UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Redesign of the SW Marine Dr. / W 16th Ave. Intersection

Trevor Cheung, Finn Crawford, Claudia Derworiz, Matthew Hemphill, Hae Min Kim,

Joshua Ip, Ryan Leung

University of British Columbia

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Executive Summary

UBC Campus and Community Planning has requested a redesign of the SW Marine Dr. and W 16th Ave. intersection entering the UBC campus to accommodate the population growth of UBC and the neighbourhood around the university and reduce the speed of drivers to improve safety for all users. UBC Campus and Community Planning requires the new design to prioritize public transit and active modes of transportation, reduce the speed of traffic as they enter campus, create a gateway feature for the UBC entrance, and integrate a rain/stormwater retention solution. This report summarizes our team's proposed solution for this intersection, which was designed in accordance with UBC's commitment to sustainable urban development.

Following the submission of the preliminary design report in December 2023, our team has been preparing this detailed design report. A detailed analysis of the intersection was conducted, which included additional modelling for the traffic volume and patterns on SIDRA INTERSECTION 9.1, and hydro-technical analysis on EPA SWMM. This data was utilized to fortify our design. The product of this is a turbo roundabout with rain gardens and bioswales.

Additionally, our team designed a gateway to welcome people to the campus. One of the key goals for this gateway was to develop an aesthetically appealing structure which does not hinder the site lines of drivers.

A Class A cost estimate and construction schedule have been provided, considering construction scope, traffic management, and long-term maintenance. It is estimated that the project will cost $5,100,000, assuming a construction start date of May 2024 and a completion date of June 2025.

In conclusion, this detailed design report presents a holistic approach to mitigating current challenges, fostering sustainable transportation, and enhancing safety and functionality for the student population of UBC, as well as the residents of the University Endowment Lands.

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1.0 Introduction

As one of the three entry/exit points from the UBC Vancouver campus, which educates over 60,000 university students annually, houses about 30,000, and contains multiple schools, the intersection of SW Marine Dr. and W 16th Ave. has seen a decline in safety for users travelling on bikes and on foot as automobile traffic has increased alongside the student population. The intersection functions especially poorly in the peak afternoon period, while morning peak period traffic is mitigated by a free-flow right-turn lane.

UBC Campus and Community Planning has requested for this intersection to be re-designed. Ms. Krista Falkner, representing UBC Campus and Community Planning, identified several key goals for the intersection. These objectives include prioritizing public transit and active modes of transportation, improving the safety and comfort of active road users, calming entering traffic, creating a gateway design welcoming people to UBC, and incorporating green infrastructure to store stormwater. Furthermore, the intersection is located adjacent to the UBC Botanical Gardens, which are not to be encroached upon.

Following the submission of the preliminary design report in December 2023, the design was further analyzed, refined, and detailed. This design ensures that all UBC Campus and Community Planning objectives have been achieved. This report summarizes all design work, project scheduling, class A cost estimate, construction plan, and project specifications.

Table 1. Team Member Contribution Table

Team Member	Contributions
Trevor Cheung	Executive Summary; Introduction; Gateway Structural Design, Calculations, and Drawings; Standards and Technical Specifications; Site Overview
Finn Crawford	Intersection Traffic Count, Site Analysis, Traffic Volume and Patterns, Pedestrian and Cyclist Considerations, Surrounding Land Use, SIDRA INTERSECTION Analysis, Drawing CD09
Claudia Derworiz	Design Criteria – Pedestrian and Cyclist Considerations, Safety and Accident Analysis, Regulatory Considerations; Tender and Construction Documentation
Matthew Hemphill	Project Overview; Project Design Considerations; Conclusion; Drawing Cover Sheet; Legend Sheet
Hae Min Kim	Hydrologic Considerations; Stormwater Facility Design
Joshua Ip	Design Rationale; Design Drawing; Design Specifications; Turbo Roundabout Conceptual Render
Ryan Leung	Construction Plan, Project Schedule, Cost Estimate, 3D Model of Site

2.0 Project Overview

2.1 Site Overview

Figure 1. Aerial View of Existing Intersection of SW Marine Dr. and W 16th Ave.

The project is situated at SW Marine Dr. and W 16th Ave. The intersection serves as an introduction for users into the area, as well as a key transit route for pedestrians, automobiles, and the R4 bus route. The ground conditions for the first 2 metres of stratigraphy consist mostly of sandy gravel. To the west of the intersection, there are large bluffs which lead into the ocean. There are several species of trees around the intersection such as western red cedar, coastal Douglas fir, western hemlock, and many others.

Surrounding land use is identified on the satellite image of the project site below:

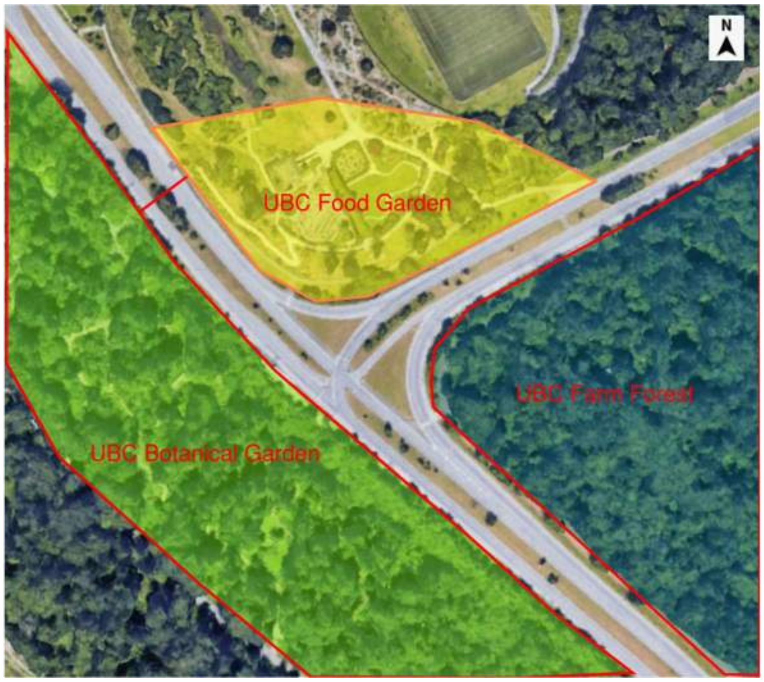

Figure 2. Project Site Surrounding Land Use Diagram

The intersection is surrounded to the North, West, and South by the UBC Botanical Garden, which then connects to the UBC Food Garden (a branch of the botanical garden) via an underpass. Maintaining tree cover to reduce incoming vehicle noise to these locations is critical. To the east, a dense forest connects to the UBC Farm. It is critical to preserve this forest for rainwater retention in the soil and environmental sustainability.

The intersection is also utilized by people visiting the Museum of Anthropology, University Hill Secondary School, UBC, Wreck Beach, and people living in the neighbouring areas. Additionally, SW Marine Dr. is often populated by cyclists throughout the year. The intersection is an essential artery for people travelling to and from the south of the UBC campus.

2.2 Project Design Criteria

Given the location of the SW Marine Dr. and W 16th Ave. intersection, coupled with the future aspirations of UBC and UBC's Campus and Community Planning (C+CP), a full redesign of the intersection was requested, accompanied by a list of key deliverables for the project. The key requirements for the project are listed below:

Transportation Requirements

- ***Reduce Speeds for Incoming Traffic:*** Implement measure to cause traffic to slow when entering the intersection, as well as slow users to speed levels more suitable for the surrounding UBC campus
- ***Support Short- and Long-Term Traffic Demand:*** Develop a design solution capable of accommodating both existing traffic volume and anticipated future growth, while being efficient and safe
- ***Encourage Active Transportation Mode Use:*** Create an environment that is safe and attractive for cyclists, pedestrians, and other active road users, encouraging their usage to meet future transportation goals
- ***Improve Safety and Minimize Accident Rates:*** Implement design features to minimize the number of conflict zones, reduce speeds, and incorporate other techniques to decrease accident rates

Environmental Considerations

- ***Retain Stormwater and Incorporate Green Infrastructure:*** Using environmentally friendly solutions to retain stormwater to prevent further erosion of the local area, as well as incorporate sustainable ecological design
- ***Reduce Impermeable Surface Area:*** Minimize the impermeable area to help mitigate the local erosion issues, as well as decrease the overall footprint of the intersection on the local ecology
- ***Minimize Tree Loss:*** Prioritize the preservation of existing trees and vegetation, promoting sustainable construction practice

Campus Requirements

- ***Create a Welcoming Visual Gate to the UBC Campus:*** Create a welcoming feature that invites users to the University of British Columbia grounds, as well as reinforcing the campus identity
- ***Transition the Intersection into a More Visually Appealing Area:*** Create a visually appealing environment: Enhance the visual appeal of the intersection, helping promote its use and integrating it further with the local campus

- ***Maintain a Buffer with Local Botanical Gardens:*** Respect the existing local infrastructure, and maintain a certain level a disconnect to prevent damaging or encroaching within their property

Additional Project Requirements

- ***Adhere to All Relevant Design Standards:*** Ensure that the design follows relevant design guides and standards and meets the expected industry expectations regarding technical content
- ***Follow Necessary Regulatory Requirements:*** Comply with all applicable regulatory frameworks, codes, and permitting processes governing the planning and execution of the project

All these design requirements have been met throughout the design process; the later sections of this report provide additional information and insight into the analysis and detailed breakdown of each of the requirements, followed by the technical section of the report that covers the ways in which these considerations were addressed.

3.0 Technical Considerations

3.1 Traffic Volumes and Projections

To obtain key design traffic metrics, an analysis of current traffic volumes and patterns was conducted. Our process for assessing current demand and predicting future demand is summarized as follows. An evening peak hour traffic count was conducted on October 12th, 2023. The results of the count are summarized in the table below:

Table 2. PM Peak Traffic Count @ 16th & Marine Drive, Oct 12, 2023

PM Peak Traffic Count @ W16th & SW Marine Drive, Oct 12, 2023						
Direction of Traffic	**Movement**	**3:00-3:15**	**3:15-3:30**	**3:30-3:45**	**3:45-4:00**	**Sum**
NW-Bound	Straight	58	52	53	66	229
	Right Turn	69	83	77	100	329
SW-Bound	Left Turn	143	122	126	78	469
	Right Turn	18	21	18	11	68
SE-Bound	Straight	126	83	116	71	396
	Left Turn	33	22	26	18	99

An analysis of average daily traffic volume along SW Marine Dr. was conducted by relating the overall UBC student headcount to local traffic demand. Linear regression was performed to determine future average daily traffic volume, shown in the below figure. Average daily traffic volume for 2023 and 2073, corresponding to a service life of 50 years, were extrapolated to be 21,905 v/hr and 34,390 v/hr respectively.

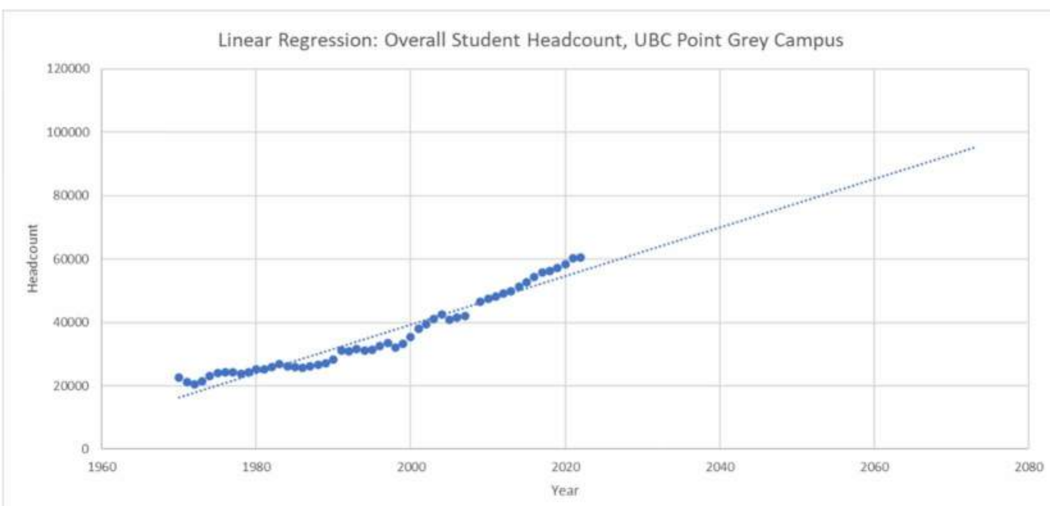

Figure 3. Linear Regression of UBC Student Headcount

UBC C+CP hopes to maintain current average daily flow volumes in the future by adding express transit options that connect UBC to Metro Vancouver. This approximation assumes a linear relationship between student headcount and average daily traffic demand. Due to increasing efforts to increase sustainable options and diversify modal opportunities leading to decreased automobile use, this assumption will produce a conservative estimation. Since plans for express transit (SkyTrain, etc.) to UBC have not officially begun and delays are to be expected, our team used this conservative assumption in our models to ensure potential traffic demand is met.

Weekly average traffic flows taken at SW Marine Dr. & Wesbrook Mall were analyzed to reveal daily patterns and peak flow periods. Traffic flows were sorted by direction, eastbound and westbound traffic, then 2021 data was compared to 2022. A westbound morning peak hour of 8:00 am – 9:00 am was identified and an eastbound evening peak hour of 3:00 pm - 4:00 pm was identified. These trends are evident in Figures 4 and 5 below:

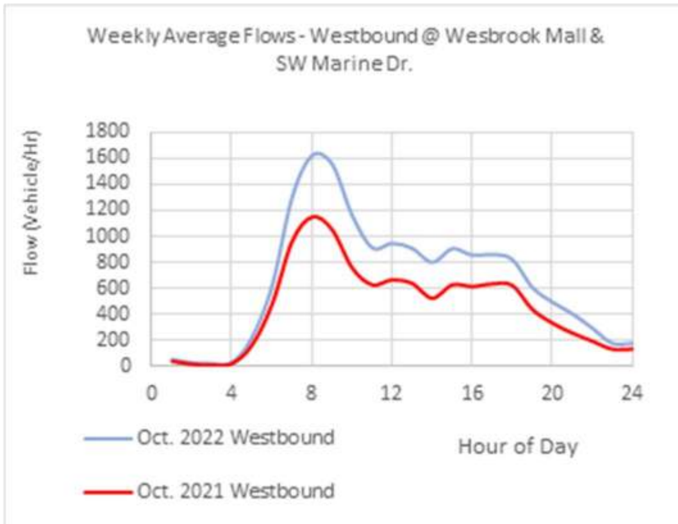

Figure 4. Westbound Weekly Average Flows, Wesbrook Mall & SW Marine Dr.

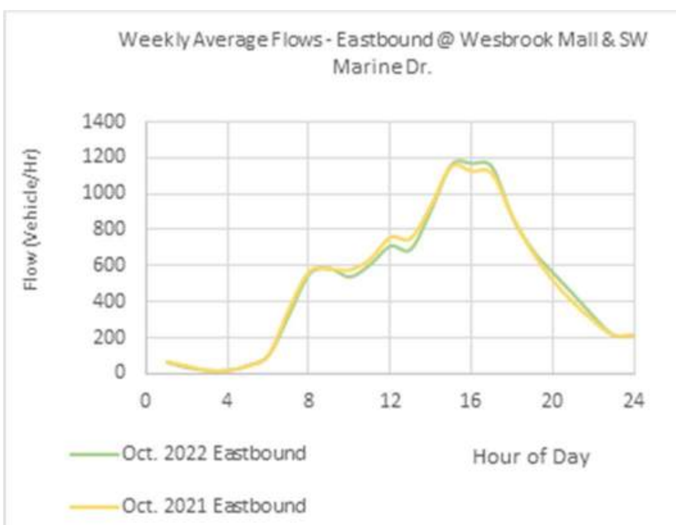

Figure 5. Eastbound Weekly Average Flows, Wesbrook Mall & SW Marine Dr.

3.2 Pedestrian and Cyclist Considerations

As the client wishes to prioritize the safety and comfort of active intersection users, the modal priority hierarchy adhered to during design is as follows:

1. Vulnerable road users (VRU)
2. Public transit vehicles
3. High-occupancy vehicles
4. Single-occupancy vehicles

On October 12th, 2023, a traffic count was conducted during the PM peak period to estimate the intersection's current peak weekday cyclist demand during a typical Fall academic term. The highest volume maneuver observed was commuting cyclists leaving UBC, turning left from W 16th Ave. onto SW Marine Dr. The results of the cyclist count are summarized in the table below.

Table 3. PM Peak Cyclist Count @ 16th Avenue & Marine Drive on Oct 12, 2023

Cyclist Traffic Count @ 16th Ave. & Marine Dr., PM Peak (Fall)		
Direction of Traffic	**Movement**	**15:00 - 16:00**
NW-bound	Straight	14
	Right Turn	15
SW-bound	Left Turn	32
	Right Turn	20
SE-bound	Straight	12
	Left Turn	0

Cyclist traffic at the focal intersection is expected to increase over its design life. *Transport 2050*, TransLink's Regional Transportation Strategy, proposes an 850-kilometer, continuous Major Bikeways Network throughout the Lower Mainland. The planned network includes bike lanes along NW and SW Marine Dr., encircling UBC and expanding the ability of commuters to choose active transport modes.

Participants in a 2014 study who were surveyed about their perceptions of safety at UBC said the intersection at W 16th Ave. and SW Marine Dr. felt very unsafe because of confusing geometry and high vehicle speeds. To protect VRUs, traffic calming was a key objective of the design. Roundabouts calm traffic with large entry angles that cause entry deflection, reduced speed limits and relative complexity; situational awareness is required of drivers, who must judge their ability to proceed rather than being directed by a signal.

3.3 Safety and Accident Analysis

19 vehicle-on-vehicle crashes occurred at the intersection of SW Marine Dr. and W 16th Ave. over the 2018-2022 period. Of these, 7 resulted in driver casualties. While speeds limits decrease on SW Marine Dr. for NW-bound drivers approaching the intersection, field observation conducted on October 12th, 2023, revealed that drivers tend not to reduce their speeds. This may be attributable to speed adaptation, whereby drivers underestimate their speeds for up to five minutes after leaving a freeway.

A Collision Modification Factor (CMF) is the ratio of the expected number of collisions with a design change to the expected number of collisions without the change. Therefore, a CMF below 1.0 represents an expected reduction in the number of collisions. In B.C., the CMF of converting a signalized intersection to a roundabout is 0.83. Furthermore, adding pedestrian signals to the crosswalk has a CMF of 0.3-0.9. This large range reflects uncertainty as the volume of pedestrian safety studies conducted is limited to date. Raised medians or crosswalks were considered because of their substantial contribution to pedestrian safety, but ultimately excluded to avoid emergency vehicle delays along a disaster response route.

Another safety benefit of roundabouts is the lower number of conflict points between motor vehicles, as well as vehicles and pedestrians, than exist at signalized intersections. Turbo roundabouts further improve safety for VRUs by disallowing the potentially distracting act of lane switching by drivers.

Reducing the intersection's speed limit from 60 km/h to 30 km/h is expected to dramatically lower the severity of collisions involving pedestrians and cyclists. The risk of death for a pedestrian struck at 30 km/h is 9%, compared to 25% at 51 km/h and 50% at 68 km/h.

3.4 Regulatory Considerations

The B.C. Ministry of Transportation and Infrastructure employs a policy of selecting roundabouts over traffic signals to control new intersections wherever feasible. The TAC Geometric Design Guide for Canadian Roads (2017), BC MoTI Supplement to TAC Geometric Design Guide, and TAC Canadian Roundabout Design Guide (2017) are the ministry's primary references used for roundabout design.

3.5 Hydrologic Considerations

The following hydrologic considerations were derived from previous hydrogeological analyses performed by Piteau Associates and AECOM for UBC Properties Trust and UBC Campus and Community Planning, respectively.

Situated on the west coast of Vancouver, the University of British Columbia's Point Grey campus is surrounded by cliffs, forests, and the ocean, and is essentially situated at the edge of a peninsula. The location of our proposed roundabout design, located at the intersection of W 16th Ave. and SW Marine Dr., is located towards the southern part of the campus. Located near the cliffs and somewhat surrounded by forests, the area already maintains a certain level of natural stormwater retention from the pre-existing nature. The Botanical Garden property maintains a rainwater buffer allowing for the slowed runoff of rainwater off the cliffs.

The stormwater catchment areas in UBC are composed of the north, northwest, south, southwest catchment areas. The general vicinity of our roundabout is within the southwest and northwest catchment, which as the name suggests, encompasses the southwest and northwest parts of the campus. Both catchments lead to rainwater runoff over the cliffs to the west, with the Botanical Garden being in the northwest catchment.

To prevent the erosion of the cliff face and the instability of slopes near the cliff edge, it is desired that the speed and volume of the stormwater runoff be minimized near the cliff edges, and the stormwater infiltration near the cliff edges to be minimized as well.

Lastly, it is obviously desirable to ensure the surrounding area including the intersection remains unflooded unless in a very unlikely rainstorm event.

4.0 Design Overview

The replacement design chosen for the intersection upgrade will be that of a turbo roundabout. The roundabout will reduce conflict points for both drivers and active road users, as well as increase cyclist safety by adding a separated bike lane. This design will force drivers entering the University Endowment Lands to slow down to 30 km/h when entering the roundabout. In addition to the safety features, the roundabout design will also include a rain garden that contains native plant species to help reduce corrosion by rainwater of the nearby slope and increase the aesthetic of the intersection altogether. The usage of native plant species will also decrease the maintenance required when compared to just planting grass.

Figure 6. 3D Rendering of Turbo Roundabout

4.1 Geometric Design

The roundabout was designed to accommodate for the WB-20 Design vehicle, with an ICD of 64 m as is common for multi-lane roundabouts showcased in the BC-MOTI Manual of Standards. The turbo roundabout design was used to improve traffic flow and safety as it reduces conflict points for drivers entering the intersection. Each driver only needs to pay attention to pedestrian – cyclist crossing and only one lane of traffic, whereas the traditional signalized intersection would require drivers to pay attention to 8 different points of conflict.

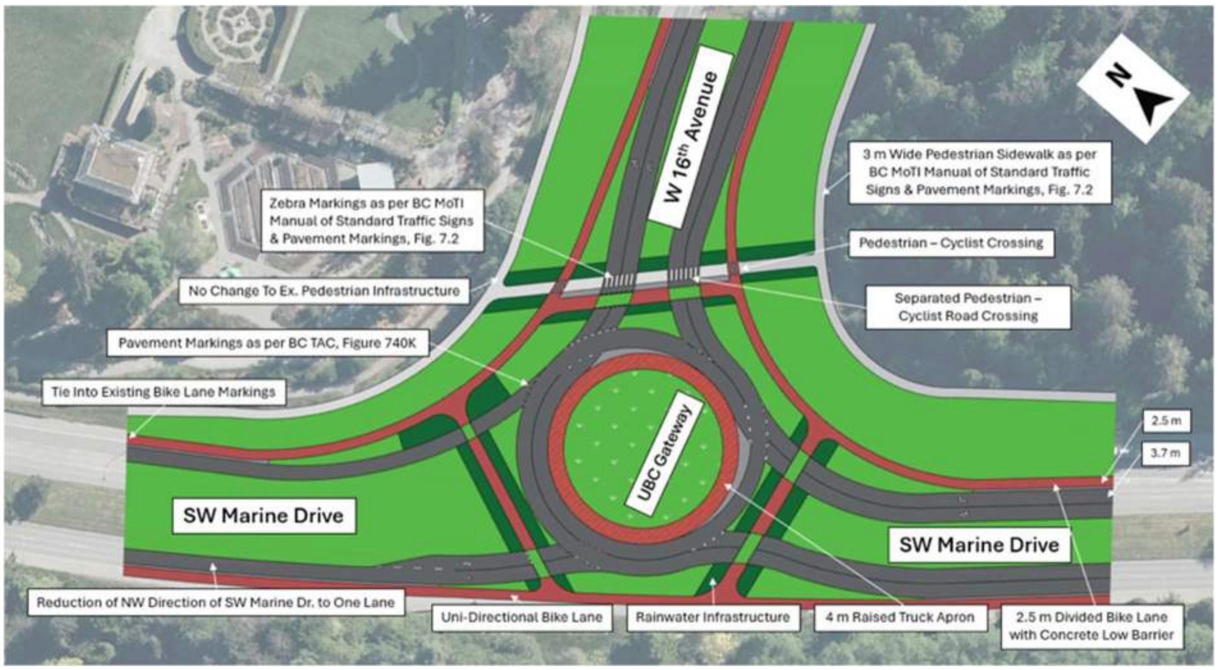

Figure 7. Overview of Roundabout Design

Both travel lanes will be retained in the NE and SE directions, but traffic will be reduced to one lane at the NW exit. The design of the roundabout is designed in accordance with the BC-TAC Section 740 for design vehicle WB-20 with an ICD of 64 m and with a speed limit of 30 km/h. 2.5m divided bike lanes on all directions of the intersection are added, as shown in Figure 6. Bike lanes will be separated by the standard concrete gravity barriers that will be 0.6 m wide on all directions of the intersection. Vehicle travel lanes entering the roundabout will be 3.7 m wide and will transition to 4 m wide within the roundabout. An additional 4 m wide raised truck apron will be present to accommodate for vehicles that are larger than the WB-20 design vehicle, as both SW Marine Dr. and W 16th Ave. are disaster response routes.

Crosswalk positioning is designed in accordance with BC TAC Figure 740.K, with the crosswalk positioned 7 m away from yield lines. The pedestrian crosswalk is 3 m wide and the bike crossing will be 3.5 m wide. There will be a separation of 1.5 m between the two crossings. Each crossing will have manually activated flasher warning drivers of a pedestrian/cyclist crossing the crosswalk. The pedestrian sidewalk will remain mostly unchanged from the current design, with the only change being the location of the crosswalk across W 16th Ave. The SE direction of the intersection on SW Marine Dr. will have a W-129 sign placed 130 m prior to the cyclist crossing in accordance with the BC MoTI Manual of Standard Traffic Signs and Pavement Markings. Streetlights will be spaced 50 m apart, with 4 within the roundabout, and 4 in each lane of traffic entering and exiting the intersection. Detailed drawings with regards to the plan view, dimensions and pavement markings can be found in Appendix 1 – Design Package.

The center of the roundabout will contain a rain garden with native plant species to promote local ecology and slow corrosion caused by rainwater. The center of the intersection will also contain a gateway into UBC, as discussed in Section 4.4 – Gateway Feature. This will be a visual blocker for risky drivers entering the endowment lands and be an appealing piece of signage that welcomes visitors to UBC.

4.2 Active Transportation Facility Design

4.2.1 Bicycle and Scooter Facilities

According to the City of Vancouver, nearly 9% of all trips and over 13% of commute trips in Vancouver are by bike, exceeding the City's 2020 target of 7%, and on track to achieve the 2040 target of 12%. Therefore, the intersection will accommodate the active modes of transportation by ensuring safety and ease of access. In addition to the updated infrastructure to the active modes, the design will also tie into existing bike lanes at the intersection (bike lanes on the north side of SW Marine Dr. and W 16th Ave. and the shoulder on south side of SW Marine Drive)

Bike lanes are protected and unidirectional to tie into existing bike lanes and shoulder of the exits of the current intersection. A bike crossing will be added to the northern side of SW Marine Drive to ensure safety of cyclists. The lane width is 2.5 m wide in each direction to accommodate for passing, this is recommended by the Transportation Design Guidelines. Protected bike lanes are also used to reduce the perceived lane width and increase safety of cyclists.

The bike lane-roadway buffer south of the roundabout is set to be the standard roadside gravity barrier at 0.69 m high and 0.55 m wide. The buffer is set at 0.6 m in the drawing. A smaller barrier or molded curb was not used as buffer was because vehicles entering the roundabout from SW Marine Dr. would be travelling at high speeds and anything smaller than a standard gravity barrier would prove to be a safety hazard for cyclists.

The bike lane–roadway buffer north and northeast of the roundabout on SW Marine Dr. and W 16th Ave. respectively will be the standard curb at 150 mm tall and 0.6 m wide. This is to improve the aesthetic of the slower speed zones and provide adequate protection to cyclists and pedestrians alike. In addition to that, the "perceived lane width" will decrease, thus reducing the overall speed of vehicles.

Bike Lane Specifications:

Bike lanes will be 2.5 m for unidirectional bike lanes to allow for comfortable passing.

Each bike lane will be constructed with 0.6 m of buffer protection between the roadway and bike lane to allow for seamless transitions between the intersection and the existing roadway, as well as to promote the safe usage of the active mode of transportation. Crossings across SW marine drive is manually controlled with yellow flasher signal lights signalling an active crossing. The crossing will be 3 m wide.

The multi-use crossing across W 16th Ave. will be a multiuse crossing for both pedestrians and cyclists. This crossing will also be manually signalled with rectangular rapid flashing beacons (RRFBs).

4.2.2 Pedestrian Facilities

Existing pedestrian infrastructure will remain as is since upgrades are not urgently needed. However, there will be a pedestrian/cyclist crossing added on the W 16th Ave. side of the roundabout to ensure a safe corridor within a continuous network. The crossing will be governed by a rapid flashing beacon, activated by a pedestrian or cyclist.

Crosswalk positioning is designed in accordance with BC TAC Figure 740.K with crosswalk positioned 7 m away from yield lines. Each crosswalk will have manually activated flasher warning drivers of a pedestrian/cyclist crossing the crosswalk. The pedestrian sidewalk will remain mostly unchanged from the current design, with the only change being the location of the crosswalk across W 16th Ave. The SE direction of the intersection on SW Marine Dr. will have a W-129 sign placed 130 m prior to the cyclist crossing in accordance with the BC MoTI Manual of Standard Traffic Signs and Pavement Markings.

Sidewalk Specifications:

The pedestrian infrastructure will not change except for the multiuse crosswalk described below. The sidewalk width will remain constant at 2.5 m as measured on Google Earth.

Crossing Specifications:

Multi-use crossing will be governed by a rapid flashing beacon crossing, manually activated by a cyclist or pedestrian. Crossing width will be 3 m wide and will cross W 16th Ave. and the northwestern side of the roundabout on the SW Marine Dr.

4.3 Stormwater Facility Design

4.3.1 Stormwater Design Overview

Considering the factors mentioned in Section 3.5 - Hydrologic Considerations, including the minimization of rainwater near the cliffs, the prevention of foods near the intersection, it was decided that the stormwater within the vicinity of the intersection would be maintained, retained, and buffered by green infrastructure. Green architecture was chosen over traditional “gray” rainwater architecture (such as pipes and drains), as it is more aesthetically pleasing, cheaper, and environmentally resistant and friendly. A plan view drawing of the green architecture is provided below. A detailed plan view drawing of the green architecture can be found in Appendix 1 – Drawing Package.

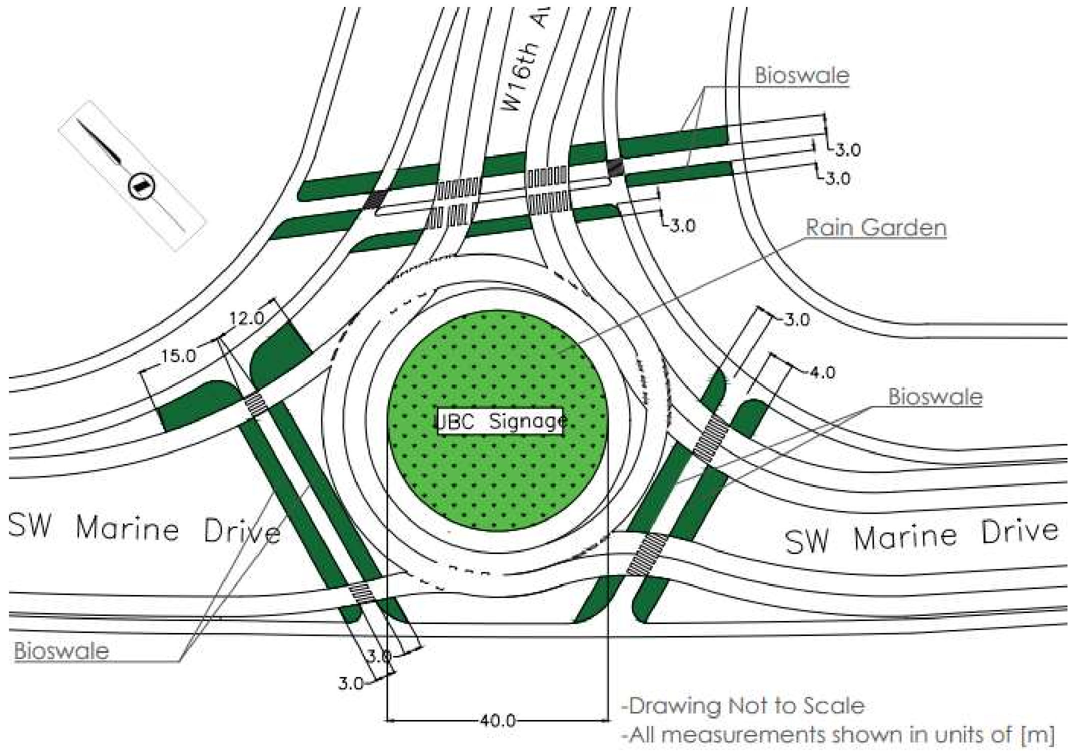

Figure 8. Plan View of Green Architecture

4.3.2 Stormwater Retention Specifications

The green infrastructure incorporated in our design consists of two types. The first is a rain garden, which as the name implies, is a garden consisting of typically deep-rooted plantation. The garden acts somewhat as a pond, with the ground being sunken in to allow more water to be retained within the garden. Our design uses a rain garden with native vegetation and visually appealing plantation including various species of flowers to contribute to the visual appeal of the roundabout. The rain garden is in the middle of the roundabout, enclosed within the circular area (shown in Figure 8) and surrounding the UBC Signage, covering a total of approximately 1256 m^2. This rain garden would be dug in at an angle to a depth of around 30 cm (1 ft) with a soil mix at the bottom of the pit, then a layer of mulch on top, followed by the water that is retained by the garden after rainfall. Additionally, the following native plants - Saskatoon, Mock-orange, beaked sedge, bunchgrass, mulch are to be planted. See the diagram below for a cross sectional view.

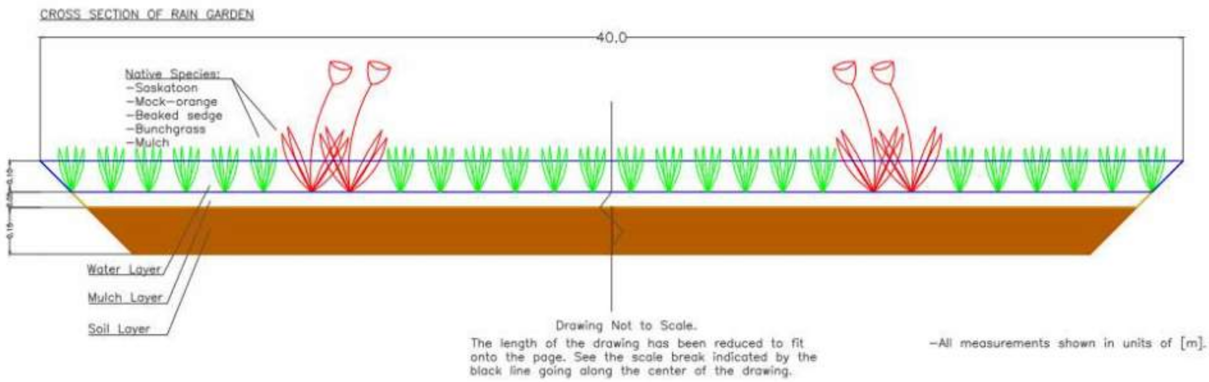

Figure 9. Cross Section of Rain Garden

The second type of green infrastructure used in our design is a bioswale. Bioswales are a similar concept to rain gardens except placed typically narrowly along sidewalks and such. In our design, the bioswales are placed along the sidewalks and pedestrian crossways to improve the aesthetics of the roundabout for pedestrians as they walk across the roundabout. The swales consist of 665 m^2. In total, green architecture accounts for roughly 1921 m^2 of our roundabout, with the remaining areas aside from the roads, crosswalks, and sidewalks turned or kept as simple greenery. This bioswale would be dug in at an angle to a depth of around 15 cm (0.5 ft) with a soil mix at the bottom of the pit, then a layer of mulch on top, followed by the water that is retained by the garden after rainfall. The following native plants - Saskatoon, Mock-orange, beaked sedge, bunchgrass, mulch are to be planted. See the diagram below for a cross sectional view.

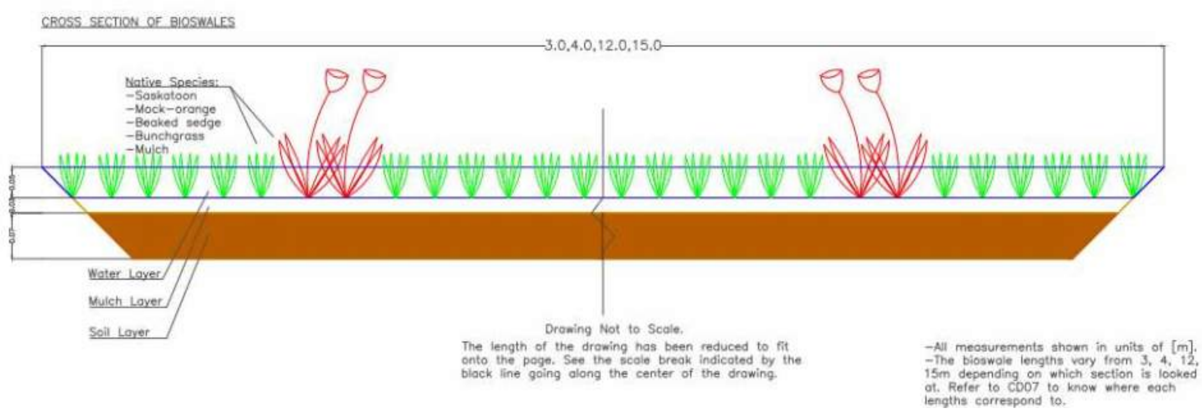

Figure 10. Cross Section of Bioswales

See Appendix 1 for the detailed drawings of the rain garden and the bioswale.

4.3.3 Stormwater Analysis

The stormwater runoff around the roundabout was then analyzed using EPA SWMM for a 100-year rainstorm event. With the additional grass and green infrastructure being implemented in the design, a reduction of peak water elevation from 67.6 m to 67.4 m (at a ground elevation of 67 m), and a reduction of peak runoff from 42 LPS to 37 LPS was found. This shows a somewhat marginal improvement of stormwater retention.

4.3.4 Stormwater Retention Maintenance Plan

Lastly, the stormwater retention system will need maintenance throughout the year, with pruning every October, watering weekly during summer for the first two years, until plants are fully grown, mulching in February, May, and October, and clearing of debris once a month during summer and twice a month for the remaining seasons. See the table below for the yearly maintenance plan.

Table 4. Stormwater Retention System Yearly Maintenance Plan

Task	Frequency
Pruning	Once in October.
Watering	Must be done weekly during the summer for first two years, until plants grow to completion. Afterwards, can let rain do watering.
Mulching	Once in February, May, and October.
Weeding	Once in February, May, and October.
Cleaning Debris	Once a month during the summer, twice a month for all other seasons.

This section was written with the help of the document "RAIN GARDEN CARE: A GUIDE FOR RESIDENTS AND COMMUNITY ORGANIZATIONS". The yearly maintenance table is once again provided in Appendix 6 - Long-Term Maintenance Plan.

4.4 Gateway Feature

Figure 11. 3D Render of Gateway Structure

The gateway design presented the creative freedom to build an aesthetically pleasing and safe structure. One of the main design goals was to create a noticeable and welcoming gateway structure without obstructing the view of the road or distracting drivers. The gateway design took inspiration from the UBC signs at the Robson Square UBC Campus, and the UBC bus loop. This design was chosen since it provides a minimalist aesthetic which won't hinder the performance of drivers.

The structural design of the gateway was completed in compliance with the BC Building Code, National Building Code of Canada, and CSA A23.3. Structural design and analyses were completed to ensure the gateway could withstand 150 km/h winds without tipping and support a 2.136 kPa dead load and 2.4 kPa snow load. A conservative assumption was made that the soil stratigraphy beneath the gateway consisted of loose sand and gravel. This conservative estimation was done to ensure the soil would not fail from the applied pressure of the gateway. Calculations were made to ensure the bearing pressure did not exceed 50 kPa. Finally, in reference to the BC Building Code and the National Building Code of Canada, and CSA A23.3:19 and CSA S474:04, it was concluded that the design service life of the gateway will be 30 years, however, it will likely last for 50 to 100 years.

The British Columbia Building Code was utilized to complete the structural calculations. The structural calculations were completed in three primary steps:

1. Slab design
2. Column design
3. Foundation design

The slab was first designed. The key goals for the slab design were to determine the slab thickness and rebar geometry within the slab. To complete this, the volume of a 2 m tall UBC sign was calculated to be 0.044 m^3. This was multiplied by the density of steel (for the sign) to calculate the self-weight of the sign. Load combinations were used to determine a dead load for the structure and combined with a snow load. This was calculated to be 6.27 kPa. The shear resistance was then calculated to ensure that the maximum shear force did not surpass the resistance. Calculations were then made to determine the architecture of the top and bottom reinforcements. It was determined that the bottom lower layer (BLL) and bottom upper layer (BUL) should use 10M rebar at a spacing of 320 mm. Additionally, the top upper layer (TUL) should use 10M rebars at 240 mm spacing and the top lower layer (TLL) should use 1 10M rebar. After this was determined, calculations were completed to ensure that the maximum applied bending moment would not surpass the bending moment resistance for the structure. Additionally, a 10 cm Grade 40 steel coupler will be used to attach the UBC letters to the slab. A diagram of this geometry is shown in the following figure.

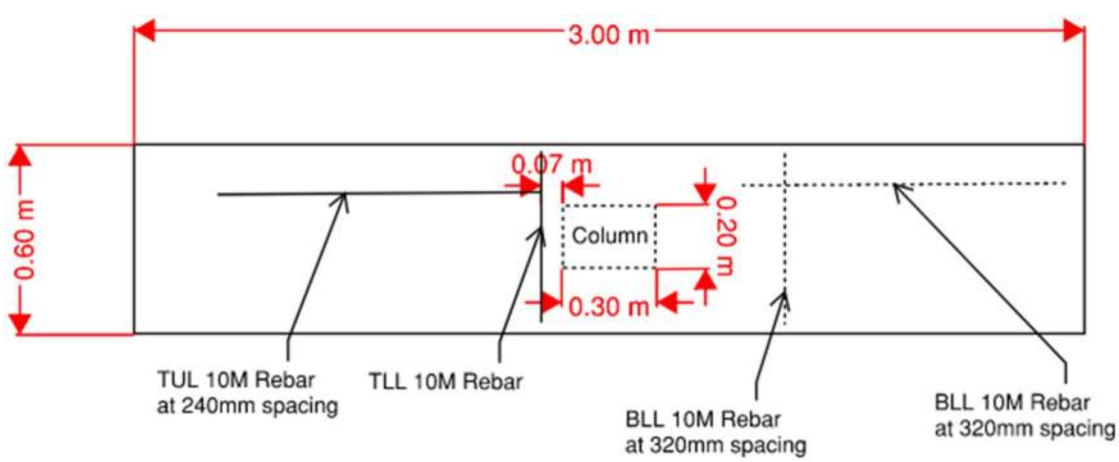

Figure 12. Gateway Slab Design Summary

From the slab design, the column leading the footing was designed. The main objectives for this were to determine the rebar geometry within the column and to confirm that the column could support the load. Dimensions for the column and the percentage of steel in the column were assumed. From this, calculations were completed to determine the type and amount of rebars that were needed. It was found that 8 15M rebars at a spacing of 21 mm would be sufficient for the column. Column tie spacing was then determined to be 150 mm for 10M rebars. From this geometry, the axial load resistance was calculated to certify that the column could support the load. A diagram of the column geometry is shown in the following figure.

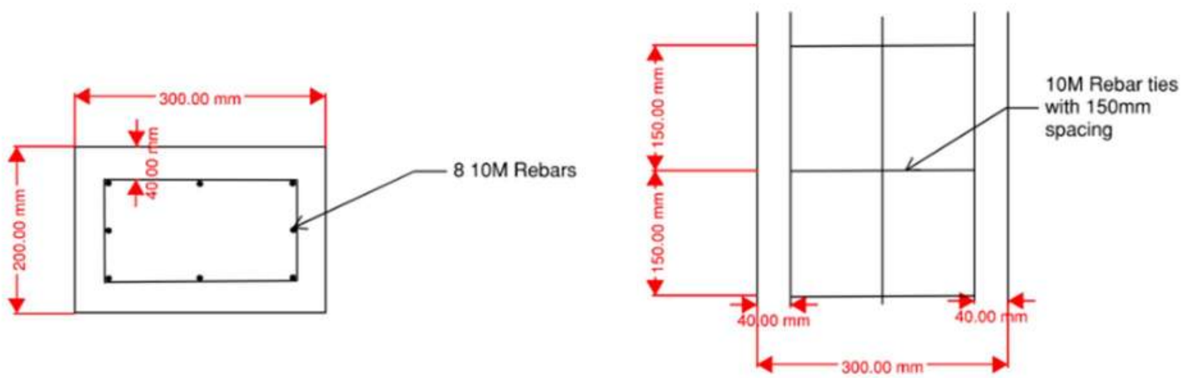

Figure 13. Gateway Column Design Summary

The footing was then designed for the stratigraphy in the area. From previous work experience in the area and geological reports, it was found that the ground conditions consisted of clay, sand, and gravel. For the design, it was assumed that the stratigraphy for the foundation consisted of loose sand & gravel, as this would yield the lowest bearing capacity. The bearing capacity for this condition is 50 kPa. Dimensions were assumed for the footing to be at a 1 m depth and be 1 m x 1 m x 0.5 m. The load was calculated for the footing, column, slab and UBC sign above the footing. From this, the bearing pressure induced on the ground was calculated to be 36.55 kPa. Checks were then completed to ensure that the footing had enough strength to support one and two-way shear and bending. Calculations were then completed to determine the rebar geometry in each direction of the footing. It was found that 10 10M rebars would be sufficient for this. A diagram of the footing is shown in the following figure.

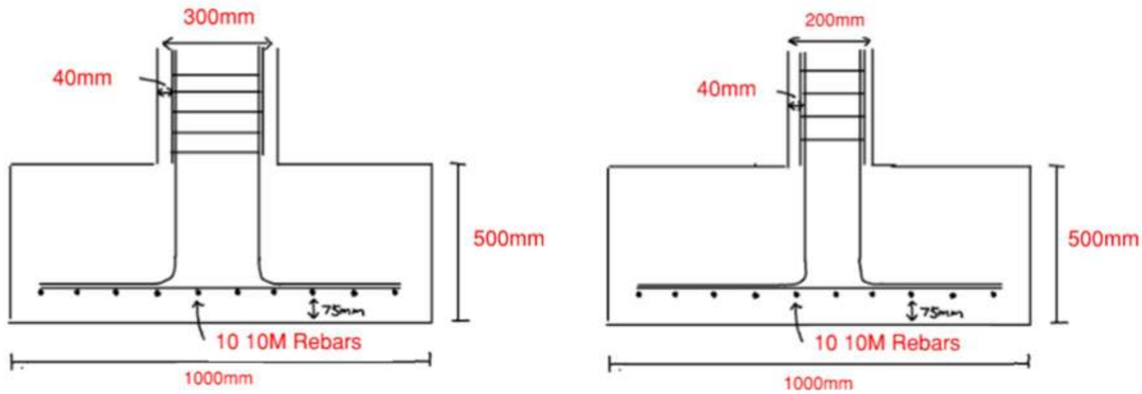

Figure 14. Footing Design Summary

Detailed structural calculations for the slab, column and footing are available in Appendix 4 – Gateway Structural Calculations.

5.0 Project Specifications and Software Tools

5.1 Standards and Technical Specifications

Standards and codes were utilized for the intersection design and will need to be followed during construction. The standards and codes were taken from BC and National building codes, Master Municipal Construction Documents, CSA, MoTI, TAC, and ASTM documents. These standards and codes specify design and installation methods for concrete, asphalt, soil, and roadwork. Additional guidelines and agencies will need to be consulted to ensure that construction is correctly approved and permitted.

The general design and construction of the project will be completed in compliance with:

- BC Building Code (Gateway structural design and analysis)
- National Building Code of Canada
- Master Municipal Construction Document (MMCD) Platinum Edition

Concrete will be constructed and designed according to the following guidelines:

- CSA Z151:17 Concrete Pumps and Placing Booms
- CSA A23.3:19 Design of Concrete Structures

- CSA S474:04 Concrete Structures
- CSA A23.2:19 Concrete Materials and Methods of Concrete Construction
- CSA S269.1-6 Falsework and Formwork

All roadway construction will be constructed and designed in compliance with the following specifications:

- ASTM D448-12 Standard Classification for Sizes of Aggregate for Road and Bridge Construction
- ASTM D2027 Standard Specification for Cutback Asphalt.
- All excavation and geotechnical work will be completed according to:
- ASTM D6169 Standard Guide for Selection of Subsurface Soil Sampling Devices for Environmental and Geotechnical Investigations
- CSA S472-04 Foundations

Traffic analysis and design was completed in compliance with the following codes:

- BC MoTI
- BC TAC

Permits and approvals must be obtained from the following agencies:

- BC Ministry of Transportation
- UBC SEEDS
- BC One Call
- UBC Campus and Community Planning

5.2 Software Tools

5.2.1 SIDRA INTERSECTION

The turbo roundabout was modelled on SIDRA INTERSECTION using traffic volumes and patterns obtained in Section 3.1. Current and service life conditions (2023 and 2073) models were generated at morning and evening peaks. Morning peak data was generated using screen line data from: SW Marine Dr. & Wesbrook Mall and W 16th Ave & East Mall. The linear regression performed in Section 3.1 was then applied to both morning and evening peaks to obtain expected traffic volumes for 50-year service life conditions. Models were simulated using this flow data, geometric inputs, and the following notable assumptions:

- The R4 RapidBus continues to operate at the same bus size and frequency.
- Since crossing are shared cyclist/pedestrian and pedestrian volumes are currently negligibly low, crossing speeds, volumes, and parameters relate to cyclists instead according to data gathered from *An analysis of cyclists' speed at combined pedestrian and cycle paths*
- Cyclist accommodation is a critical project objective. Annual cycle commuting to UBC counts do not reveal a clear trend, so a best-case scenario approach is adopted where ridership is assumed to have doubled in 2073.
- Since cyclist and pedestrian crossings run adjacent and parallel, volumes were combined and cyclists were assumed to cross at pedestrian pace due to model limitations.
- Heavy vehicle traffic is assumed to be 2% for all lanes of traffic.

The below figure is the developed model to simulate intersection traffic demand.

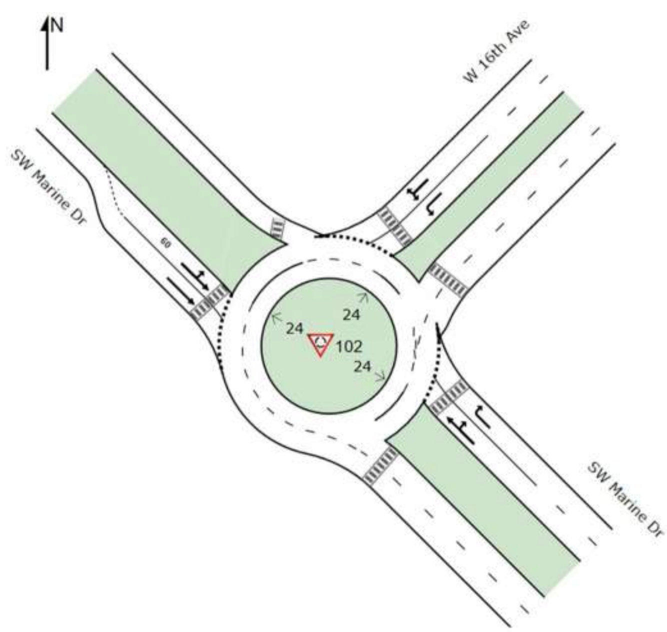

Figure 15. SIDRA INTERSECTION Model

Simulation data for LOS and delay are critical metrics for determining the effectiveness of the design. These values are summarized in the following two tables.

Table 5. SW Marine Dr. & W 16th Ave. – SIDRA INTERSECTION LOS Analysis Results

SW Marine Dr. & W 16th Ave. – SIDRA INTERSECTION LOS Analysis Results						
Simulation	**NWB RT**	**NWB Th/RT**	**SWB LT/RT**	**SWB LT**	**SEB Th/LT**	**SEB Th**
AM Peak - 2023	A	A	A	A	A	A
PM Peak - 2023	A	A	A	A	A	A
AM Peak - 2073	A	A	B	B	A	A
PM Peak - 2073	A	A	B	B	D	D

Table 6. SW Marine Dr. & W 16th Ave. – SIDRA INTERSECTION Average Delay Analysis Results

SW Marine Dr. & W 16th Ave. – SIDRA INTERSECTION Average Delay Analysis Results (s/veh)						
Simulation	**NWB RT**	**NWB Th/RT**	**SWB LT/RT**	**SWB LT**	**SEB Th/LT**	**SEB Th**
AM Peak - 2023	3.5	3.0	4.4	9.0	10.0	4.8
PM Peak - 2023	3.4	2.9	5.1	9.8	8.2	3.2
AM Peak - 2073	6.4	6.5	16.3	11.0	9.1	4.0
PM Peak - 2073	4.4	4.0	11.2	16.2	51.4	43.7

Assuming the determined conservative estimation of the average daily flow increase, it's evident that the southeast-bound movements in 2073 are critical. At the end of the intersection's lifespan, these lanes reach a LOS of D and an average delay of 45 seconds per vehicle. While these values are serviceable, the delay is significant and at this time and under this set of assumed circumstances, redesign to accommodate increased demand should be considered. The simulations conclude that current flow demands can be easily accommodated by the intersection, even with the lane deduction on the Northwest approach. Complete intersection reports can be found in Appendix 3 – SIDRA INTERSECTION Traffic Analysis.

5.2.2 EPA SWMM

The stormwater runoff around our roundabout was analysed using EPA SWMM, a stormwater management program. The software is used for analyzing stormwater runoff and pipe systems for the purposes of designing or planning managing systems. It was used in this report to analyze the roundabout and its surrounding areas for flooding under a 100-year storm.

5.2.3 Autodesk InfraWorks

Autodesk InfraWorks was used to generate the 3D model of the intersection. The software allows for multiple sources of data, such as DEMs, site orthophotos, drawings, and point clouds to be imported, creating a single high-resolution 3D model that can be easily navigated. 3D objects such as cars and streetlights can then be added to the model, which can then be used to produce renders of the intersection.

A rendering of the intersection can be found in Appendix 2 – 3D Model of Intersection.

5.2.4 SolidWorks

SolidWorks is a Computer Aided Design (CAD) software that is used to generate 3D models of objects. SolidWorks was used in this project to create a 3D model of the gateway structure, which was then added to the Autodesk InfraWorks model.

5.2.5 Autodesk AutoCAD

AutoCAD is a Computer Aided Design (CAD) software that is used to generate drawings. For this project, AutoCAD was used to create the drawing package (see Appendix 1)

5.2.6 GanttProject

GanttProject was used to create the project schedule for this project. Firstly, a rough Work Breakdown Structure was created, and the then more specific tasks were added. The final output of GanttProject was a Gantt chart, which is discussed in Section 8.0 – Project Schedule. The complete schedule can be found in Appendix 7 - Project Schedule.

6.0 Construction Contract

A tender document package containing both tendering and legally binding contract documentation must be submitted to the BC Ministry of Transportation and Infrastructure contract administration staff in order to have an Invitation to Tender (ITT) published to the BC Bid website. The tender package consists of the following documents:

- Request to Advertise for Major Works, Minor Works, Design-Build Minor, and Operational Services Contracts (H0330)
- Schedule T1 – Conditions of Tender
- Schedule T2 – Tender Securities (INS-261)
  - Specimen Bid Bond (BID 0404)
- Tender Envelope (H0384)
  - Tender Form (H0033)
- Contract General Conditions
- Schedule 1 – Supplemental General Conditions/Glossary of Terms
- Schedule 2 – Contract Securities
  - Contract Securities Requirements and Bond Specimens (INS-265)
  - Specimen Performance Bond (Perf9702)
  - Specimen Labour and Material Payment Bond (LM9702)
- Schedule 3 – Special Provisions and Appendices
  - 2018 Design Build Standard Specifications for Highway Construction Errata No. 1
- Schedule 4 – Drawings
- Schedule 5 – Time Schedule
- Schedule 6 – Insurance
  - Notice to Contractors - Ensuring Compliance with Insurance, Bonds and WorkSafeBC Requirements (INS-NOTICE)
  - Insurance Specifications - Design-Build Minor (INS-172)
  - Certificate of Insurance (H0111)
- Schedule 7 – Approximate Quantities and Unit Prices
  - Schedule of Approximate Quantities and Unit Prices (H0088)
- Schedule 8 – Prime Contract Designation Form
- Schedule 9 – Contract Amendments

A Lump Sum contract was selected to minimize the risk assigned to the province. UBC Campus and Community Planning have gained roundabout design experience by similarly retrofitting other intersections in recent years. Therefore, the level of risk assigned to this project will be relatively low.

7.0 Construction Plan

In order to minimize impacts to vehicles during the construction of the roundabout, a construction plan was developed. This plan includes a traffic management plan, cranage plan, and a project phasing plan.

7.1 Project Phasing

The construction of the roundabout will be completed in two phases. Phase 1 of construction will involve the demolition of the existing intersection, construction of the roundabout, construction of the bike lanes on the west side of the project site, and construction of the pedestrian and bike crossings. Phase 2 will involve the demolition of the existing slip road and the construction of the new bike lane on the east side of the project site.

7.2. Traffic Management Plan

A Category 2 Traffic Management Plan (TMP) was created following the example Category 2 TMP by the BC MoTI, the Traffic Management Manual for Work on Roadways (TMM), and Section 5 of the Manual of Standard Traffic Signs and Pavement Markings. An abridged version of the TMP can be found in Appendix 5 – Traffic Management Plan. Drawings TMP-001 and TMP-002 show the planned construction signage as well as the temporary asphalt pavement that will be installed during each phase of construction.

During Phase 1 of construction, the existing two-lane slip lane from SW Marine Dr. to W 16th Ave. will be reconfigured as a temporary two-way road through the intersection. In Phase 2, the roundabout will be reconfigured temporarily in a clockwise orientation for vehicles to travel through the intersection. In addition to the reconfiguration of the intersection, access to certain sections of

SW Marine Dr. will be affected. During Phase 1 of construction, the portion of SW Marine Dr. between W 16th Ave. and Stadium Dr. will be shut down for vehicular traffic. In Phase 2 of construction, access to SW Marine Dr. north of W 16th Ave. will only be available via W 16th Ave., and vehicles heading southeast along SW Marine Dr. toward the intersection will only be allowed to continue along SW Marine Dr. Vehicles will be detoured around the site, following Drawing TMP-003 and TMP-004.

7.3 Cranage Plan

As part of the gateway structure installation, a mobile crane will be required to hoist the steel elements into place. After referencing the site plan and the construction schedule, it was determined that there will be no overhead obstructions for the crane during installation.

8.0 Project Schedule

Following the project phasing plan in Section 7.1, a full project schedule was created using GanttProject. The schedule aims for a handover date of June 2025, assuming a Notice to Proceed date of August 1, 2024, following permitting approval and prime contractor selection. Major project phases include permitting, procurement (of contractor and of material), pre-construction, construction (Phase 1 and Phase 2), commissioning, project close-out and project handover.

The following Gantt chart provides a summary of the major phases of the project.

Table 7. Summary of Project Schedule

Task	2024								2025					
	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Issued For Construction Drawings Released	★													
Permitting	■	■												
Procurement		■	■											
Pre-Construction			■	■										
Construction - Phase 1				■	■	■	■	■	■	■				
Construction - Phase 2										■	■	■	■	
Commissioning													■	
Substantial Completion													★	
Close-out													■	■
Project Handover														★

The full project schedule can be found in Appendix 7 – Project Schedule.

9.0 Class A Class Estimate

Based on our final design, a Class A estimate was prepared. Class A estimates are characterized by a high level of accuracy, with a margin of error typically ranging between plus or minus 5% to 10%. Cost data was collected using publicly available data as well as RSMeans, a large database of construction unit costs. The figures were then extrapolated according to Statistics Canada's Building Construction Price Indexes in order to obtain expected unit costs for 2024.

As of the submission of this report, we expect the project to cost $5,100,000 Canadian Dollars, including maintenance, assuming a service life of 50 years. The following pie chart shows the breakdown between design costs, permitting costs, project execution costs, and long-term maintenance costs.

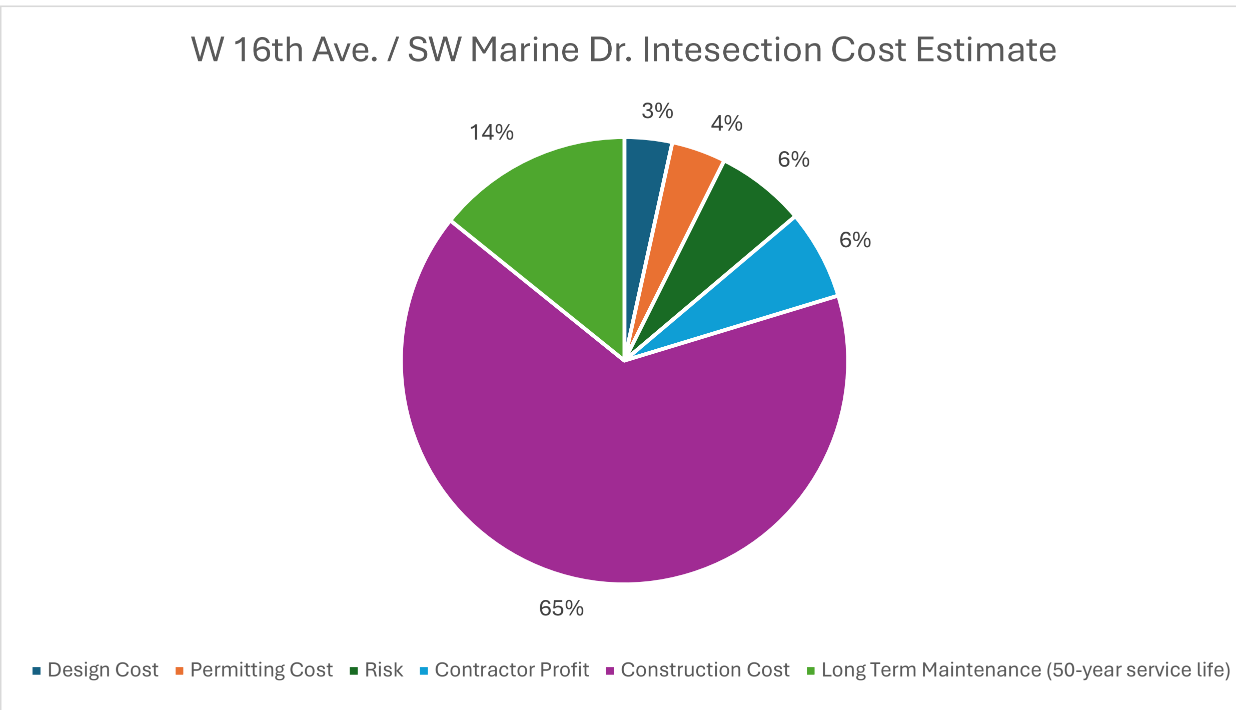

Figure 16. Breakdown of Class A Cost Estimate

9.1 Design Cost

The work conducted by our firm is estimated to cost $175,000 Canadian Dollars. This figure reflects not only billable hours, but also includes the company's operational costs, professional expertise, and overhead.

As part of this project, extra geotechnical work had to be completed in order to design the gateway structure, and extra stormwater modelling had to be completed to measure the impact of the rain garden. These analyses are typically not needed in the design of other intersections and are further justification for the increased cost of the design of this intersection.

9.2 Permitting Costs

Based on publicly available information, the permitting costs of an infrastructure project average around 5 percent of the total construction cost. This is equal to a total permitting cost of around $200,000 Canadian Dollars.

9.3 Project Execution Cost

Based on our quantity takeoff and cost information, a thorough construction cost estimate was generated for this project. We have allotted 10% of the total construction cost to account for a general contractor's markup, and an extra 10% to address potential risks. Based on a start date of May 2024, we expect the project execution costs to cost $4,000,000 Canadian Dollars.

Please refer to Appendix 8 – Class A Cost Estimate for the full construction cost estimate.

9.4 Long Term Maintenance Cost

A separate cost estimate was completed to determine the annual cost of maintenance for the intersection. As per the annual maintenance plan for the stormwater management system, pruning, watering, mulching, weeding, and clearing of debris must be completed at regular intervals. The long-term maintenance cost also includes provisions for the annual inspection of the roadway, annual maintenance of the asphalt surface and a resurface of the intersection every 12 years. This is detailed in Appendix 9 – Long Term Maintenance Cost Estimate.

The annual maintenance cost for the intersection is roughly $14,500 Canadian Dollars per year, or $725,000 Canadian Dollars in total, assuming a 50-year service life.

10.0 Conclusion

Due to the inefficiency, safety issues, and environmental concerns regarding the current intersection of SW Marine Dr. and W 16th Ave., UBC Campus and Community Planning has requested a full redesign of the intersection. The primary concerns with the current intersection were related to the speed of incoming traffic, the lack of active transportation modes being used, and the issues regarding excess water runoff and its impact on erosion of the local landscape.

This report outlined the design requirements, technical considerations, design, cost estimate, project timeline, and all other key points of information regarding the redesign project. The design featured a turbo roundabout, which aims to slow the speed of traffic, and provide increased capacity and safety compared to the current signalized intersection. Stormwater management is achieved through rain gardens and bioswales along pedestrian and cyclist facilities and in the central roundabout ring. This provides the intersection with an attractive and environmentally friendly setting that also strengthens the local ecology and helps prevent excessive water runoff. Finally, the centerpiece of the roundabout is a newly constructed gateway structure, which will welcome visitors to the UBC campus.

All the technical and other design requirements were met and addressed in their respective sections of the report, and the relevant technical analysis and reasoning behind the design choices were also presented. A full list of the design standards and specifications used during the design process was also presented.

The project is designed to be constructed in two primary phases; the first phase involves the demolition of the current infrastructure, building the roundabout and western pedestrian and cyclist sections. The second phase involves the demolition of the slip road and construction of the eastern bike lane. Based on the assumed construction start date of August 1st, 2024, the project is projected to reach completion in June 2025.

The overall cost of the project is expected to be $5,100,000 Canadian dollars, based on the construction cost, design cost, maintenance, permitting, and long-term maintenance assuming a 50-year service life. With the completion of the intersection's design, the project can now move into the tendering phase and begin construction once tendering is complete. Our team is happy to have been able to provide our services for the project and firmly believe that our work has been of the highest quality possible.

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Appendix 1

Drawing Package

SW Marine Drive & W 16th Avenue Intersection Redesign

CONSTRUCTION DOCUMENTS

INDEX

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	COVER PAGE	MH	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: CD01 - COVER

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
N/A	10/04/2024	MH	N/A

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD01/13	A

ABBREVIATIONS

A.
AP - ASPHALT PAVEMENT

C.
CBC - CRUSHED BASE COURSE
CD - CONSTRUCTION DRAWING/DOCUMENT

D.
DR. - DRIVE

G.
GU - GENERAL USE

L.
L.E - LANE EDGE

N.
NE - NORTHEAST
NW - NORTHWEST

P.
P.E - PAVEMENT EDGE

R.
REBAR - STEEL REINFORCEMENT BARS

S.
SE - SOUTHEAST
SGSB - SELECT GRANULAR SUB BASE
STRMWTR - STORMWATER
SW - SOUTHWEST

T.
TYPE D - EARTH EMBANKMENT MATERIAL PER SS 201.37

U.
UBC - UNIVERSITY OF BRITISH COLUMBIA

X.
[X]M - X MM DIAMETER STEEL REINFORCEMENT BARS

SYMBOLS

Ø - DIAMETER

℄ - CENTERLINE

R - Radius

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	LEGEND SHEET	MH	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: CD02 - LEGEND SHEET

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PROJECT NO:	DRAWING NO:	REVISION:
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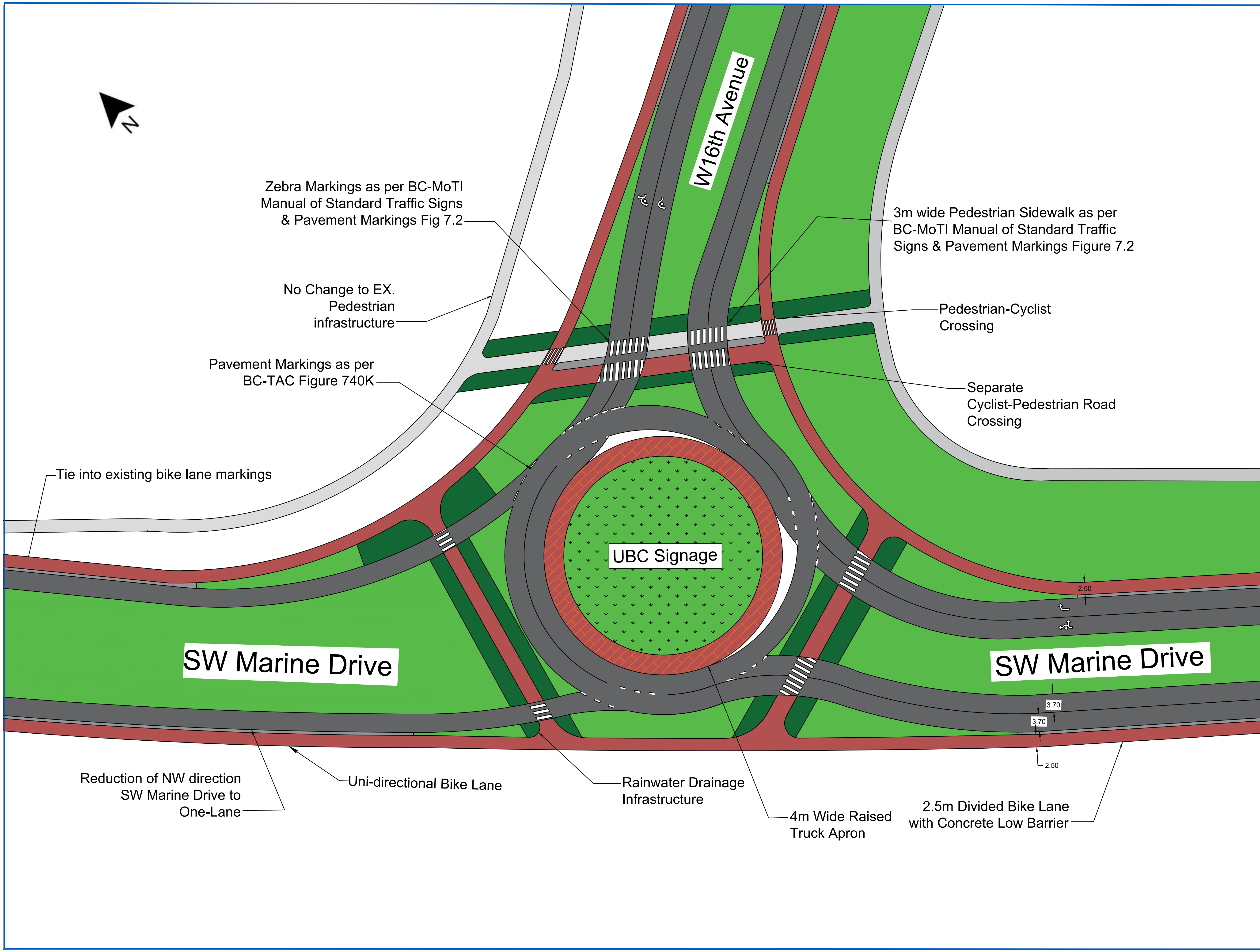

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STATUS:

CLIENT:
UBC Community and Campus Planning
2210 West Mall
Vancouver, BC
V6T 1Z4

SITE:
SW Marine Drive & W 16th Ave

TITLE:
Plan View

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
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PROJECT NO:	DRAWING NO:		REVISION:
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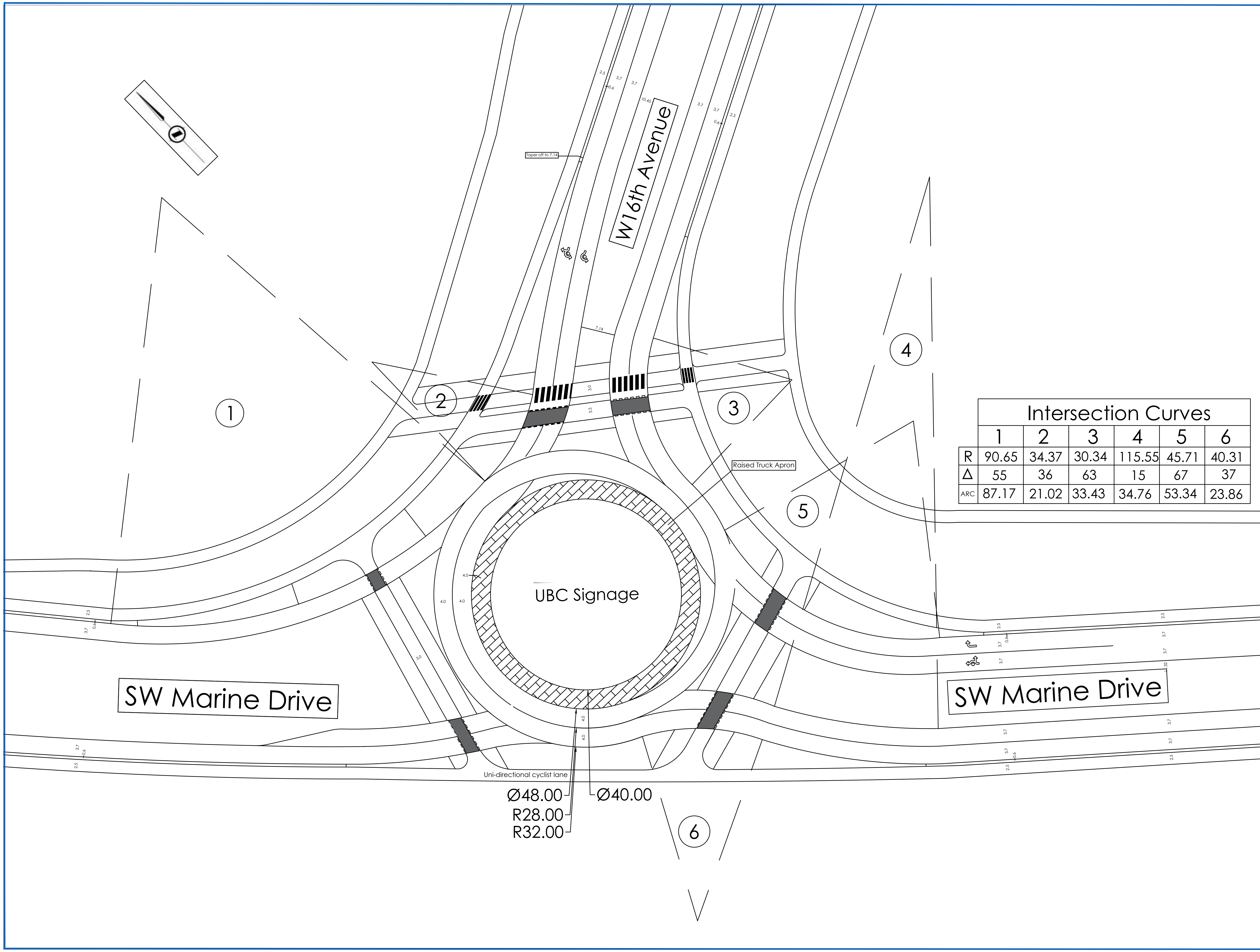

	Intersection Curves					
	1	2	3	4	5	6
R	90.65	34.37	30.34	115.55	45.71	40.31
Δ	55	36	63	15	67	37
ARC	87.17	21.02	33.43	34.76	53.34	23.86

Notes:

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STATUS:

CLIENT:
UBC Community and Campus Planning
2210 West Mall
Vancouver, BC
V6T 1Z4

SITE:
SW Marine Drive & W 16th Ave

TITLE:
Road Radii

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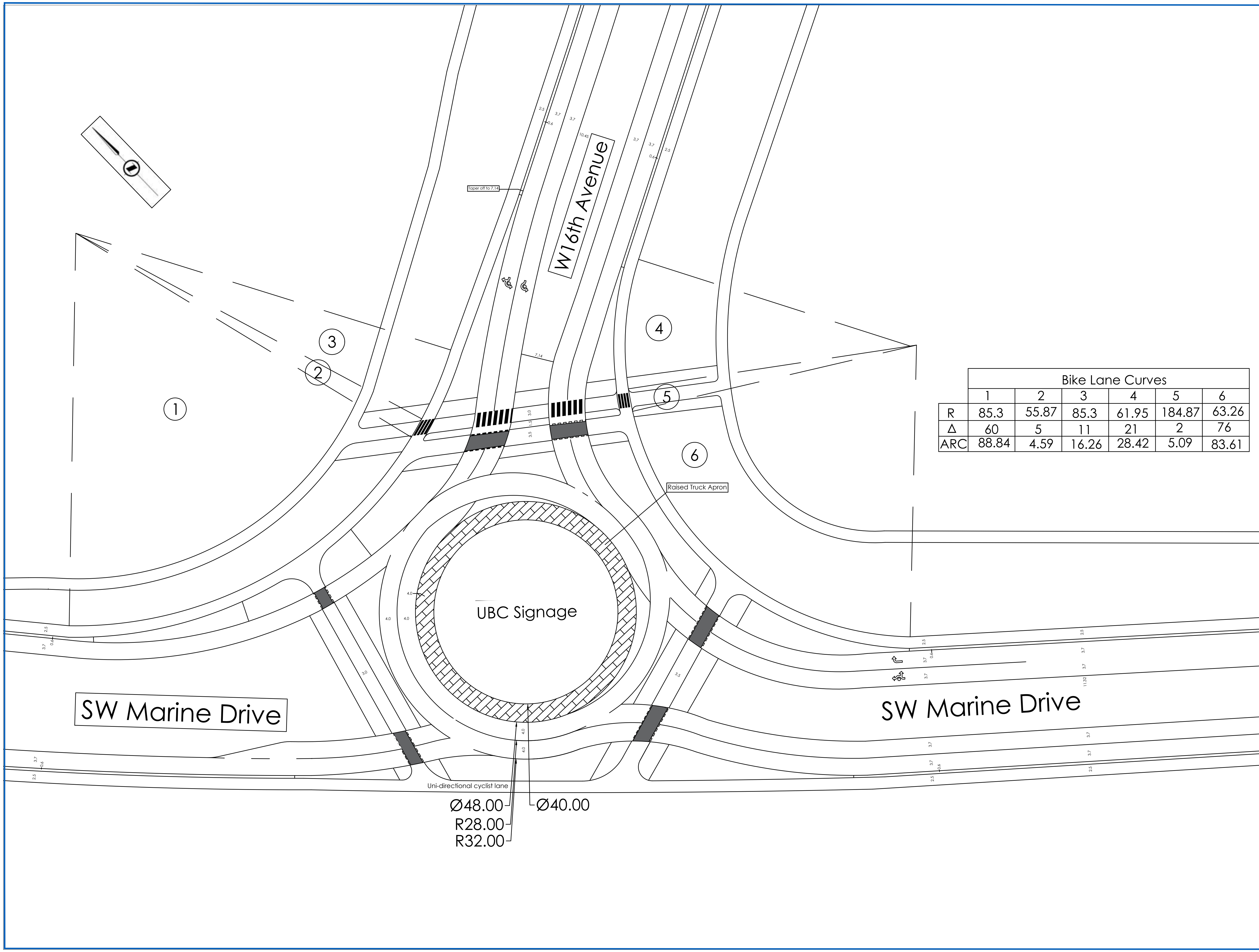

	1	2	3	4	5	6
	Bike Lane Curves					
R	85.3	55.87	85.3	61.95	184.87	63.26
Δ	60	5	11	21	2	76
ARC	88.84	4.59	16.26	28.42	5.09	83.61

Notes:

REV:	DESCRIPTION:	BY:	DATE:

STATUS:

CLIENT:
UBC Community and Campus Planning
2210 West Mall
Vancouver, BC
V6T 1Z4

SITE:
SW Marine Drive & W 16th Ave

TITLE:
Cyclist Radii

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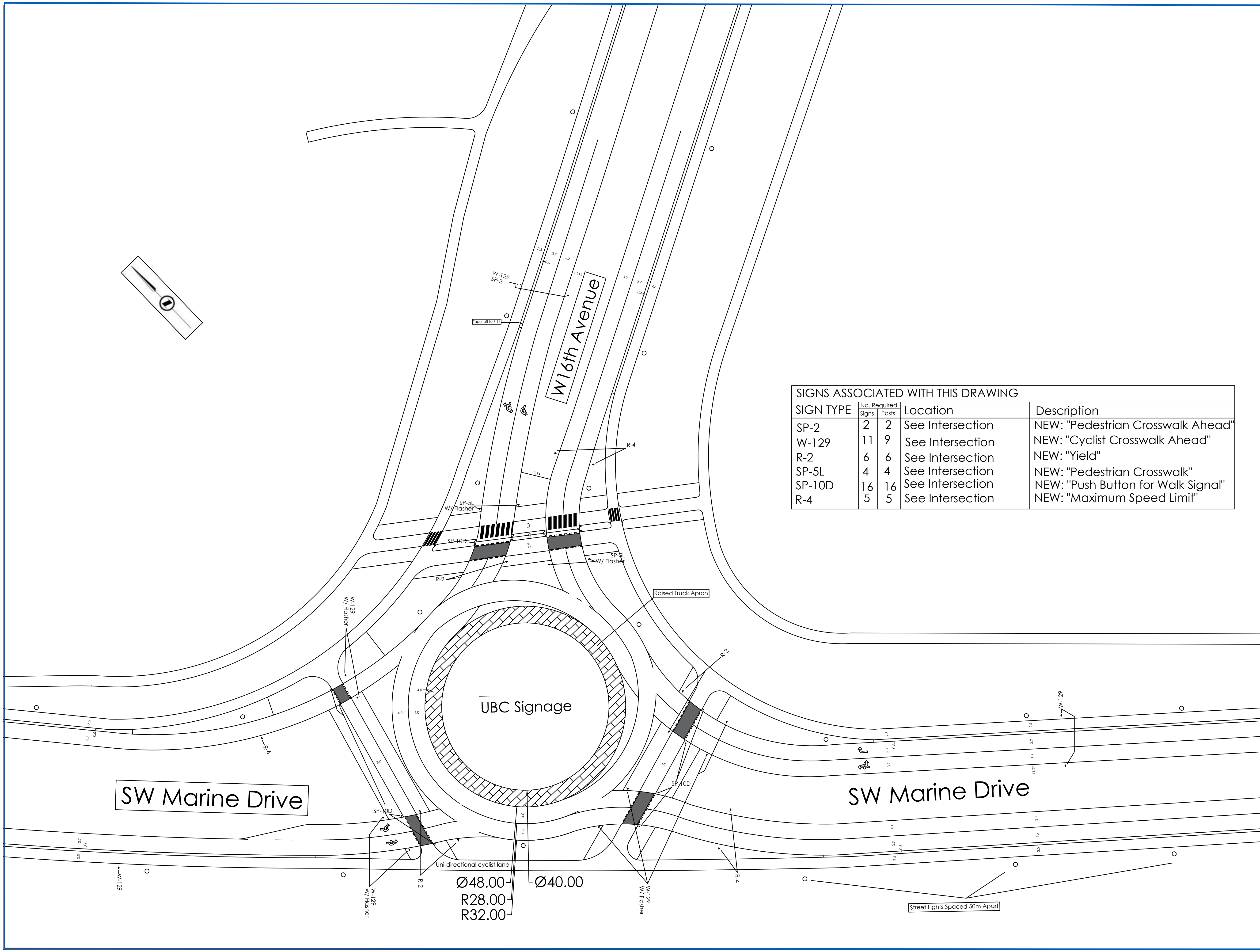


SIGNS ASSOCIATED WITH THIS DRAWING				
SIGN TYPE	No. Required: Signs	No. Required: Posts	Location	Description
SP-2	2	2	See Intersection	NEW: "Pedestrian Crosswalk Ahead"
W-129	11	9	See Intersection	NEW: "Cyclist Crosswalk Ahead"
R-2	6	6	See Intersection	NEW: "Yield"
SP-5L	4	4	See Intersection	NEW: "Pedestrian Crosswalk"
SP-10D	16	16	See Intersection	NEW: "Push Button for Walk Signal"
R-4	5	5	See Intersection	NEW: "Maximum Speed Limit"

Notes:

REV:	DESCRIPTION:	BY:	DATE:

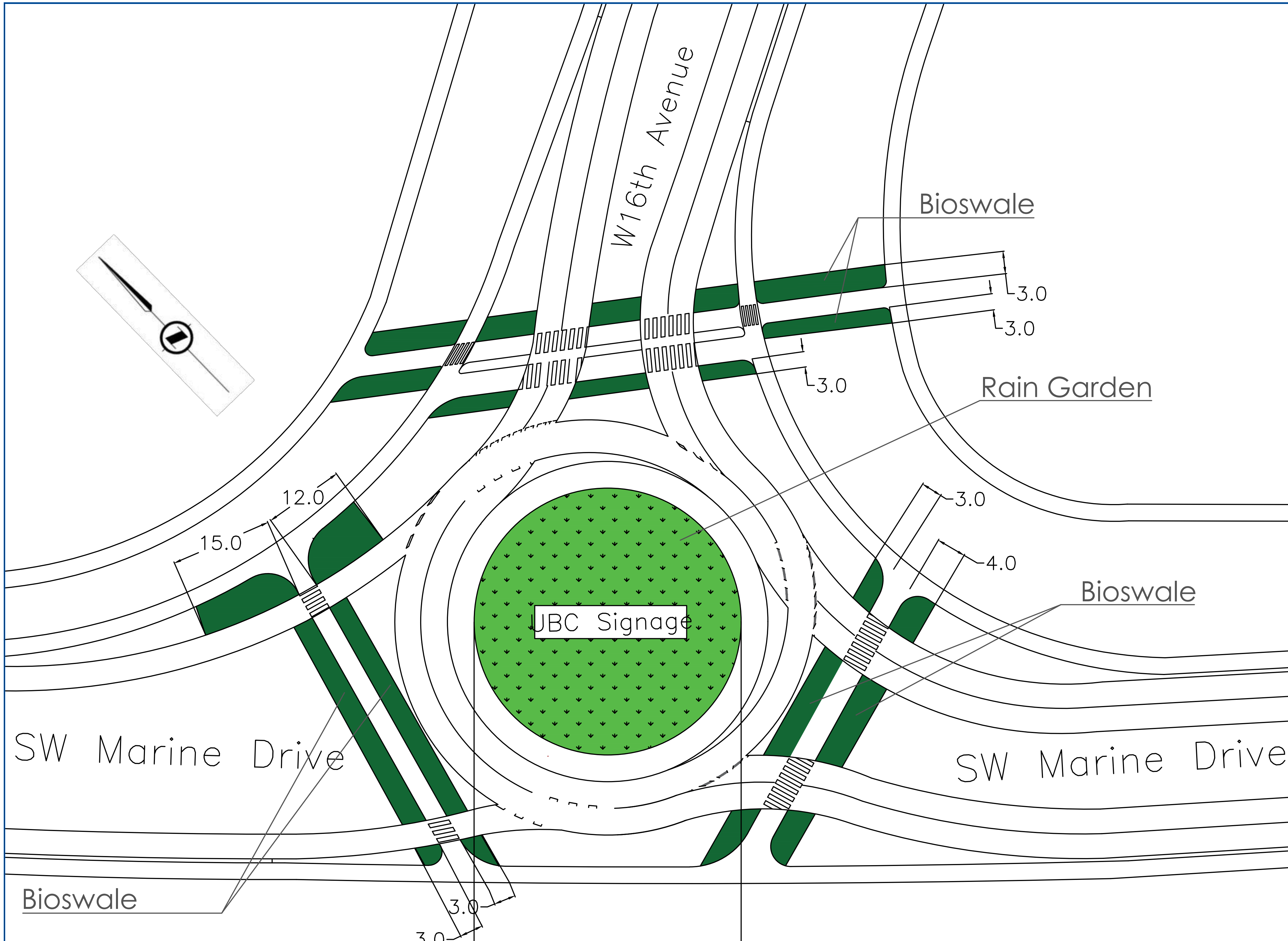
STATUS:

CLIENT:
UBC Community and Campus Planning
2210 West Mall
Vancouver, BC
V6T 1Z4

SITE:
SW Marine Drive & W 16th Ave

TITLE:
Sign and Pavement Marking

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
TBD	06/03/24	JI	FC
PROJECT NO:	DRAWING NO:		REVISION:
0001	CD06/CD13		A



-Drawing Not to Scale
-All measurements shown in units of [m]

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	STRMWTR RETENTION PLAN VIEW	HK	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

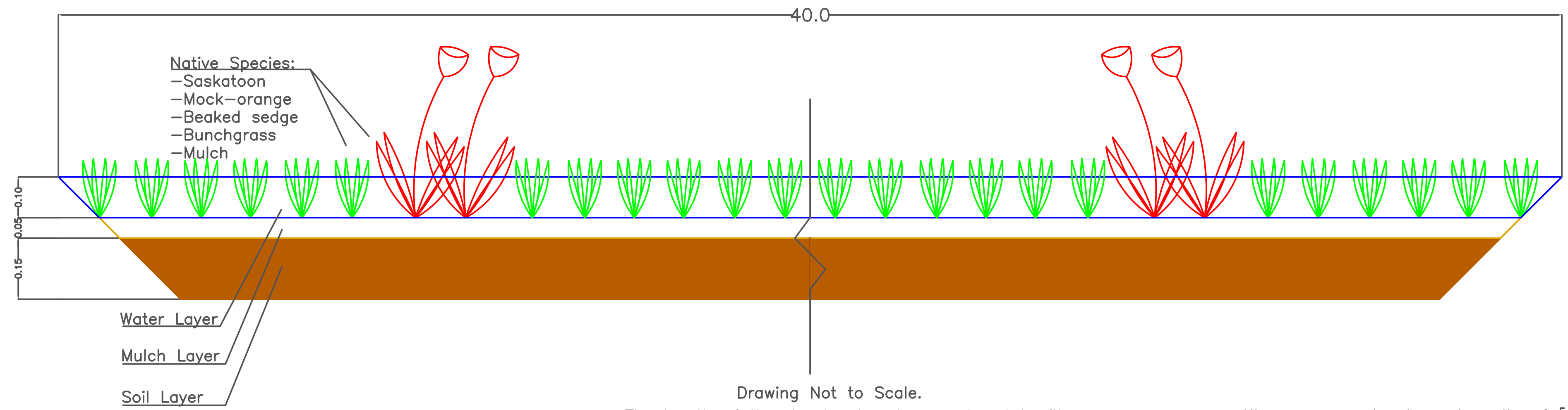
SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: STRMWTR RETENTION PLAN VIEW

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:250	10/04/2024	HK	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD07/CD13	A

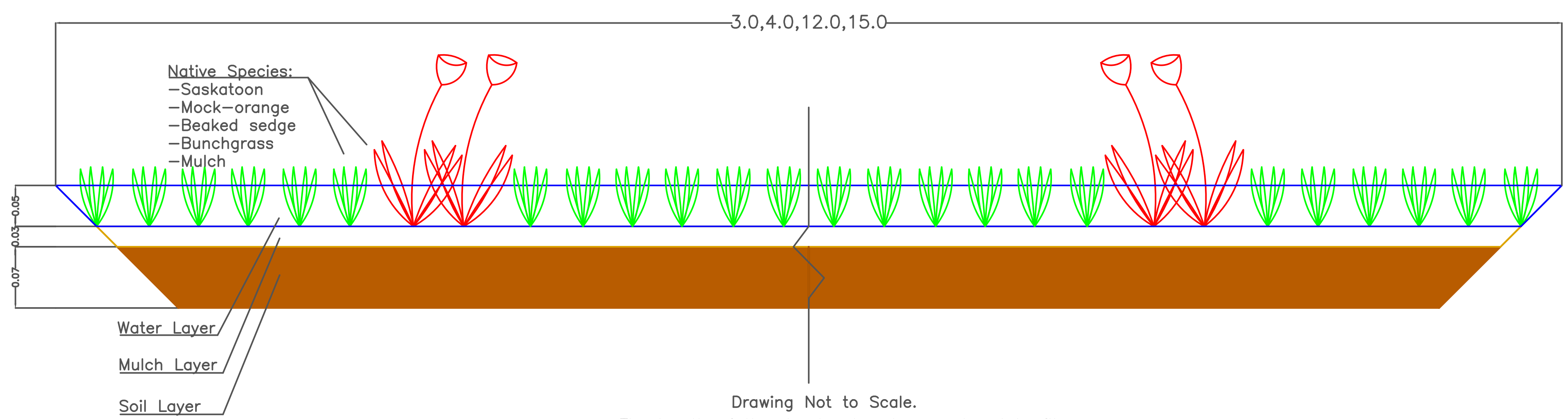
CROSS SECTION OF RAIN GARDEN



Drawing Not to Scale.
The length of the drawing has been reduced to fit onto the page. See the scale break indicated by the black line going along the center of the drawing.

–All measurements shown in units of [m].

CROSS SECTION OF BIOSWALES



Drawing Not to Scale.
The length of the drawing has been reduced to fit onto the page. See the scale break indicated by the black line going along the center of the drawing.

–All measurements shown in units of [m].
–The bioswale lengths vary from 3, 4, 12, 15m depending on which section is looked at. Refer to CD07 to know where each lengths correspond to.

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	STRMWTR RETENTION CROSS SEC.	HK	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

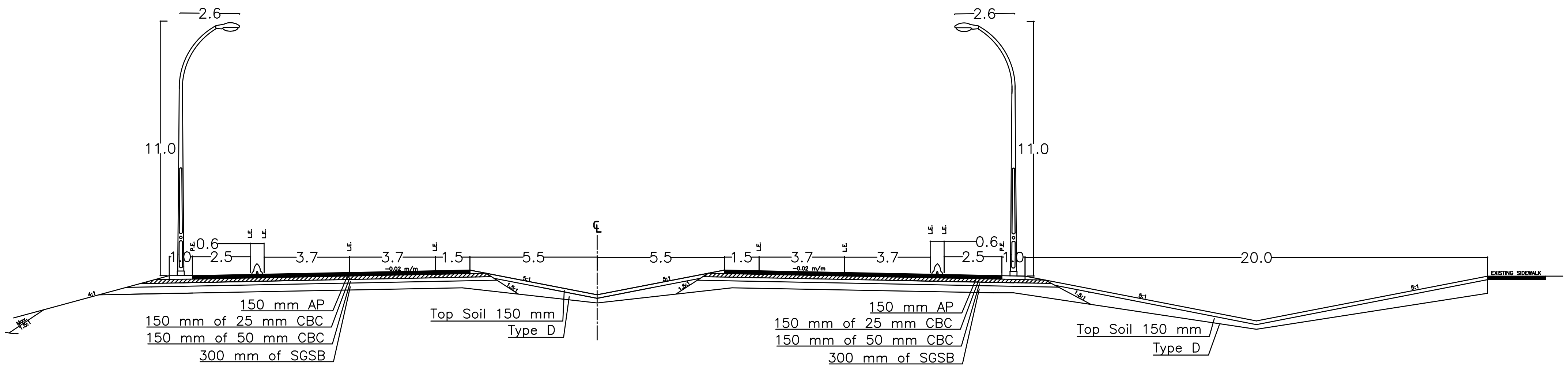
SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: STRMWTR RETENTION CROSS SECTION

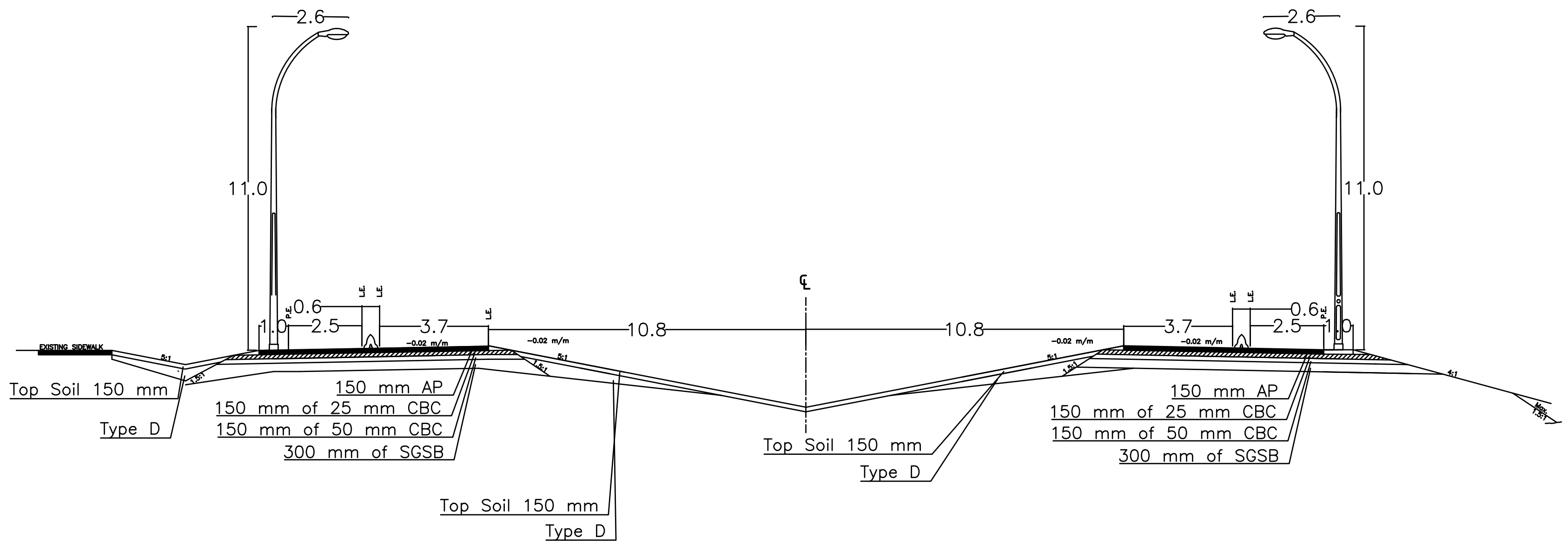
SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:100, 1:50	10/04/2024	HK	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD08/CD13	A

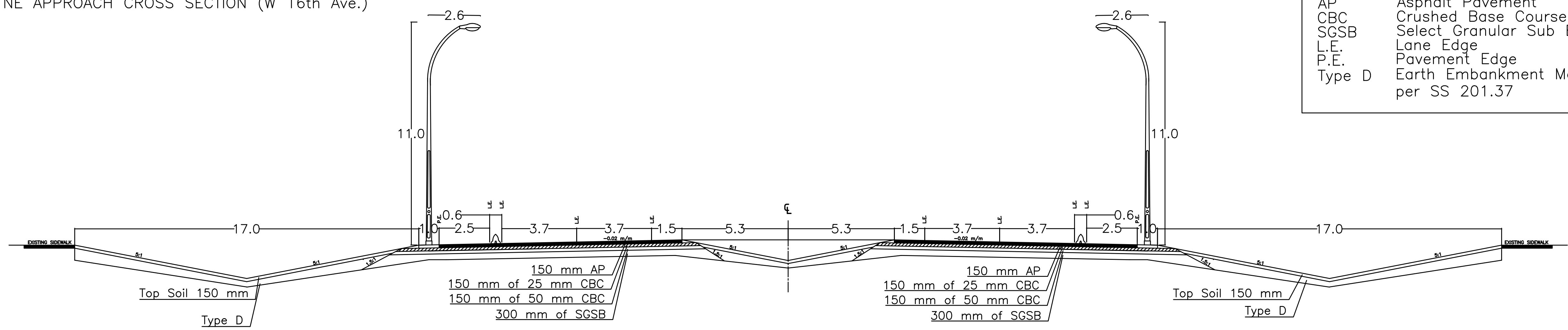
SE APPROACH CROSS SECTION (SW MARINE DR.)



NW APPROACH CROSS SECTION (SW MARINE DR.)



NE APPROACH CROSS SECTION (W 16th Ave.)



Terms:

AP	Asphalt Pavement
CBC	Crushed Base Course
SGSB	Select Granular Sub Base
L.E.	Lane Edge
P.E.	Pavement Edge
Type D	Earth Embankment Material per SS 201.37

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	APPROACH CROSS SECTIONS	FC	03/04/2024

STATUS: CONSTRUCTION ISSUE

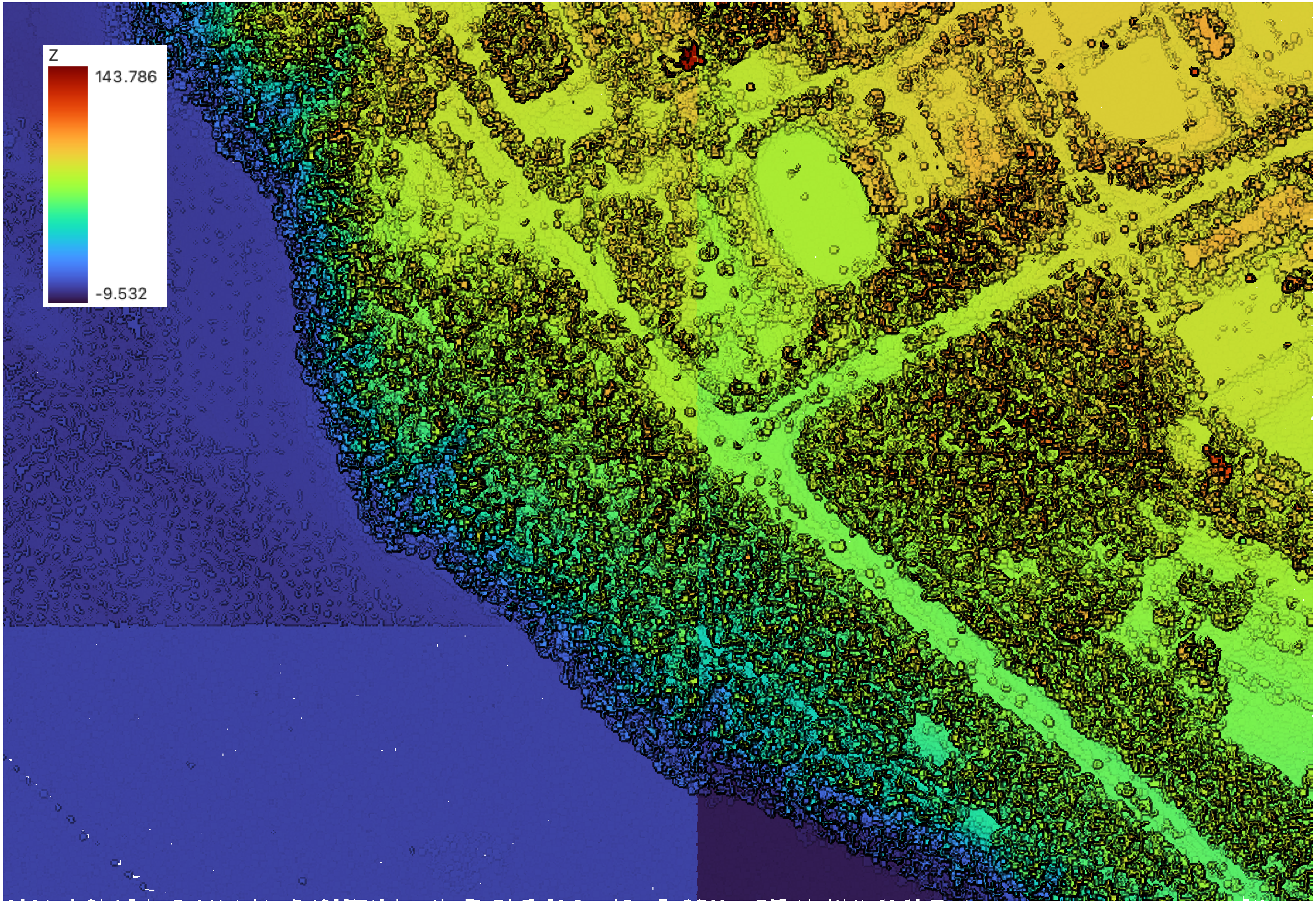
CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: APPROACH CROSS SECTIONS

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:170	06/03/24	FC	RL

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD09/CD13	A



Notes:

REV:	DESCRIPTION:	BY:	DATE:
A	ISSUED FOR CONSTRUCTION	RL	04/06

STATUS: ISSUED FOR CONSTRUCTION

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL
VANCOUVER, BC V6T 1Z4

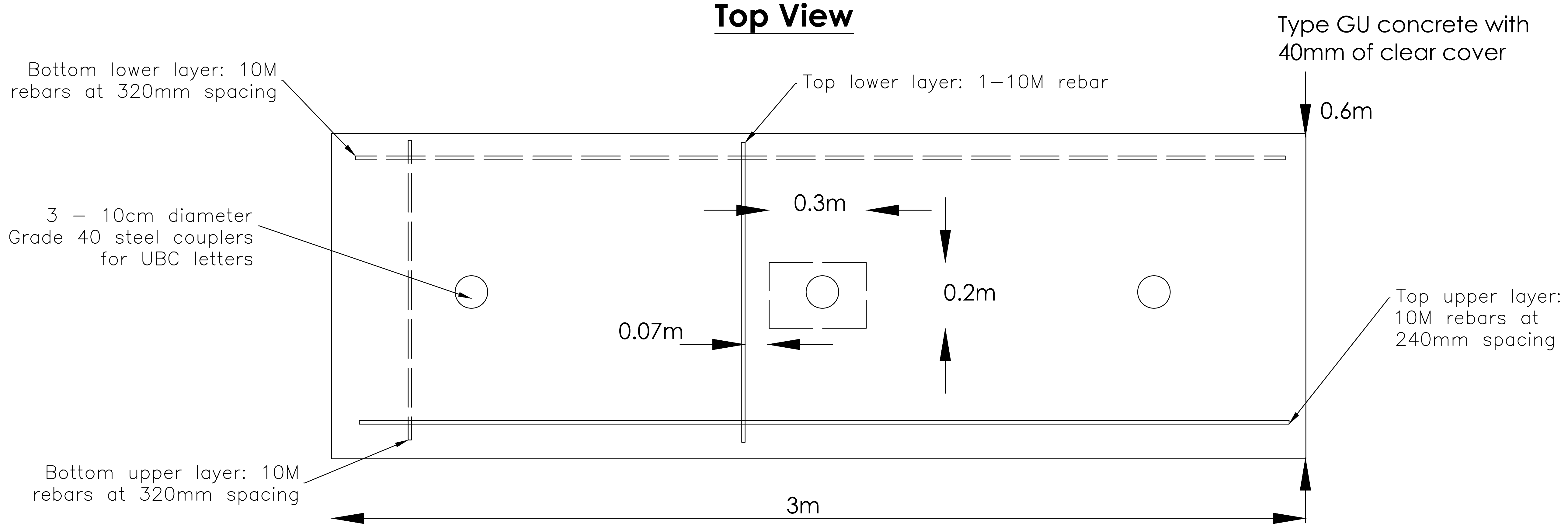
SITE: W 16 AVE. AND SW MARINE DR. ROUNDABOUT

TITLE: ELEVATION HEATMAP

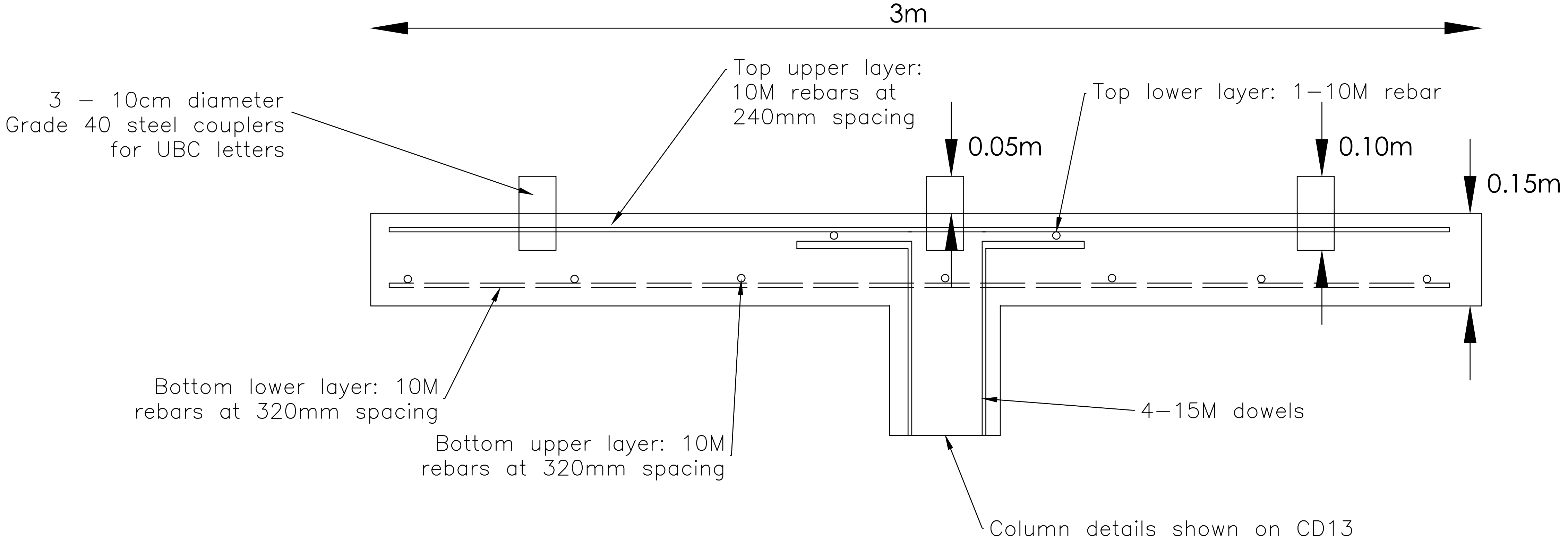
SCALE AT A2:	DATE:	DRAWN:	CHECKED:
NTS	04/06/24	RL	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD10/CD13	A

Top View



Front View



Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	GATEWAY SLAB DESIGN	TC	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

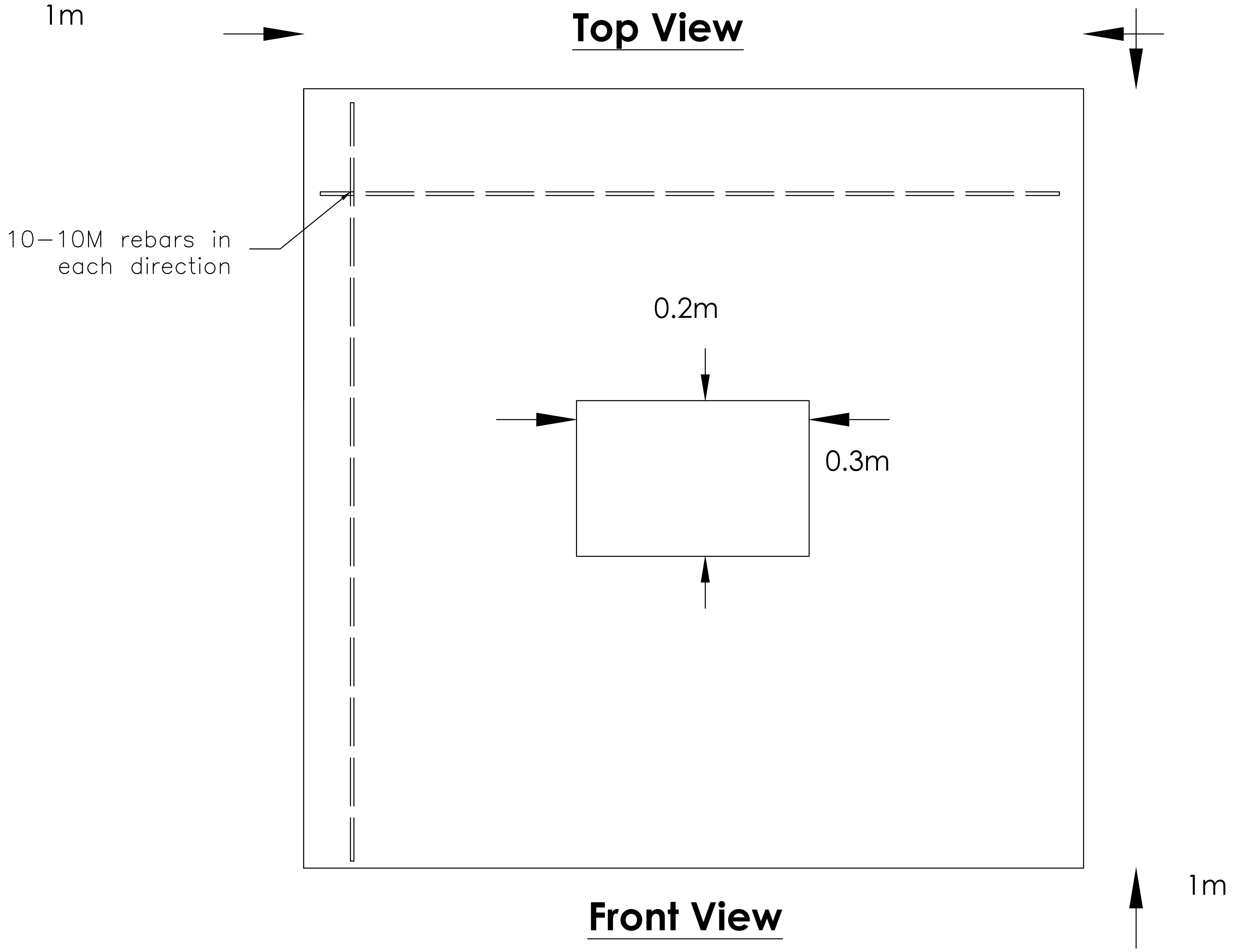
SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: GATEWAY SLAB DESIGN

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:125	10/04/2024	TC	FC

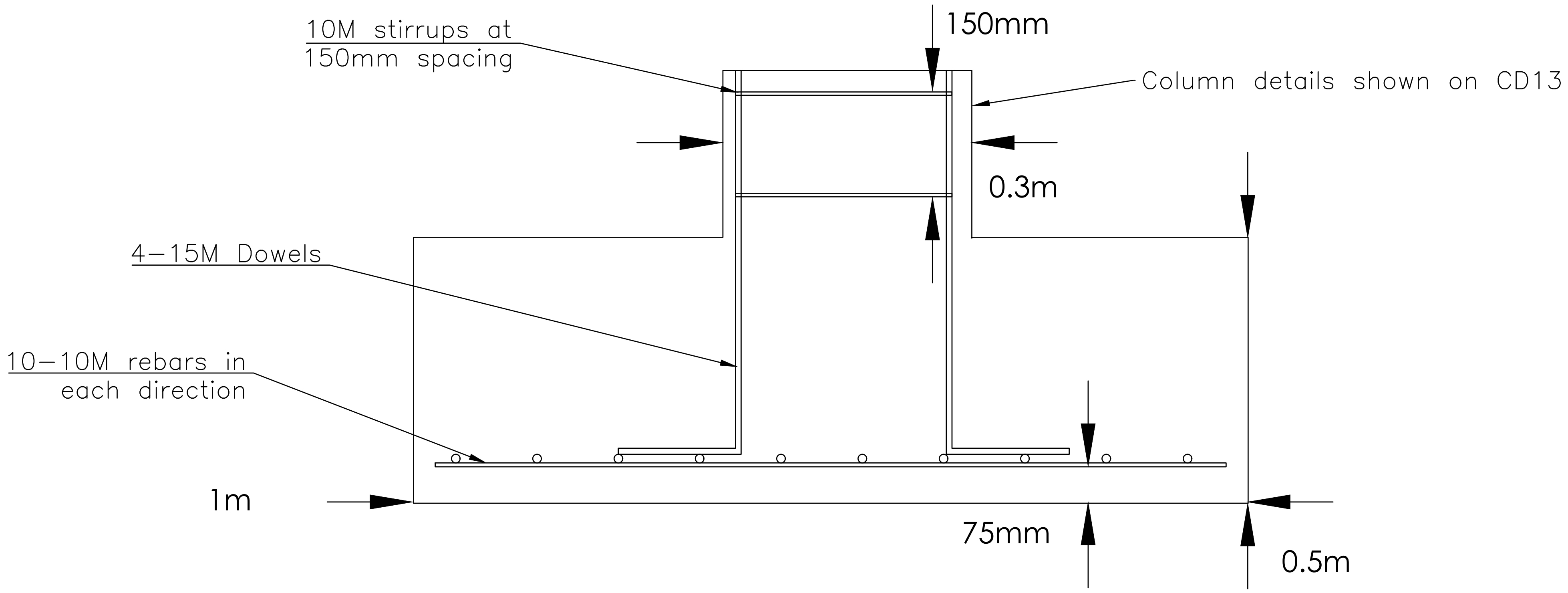
PROJECT NO:	DRAWING NO:	REVISION:
0001	CD11/CD13	A

Top View



Type GU concrete with 40mm of clear cover. Use 75mm clear cover for concrete exposed to soil.

Front View



Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	GATEWAY FOOTING DESIGN	TC	10/04/2024

STATUS: CONSTRUCTION ISSUE

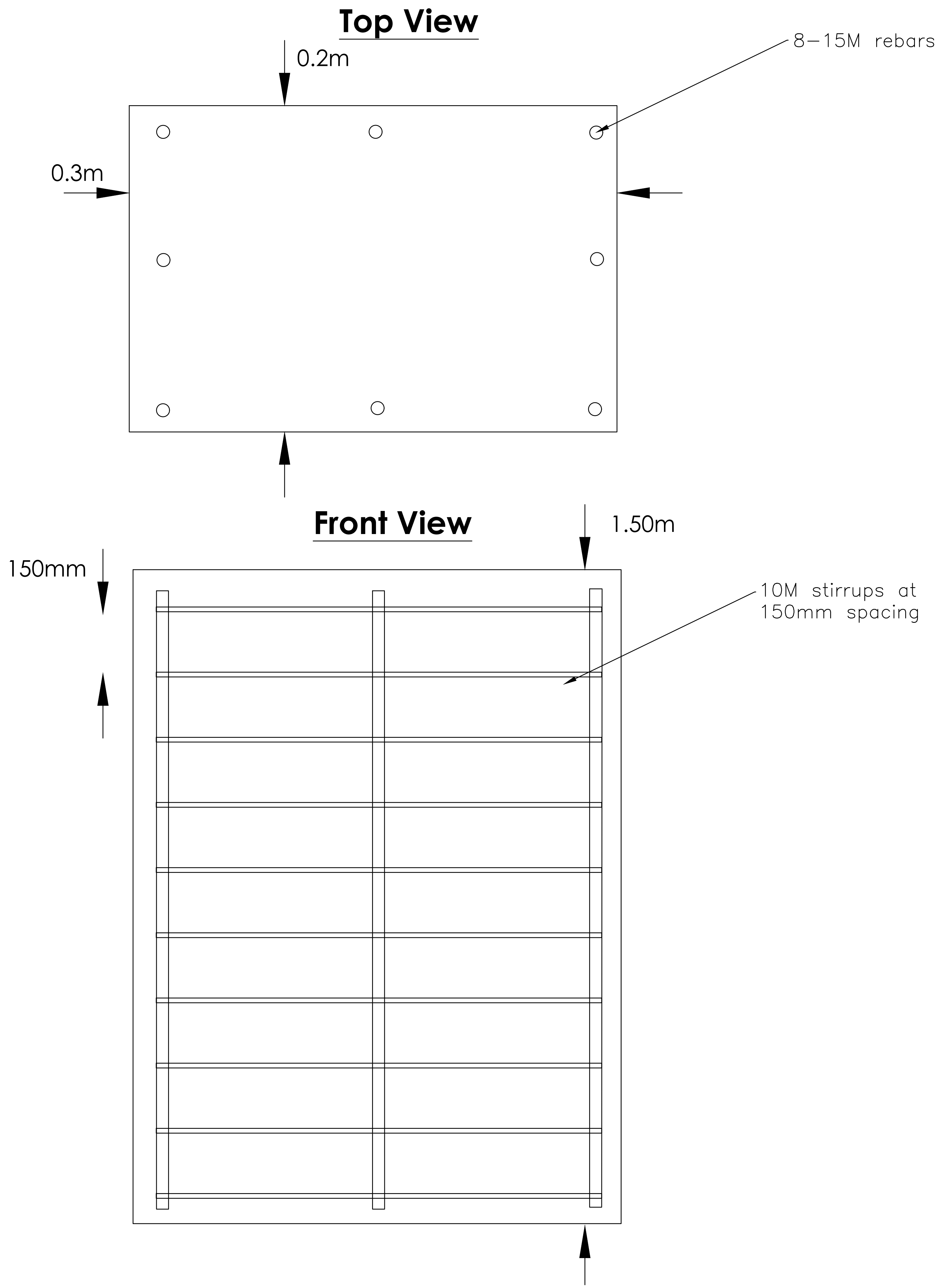
CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: GATEWAY FOOTING DESIGN

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:100	10/04/2024	TC	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD12/CD13	A



Type GU concrete with
40mm of clear cover

Notes:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S, SERVICE ENGINEER'S AND COASTAL COMMUTE SOLUTIONS DRAWINGS AND SPECIFICATIONS.

REV:	DESCRIPTION:	BY:	DATE:
A	GATEWAY COLUMN DESIGN	TC	10/04/2024

STATUS: CONSTRUCTION ISSUE

CLIENT: UBC COMMMUNITY AND CAMPUS PLANNING
2210 WEST MALL
VANCOUVER, BC
V6T 1Z4

SITE: SW MARINE DRIVE & W 16TH AVE

TITLE: GATEWAY COLUMN DESIGN

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
1:80	10/04/2024	TC	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	CD13/CD13	A

Notes:

1. THIS TRAFFIC MANAGEMENT PLAN MUST BE EXECUTED BY A QUALIFIED TRAFFIC CONTROL COMPANY.
2. ANY FIELD ADJUSTMENTS TO THE PLAN SHALL BE MADE BY QUALIFIED PERSONNEL.
3. MAJOR ADJUSTMENTS WHICH HAVE THE POTENTIAL TO IMPACT TRAFFIC OPERATIONS WILL REQUIRE A REVISED TRAFFIC MANAGEMENT PLAN.

REV:	DESCRIPTION:	BY:	DATE:
A	ISSUED FOR IMPLEMENTATION	RL	04/06

STATUS: ISSUED FOR IMPLEMENTATION

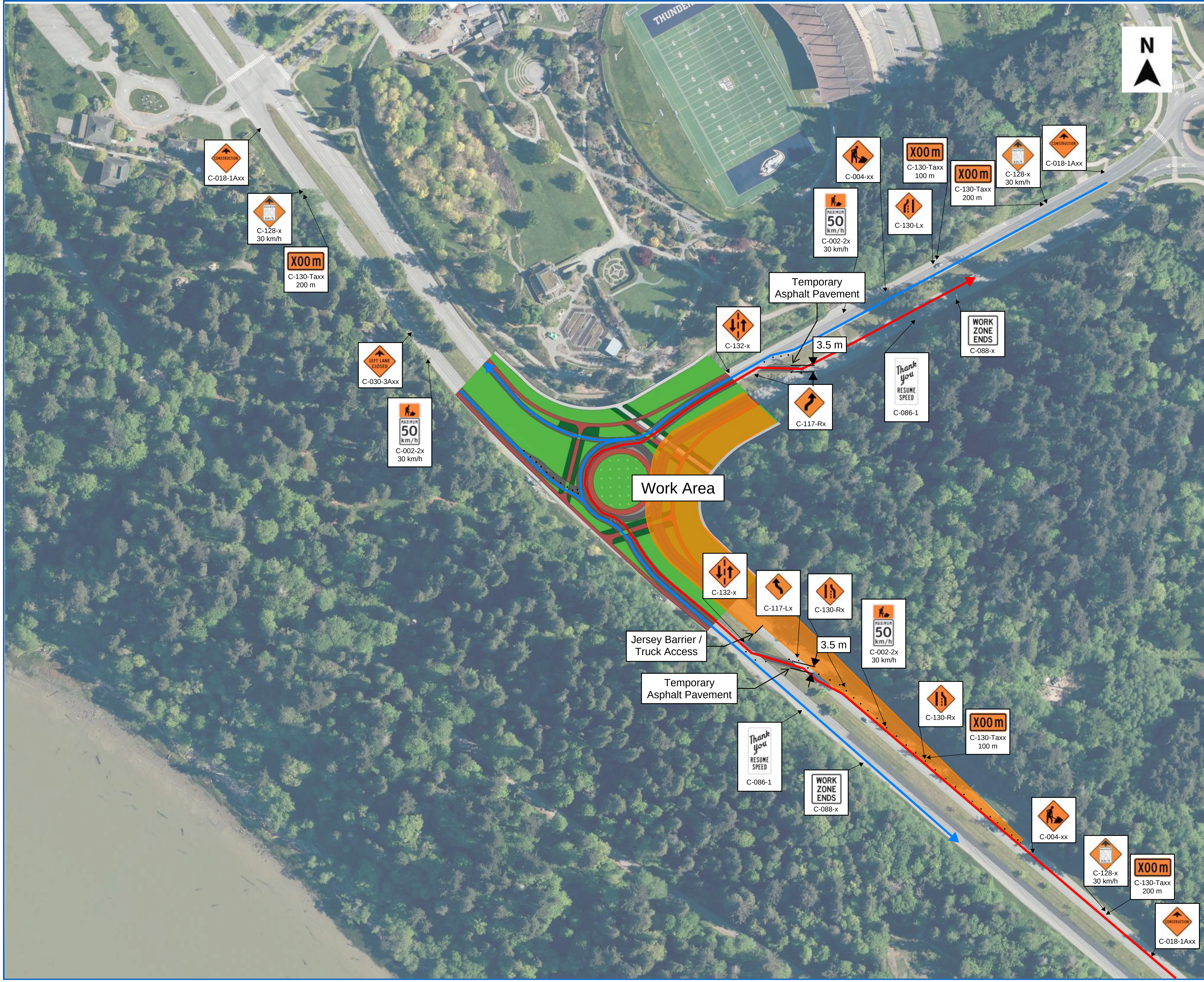
CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL
VANCOUVER, BC V6T 1Z4

SITE: W 16 AVE. AND SW MARINE DR. ROUNDABOUT

TITLE: TRAFFIC CONTROL PLAN - PHASE 1

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
NTS	04/06/24	RL	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	TMP-001	A



Notes:

1. THIS TRAFFIC MANAGEMENT PLAN MUST BE EXECUTED BY A QUALIFIED TRAFFIC CONTROL COMPANY.
2. ANY FIELD ADJUSTMENTS TO THE PLAN SHALL BE MADE BY QUALIFIED PERSONNEL.
3. MAJOR ADJUSTMENTS WHICH HAVE THE POTENTIAL TO IMPACT TRAFFIC OPERATIONS WILL REQUIRE A REVISED TRAFFIC MANAGEMENT PLAN.

REV:	DESCRIPTION:	BY:	DATE:
A	ISSUED FOR IMPLEMENTATION	RL	04/06

STATUS: ISSUED FOR IMPLEMENTATION

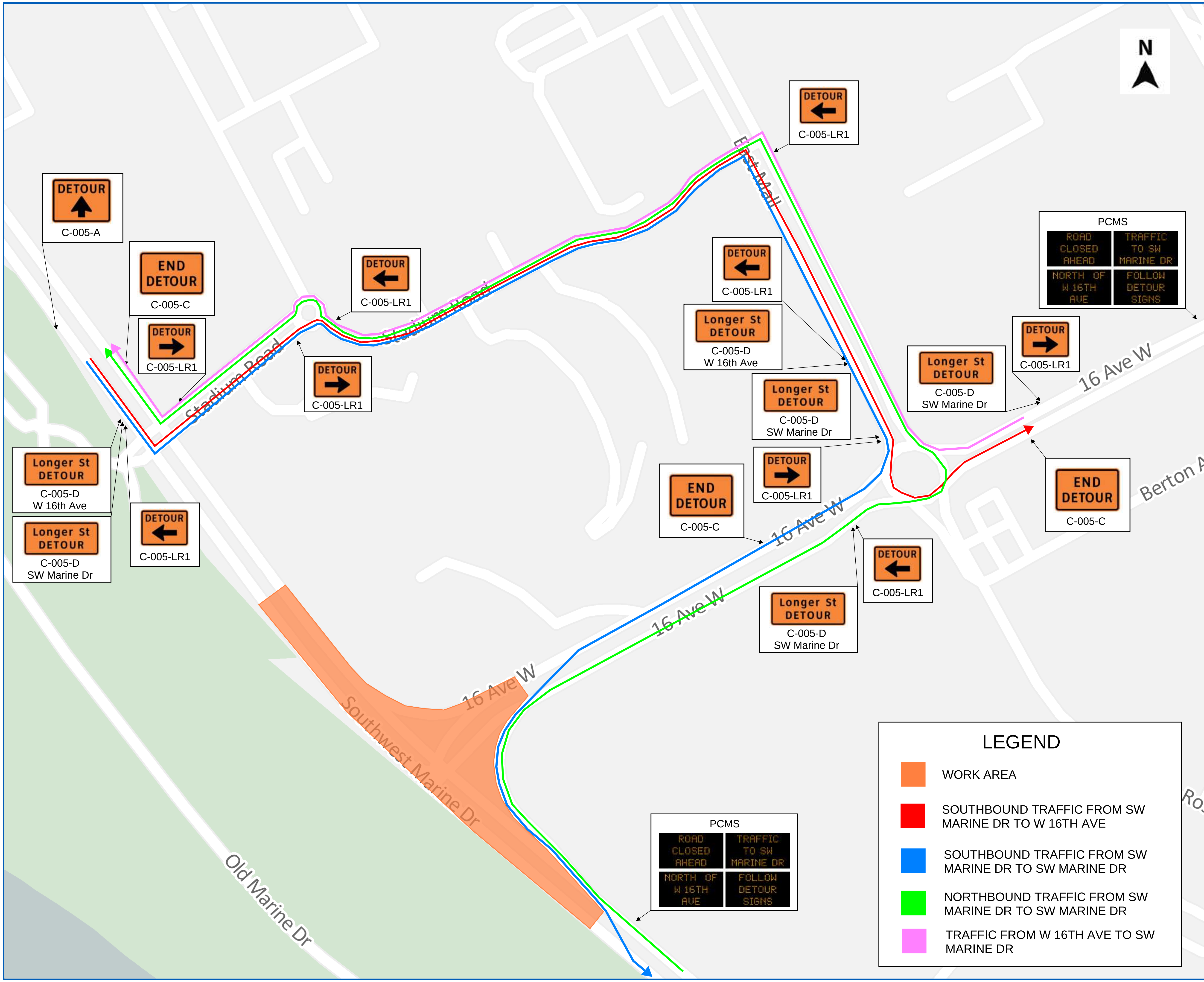
CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL
VANCOUVER, BC V6T 1Z4

SITE: W 16 AVE. AND SW MARINE DR. ROUNDABOUT

TITLE: TRAFFIC CONTROL PLAN - PHASE 2

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
NTS	04/06/24	RL	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	TMP-002	A



Notes:

1. THIS TRAFFIC MANAGEMENT PLAN MUST BE EXECUTED BY A QUALIFIED TRAFFIC CONTROL COMPANY.
2. ANY FIELD ADJUSTMENTS TO THE PLAN SHALL BE MADE BY QUALIFIED PERSONNEL.
3. MAJOR ADJUSTMENTS WHICH HAVE THE POTENTIAL TO IMPACT TRAFFIC OPERATIONS WILL REQUIRE A REVISED TRAFFIC MANAGEMENT PLAN.

REV:	DESCRIPTION:	BY:	DATE:
A	ISSUED FOR IMPLEMENTATION	RL	04/06

STATUS: ISSUED FOR IMPLEMENTATION

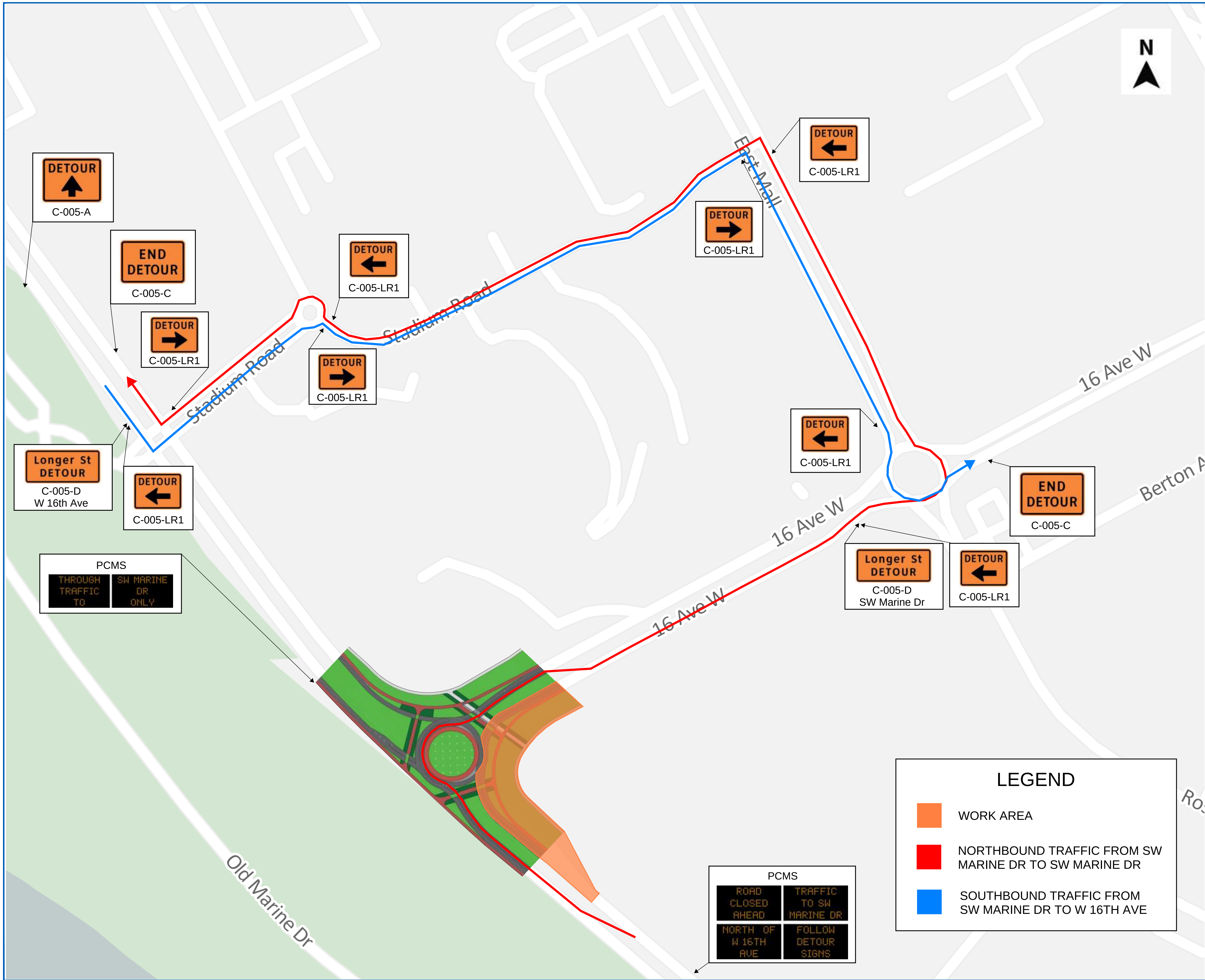
CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL
VANCOUVER, BC V6T 1Z4

SITE: W 16 AVE. AND SW MARINE DR. ROUNDABOUT

TITLE: SW MARINE DR. DETOUR MAP - PHASE 1

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
NTS	04/06/24	RL	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	TMP-003	A



Notes:

1. THIS TRAFFIC MANAGEMENT PLAN MUST BE EXECUTED BY A QUALIFIED TRAFFIC CONTROL COMPANY.
2. ANY FIELD ADJUSTMENTS TO THE PLAN SHALL BE MADE BY QUALIFIED PERSONNEL.
3. MAJOR ADJUSTMENTS WHICH HAVE THE POTENTIAL TO IMPACT TRAFFIC OPERATIONS WILL REQUIRE A REVISED TRAFFIC MANAGEMENT PLAN.

REV:	DESCRIPTION:	BY:	DATE:
A	ISSUED FOR IMPLEMENTATION	RL	04/06

STATUS: ISSUED FOR IMPLEMENTATION

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL
VANCOUVER, BC V6T 1Z4

SITE: W 16 AVE. AND SW MARINE DR. ROUNDABOUT

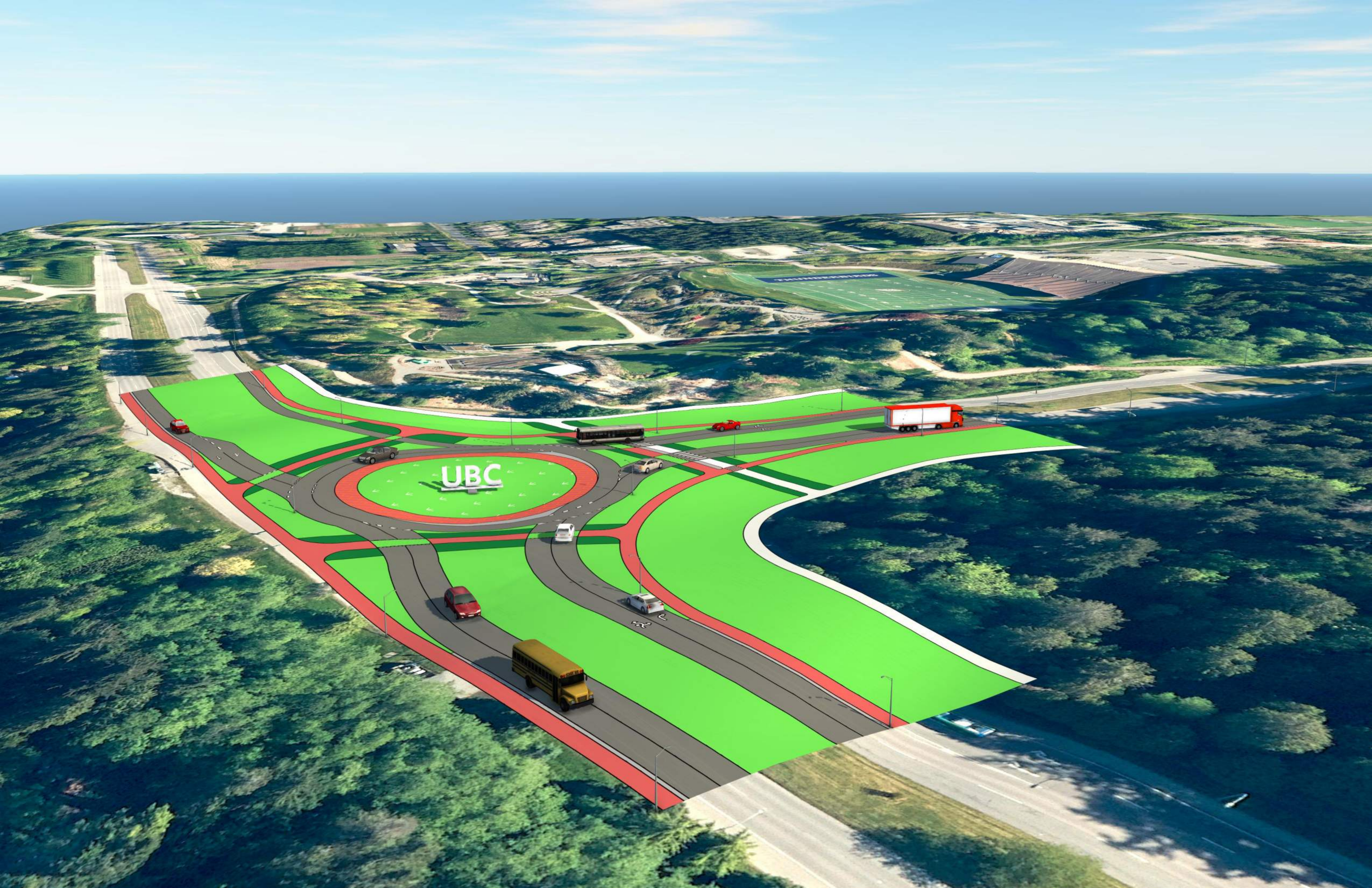
TITLE: SW MARINE DR. DETOUR MAP - PHASE 2

SCALE AT A2:	DATE:	DRAWN:	CHECKED:
NTS	04/06/24	RL	FC

PROJECT NO:	DRAWING NO:	REVISION:
0001	TMP-004	A

Appendix 2

3D Model of Intersection


UBC

Appendix 3

SIDRA INTERSECTION Traffic Analysis

LANE SUMMARY

Site: 102 [PM Peak (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.4.221

New Site
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows [Total	HV]	Arrival Flows [Total	HV]	Cap.	Deg. Satn	Lane Util.	Aver. Delay	Level of Service	95% Back Of Queue [Veh	Dist]	Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	veh/h	%	veh/h	%	veh/h	v/c	%	sec			m		m	%	%
SouthEast: SW Marine Dr															
Lane 1	376	2.5	376	2.5	1232	0.305	100	3.1	LOS A	1.8	12.7	Full	500	0.0	0.0
Lane 2[d]	396	5.0	396	5.0	1297	0.305	100	3.5	LOS A	1.8	13.1	Full	500	0.0	0.0
Approach	772	3.8	772	3.8		0.305		3.3	LOS A	1.8	13.1				
NorthEast: W 16th Ave															
Lane 1	358	5.0	358	5.0	1026	0.349	100	9.1	LOS A	1.9	14.0	Full	500	0.0	0.0
Lane 2[d]	384	4.3	384	4.3	1103	0.349	100	7.8	LOS A	1.9	14.1	Full	500	0.0	0.0
Approach	742	4.6	742	4.6		0.349		8.4	LOS A	1.9	14.1				
NorthWest: SW Marine Dr															
Lane 1	322	2.0	322	2.0	845	0.381	100	7.2	LOS A	1.9	13.2	Short	60	0.0	NA
Lane 2[d]	363	2.0	363	2.0	952	0.381	100	4.6	LOS A	1.9	13.4	Full	500	0.0	0.0
Approach	684	2.0	684	2.0		0.381		5.8	LOS A	1.9	13.4				
All Vehicles	2198	3.5	2198	3.5		0.381		5.8	LOS A	1.9	14.1				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

SouthEast: SW Marine Dr

Mov. From SE To Exit:	T1 NW	R2 NE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	317	59	376	2.5	1232	0.305	100	NA	NA
Lane 2	-	396	396	5.0	1297	0.305	100	NA	NA
Approach	317	455	772	3.8		0.305			

NorthEast: W 16th Ave

Mov. From NE To Exit:	L2 SE	R2 NW	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	358	-	358	5.0	1026	0.349	100	NA	NA
Lane 2	291	94	384	4.3	1103	0.349	100	NA	NA
Approach	648	94	742	4.6		0.349			

NorthWest: SW Marine Dr

Mov. From NW To Exit:	L2 NE	T1 SE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	137	185	322	2.0	845	0.381	100	0.0	2
Lane 2	-	363	363	2.0	952	0.381	100	NA	NA
Approach	137	547	684	2.0		0.381			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	2198	3.5	0.381

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h pcu/h	Critical Gap sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
SouthEast: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthEast: W 16th Ave				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthWest: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 102 [PM Peak (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.4.221

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 50 years

Lane Use and Performance

	Demand Flows [Total	Demand Flows HV]	Arrival Flows [Total	Arrival Flows HV]	Cap.	Deg. Satn	Lane Util.	Aver. Delay	Level of Service	95% Back Of Queue [Veh	95% Back Of Queue Dist]	Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	veh/h	%	veh/h	%	veh/h	v/c	%	sec			m		m	%	%
SouthEast: SW Marine Dr															
Lane 1	646	2.5	646	2.5	1096	0.589	100	4.1	LOS A	4.9	35.2	Full	500	0.0	0.0
Lane 2 d	687	5.0	687	5.0	1166	0.589	100	4.3	LOS A	5.0	36.7	Full	500	0.0	0.0
Approach	1333	3.8	1333	3.8		0.589		4.2	LOS A	5.0	36.7				
NorthEast: W 16th Ave															
Lane 1	607	5.0	607	5.0	788	0.771	100	16.6	LOS B	9.3	67.8	Full	500	0.0	0.0
Lane 2 d	675	4.3	675	4.3	876	0.771	100	14.7	LOS B	9.7	70.5	Full	500	0.0	0.0
Approach	1282	4.6	1282	4.6		0.771		15.6	LOS B	9.7	70.5				
NorthWest: SW Marine Dr															
Lane 1	531	2.0	531	2.0	530	1.002	100	48.7	LOS D	20.4	145.1	Short	60	0.0	NA
Lane 2 d	651	2.0	651	2.0	650	1.002	100	42.4	LOS D	23.2	165.5	Full	500	0.0	0.0
Approach	1182	2.0	1182	2.0		1.002		45.2	LOS D	23.2	165.5				
All Vehicles	3798	3.5	3798	3.5		1.002		20.8	LOS C	23.2	165.5				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

SouthEast: SW Marine Dr

Mov. From SE To Exit:	T1 NW	R2 NE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	548	98	646	2.5	1096	0.589	100	NA	NA
Lane 2	-	687	687	5.0	1166	0.589	100	NA	NA
Approach	548	786	1333	3.8		0.589			

NorthEast: W 16th Ave

Mov. From NE To Exit:	L2 SE	R2 NW	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	607	-	607	5.0	788	0.771	100	NA	NA
Lane 2	513	162	675	4.3	876	0.771	100	NA	NA
Approach	1121	162	1282	4.6		0.771			

NorthWest: SW Marine Dr									
Mov. From NW To Exit:	L2 NE	T1 SE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	236	295	531	2.0	530	1.002	100	47.0	2
Lane 2	-	651	651	2.0	650	1.002	100	NA	NA
Approach	236	946	1182	2.0		1.002			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	3798	3.5	1.002

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h pcu/h	Critical Gap sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
SouthEast: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthEast: W 16th Ave				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthWest: SW Marine Dr				
Lane 1	0.0	0.6	3.8	NA
Lane 2	0.0	0.7	3.8	NA

LANE SUMMARY

Site: 102 [AM Peak (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.4.221

New Site
Site Category: (None)
Roundabout

Lane Use and Performance

	Demand Flows [Total	HV]	Arrival Flows [Total	HV]	Cap.	Deg. Satn	Lane Util.	Aver. Delay	Level of Service	95% Back Of Queue [Veh	Dist]	Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	veh/h	%	veh/h	%	veh/h	v/c	%	sec			m		m	%	%
SouthEast: SW Marine Dr															
Lane 1	629	2.4	629	2.4	1319	0.477	100	3.0	LOS A	3.3	23.3	Full	500	0.0	0.0
Lane 2[d]	677	5.0	677	5.0	1420	0.477	100	3.4	LOS A	3.3	24.0	Full	500	0.0	0.0
Approach	1306	3.8	1306	3.8		0.477		3.2	LOS A	3.3	24.0				
NorthEast: W 16th Ave															
Lane 1	126	5.0	126	5.0	854	0.147	100	10.0	LOS A	0.7	5.3	Full	500	0.0	0.0
Lane 2[d]	139	4.3	139	4.3	946	0.147	100	8.6	LOS A	0.7	5.4	Full	500	0.0	0.0
Approach	265	4.6	265	4.6		0.147		9.3	LOS A	0.7	5.4				
NorthWest: SW Marine Dr															
Lane 1	217	2.0	217	2.0	1111	0.195	100	5.3	LOS A	0.9	6.3	Short	60	0.0	NA
Lane 2[d]	228	2.0	228	2.0	1172	0.195	100	3.2	LOS A	0.9	6.4	Full	500	0.0	0.0
Approach	445	2.0	445	2.0		0.195		4.2	LOS A	0.9	6.4				
All Vehicles	2017	3.5	2017	3.5		0.477		4.2	LOS A	3.3	24.0				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

SouthEast: SW Marine Dr

Mov. From SE To Exit:	T1 NW	R2 NE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	536	93	629	2.4	1319	0.477	100	NA	NA
Lane 2	-	677	677	5.0	1420	0.477	100	NA	NA
Approach	536	771	1306	3.8		0.477			

NorthEast: W 16th Ave

Mov. From NE To Exit:	L2 SE	R2 NW	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	126	-	126	5.0	854	0.147	100	NA	NA
Lane 2	106	34	139	4.3	946	0.147	100	NA	NA
Approach	232	34	265	4.6		0.147			

NorthWest: SW Marine Dr

Mov. From NW To Exit:	L2 NE	T1 SE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	89	127	217	2.0	1111	0.195	100	0.0	2
Lane 2	-	228	228	2.0	1172	0.195	100	NA	NA
Approach	89	356	445	2.0		0.195			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	2017	3.5	0.477

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h pcu/h	Critical Gap sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec

There are no Exit Short Lanes for Merge Analysis at this Site.

Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
SouthEast: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthEast: W 16th Ave				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthWest: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

LANE SUMMARY

Site: 102 [AM Peak (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.4.221

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 50 years

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
SouthEast: SW Marine Dr															
Lane 1	1083	2.4	1083	2.4	1226	0.883	100	6.6	LOS A	16.8	120.0	Full	500	0.0	0.0
Lane 2[d]	1174	5.0	1174	5.0	1329	0.883	100	6.3	LOS A	16.6	121.2	Full	500	0.0	0.0
Approach	2257	3.8	2257	3.8		0.883		6.4	LOS A	16.8	121.2				
NorthEast: W 16th Ave															
Lane 1	211	5.0	211	5.0	438	0.481	100	16.8	LOS B	3.8	27.6	Full	500	0.0	0.0
Lane 2[d]	248	4.3	248	4.3	515	0.481	100	14.6	LOS B	4.1	29.7	Full	500	0.0	0.0
Approach	458	4.6	458	4.6		0.481		15.6	LOS B	4.1	29.7				
NorthWest: SW Marine Dr															
Lane 1	370	2.0	370	2.0	919	0.402	100	6.2	LOS A	2.2	15.5	Short	60	0.0	NA
Lane 2[d]	400	2.0	400	2.0	994	0.402	100	3.9	LOS A	2.2	15.8	Full	500	0.0	0.0
Approach	769	2.0	769	2.0		0.402		5.0	LOS A	2.2	15.8				
All Vehicles	3485	3.5	3485	3.5		0.883		7.3	LOS A	16.8	121.2				

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

d Dominant lane on roundabout approach

Approach Lane Flows (veh/h)

SouthEast: SW Marine Dr

Mov. From SE To Exit:	T1 NW	R2 NE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	926	157	1083	2.4	1226	0.883	100	NA	NA
Lane 2	-	1174	1174	5.0	1329	0.883	100	NA	NA
Approach	926	1332	2257	3.8		0.883			

NorthEast: W 16th Ave

Mov. From NE To Exit:	L2 SE	R2 NW	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	211	-	211	5.0	438	0.481	100	NA	NA
Lane 2	190	58	248	4.3	515	0.481	100	NA	NA
Approach	400	58	458	4.6		0.481			

NorthWest: SW Marine Dr										
Mov. From NW To Exit:	L2 NE	T1 SE	Total	%HV	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Prob. SL Ov. %	Ov. Lane No.
Lane 1	155	215	370	2.0	919	0.402	100	0.0	2
Lane 2	-	400	400	2.0	994	0.402	100	NA	NA
Approach	155	615	769	2.0		0.402			

	Total	%HV	Deg.Satn (v/c)
All Vehicles	3485	3.5	0.883

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Merge Analysis

	Exit Lane Number	Short Lane Length m	Percent Opng in Lane %	Opposing Flow Rate veh/h pcu/h	Critical Gap sec	Follow-up Headway sec	Lane Flow Rate veh/h	Capacity veh/h	Deg. Satn v/c	Min. Delay sec	Merge Delay sec
There are no Exit Short Lanes for Merge Analysis at this Site.											

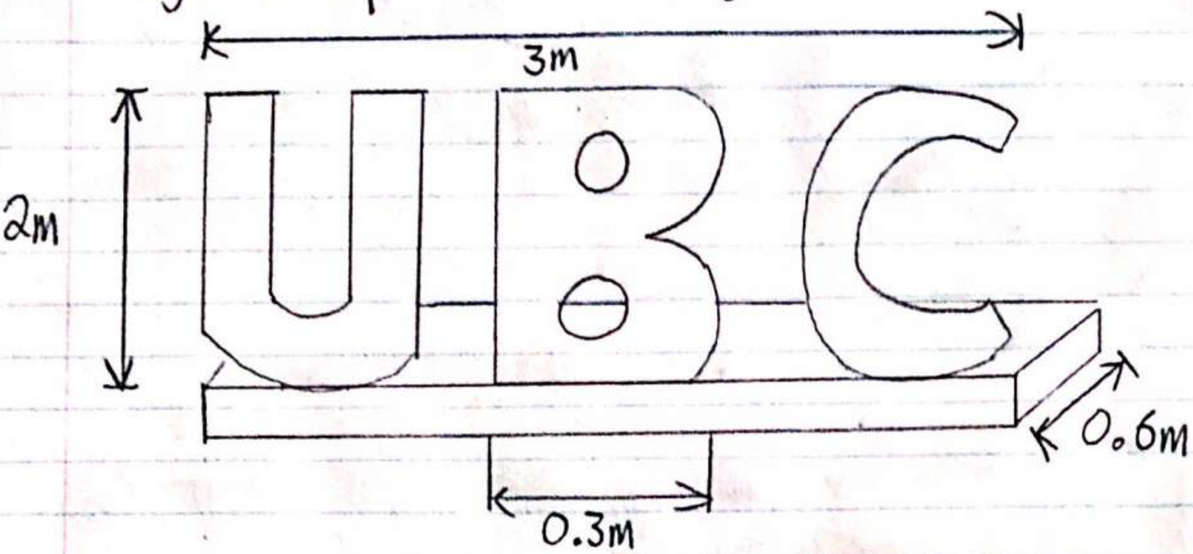
Variable Demand Analysis

	Initial Queued Demand veh	Residual Queued Demand veh	Time for Residual Demand to Clear sec	Duration of Oversatn sec
SouthEast: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthEast: W 16th Ave				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0
NorthWest: SW Marine Dr				
Lane 1	0.0	0.0	0.0	0.0
Lane 2	0.0	0.0	0.0	0.0

Appendix 4

Gateway Structural Calculations

Design 1-Way Slab For Sign



Density of steel = $7750\,kg/m^3$

Volume of 2m tall 0.01m thick sign $= 0.044\,m^3$

$$Load = (7750\,kg/m^3)(9.81\,m/s^2)(0.044\,m^3) = 3.345\,kN$$

$$\text{Min thickness} = \frac{l_n}{10} = \frac{1.5m - 0.15m}{10} = 0.135m \leq h$$

Use thickness of 0.15m

Determine load: Snow load = 2.4kPa (Conservative)

$D = 3.845\,kN = 3.345\,kN + 0.5\,kN$ (In case of people on structure)

$$D = \frac{3.845kN}{(0.6m)(3m)} = 2.136\,kPa$$

$$1.25D + 1.5S = 1.25(2.136kPa) + 1.5(2.4kPa) = 6.27\,kPa$$

Check 1-way shear:

$$V_r = \phi_c \beta \sqrt{f'_c}\, b_w d_v = 0.65\left(\frac{230}{1000 + 0.9(150)}\right)\sqrt{30MPa}\,(0.6m)0.9(0.15m)$$

$V_r = 58.44\,kN$

$$V_f = q\,l_n = (6.27kPa)(0.6m)(1.35m) = 5.079\,kN$$

$$V_r >> V_f$$

Bottom reinforcement

Cover for freeze thaw = 40mm

BLL: $\frac{A_s}{A_g} \geq 0.002$ $A_s \geq 0.002(600mm)(150mm) = 180mm^2$

BUL: $A_s \geq 0.002(1500mm)(150mm) = 450 mm$

Spacing: $(5)(150mm) = 750mm$ $S \leq 500mm$

$\frac{A_b}{st} \geq 0.002$ Try 10M bar $\frac{(100mm^2)}{0.002(150mm)} = 333mm$

Use 320mm spacing

Check bending resistance: $M_r = \phi_s f_y A_s (d - \frac{\beta_1 c}{2})$

$M_r = \phi_s f_y A_s \left(d - \frac{\phi_s f_y A_s}{2\alpha_1 \phi_c f'_c b}\right)$

$M_r = 0.85(400MPa)(200mm^2)\left(150mm - \frac{0.85(400MPa)(200mm^2)}{2(0.79)(0.65)(30MPa)(600mm)}\right)$

$M_r = 9.950kNm$

$M_f = \frac{qL^2}{2}$ for maximum cantilever

$q = 6.27kPa(0.6m) = 3.762kN/m$

$M_f = \frac{(3.762kN/m)(1.5m)^2}{2} = 4.232kNm$

$M_r > M_f$

For BLL & BUL use 10M rebar at 320mm spacing.

Top Reinforcement:

TUL at column: $\frac{A_s}{st} \geq \frac{0.2\sqrt{f'_c}}{f_y}$ $\quad \frac{0.2\sqrt{30MPa}}{400MPa} = 0.00274$

Try 10M rebar:

$$s = \frac{A_b}{0.00274t} = \frac{100mm^2}{0.00274(150mm)} = 243mm$$

For TUL, use 10M rebars at 240mm spacing.

Find TLL:

$$\frac{l_n}{20} = \frac{1.35m}{20} = 0.0675m = 67.5mm$$

$$\frac{A_s}{A_g} \geq 0.004 \quad A_s \geq 0.004(67.5mm)(150mm) = 40.5\ mm^2$$

Use 10M rebar (1 rebar)

Design Column: 300mm x 200mm

$$1\% \leq \frac{A_s}{A_g} \leq 4\% \quad \text{Try } 2\%$$

$$A_s = 0.02A_g = 0.02(300mm \times 200mm) = 1200mm^2$$

To increase strength, use 8 15M bars

$$\frac{8 \times 200mm^2}{300mm \times 200mm} = 0.0267 \checkmark$$

Spacing $= 1.4 d_b = 1.4(15mm) = 21mm$ = Spacing between bars.

Column tie spacing:

$$\text{Tie spacing} = \text{Minimum} \begin{cases} 10(15) = 150mm \\ 480mm \\ 200mm \end{cases}$$

Ties are 10M bars with 150mm spacing.

Check axial Load:

$P_{rMax} = 0.8 P_{ro} \geq P_f$

$P_f = 6.27 kPa (0.6m)(3m) = 11.286 kN$

Self load from slab $= (23.5 kN/m^3)(3m)(0.6m)(0.15m)(1.25)$
$= 7.931 kN$

$P_f = 19.217 kN$

$P_{rMax} = 0.80(\alpha_1 \phi_c f'_c A_c + \phi_s f_y A_s)$

$A_c = 200mm \times 300mm - 8(200mm^2) = 58400mm^2$

$P_{r,Max} = 0.80(0.81 \cdot 0.65 \cdot 30MPa \cdot 58400mm^2 + 0.85 \cdot 400MPa \cdot 1600mm^2)$
$P_{r,Max} = 1173.14 kN$

Design Footing

Stratigraphy from reports & previous experience suggests clay, sand & gravel. For factor of safety, we will say it is loose sand & gravel.

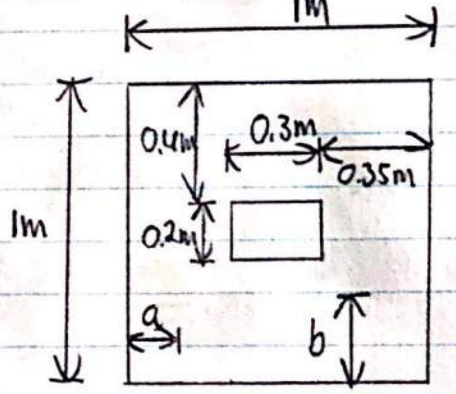
Max bearing pressure = 50 kPa

Assume foundation is 1m deep and column is 0.5m above ground.

$$\text{Load} = 19.217\,kN + 1.25(23.5\,kN/m^3)(0.2m)(0.3m)(1.5m)$$
$$+1.25(23.5\,kN/m^3)(1m^2)(0.5m) = 36.548\,kN$$

Try 1m x 1m footing:

$$q = \frac{36.55}{1m^2} = 36.55\,kPa \qquad q_{applied} < q_{ult}$$



$h = 0.5m$

$d = 0.3m \quad d_v = 0.9d = 0.27m$

$$a = 0.5m - 0.15m - 0.27m$$
$$= 0.08m$$

$$b = 0.5m - 0.1m - 0.27m = 0.13m$$

Check 1-Way Shear:

Section a: 1m x 0.08m $\qquad V = \dfrac{36.55\,kPa\,(1m \times 0.08m)}{2} = 1.462\,kN$

$$V_r = \phi_c \beta \sqrt{f_c'}\, b_w\, d_v$$
$$= 0.65\left(\frac{230}{1000+270}\right)\sqrt{30MPa}\,(80mm)(270mm) = 13.93\,kN \checkmark$$

Section b: 1m x 0.13m $\qquad V = \dfrac{36.55\,kPa\,(1m \times 0.13m)}{2} = 2.376\,kN$

$$V_r = 0.65\left(\frac{230}{1000+270}\right)\sqrt{30MPa}\,(130mm)(270mm) = 22.63\,kN$$

$V_r > V$ for both cases.

2-Way Shear

$c+d = 0.27m + 0.2m = 0.47m$

$V_f = 36.55kPa(1m^2 - 0.47m^2) = 28.48kN$

$v_f = \frac{28.48kN}{1m^2} = 28.48kPa$

$v_r = (1 + \frac{2}{B_c})(0.19)\phi_c\sqrt{f'_c}$

$= (1 + \frac{2}{3/2})(0.19)(0.65)\sqrt{30MPa} = 1578.30kPa$

$V_r > V_f$ ✓

Check bending moment:

$\frac{L}{2} - \frac{c_1}{2} = \frac{1}{2} - \frac{0.3}{2} = 0.35$ $\frac{L}{2} - \frac{c_2}{2} = \frac{1}{2} - \frac{0.2}{2} = 0.4m$

$M_1 = 36.55kPa \cdot 1m \cdot \frac{0.35m^2}{2} = 2.239kNm$

$M_2 = 36.55kPa \cdot 1m \cdot \frac{0.4m^2}{2} = 2.924kNm$

$A_s = 0.002(1m)(0.5m) = 1 \cdot 10^{-3}m^2 = 1000mm^2$

Use 10 10M rebars

$B_1 c = \frac{\phi_s f_y A_s}{\alpha_1 \phi_c f'_c b} = \frac{(0.85)(400MPa)(1000mm^2)}{0.81(0.65)(30MPa)(400mm)} = 53.81$

$M_r = \phi_s f_y A_s(d - \frac{B_1 c}{2}) = 0.85(400MPa)(1000mm^2)(500mm - \frac{53.81}{2})$

$M_r = 160.95kNm$ $M_r > M_1$ & M_2 ✓

Calculate dowel strength:

$F_b = 2(0.85)(0.65)(30MPa)(0.3m)(0.2m) = 1.989kN$

$21.86kN - 1.989kN = 19.87kN$

The dowels must resist 19.87kN.

Wind Analysis:

$150\ km/hr = 41.67\ m/s$

$P = \frac{1}{2}\rho V^2 = \frac{1}{2}(1.2\ kg/m^3)(41.67\ m/s)^2 = 1041.8\ Pa = 1.041\ kPa$

$(1.041\ kPa)(3\ m) = 3.13\ kN/m$

$Load = (3.13\ kN/m)(2m) = 6.25\ kN$

$M = (6.25\ kN)(2m + 0.15m + 0.3m)(\frac{1}{2}) = 7.66\ kNm$

$Self\ weght = (3.345\ kN) + (6.345\ kN) + (0.423\ kN) + (7.05\ kN)$
$= 17.16\ kN$

$M = (17.16\ kN)(1m)(\frac{1}{2}) = 8.58\ kNm$

Appendix 5

Traffic Management Plan

Traffic Management Plan

16^{th} Avenue / SW Marine Drive Intersection

Category 2 TMP

Prepared by

Prime Contractor: TBD

April 10, 2024

Note: Section 3 – Implementation Plan and Section 5 – Incident Management Plan have been removed from this Traffic Management Plan in the interest of conserving space. These sections are as per the example Category 2 TMP published by the British Columbia Ministry of Transportation and Infrastructure (MoTI).

1.0 Introduction

This Traffic Management Plan (TMP) outlines the traffic control procedures and requirements for the anticipated lane closures caused by the construction of the new roundabout at the intersection of W 16th Avenue and SW Marine Drive in the University Endowment Lands. This TMP must be executed by a qualified Traffic Control Company. Any field adjustments to the plan shall be made by qualified personnel.

The Traffic Control Company shall implement the plan in accordance with the following guidelines and standards:

- BC Ministry of Transportation and Infrastructure (MoTI) 2020 Traffic Management
- Manual for Work on Roadways (2020 TMM)
- MoTI Manual of Standard Traffic Signs and Pavement Markings
- MoTI Standard Specifications – Section 194

This Traffic Management Plan is formulated as per the Category 2 guidelines in the 2020 TMM.

2.0 Project Overview

This section provides a description of the planned work, geographical description of the project location and pre-construction traffic operations (traffic volume, speed limits, etc.).

2.1 Project Description

The general contractor will be demolishing the existing intersection at W 16th Ave. and SW Marine Dr. and will be constructing a roundabout, sidewalks / bike paths, as well as new pedestrian and bike crossings.

The work is expected to take approximately 9 months from August 1, 2024, to May 12, 2025.

2.2 Project Area

The intersection of W 16th Avenue and SW Marine Drive is located in the University Endowment Lands (circled in red in Figure 1 below).

Figure 1. Project Location Map

SW Marine Drive currently has a posted speed limit of 80 km/h, and W 16th Avenue has a speed limit of 50 km/h. Using data from the *Fall UBC Transportation Status Reports*, the Annual Average Daily Traffic (AADT) in 2023 along SW Marine Drive was estimated to be 21,905 vehicles/day.

The intersection is surrounded to the north, west, and south by the UBC Botanical Garden, which connects to the UBC Food Garden (a branch of the botanical garden) via an underpass. To the east, a dense forest borders the work zone.

2.3 Work Activity

This section contains an overview of the work being carried out as part of this project.

Construction is expected to be completed in two phases. Phase 1 of construction will involve the demolition of the existing intersection, construction of the roundabout, construction of the bike lanes on the west side of the project site, and construction of the pedestrian and bike crossings. Phase 2 will involve the demolition of the existing slip road and the construction of the new bike lane on the east side of the project site.

Construction limits for this project will be up to 500 m in length along each approach into the intersection, and the work area will be separated from the travelled roadway.

Construction of the roundabout will be conducted during the daytime only from 7 am – 5 pm, 6 days per week (Monday – Saturday)

During active work, the Traffic Control Plan corresponding to each phase of construction will be implemented (see Section 4.0). A reduced construction speed limit of 30 km/h will also be implemented to allow for access and egress of construction vehicles. Traffic control people (TCPs) may be used to assist with access and egress to the work area during busy periods. It is expected that there will 10-20 trucks per hour accessing and leaving the work area. The traffic control measures will be kept in place during inactive work.

Delay to vehicular traffic travelling along SW Marine Dr. and W 16th Ave. is expected to not exceed 20 minutes.

3.0 Implementation Plan

This Implementation Plan outlines the role of individuals involved in the implementation of this Traffic Management Plan.

Figure 2 – Phase 1 Temporary Traffic Controls will be used during Phase 1 of construction, and Figure 3 – Phase 2 Temporary Traffic Controls will be used during Phase 2 of construction. During active work, construction vehicles will used the closed lane to access the work site.

Traffic control people (TCPs) will be on-site to assist with any incidents that may occur and assist with access and egress into the work area as needed. During the switch from Phase 1 to Phase 2 of the Traffic Control Plan, more TCPs will be on-site to set up and take down the lane closure and associated devices.

3.1 Site Supervisor

The Site Supervisor will be responsible for conducting daily toolbox meetings, addressing issues as they occur, leading the crew, and being the point of contact with the Ministry Representative.

As part of their role, the Site Supervisor will ensure that:

- Each crew member is familiar with the Traffic Control Plan
- Each crew member wears the required safety apparel
- Each crew member has adequate training on the equipment they will be using
- The work area is protected by implementing this TMP

The Site Supervisor will also be responsible for liaising with the Traffic Control Manager and Traffic Control Supervisor to inform them of the work schedule, day's activities, and to address any incidents, improvements or changes which need to be made.

3.2 Traffic Control Manager

The Traffic Control Manager will be responsible for preparing, implementing, and managing this Traffic Management Plan. They will be responsible for, but not limited to, the following tasks:

- Monitoring traffic operations to determine the effectiveness and possible improvements to the TMP
- Overseeing modifications to the TMP as required
- Ensuring daily traffic control logs are maintained
- Sets up and implements a monitoring schedule for both active and inactive work periods throughout the course of the project
- Notifying the MoTI and emergency personnel of any major incidents within or near the project location
- Liaising with the Site Supervisor as needed

3.3 Traffic Control Supervisor

The Traffic Control Supervisor (TCS) will be responsible for, but not limited to, the following tasks:

- Overseeing traffic control operations, ensuring traffic control is executed according to the Traffic Control Plan, and taking note of any improvements or changes that should be made
- Ensuring compliance with the requirements outlined in Part 18 of WorkSafeBC's Occupational Health and Safety Regulations regarding supervision of TCPs
- Supervision and authority over all of the TCPs on site
- Providing direction to TCPs
- Ensuring traffic control devices are in place, checked, maintained, and moved as required
- Ensuring daily traffic control setups are documents and changes are identified in the daily traffic control log
- Ensuring traffic concerns are reported to the Traffic Control Manager and/or Site Supervisor, as required

On site, the TCS will also be responsible for ensuring all TCPs are:

- Carrying evidence of their current TCP certification
- Wearing the required safety apparel and have the appropriate equipment
- Performing traffic control duties competently and safely
- Positioned in safe locations
- Provided with rest breaks

The procedures outlined below will also be followed by the TCS:

3.3.1 Before Work Begins

- Confirm the TMP for the day's activities and document traffic management strategies to be implemented
- Conduct safety meeting with TCPs and coordinate with the Prime Contractor's staff on the traffic management requirements of the day
- Place signs and traffic control devices according to the drawings found in this TMP and the 2020 TMM. Note any adjustments which may need to be made based on local site conditions
- Cover conflicting signs
- Inspect and check for the effectiveness of signing and traffic control devices

3.3.2 During Active Work

- Periodically inspect and check all signs and devices
- Adjust signs as required

3.3.3 At the End of the Shift

- Conduct a pre-close down inspection
- Remove unnecessary signage
- Reinstate all vehicle traffic lanes
- Liaise with the Prime Contractor's staff to see if there are any considerations or concerns regarding the TMP and associated strategies
- Complete Daily Traffic Control Log
- Complete Incident Management Report – as required

3.4 Traffic Control Person

The Traffic Control People (TCPs) used on this project will:

- Be adequately trained in a manner acceptable to WorkSafeBC
- Carry evidence of their current TCP certification
- Ensure compliance with the requirements outlined in Part 18 – Traffic Control of WorkSafeBC's Occupational Health and Safety Regulations
- Perform their work effectively in accordance with the traffic control arrangements and procedures for the work
- Try to assess the layout through the eyes of a road user to help anticipate traffic control issues
- Communicate instructions and directions to drivers effectively by using traffic control motions and signals that are precise and deliberate to be clearly understood by road users
- Identify required changes to the Traffic Control Plan and bring them forward to the TCS

4.0 Traffic Control Plan

This Traffic Control Plan documents how traffic control will be achieved during the construction period. Typical traffic control layouts will be implemented as mentioned in the sections below.

The TCS will implement the traffic control layouts outlined in this TMP. Minor adjustments made to the typical traffic control layouts (such as adjusting signs for local site conditions) will follow guidelines outlined in the 2020 TMM and will be documented in the Daily Traffic Control Log. Major adjustments which have the potential to impact traffic operations will be noted and a revised TMP will be submitted to the Ministry for approval before implementation.

4.1 Phase 1 – Southeast-Bound Lane Closure

During Phase 1 of construction, which is expected to occur between August 2024 and February 2025, the existing two-lane slip lane from SW Marine Dr. to W 16th Ave. will be reconfigured as a temporary two-way road through the intersection. Temporary pavement and line marking will be installed at each end of the temporary road in order for southbound traffic on W 16th Ave. to cross the median.

The remainder of the intersection will be closed to vehicular traffic as construction occurs. As a result, access to the intersection from SW Marine Dr. north of W 16th Ave., and traffic heading to SW Marine Dr. north of W 16th Ave. from the intersection will be obstructed. To maintain access to the affected area, vehicles will be detoured around the site (see Section 4.3).

Construction signage will be placed around the site as per Drawing TMP-001 – Traffic Control Plan – Phase 1.

4.2 Phase 2 – Northeast-Bound Lane Closure

During Phase 2 of construction, which is expected to occur between February 2025 and May 2025, the existing slip road from SW Marine Dr. to W 16th Ave. will be closed for demolition. The roundabout will be reconfigured temporarily in a clockwise orientation for vehicles to travel through the intersection. Temporary pavement and markings will be installed at each end of the intersection in order for northbound traffic from SW Marine Dr. towards W 16 Ave. to cross the median.

Traffic northbound on SW Marine Dr. continuing towards SW Marine Dr. and southbound traffic on SW Marine Dr. turning left to W 16th Ave. will be affected. To maintain access to the affected area, vehicles will be detoured around the site (see Section 4.3).

Construction signage will be placed around the site as per Drawing TMP-002 – Traffic Control Plan – Phase 2.

4.3 Detour of SW Marine Dr. North of W 16th Ave.

During Phase 1 of construction, the portion of SW Marine Dr. between W 16th Ave. and Stadium Dr. will be shut down for vehicular traffic. In Phase 2 of construction, access to SW Marine Dr. north of W 16th Ave. will only be available via W 16th Ave., and vehicles heading southeast along SW Marine Dr. toward the intersection will only be allowed to continue along SW Marine Dr.

To inform vehicles of the detour, signage will also be shown to direct drivers through the detour route, which is along East Mall and Stadium Dr. Full Matrix Portable Changeable Message Signs (PCMSs) will also be positioned along SW Marine Dr. and W 16th Ave. Examples of messages to be displayed by each PCMS are illustrated in Figures 2 and 3.

Figure 2. PCMS Message 1

Figure 3. PCMS Message 2

A detailed map of the detour route, along with specific locations of the PCMSs and the detour signs can be found in Drawing TMP-003 – SW Marine Dr. Detour Map – Phase 1, and Drawing TMP-004 – SW Marine Dr. Detour Map – Phase 2.

4.4 Active Transportation Road Users

In October 2023, a traffic count was conducted to analyze, in part, the cyclist demand of the intersection. Notable observed volumes were the result of recreational road cyclists, often in pelotons (groups of cyclists), travelling at high speeds. In this Traffic Management Plan, cyclists travelling through the work zone will be treated as vehicles and are expected to follow the Traffic Control Plan. Pedestrian volumes around the project site are expected to be low. If pedestrians are encountered on-site, the TCP will direct them through the work zone.

4.5 Emergency Vehicles

During active work, the TCP will ensure emergency vehicles are given priority in travelling through the work zone. If required, TCPs may stop general traffic, and hold active transportation road users, to assist emergency vehicles with proceeding through the work zone.

5.0 Incident Management Plan

The Incident Management Plan included in this TMP establishes general protocols for the TCS to follow in the event of an incident. It aims to maintain efficient emergency services, enable safe traffic movements, and reduce the time required to restore traffic flow, should an incident occur.

All crew members will be familiar with the incident management procedures outlined in this TMP. The Prime Contractor will ensure that resources are available to respond to emergencies as needed. The TCS, Traffic Control Manager and Site Supervisor will work together to provide efficient response and coordination, including any changes that may need to be made to the traffic control layout.

Incidents covered in this Incident Management Plan include unforeseen events which affect traffic operations. Examples include vehicle collisions, vehicle breakdown, stalls, objects falling from vehicles, or any other event which causes disruptions to traffic flow. It also includes situations where emergency vehicles require access to and/or through the construction zone.

If the incident occurs within the construction zone, the Prime Contractor will be responsible for providing, or obtaining, towing services. Should the incident occur outside the construction zone, but have the potential to impact traffic operations within the construction zone, the Prime Contractor will coordinate with the Ministry's Maintenance Contractor (MC).

5.1 Detection of an Incident

The TCS will monitor the areas within, and in the vicinity of, the work zone. If an incident is detected, the TCS will immediately respond. If any of the crew members or TCPs detect an incident, they will relay all relevant information to the TCS. Relevant information includes the following:

- Location of the incident
- Number of people involved and their current condition
- Whether or not emergency services may need to be called
- Any other relevant information such as accessibility issues, fire, or hazards

5.2 Incident Management Procedures

The TCS will then verify the incident, assess the severity of the incident, call emergency services if required, and inform the Traffic Control Manager who will work with the TCS, Site Supervisor, and relevant field staff in order to respond to the incident appropriately. The TCS will follow the procedure below, coordinating with the Traffic Control Manager and Site Supervisor as necessary:

1) Based on the severity of the incident, monitor and secure the area as necessary
2) Adjust the traffic control layout as required to allow emergency services access to the incident as quickly as possible
3) Direct emergency responders to the incident and assist as necessary
4) Modify the traffic control layout as necessary if possible. This includes removing any field equipment or materials which may interfere with incident management operations.

The Site Supervisor will be responsible for the following:

1) Informing all crew members (by radio or directly talking to them) of the incident and the possibility of emergency crews entering the work zone
2) Notifying the Ministry Representative and the MC as soon as practical – including the following information, as available:
    a. That an incident has occurred
    b. Planned clearance time of the incident
    c. Clearance measures required
    d. Response measures taken
    e. Planned measures, including modified traffic control layout, to restore traffic flow
3) Providing regular updates to the Ministry Representative and MC – typically every 30 mins.

5.3 Public Notification

Upon notification of the incident, the Ministry Representative will immediately contact the Transportation Management Centre BC (TMCBC) to notify them of the incident, changes to traffic patterns, and estimated clearance time. The Ministry Representative will update TMCBC with information as made available from the Site Supervisor.

Depending on the severity of incident, if there are significant delays (longer than 30 mins), TCPs and other crew members may be used to walk the queue and inform drivers of the following information:

- That an incident has occurred
- Estimated delay and clearance time
- Alternate routes (if available)

5.4 Resumption of Traffic Flow

At the conclusion of the incident, crew members will work with the TCS and Site Supervisor to clear the incident area of equipment and debris before restoring traffic flow to the layouts in this TMP. The Site Supervisor will notify the Ministry Representative once the incident is cleared and normal traffic flow is restored.

In addition, the TCS will work with the Traffic Control Manager and Site Supervisor for the following:

1) Survey the incident area for any damage to infrastructure, equipment and materials. If significant damage is observed, the affected area should be protected from general traffic and the public. The Site Supervisor will notify the Ministry Representative of any repairs which may need to be made.
2) Complete the Incident Management Report – which will then be sent to the Ministry Representative
3) Relevant parties will meet to discuss the incident including:
    - What happened?
    - Why did it happen?
    - What could have prevented it from happening?
    - What improvements can be made to the traffic control layouts or the TMP as a whole to prevent this, or similar incidents, from happening again in the future?

5.5 Emergency Contract List

Emergency/Public Services	Phone Number
Emergency – Police, Fire, Ambulance	911
Vancouver Fire Rescue Services (non-emergency)	604-665-6010
RCMP University Detachment (non-emergency)	604-224-1322
BC Ambulance (non-emergency)	604-872-5151
UBC Hospital (non-emergency)	604-822-7121
BC Hydro	1-800-224-9376
FortisBC Gas	1-800-663-9911
Telus Communications	XXX-XXX-XXXX
Rogers Communications	XXX-XXX-XXXX
WorkSafeBC	1-888-621-7233
BC Provincial Emergency Coordination Centre	1-800-663-3456

Ministry of Transportation	Phone Number
Ministry Representative - TBD	XXX-XXX-XXXX
Road Area Manager – TBD	XXX-XXX-XXXX
Operations Manager – TBD	XXX-XXX-XXXX
District Manager - TBD	XXX-XXX-XXXX

Maintenance Contractor	Phone Number
Local Road Maintenance Contractor	XXX-XXX-XXXX

Contractor	Phone Number
Site Supervisor - TBD	XXX-XXX-XXXX
Project Manager - TBD	XXX-XXX-XXXX
Site HSE Representative – TBD	XXX-XXX-XXXX
Traffic Control Manager - TBD	XXX-XXX-XXXX
Traffic Control Supervisor - TBD	XXX-XXX-XXXX

6.0 Public Information Plan

This Public Information Plan details methods for communicating to the travelling public the impacts of the project, especially any delays in travel. It also outlines methods for providing work updates to the Road Authority.

Two weeks prior to the beginning of the work, the Site Supervisor will notify the Ministry Representative of the proposed schedule and anticipated traffic impacts. Any changes to the proposed schedule will require advanced notice of at least 24 hours. This information will also be shared with the City of Vancouver, UBC Campus + Community Planning, TransLink, and other major stakeholders. Any changes to the proposed schedule will require advanced notice of at least 24 hours.

Due to the length of construction, Portable Changeable Message Signs (PCMSs) will be used on this project to convey essential details to the public such as upcoming modifications to the traffic control plan, lane closures, detours, and anticipated delays. The changeable message signs are indicated in the traffic control drawings and will remain on-site throughout construction.

Appendix 6

Long Term Maintenance Plan

SW Marine Dr. / W 16th Ave. Stormwater Retention System

Maintenance Plan

Task	Frequency
Pruning	Once in October.
Watering	Must be done weekly during the summer for first two years, until plants grow to completion. Afterwards, can let rain do watering.
Mulching	Once in February, May, and October.
Weeding	Once in February, May, and October.
Cleaning Debris	Once a month during the summer, twice a month for all other seasons.

Appendix 7

Project Scheule

Project manager	
Project dates	May 1, 2024 - Jun. 3, 2025
Completion	0%
Tasks	70
Resources	0

Tasks

Name	Begin date	End date	Notes
Issued For Construction Drawings Released	2024-05-01	2024-05-01	
Permitting	2024-05-01	2024-06-28	
Highway Work Permit	2024-05-01	2024-06-28	
Environmental Approval	2024-05-01	2024-06-28	
Procurement	2024-06-03	2024-07-25	
Invitation to Tender Released	2024-06-03	2024-06-03	
Contractor Bidding	2024-06-03	2024-06-28	
Contractor Selection	2024-07-02	2024-07-02	
Post-Bid Negotiation	2024-07-02	2024-07-11	
Contract Execution	2024-07-12	2024-07-12	
Contractor Material Procurement	2024-07-12	2024-07-25	
Pre-Construction	2024-07-12	2024-08-23	
Project Team Mobilization	2024-07-26	2024-07-31	
Contractor Submittals	2024-07-12	2024-07-31	
Notice to Proceed Issued	2024-08-01	2024-08-01	
Mobilize to Site	2024-08-01	2024-08-16	
Pre-Construction Survey	2024-08-12	2024-08-16	
Tree Protection	2024-08-19	2024-08-23	
Phase 1	2024-08-19	2025-02-14	
Implement Temporary Traffic Controls	2024-08-19	2024-08-30	
Demolition - Phase 1	2024-08-26	2024-10-11	
Clearing / Grubbing	2024-08-26	2024-09-06	
Removal of Existing Luminaires	2024-09-03	2024-09-13	
Asphalt Sawcutting	2024-09-16	2024-09-18	
Asphalt Removal	2024-09-19	2024-10-01	
Concrete Removal	2024-10-02	2024-10-11	
Contruction - Phase 1	2024-10-15	2025-02-14	
Layout Survey	2024-10-15	2024-10-21	
Sidewalk and Bike Path Subgrade Preparation	2024-10-22	2024-10-30	
Sidewalk and Bike Path Base Course	2024-10-31	2024-11-08	
Form + Pour Concrete Sidewalks	2024-11-12	2024-11-18	
Pave Asphalt Bike Paths	2024-11-19	2024-11-25	
Installation of UG Conduit	2024-10-22	2024-11-04	
Installation of Luminaires	2024-11-05	2024-11-18	
Installation of Crosswalk Signals	2024-11-19	2024-11-25	
Roadway Subgrade Preparation	2024-11-26	2024-12-09	
Roadway Subbase Installation	2024-12-10	2024-12-20	
Roadway Base Course Installation	2024-12-23	2025-01-07	
Form + Pour Concrete Curbs	2025-01-08	2025-01-16	
Form + Pour Truck Apron	2025-01-17	2025-01-21	
Installation of Gateway Structure	2025-01-22	2025-01-28	
Pave Roadway	2025-02-03	2025-02-14	
Landscaping / Stormwater Management	2025-01-29	2025-02-07	
Phase 2	2025-02-18	2025-05-02	
Implement Temporary Traffic Controls	2025-02-18	2025-02-28	
Demolition - Phase 2	2025-02-24	2025-03-21	
Clearing and Grubbing	2025-02-24	2025-02-28	
Removal of Existing Luminaires	2025-03-03	2025-03-07	
Asphalt Sawcutting	2025-03-10	2025-03-10	
Asphalt Removal	2025-03-11	2025-03-17	

Tasks

Name	Begin date	End date	Notes
Concrete Removal	2025-03-18	2025-03-21	
Construction - Phase 2	2025-03-24	2025-05-02	
Layout Survey	2025-03-24	2025-03-26	
Installation of UG Conduit	2025-03-27	2025-04-01	
Installation of Luminaires	2025-04-02	2025-04-07	
SIdewalk and Bike Path Subgrade Preparation	2025-03-27	2025-04-02	
Sidewalk and Bike Path Base Course	2025-04-03	2025-04-09	
Form + Pour Concrete Sidewalk + Curbs	2025-04-10	2025-04-17	
Pave Asphalt Bike Path	2025-04-21	2025-04-25	
Paveway Marking	2025-04-28	2025-05-02	
Commissioning	2025-05-05	2025-05-09	
Commissioning of Street Lighting System	2025-05-05	2025-05-09	
Commissioning of Traffic Control System	2025-05-05	2025-05-09	
Substantial Completion	2025-05-12	2025-05-12	
Close-out	2025-05-12	2025-06-02	
Quality Assurance Submittals	2025-05-12	2025-06-02	
As-Built Survey	2025-05-12	2025-05-16	
Demolition of Temporary Traffic Controls	2025-05-20	2025-05-26	
Landscaping	2025-05-27	2025-06-02	
Project Handover	2025-06-03	2025-06-03	

Gantt Chart

Name	Begin date	End date
Issued For Construction Drawings Released	2024-05-01	2024-05-01
Permitting	2024-05-01	2024-06-28
Highway Work Permit	2024-05-01	2024-06-28
Environmental Approval	2024-05-01	2024-06-28
Procurement	2024-06-03	2024-07-25
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Contract Execution	2024-07-12	2024-07-12
Contractor Material Procurement	2024-07-12	2024-07-25
Pre-Construction	2024-07-12	2024-08-23
Project Team Mobilization	2024-07-26	2024-07-31
Contractor Submittals	2024-07-12	2024-07-31
Notice to Proceed Issued	2024-08-01	2024-08-01
Mobilize to Site	2024-08-01	2024-08-16
Pre-Construction Survey	2024-08-12	2024-08-16
Tree Protection	2024-08-19	2024-08-23
Phase 1	2024-08-19	2025-02-14
Implement Temporary Traffic Controls	2024-08-19	2024-08-30
Demolition - Phase 1	2024-08-26	2024-10-11
Clearing / Grubbing	2024-08-26	2024-09-06
Removal of Existing Luminaires	2024-09-03	2024-09-13
Asphalt Sawcutting	2024-09-16	2024-09-18
Asphalt Removal	2024-09-19	2024-10-01
Concrete Removal	2024-10-02	2024-10-11
Contruction - Phase 1	2024-10-15	2025-02-14
Layout Survey	2024-10-15	2024-10-21
Sidewalk and Bike Path Subgrade Preparation	2024-10-22	2024-10-30
Sidewalk and Bike Path Base Course	2024-10-31	2024-11-08
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Roadway Subbase Installation	2024-12-10	2024-12-20
Roadway Base Course Installation	2024-12-23	2025-01-07
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Form + Pour Truck Apron	2025-01-17	2025-01-21
Installation of Gateway Structure	2025-01-22	2025-01-28
Pave Roadway	2025-02-03	2025-02-14
Landscaping / Stormwater Management	2025-01-29	2025-02-07
Phase 2	2025-02-18	2025-05-02
Implement Temporary Traffic Controls	2025-02-18	2025-02-28
Demolition - Phase 2	2025-02-24	2025-03-21
Clearing and Grubbing	2025-02-24	2025-02-28
Removal of Existing Luminaires	2025-03-03	2025-03-07
Asphalt Sawcutting	2025-03-10	2025-03-10
Asphalt Removal	2025-03-11	2025-03-17
Concrete Removal	2025-03-18	2025-03-21
Construction - Phase 2	2025-03-24	2025-05-02
Layout Survey	2025-03-24	2025-03-26
Installation of UG Conduit	2025-03-27	2025-04-01
Installation of Luminaires	2025-04-02	2025-04-07
SIdewalk and Bike Path Subgrade Preparation	2025-03-27	2025-04-02
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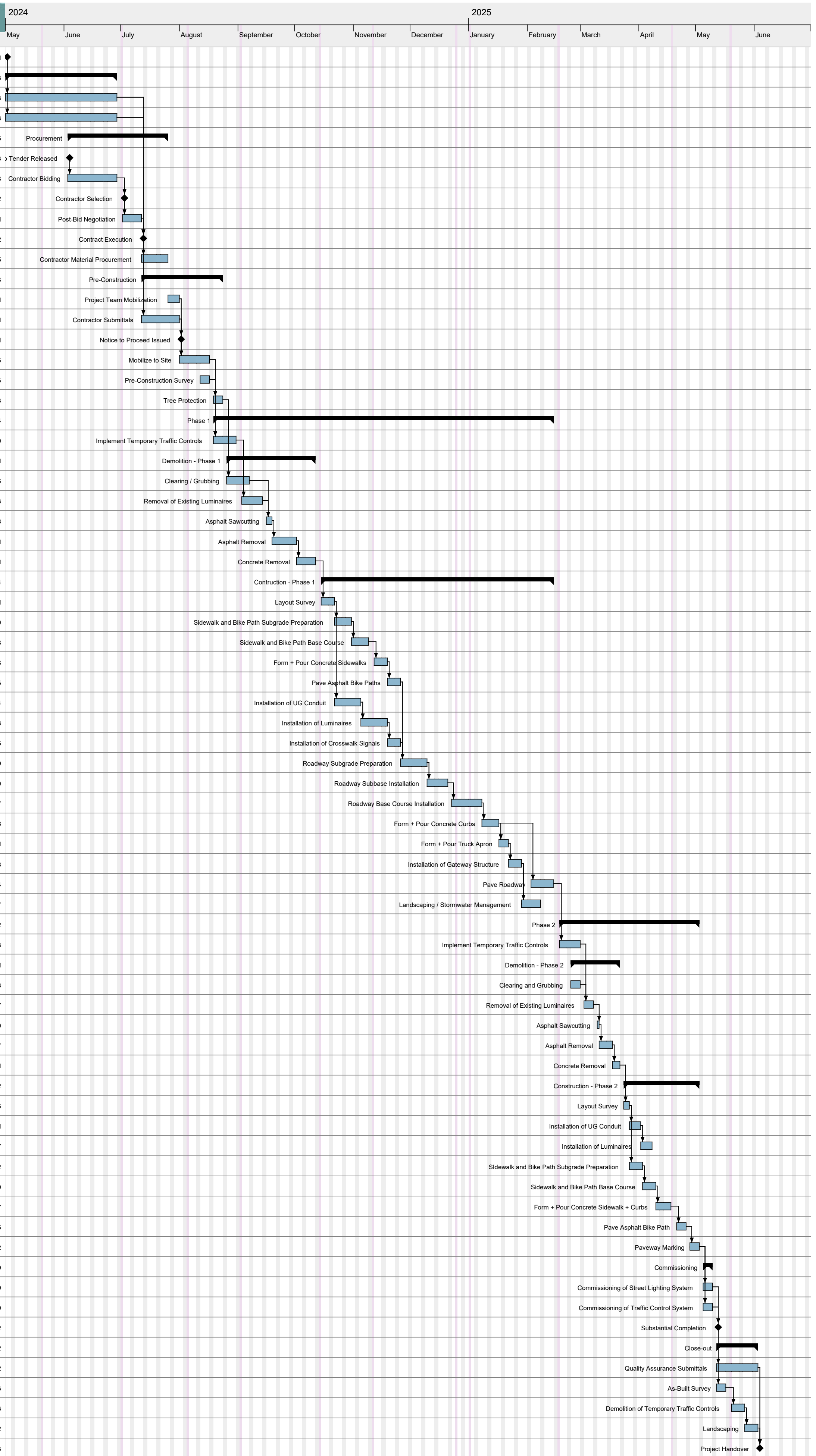
Form + Pour Concrete Sidewalk + Curbs	2025-04-10	2025-04-17
Pave Asphalt Bike Path	2025-04-21	2025-04-25
Paveway Marking	2025-04-28	2025-05-02
Commissioning	2025-05-05	2025-05-09
Commissioning of Street Lighting System	2025-05-05	2025-05-09
Commissioning of Traffic Control System	2025-05-05	2025-05-09
Substantial Completion	2025-05-12	2025-05-12
Close-out	2025-05-12	2025-06-02
Quality Assurance Submittals	2025-05-12	2025-06-02
As-Built Survey	2025-05-12	2025-05-16
Demolition of Temporary Traffic Controls	2025-05-20	2025-05-26
Landscaping	2025-05-27	2025-06-02
Project Handover	2025-06-03	2025-06-03



Appendix 8

Class A Class Estimate

Calculation

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
	W 16 Ave. and SW Marine Dr. Roundabout						**3,958,672.50**		**3,958,672.50**	
1.	**Profit (10%)**						**329,889.38**		**329,889.38**	
1.1.	Profit			ls	1	329,889.38	329,889.38	329,889.38	329,889.38	1
2.	**Risk (10%)**						**329,889.38**		**329,889.38**	
2.1.	Risk			ls	1	329,889.38	329,889.38	329,889.38	329,889.38	1
3.	**Project Indirects**	**00**					**432,000.00**		**432,000.00**	
3.1.	Site Superintendent			month	10	12,000.00	120,000.00	12,000.00	120,000.00	1
3.2.	Project Manager			month	13	12,000.00	156,000.00	12,000.00	156,000.00	1
3.3.	Coordination from Head Office			month	13	12,000.00	156,000.00	12,000.00	156,000.00	1
4.	**General Requirements**	**01**					**201,000.00**		**201,000.00**	
4.1.	**Temporary Utilities**	**51**		**ls**	**1**	**6,000.00**	**6,000.00**	**6,000.00**	**6,000.00**	**1**
4.1.1.	Temporary Electricity			month	10	300.00	3,000.00	300.00	3,000.00	1
4.1.2.	Temporary Telecommunications			month	10	150.00	1,500.00	150.00	1,500.00	1
4.1.3.	Temporary Water			month	10	150.00	1,500.00	150.00	1,500.00	1
4.2.	**Construction Facilites**	**52**		**ls**	**1**	**35,000.00**	**35,000.00**	**35,000.00**	**35,000.00**	**1**
4.2.1.	Field Offices and Sheds	13		month	10	1,500.00	15,000.00	1,500.00	15,000.00	1
4.2.2.	First Aid Facilities	16		month	10	1,000.00	10,000.00	1,000.00	10,000.00	1
4.2.3.	Sanitary Facilities	19		month	10	1,000.00	10,000.00	1,000.00	10,000.00	1
4.3.	Temporary Construction	53		ls	1	50,000.00	50,000.00	50,000.00	50,000.00	1
4.4.	Temporary Controls	57		ls	1	50,000.00	50,000.00	50,000.00	50,000.00	1
4.5.	**Quality Control**	**45**		**ls**	**1**	**20,000.00**	**20,000.00**	**20,000.00**	**20,000.00**	**1**
4.5.1.	Testing and Inspecting Services	23		ls	1	20,000.00	20,000.00	20,000.00	20,000.00	1
4.6.	**Temporary Barriers and Enclosures**	**56**		**ls**	**1**	**25,000.00**	**25,000.00**	**25,000.00**	**25,000.00**	**1**
4.6.1.	Temporary Tree and Plant Protection	39		ea	25	1,000.00	25,000.00	1,000.00	25,000.00	1
4.7.	**Examination and Preparation**	**71**		**ls**	**1**	**15,000.00**	**15,000.00**	**15,000.00**	**15,000.00**	**1**
4.7.1.	Field Engineering	23		days	20	750.00	15,000.00	750.00	15,000.00	1
5.	**Existing Conditions**	**02**					**259,175.00**		**259,175.00**	
5.1.	Surveys	21		hrs	40	100.00	4,000.00	100.00	4,000.00	1
5.2.	**Demolition**	**41**		**ls**	**1**	**255,175.00**	**255,175.00**	**255,175.00**	**255,175.00**	**1**
5.2.1.	**Selective Site Demolition**	**13**		**ls**	**1**	**255,175.00**	**255,175.00**	**255,175.00**	**255,175.00**	**1**
5.2.1.1.	Paving Removal			m^2	8,175	25.00	204,375.00	25.00	204,375.00	1

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
5.2.1.2.	Concrete Curb Removal			lm	2,540	20.00	50,800.00	20.00	50,800.00	1
6.	**Concrete**	**03**					**42,000.00**		**42,000.00**	
6.1.	**Precast Concrete**	**40**		**ls**	**1**	**42,000.00**	**42,000.00**	**42,000.00**	**42,000.00**	**1**
6.1.1.	**Precast Structural Concrete**	**31**		**ls**	**1**	**42,000.00**	**42,000.00**	**42,000.00**	**42,000.00**	**1**
6.1.1.1.	Precast Concrete Lighting Base			ea	28	1,500.00	42,000.00	1,500.00	42,000.00	1
7.	**Specialities**	**10**					**102,000.00**		**102,000.00**	
7.1.	**Gateway Feature**	**14**		**ls**	**1**	**102,000.00**	**102,000.00**	**102,000.00**	**102,000.00**	**1**
7.1.1.	Steel Structure			ls	1	100,000.00	100,000.00	100,000.00	100,000.00	1
7.1.2.	Concrete Foundation			m^3	2	500.00	1,000.00	500.00	1,000.00	1
7.1.3.	Concrete Reinforcement			ls	1	1,000.00	1,000.00	1,000.00	1,000.00	1
8.	**Electrical**	**26**					**272,000.00**		**272,000.00**	
8.1.	**Exterior Lighting**	**56**		**ls**	**1**	**112,000.00**	**112,000.00**	**112,000.00**	**112,000.00**	**1**
8.1.1.	Nova NSD368 Davit Poles	13		ea	28	2,500.00	70,000.00	2,500.00	70,000.00	1
8.1.2.	LED Exterior Lighting	19		ea	28	1,500.00	42,000.00	1,500.00	42,000.00	1
8.2.	**Common Work Results for Electrical**	**05**		**ls**	**1**	**160,000.00**	**160,000.00**	**160,000.00**	**160,000.00**	**1**
8.2.1.	Low-Voltage Electrical Power Cables	19		lm	1,600	50.00	80,000.00	50.00	80,000.00	1
8.2.2.	Underground Ducts and Raceways for Electrical Systems	43		lm	1,600	50.00	80,000.00	50.00	80,000.00	1
9.	**Earthwork**	**31**					**406,731.25**		**406,731.25**	
9.1.	Selective Tree and Shrub Removal and Trimming	13		ea	25	1,000.00	25,000.00	1,000.00	25,000.00	1
9.2.	**Excavation and Fill**	**23**		**ls**	**1**	**381,731.25**	**381,731.25**	**381,731.25**	**381,731.25**	**1**
9.2.1.	**Excavation**	**16**		**ls**	**1**	**320,418.75**	**320,418.75**	**320,418.75**	**320,418.75**	**1**
9.2.1.1.	Excavation			m^3	12,262.5	3.50	42,918.75	3.50	42,918.75	1
9.2.1.2.	Trucking			hr	1,850	150.00	277,500.00	150.00	277,500.00	1
9.2.2.	Fill	23		m^3	4,087.5	15.00	61,312.50	15.00	61,312.50	1
10.	**Exterior Improvements**	**32**					**1,478,987.50**		**1,478,987.50**	
10.1.	**Flexible Paving**	**12**		**ls**	**1**	**726,000.00**	**726,000.00**	**726,000.00**	**726,000.00**	**1**
10.1.1.	**Asphalt Paving**	**16**			**1**	**726,000.00**	**726,000.00**	**726,000.00**	**726,000.00**	**1**
10.1.1.1.	Material + Labour			m^2	8,590	75.00	644,250.00	75.00	644,250.00	1
10.1.1.2.	Trucking			hr	545	150.00	81,750.00	150.00	81,750.00	1
10.2.	**Curbs, Gutters, Sidewalks, and Driveways**	**16**		**ls**	**1**	**343,050.00**	**343,050.00**	**343,050.00**	**343,050.00**	**1**
10.2.1.	**Sidewalks**	**23**		**ls**	**1**	**203,550.00**	**203,550.00**	**203,550.00**	**203,550.00**	**1**
10.2.1.1.	Cast-in-Place Concrete Sidewalk			m^2	135	100.00	13,500.00	100.00	13,500.00	1
10.2.1.2.	**Asphalt Multi-Use Pathway**			**ls**	**1**	**190,050.00**	**190,050.00**	**190,050.00**	**190,050.00**	**1**
10.2.1.2.1.	Material + Labour			m^2	3,000	50.00	150,000.00	50.00	150,000.00	1

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
10.2.1.2.2.	Trucking			hr	267	150.00	40,050.00	150.00	40,050.00	1
10.2.2.	**Curbs and Gutters**	**13**		**ls**	**1**	**139,500.00**	**139,500.00**	**139,500.00**	**139,500.00**	**1**
10.2.2.1.	Curbs			lm	2,155	50.00	107,750.00	50.00	107,750.00	1
10.2.2.2.	Truck Apron			m^2	555	50.00	27,750.00	50.00	27,750.00	1
10.2.2.3.	Curb Ramps			ea	8	500.00	4,000.00	500.00	4,000.00	1
10.3.	**Paving Specialties**	**17**		**ls**	**1**	**10,187.50**	**10,187.50**	**10,187.50**	**10,187.50**	**1**
10.3.1.	**Pavement Marking**	**23**		**ls**	**1**	**10,187.50**	**10,187.50**	**10,187.50**	**10,187.50**	**1**
10.3.1.1.	Lane Marking			lm	955	2.50	2,387.50	2.50	2,387.50	1
10.3.1.2.	Crosswalk Marking			m^2	120	40.00	4,800.00	40.00	4,800.00	1
10.3.1.3.	Arrows			ea	6	500.00	3,000.00	500.00	3,000.00	1
10.4.	**Turf and Grasses**	**92**		**ls**	**1**	**20,000.00**	**20,000.00**	**20,000.00**	**20,000.00**	**1**
10.4.1.	Seeding	19		m^2	10,000	2.00	20,000.00	2.00	20,000.00	1
10.5.	Plants	93		m^2	1,950	100.00	195,000.00	100.00	195,000.00	1
10.6.	**Base Courses**	**11**		**ls**	**1**	**184,750.00**	**184,750.00**	**184,750.00**	**184,750.00**	**1**
10.6.1.	**Aggregate Base Courses**	**23**			**1**	**184,750.00**	**184,750.00**	**184,750.00**	**184,750.00**	**1**
10.6.1.1.	**75mm Road Base**				**1**	**123,125.00**	**123,125.00**	**123,125.00**	**123,125.00**	**1**
10.6.1.1.1.	Material			ton	3,850	12.50	48,125.00	12.50	48,125.00	1
10.6.1.1.2.	Trucking			hr	500	150.00	75,000.00	150.00	75,000.00	1
10.6.1.2.	**20mm Road Base**				**1**	**61,625.00**	**61,625.00**	**61,625.00**	**61,625.00**	**1**
10.6.1.2.1.	Material			ton	1,930	12.50	24,125.00	12.50	24,125.00	1
10.6.1.2.2.	Trucking			hr	250	150.00	37,500.00	150.00	37,500.00	1
11.	**Transportation**	**34**					**105,000.00**		**105,000.00**	
11.1.	Roadway Signaling and Control Equipment	41		ea	3	35,000.00	105,000.00	35,000.00	105,000.00	1

Appendix 9

Long Term Maintenance Cost Estimate

Calculation

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
	W 16 Ave. and SW Marine Dr. - Maintenance						**14,150.00**		**14,150.00**	
1.	**Landscaping**						**11,450.00**		**11,450.00**	
1.1.	**Pruning**			**ls**	**1**	**800.00**	**800.00**	**800.00**	**800.00**	**1**
1.1.1.	Labour			hr	16	50.00	800.00	50.00	800.00	1
1.2.	**Watering**			**ls**	**1**	**650.00**	**650.00**	**650.00**	**650.00**	**1**
1.2.1.	Labour			hr	13	50.00	650.00	50.00	650.00	1
1.3.	**Mulching**			**ls**	**1**	**3,400.00**	**3,400.00**	**3,400.00**	**3,400.00**	**1**
1.3.1.	Labour			hr	48	50.00	2,400.00	50.00	2,400.00	1
1.3.2.	Material			m^2	5	200.00	1,000.00	200.00	1,000.00	1
1.4.	**Weeding**			**hr**	**1**	**2,400.00**	**2,400.00**	**2,400.00**	**2,400.00**	**1**
1.4.1.	Labour			hr	48	50.00	2,400.00	50.00	2,400.00	1
1.5.	**Clearing Debris**			**hr**	**1**	**4,200.00**	**4,200.00**	**4,200.00**	**4,200.00**	**1**
1.5.1.	Labour			hr	84	50.00	4,200.00	50.00	4,200.00	1
2.	**Asphalt Inspection/Maintenance**						**2,700.00**		**2,700.00**	
2.1.	Asphalt Resurfacing (every 12 years)			km	1	1,000.00	1,000.00	1,000.00	1,000.00	1
2.2.	Asphalt Inspection			hr	8	150.00	1,200.00	150.00	1,200.00	1
2.3.	Pothole Repair			ls	1	500.00	500.00	500.00	500.00	1