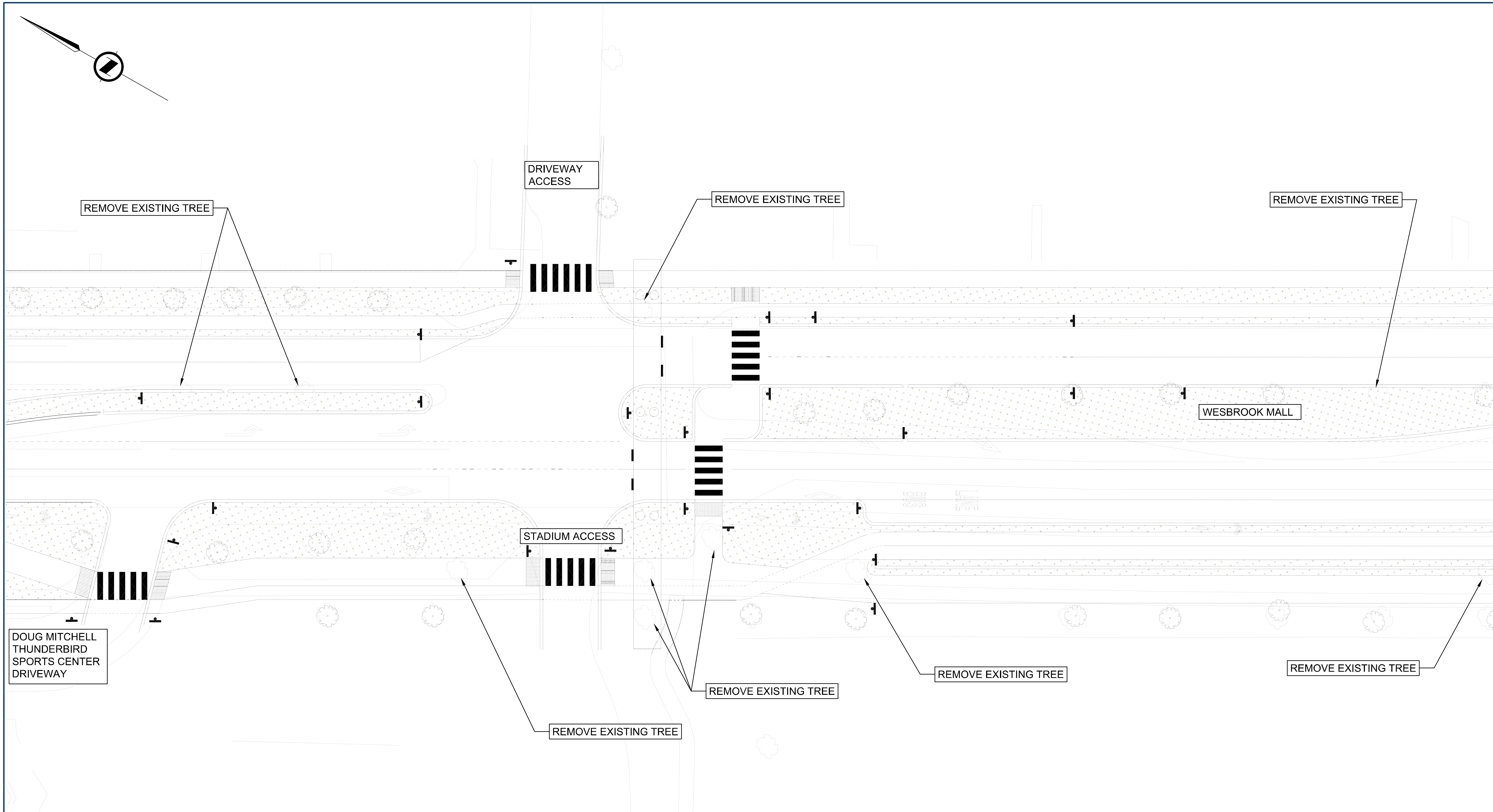
DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LANDSCAPE

THUNDERBIRD BLVD TO GREENWOOD COMMONS DRIVEWAY ACCESS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-400	0



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SEE DWG D1-955-305 DETAIL A FOR ADDITIONAL INFORMATION ON BIOSWALE (TYP)

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

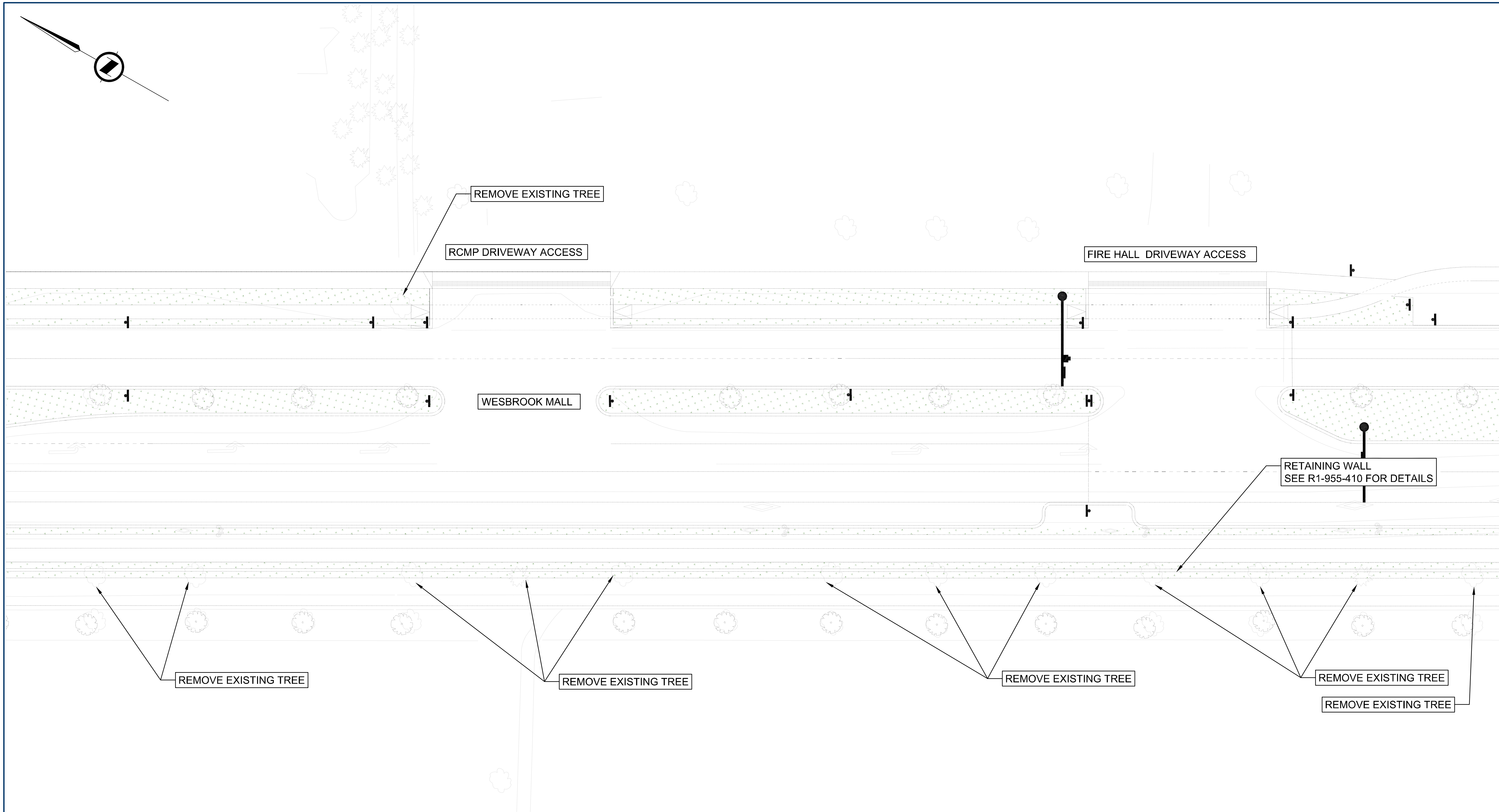
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LANDSCAPE

GREENWOOD COMMONS DRIVEWAY ACCESS TO RCMP DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-401	0



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SEE DWG D1-955-305 DETAIL A FOR ADDITIONAL INFORMATION ON BIOSWALE (TYP)

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

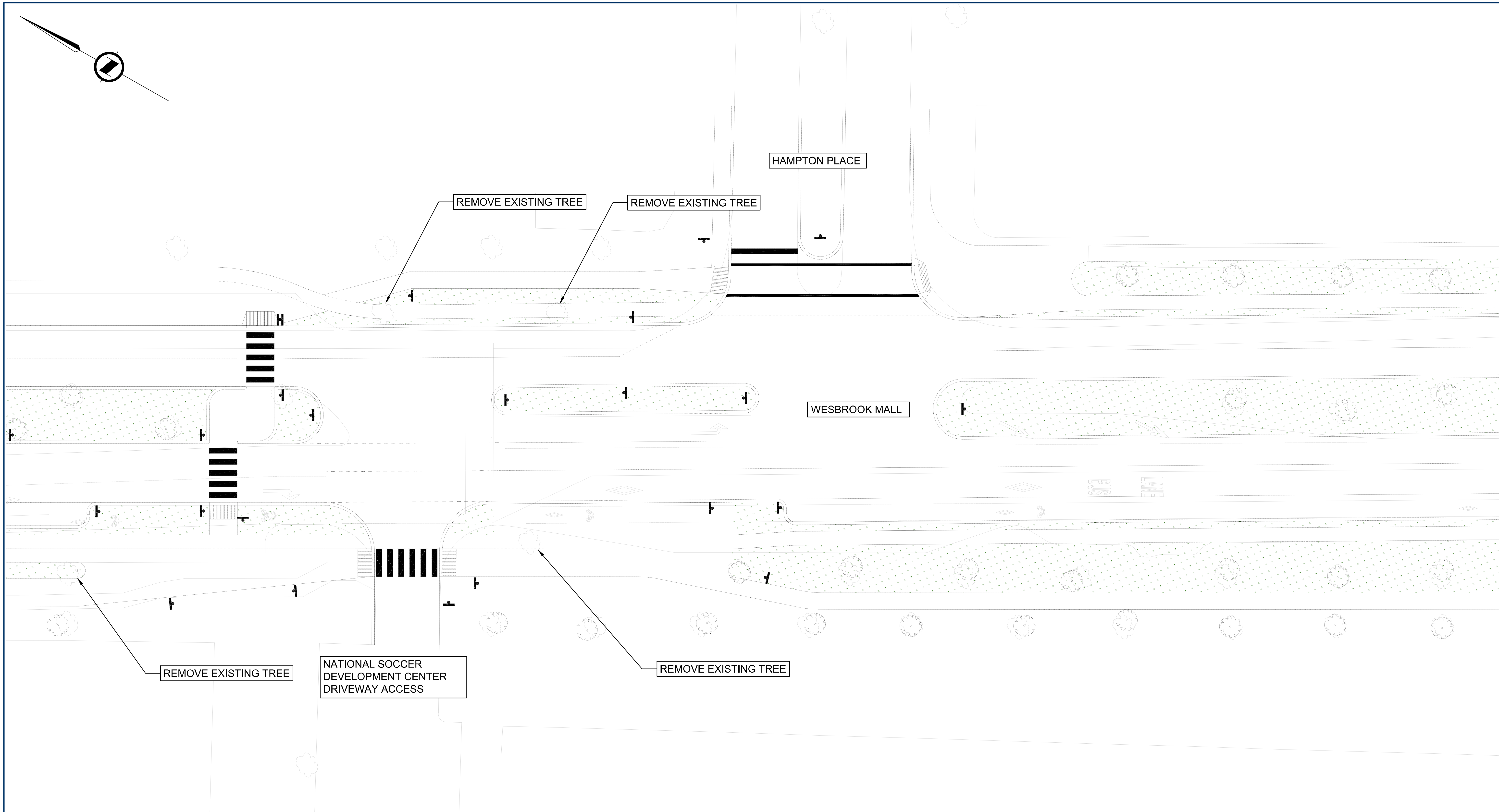
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LANDSCAPE

RCMP DRIVEWAY TO FIRE HALL DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-402	0



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SEE DWG D1-955-305 DETAIL A FOR ADDITIONAL INFORMATION ON BIOSWALE (TYP)

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

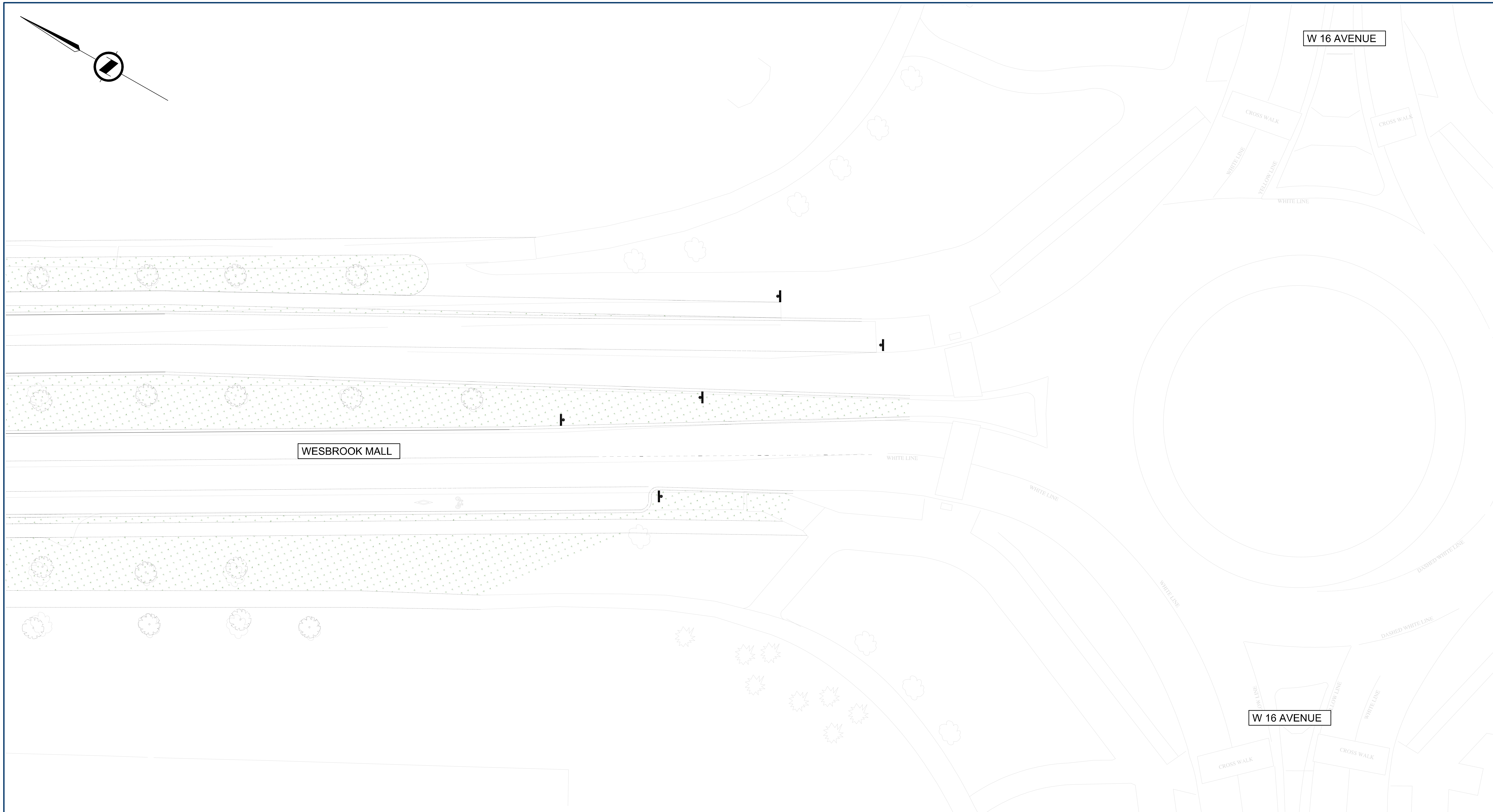
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LANDSCAPE

FIRE HALL DRIVEWAY TO HAMPTON PLACE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-403	0



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SEE DWG D1-955-305 DETAIL A FOR ADDITIONAL INFORMATION ON BIOSWALE (TYP)

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

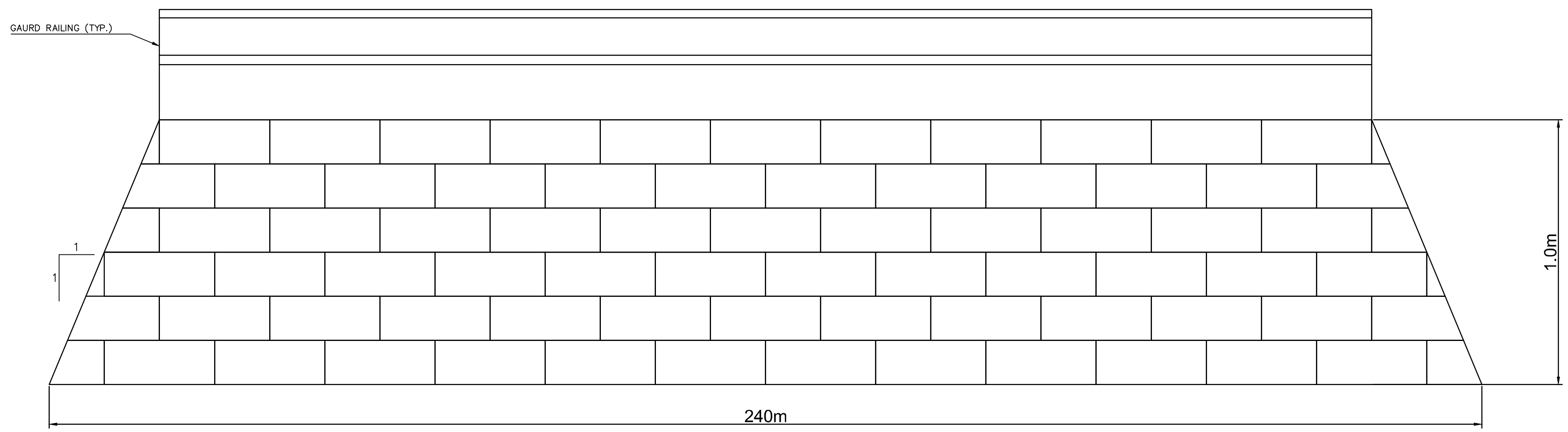
H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

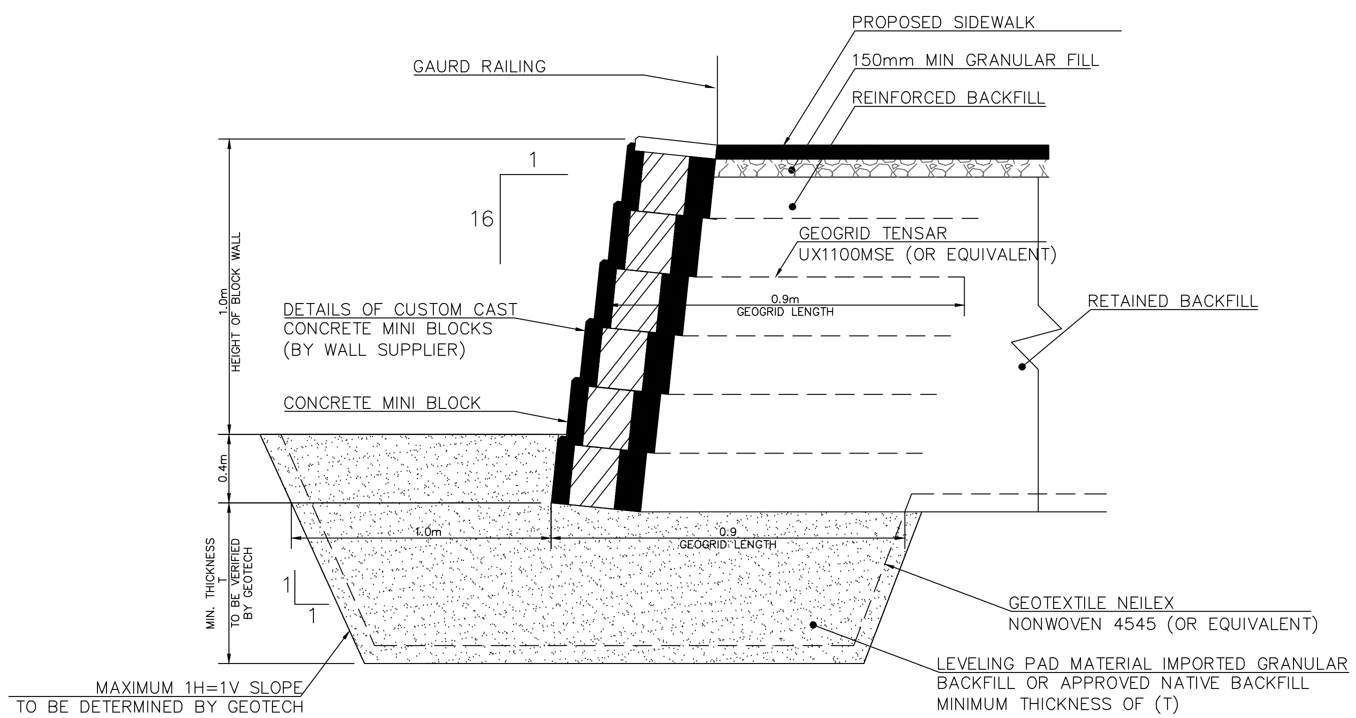
PLAN

WESBROOK MALL PHASE 4
REDESIGN - LANDSCAPE
HAMPTON PLACE TO W 16 AVENUE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-404	0



RETAINING WALL SECTION
SCALE: NTS.



RETAINING WALL DETAIL
SCALE: NTS.

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

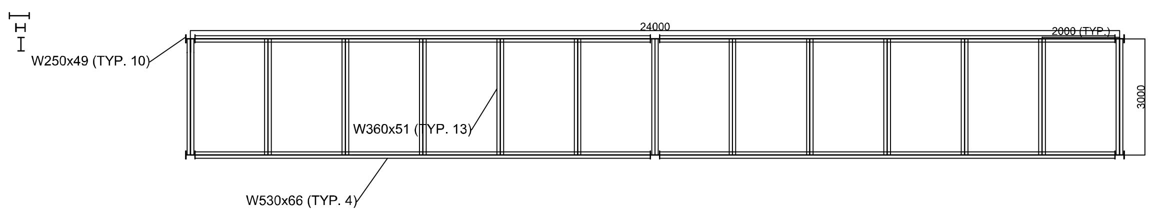
DETAILS

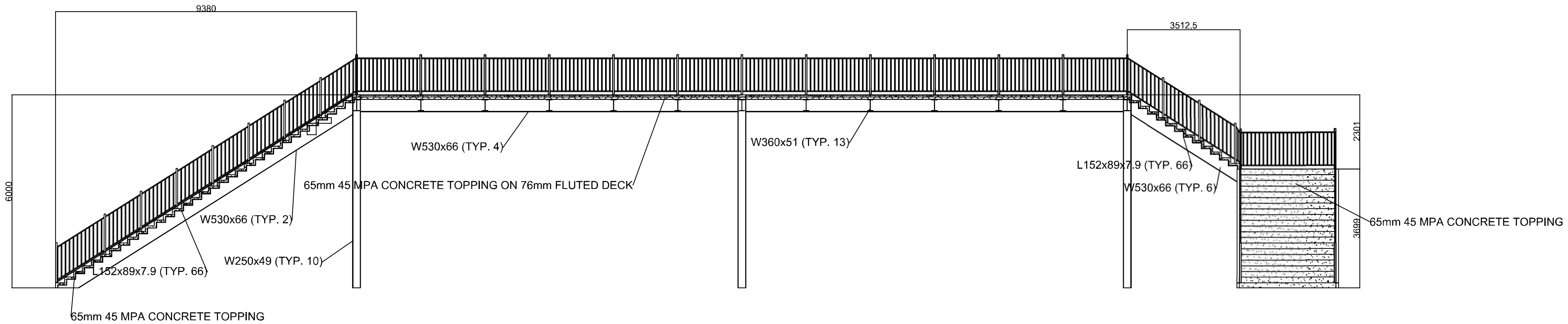
WESBROOK MALL PHASE 4
REDESIGN - RETAINING WALL

RETAINING WALL PLAN AND DETAILS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-410	0

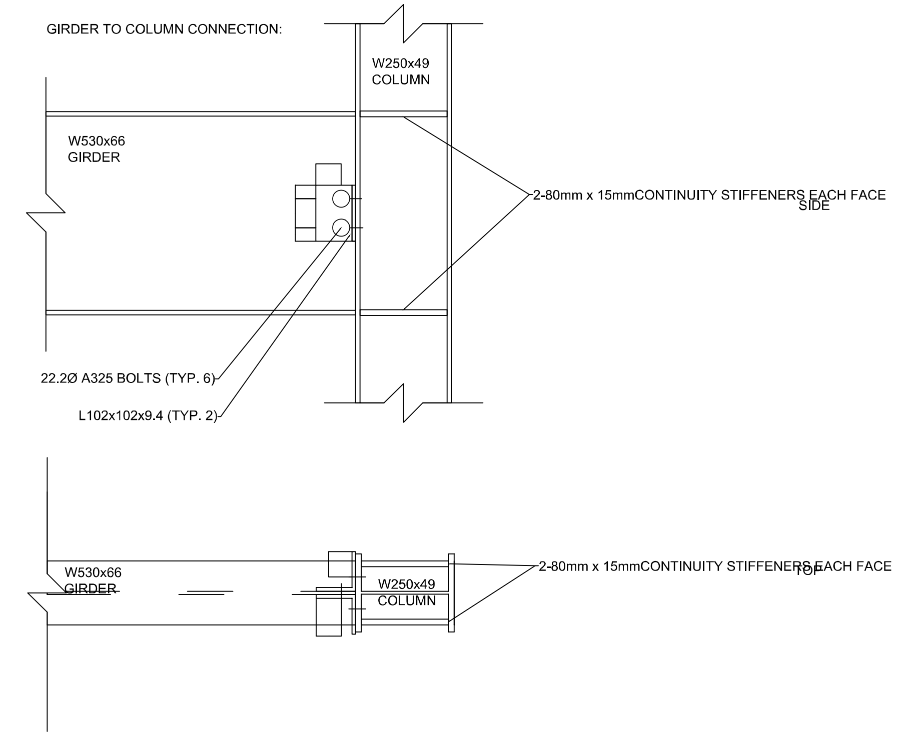
FRAMING PLAN



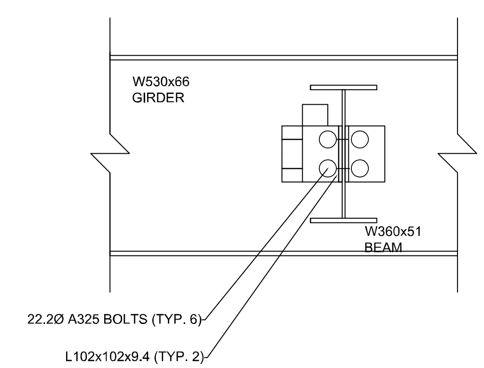


SIDE VIEW LOOKING NORTH

GIRDER TO COLUMN CONNECTION:

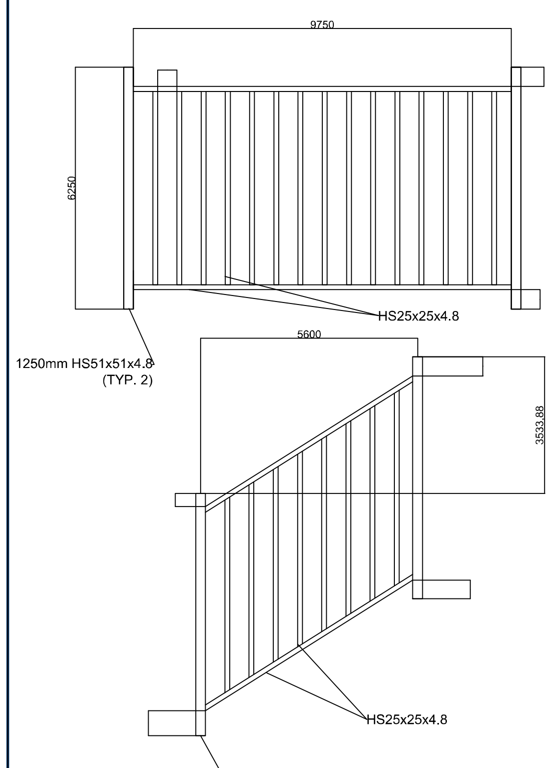


BEAM TO GIRDER CONNECTION:

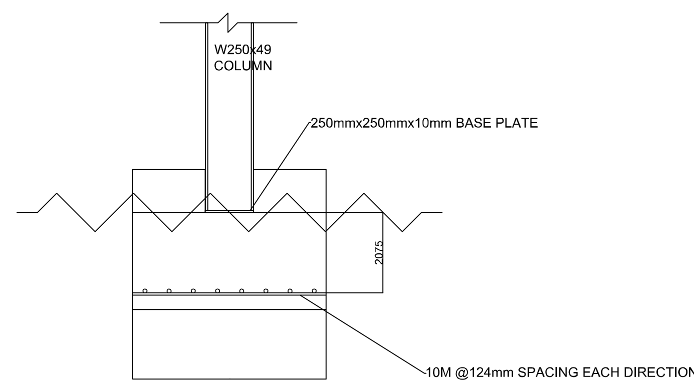


DETAILS:

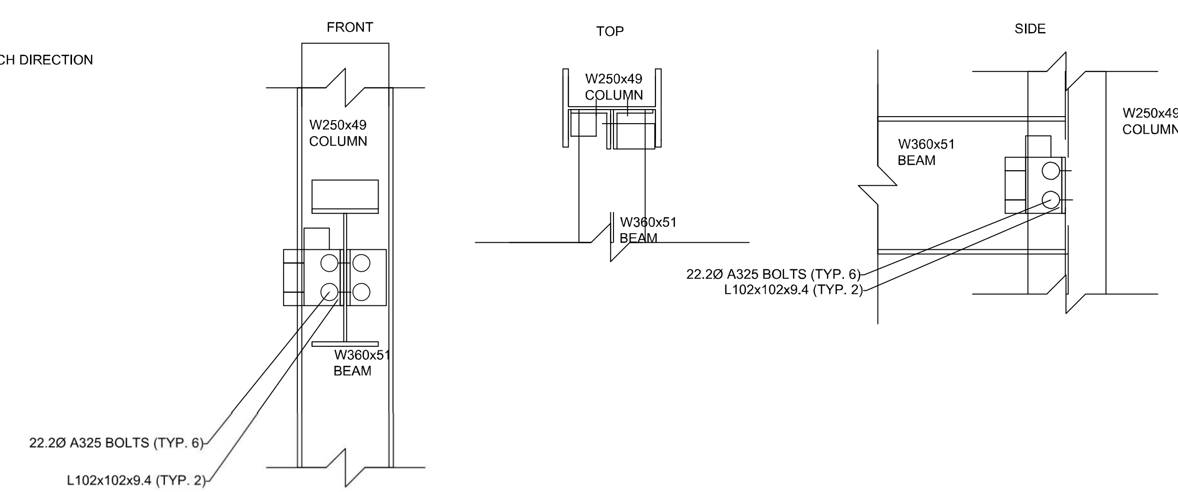
RAILING DESIGN:



FOOTING DESIGN:



BEAM TO COLUMN CONNECTION:



PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

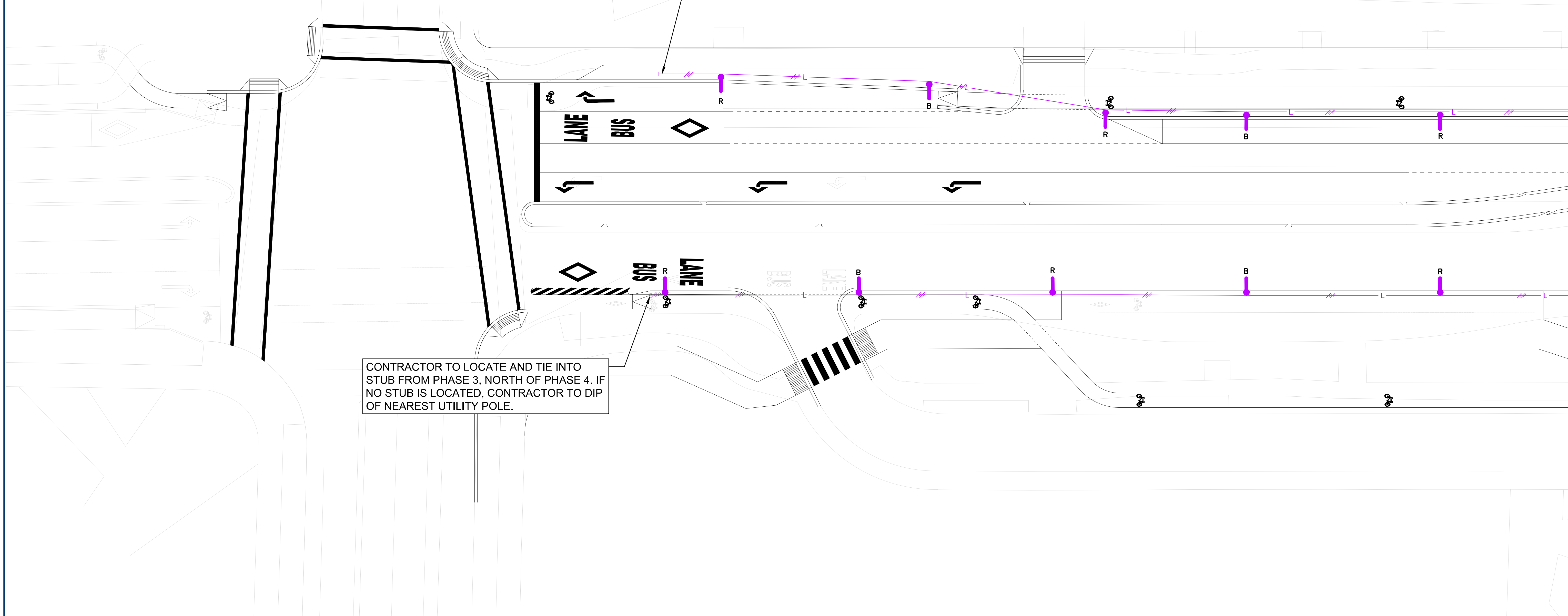
STRUCTURAL
WESBROOK MALL PHASE 4 REDESIGN - ROADWORKS
TRAFFIC SIGN DETAILS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-500	0

STREET LIGHTING LEGEND

- PROPOSED 9.1m 124W LED ATB0-P304-R2-4K DAVIT STREET LIGHT POLE
- R — LUMINAIRE ON RED PHASE CONDUCTOR
- B — LUMINAIRE ON BLACK PHASE CONDUCTOR
- L — PROPOSED 2 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN PROPOSED 32mm R.PVC CONDUIT
- C.O. — PROPOSED 32mm RIGID PVC (CONDUIT ONLY) FOR FUTURE EXTENSIONS
- L — EXISTING 3 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN EXISTING 32mm R.PVC CONDUIT

ITEM	DESIGN REQUIREMENTS	DESIGN ACHIEVED
STREET NAME(S)	WESBROOK MALL	
PEDESTRIAN CONFLICT	HIGH	
ROAD CLASSIFICATION	ARTERIAL	
ILLUMINATION TYPE	9.1m HIGH 124W LED- ATB0-P304-R2-4K	
SPACING (MAX)	20m	20m
ILLUMINANCE LEVEL (AVG.)	17.0 LUX	19.5 LUX
ILLUMINANCE UNIFORMITY RATIO (AVG.:MIN.)	3.0:1	3.0:1



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LIGHTING

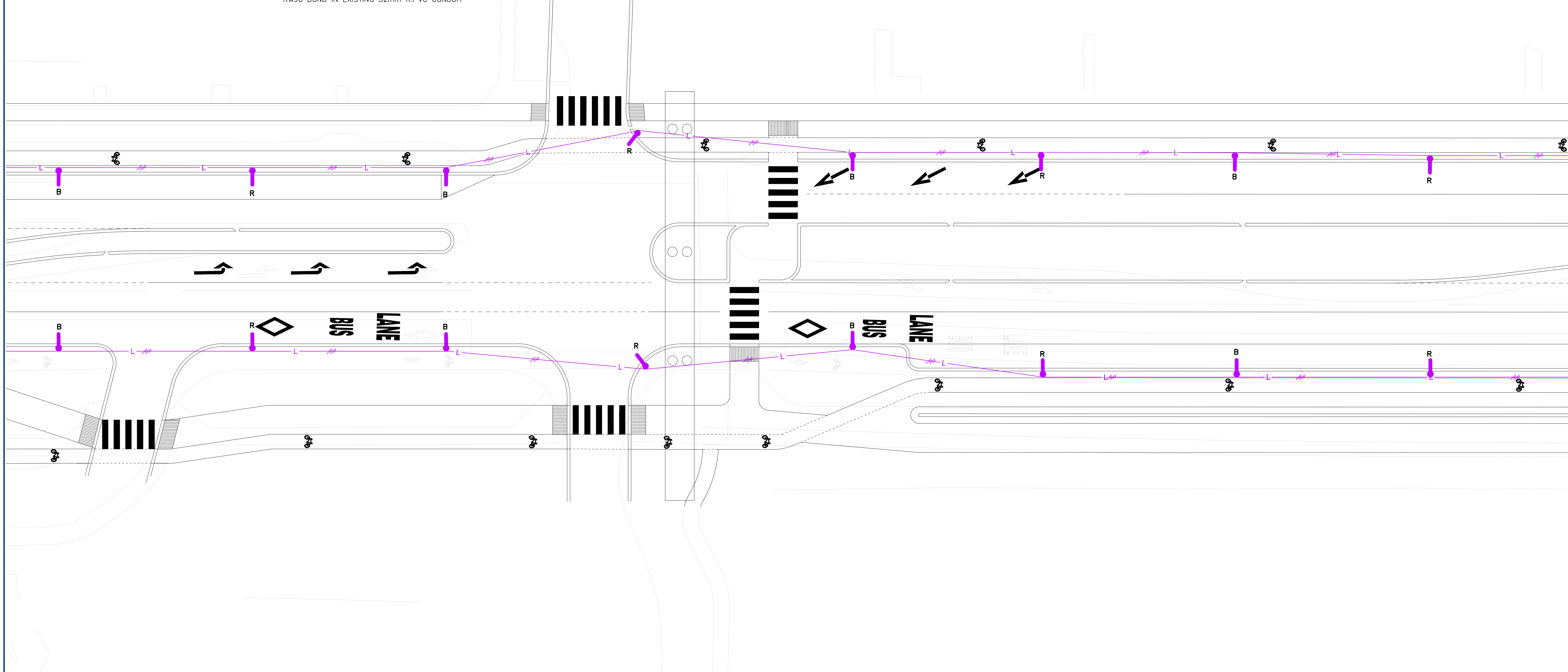
THUNDERBIRD BLVD TO GREENWOOD COMMONS DRIVEWAY ACCESS

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-600	0

STREET LIGHTING LEGEND

- PROPOSED 9.1m 124W LED ATB0–P304–R2–4K DAVIT STREET LIGHT POLE
- R — LUMINAIRE ON RED PHASE CONDUCTOR
- B — LUMINAIRE ON BLACK PHASE CONDUCTOR
- L — PROPOSED 2 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN PROPOSED 32mm R.PVC CONDUIT
- C.O. — PROPOSED 32mm RIGID PVC (CONDUIT ONLY) FOR FUTURE EXTENSIONS
- L — EXISTING 3 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN EXISTING 32mm R.PVC CONDUIT

ITEM	DESIGN REQUIREMENTS	DESIGN ACHIEVED
STREET NAME(S)	WESBROOK MALL	
PEDESTRIAN CONFLICT	HIGH	
ROAD CLASSIFICATION	ARTERIAL	
ILLUMINATION TYPE	9.1m HIGH 124W LED- ATB0-P304-R2-4K	
SPACING (MAX)	20m	20m
ILLUMINANCE LEVEL (AVG.)	17.0 LUX	19.5 LUX
ILLUMINANCE UNIFORMITY RATIO (AVG.:MIN.)	3.0:1	3.0:1



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LIGHTING

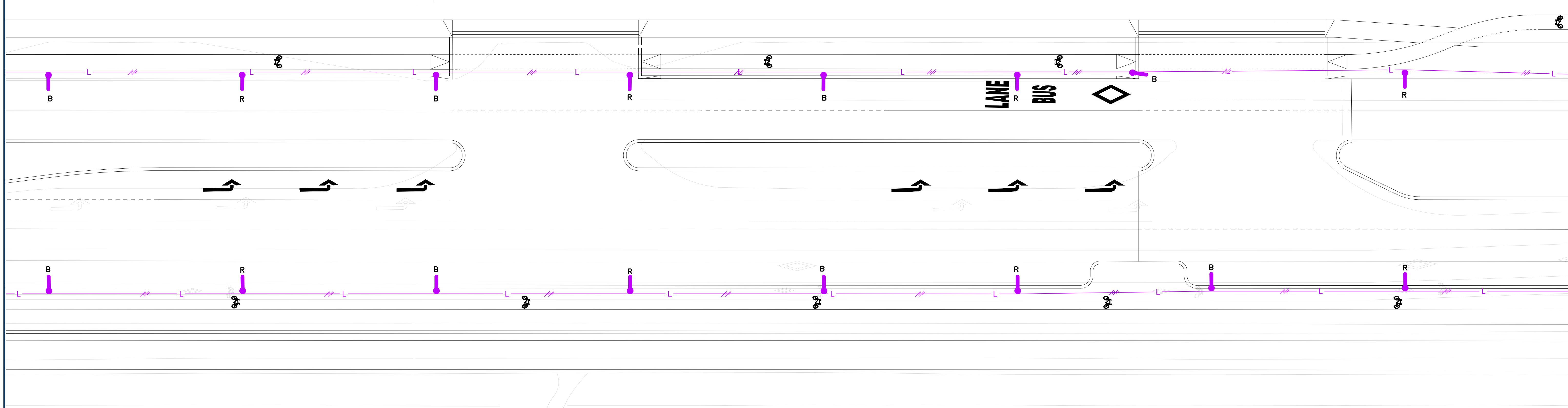
GREENWOOD COMMONS DRIVEWAY ACCESS TO RCMP DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-601	0

STREET LIGHTING LEGEND

- PROPOSED 9.1m 124W LED ATB0-P304-R2-4K DAVIT STREET LIGHT POLE
- R — LUMINAIRE ON RED PHASE CONDUCTOR
- B — LUMINAIRE ON BLACK PHASE CONDUCTOR
- PROPOSED 2 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN PROPOSED 32mm R.PVC CONDUIT
- C.O. — PROPOSED 32mm RIGID PVC (CONDUIT ONLY) FOR FUTURE EXTENSIONS
- EXISTING 3 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN EXISTING 32mm R.PVC CONDUIT

ITEM	DESIGN REQUIREMENTS	DESIGN ACHIEVED
STREET NAME(S)	WESBROOK MALL	
PEDESTRIAN CONFLICT	HIGH	
ROAD CLASSIFICATION	ARTERIAL	
ILLUMINATION TYPE	9.1m HIGH 124W LED- ATB0-P304-R2-4K	
SPACING (MAX)	20m	20m
ILLUMINANCE LEVEL (AVG.)	17.0 LUX	19.5 LUX
ILLUMINANCE UNIFORMITY RATIO (AVG.:MIN.)	3.0:1	3.0:1



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

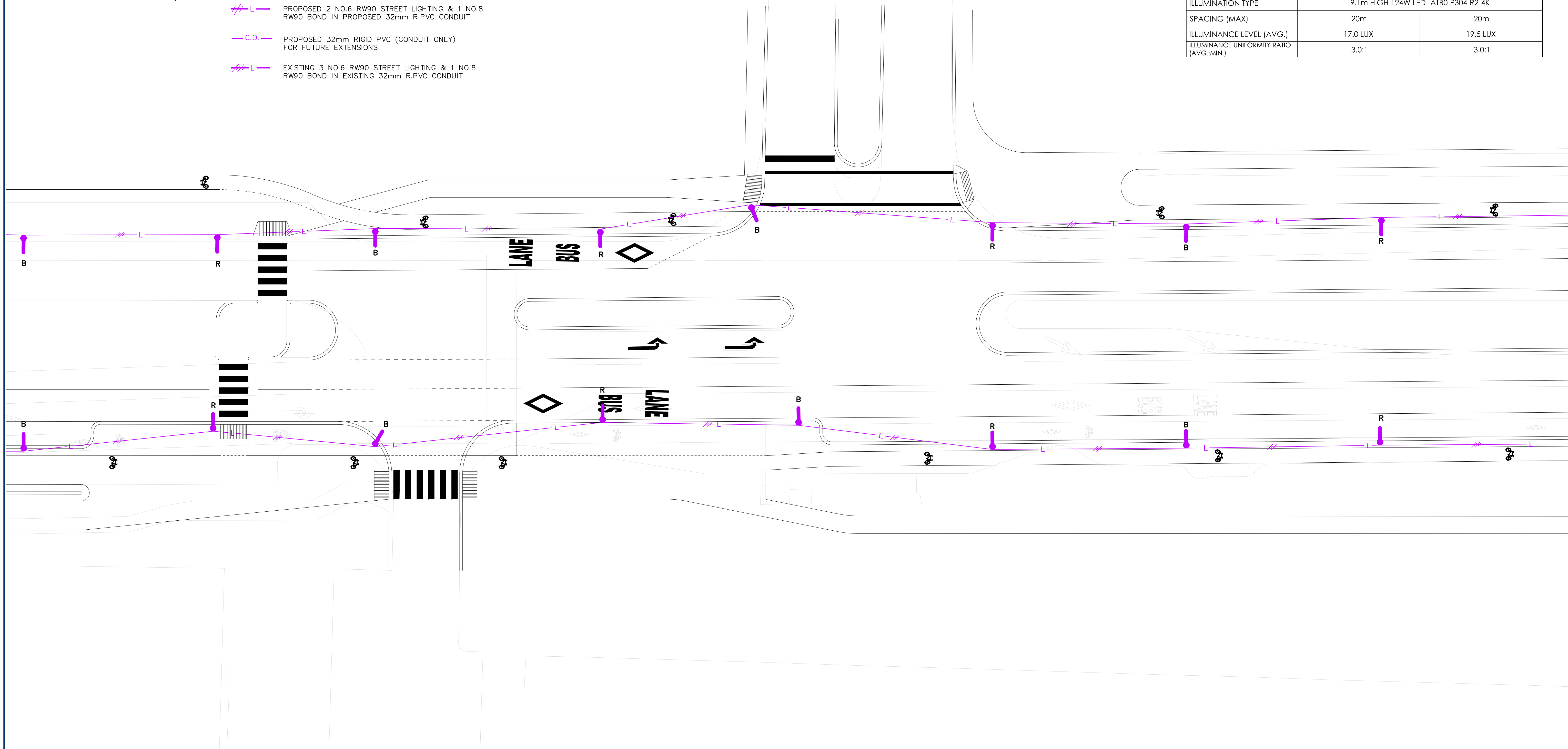
WESBROOK MALL PHASE 4
REDESIGN - LIGHTING
RCMP DRIVEWAY TO FIRE HALL DRIVEWAY

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-602	0

STREET LIGHTING LEGEND

- PROPOSED 9.1m 124W LED ATB0-P304-R2-4K DAVIT STREET LIGHT POLE
- R — LUMINAIRE ON RED PHASE CONDUCTOR
- B — LUMINAIRE ON BLACK PHASE CONDUCTOR
- L — PROPOSED 2 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN PROPOSED 32mm R.PVC CONDUIT
- C.O. — PROPOSED 32mm RIGID PVC (CONDUIT ONLY) FOR FUTURE EXTENSIONS
- L — EXISTING 3 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN EXISTING 32mm R.PVC CONDUIT

ITEM	DESIGN REQUIREMENTS	DESIGN ACHIEVED
STREET NAME(S)	WESBROOK MALL	
PEDESTRIAN CONFLICT	HIGH	
ROAD CLASSIFICATION	ARTERIAL	
ILLUMINATION TYPE	9.1m HIGH 124W LED- ATB0-P304-R2-4K	
SPACING (MAX)	20m	20m
ILLUMINANCE LEVEL (AVG.)	17.0 LUX	19.5 LUX
ILLUMINANCE UNIFORMITY RATIO (AVG.:MIN.)	3.0:1	3.0:1



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LIGHTING

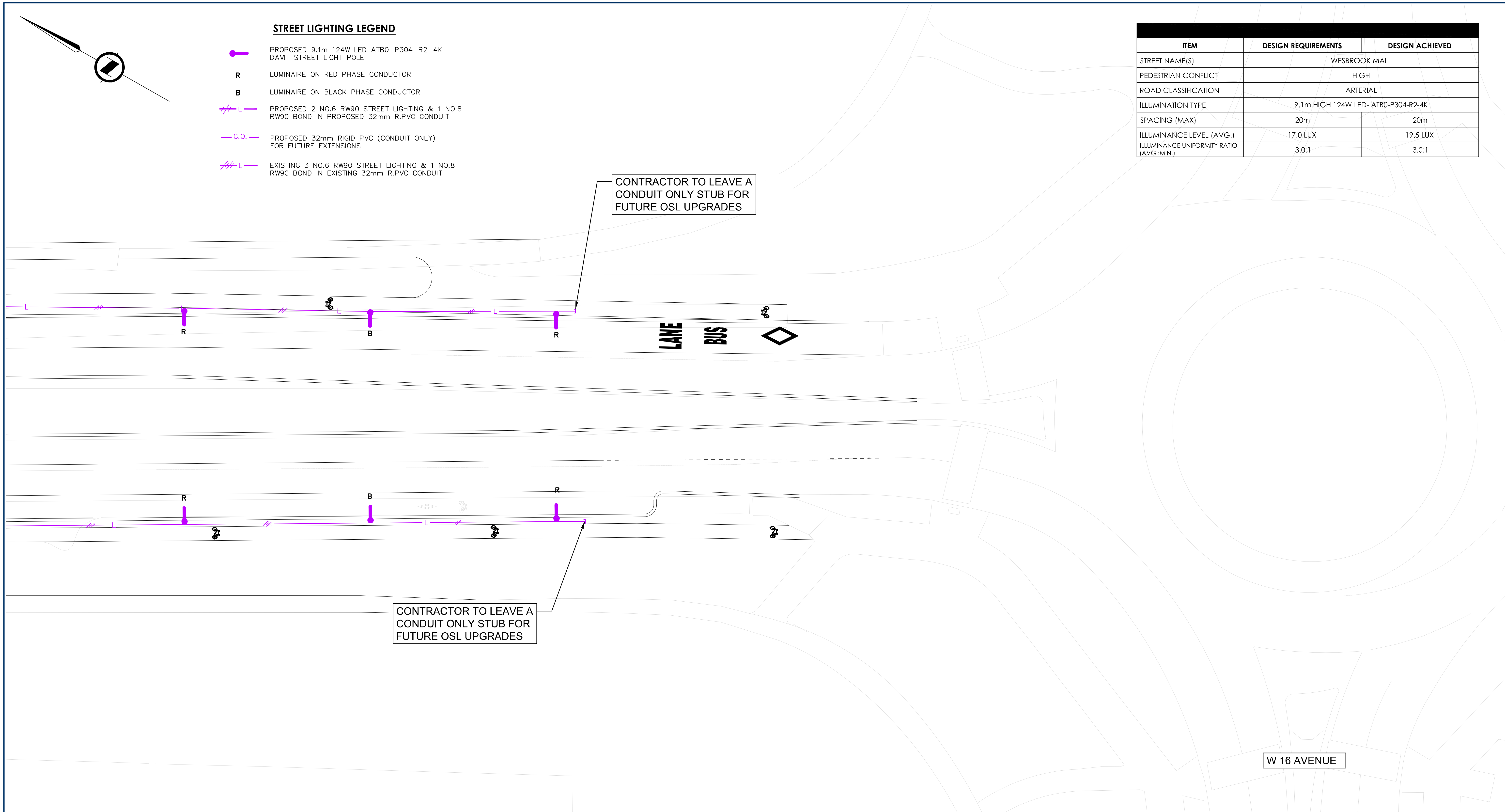
FIRE HALL DRIVEWAY TO HAMPTON PLACE

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-603	0

STREET LIGHTING LEGEND

- PROPOSED 9.1m 124W LED ATB0–P304–R2–4K DAVIT STREET LIGHT POLE
- R — LUMINAIRE ON RED PHASE CONDUCTOR
- B — LUMINAIRE ON BLACK PHASE CONDUCTOR
- L — PROPOSED 2 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN PROPOSED 32mm R.PVC CONDUIT
- C.O. — PROPOSED 32mm RIGID PVC (CONDUIT ONLY) FOR FUTURE EXTENSIONS
- L — EXISTING 3 NO.6 RW90 STREET LIGHTING & 1 NO.8 RW90 BOND IN EXISTING 32mm R.PVC CONDUIT

ITEM	DESIGN REQUIREMENTS	DESIGN ACHIEVED
STREET NAME(S)	WESBROOK MALL	
PEDESTRIAN CONFLICT	HIGH	
ROAD CLASSIFICATION	ARTERIAL	
ILLUMINATION TYPE	9.1m HIGH 124W LED- ATB0-P304-R2-4K	
SPACING (MAX)	20m	20m
ILLUMINANCE LEVEL (AVG.)	17.0 LUX	19.5 LUX
ILLUMINANCE UNIFORMITY RATIO (AVG.:MIN.)	3.0:1	3.0:1



INFORMATION ON EXISTING UTILITIES MAY NOT BE COMPLETE OR ACCURATE. PRIOR TO CONSTRUCTION CONSTRUCTOR SHALL EXPOSE LOCATIONS OF EXISTING UTILITIES AND ADVISE THE ENGINEER OF RECORD OF POTENTIAL CONFLICTS.

SCALE 0 5 10 Meters

PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

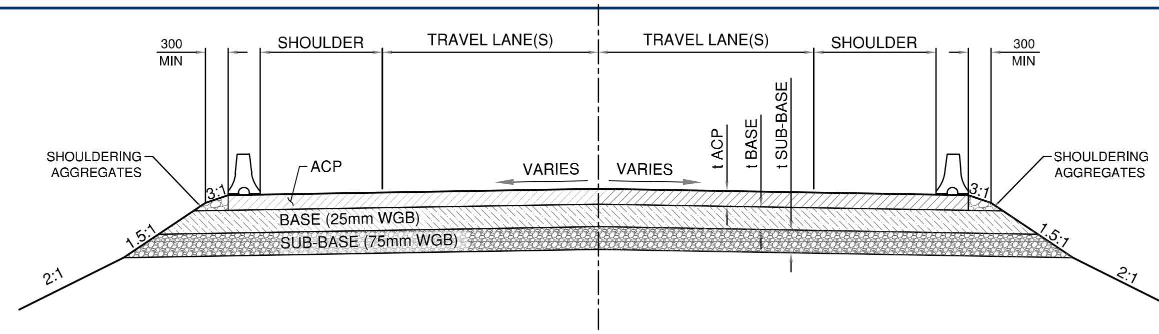
DESIGNED H.SANDHU DATE 2022-01-08
QUALITY CONTROL A. NIJJAR DATE 2022-03-20
QUALITY ASSURANCE A. NATT DATE 2022-03-25
DRAWN H. SANDHU DATE 2022-02-05

PLAN

WESBROOK MALL PHASE 4
REDESIGN - LIGHTING

HAMPTON PLACE TO W 16 AVENUE

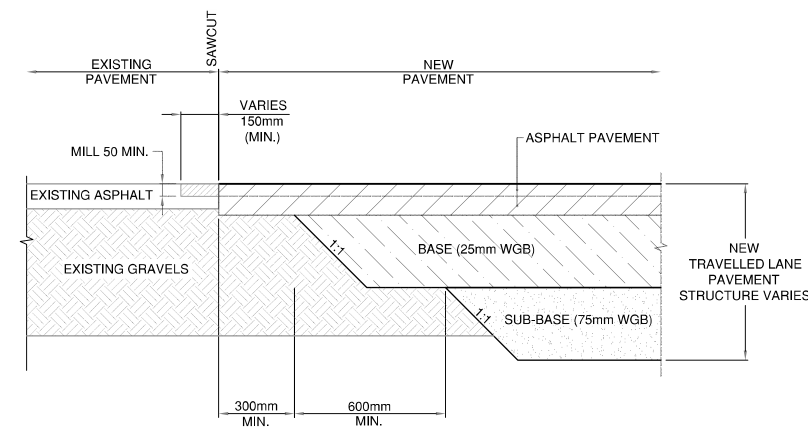
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-604	0



TYPICAL SECTION SHOWING FULL DEPTH PAVEMENT CONSTRUCTION

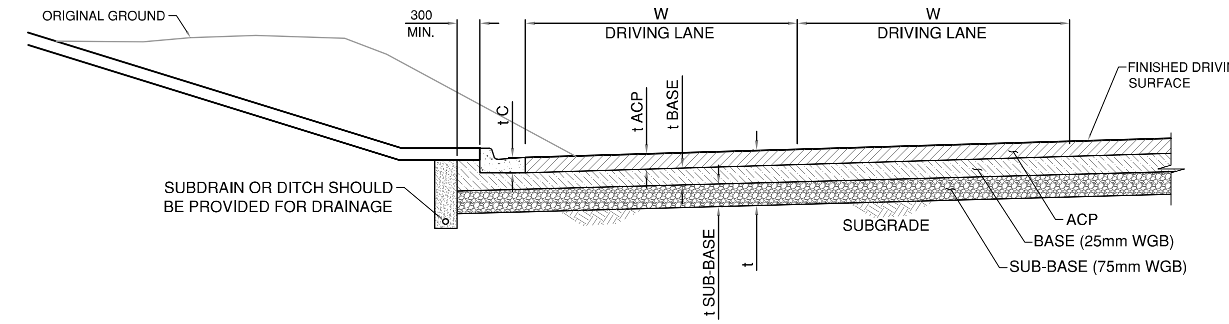
1:50

t ACP	= ASPHALT THICKNESS AS PER ITN
t BASE	= 25mm WGB THICKNESS
t SUB-BASE	= 75mm WGB THICKNESS
t	= THICKNESS OF PAVEMENT STRUCTURE
t C	= THICKNESS OF CONCRETE CURB (MAXIMUM OF 200 mm OR t ACP)
W	= WIDTH OF DRIVING LANE

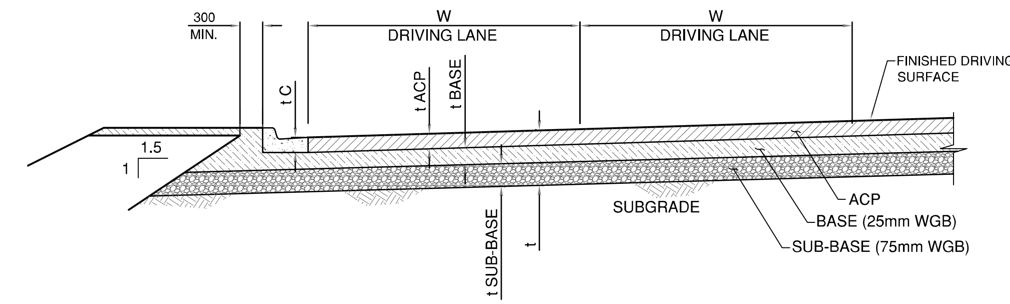


PAVEMENT JOINT DETAIL

0 0.1 1:15 0.5m



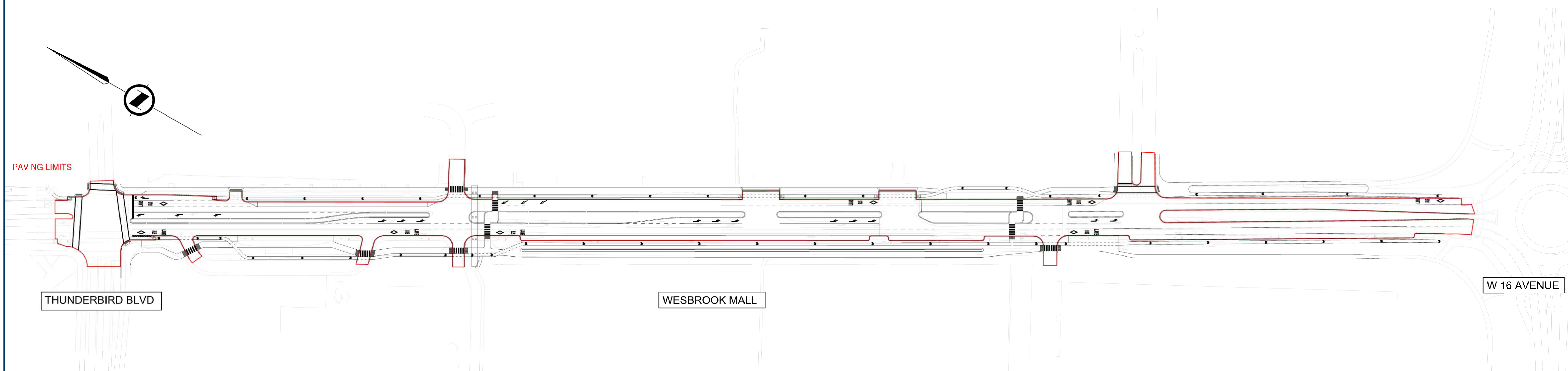
CUT



FILL

TYPICAL SECTION SHOWING PAVEMENT STRUCTURE AT CURB AND GUTTER INTERFACE FOR NEW CONSTRUCTION

1:50



PLOT DATE 2022-04-06

REV	DATE	REVISIONS	NAME
0	2022-04-06	ISSUED FOR TENDER	H. SANDHU

THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science

TEAM 9
CIVL 446

H.SANDHU
SENIOR DESIGNER
DATE 2022-04-06

DESIGNED	H.SANDHU	DATE	2022-01-08
QUALITY CONTROL	A. NIJJAR	DATE	2022-03-20
QUALITY ASSURANCE	A. NATT	DATE	2022-03-25
DRAWN	H. SANDHU	DATE	2022-02-05

PLAN AND DETAILS
WESBROOK MALL PHASE 4
REDESIGN - PAVEMENT DESIGN

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
R1-100-101	446-T9-WB	1	R1-955-700	0