UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

# Chancellor Boulevard & East Mall Intersection Redesign


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## Executive Summary

Pacific Urban Consulting (PUC) presents a transformative redesign of the Chancellor Boulevard and East Mall intersection at the University of British Columbia (UBC), a vital yet currently hazardous junction near the Point Grey cliffs. The existing intersection is characterized by excessive vehicular speeds, confusing geometry, limited infrastructure for active transportation users, and inadequate stormwater management, all of which compromise safety, accessibility, and environmental sustainability.

To address these multifaceted challenges, three conceptual alternatives were initially developed: signalized intersection, roundabout, and protected bike lane configurations. Following a comprehensive evaluation through a weighted decision matrix prioritizing cost-effectiveness, safety, and environmental resilience, the protected bike lane design was selected. This design fundamentally reimagines the intersection, converting it into a simplified three-leg configuration by eliminating vehicular access to Northbound NW Marine Drive. In its place, a two-way protected bike lane is introduced, enhancing cyclist safety and connecting directly to Vancouver's AAA cycling network.

The design integrates extensive pedestrian safety improvements, including pedestrian-actuated traffic signals, protected crossings, and simplified vehicular movements through left-turn restrictions. To further improve safety and reduce vehicular speeds, the project implements traffic-calming measures such as median realignment and physical barriers. The layout supports a welcoming gateway to UBC, featuring a prominently designed reinforced concrete gateway structure with architectural detailing that reflects the university's identity.

Environmental considerations are central to the project. An integrated stormwater management system, including a rainwater garden and an ACO underground detention tank, has been engineered to retain runoff from a 1-in-100-year storm event entirely on-site, mitigating the erosion of the nearby cliffs and promoting groundwater infiltration and reuse. The project also minimizes ecological disruption by reusing existing roadway alignments and compensating for all necessary tree removals through replanting.

Supported by stakeholder consultation, detailed traffic modeling, and engineering analyses, the proposed redesign enhances user safety, advances UBC's sustainability goals, and preserves the environmental integrity of the Point Grey cliffs. With a total estimated capital cost of $7.35 million and a scheduled completion date prior to the 2025 fall semester, the project embodies a forward-looking, resilient, and community-informed infrastructure solution.

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**Glossary of Terms**

| Abbreviation | Meaning |
|---|---|
| BC MoTI or MoTI | British Columbia Ministry of Transportation and Infrastructure |
| UBC | University of British Columbia |
| MoA | Museum of Anthropology at UBC |
| PoI | Points of Interest |
| SOV | Single Occupancy Vehicle |
| HOV | High Occupancy Vehicle |
| BCBC 2024 | BC Building Code 2024 |
| TCP | Traffic Control Plan |
| SWMP | Stormwater Management Plan |
| MMCD | Master Municipal Construction Documentation |
| FDW | Flash Don’t Walk |
| SRC | Student Recreation Centre |
| AASHTO | American Association of State Highway and Transportation Officials |
| ASTM | American Society for Testing and Materials |
| ACI | American Concrete Institute |

## 1.0 Project Background & Goals

The four-way intersection of Chancellor Blvd. and East Mall (and NW Marine Dr.), as illustrated in the South-West corner of Figure 1, serves as a minor gateway to the UBC Point Grey campus. Despite its functional importance, the intersection's existing configuration is outdated and inconsistent with contemporary design standards. Its highway-style layout poses significant challenges for safety, comfort, and accessibility, particularly for users of active transportation modes such as pedestrians and cyclists.

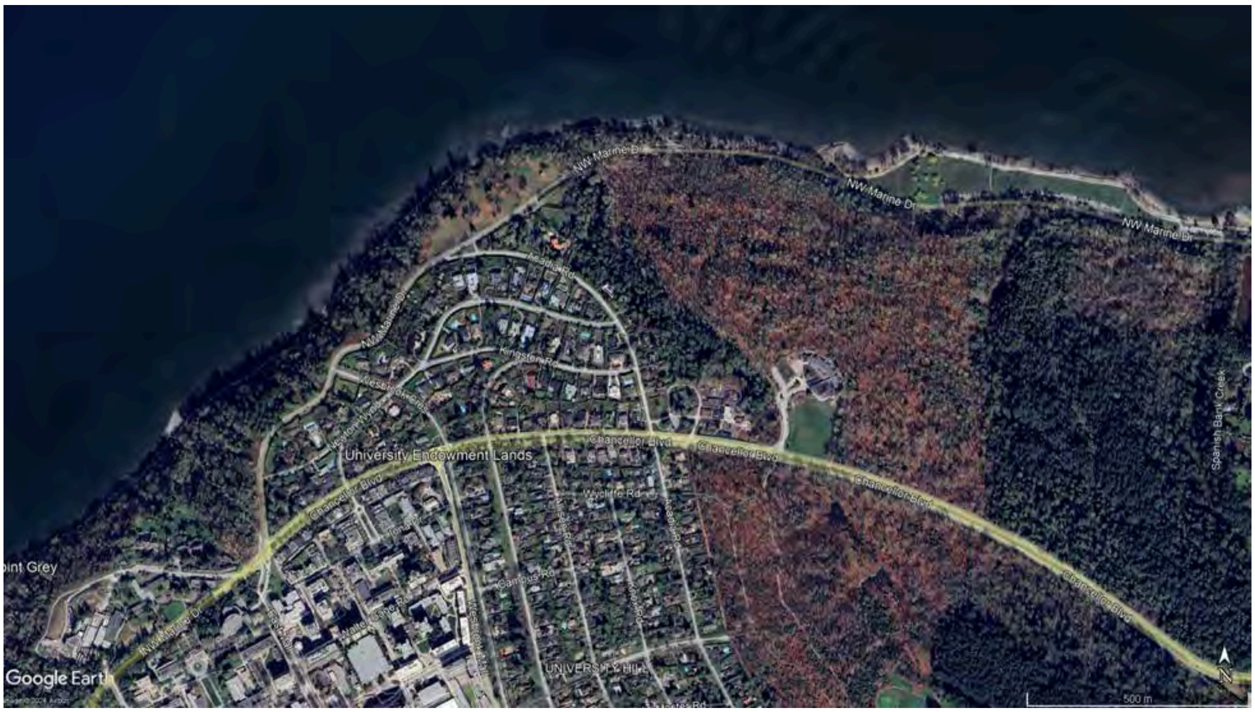


***Figure 1:*** *Project Overview Map*

The current intersection has traffic going in four directions:

- Towards Spanish Banks beach via the **Northbound NW Marine Dr.**
- Towards Peter A. Allard School of Law via **East Mall**
- Towards the MoA or Rose Garden Parkade via **Westbound NW Marine Dr.**
- Towards Vancouver via the **Chancellor Blvd.**

Figure 2 highlights these important road sections. These road names will be used frequently in the report sections to follow.

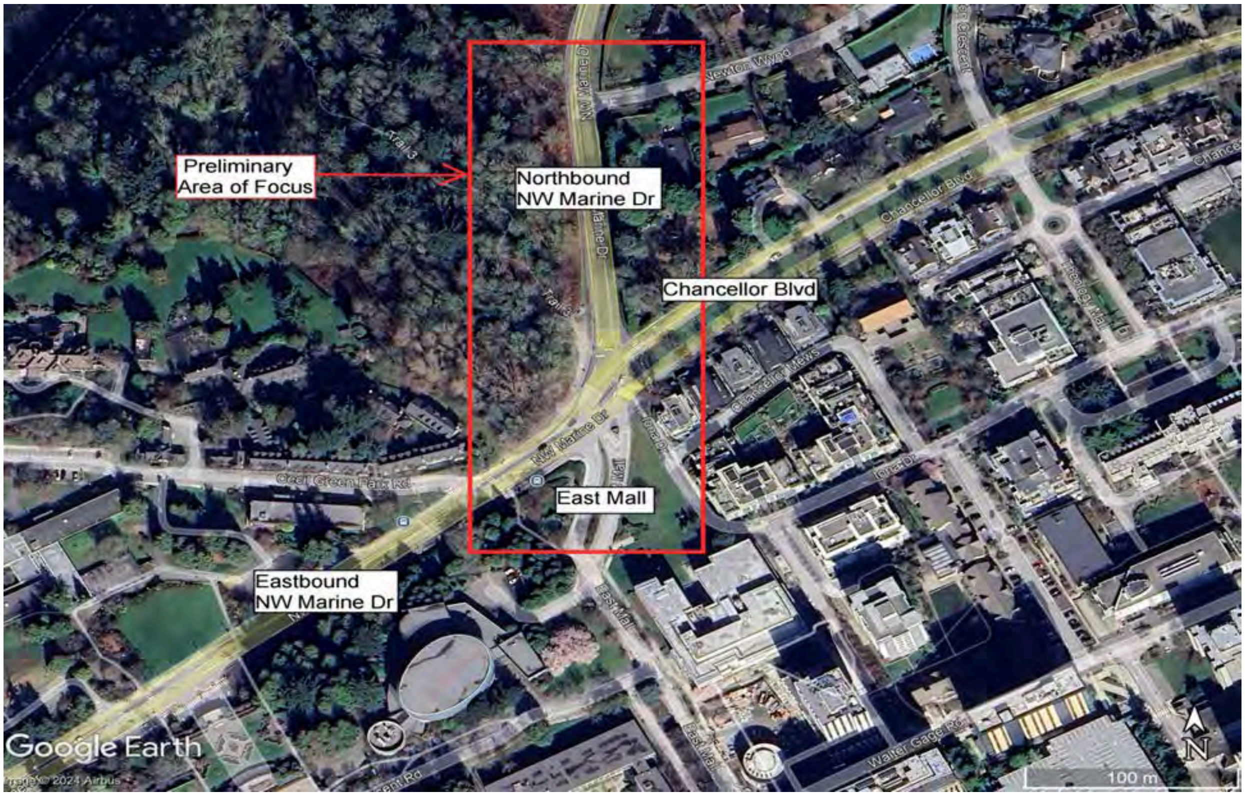


***Figure 2:*** *Route Map at the Existing Intersection*

Additionally, special consideration was given to areas of interest and buildings that would likely be of concern to motorists, cyclists, and pedestrians crossing the intersection. The list is as follows:

- Tower Beach Access Point/Trail: The public uses this route to get to Tower Beach by foot. It is also referred to as "Trail 3" at times.
- The Peter A. Allard School of Law: The law school at UBC offers a Juris Doctor degree with courses in business law, tax law, environmental law, Indigenous law, Pacific Rim issues, and feminist legal theory. Many students and faculty access this building.
- The Chan Centre for the Performing Arts: The Chan Centre hosts UBC music, film, and theatre classes, rehearsals, and performances, alongside a diverse annual performing arts season drawing audiences from across the Lower Mainland.
- North Pakade, Fraser Parkade, and the Rose Garden Parkade: commonly used parking lots for motorists coming to UBC.
- MOA: A famous tourist and local destination, the Museum of Anthropology at UBC showcases world-renowned collections of global Indigenous art and cultural artifacts, with a focus on the rich traditions of Northwest Coast First Nations.
- AMS Nest: The Nest at UBC is a vibrant student hub featuring dining, study spaces, and the Bike Kitchen, a community bike shop offering repairs, rentals, and cycling resources.

An aerial map of these nearby points of interest has been attached below (see Figure 3):


***Figure 3:*** *Aerial Map of Nearby POIs*

### 1.1 Key Issues with the Current Intersection

1. **Facilitation of High Travel Speeds:** The design promotes vehicular movement at high speeds, creating unsafe conditions for all users.
2. **Complex Geometry:** The intersection's large size and unintuitive layout result in user confusion, reducing navigational clarity and safety.
3. **Limited Accommodation of Active Modes:** The existing infrastructure fails to adequately support pedestrians and cyclists, discouraging active transportation and compromising inclusivity.
4. **Environmental Concerns:** The lack of effective on-site rainwater retention exacerbates erosion of the adjacent cliffs, contributing to environmental degradation.

### 1.2 Project Goals

The primary goal of this project is to design a new intersection at the location highlighted in Figure 2, complying with the design requirements of the MoTI. In addition to meeting these regulatory standards, the project will address several objectives identified by UBC to enhance safety, accessibility, and environmental sustainability.

The detailed project goals include:

1. **Prioritizing Active Travel Modes:**
    - Develop a clear and intuitive intersection layout that facilitates safe and comfortable navigation for pedestrians and cyclists.
    - Establish seamless connections to existing and planned active transportation facilities.
    - Incorporate design elements that cater to users of all ages and abilities, fostering inclusivity.

2. **Reducing Vehicle Travel Speeds:**
    - Implement traffic-calming measures to lower travel speeds, enhancing safety for all road users.

3. **Establishing a Gateway to UBC:**
    - Design the intersection as a welcoming and recognizable entry point to the UBC neighbourhood.
    - Integrate a UBC gateway sign as a defining feature of the project area.

4. **Retaining All Rainwater On-Site:**
    - Incorporate stormwater management systems capable of handling a 100-year storm event.
    - Prevent rainwater from infiltrating and draining off the cliffs to mitigate ongoing erosion.
    - Enable on-site reuse of retained rainwater, serving the entire catchment area around the intersection.

By achieving these objectives, the project will deliver a safe, sustainable, and visually appealing intersection that aligns with UBC's commitment to fostering a vibrant and accessible campus environment.

## 2.0 Stakeholder Consultation

This project involves various stakeholders with different values and priorities. The goal of the stakeholder consultation and engagement process was to ensure all stakeholder feedback is considered throughout the design and construction. The consultation helped identify the concerns stakeholders have with the current intersection, which were then addressed in the design. The following rights holders and stakeholders have been identified for the project.

**Rightsholders**

- Local Indigenous Communities (Musqueam Nation)
- Ministry of Transportation and Infrastructure (MoTI)

The rightsholder consultation for the intersection design, involving the Musqueam Nation and the MoTI, was conducted with a focus on collaboration, cultural respect, and compliance with provincial standards. The Musqueam Nation provided valuable input and integrated traditional ecological knowledge while contributing to the design through Indigenous art, place names, and environmental stewardship. At the same time, MoTI ensured the project aligned with regional transportation plans and adhered to safety and provincial road standards. Transparent communication and joint workshops throughout the design process facilitated a balance between cultural priorities and technical requirements, resulting in a design that honoured Indigenous rights, supported reconciliation, and addressed the functional needs of all stakeholders.

**Stakeholders**

- Cyclists
- Pedestrians
- Vehicle Drivers
- UBC Students and Facility
- Tower Beach and Spanish Banks visitors
- Local Residents
- Chan Centre Visitors

**Cyclists**

To get specific feedback and consult with cyclists who use the intersection, efforts were focused on key areas around UBC campus, as most of the stakeholder cyclists are living or commuting to campus. QR codes and posters were displayed at UBC Bike Kitchen to enable users with the opportunity to provide feedback and express concerns regarding the project. Staff were also informed to provide further details to customers. Additionally, posters were placed near large bike racks around campus, such as the ones at the AMS Nest, SRC, and Sauder School of Business. To further engagement and target UBC cyclists, advertisements were posted on social media.

Through consultation with cyclists, the primary concern of safety was elucidated. Drivers traveling through the intersection at high speeds and do not exercise caution with respect to cyclists, particularly on Northbound NW Marine Dr. Many cyclists desire segregated bike lanes on this road. Additionally, cyclists highlighted the lack of bike lanes crossing the intersection. This induces confusion as to how to properly engage in the intersection when crossing the road. This remains true for vehicles as well, emphasizing the risk to safety when considering high vehicle speeds.

**Pedestrians**

Similar to cyclists, pedestrian engagement will be centered on and adjacent to UBC campus, where there is high pedestrian foot traffic. The primary area of focus will be the AMS Nest as it is a pedestrian dense area and relatively proximal to the intersection. Establishing an information booth here for two days on a Tuesday and Wednesday will enable people to ask questions and learn more about the project. Tuesday and Wednesday were selected for this endeavor as these are the busiest days on campus. In addition to this booth, posters and QR codes will be made available on Main Mall, as this road is a major pedestrian walkway. These will be similar to the ones at the Bike Kitchen and allow for the continuous collection of feedback rather than being limited to the two days of feedback collected at the booth.

Pedestrians provided similar feedback as cyclists. Their main concern pertained to safety. Currently, there is only one crosswalk at the intersection, forcing many pedestrians to jaywalk the busy road. Additionally, this crosswalk does not have any signal lights, thus forcing many pedestrians to wait in order to cross, as many drivers do not yield. Reports of pedestrians being struck while crossing the intersection at night further showcase the dangers of a non-signalized intersection.

**Drivers**
In addition to active travel users, drivers are a major stakeholder in this project. To engage with these drivers, the focus was on the large parkades around UBC campus, with special attention to North Parkade and Rose Garden Parkade. Similar to the pedestrian engagement, QR codes and posters were placed at all main parkades. To gather feedback from drivers using the intersection, information booths were held at the Rose Garden and North Parkades. These booths were held on Tuesday and Wednesday in the week following the pedestrian booths.

The drivers provided slightly different feedback than the active travel users. The main concern for drivers was the unintuitive layout of the intersection. Drivers on Northbound NW Marine and East Mall also found it difficult to cross the intersection, especially with high vehicle speeds on the main road. The minimal signage and lack of signals at the intersection further increase drivers' confusion. However, it is important to note that drivers accessing North Parkade tend to avoid this intersection, preferring to use the Chancellor and Westbrook intersection, which precedes it. Additionally, based on the feedback received, the Rose Garden Parkade entrance is not affected by the intersection as drivers pass it to access the parkade.

**UBC Students and Faculty**
Separate from the different travel mode stakeholders, there are also specific groups of stakeholders. For UBC students and faculty, much of the engagement had been completed via cyclist, pedestrian, and driver consultation. To further expand this group's engagement, efforts were focused on the Peter A. Allard School of Law, as this is the building closest to the intersection. Similar to other stakeholder engagements, QR codes and posters were set up in the building. Additionally, advertisements were posted on social media targeting UBC Law students. During the consultation, students who drove to campus reported parking at Rose Garden or North Parkade and expressed a desire to avoid any restrictions to these parkades in the new design.

**Beach Visitors**
For Tower Beach and Spanish Banks visitors, the area of focus shifted away from the campus and towards these beaches. Engagement with these visitors involved setting up posters and QR

codes at the entrance of Tower Beach and the first few parking lots at Spanish Banks. Through this consultation process, it was determined that many people cycle to Spanish Banks from UBC. Feedback from Tower Beach visitors highlighted safety concerns while crossing the intersection. The singular crosswalk at the intersection is on the opposite side of the beach entrance, and the only way for visitors to access the beach is by jaywalking across one of the Marine Dr. roads. Jaywalking on any road is a major safety hazard and will be addressed by this design.

**Local Residents**

There are a few local neighbourhoods around the intersection with varying densities. To consult with the residents living in Chancellor Place and the UBC dorms at the North end of campus, posters and QR codes were placed in the lobbies of the large buildings, such as Walter Gage, Brock Commons, and Chancellor Hall. For the houses on University Endowment Lands between Northbound NW Marine Dr. and Chancellor Blvd., flyers and brochures were handed out door to door on Sunday. During these interactions, it was found that most of these residents walk or bike to Spanish Banks. Similar to the cyclists, they expressed a desire for a separated bike lane on Northbound NW Marine Dr.

**Chan Centre Visitors**

Another stakeholder group engaged with were Chan Centre visitors. Located south of the intersection, the Chan Centre is a major performance arts event venue in the area. An information session was held right before a major performance to gain insight into the needs and concerns of the project from the audience. During this session, it was learned that many drivers do not drive directly to the front of the Centre; instead, they park at either the Rose Garden or North Parkades and walk to the Centre.

## 3.0 Protected Bike Lane Design

A Weighted Decision Matrix (WDM) was used to compare the different design alternatives across several criteria. Weights were assigned based on two different selection methods. Both of these methods were focused on equally.

First, prioritizing listening to what mattered the most to stakeholders was essential. The stakeholder consultation notes were summarized and discussed amongst the design team, enabling the assignment of weight from a stakeholder point of view. Then, all designs were analyzed from an engineering feasibility standpoint, focusing on investments that yielded the most returns with the least cost and environmental damage. Strong emphasis was placed on safety for all users. The WDM can be found in Appendix L.

**Proposed Design Highlights**

The proposed intersection design incorporates the following key features to enhance safety, promote active transportation, and minimize environmental and financial impacts:

**Prioritizing Active Modes of Travel**

- **Vehicle Restriction on NW Marine Dr.:**
  - Block vehicular access to NW Marine Dr. from the intersection to Spanish Banks using concrete Jersey barriers.
  - Provide a protected 2-way bike lane to increase cyclist safety and connectivity.
  - Establish a seamless link between UBC and Vancouver's AAA cycling network.
  - Maintain driveway access for local traffic at Acadia Road with a gap in the bike lane.
  - Introduce a cost-effective U-turn at Spanish Banks using the existing parking lot configuration.
  - Redirect drivers heading to UBC via NW Marine Dr. to West 4th Avenue.

**Minimizing Environmental Impacts and Costs**

- Utilize existing road configurations to limit new construction and reduce financial costs.

**Enhancing Safety**

From consultation with cyclists, via survey forms and information sessions, it was deduced that the Northbound NW Marine Dr. road had the highest safety concerns from the cyclists' point of view. It is important to note that similar concerns were also expressed by motorists trying to get across the intersection from the Spanish Banks side, onto East Mall, or those trying to take a left onto Chancellor.

- **Left Turn Removal:**
  - Eliminate all left turns at the intersection to reduce collision risks and improve vehicle safety.
  - Avoid the need for costly traffic signals by adopting a simpler configuration.

**Pedestrian and Cyclist Safety**

Install flashing green pedestrian-actuated signals and bike queue-boxes at the main intersection (Chancellor Blvd. and NW Marine Dr.).

- Improve safety for pedestrians and cyclists.
- Use familiar regional signal designs to ensure intuitive driver response.

**Protecting Adjacent Point Grey Cliffs**

Retain all rainwater on-site for a 1-in-100-year storm event using the following measures:

- A rainwater garden located along NW Marine Dr. between the intersection and Newton Wynd.
- A high-capacity ACO underground stormwater tank positioned at the end of the rainwater garden.

This design balances safety, environmental sustainability, and cost-effectiveness while meeting UBC's objectives and enhancing the gateway to the campus.

## 4.0 Design Rationale

The features of the protective bike lane design were developed based on stakeholder consultations, data analysis, and the project goals and requirements. Using a data-driven approach, the design maximizes the benefits to stakeholders and meets the client's expectations.

### 4.1 Bike Lanes

The main distinct feature of the design is the protective bike lane that blocks vehicle access on Northbound NW Marine Dr. from the intersection all the way down to Spanish Banks. This feature was created to address cyclist safety concerns and simplify the intersection to reduce driver confusion. By blocking off Northbound NW Marine Dr., the 4-way intersection was transformed into a 3-way, which lowered the signal installation cost and provided space to build a rain garden. Additionally, the bike lane aligns with the project objectives of prioritizing active modes of travel. A safe bike lane, completely isolated from vehicles, is expected to encourage more people to cycle, especially those hesitant due to safety concerns. The bike lane will also connect to Vancouver's all ages and abilities bike lane network, enabling commuters to cycle from Downtown to the UBC campus entirely on protected bike lanes (see Appendix I for a map of Vancouver's AAA network).

The vehicle count data also reinforces the need to add a bike lane on this road. Despite currently only having a shared use lane, Northbound NW Marine Dr. has a disproportionately high cyclist-to-vehicle ratio (see Table 1 below for more detail). This shows that there is a high demand for cyclists on this road, which will only increase during the summer as more people start cycling and going to Spanish Banks. It is important to mention that a small section of Northbound NW Marine Dr. will have vehicle access for local residents. This section will be a local street bikeway similar to other quiet, low-density neighborhoods in the area. The reason for this is to allow the few homes on this road vehicle access to their driveways (see drawing C-02 in Appendix C for more details).

***Table 1:*** *Cyclist to Vehicle Ratio*

| | Eastbound NW Marine Dr. | Northbound NW Marine Dr. | Chancellor Blvd. | East Mall |
|---|---|---|---|---|
| Ratio of Cyclists to Vehicles | 0.03 | 0.41 | 0.03 | 0.03 |

### 4.2 Vehicle Turning Restrictions

Another main feature of the design is the removal of left turns at the intersection. Two of the current left turns were eliminated as the intersection is now a three-way. The other two left turns were removed to improve safety, reduce congestion, and lower costs. Left turns are inherently dangerous, as they require vehicles to cross paths with incoming traffic and pedestrians. On a high-speed road like this intersection, drivers may misjudge safe headways or become impatient, resulting in dangerous turns. Although signalized lights with protected left-turn phases could be added for safety, this would increase congestion, as vehicles would need to wait for the left-turn phase to end before continuing. Additionally, installing three of these signals would be costly and extend construction time. By eliminating left turns, these hazards are avoided without incurring extra costs. This decision was also informed by feedback during stakeholder consultations, where the main concern from drivers was the confusing layout. The design simplifies the road, making it easier to navigate. A concrete median prevents left turns, shifting drivers' focus from navigation to other road users.

Regarding the two major parkades near the intersection, feedback from drivers indicated that eliminating left turns would not hinder access. Most drivers heading to the North Parkade will use the Chancellor and Westbrook roundabout and continue on Student Union Blvd. Drivers heading to the Rose Garden Parkade will pass the intersection and take the first left. The only concern involves drivers from East Mall going to the Museum of Anthropology, who can simply do a U-turn at the Chancellor and Westbrook roundabout, adding only a minute to their commute. The roundabout is expected to handle the additional vehicles from East Mall without issue. Drivers coming from Chancellor going to East Mall can use Walter Gage Rd instead, which connects to both directions of East Mall (see Figure 4 for traffic flow). Data analysis also supports the decision to eliminate left turns. The vehicle count data shows that a small number of vehicles currently make left turns, while the majority continue straight (see Table 4). This design will only negatively impact a small number of drivers while benefiting the majority of intersection users.

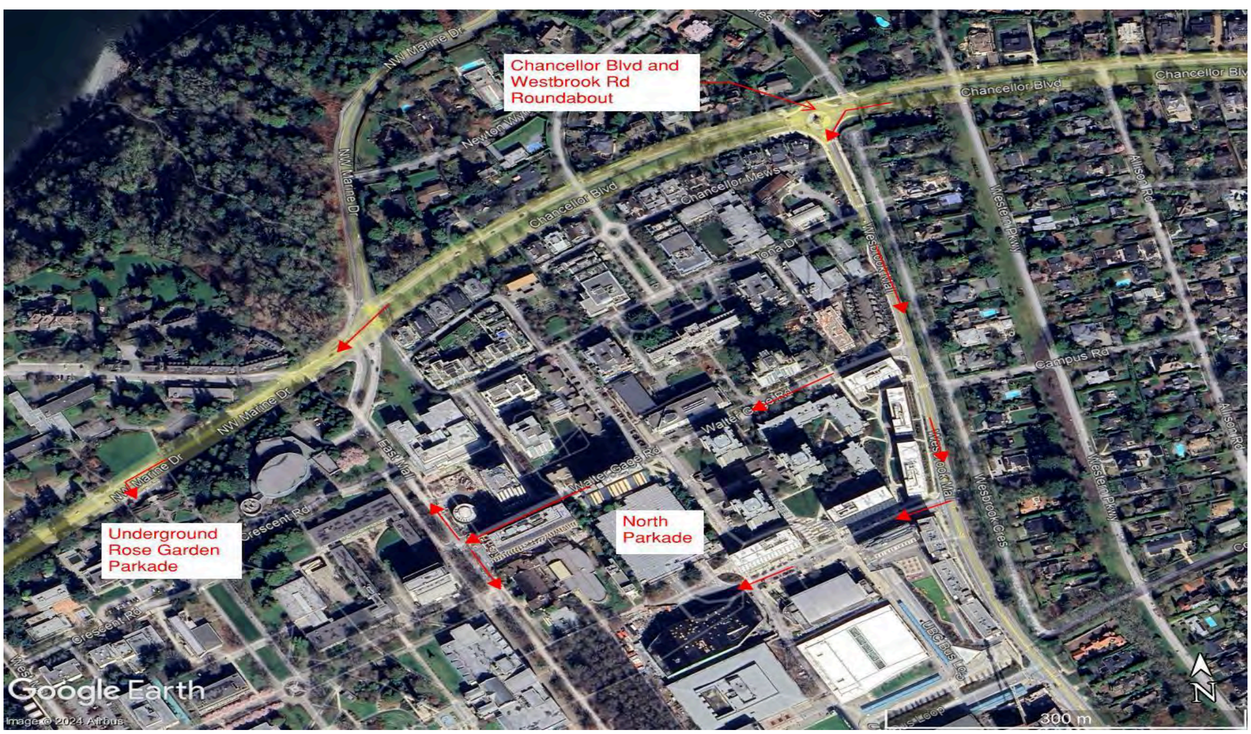


***Figure 4:*** *Left Turn Alternative Traffic Flow Paths*

### 4.3 Pedestrian and Cyclist Safety

A downside of simplifying the intersection and reducing vehicle crossing paths is that drivers will feel more comfortable driving faster. This, in return, will make pedestrians and cyclists more concerned for their safety. But it is important to note that by eliminating left turns, both cyclists and pedestrians do not need to worry about getting hit by vehicles making a left turn. To further cyclist safety while going through the intersection, green paint will be added to bike lanes at the intersection. This will let drivers know that there is a bike lane here and to be more cautious of cyclists. Additionally, cyclists will use queue-boxes to do a 2 stage left turn, which is much safer than the typical left turns.  For pedestrians, two pedestrian-actuated traffic signals will be implemented, with one on Eastbound NW Marine Dr. and the other on Chancellor Blvd. (see drawing C-03 in Appendix C for more detail). This will allow pedestrians to safely cross the busy intersection despite the high vehicle speeds. Traffic signal crossings were selected instead of amber light ones as drivers do not obey these lights on occasion. In this case, a collision at the crossings will most certainly be fatal. In order to avoid this, the traffic signal option was pursued, as all drivers tend to obey and follow as these lights appear red, which is the exact same as vehicle-controlled intersections. These lights have also been installed nearby on W-16th Ave. and on University Blvd., so local drivers are familiar with them.

## 5.0 Environmental Considerations

The design minimizes environmental impacts and tree loss. Overall, only 5 existing trees will be cut down. These trees will then be replaced by 10 new trees planted at the end of the project, replacing every tree cut down with two new ones. It's also important to note that large trees will not be removed; the tallest tree removed will be less than 25 feet. See Figure 5 below for location and justification for tree removals. The project will achieve this level of environmental protection by utilizing the current road configuration, which has allowed for avoiding the removal of additional vegetation for the new intersection. To further the positive environmental benefits of this project, a rainwater garden has been implemented, which is a sustainable and environmentally friendly way to collect rainwater. The garden will filter out pollutants from the runoff at the intersection. This filtering is important because the water could be contaminated by oil or chemicals from vehicles. Also, the garden will help the local ecosystem and become a habitat for wildlife such as birds and insects. Additionally, this garden is a carbon sink and will capture greenhouse gas emissions from the vehicles on the intersection.

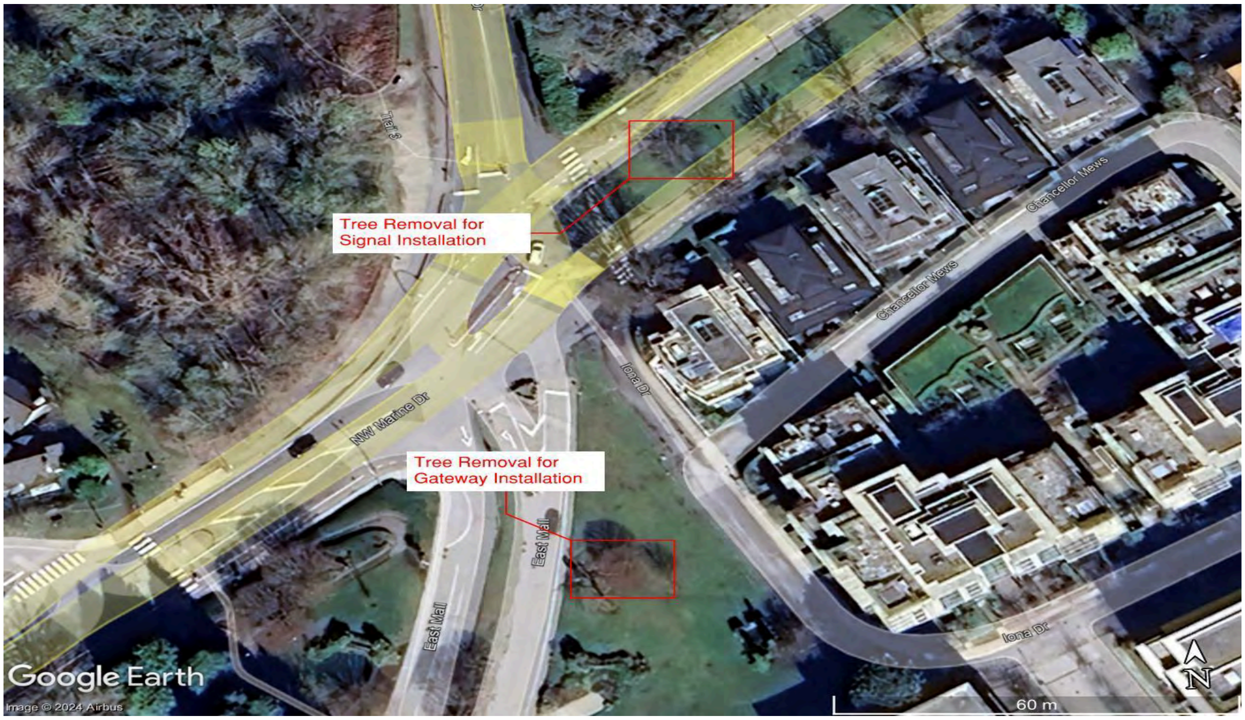


***Figure 5:*** *Tree Removal*

## 6.0 Traffic Analysis and Management

**Data Collection and Forecasting Approach**

To design the intersection for the future design year (2050), a combination of historical traffic data and recent vehicle counts was utilized. This methodology allows for a robust estimation of future traffic volumes by extrapolating observed trends and adjusting for current conditions. The steps in this approach are detailed below:

**Historical Traffic Data Analysis**

Historical traffic data provides valuable insights into long-term trends and growth patterns in vehicle volumes within the UBC area. Traffic volume data publicly made available on the UBC Sustainability Portal by Krista Falkner was utilized. This dataset, spanning several years, provided details of the mode share and vehicular traffic at UBC Vancouver for the period 1997-2023 and formed the basis for calculating the traffic growth rate. Figure 6 below represents the dataset, along with an added extrapolation trendline.

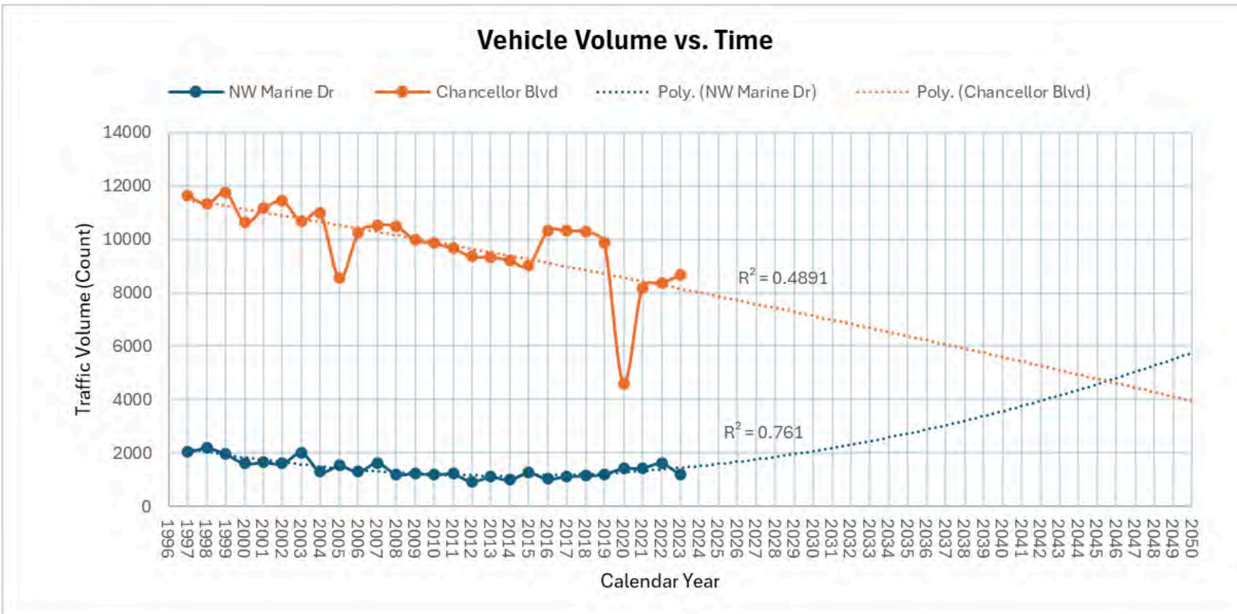


***Figure 6:*** *Vehicle Volume Trends for NW Marine Dr and Chancellor Blvd*

In 2023, UBC successfully achieved a 6% reduction in daily private automobile traffic compared to 1997 levels, with 58,800 private vehicles per day. This is in line with Target 3, which aims to maintain daily private automobile traffic at or below the 1997 levels. The target specifically considers private automobiles, including single-occupant vehicles and carpools/vanpools, but excludes buses, motorcycles, and trucks. This achievement is part of UBC's ongoing efforts to promote more sustainable transportation and reduce the reliance on private vehicles (University of British Columbia, 2023). Attached below is a table from the report highlighting reduction SOV trends.

***Table 2:*** *SOV Data Table (University of British Columbia, 2023)*

| Average Weekday SOV Trips | Fall 1997 | Fall 2022 | Fall 2023 | Change 1997-2023 (count/percentage) | |
|---|---|---|---|---|---|
| Person Trips | 46,000 | 54,500 | 53,200 | +7,200 | +16% |
| Trips Per Person | 1.09 | 0.87 | 0.83 | -0.26 | -24% |
| SOV Mode Share | 43% | 40% | 37% | -7% | -15% |

Additionally, data from Metro Vancouver for population changes and projections for 2030, 2040, and 2050 allowed calculation of an annual growth rate of **3.11%** for the combined areas of Electoral Area A (UEL) and Electoral Area A (UBC). This further enabled computation of a population growth factor of **2.15**, which was then used to scale the pedestrian count for future demand. Figure 7 below highlights the population trends obtained from Metro Vancouver's population projections.

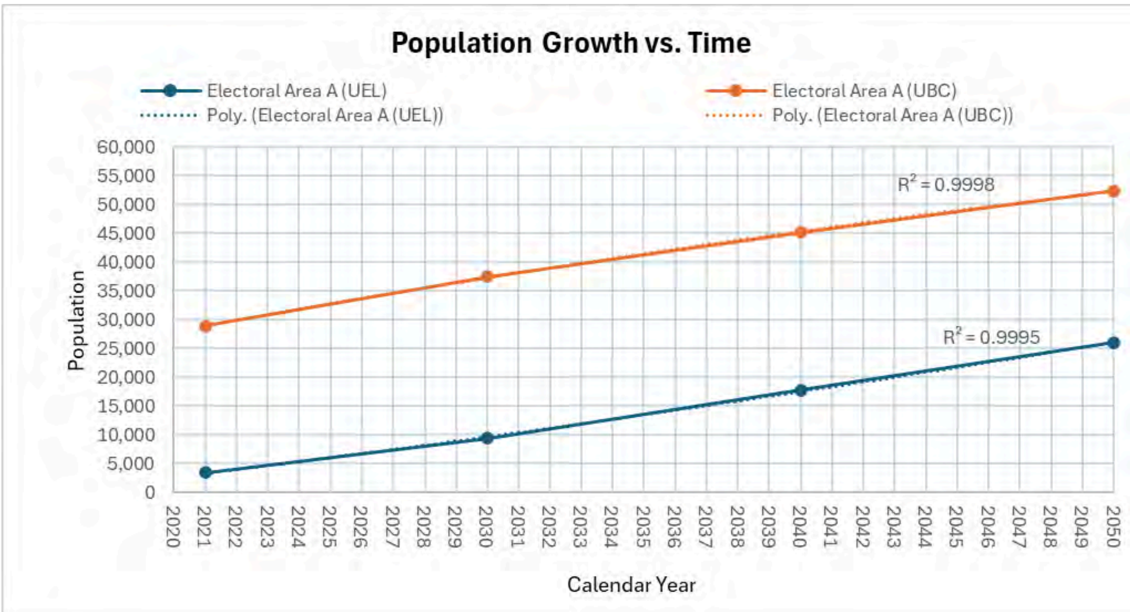


***Figure 7:*** *Population Growth Trends for Electoral Areas of UEL and UBC*

**Recent Volume Counts**

To ensure the projections accurately reflect current conditions, vehicle and pedestrian counts were conducted at the subject intersection. These recent observations act as a baseline for traffic volumes, accounting for any changes in travel behavior or infrastructure that may not yet appear in historical data. The data was collected on November 19th from 8:45 am to 9:45 am (Table 3). It is important to note that it was a colder than usual day with low temperatures at the time of data collection.

***Table 3:*** *Traffic Volume Data*

| From | Going Straight | | Taking a Left Turn | | Taking a Right Turn | |
|---|---|---|---|---|---|---|
| | Current | Future | Current | Future | Current | Future |
| Eastbound NW Marine Dr. | 253 | 171 | 12 | 8 | 25 | 17 |
| East Mall | 2 | 1 | 19 | 13 | 50 | 34 |
| Chancellor Blvd | 450 | 305 | 57 | 39 | 7 | 5 |
| Northbound NW Marine Dr. | 4 | 3 | 12 | 8 | 33 | 22 |

***Table 4:*** *Pedestrian Traffic Data*

| Pedestrians | Eastbound NW | Northbound | Chancellor | East Mall |
|---|---|---|---|---|

| Encountered | Marine Dr | NW Marine Dr | Blvd | |
|---|---|---|---|---|
| Current | 34 | 15 | 12 | 6 |
| Future | 73 | 32 | 26 | 13 |

**Other Key Considerations**

The design process incorporated several key considerations, including anticipated changes in public transit usage, projected growth in the student population, and trends in single-occupancy vehicle (SOV) versus high-occupancy vehicle (HOV) travel. Comprehensive datasets obtained from the Metro Vancouver Regional Planning Report (June 2024) and the UBC Sustainability Portal enabled detailed data analysis and the development of growth factor calculations.

Figure 8 summarizes the critical metrics used to inform design decisions. These metrics provided insight into evolving travel behaviours and patterns, as well as the influence of population growth on transportation mode distribution within the UBC/UEL region.

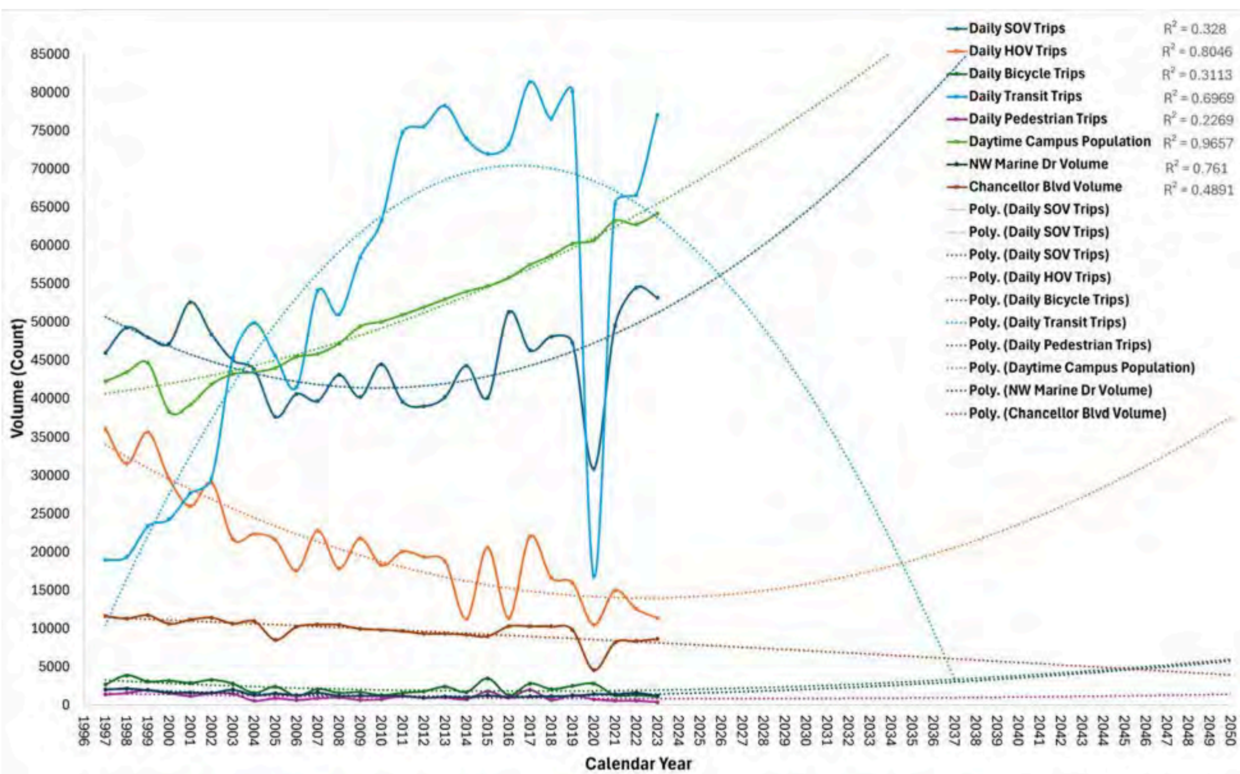


***Figure 8:*** *Overall Comparison of Important Metrics vs. Time*

For the design year 2050, projections indicate that the UBC and UEL area will experience rapid population growth, with a projected increase factor of 2.149, while the daytime campus population is expected to grow by 1.495, reflecting the need for enhanced transit access. Transit usage is forecast to increase by 3.854, suggesting a robust recovery following the COVID-19 pandemic, whereas single-occupancy vehicle trips are anticipated to rise by 1.150, outpacing high-occupancy vehicle trips, which are projected to grow by 0.330 and indicate a continued reliance on private vehicles. Additionally, vehicle volumes at the intersection are expected to increase by 0.677, while growth in active transportation modes, such as bicycle and pedestrian travel, is projected at 0.422 and 0.299, respectively, highlighting a need for strategic planning. Detailed calculations for the same can be found in Appendix K.

**Growth Trend Extrapolation**

Using the historical data and growth rate derived from it, future traffic volumes are projected using the following formula:

$$\text{Future Volume} = \text{Current Volume} \times (1 + \text{Annual Growth Rate})^{\text{Years to Design Year}}$$

$$\text{Future Volume} = \text{Current Volume} \times \text{Growth Factor}$$

This approach accommodates both linear and non-linear growth patterns observed in the historical data.

**Integration with Synchro Modeling**

The projected traffic volumes serve as input for a Synchro traffic model to analyze and optimize the intersection's operation. The Synchro model will assess parameters such as level of service (LOS), delay, and queue lengths for the design year, ensuring the proposed intersection design can accommodate future traffic demands effectively.

**Validation of Assumptions**

To validate the projected population growth factor, real-world growth trends within the UBC area were examined. Between 2007 and 2023, Wesbrook Place, UBC's largest residential neighbourhood, grew from zero to over 9,100 residents (Knowles, 2024), reflecting a rapid population increase. This growth closely aligns with the projected 2.15 growth factor for the UBC/UEL area by 2050, supporting the validity of the study's assumptions, especially given the consistent land use patterns and transit-oriented strategies in both timeframes. These comparisons suggest that the selected growth factors align with real-world regional trends under similar planning conditions.

Key assumptions, such as the annual growth rate, land use changes, and the relevance of historical trends, were critically examined to ensure reliability. Furthermore, alignment with regional growth policies, including UBC's sustainability initiatives and Metro Vancouver's transportation strategy, adds further validation. This approach combines empirical data and predictive modeling to create an intersection design that meets future traffic demands while supporting regional transportation and sustainability goals.

### 6.1 Synchro 6 Modelling

For the computational analysis of the redesign, Synchro 6 software was used. This comprehensive traffic analysis tool is employed for designing, modeling, optimizing, and simulating traffic signal systems at intersections. It was utilized to enhance traffic flow, reduce delays, and optimize signal timings for pedestrian-actuated traffic signals.

The analysis adhered to the City of Vancouver's Guidelines for Synchro usage. First, the factored vehicle count data and all road geometries were input into the software. Minimum signal timing values were set in accordance with the City's standards (see Appendix J). Specifically, the Amber Clearance Interval (yellow time) was set to 3.5 seconds, and the All-Red Clearance Interval was set to 2.5 seconds. For the pedestrian clearance interval, the Flash Don't Walk (FDW) time from Chancellor Blvd was used, as its curb-to-curb distance was significantly greater than Eastbound NW Marine Dr.

$$FDW = \frac{33m}{1\,m/s} - 3.5\,sec - 2.5\text{ sec} = 27\text{ sec}$$

The value was rounded to 30 seconds to enhance safety and accommodate pedestrians who may begin walking while the Flash Don't Walk (FDW) signal is active. For the initial walk time, the recommended 7 seconds was increased to 15 seconds. This adjustment was made in anticipation of higher pedestrian traffic in the area once the project is completed.

For the analysis, a 60-minute time period was considered. After multiple iterations, the optimal minimum green time for vehicles was determined to be 56 seconds (see Table 5 for full phase timing). This resulted in a LOS of B for both Eastbound NW Marine Dr. and Chancellor Blvd., while East Mall had a LOS of A. For more information, see Table 6, and for the full Synchro report, refer to Appendix E.

***Table 5:*** Phase Timing

| Phasing Window | 1-Ped | 4-NESW |
|---|---|---|
| Minimum Initial (s) | 45 | 56 |
| Minimum Split (s) | 51 | 62 |
| Maximum Split (s) | 51 | 300 |
| Yellow Time (s) | 3.5 | 3.5 |
| All-Red Time (s) | 2.5 | 2.5 |
| Lead/Lag | — | — |
| Allow Lead/Lag Optimize? | — | — |

| | | |
|---|---|---|
| Vehicle Extension (s) | 8 | 8 |
| Minimum Gap (s) | 8 | 8 |
| Time Before Reduce (s) | 0 | 0 |
| Time To Reduce (s) | 0 | 0 |
| Recall Mode | Ped | Min |
| Pedestrian Phase | Yes | No |
| Walk Time (s) | 15 | — |
| Flash Don't Walk (s) | 30 | — |
| Pedestrian Calls (#/hr) | 10 | — |

***Table 6:*** Synchro Results

| Route | East Mall | Eastbound NW Marine Dr. | Chancellor Blvd. |
|---|---|---|---|
| Level of Service | A | B | B |
| Delay/Veh (s) | 0.8 | 12.6 | 14.4 |
| Avg. Queue (m) | 0.2 | 22.2 | 35.7 |
| Avg. Speed (kph) | 30 | 17 | 14 |

### 6.2 Traffic Signage and Marking

The intersection features a comprehensive arrangement of traffic signs and road markings designed to enhance safety and clarify movement for various modes of transportation, including vehicles, cyclists, and pedestrians (see Drawings C-15, C-16 and C-17 for more details). There are multiple “No Left Turn” signs at key points on the intersection. Also, there are numerous “No Entry Expect Bicycle” signs along the protected bike lane. These signs help control the flow of traffic, reducing potential conflict points and managing turning movements that could otherwise disrupt the efficiency of the intersection. A "No U-Turn" sign has been installed on Westbound NW Marine Dr to address the turning restrictions on Chancellor Blvd. Drivers who use Chancellor to get to East Mall may be tempted to make a U-turn at the end of the medium barrier. This sign helps discourage such dangerous behavior, which could create conflicts with other road users and compromise safety at the intersection. A stop sign is located at East Mall, ensuring that drivers yield before turning right. Additionally, bicycle routes are clearly marked with green lanes and signage to delineate bike paths and direct cyclists safely through the area. The “Bike Route” and “Bike Lane Ends” signage communicates transitions in cycling infrastructure, alerting cyclists and motorists alike to upcoming changes. At the Spanish Banks roundabout, there are many “No Parking” signs to communicate to drivers that this location is no longer a parking lot. There is also a roundabout and left and right turn signs to show drivers where to go. This helps manage the flow of traffic and prevents drivers from going the wrong way. Together, these signs and markings create a safer, more efficient flow of traffic while minimizing the risk of confusion or collision.

# 7.0 Earthworks and Site Preparation

This section discusses the specifications for site preparation and earthworks needed for the site. It also reviews the findings obtained from the Hydrogeological & Geotechnical Assessment by Piteau Associates.

## 7.1 Hydrogeological & Geotechnical Background

The geotechnical assessment conducted for the Point Grey Cliffs north of Marine Dr. at the University of British Columbia provides a comprehensive analysis of the geological and hydrogeological conditions that must be carefully considered in the context of redesigning the proximal intersection at East Mall and Chancellor Blvd. This area is underlain by a stratigraphic sequence of unconsolidated Quaternary deposits, prominently featuring the Quadra Sand unit, which functions as the principal aquifer system. The Quadra Sand unit is stratified into two subunits. Q1 is the upper layer, comprising well-sorted, medium to coarse sands with high permeability, while Q2 is the lower layer, interbedded with fine sands and silts, serving as an aquitard. Atop portions of this sand sequence are a glacial till unit. It is an impermeable layer that varies in thickness across the site, reaching up to 29 m in some areas but is not present elsewhere. The variable presence of this till significantly influences groundwater infiltration and flow patterns, creating concentrated perched water zones where the layer thickness diminishes or is non-existent.

The stratigraphy of these geologic units in this area controls the local groundwater dynamics. Precipitation infiltrates through the surface and perches above the low permeability till layer, where it flows laterally, permeates the underlying Quadra Sand unit, or discharges at the cliff face. The Q1 unit acts as the upper aquifer, with discharge points identified at the contact between Q1 and Q2 along the cliffs. The Q2 unit acts as a barrier and limits vertical flow, but water penetrates through it into the lower aquifer intermittently. This aquifer system is a critical consideration for infrastructure planning, as unmitigated seepage from the upper aquifer has been associated with slope instability. The provided hydrogeological and geotechnical assessment indicates that the groundwater table in the upper aquifer has remained stable for 25 years. This suggests that previous infrastructure developments, including the MoA, have not affected regional hydrogeological conditions of any great magnitude.

The stability of the Point Grey cliffs proximal to the intersection is of paramount importance. Slope instability is observed at the contact between Q1 and Q2, where the seepage of groundwater intensifies erosion and slope failures. Field studies convey dispersed seepage patterns and no significant presence of piping. Transient conditions, such as freezing and thawing cycles, however, could generate elevated pore water pressures that further destabilize the slope. From stability analyses presented in the geotechnical report, a setback line of 35 degrees from the toe of the cliff will aim to account for the impacts of static and seismic forces on the slope. The seismic analyses show that horizontal displacements that occur during earthquake activity are minimal when they are 25 m or more from the crest of the slope. This revelation highlights the significance of maintaining a conservative setback when carrying out new infrastructure projects.

Inferred from the pre-existing hydrogeological and geotechnical assessment, this locale requires thoughtful and meticulous engineering approaches for the successful redesign of the intersection at East Mall and Chancellor Blvd. Effective drainage management is obligatory to mitigate the risks associated with groundwater flow and surface water infiltration. The provided assessment calls attention to the reliability of current seepage control methods that work to reduce the discharge of groundwater to the face of the cliff. Geologic mapping to characterize the till and Quadra sand units are imperative to prevent destabilization of the aquifer system. Ensuring the appropriate setback is maintained and employing robust drainage or water collection measures will satisfy concerns regarding stability and safety long-term. Such considerations parallel best practices for sustainable infrastructure development.

### 7.2 Site Grading and Preparation Specifications

Site grading shall involve the preparation of subgrade through stripping, rough grading, filling, and compaction to support the placement of growing medium (topsoil) in landscaped areas. This work excludes grading intended for paved or concrete surfaces. All grading activities shall conform to the British Columbia Landscape Standard and will be executed under the supervision of the Contract Administrator. Site examination is required prior to commencement, and grading shall follow the profiles and elevations indicated in the contract drawings. Subgrade must be compacted to a minimum of 80% Modified Proctor Density (ASTM D1557), and unsuitable or unstable material shall be removed and replaced with approved fill. Scarified areas showing excessive compaction must be reconditioned prior to topsoil placement.

All organic material shall be stripped to specified depths and stockpiled for reuse where applicable. Fill materials must be non-toxic and suitable for supporting vegetation, and placement shall occur in 200 mm lifts with proper compaction. Debris, contaminated subsoil, and materials that may hinder plant growth must be removed and disposed of at approved off-site locations. Proper drainage and erosion control measures are required during grading to prevent impacts on adjacent areas and natural watercourses. Measurement and payment for grading, stripping, disposal, and fill will be based on truck box volumes and approved weight tickets as verified by the Contract Administrator.

### 7.3 Excavating and Fill Specifications

Excavation, trenching, and backfilling shall be performed to accommodate underground utilities such as water, sewer, storm, and communication services. Work includes clearing, trench excavation, over-excavation (if required), stockpiling of topsoil and fill materials, and appropriate disposal of unsuitable material. All trenching must comply with safety standards (WorkSafe BC), maintain controlled trench lengths, and follow specified alignment and elevations. Backfill is to be placed in layers and compacted to minimum Modified Proctor Density standards: 95% for roads and driveways, and 90% for boulevards and easements, as outlined in ASTM D1557. Granular or approved native backfill shall be used as appropriate for roadways, boulevards, and ditches. Over-excavation and removals must be approved by the Contract Administrator, and all open trenches must be protected with barricades or fencing.

Controlled Density Fill (CDF) shall be used where specified for trench backfilling beneath paved or landscaped surfaces. CDF shall be designed and supplied by the contractor, in accordance with CSA-A23.1 and CSA-A266.2 standards, and be approved by a Professional Engineer. It shall be placed without segregation in layers up to 300 mm, and no compaction is required. The material shall achieve a compressive strength of 0.5 to 1.0 MPa after 28 days, allowing future excavation if necessary. Placement requires minimum notice and approval, with proper formwork where needed to maintain shape. CDF must be protected from water, and no load may be applied until approved. Payment for CDF is based on volume within limits shown on the drawings, with unauthorized over-excavation or remedial work not compensated.

### 7.4 Surface Restoration

All disturbed surfaces shall be restored to a condition equal to or better than that which existed prior to construction. Restoration activities shall include repairing damage to adjacent properties, resolving landowner claims, and completing all surface work immediately following trench backfilling. For boulevards and easements, this includes restoring topsoil to a minimum depth of 100 mm and using materials that match the original condition—such as bark mulch for gardens or sod for lawns. Gravel surfaces and unimproved areas must be reinstated with matching granular or native materials.

For roads, driveways, ditches, and paved surfaces, surface restoration includes re-shaping, proper base preparation, and achieving a minimum 95% Modified Proctor density for compaction. Temporary patches using hot-mix asphalt must be installed within 24 hours of closing trenches and maintained in safe condition. Permanent pavement restoration must occur within 30 days, including the removal of failed patches or base layers and placement of new pavement to specified depths and profiles per standard detail drawings. Pavement overlays, surface finishing, and matching to adjacent grades shall also be carried out, and all restored pavements must be maintained in good repair during the warranty or maintenance period.

# 8.0 Pavement Design

## 8.1 Road Structure Pavement

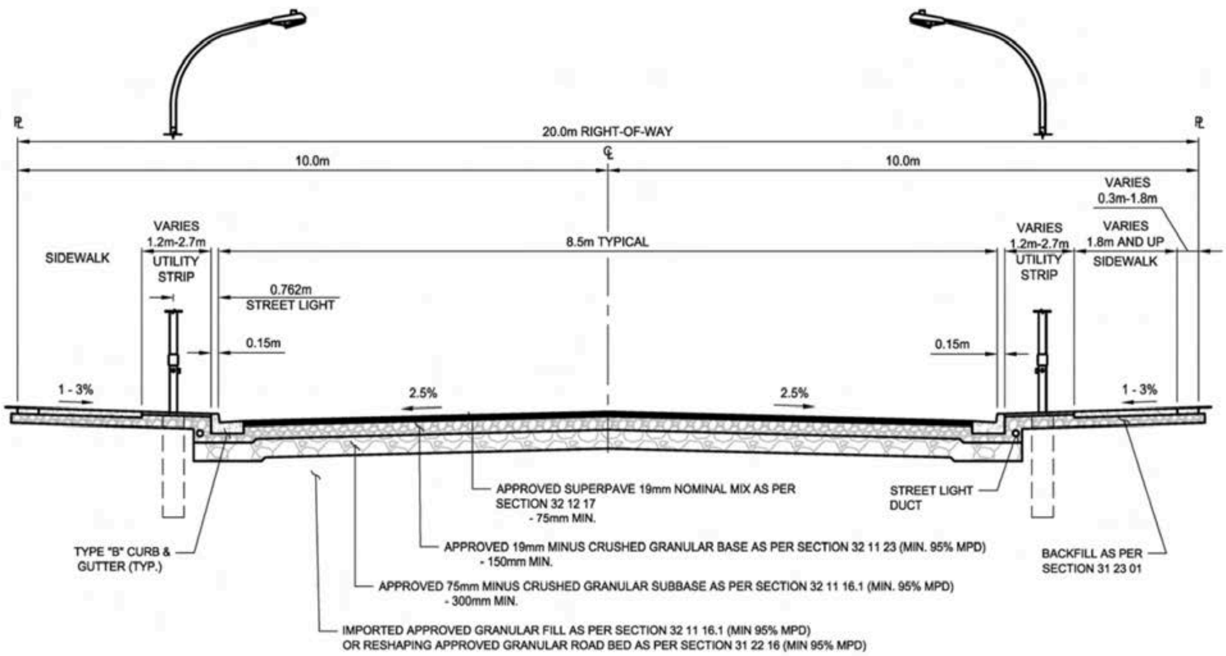


***Figure 9:*** *Standard Road Cross Section for Residential Streets from City of Vancouver*

A typical road cross section for a residential street, referenced from the City of Vancouver's standard detail drawings for roadworks, was used for the proposed paved roads. The cross section will consist of a subgrade with imported approved granular fill, a 300 mm thick subbase layer of 75 mm minus crushed granular subbase, a 150 mm thick granular base of 19 mm minus crushed granular base, and a 75 mm thick approved superpave of 19 mm asphalt nominal mix on top. The proposed roads will be crowned at the center and slope at 2% on both sides for drainage purposes.

### *8.1.1 Granular Subbase*

Granular subbase materials shall be supplied, placed, and compacted in accordance with project specifications to provide a stable foundation for roadways and paved areas. Acceptable materials include select granular subbase, pit run gravel, crushed gravel, river sand, recycled concrete, and other approved aggregates. Subbase shall be spread on clean, frost-free surfaces, beginning from the crown or high side of the road, and placed in uniform layers not exceeding 300 mm thick. Each layer must be compacted to a minimum of 95% Modified Proctor Density, shaped to smooth contours, and meet specified tolerances of ±15 mm from design grade. Granular materials must not segregate during handling or placement, and unsuitable materials identified during placement shall be removed and replaced.

Before placement, the subgrade must be inspected and approved by the Contract Administrator to ensure it is properly compacted and graded. Proof rolling using fully loaded dump trucks or other approved equipment is required to verify subgrade stability. Where unsuitable conditions are detected, the material shall be excavated and replaced with suitable fill at no additional cost. Final finished surfaces must be free of irregularities exceeding 15 mm, and any defects corrected to meet tolerance requirements. Measurement for payment will be based on actual volume placed and approved by weight tickets, with a standard thickness of 300 mm unless otherwise specified.

### *8.1.2 Granular Base*

Granular base construction involves the supply, placement, and compaction of approved base materials, typically 19 mm crushed gravel, to specified depths and tolerances. The underlying sub base must be inspected and approved by the Contract Administrator prior to placement. Base materials must be spread on clean, unfrozen surfaces and placed in uniform layers not exceeding 150 mm in compacted thickness. Each layer must be shaped to proper contour and compacted to at least 95% Modified Proctor Density (ASTM D1557). Compaction equipment must be suitable for achieving specified densities, and water may be applied to aid compaction if necessary. Irregularities must be corrected before proceeding with additional layers.

Proof rolling is required to confirm the integrity of the base and subgrade. A fully loaded dump truck or other approved equipment must be used to apply three passes of loaded tire pressure across all areas. If unsuitable conditions are revealed, the base and underlying layers must be removed and replaced as directed, with new materials compacted per specification at no additional cost. Finished surfaces must meet a tolerance of ±10 mm from design elevation, with no high points or depressions exceeding 10 mm over a 3 m span. The base shall be maintained in good condition until accepted or until the next construction layer is placed.

### *8.1.3 Superpave Asphalt Paving*

Superpave paving shall follow the specifications for material selection, mix design, placement, and compaction to ensure long-lasting, high-performance pavement. The asphalt mix design must conform to AASHTO standards (including M320, M323, R35) and be submitted for approval prior to paving. Asphalt mixes shall be designed according to job-mix formulas (JMF) for specific aggregate gradation, asphalt binder content, and performance properties. Paving materials must meet mix tolerances for asphalt content (±0.3%) and temperature (±5°C), and must be placed using mechanical pavers, rollers, and haul trucks suited to maintain continuous, uniform operation. Field thickness and segregation shall be verified via cores and visual inspection, with corrective actions applied as needed to meet density and texture specifications. Payment will be based on actual asphalt quantity delivered and in-place thickness, subject to approval by the Contract Administrator.

Asphalt production, transport, and placement must ensure temperature control, uniform mixing, and proper handling to prevent segregation and moisture retention. Hot mix shall be stored no longer than 12 hours and placed at the required thickness using approved rolling patterns to achieve compaction. Equipment must include rollers capable of achieving the specified density and haul trucks with insulated boxes for cold weather paving. Paving over existing surfaces requires prior cleaning and removal of defects, and the base must be prepared in accordance with approved grading and compaction requirements. A Quality Control Plan (QCP) covering materials, testing, and process control shall be submitted and implemented to ensure compliance throughout the asphalt paving process.

### 8.2 Concrete Sidewalks Pavement

The details for the concrete sidewalk pavement design can be found in Appendix C, referencing the standard MMCD details. The cross section will include a granular subbase, a granular subgrade, and a granular base, all compacted to 95% modified proctor density. A barrier curb will be installed along with the sidewalks. The proposed sidewalks will have a width of 1.5 m, sloping at 2% towards the barrier curb to assist with drainage.

## 9.0 Welcome Gateway

### 9.1 Structural Design & Calculations

This intersection will include an 8 m tall UBC gateway sign. PUC designed the sign as a concrete moderately ductile shear wall complying to CSA A23.3 standards. It will be 4 m wide and 0.6 m thick which will impose an area load of 188 kPa. The total factored dead load was calculated to be 632 kN. Given the site is close to Spanish Banks Beach, PUC determined the wind load using the static procedure from BCBC 4.1.7.3 which calculated to be 0.6 kPa. The lateral earthquake load was the governing load case using 632 kN as the weight BCBC 4.1.8.11. The summarized calculations are referenced in Appendix G.

To increase the sign's lateral resistance, longitudinal bars are added to the shear wall design. To determine the reinforcements, the minimum reinforcement areas at the concentrated and distributed zones of the shear walls were calculated to be 1800 $mm^2$ and 6000 $mm^2$. Using these values as starting points, different reinforcing steel configurations were iterated to ensure the most efficient lateral resistance. The shear wall will consist of 8-20M bars in each concentrated zone and 30-15M bars in the distributed zones. To maintain the longitudinal bars, 10M column ties will be spaced at 240 mm along the height of the wall. The reinforcements will also need a concrete cover of 40 mm. Final drawing of the gateway structure is in Appendix C-21.

### 9.2 Footing Design & Calculations

To effectively support the dead load determined from structural analysis while accounting for the bearing capacity of the underlying soil, various shallow foundation solutions were evaluated. Utilizing Meyerhof's bearing capacity equations, calculations were conducted to ascertain the requisite dimensions for both pad and strip footing designs, the detailed results of which are presented in Appendix H. Given the structural configuration of the gateway and its function as a shear wall, PUC determined that a strip footing would provide the most suitable shallow foundation system. The decision to adopt a shallow foundation was based on the fact that the imposed loads resulted in feasible footing dimensions, rendering deep foundation alternatives, such as driven piles, unwarranted. The analysis indicated that shallow foundations would achieve satisfactory factors of safety, thereby justifying their selection.

For the strip footing design, Meyerhof's bearing capacity equations and associated bearing capacity factors were employed to determine the minimum required footing width. The calculations established that a minimum width of 0.25 m would be adequate for a 5 m long strip footing. However, to accommodate the 0.6 m width of the shear wall, a footing width of 1.0 m was ultimately selected. The proposed strip footing, with dimensions of 5.0 m in length and 1.0 m in width, was found to provide an ultimate bearing capacity of 2,071.77 kPa at an embedment depth of 1.0 m. Given an allowable bearing capacity of 126.40 kPa, the resulting factor of safety for this design was calculated to be 16.4. This design approach not only ensures adequate support for vertical loads but also mitigates the potential risk of overturning failure due to external forces such as vehicular impact, seismic activity, and wind loads.

In accordance with the ACI 318 Building Code provisions for footings, a minimum thickness of 0.15 m is recommended for reinforced concrete footings bearing directly on soil. Further structural calculations determined that a footing thickness of 0.24 m was necessary to meet design requirements. Additionally, in compliance with ACI 318 specifications, the minimum concrete cover for reinforced concrete cast against and in direct contact with the ground is 0.075 m. Consequently, the total required thickness of the concrete footing, accounting for the additional depth from concrete cover and reinforcement, was determined to be 0.34 m. This configuration results in a total concrete volume of 1.7 $m^3$.

To ensure structural adequacy against flexural and shear forces, reinforcement was designed in accordance with ACI 318 and industry best practices. The strip footing is reinforced with 4-20M longitudinal reinforcement which is uniformly distributed along the length of the footing to ensure even stress distribution and to prevent cracking due to tensile stresses. The effective depth of the reinforcement was determined to be 240 mm, taking into account the required concrete cover and bar diameter.

Given the shear demand imposed by the structural loads, shear reinforcement was introduced to enhance the footing's resistance to one-way shear failure. The applied factored shear force at the critical section was calculated to be 884.8 kN, which exceeds the concrete's shear capacity of 223.4 kN, necessitating the inclusion of stirrups. Shear reinforcement consists of 4-10M closed-loop stirrups, spaced at 100 mm intervals along the depth of the footing. Each stirrup placement comprises a closed-loop configuration, ensuring comprehensive shear resistance on both sides of the footing. The stirrup spacing was determined based on the required shear resistance, ensuring that the applied shear forces do not exceed the design capacity of the reinforced concrete section.

This reinforcement configuration effectively mitigates bending and shear-induced failures while maintaining compliance with structural design standards. The incorporation of shear stirrups enhances the structural integrity of the footing, preventing brittle failure modes and ensuring long-term durability under sustained and transient loading conditions. The final reinforcement design, as detailed in the accompanying structural drawings, optimally balances strength, serviceability, and constructability, thereby ensuring the stability of the foundation system.

### 9.3 Aesthetics & Visibility

To mark the entrance of the campus for drivers, the gateway sign will be on the south of the intersection next to East Mall and will face north-east. The sign will revive the old traditional shield of UBC with "UNIVERSITY OF BRITISH COLUMBIA" on top and "TUUM EST" at the bottom, as shown in Appendix G. The shield and writings on the sign will be carved out of the concrete to achieve an institutional feel. There will be spotlights at the base to bring more visibility at night. The lights will also create shadows in the carvings for more depth and dimension. PUC aims to treat the concrete shear wall with an architectural finish to achieve a smoother, more aesthetic sign. The concrete is to be thoroughly vibrated in its formworks to prevent honeycombing for a uniform face finish.


***Figure 10:*** *Rendering of Gateway Sign*

## 10.0 Stormwater Management

One of the goals of this project was to capture and retain stormwater on the site for a 1 in 100-year storm event. One of the main reasons to retain the stormwater on site was to protect and prevent the erosion of the Point Grey Cliffs adjacent to the site. Two of the main methods were used to retain the stormwater on site. The first method will be a rainwater garden running from the proposed intersection along the protected bike lane on Northbound NW Marine Dr. till Newton Way. The second method will be an underground stormwater tank that will be located after the rain garden underneath the protected bike lane along Northbound NW Marine Dr.

## 10.1 Stormwater Management Plan (SWMP)

A stormwater management plan (SWMP) was conducted for this site to help size the underground stormwater tank. The SWMP was conducted using the rational method from the MMCD Design Guidelines 2019. Before conducting the rational method for this site, the storm network was designed for the proposed site.

### *10.1.1 Stormwater Network*

The stormwater network consists of 350 mm diameter gravity PVC storm mains, 200 mm diameter PVC storm service lines, typical top inlet catch basins, and 1050 mm diameter storm drainage manholes. The plan and profile of this storm network can be found in Appendix C - Drawing C-1.6. A minimum of 1 m cover was provided to the storm mains having a minimum slope of 0.5% to make sure the water flows down with gravity. A control manhole will be placed just before the underground stormwater tank. The stormwater mains will run underneath the newly paved Eastbound NW Marine Dr. and under the proposed protected bike lane on Northbound NW Marine Dr.

The excavation of the storm mains will be done in a typical utility trench according to standard MMCD details (Appendix C). The pipe will be surrounded with granular pipe bedding consisting of approved native backfill. The backfill for the pipes will consist of imported granular backfill compacted to 95% modified proctor density, as they are largely under roadways.

### *10.1.2 Storm Sewer Specifications*

Storm sewer installation shall follow standardized specifications, including trenching, bedding, pipe laying, and backfilling. Trenches shall be excavated to line and grade as shown on the contract drawings, and over-excavation shall be filled with compacted granular bedding. Bedding layers must not exceed 150 mm in thickness and shall be compacted to a minimum of 95% Modified Proctor Density (ASTM D1557). For this project, all storm sewer mains (350 mm PVC) and service connections (200 mm PVC) shall be installed on shaped, compacted bedding with full barrel contact and laid from outlet to inlet, with bell ends facing upgrade. Installation tolerances are ±50 mm horizontally and ±10 mm vertically. Pipe joints shall follow manufacturer guidelines for alignment, gasket placement, and joint integrity, ensuring they are clean and free from foreign materials. Connections to existing mains must be made using approved fittings, with coring and grouting procedures performed in accordance with specified tolerances.

The 300 mm perforated PVC storm sewer pipe shall be installed with perforations facing downward, adjacent to curbs or sidewalks as shown on the contract drawings. It shall connect to catch basins, include sweep bends and caps at upstream ends, and be laid to maintain proper gradient and drainage. Pipe surround shall be hand placed in 150 mm lifts and compacted to 95% Modified Proctor Density from springline to crown. Backfilling procedures shall comply with trenching and compaction specifications. Following installation, all pipes must be flushed, cleaned, and video-inspected (CCTV) for final approval. Acceptable ponding for the 350 mm PVC mainline shall not exceed 30 mm over a 5 m length. Any deficiencies or leaks shall be repaired immediately at the contractor's expense to meet performance standards prior to commissioning.

### *10.1.3 Rational Method*

To conduct the rational method, the site was divided up into 6 catchment areas, which can be seen in Appendix C. Each of the six areas were further divided into grasslands and paved sections. This was done as both types of areas have different runoff coefficients.The intensities for the calculations were obtained from IDF curves for a 1 in 100-year storm event, provided by Metro Vancouver. The formula below was used to calculate runoff flows, where Q is flow in cubic meters per second, R is the runoff coefficient, A is the drainage areas in hectares, I is the intensity in mm/hr, and N is a factor of 0.00278.

$$Q = RAIN$$

An infiltration time of eight minutes was selected from the MMCD Design Guidelines 2022, as the site is primarily a multi-family residential area. The runoff flows were then compared with the pipe capacity flows from the stormwater design, assuming the pipes would be full in order to compare the maximum capacities with the runoff flows. Detailed calculations for the Stormwater Management Plan (SWMP) are provided in Appendix F. The calculated flow entering the underground stormwater tank was 0.43 $m^3/s$, while ensuring that none of the storm mains approached their maximum capacity.

### *10.1.4 ACO Stormwater Tank and Sizing*

The flow calculated above was used to determine the required tank size. A storage period of 1 hour was assumed to be reasonable for a 1 in 100-year storm event. With a flow rate of 0.43 $m^3/s$, the required storage volume was calculated to be 1,550 $m^3$. Due to space limitations, the tank will be restricted to a width of 9 m, and its depth is limited to 2.7 m (9 ft) based on the specifications from the tank provider (ACO). This results in a tank length of 64 m. The tank will be located after the rainwater garden and tied into the respective utilities nearby. Additionally, the water collected in the tank will be allowed to seep through the surrounding soil.

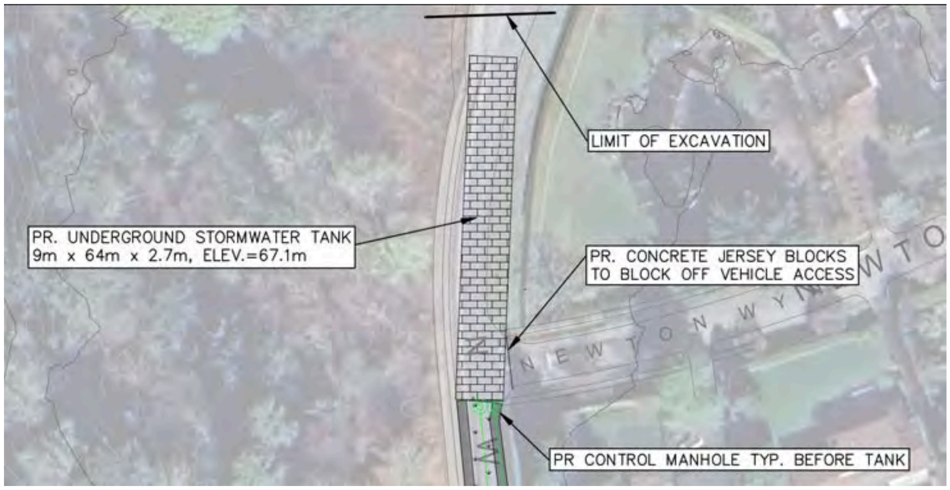


***Figure 11:*** *Orientation and Plan of Stormwater Tank*

The tank will be oriented in a way where it will lie completely below the proposed bike lanes, not requiring any disturbance or excavation beyond the limit stated above. This would ensure the protection of the adjacent Point Grey Cliffs from further damage or erosion. As shown in Figure 12, the tank will have a cover of 1 m from the ground surface, consisting of 95% compacted imported granular backfill. A 150 mm (6 in) base layer consisting of 20 mm size gravel similar to the material used for the pipe bedding.

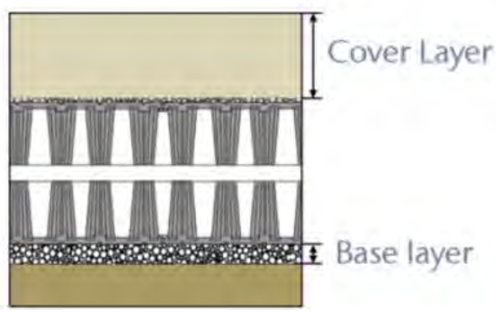


***Figure 12:*** *Cross Section of Stormwater Tank Excavation*

ACO Stormbrixx underground stormwater tanks were chosen for this design due to their tanks being durable and long lasting, increased structural strength and stability, easy to access and maintain, and they are eligible for LEED certified projects.

### 10.2 Rainwater Garden

The proposed rain garden will run from the proposed intersection along Northbound NW Marine Dr. in between the two protected bike lanes. The rain garden will run until Newton Drive before the start of the underground stormwater tank. A metal grate walkway will be placed at the start of the rain garden, as seen in Figure 13 below, to allow rainwater to easily drain into the rainwater garden while at the same time acting as a pedestrian crosswalk.

The proposed rain garden will act in conjunction with the proposed stormwater network, helping to capture and retain the rainwater on site. The soil profile for the site is also very favourable for a rainwater garden. From 0 to 3 m, the soil layer consists of fine to coarse sand with minimal silt and gravel, which is good for drainage. From 3-10 m, the soil layer consists of interbedded silt with fine sand and minor peat. During excavation, the peat can be removed, as it is not an ideal soil type to have for a rain garden. Silt is good for water retention and can be used to hold extra rainwater that seeps in. Landscaping services, bringing in bioretention soils, and hydroseeding will be done for the rainwater garden.

Vegetated swales will also be used to help with drainage of water on the surface of the rainwater garden. A typical section of the swales can be seen in Figure 13 below. The raingarden will also have a 300 mm diameter perforated gravity storm main that runs beneath the rainwater garden, eventually tying into the underground stormwater tank at the end. A drainage manhole will be placed at the end of the rainwater garden to capture any surface rainwater, essentially storing it in the underground stormwater tank.

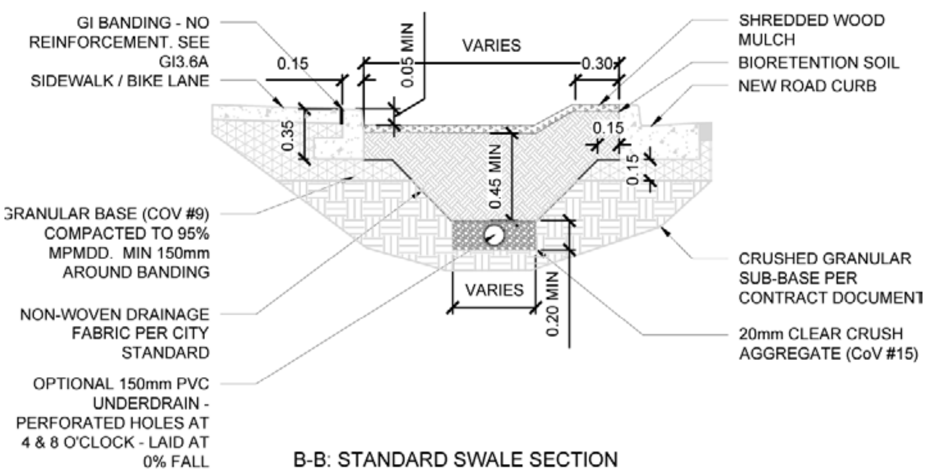


***Figure 13:*** *Standard Swale Section from City of Vancouver Green Infrastructure Details*

## 11.0 Construction

The construction plan for the intersection redesign at Chancellor Blvd. and NW Marine Dr. is structured into five main phases to ensure safety, minimize disruption, and maintain traffic flow wherever possible. This section provides an overview of the Traffic Management Plan (TMP) and outlines the construction phasing strategy used to execute the project efficiently.

### 11.1 Traffic Management Plan

This TMP outlines the traffic control measures for the intersection redesign at Chancellor Blvd and NW Marine Dr. The construction sequence prioritizes the median construction and traffic light installation to minimize prolonged traffic disruptions. A 300 m section of NW Marine Dr. will be closed with clear signage and barriers in place to guide motorists. Once completed, both lanes will reopen to all traffic.

During the median and traffic light construction, East Mall will remain open with minimal restrictions. However, during Phase 2, East Mall will be fully closed, as this phase aligns with the end of the second semester of the school year (April) when student activity is lower. This closure will allow machinery to navigate freely.

To ensure safety and minimize disruptions, a Traffic Control Person (TCP) will be present at all times to help manage traffic flow, specifically pedestrian and cyclist crossing, and construction equipment. . Portable traffic signal will be installed at the end of the lane shift. Temporary traffic signals and warning signs will be installed at key points to alert drivers to the changes. Emergency access will be maintained throughout the construction period, and public notifications will be issued in advance to inform local residents and businesses of expected impacts.

***Road Closure.*** Maintain one lane open at all times to ensure continuous traffic flow throughout the construction period.

- Temporary NW Marine Dr. Closure and Chancellor Blvd.
  a. Phase 1 - Left Lane Closure (West side)
     - A 300-meter left lane closure on Chancellor Blvd (west side) will be implemented.
     - Vehicles traveling on Chancellor Blvd will use the designated crossover lane to merge into the right lane to bypass the work zone and then transition back into their original lane once past the construction area (See Appendix D1)
     - Crossover lanes will divert traffic into the opposite lane of the work zone, maintaining a steady traffic flow.
     - During this phase, the crossover will also accommodate public vehicles traveling from Chancellor Blvd to eastbound NW Marine Dr., allowing them to safely navigate around the closed left lane of NW Marine Dr. (west side).
  b. Phase 2 - Right Lane Closure (East side)
     - Right lane of Chancellor Blvd (east side) will be closed while the left lane remains open
     - Vehicles traveling in the right lane will use the designated crossover before the median to merge into the left lane and continue through the work zone (See Appendix D2)
- Full Closure of East Mall
     - During Phase 1, East Mall will remain accessible to traffic with limitations, allowing vehicles traveling from NW Marine Dr. to East Mall to turn right. Vehicles coming from Chancellor Blvd. will not be able to turn left to East mall nor can turn right on Northbound of NW Marine Dr. However, vehicles on East Mall will only be able to turn right onto Chancellor Blvd and will not be able to turn left onto NW Marine Dr or continue straight to Northbound of NW Marine Dr.
     - Once Phase 2 begins, East Mall will be fully closed to all traffic, taking advantage of the lower student activity at the end of the winter term to enable machinery to move safely and freely.

- Install advanced detour signage at key locations leading to alternative routes for vehicles entering/exiting East Mall.

- Full Closure of Northbound NW Marine Dr.
  - Northbound NW Marine Dr. will be close to traffic once Phase 1 begins.
  - Install advanced detour signage at key locations leading to alternative routes for vehicles entering/exiting Northbound of NW Marine Dr.

***General Safety Measures.*** Set up the necessary warning and directional signage and redirect pedestrians and cyclists.

- Warning and Directional Signage
  - Install detour signs to direct vehicles to the ramp and alternate routes, ensuring that all vehicles are aware of the available detour
  - All crossover areas and temporary lane shifts will be clearly marked with reflective barriers and warning signs, such as "Temporary Lane Change Ahead", “Slow Down”, "Construction Zone Ahead", Speed Limit
- Pedestrian/Cyclist
  - Redirect pedestrian and cyclist flow using temporary barricades and signage to pathways away from the construction zone
  - Provide temporary pedestrian crossings where necessary to ensure safe passage around the work area (see Appendix D3)
- Traffic Control Person (TCP)
  - Use flaggers at all times to manage the flow of public vehicles using the temporary ramp and to ensure smooth traffic movement through the work zone
  - Flaggers will assist with pedestrian, and cyclist crossing, and construction vehicles.
- Temporary Traffic Control Devices:
  - Place traffic cones, barricades, and reflective markers to clearly define the work zone, the temporary ramp, and lane closures
- Construction Equipment Placement
  - Store equipment and materials away from active traffic lanes on both NW Marine Dr. and Chancellor Blvd. to minimize obstruction to public vehicles
- Portable Traffic Signal
  - To ensure vehicle safety both day and night, a portable traffic signal will be installed at the end of the lane shift.

***Detours***

- Detours during construction
  - For vehicles coming from Chancellor Blvd turning right to Northbound of NW Marine Dr., vehicles can turn right onto Wesbrook Cres to access the Northbound of NW Marine Dr.
  - For vehicles coming from East Mall turning left to Eastbound of NW Marine Dr. or or going straight to Northbound of NW Marine Dr., vehicles can exit through Walter Gage Rd.

- Detours after construction
  - Vehicles coming from Chancellor Blvd and turning left onto East Mall can access via Walter Gage Rd.
  - Vehicles traveling from eastbound on NW Marine Dr. and turning left onto northbound NW Marine Dr. can turn left onto Wesbrook Cres.
  - Vehicles traveling from East Mall and turning left onto eastbound NW Marine Dr. or continuing straight onto northbound NW Marine Dr. can exit via Walter Gage Rd.
  - Vehicles traveling from northbound on NW Marine Dr. and accessing East Mall can reroute to Wesbrook Cres, then to Wesbrook Mall, and finally to Walter Gage Rd.
  - Vehicles traveling from eastbound on NW Marine Dr. can reroute to Wesbrook Cres and turn left onto Chancellor Blvd.
- Detours for Nearby Attractions
  - Tower Beach and Spanish Banks will remain open and will not be affected during construction.
  - Visitors to the Law Building will need to use Walter Gage Road to access East Mall.

## 11.2 Construction Phasing

The construction phasing plan outlines a systematic and sequential approach to executing the project efficiently while minimizing disruptions to traffic and the local community. To reduce prolonged traffic disturbances, the plan prioritizes median construction and traffic light installation early in the process, ensuring smoother traffic flow once construction is complete.

By strategically overlapping activities, the plan prevents workflow disruptions and optimizes equipment deployment like excavation, structural pouring, and pavement construction occur simultaneously where possible.

The project is divided into 5 phases (see Appendix C-12 & C-13), each carefully scheduled to maintain safety, quality, and adherence to project timelines:

***Initial Set-up & Traffic Control (Week 1)***

- Traffic Control Setup
  - Install barriers, signage, and detour routes for the entire project
  - Set up temporary lanes and pedestrian pathways as necessary
  - Install portable traffic signals
  - Deploy flaggers at all times to manage traffic flow
- Barriers and Signage Installation
  - Position barriers along the construction zones, ensuring the safety of both pedestrians and vehicles
  - Install advanced warning signs to inform drivers of upcoming construction

***Phase 1: Median Construction and West Traffic Light Installation (Weeks 2-9)***

- Median Construction

  - Pavement Removal, Excavation, and Disposal
  - Manholes and Catch Basin Installation
  - 350 mm dia PVC Installation
  - Backfill and Compaction
  - Prepare the median subgrade and alignment
  - Begin formwork, concrete pouring, and curing
- Traffic Light Installation on West Side
  - Excavate and remove pavement for the installation of traffic lights, poles, and related electrical work
  - Install wiring for the traffic lights, pedestrian signals, and lighting systems
  - Begin installing the necessary foundations for traffic lights and pedestrian signal poles
  - Install traffic light poles and mounts, followed by the installation of signal heads, flashing beacons, and pedestrian push button activators
- Bike Lanes & Sidewalks Paving
  - Complete the paving of bike lanes, sidewalks, and any other paved surfaces within the construction zone

***Phase 2: Lane Realignment on East Mall, Gateway Structure, and East Traffic Light Installation (Weeks 6-7)***

During Phase 3, East Mall will be completely closed to all traffic. The lane realignment on East Mall to Chancellor Blvd will be implemented to create a smoother transition for vehicles turning right from East Mall. This realignment will also make space for essential new infrastructure, such as queue boxes, pedestrian pathways, and a dedicated bike lane.

By combining the lane realignment, gateway structure installation, and traffic light installation into a single phase, traffic disruption can be minimized. This approach is especially beneficial as these changes will all occur on the same side of the road, reducing the need for multiple construction phases and providing a more efficient solution for both vehicles and pedestrians.

- Lane Realignment
  - Surveying and marking the work zone
  - Removing existing aisle and preparing the roadway for realignment
  - Grading and resurfacing for the new alignment
- Traffic Light Installation on East Mall (East Side)
  - Excavate and remove pavement for the installation of traffic lights, poles, and related electrical work
  - Install wiring for the traffic lights, pedestrian signals, and lighting systems
  - Begin installing the necessary foundations for traffic lights and pedestrian signal poles
  - Install traffic light poles and mounts, followed by the installation of signal heads, flashing beacons, and pedestrian push button activators

- Gateway Structure Installation
  - Clear and excavate the foundation area
  - Install formwork, pour, and cure concrete
  - Structural installation of the gateway
- Landscaping & Final Details for the Gateway Structure
  - Install lighting for the gateway and surrounding areas
  - Complete planting and final landscaping for the rain gardens, medians, and sidewalks

- Bike Lanes & Sidewalks Paving
  - Complete the paving of bike lanes, sidewalks, and any other paved surfaces within the construction zone

***Phase 3: Protected Bike Lanes & Stormwater Management (Weeks 8-14)***

- Excavation for Protected Bike Lanes
  - Excavation for bike lanes, including rain garden construction area and stormwater system
- Rain Garden Construction
  - Construct the rain gardens
  - Grading and soil preparation
  - 350 mm dia. Main PVC Installation
  - 300 mm dia. Perforated PVC Installation
  - Install necessary manholes and tie-in the stormwater systems to existing pipes
  - Ensure adequate infiltration and water management capacity of the rain gardens
- Protected Bike Lane Construction
  - Ensure all trenches are backfilled and compacted properly before paving.
  - Construct bike lanes and sidewalks, including subgrade preparation, formwork, pouring, and curing
  - Install Jersey barriers along the bike lanes for separation from traffic.
- Stormwater System Installation
  - Tank Installation
  - Tie in to 350 mm dia. Storm Main PVC Pipe
  - Tie in to 300 mm dia. Perforated Storm Main PVC Pipe
- Completion of Rain Garden and Stormwater System
  - Finalize the installation of the stormwater management tanks and pipe tie-ins
  - Backfill engineered soil to support infiltration and plant growth
  - Restore the excavation sites around the stormwater system

***Phase 4: Final Roadwork & Paving (Weeks 15-16)***

- Median Paving
  - Once the concrete has cured, pave the median and apply final finishing
- Jersey Barriers along NW Marine Dr. to Spanish Banks

  - Install Jersey barriers on Newton Wynd and Wesbrook Cres, to block vehicles from entering the bike lane
  - Install jersey barriers on Spanish Banks West Parking Lot A to block vehicles from entering the bike lane
- Protected Bike Lanes & Sidewalks Paving
  - Complete the paving of bike lanes, sidewalks, and any other paved surfaces within the construction zone
  - Finalize the installation of traffic markings, lane divisions, and directional signage.
- Final Paving of Main Road
  - Final surfacing and markings including queue boxes on the main road

***Phase 5: Final Inspections & Project Completion (Weeks 16-17)***

- Traffic Light Commissioning
  - Perform final testing to ensure signals operate correctly
- Stormwater System Completion
  - Ensure stormwater drainage is functioning as designed
- Final Inspection & Testing
  - Perform a final inspection to ensure that all components are installed correctly, systems are functioning, and the project is ready for handover
- Site Cleanup
  - Clear all construction materials, machinery, and temporary structures
  - Inspect the site to ensure it meets all safety and quality standards before opening up to the public

This structured approach ensures a streamlined workflow, minimal delays, and efficient resource allocation, leading to a successful and timely project completion. Regular monitoring and adjustments will be implemented as needed to maintain progress and meet the target deadline.

## 12.0 Construction Schedule

The construction is scheduled to commence on May 5, 2025, with a duration of 17 weeks (81 working days), and is expected to be completed by August 29, 2025. The timeline was carefully selected to ensure the project is completed before the start of the fall school term, minimizing disruption to traffic and providing a smooth transition for students returning to campus. Additionally, the construction is scheduled during the summer months when weather conditions are typically optimal, significantly reducing the likelihood of weather-related delays. This strategic timing allows for uninterrupted progress on weather-sensitive tasks such as concrete pouring and curing, ensuring the work proceeds as scheduled without significant setbacks.

The schedule was designed to maximize the productivity of construction equipment and labor. Critical machinery such as excavators, concrete mixers, and trucks will be continuously utilized, minimizing idle time and ensuring efficient use of construction equipment. For example:

- Excavators will be engaged in tasks such as pavement removal and trench excavation, followed immediately by backfilling and surface preparation.
- Concrete mixers will be used continuously for activities like structural installations and pavement construction to avoid unnecessary downtime.

To further optimize efficiency, overlapping tasks are carefully coordinated to prevent workflow disruptions. By sequencing tasks in a manner that avoids machinery being used in multiple locations at once, the schedule ensures that each piece of equipment is deployed effectively without delays or conflicts. For example, while excavators are completing excavation work, concrete mixers can be dedicated to simultaneous tasks like structural pouring or pavement laying. See Appendix B for a more detailed construction schedule.

Overall, the schedule is designed with a focus on maximizing efficiency and productivity while ensuring high-quality outcomes. Regular monitoring and adjustments will be made as necessary to maintain progress and meet the target completion date.

## 13.0 Class A Cost Estimate

The detailed Class A Cost Estimate can be found in Appendix A. A summary of the cost estimate is provided below. The total capital cost for this project is **$7,348,000**.

***Table 7:*** *Summary of Class A Cost Estimate*

| Section | Section Name | Subtotal |
|---|---|---|
| 1.0 | General Requirements | $ 167,000.00 |
| 2.0 | Earthworks | $ 2,936,000.00 |
| 3.0 | Concrete | $ 354,000.00 |
| 4.0 | Stormwater Utilities | $ 920,000.00 |
| 5.0 | Road & Site Improvements | $ 1,603,000.00 |
| 6.0 | Structural Works & Gateway Design | $ 15,000.00 |
| 7.0 | Rainwater Garden | $ 28,000.00 |
| | *Subtotal Capital Cost* | $ 6,023,000.00 |
| | *Engineering Fees (12%)* | $ 723,000.00 |
| | *Contingency (+/- 10%)* | $ 602,000.00 |
| | **Total Capital Cost** | **$ 7,348,000.00** |

A +/- 10% contingency was taken for this cost estimate to account for the uncertainties and risks of the project. An engineering fee estimate of 12% was considered for the cost estimate to account for the cost of professional engineering services required to design, plan, and oversee the execution of the project.

The line items for the Class A Cost Estimate were referenced from the master schedule of quantities from the Master Municipal Construction Documentation (MMCD) 2019 edition. Unit rates were obtained from research and past experiences on civil engineering projects in British Columbia.

## 14.0 Service Life Maintenance Plan

The service life maintenance plan for the redesigned intersection at Chancellor Blvd. and East Mall has been carefully developed to ensure long-term functionality, structural integrity, and alignment with the project's sustainability and safety objectives. The various infrastructural components, including pavement systems, stormwater management facilities, active transportation infrastructure, and architectural features, have been assigned tailored maintenance strategies based on their projected life cycles, material properties, and exposure to environmental and operational stressors.

The asphalt roadway is anticipated to have a service life of approximately 15 to 20 years, contingent on traffic loading and climatic conditions. Preventive maintenance measures, including periodic crack sealing and surface treatments, are recommended every five to seven years, with comprehensive resurfacing projected at the midpoint or conclusion of the life cycle. Adjacent concrete sidewalks and curbs are expected to endure for 25 to 30 years, with minor interventions such as crack remediation or localized replacement being undertaken as needed, based on annual condition assessments.

The stormwater management infrastructure, comprising a high-capacity ACO underground stormwater tank and an extensive rainwater garden, has been designed with resilience and longevity in mind. The tank is projected to exceed a 50-year service life with minimal structural degradation, assuming regular inspection and sediment removal protocols are adhered to. The rainwater garden, while more susceptible to environmental variability, is expected to function optimally for two to three decades with biannual maintenance, including vegetative management, debris removal, and soil performance evaluations.

Active transportation facilities, including the protected bike lanes and their associated delineators, markings, and signage, are subject to moderate wear and thus necessitate more frequent upkeep. Painted elements such as lane demarcations and green conflict zones should be refreshed every three to five years to preserve visibility and ensure user safety. The precast concrete Jersey barriers incorporated into the design are anticipated to have a service life of 20 to 30 years and require minimal intervention beyond periodic inspection and surface cleaning.

The gateway structure, a prominent architectural element, has been engineered for a service life exceeding 50 years. Constructed as a reinforced concrete shear wall, it requires only routine structural assessments at five-year intervals and periodic aesthetic maintenance, such as pressure washing and surface treatment, to retain its visual prominence and prevent material degradation.

Collectively, these maintenance strategies underscore a proactive, asset-management-based approach that extends the functional longevity of the intersection, reduces life-cycle costs, and sustains the project's safety, accessibility, and environmental performance over time. Regular monitoring and timely intervention will be critical in preserving the integrity of the infrastructure and ensuring its continued service to the UBC community and surrounding stakeholders.

## 15.0 Risk Analysis and Management

### 15.1 Potential Risks

With the pursuit of the intersection redesign at East Mall and Chancellor Blvd, there are several potential risks to consider commensurate with a multifaceted project. Geotechnical, hydrological, environmental, safety, construction, and project management risks are all key contenders and require careful management to ensure successful project implementation and outcomes.

**1. Geotechnical Risks**

A. *Subsurface Heterogeneity*: Excavation and foundation emplacement may be complicated by subsurface diversity in till thickness and intermittent zones of perched water.

B. *Slope Destabilization*: The proximity of the intersection to the Point Grey Cliffs presents risk for destabilization, particularly with respect to the contact between the Q1 and Q2 Quadra Sand subunits if groundwater seepage were to compound.

**2. Hydrological Risks**

A. *Stormwater Runoff*: Poor efforts to retain stormwater may exacerbate erosion of the proximal Point Grey Cliffs or lead to local flooding.

B. *Groundwater Mismanagement*: Inability or failure to manage seepage could lead to the destabilization of the Point Grey Cliffs.

**3. Environmental Risks**

A. *Environmental Disruption*: Construction activities as a result of design implementation may disturb local wildlife in the area or damage flora.

B. *Erosion*: Increased exposure of the cliffs to water would exacerbate erosion and negatively impact the stability of the slope, invoking further harm to local ecosystems.

**4. Safety Risks**

A. *Pedestrians and Cyclists*: Re-routing pedestrian and cyclist traffic during construction phases could lead to road accidents.

B. *Traffic Management*: Re-routing vehicle users during construction phases could increase the likelihood of road accidents due to detours or alterations to road layout.

**5. Project Management Risks**

A. *Delays*: Changes to scheduling due to stakeholder disagreements, weather conditions, or unexpected geotechnical conditions during excavation could delay project completion.

B. *Cost*: Increased costs may result in the budget being exceeded as a result of unexpected changes and challenges during project implementation.

### 15.2 Risk Assessment Matrix

A risk assessment matrix was created with clear descriptions of the various types of risk that can occur throughout the project. Probabilities and risk levels were assigned to quantify the potential impact of each identified risk. Below is a table created for the scope of this project:

***Table 8:*** *Risk Assessment Matrix*

| Risk | Probability | Impact | Risk Level |
|---|---|---|---|
| Slope Destabilization | High | High | Critical |
| Traffic Accidents | High | High | Critical |
| Groundwater Mismanagement | Medium | High | High |
| Cost Overruns | Medium | High | High |
| Cliff Erosion | Medium | High | High |
| Weather Delays | Medium | High | Medium |
| Stormwater Runoff | Medium | Medium | Medium |
| Construction Delays | Medium | Medium | Medium |
| Environmental Disruption | Low | Medium | Low |

### 15.3 Risk Mitigation Strategies

To appropriately mitigate the aforementioned risks, the following strategies may be employed. Conducting further geotechnical investigation via drilling will aim to better characterize the site by ascertaining the variations in unit thickness, particularly the till.

Ensuring that the appropriate setback is maintained from the toe of the slope by adhering to the formerly recommended 35 degrees will address concerns regarding slope stability. If any further slope stability risks are identified, implementing retaining structures or additional dewatering systems may be required.

To address hydrological risks, the installation of dewatering wells may be fortuitous in order to redirect groundwater from the upper aquifer to more favorable discharge areas. Although PUC has presented stormwater management and rain garden elements into the design, underground retention tanks might also be considered in the case of 100-year storm events. The use of trenches or impervious barriers may also work to safeguard specific areas of concern from infiltration.

To mitigate environmental disruption and harm, construction may need to be conducted with local wildlife activity in mind. Employing control measures like vegetation buffers will aid in preventing erosion, and the nearby cliffs must be monitored regularly to assess integrity.

Generating a thorough traffic plan equipped with an on-site traffic management team including flaggers and utilizing barriers and signage will ensure the safe travel of pedestrians and cyclists amongst vehicle movement while construction activities take place. Furthermore, with the implementation of clearly marked and well protected bike lanes, crosswalks, and pedestrian controlled traffic signaling systems, the risk of traffic accidents post construction will be effectively reduced.

To reduce risks associated with project implementation and management, conducting recurring stakeholder meetings, allocating contingency funds for unpredicted costs, and imposing a practical project timeline will ensure that project goals are met and maintained with relative ease.

By carefully reviewing the relevant project risks and employing these risk mitigation strategies, PUC may amplify the likelihood of successful project completion. Rigorous monitoring and management will seek to resolve any adverse effects encountered throughout implementation and construction phases.

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# Appendix A - Class C Cost Estimate

| | | | |
|---|---|---|---|
| **Class A Cost Estimate** | | Last Opened: | 6-Apr-2025 |
| **East Mall & Chancellor Blvd Intersection Design** | | Project Commencement: | May 2025 |

| Item No. | Description | Quantity | Units | Unit Rate | Cost |
|---|---|---|---|---|---|
| Section 1.0 - General Requirements | | | | | |
| 1.1 | Permits | 1 | LS | $ 5,000.00 | $ 5,000.00 |
| 1.2 | Project Record Documents | 1 | LS | $ 7,000.00 | $ 7,000.00 |
| 1.3 | Temporary Utilities and Lighting | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| 1.4 | Temporary Structures & Facilities | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| 1.5 | Site Work & Preperation | 1 | LS | $ 15,000.00 | $ 15,000.00 |
| 1.6 | Traffic Control, Vehicle Access, and Parking | 1 | LS | $ 10,000.00 | $ 10,000.00 |
| 1.7 | Health, Safety & Environment (HSE) | 1 | LS | $ 15,000.00 | $ 15,000.00 |
| 1.8 | Mobilization & Demobilization | 1 | LS | $ 100,000.00 | $ 100,000.00 |
| Section 1.0 **Subtotal**: | | | | | **$ 167,000.00** |
| Section 2.0 - Earthworks | | | | | |
| 2.1 | Clearing and Grubbing | 700 | sq.m. | $ 10.00 | $ 7,000.00 |
| 2.2 | Isolated Tree Clearing | 5 | ea. | $ 500.00 | $ 2,500.00 |
| 2.3 | Removal and Disposal of Asphalt | 5200 | sq.m. | $ 30.00 | $ 156,000.00 |
| 2.4 | Removal and Disposal of Sidewalk and Median | 1630 | sq.m. | $ 70.00 | $ 114,100.00 |
| 2.5 | Total Excavation and Disposal | 17400 | cu. m | $ 50.00 | $ 870,000.00 |
| 2.6 | Engineered Fill - Well-graded 300mm or 150mm minus rock fill | 10440 | cu. m | $ 70.00 | $ 730,800.00 |
| 2.7 | Hauling Aggregate to Site - Well-graded 300mm or 150mm minus rock fill | 10440 | cu. m | $ 100.00 | $ 1,044,000.00 |
| 2.8 | Dust Control | 1 | allow. | $ 10,000.00 | $ 10,000.00 |
| 2.9 | Excavation of New Channels & Ditches | 1 | allow. | $ 2,000.00 | $ 2,000.00 |
| Section 2.0 **Subtotal**: | | | | | **$ 2,936,400.00** |
| Section 3.0 - Concrete | | | | | |
| 3.1 | 30 MPa Concrete for Gateway | 20 | cu. m | $ 288.00 | $ 5,760.00 |
| 3.2 | Reinforcement for Gateway | 720 | kg | $ 2.00 | $ 1,440.00 |
| 3.4 | 25 MPa Concrete for Sidewalk | 820 | cu.m. | $ 280.00 | $ 229,600.00 |
| 3.5 | Formwork Rental | 1 | LS | $ 8,000.00 | $ 8,000.00 |
| 3.6 | 72x Concrete Jersey Barriers | 72 | ea. | $ 400.00 | $ 28,800.00 |
| 3.7 | 30 MPa Concete for Footing | 2 | cu.m. | $ 288.00 | $ 576.00 |
| 3.8 | Median Barrier Concrete 25 MPa | 286 | cu. m | $ 280.00 | $ 80,080.00 |
| Section 3.0 **Subtotal**: | | | | | **$ 354,256.00** |
| Section 4.0 - Stormwater Utilities | | | | | |
| 4.1 | Storm Mains PVC 350mmØ | 235 | m | $ 1,000.00 | $ 235,000.00 |
| 4.2 | Perforated Strom Main PVC 300mmØ | 140 | m | $ 500.00 | $ 70,000.00 |
| 4.3 | 8x Drainage Manholes | 8 | ea. | $ 9,000.00 | $ 72,000.00 |
| 4.4 | 5x Top Inlet Catch Basins | 5 | ea. | $ 2,000.00 | $ 10,000.00 |
| 4.5 | 1x Control Manhole before Tank | 1 | ea. | $ 7,000.00 | $ 7,000.00 |
| 4.6 | Storm Service Lines PVC 200mmØ | 40 | m | $ 300.00 | $ 12,000.00 |
| 4.8 | Atco Stormwater Tank 9m X 29m X 6m | 1 | LS | $ 500,000.00 | $ 500,000.00 |
| 4.9 | Excavating, Trenching, and Backfilling included under pipelaying | 275 | sq.m. | $ 25.00 | $ 6,875.00 |
| 4.10 | 1x Lawn Drain | 1 | ea. | $ 1,800.00 | $ 1,800.00 |
| 4.11 | Geotextile (specify) | 1 | allow. | $ 5,000.00 | $ 5,000.00 |
| Section 4.0 **Subtotal**: | | | | | **$ 919,675.00** |
| Section 5.0 - Road & Site Improvements | | | | | |
| 5.1 | Traffic Lights and control box | 1 | LS | $125,000.00 | $125,000.00 |
| 5.2 | New Signage | 26 | ea. | $200.00 | $5,200.00 |
| 5.3 | Line Painting | 1 | LS | $5,000.00 | $5,000.00 |
| 5.4 | Road Paint Markings | 1 | LS | $5,000.00 | $5,000.00 |
| 5.6 | Bike Lane Paint | 14320 | sq. m. | $20.00 | $286,400.00 |
| 5.7 | Crosswalk Paint | 200 | sq. m. | $10.00 | $2,000.00 |
| 5.8 | Additional Street Lighting | 1 | LS | $20,000.00 | $20,000.00 |
| 5.9 | Granular Sub-Base (75mm Minus Well-Graded Crushed Rock, 300mm thickness for Roads) | 5200 | sq.m. | $40.00 | $208,000.00 |
| 5.10 | Granular Base (19mm Minus Well-Graded Crushed Gravel, 150mm thickness for Roads) | 5200 | sq.m. | $60.00 | $312,000.00 |
| 5.11 | Subgrade for Roads - Approved Granular Fill | 5200 | sq.m. | $40.00 | $208,000.00 |
| 5.12 | Asphalt Pavement - 75mm Thickness | 5200 | sq.m. | $80.00 | $416,000.00 |
| 5.13 | Landscaping Services | 1 | allow. | $10,000.00 | $10,000.00 |
| Section 5.0 **Subtotal**: | | | | | **$1,602,600.00** |
| Section 6.0 - Structural Works, Foundation & Gateway Design | | | | | |
| 6.1 | Sign Procurment and Installation | 1 | LS | $12,000.00 | $12,000.00 |
| 6.2 | 3x Sign Spotlights Procurment and Installation | 3 | ea. | $1,000.00 | $3,000.00 |
| 6.3 | 4-20M Rebar Reinforcement | 25 | m | $5.00 | $125.00 |
| 6.4 | 4-10M Stirrups | 20 | m | $4.00 | $80.00 |
| Section 6.0 **Subtotal**: | | | | | **$15,205.00** |
| Section 7.0 - Rainwater Garden | | | | | |
| 8.1 | Hydroseeding | 1000 | sq.m. | $10.00 | $10,000.00 |
| 8.2 | Vegetaded Swales | 1 | LS | $2,000.00 | $2,000.00 |
| 8.3 | Crushed River Rock and Gravel | 1 | LS | $5,000.00 | $5,000.00 |
| 8.4 | 1x Metal Grate Walkway -1.8m wide | 1 | ea. | $1,000.00 | $1,000.00 |
| 8.5 | Landscaping Services | 1 | LS | $10,000.00 | $10,000.00 |
| 8.6 | Imported Bioretension Soil for Rainwater Garden | 1000 | sq.m. | $50.00 | $50,000.00 |
| Section 7.0 **Subtotal**: | | | | | **$28,000.00** |

| | |
|---|---|
| Subtotal Capital Cost | $ 6,023,136.00 |
| Engineering Fees (12%) | $ 722,776.32 |
| Contingency (+/- 10%) | $ 602,313.60 |
| **GRAND TOTAL COST** | **$ 7,348,225.92** |

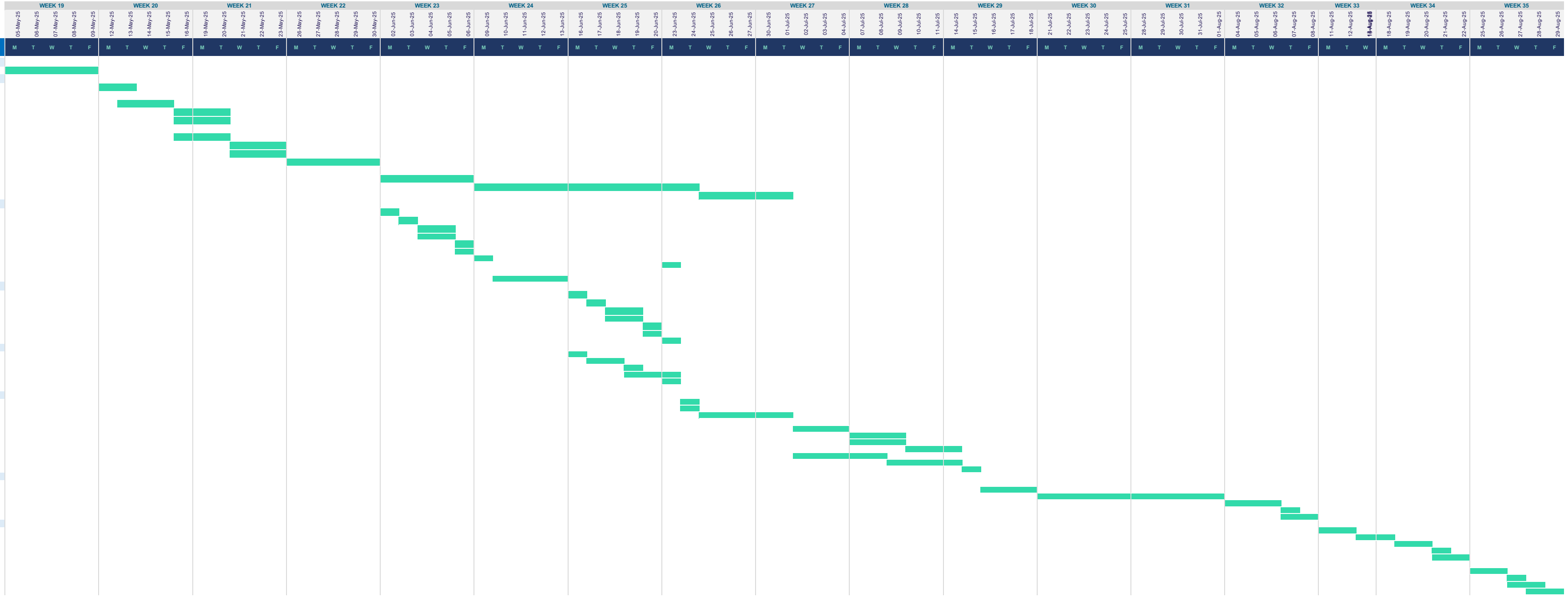
# Appendix B - Construction Schedule

# East Mall & Chancellor Blvd. Intersection Redesign

**Pacific Urban Consulting (PUC)**

**Project start date:** 05-May-25

| TASK NAME | START DATE | WORK DAYS | END DATE |
|---|---|---|---|
| **Site Preparation** | | | |
| Mobilization | 05-May-25 | 5 | 09-May-25 |
| **Construction of the Main Road** | | | |
| Traffic Control Setup | 12-May-25 | 2 | 13-May-25 |
| East of NW Marine Drive | | | |
| Pavement Removal, Excavation, and Disposal | 13-May-25 | 3 | 15-May-25 |
| Manhole and Catch Basins Installation | 16-May-25 | 3 | 20-May-25 |
| 350 mm dia PVC Installation | 16-May-25 | 3 | 20-May-25 |
| West of NW Marine Drive | | | |
| Pavement Removal, Excavation, and Disposal | 16-May-25 | 3 | 20-May-25 |
| Manhole and Catch basins Installation | 21-May-25 | 3 | 23-May-25 |
| 350 mm dia PVC Installation | 21-May-25 | 3 | 23-May-25 |
| Backfill and Compaction | 26-May-25 | 5 | 30-May-25 |
| Median Construction | | | |
| Subgrade and alignment | 02-Jun-25 | 5 | 06-Jun-25 |
| Formwork, Pouring, and Curing | 09-Jun-25 | 12 | 24-Jun-25 |
| Paving | 25-Jun-25 | 5 | 01-Jul-25 |
| **West Traffic Lights** | | | |
| Pavement Removal, Excavation, and Disposal | 02-Jun-25 | 1 | 02-Jun-25 |
| Base Installation | 03-Jun-25 | 1 | 03-Jun-25 |
| Formwork, Pouring and Curing | 04-Jun-25 | 2 | 05-Jun-25 |
| Wiring and electrical | 04-Jun-25 | 2 | 05-Jun-25 |
| Pole Installation | 06-Jun-25 | 1 | 06-Jun-25 |
| Traffic light installation | 06-Jun-25 | 1 | 06-Jun-25 |
| Relocate Equipment | 09-Jun-25 | 1 | 09-Jun-25 |
| Commisioning | 23-Jun-25 | 1 | 23-Jun-25 |
| Traffic Transition | | | |
| Realignment on East Mall | 10-Jun-25 | 4 | 13-Jun-25 |
| **East Traffic Lights** | | | |
| Pavement Removal, Excavation, and Disposal | 16-Jun-25 | 1 | 16-Jun-25 |
| Base Installation | 17-Jun-25 | 1 | 17-Jun-25 |
| Formwork, Pouring and Curing | 18-Jun-25 | 2 | 19-Jun-25 |
| Wiring and electrical | 18-Jun-25 | 2 | 19-Jun-25 |
| Pole Installation | 20-Jun-25 | 1 | 20-Jun-25 |
| Traffic light installation | 20-Jun-25 | 1 | 20-Jun-25 |
| Commisioning | 23-Jun-25 | 1 | 23-Jun-25 |
| **Gateway Structure** | | | |
| Clearing, Excavation, and Disposal | 16-Jun-25 | 1 | 16-Jun-25 |
| Foundation Preparation | 17-Jun-25 | 2 | 18-Jun-25 |
| Rebar and Formwork Installation | 19-Jun-25 | 1 | 19-Jun-25 |
| Concrete Pouring and Curing | 19-Jun-25 | 3 | 23-Jun-25 |
| Lighting and Landscaping | 23-Jun-25 | 1 | 23-Jun-25 |
| Traffic Transition | | | |
| **Stormwater Management** | | | |
| Relocate Equipment | 24-Jun-25 | 1 | 24-Jun-25 |
| Traffic Control Setup | 24-Jun-25 | 1 | 24-Jun-25 |
| Pavement Removal, Excavation, and Disposal | 25-Jun-25 | 5 | 01-Jul-25 |
| Rain Garden Construction | | | |
| Grading and Soil Preparation | 02-Jul-25 | 3 | 04-Jul-25 |
| 350 mm dia PVC Installation | 07-Jul-25 | 3 | 09-Jul-25 |
| Manholes Installation | 07-Jul-25 | 3 | 09-Jul-25 |
| Backfill and Compaction | 10-Jul-25 | 3 | 14-Jul-25 |
| Tank Installation and Tie in | 02-Jul-25 | 5 | 08-Jul-25 |
| Backfill and Restoration | 09-Jul-25 | 4 | 14-Jul-25 |
| Commisioning | 15-Jul-25 | 1 | 15-Jul-25 |
| **Protected Bike Lanes** | | | |
| Bike Lanes and Sidewalks Installation | | | |
| Subgrade for bike lanes and sidewalks | 16-Jul-25 | 3 | 18-Jul-25 |
| Formwork, Pouring, and Curing | 21-Jul-25 | 10 | 01-Aug-25 |
| Paving | 04-Aug-25 | 3 | 06-Aug-25 |
| Jersey Barriers Installation | 07-Aug-25 | 1 | 07-Aug-25 |
| Landscaping | 07-Aug-25 | 2 | 08-Aug-25 |
| **Final Inspection and Quality Control** | | | |
| Landscaping | 11-Aug-25 | 2 | 12-Aug-25 |
| Final Paving | 13-Aug-25 | 4 | 18-Aug-25 |
| Traffic Marking and Signage | 19-Aug-25 | 2 | 20-Aug-25 |
| Inspection of Traffic Control Devices | 21-Aug-25 | 1 | 21-Aug-25 |
| Testing Drainage System | 21-Aug-25 | 2 | 22-Aug-25 |
| Demobilization | | | |
| Equipment and materials removal | 25-Aug-25 | 2 | 26-Aug-25 |
| Temporary traffic control devices removal | 27-Aug-25 | 1 | 27-Aug-25 |
| Site cleanup | 27-Aug-25 | 2 | 28-Aug-25 |
| Project Handover | 28-Aug-25 | 2 | 29-Aug-25 |



# Appendix C - IFC Drawings

GENERAL NOTES:

1. THE GENERAL CONTRACTOR WILL FAMILIARIZE HIMSELF WITH THE CONTENT OF ALL RELEASED DOCUMENTS, SUCH AS (BUT NOT LIMITED TO):
2. THE TENDER FORM AND APPENDIXES;
3. THE INSTRUCTIONS TO BIDDERS;
4. THE GENERAL PROVISIONS OF THE CONTRACT.
5. THE WORK FOR THIS CONTRACT IS NOT LIMITED TO THE INDICATIONS SHOWN ON THE PLANS. THE GENERAL CONTRACTOR WILL MAKE THE NECESSARY VERIFICATIONS TO MAKE SURE THAT THE WORK WILL COMPLY WITH TRADE PRACTICES, AS WELL AS THE VARIOUS APPLICABLE STANDARDS. THE GENERAL CONTRACTOR MUST PROVIDE COMPLETE AND OPERATIONAL STRUCTURES.
6. THE GENERAL CONTRACTOR WILL VERIFY ON SITE ALL OF THE DIMENSIONS, OBSTACLES OR CONDITIONS THAT MAY AFFECT WORK AND WILL NOTIFY THE ENGINEER OF ANY ANOMALY.
7. A SITE VISIT WILL HAVE TAKEN PLACE PRIOR TO BEGINNING WORK IN ORDER TO BECOME FAMILIAR WITH THE ACTUAL SITE CONDITIONS.
8. THE GENERAL CONTRACTOR WILL VERIFY ALL OF THE ELEVATIONS, DIMENSIONS AND LEVELS SHOWN ON THE PLANS, AS WELL AS THE ARCHITECTURE PLANS AND THOSE OF THE OTHER SPECIALTIES INVOLVED IN THE CONTRACT (OR TO COME), AND WILL NOTIFY THE ENGINEER OF ANY DISCREPANCY. THE GENERAL CONTRACTOR WILL BE RESPONSIBLE FOR ANY ERROR OR OMISSION CAUSED BY A LACK OF COORDINATION.
9. THE GENERAL CONTRACTOR WILL VERIFY THE LOCATION OF ALL PUBLIC UTILITIES THAT MAY BE ON SITE (WATER SYSTEMS, SEWERS, POWER, TELEPHONE, GAS, ETC.) PRIOR TO BEGINNING WORK. HE WILL ALSO PROVIDE EFFECTIVE PROTECTION DURING EXCAVATION WORK. HE WILL ALSO BE LIABLE FOR ANY DAMAGES THAT MAY INCUR TO PUBLIC UTILITIES.
10. THESE PLANS WILL NOT BE USED FOR CONSTRUCTION UNLESS THEY ARE ISSUED AS SUCH AND SIGNED AND STAMPED BY THE ENGINEER.
11. AT THE END OF THE WORK AND PRIOR TO FINAL ACCEPTANCE, ALL OF THE SCAFFOLDS, WASTE AND TEMPORARY STRUCTURES WILL BE REMOVED FROM THE SITE AND THE SITE WILL BE CLEANED TO THE OWNER'S SATISFACTION.
12. UNLESS OTHERWISE INDICATED IN THESE SPECIFICATIONS, THE LATEST VERSION OF THE STANDARDS OR CODES AT THE TIME OF THE AWARDING OF THE CONTRACT WILL BE USED.
13. THE NQ 1809-300/2004 (R 2007) STANDARD DOCUMENT, AS WELL AS THE "CAHIER DES CHARGES ET DEVIS GÉNÉRAUX" OR CCDG, ARE AN INTEGRAL PART OF THE PLAN NOTES. THESE DOCUMENTS ARE AVAILABLE FROM THE "BUREAU DES PUBLICATIONS DU QUÉBEC".
THE GENERAL CONTRACTOR WILL TAKE INTO ACCOUNT THAT CIVIL ENGINEERING WORK WILL BE EXECUTED IN ACCORDANCE WITH THE GENERAL SPECIFICATIONS OF THESE REFERENCE DOCUMENTS. THE LIMITATIONS AND SCOPE OF THESE REFERENCE DOCUMENTS ARE HOWEVER DESCRIBED IN THE SPECIFIC PROVISIONS OF THE PLAN NOTES.
14. WHEN NECESSARY, THE REQUIREMENTS OF THE 2010 NATIONAL BUILDING CODE (NBC) WILL APPLY TO THIS PROJECT.
15. STORMWATER RETENTION REQUIRES RESPECTING THE ELEVATIONS AND GEOMETRY OF THE PARKING LOTS INDICATED ON THE PLANS.
16. ASTERISKS (*) ON THE PLANS INDICATE THAT THE INFORMATION IN QUESTION IS NOT AVAILABLE OR THAT IT IS UNRELIABLE WHEN THE PLANS WERE PREPARED. CONSULT THE ARCHITECTURE, MECHANICAL ENGINEERING AND ELECTRICITY PLANS, IF NECESSARY, OR THE PLANS OF ANY OTHER SPECIALTY.
17. FOR ANY WORK THAT MAY DISTURB THE NORMAL ACTIVITIES TAKING PLACE IN THE BUILDING, THE GENERAL CONTRACTOR WILL PROVIDE THE OWNER WITH A WRITTEN REQUEST TO PROCEED, WHICH WILL INCLUDE THE NATURE OF THE WORK TO BE EXECUTED.

EXCAVATION:

1. THE BOTTOM OF THE EXCAVATIONS WILL BE LEVELED AND CONSIST OF DRY UNDISTURBED SOIL FREE OF LOOSE ORGANIC MATERIAL, ICE OR SNOW. PROVIDE, INSTALL AND MAINTAIN THE OPERATION OF TEMPORARY DRAINS AND PUMP WATER WHEN REQUIRED.
2. DO NOT DISTURB THE 45° WEDGE-SHAPED SOIL UNDER THE FOOTINGS.
3. THE GENERAL CONTRACTOR WILL TAKE RESPONSIBILITY FOR THE CONTROL AND EVACUATION OF RUNOFF WATER, SNOW MELT, GROUND WATER, SEWER WATER OR WATER FROM ANY OTHER SOURCE AT THE CONSTRUCTION SITE IN ORDER TO ALLOW THE EXECUTION OF WORK. AT HIS OWN EXPENSE, THE GENERAL CONTRACTOR WILL REPAIR ANY DAMAGES CAUSED BE WATER, NO MATTER THE SOURCE.
4. WHEN THE SOIL AT THE BOTTOM OF THE EXCAVATIONS HAS BEEN DISTURBED BUT REMAINS STABLE, COMPACT THE BOTTOM OF THE EXCAVATIONS OR THE EXCAVATED MATERIAL TO A VOLUME MASS AT LEAST EQUAL TO THAT OF UNDISTURBED SOIL.
5. WHEN THE MATERIAL AT THE BOTTOM OF THE EXCAVATIONS HAS BEEN DISTURBED BUT IS UNSTABLE, REPLACE THE UNSTABLE MATERIAL WITH THAT WHICH IS DESCRIBED IN THE SUB-SECTION PERTAINING TO FILL WORK.
6. IF THE EXCAVATION IS TOO DEEP OR IF THE BOTTOM IS UNEVEN, LEVEL THE BOTTOM AND FILL WITH THE MATERIAL DESCRIBED IN THE SUB-SECTION ON FILL WORK IN ORDER TO OBTAIN THE LEVELS REQUIRED IN THE TENDER DOCUMENTS.

FOUNDATIONS:

1. ALL FOUNDATION CONSTRUCTION SHALL CONFORM TO THE RECOMMENDATIONS PROVIDED IN THE GEOTECHNICAL INVESTIGATION REPORT (PITEAU, 2002) AND THE PACIFIC URBAN CONSULTING (PUC) DESIGN REPORT.

2. A GEOTECHNICAL ENGINEER MUST INSPECT AND APPROVE THE FOOTING SUBGRADE BEFORE CONCRETE PLACEMENT. THE CONTRACTOR SHALL PROVIDE 48 HOURS' NOTICE FOR INSPECTION.

3. ANY UNSUITABLE OR LOOSE SOIL ENCOUNTERED AT THE FOOTING LEVEL SHALL BE OVER-EXCAVATED AND REPLACED WITH COMPACTED ENGINEERED FILL OR LEAN CONCRETE, SUBJECT TO GEOTECHNICAL APPROVAL.

4. THE ALLOWABLE BEARING CAPACITY OF THE SOIL IS 126.4 KPA, AS DETERMINED USING MEYERHOF'S BEARING CAPACITY EQUATIONS.

5. THE ULTIMATE BEARING CAPACITY OF THE SOIL AT AN EMBEDMENT DEPTH OF 1.0 M IS 2,071.77 KPA, PROVIDING A FACTOR OF SAFETY OF 16.4 AGAINST BEARING FAILURE.

6. FOUNDATIONS SHALL BE PLACED ON COMPETENT NATIVE SOIL OR COMPACTED STRUCTURAL FILL, ACHIEVING A MINIMUM COMPACTION OF 98% STANDARD PROCTOR MAXIMUM DRY DENSITY (SPMDD).

7. IF WATER SEEPAGE IS ENCOUNTERED AT THE EXCAVATION BASE, DEWATERING MEASURES SHALL BE IMPLEMENTED TO MAINTAIN A DRY AND STABLE SUBGRADE.

8. THE STRIP FOOTING SHALL HAVE A MINIMUM WIDTH OF 1.0 M TO ACCOMMODATE THE 0.6 M WIDE SHEAR WALL, ENSURING ADEQUATE LOAD DISTRIBUTION.

9. THE MINIMUM EMBEDMENT DEPTH SHALL BE 1.0 M BELOW THE FINAL GROUND SURFACE FOR FROST PROTECTION AND SOIL BEARING STABILITY.

10. FOOTING THICKNESS SHALL BE 0.34 M, BASED ON ACI 318 BUILDING CODE RECOMMENDATIONS.

11. CONCRETE COVER FOR REINFORCEMENT SHALL BE 75 MM, COMPLYING WITH ACI 318 REQUIREMENTS FOR FOOTINGS CAST DIRECTLY AGAINST SOIL.

12. PRIMARY REINFORCEMENT SHALL CONSIST OF 4-20M BARS, ENSURING STRUCTURAL STABILITY AND COMPLIANCE WITH DESIGN LOADING REQUIREMENTS.

13. SHEAR REINFORCEMENT SHALL CONSIST OF 4-10M STIRRUPS AT 100 MM SPACING, PROVIDING ADEQUATE RESISTANCE TO SHEAR FORCES AND ENHANCING THE STRUCTURAL INTEGRITY OF THE FOOTING.

14. THE SITE IS UNDERLAIN BY THE QUADRA SAND FORMATION, CONSISTING OF PERMEABLE SAND LAYERS WITH INTERBEDDED SILTS.

15. FOOTINGS SHALL BE DESIGNED CONSIDERING SEASONAL GROUNDWATER FLUCTUATIONS AND POTENTIAL SLOPE INSTABILITY DUE TO PERCHED WATER TABLES.

16. THE PROPOSED FOUNDATION SYSTEM SHALL MITIGATE HYDROSTATIC PRESSURE BUILDUP BY INCORPORATING PROPER GRADING AROUND THE STRUCTURE.

17. CONCRETE USED FOR FOOTINGS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 30 MPA AT 28 DAYS.

18. ALL CONCRETE SHALL BE PLACED ON A CLEAN AND DRY SUBGRADE, FREE OF STANDING WATER, MUD, OR DEBRIS.

19. BACKFILL AROUND FOUNDATIONS SHALL BE ENGINEERED FILL OR NATIVE SOIL FREE FROM ORGANIC MATTER, COMPACTED TO 95% SPMDD IN LIFTS OF NO MORE THAN 300 MM.

20. BACKFILL OPERATIONS SHALL BE CAREFULLY CONTROLLED TO PREVENT DIFFERENTIAL SETTLEMENT AND EXCESSIVE LATERAL LOADS ON THE FOUNDATION WALLS.

21. THE SITE IS CLASSIFIED UNDER SEISMIC SITE CLASS D, PER THE NATIONAL BUILDING CODE OF CANADA (NBCC 2020).

22. THE POINT GREY CLIFFS EXHIBIT LOCALIZED INSTABILITY, PARTICULARLY ALONG THE SILT-SAND INTERFACE, REQUIRING APPROPRIATE SETBACK DISTANCES AND SLOPE STABILIZATION MEASURES.

23. ALL STRUCTURES MUST BE SET BACK AT LEAST 25 METERS FROM THE CLIFF EDGE TO MITIGATE SEISMIC-INDUCED SLOPE MOVEMENT AND LONG-TERM EROSION EFFECTS.

24. THE FOUNDATION DESIGN SHALL ACCOMMODATE LATERAL AND VERTICAL SEISMIC LOADS TO ENSURE STABILITY UNDER EARTHQUAKE LOADING CONDITIONS.

25. A GEOTECHNICAL ENGINEER MUST INSPECT ALL FOUNDATION EXCAVATIONS TO VERIFY SOIL CONDITIONS AND APPROVE BEARING CAPACITY BEFORE CONCRETE PLACEMENT.

26. FIELD DENSITY TESTING SHALL BE CONDUCTED ON BACKFILL MATERIALS PER ASTM D6938 (NUCLEAR GAUGE) OR ASTM D1557 (MODIFIED PROCTOR TEST) STANDARDS.

27. ANY UNEXPECTED SOIL CONDITIONS, EXCESSIVE GROUNDWATER, OR DEVIATIONS FROM DESIGN ASSUMPTIONS MUST BE IMMEDIATELY REPORTED TO THE GEOTECHNICAL ENGINEER FOR FURTHER ASSESSMENT.

PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: MA
CHECKED BY: MA
DRAWN BY: MA
DRAWING DATE: 2025-04-04
SCALE: N/A

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

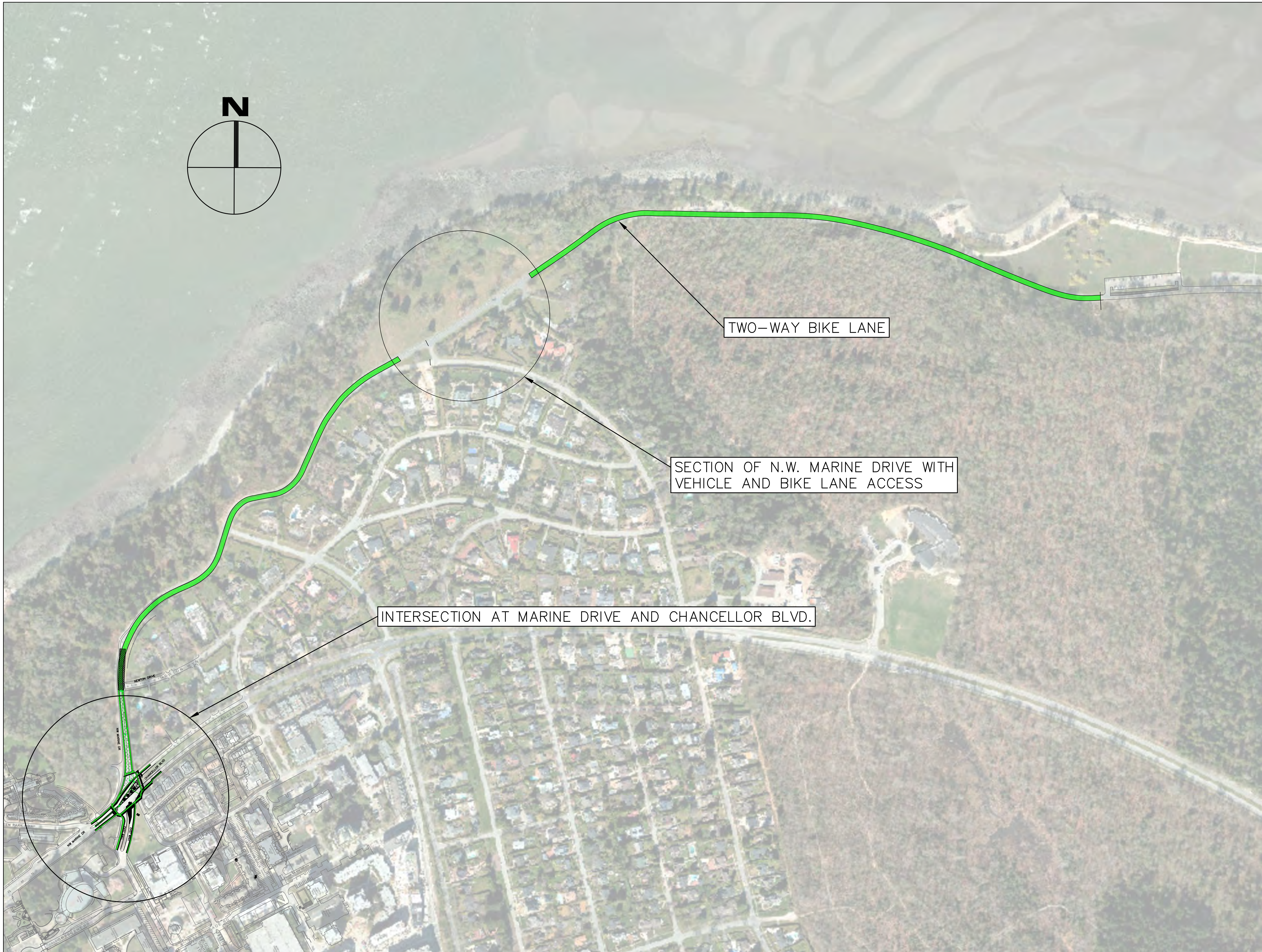
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD AT UBC

DRAWING TITLE:
GENERAL NOTEES

REVISION NO:
01

C-01




PACIFIC URBAN

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| REVISIONS | |

DESIGNED BY: MA, SJ

CHECKED BY: ID, SJ

DRAWN BY: MA

DRAWING DATE: 2025–04–04

SCALE: 1:2500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

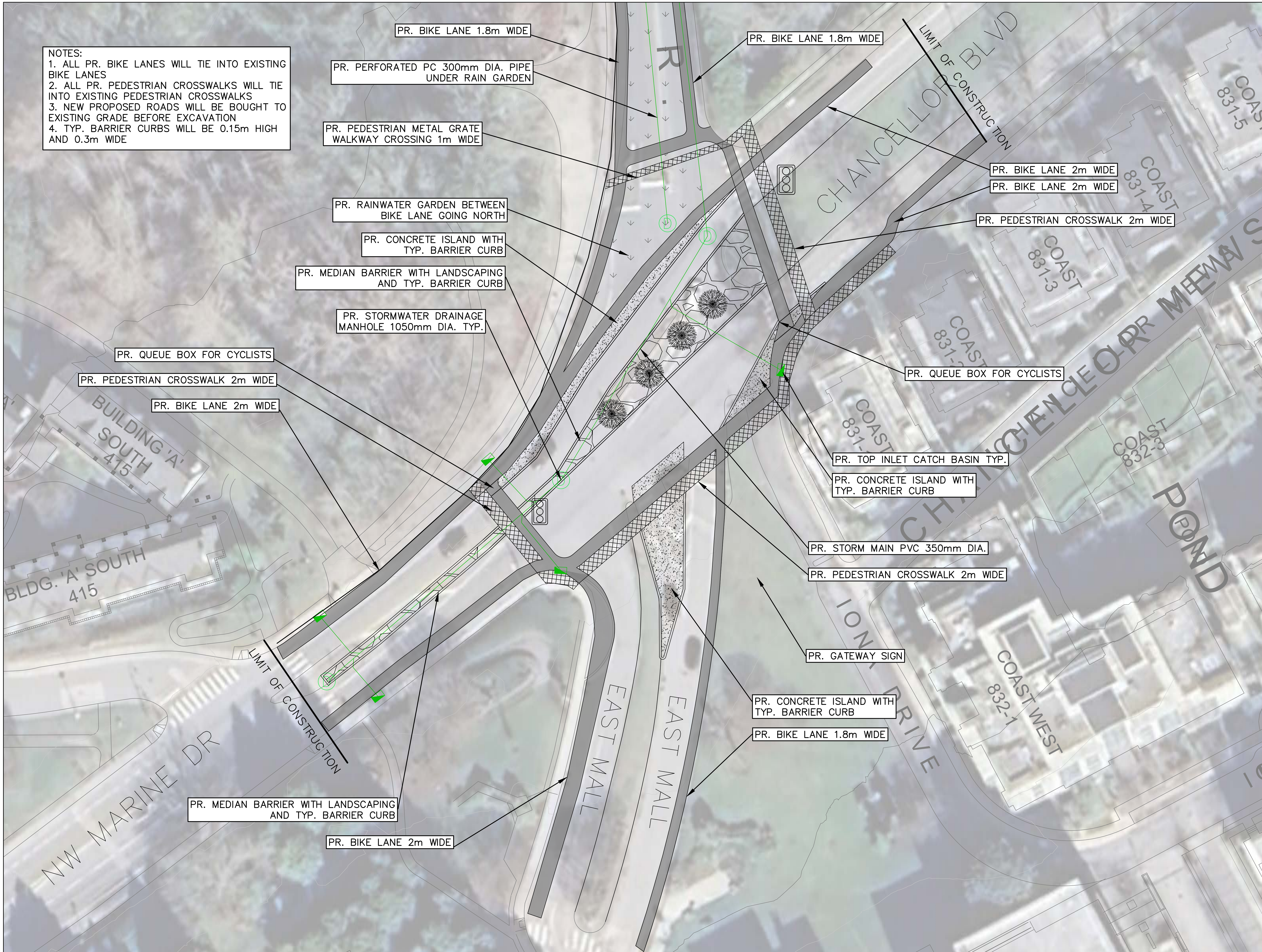
CLIENT:
TRANSPORTATION ENGINEERING SUSTAINABILITY AND ENGINEERING, CAMPUS + COMMUNITY AT UBC

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
PROTECTED BIKE LANE
OVERALL SITE PLAN

REVISION NO:
01

C–02




PACIFIC URBAN

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| REVISIONS | |

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025-03-04

SCALE: 1:250

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

DRAWING TITLE:
NEW INTERSECTION DESIGN
PLAN VIEW 1

REVISION NO:
01

C-03


PACIFIC URBAN

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| REVISIONS | |

DESIGNED BY: MA
CHECKED BY: MA
DRAWN BY: MA
DRAWING DATE: 2025-04-04
SCALE: 1:250

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN
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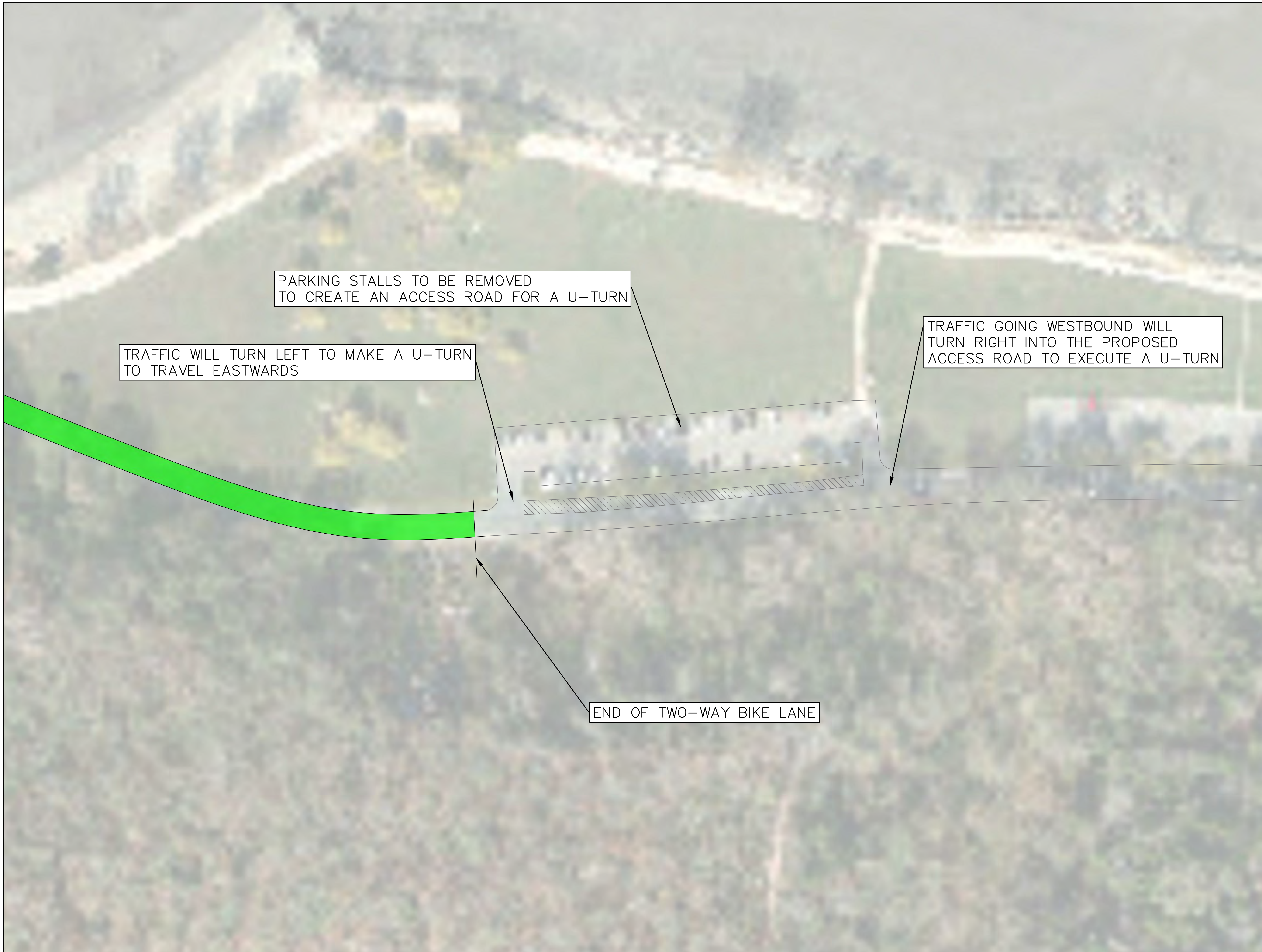
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

DRAWING TITLE:
NEW INTERSECTION DESIGN
PLAN VIEW 2

REVISION NO:
01

C-04




PACIFIC URBAN

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REVISIONS

DESIGNED BY: SJ, MA

CHECKED BY: SJ. ID

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
FIRST SPANISH BANKS PARKING
LOT BY N.W. MARINE DRIVE

DRAWING TITLE:
PROTECTED BIKE LANE
SPANISH BANKS PARKING LOT
PLAN VIEW

REVISION NO:
01

C-05


PACIFIC URBAN

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REVISIONS

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2024-04-04

SCALE: 1:250

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

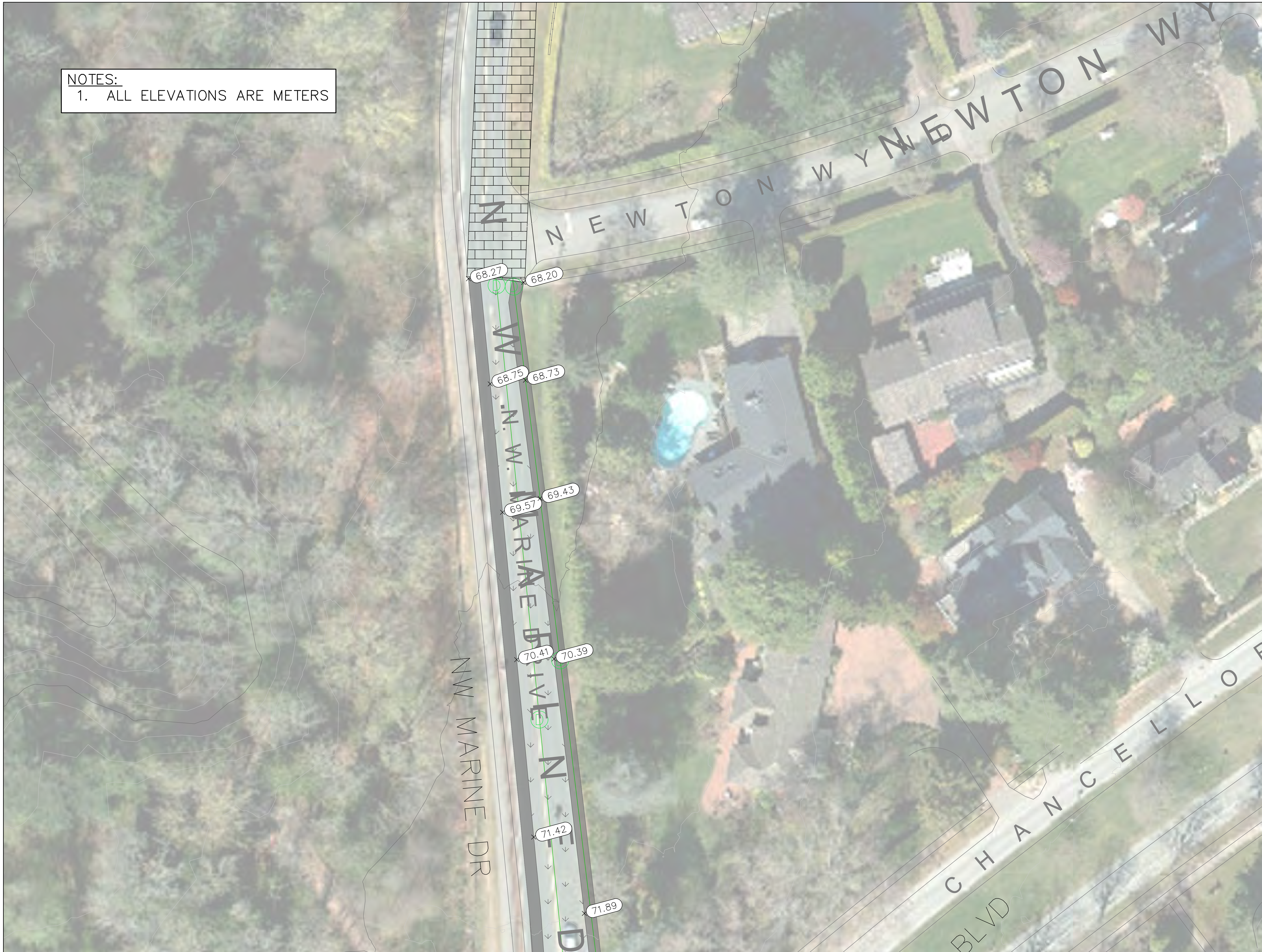
PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

DRAWING TITLE:
INTERSECTION GRADING
PLAN 1

REVISION NO:
01

C-06

NOTES:
1. ALL ELEVATIONS ARE METERS




PACIFIC URBAN

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| REVISIONS | |

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2024-04-04

SCALE: 1:250

PROJECT NAME:
EAST MALL & CHANCELLOR
INTERSECTION REDESIGN

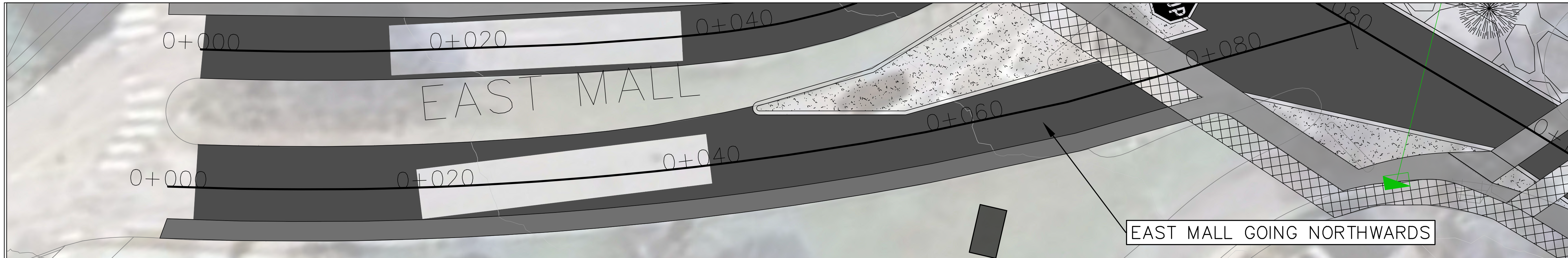
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

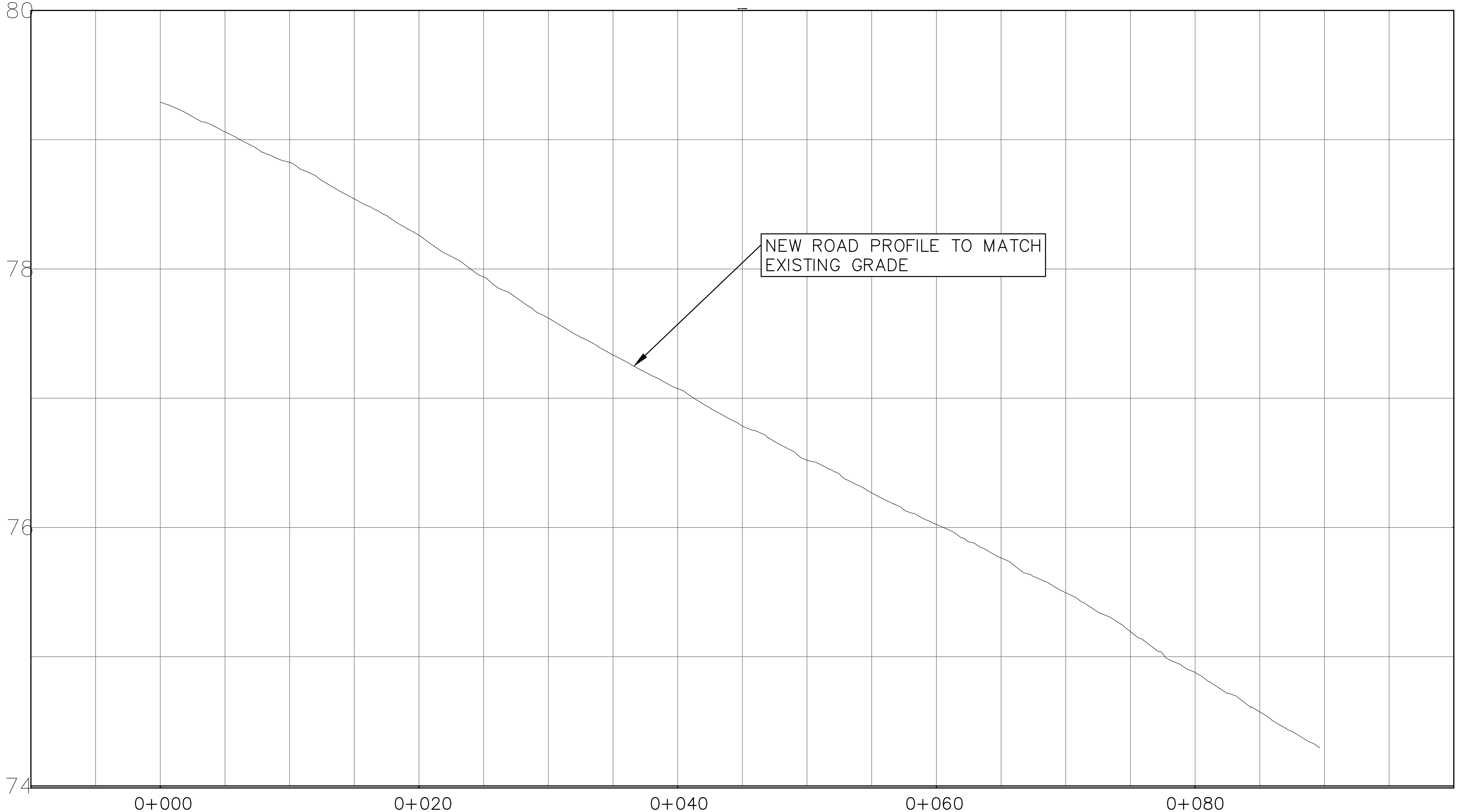
DRAWING TITLE:
INTERSECTION GRADING
PLAN 2

REVISION NO:
01

C-07




NORTH BOUND EAST MALL ROAD PROFILE




PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025–04–04

SCALE: 1:150

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN

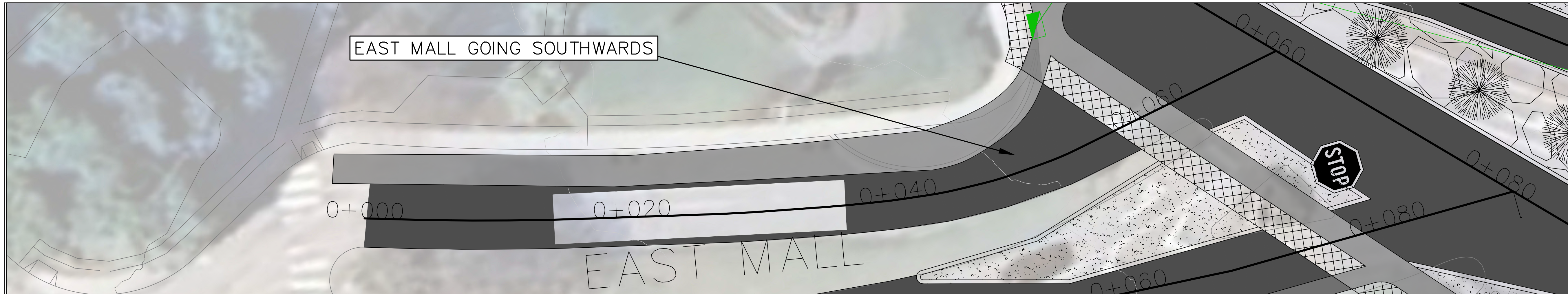
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

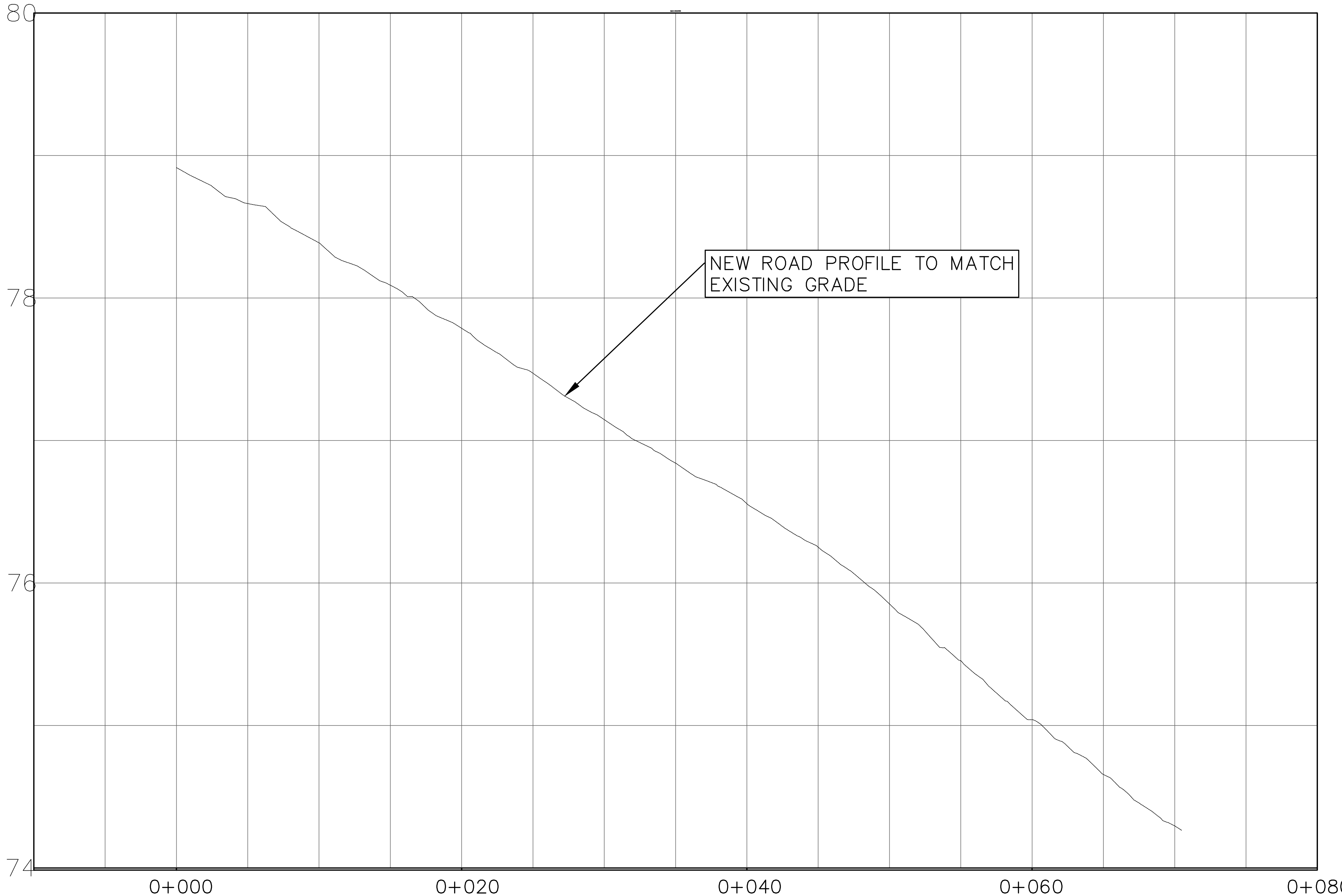
DRAWING TITLE:
NORTH BOUND EAST MALL ROAD
PLAN AND PROFILE

REVISION NO:
01

C–08




SOUTH BOUND EAST MALL ROAD PROFILE




PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025–04–04

SCALE: 1:150

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN

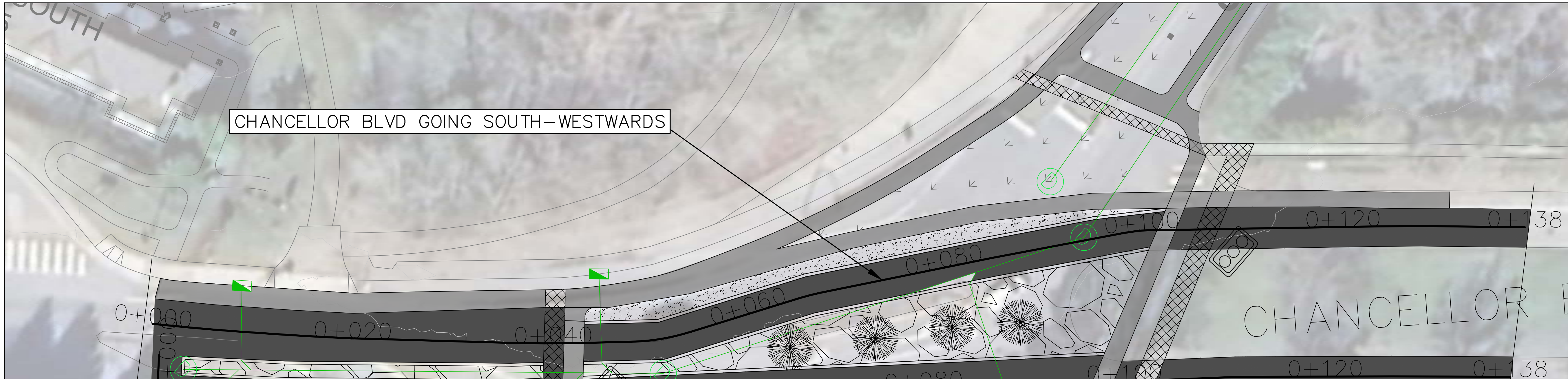
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

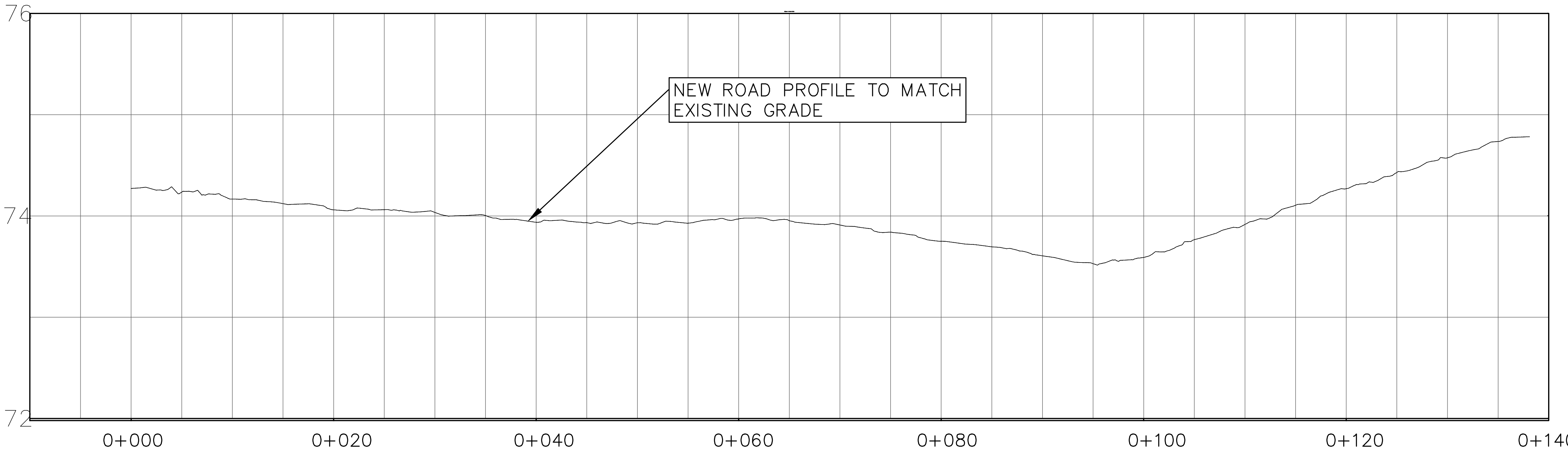
DRAWING TITLE:
SOUTH BOUND EAST MALL ROAD
PLAN AND PROFILE

REVISION NO:
01

C–09




WEST BOUND CHANCELLOR BLVD. ROAD PROFILE




PACIFIC URBAN

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|---|---|
| | 5 |
| | 4 |
| | 3 |
| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: MA

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025–04–04

SCALE: 1:200

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN

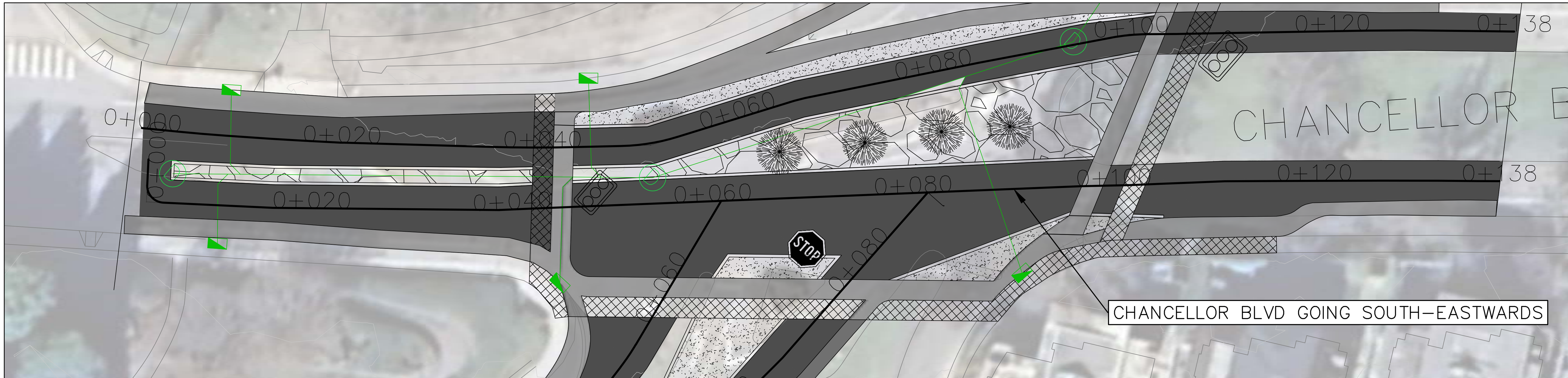
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

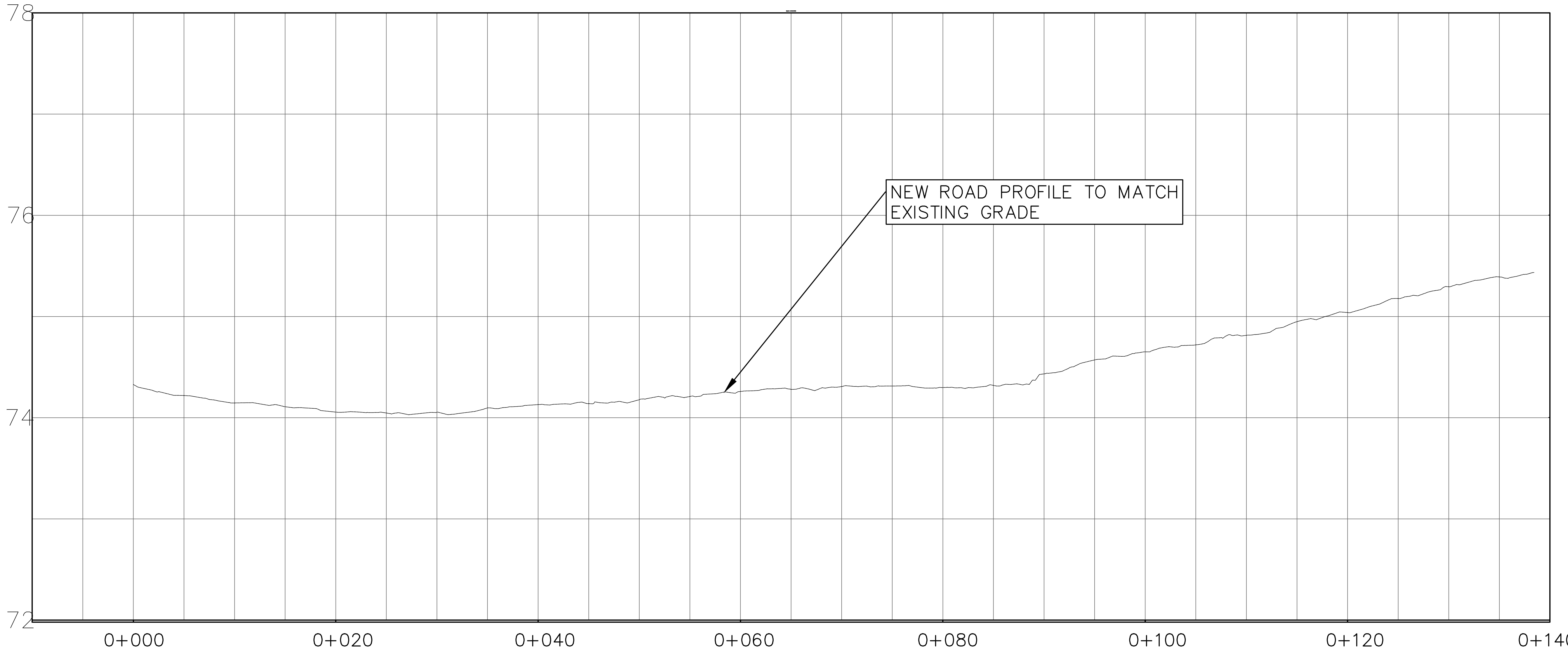
DRAWING TITLE:
WEST BOUND CHANCELLOR BLVD ROAD
PLAN AND PROFILE

REVISION NO:
01

C–10




## EAST BOUND CHANCELLOR BLVD. ROAD PROFILE




PACIFIC URBAN

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| | 5 |
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| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: MA
CHECKED BY: MA
DRAWN BY: MA
DRAWING DATE: 2025-04-04
SCALE: 1:200

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

DRAWING TITLE:
EAST BOUND CHANCELLOR BLVD ROAD
PLAN AND PROFILE

REVISION NO:
01

C-11

NOTES:
1. PHASE 4: JERSEY BARRIERS TO BE INSTALLED AFTER PHASE 3 IN LOCATIONS MENTIONED IN DRAWING C–X.X


PACIFIC URBAN

| REVISIONS | |
|---|---|
| | 5 |
| | 4 |
| | 3 |
| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |

DESIGNED BY: IJD
CHECKED BY: MA
DRAWN BY: MA
DRAWING DATE: 2025–04–04
SCALE: 1:500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
CHANCELLOR BLVD. AND EAST MALL INTERSECTION, UBC

DRAWING TITLE:
CONSTRUCTION PHASING PLAN 1

REVISION NO:
01

C–12


PACIFIC URBAN

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| | 5 |
| | 4 |
| | 3 |
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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: IJD

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:2500

PROJECT NAME:
EAST MALL AND CHANCELLOR BLVD
INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
CHANCELLOR BLVD & EAST MALL
INTERSECTION, UBC

DRAWING TITLE:
CONSTRUCTION PHASING
PLAN 2

REVISION NO:
01

C-13


PACIFIC URBAN

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|---|---|
| | 5 |
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| ISSUED FOR IFC | 1 |
| REVISIONS | |

DESIGNED BY: SJ

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:250

PROJECT NAME:
EAST MALL AND CHANCELLOR BLVD INTERSECTION REDESIGN

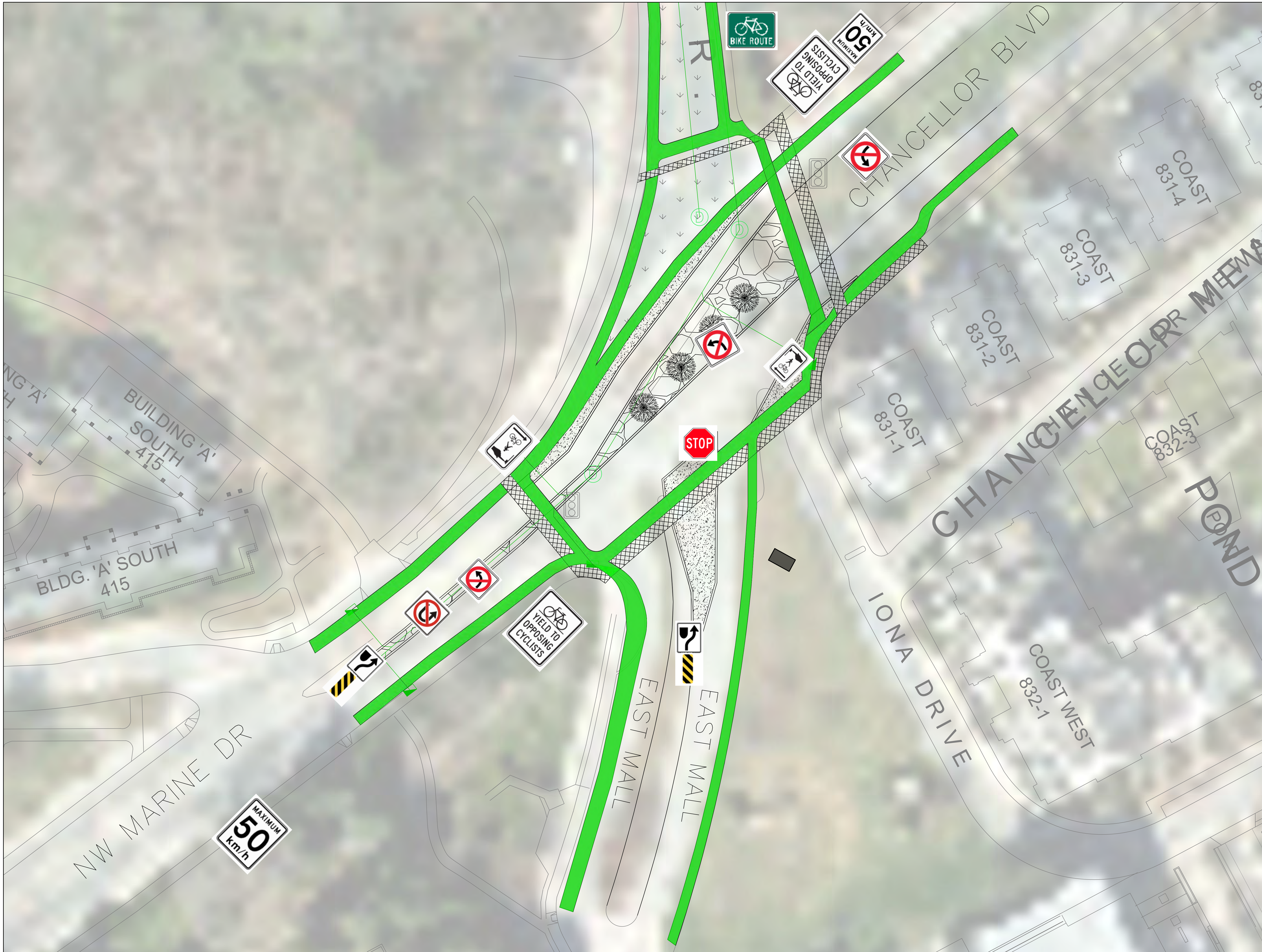
CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL AND CHANCELLOR BLVD AT UBC

DRAWING TITLE:
INTERSECTION ROAD MARKING PLAN VIEW

REVISION NO:
01

C-14




PACIFIC URBAN

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| ISSUED FOR IFC | 1 |
| REVISIONS | |

DESIGNED BY: SJ

CHECKED BY: MA

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:250

PROJECT NAME:
EAST MALL AND CHANCELLOR BLVD INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL AND CHANCELLOR BLVD AT UBC

DRAWING TITLE:
INTERSECTION SIGNAGE PLAN VIEW

REVISION NO:
01

C-15


PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: MA, SJ

CHECKED BY: ID, SJ

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:2500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

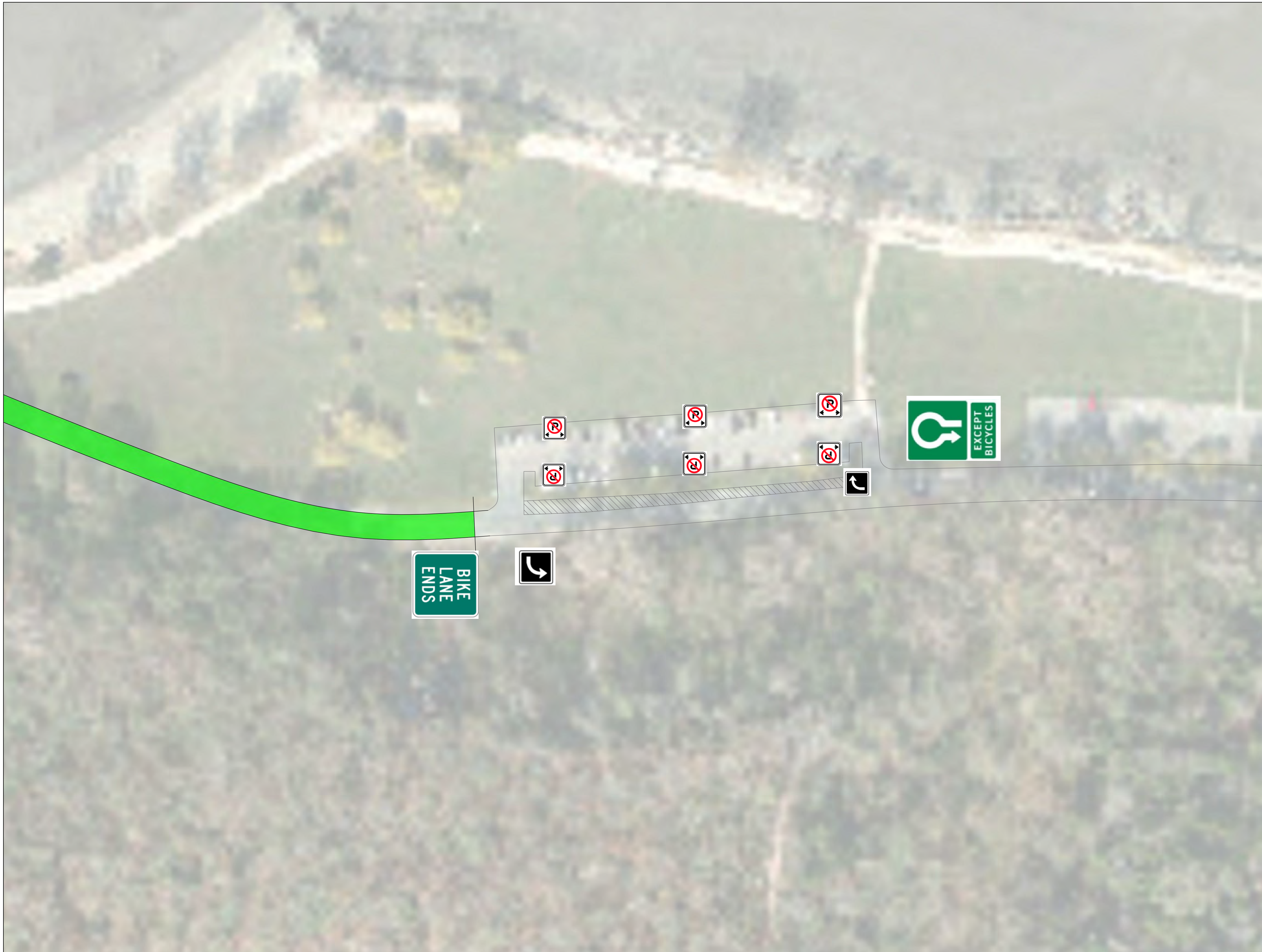
CLIENT:
TRANSPORTATION ENGINEERING SUSTAINABILITY AND ENGINEERING, CAMPUS + COMMUNITY AT UBC

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
OVERALL PROJECT SIGNAGE PLAN VIEW

REVISION NO:
01

C-16




PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: SJ, MA

CHECKED BY: SJ. ID

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

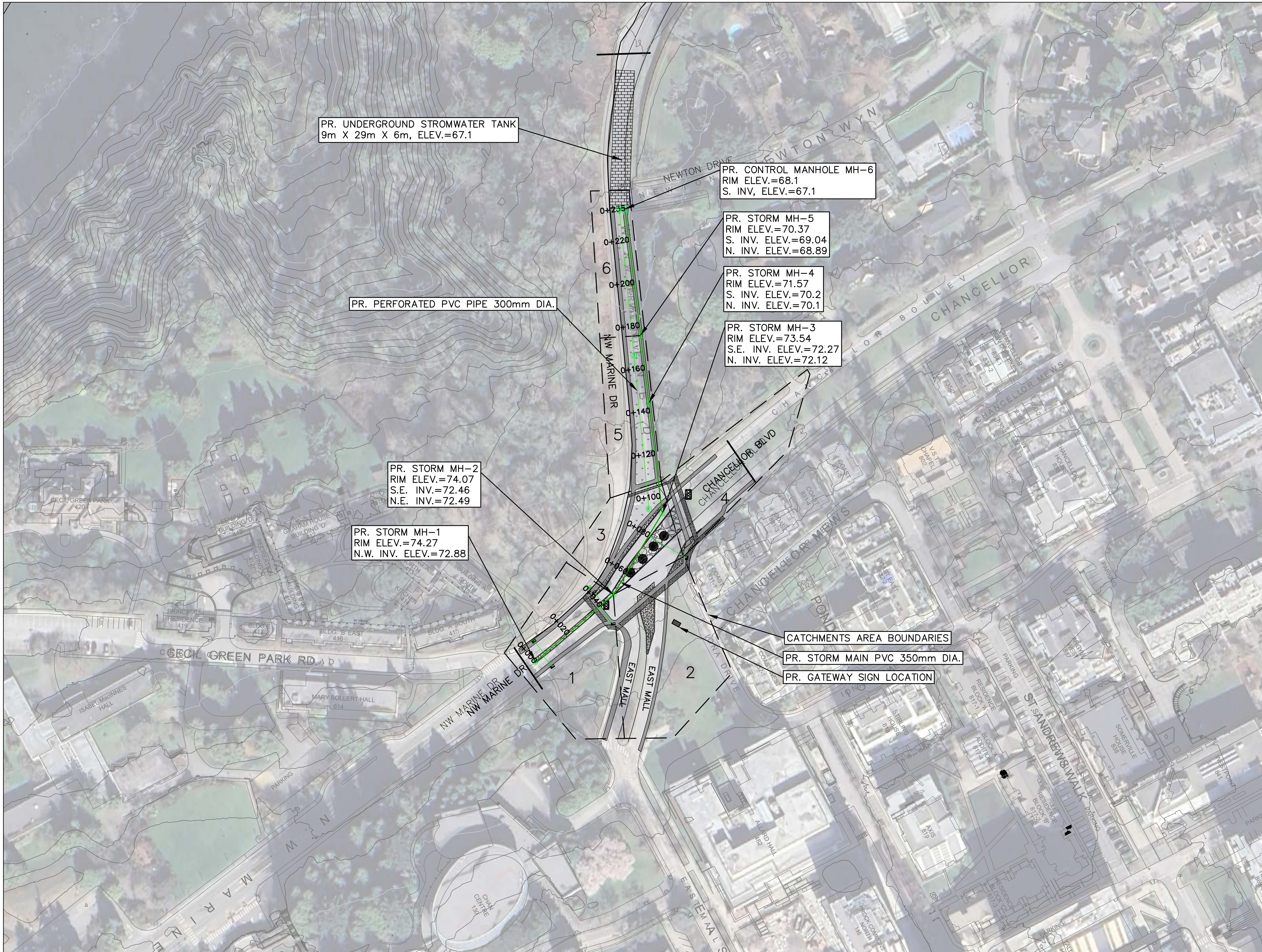
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
FIRST SPANISH BANKS PARKING
LOT BY N.W. MARINE DRIVE

DRAWING TITLE:
SPANISH BANKS LOT
SIGNAGE PLAN VIEW
PLAN VIEW

REVISION NO:
01

C-17




N

PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: MA

CHECKED BY: SJ, LR

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:750

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD. INTERSECTION DESIGN

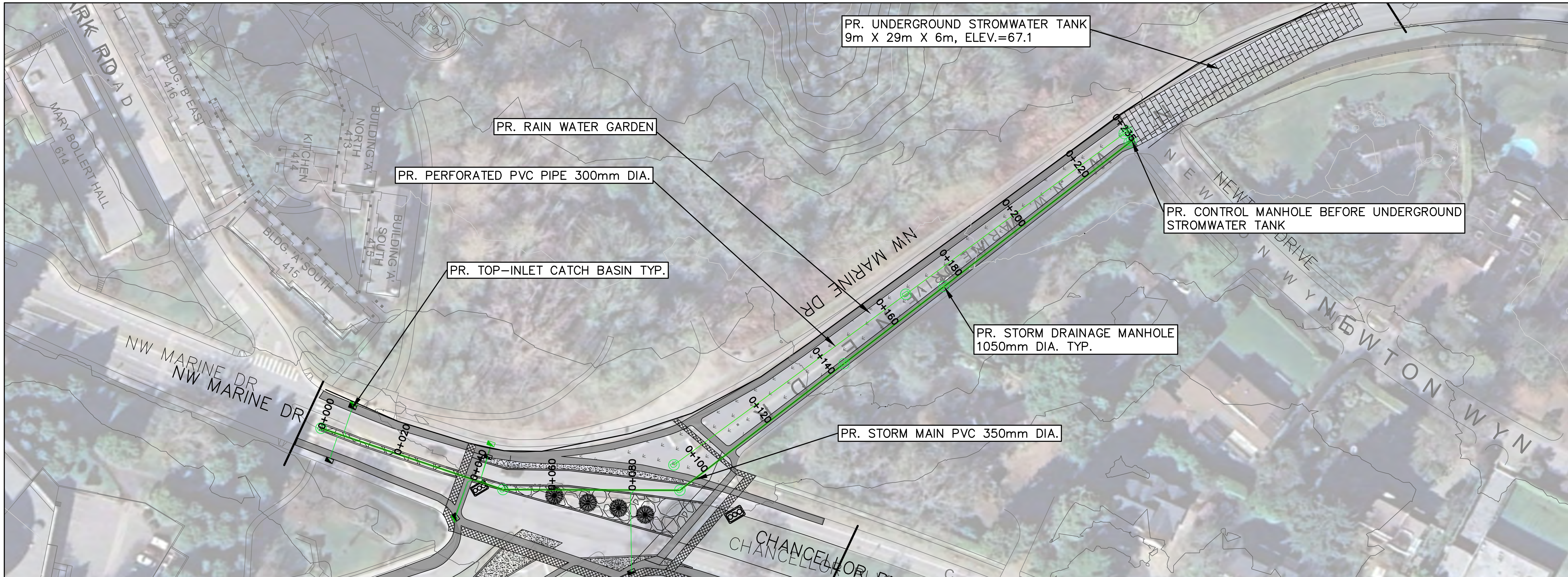
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

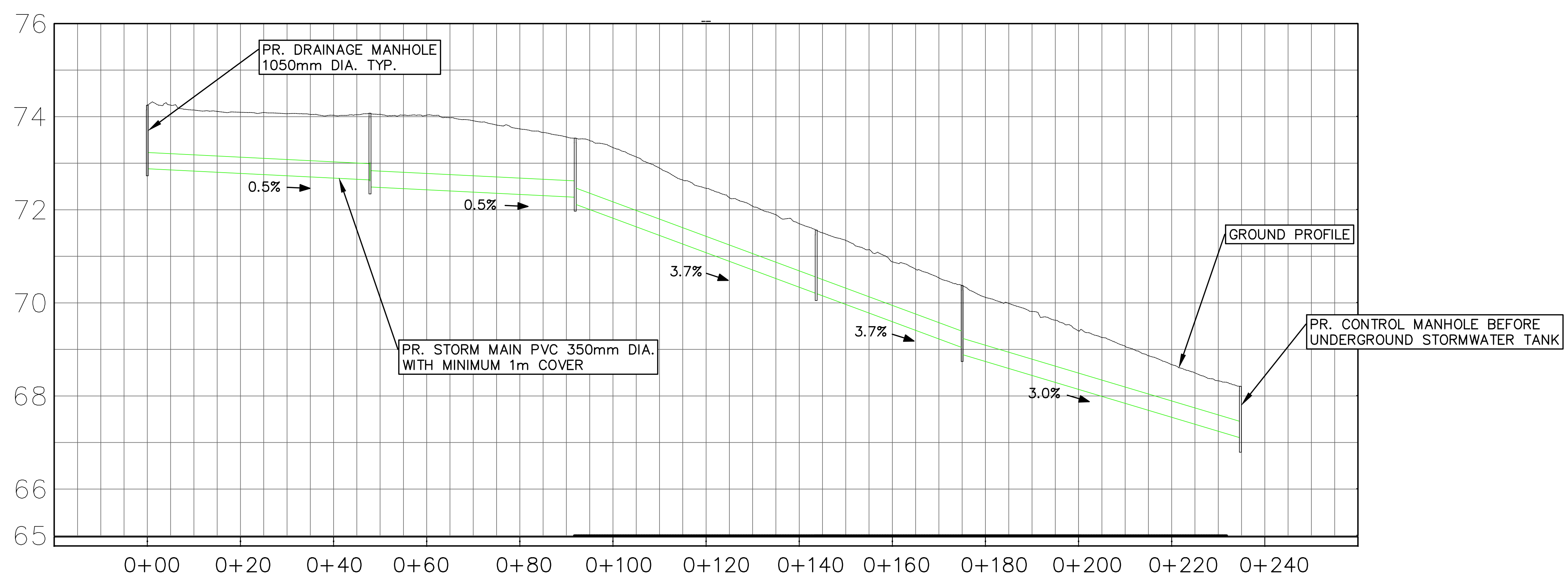
PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD.
UBC

DRAWING TITLE:
EAST MALL & CHANCELLOR BLVD
PROPOSED INTERSECTION
STORMWATER MANAGEMENT PLAN

REVISION NO:
01

C-18




PROFILE VIEW OF STORM MAINS

PACIFIC URBAN

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|---|---|
| | 5 |
| | 4 |
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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: MA

CHECKED BY: SJ, LS

DRAWN BY: MA

DRAWING DATE: 2025-04-04

SCALE: 1:500

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH OF COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

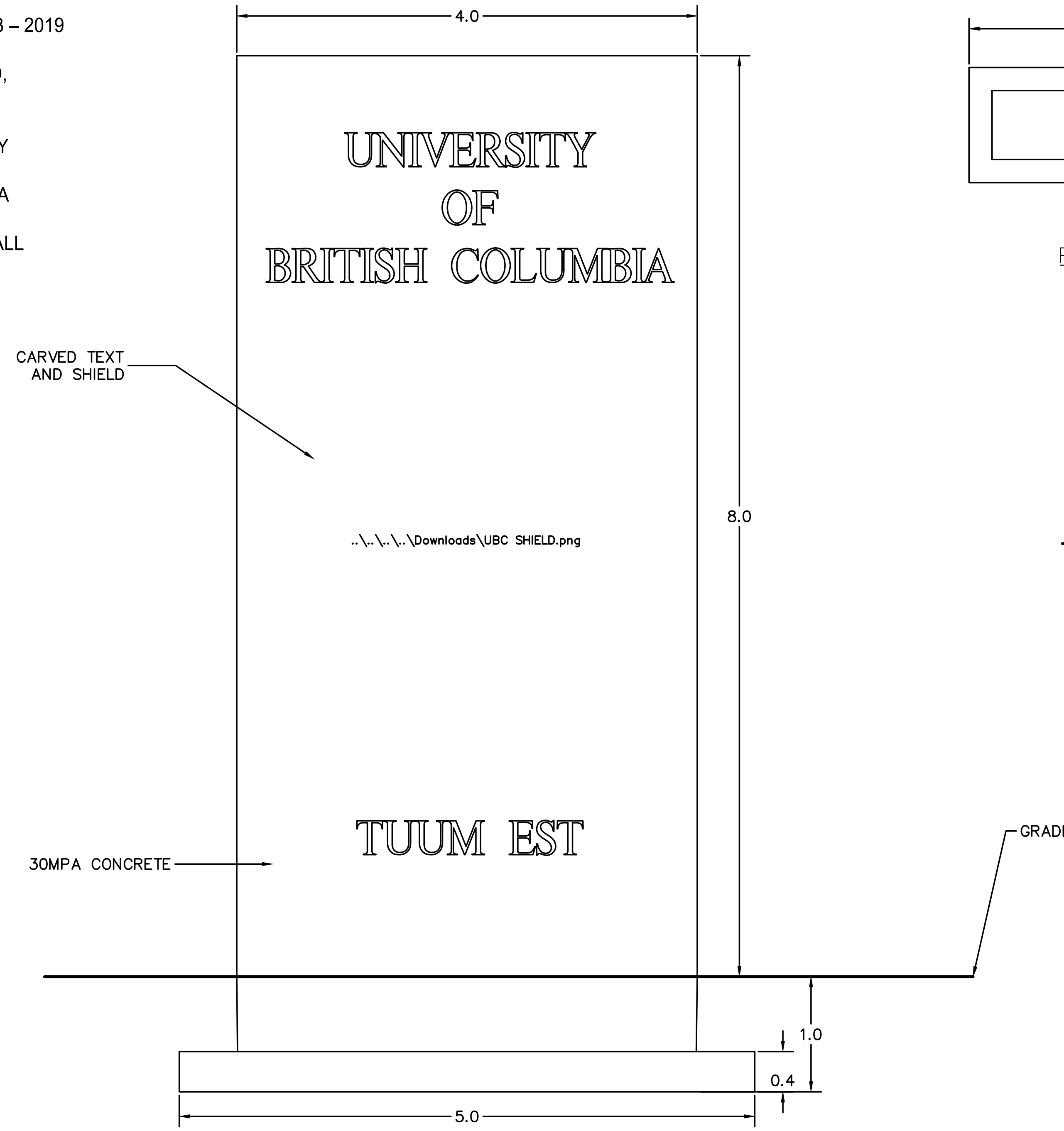
DRAWING TITLE:
STORMWATER UTILITIES
PLAN AND PROFILE

REVISION NO:
01

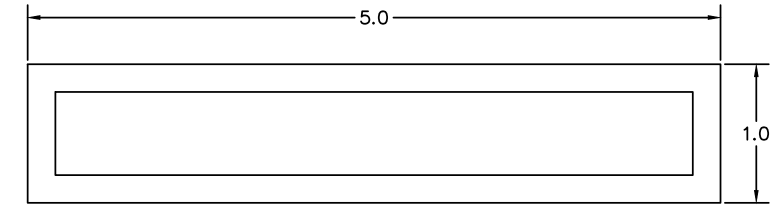
C-19

STRUCTURAL NOTES:

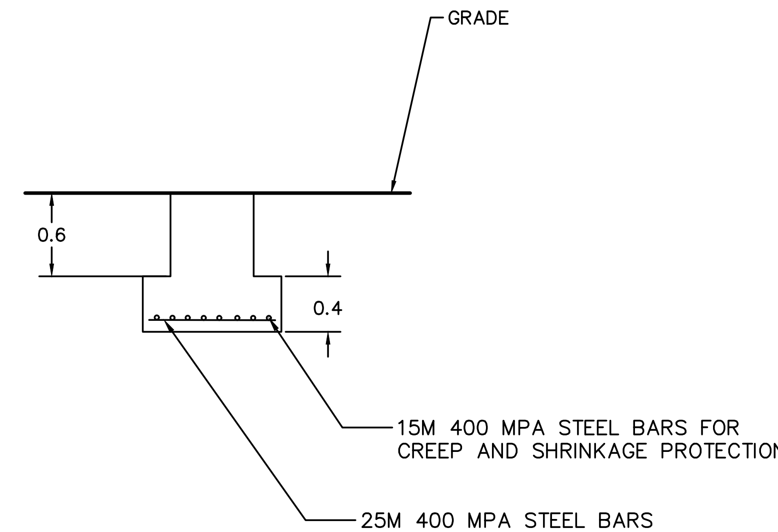
1. SHEAR WALL DESIGN TO FOLLOW CSA A23.3 – 2019 STANDARDS
2. LOADS CONSIDERED IN DESIGN: DEADLOAD, WINDLOAD, AND SEISMIC LOAD
3. ASSUMED SITE CLASSIFICATIONS CLASS D
4. SHEAR WALL DESIGNED TO BE MODERATELY DUCTILE, APPROPRIATE FOR VANCOUVER
5. SPECIFIED CONCRETE STRENGTH OF 30 MPA
6. ALL REINFORCEMENT STEEL 400 GRADE
7. CONCRETE COVER OF 30MM FOR SHEAR WALL



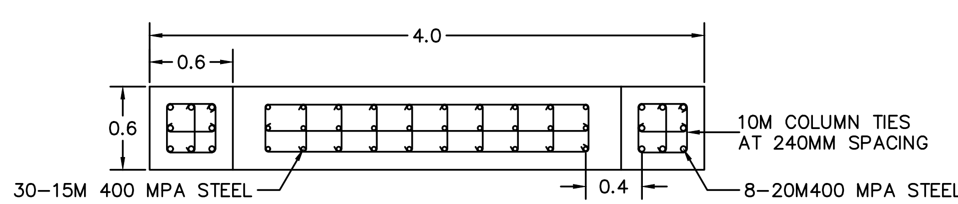

PROFILE VIEW OF GATEWAY SIGN (SHEAR WALL) AND STRIP FOOTING




PLAN VIEW OF STRIP FOOTING FOR GATEWAY SIGN




CROSS SECTION VIEW OF THE STRIP FOOTING




PLAN VIEW OF GATEWAY SIGN (SHEAR WALL)

PACIFIC URBAN

| REVISIONS | |
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| | 5 |
| | 4 |
| | 3 |
| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |

DESIGNED BY: SH, JB

CHECKED BY: MA

DRAWN BY: SH

DRAWING DATE: 2025–04–04

SCALE: 1:25

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION DESIGN

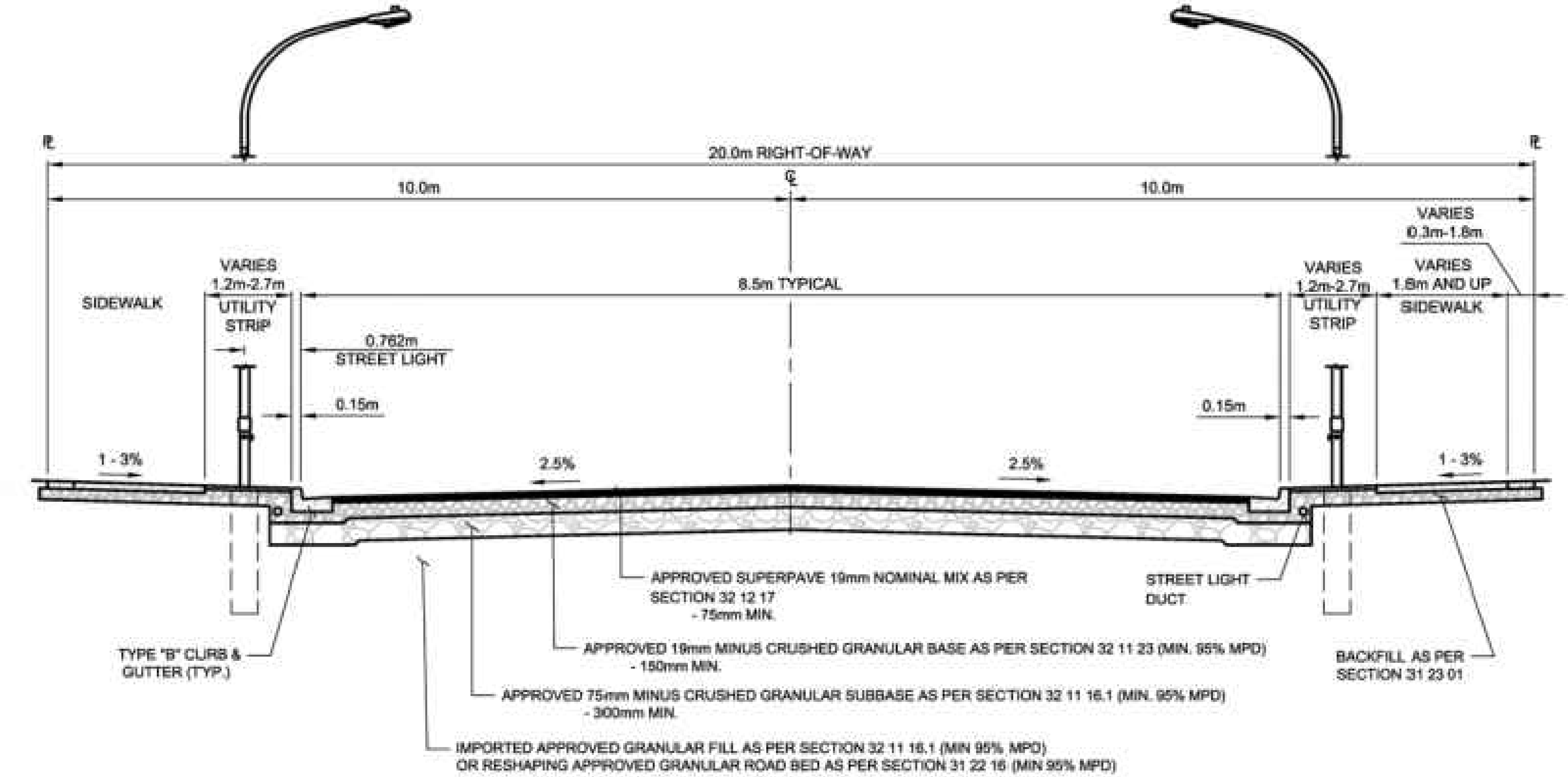
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNVIERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
GATEWAY SIGN AND FOUNDATION DETAILS

REVISION NO:
01

C–21




NOTE: 1. ONLY TO BE USED FOR NEW ROAD CONSTRUCTION.
2. FOR SUBGRADE SOIL CLASS, SC, ML OR CL ONLY. OTHER SOIL CLASSES REQUIRE SPECIAL TREATMENT. GEOTECHNICAL ENGINEER REQUIRED TO DETERMINE SUBGRADE SOIL CLASSIFICATION.

NOT TO SCALE

## TYPICAL CROSS SECTION RESIDENTIAL STREET

PACIFIC URBAN

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| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: –
CHECKED BY: –
DRAWN BY: MA
DRAWING DATE: 2025–04–04
SCALE: NOT TO SCALE

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

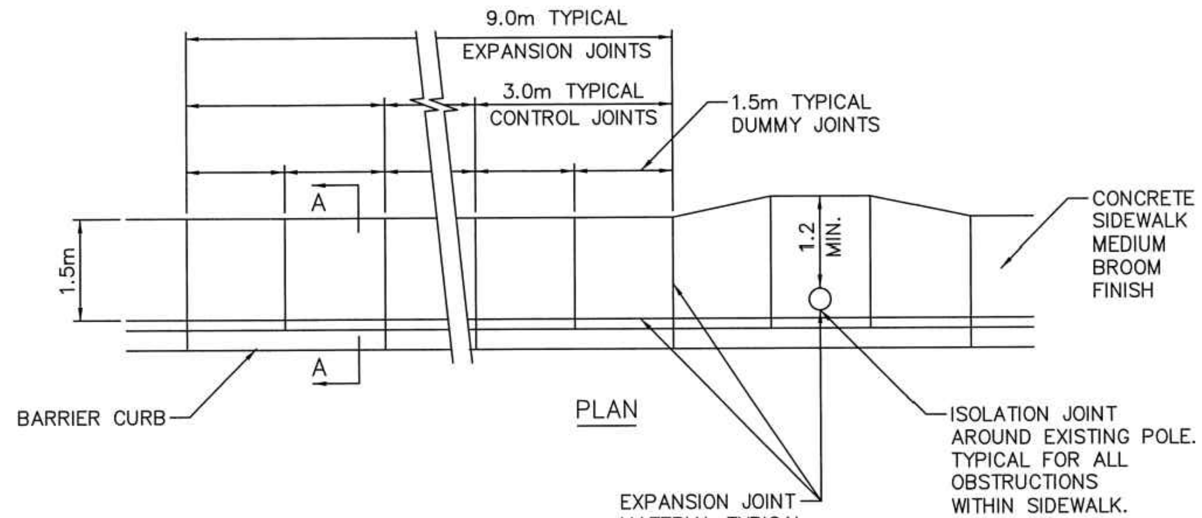
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

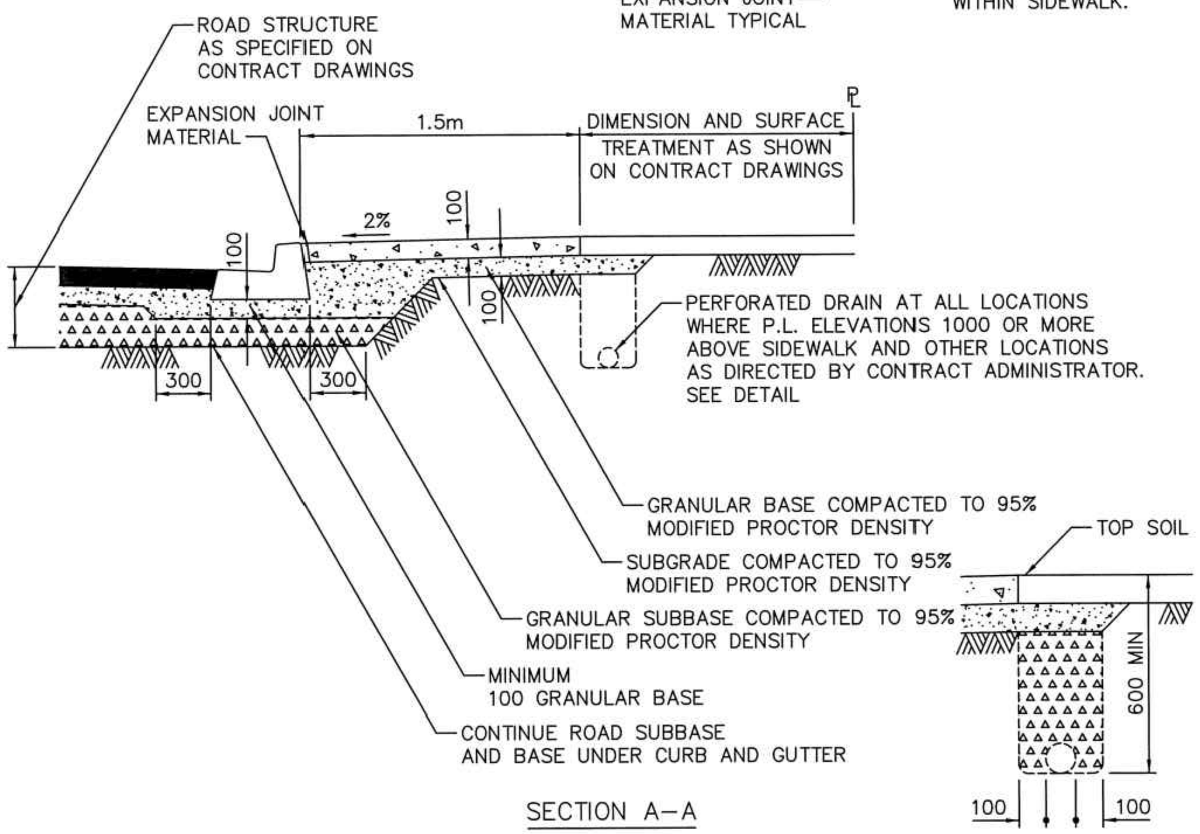
PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
ROAD PAVEMENT DETIALS

REVISION NO:
01

C–21

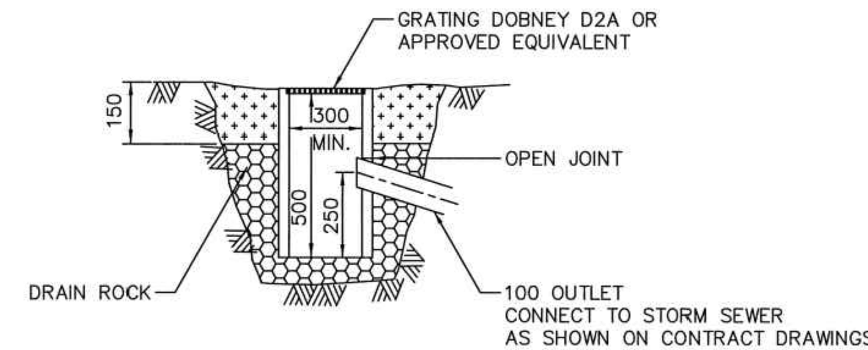


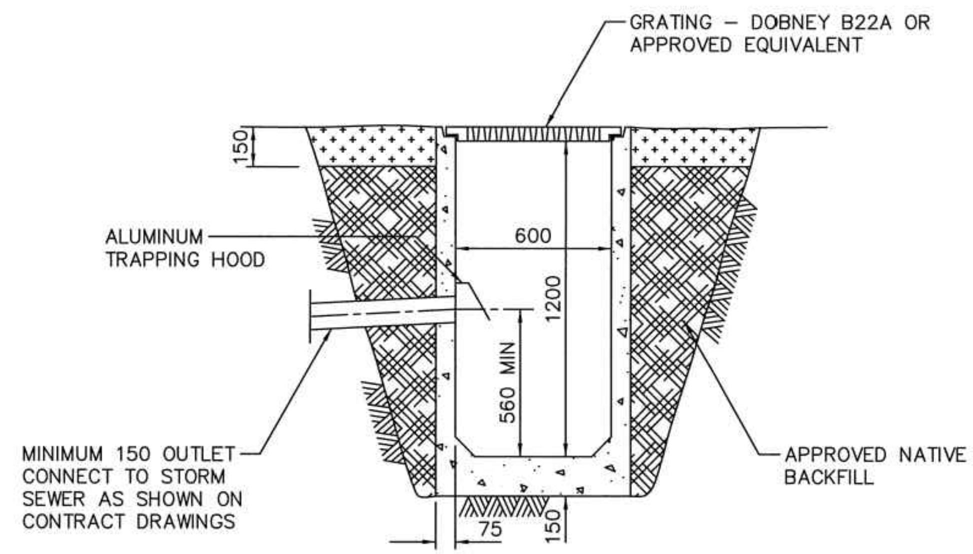

NOTE: 1. REFER TO DRAWING C4 OR C5 FOR CURB AND GUTTER DIMENSIONS.
2. REFER TO CONTRACT DRAWINGS, SECTION 03 30 20 FOR DETAILED SPECIFICATIONS.

NOT TO SCALE

## CONCRETE SIDEWALK AND BARRIER CURB




TYPE 1




TYPE 2

NOTE: 1. REFER TO CONTRACT DRAWINGS, SECTION 33 44 01 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

NOT TO SCALE

## LAWN DRAINS DETAILS

PACIFIC URBAN

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| | 5 |
| | 4 |
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| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: –
CHECKED BY: –
DRAWN BY: MA
DRAWING DATE: 2025–04–04
SCALE: NOT TO SCALE

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

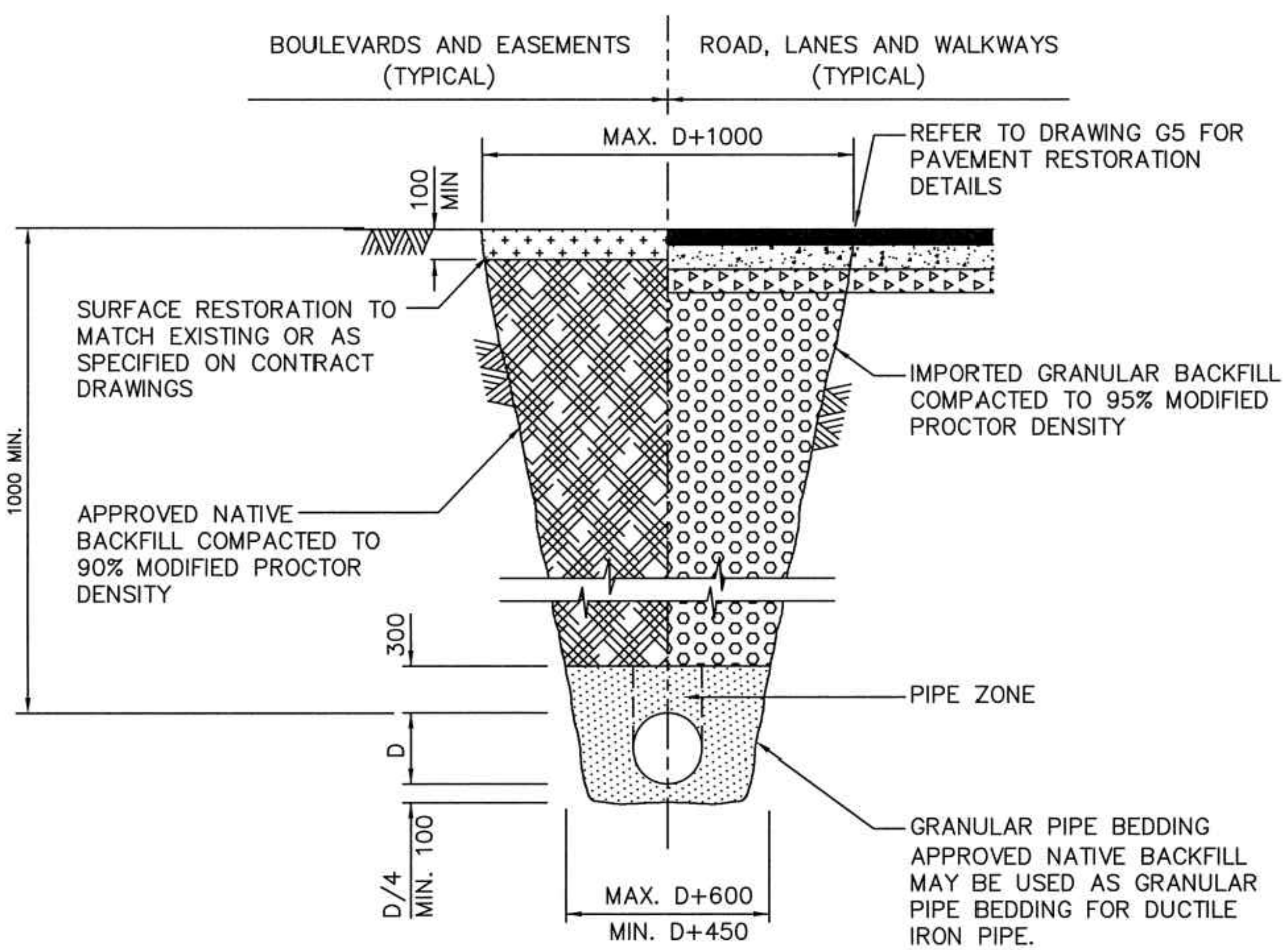
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
CONCRETE SIDEWALK
AND LAWN DRAIN DETAILS

REVISION NO:
01

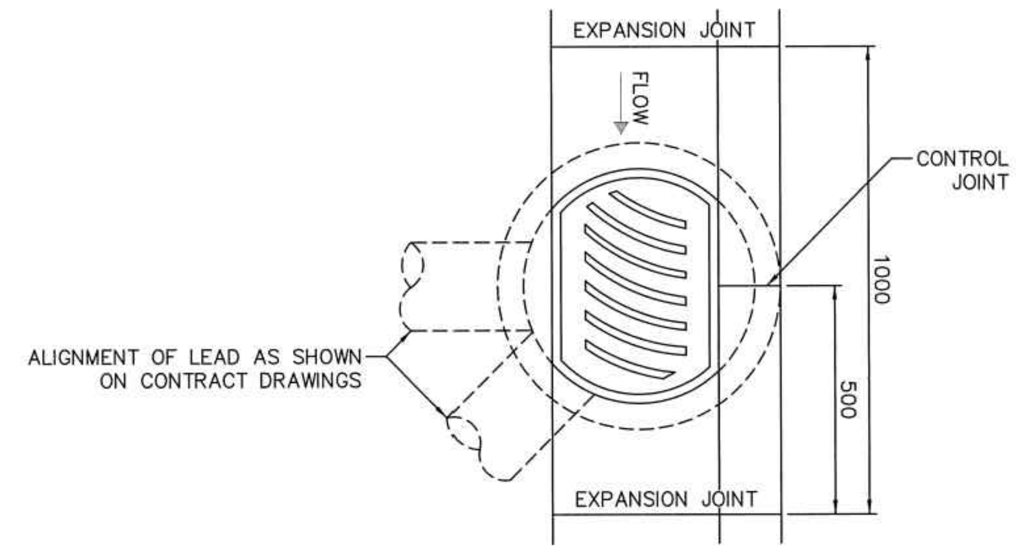
C–22



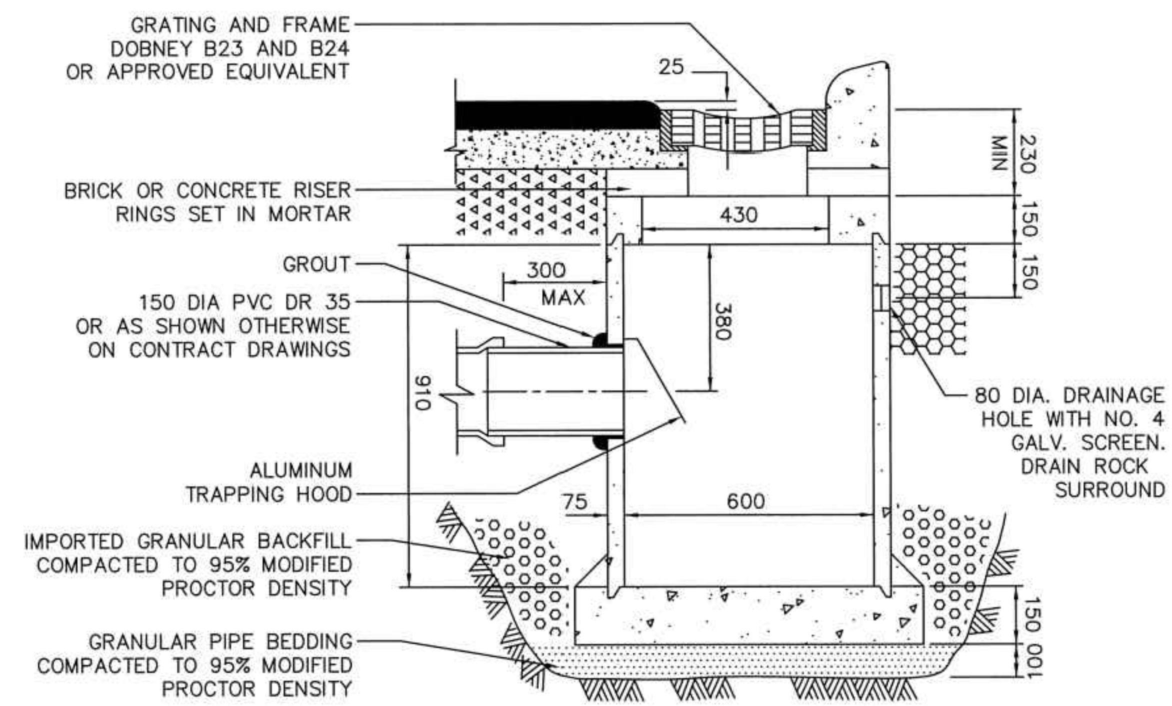

NOTE: 1. TRENCHING TO COMPLY WITH ALL REQUIREMENTS OF WORKSAFE BC.
2. REFER TO CONTRACT DRAWINGS, SECTION 31 23 01 FOR DETAILED SPECIFICATIONS
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

NOT TO SCALE

## UTILITY TRENCH DETAILS




FRAME AND COVER DETAILS




STANDARD CATCHBASIN

NOTE: 1. PRECAST UNITS c/w BASE, APPROVED BY CONTRACT ADMINISTRATOR, ARE ACCEPTABLE.
2. REFER TO CONTRACT DRAWINGS, SECTION 33 44 01 FOR DETAILED SPECIFICATIONS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

NOT TO SCALE

## TOP INLET CATCHBASIN DETAILS

PACIFIC URBAN

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| | 5 |
| | 4 |
| | 3 |
| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: –

CHECKED BY: –

DRAWN BY: MA

DRAWING DATE: 2025–04–04

SCALE: NOT TO SCALE

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION DESIGN

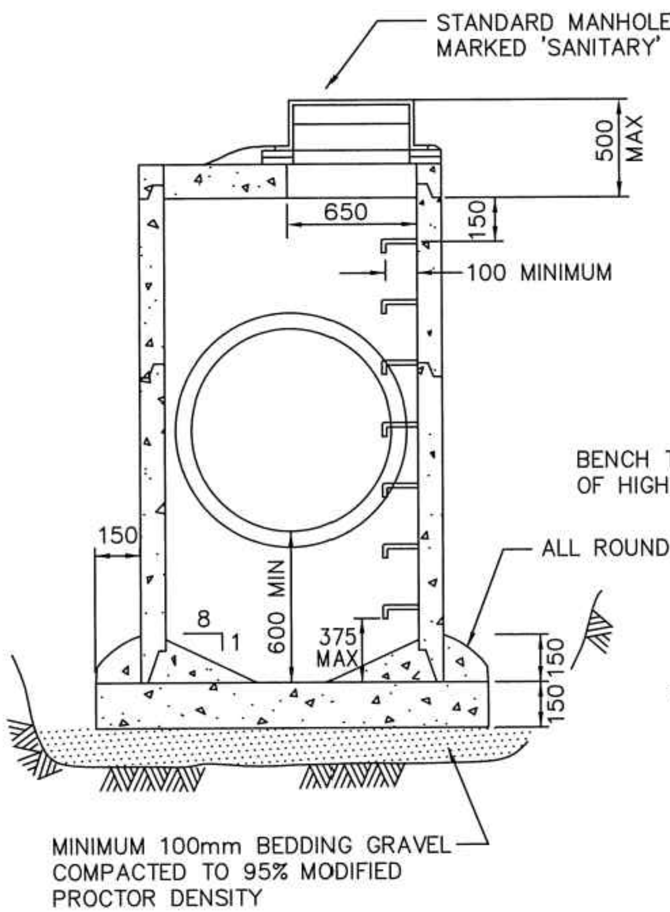
CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

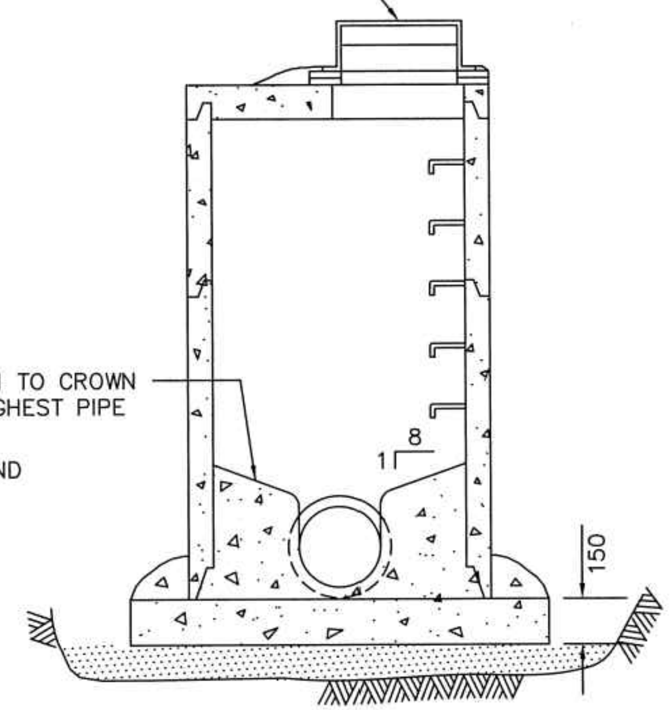
DRAWING TITLE:
UTILITY TRENCH AND CATCH BASIN DETAILS

REVISION NO:
01

C–23

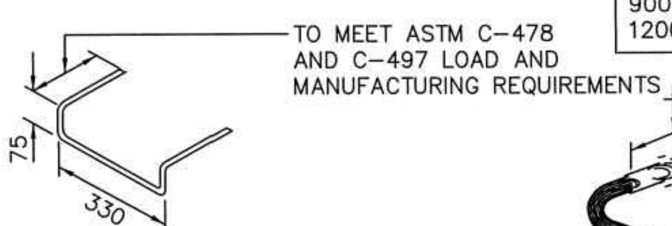



MANHOLE WITH SUMP

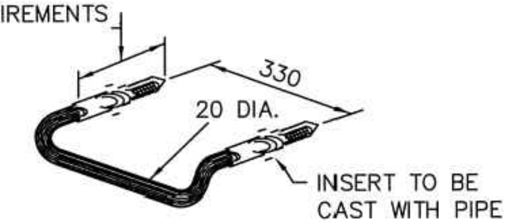



STANDARD 1050mm MANHOLE

| INSIDE PIPE DIA. | INSIDE MANHOLE DIA. |
|---|---|
| 450mm AND LESS | 1050 |
| 525 AND 600 | 1200 |
| 675 AND 750 | 1350 |
| 900 AND 1050 | 1500 |
| 1200 AND OVER | RISER MANHOLE |




GALVANIZED LADDER RUNG
TO BE CAST WITH PIPE

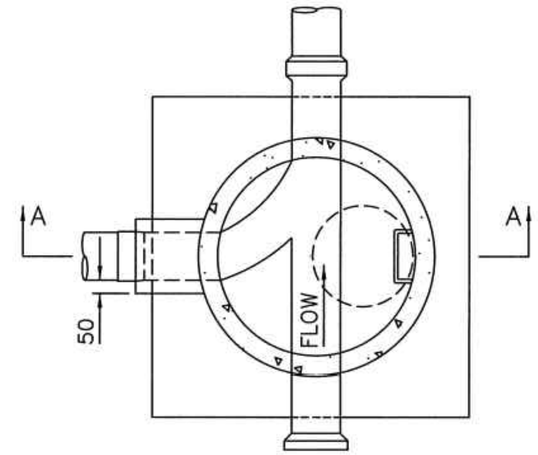



GALVANIZED, ALUMINUM OR POLY-
ENCASED LADDER RUNG

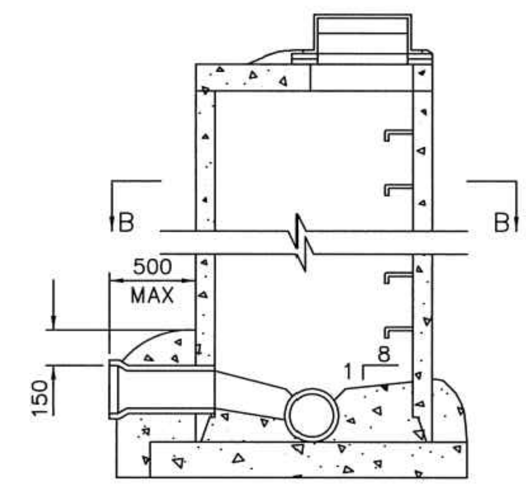
NOTE:
1. DETAILS ARE DRAWN FOR PRECAST RISERS ON CAST-IN-PLACE BASE. PRECAST BASES APPROVED BY CONTRACT ADMINISTRATOR ARE ACCEPTABLE.
2. MAXIMUM DEPTH TO FIRST RUNG IS 500mm. WHEN HANDHOLD IS INSTALLED BETWEEN TOP AND FIRST RUNG, MAXIMUM DEPTH MAY BE INCREASED TO 660mm
3. FOR MANHOLES OVER 1200mm DIA. BASE THICKNESS TO BE 200mm.
4. REFER TO DRAWING S2 FOR CONNECTION DETAILS.
5. REFER TO CONTRACT DRAWINGS, SECTION 33 44 01 FOR DETAILED SPECIFICATIONS.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

NOT TO SCALE

## STANDARD SUMP AND MANHOLES DETAILS




SECTION B–B




SECTION A–A

NOTE:
1. THIS DRAWING SHOWS CONNECTION DETAILS ONLY, REFER TO DRAWING S1 FOR ALL OTHER DETAILS PERTAINING TO MANHOLE REQUIREMENTS AND INSTALLATION
2. REFER TO CONTRACT DRAWINGS, SECTION 33 44 01 FOR DETAILED SPECIFICATIONS.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

NOT TO SCALE

## STANDARD MANHOLE CONNECTION DETAILS

PACIFIC URBAN

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| | 5 |
| | 4 |
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| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |

REVISIONS

DESIGNED BY: –
CHECKED BY: –
DRAWN BY: MA
DRAWING DATE: 2025–04–04
SCALE: NOT TO SCALE

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD
INTERSECTION DESIGN

CLIENT:
KRISTA FALKNER, P.ENG
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

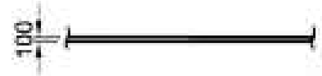
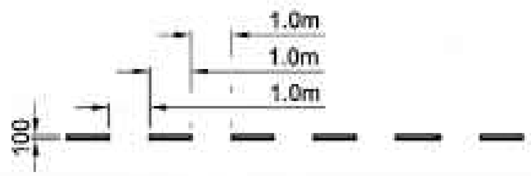
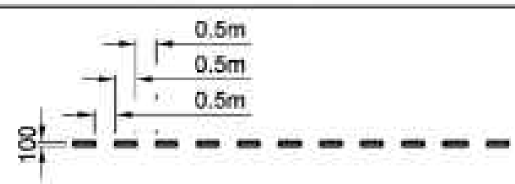
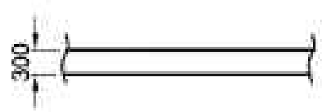
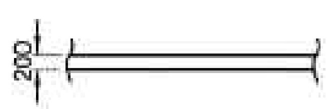
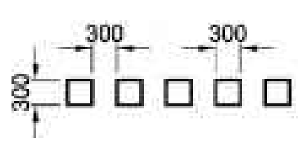
PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
UBC

DRAWING TITLE:
STANDARD MANHOLE DETAILS

REVISION NO:
01

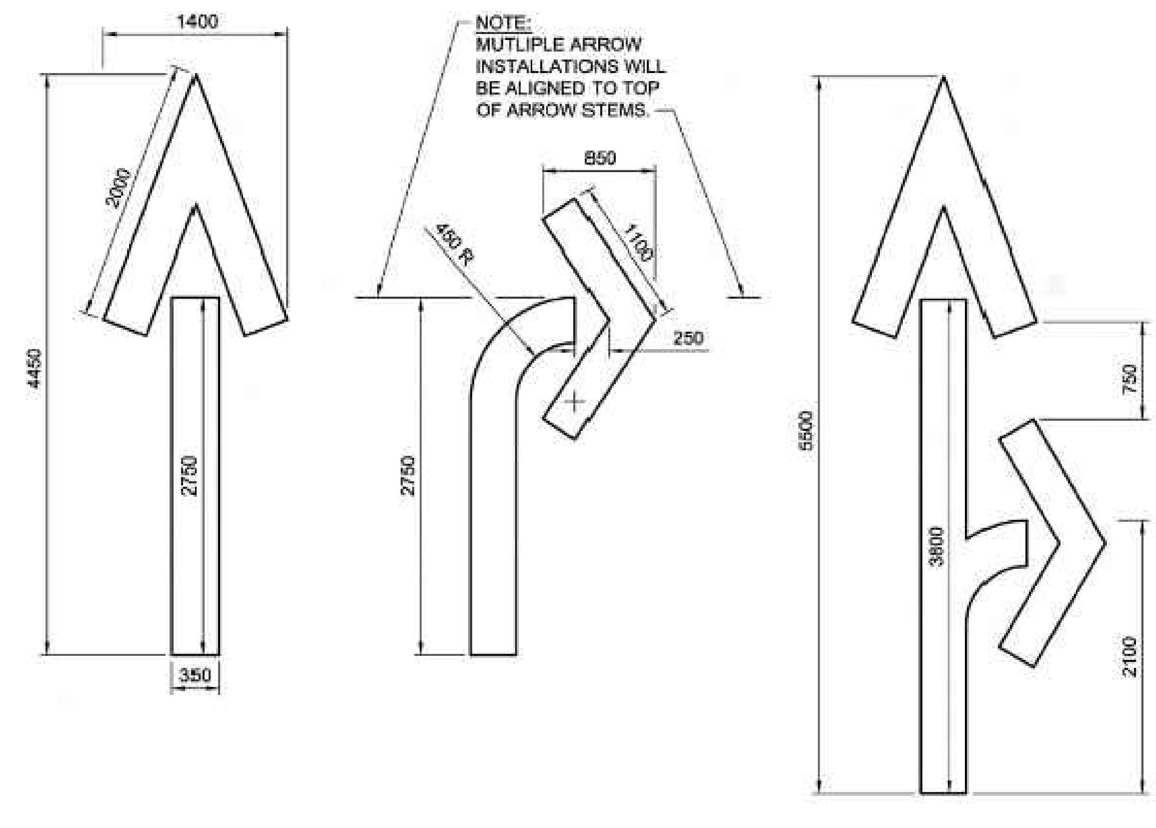
C–24

# INSTALLATION OF PAVEMENT MARKINGS

| TYPE | LINE DIMENSIONS (mm) | COLOR | |
|---|---|---|---|
| | | WHITE | YELLOW |
| SOLID |  | 1. EDGELINES ON THE RIGHT<br>2. LANE LINES PROHIBITING LANE CHANGES | 1. EDGELINES ON THE LEFT<br>2. DIRECTIONAL DIVIDING LINES |
| BROKEN |  | 1. LANE LINES | 1. DIRECTIONAL DIVIDING LINES |
| SHORT BROKEN |  | 1. CONTINUITY LINES IN MERGING AND DIVERGING AREAS<br>2. LEFT TURN BAYS | |
| DENSE BROKEN |  | 1. GUIDE LINES FOR INTERSECTION MOVEMENTS | 1. GUIDE LINES FOR INTERSECTION MOVEMENTS |
| STOP |  | 1. STOP LINES | |
| CROSSWALK |  | 1. CROSSWALKS | |
| ELEPHANT'S FEET |  | 1. BIKE CROSSINGS | |

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

SCALE: N.T.S.




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

SCALE: N.T.S

PACIFIC URBAN

| | |
|---|---|
| | 5 |
| | 4 |
| | 3 |
| | 2 |
| ISSUED FOR CONSTRUCTION | 1 |
| REVISIONS | |

DESIGNED BY: MA
CHECKED BY: MA
DRAWN BY: MA
DRAWING DATE: 2025-04-04
SCALE: NOT TO SCALE

PROJECT NAME:
EAST MALL & CHANCELLOR BLVD INTERSECTION REDESIGN

CLIENT:
KRISTA FALKNER, P.ENG.
CAMPUS + COMMUNITY PLANNING
AT UNIVERSITY OF BRITISH COLUMBIA

PROJECT ADDRESS:
EAST MALL & CHANCELLOR BLVD
AT UBC

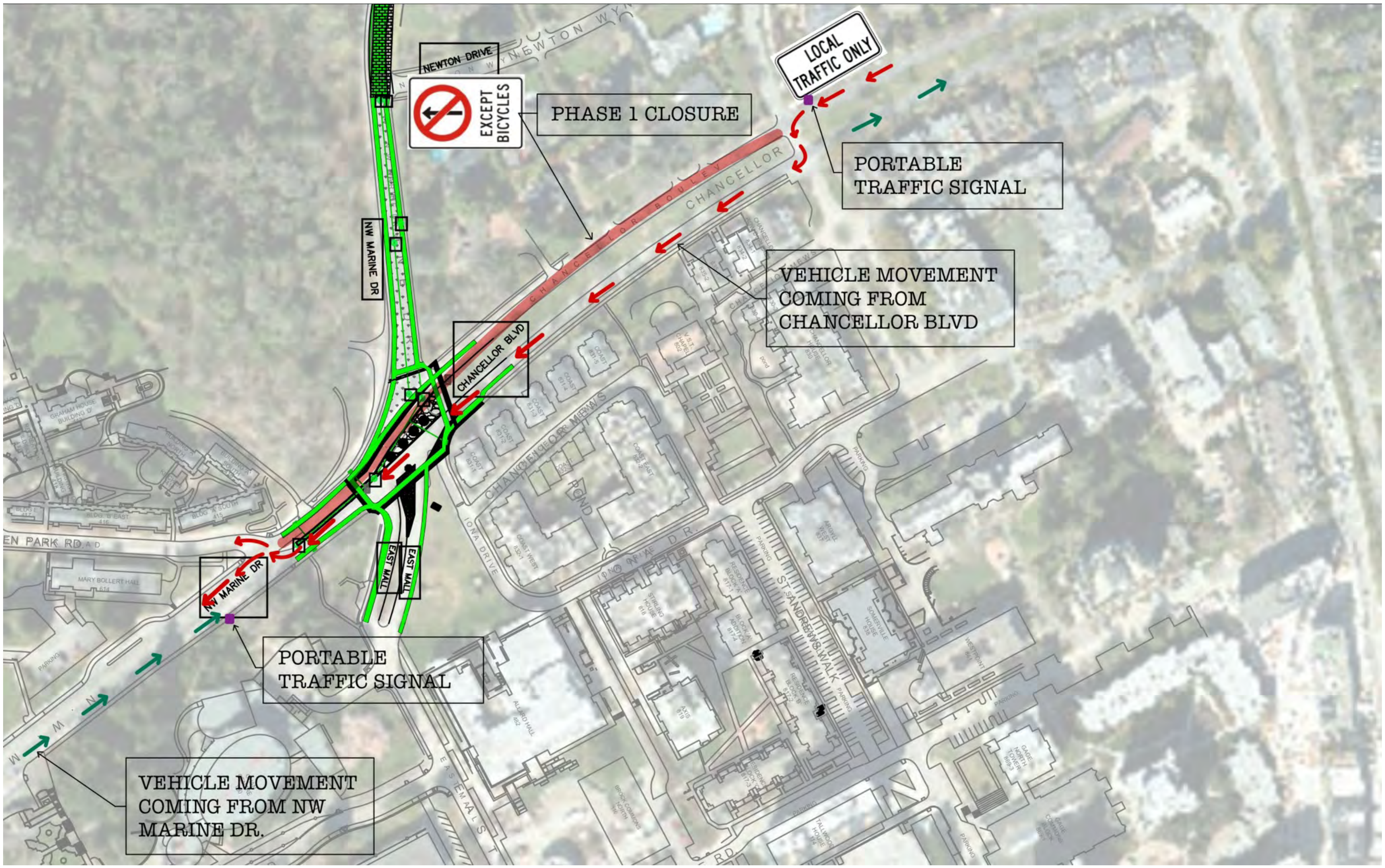
DRAWING TITLE:
ROAD MARKING DETAILS

REVISION NO:
01

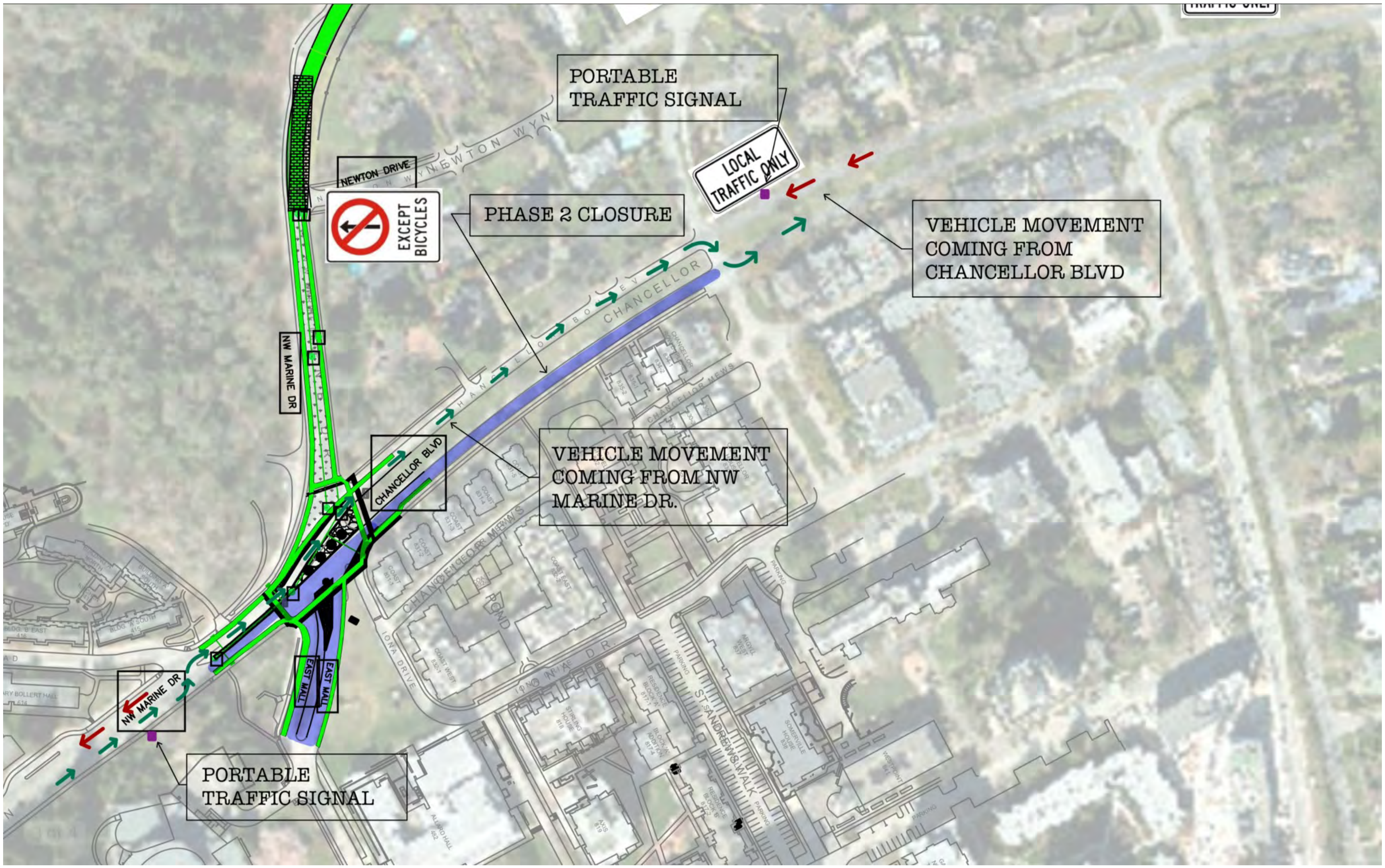
C-25

# Appendix D - Traffic Management Plan

D1. Phase 1 Closure and Vehicle Movement



D2. Phase 2 Closure and Vehicle Movement



D3. Temporary Pedestrian Lane

# Appendix E - Synchro Report

## Summary of All Intervals

| | |
|---|---|
| Start Time | 8:45 |
| End Time | 10:00 |
| Total Time (min) | 75 |
| Time Recorded (min) | 60 |
| # of Intervals | 2 |
| # of Recorded Intvls | 1 |
| Vehs Entered | 529 |
| Vehs Exited | 526 |
| Starting Vehs | 4 |
| Ending Vehs | 7 |
| Denied Entry Before | 0 |
| Denied Entry After | 0 |
| Travel Distance (km) | 117 |
| Travel Time (hr) | 4.8 |
| Total Delay (hr) | 2.0 |
| Total Stops | 231 |
| Fuel Used (l) | 39.1 |

## Interval #0 Information Seeding

| | |
|---|---|
| Start Time | 8:45 |
| End Time | 9:00 |
| Total Time (min) | 15 |

Volumes adjusted by Growth Factors.

No data recorded this interval.

## Interval #1 Information Recording

| | |
|---|---|
| Start Time | 9:00 |
| End Time | 10:00 |
| Total Time (min) | 60 |

Volumes adjusted by Growth Factors.

| | |
|---|---|
| Vehs Entered | 529 |
| Vehs Exited | 526 |
| Starting Vehs | 4 |
| Ending Vehs | 7 |
| Denied Entry Before | 0 |
| Denied Entry After | 0 |
| Travel Distance (km) | 117 |
| Travel Time (hr) | 4.8 |
| Total Delay (hr) | 2.0 |
| Total Stops | 231 |
| Fuel Used (l) | 39.1 |

## 3: Int Performance by approach

| Approach | NB | NE | SW | All |
|---|---|---|---|---|
| Total Delay (hr) | 0.0 | 0.7 | 1.2 | 1.9 |
| Delay / Veh (s) | 0.8 | 12.6 | 14.4 | 12.7 |
| Total Stops | 5 | 87 | 139 | 231 |
| Stop/Veh | 0.13 | 0.46 | 0.46 | 0.44 |
| Travel Dist (km) | 2.9 | 20.6 | 27.8 | 51.3 |
| Travel Time (hr) | 0.1 | 1.2 | 1.9 | 3.2 |
| Avg Speed (kph) | 30 | 17 | 14 | 16 |
| Fuel Used (l) | 1.1 | 7.8 | 14.1 | 23.0 |
| HC Emissions (g) | 1 | 8 | 11 | 20 |
| CO Emissions (g) | 68 | 383 | 507 | 958 |
| NOx Emissions (g) | 5 | 29 | 43 | 76 |
| Vehicles Entered | 38 | 191 | 300 | 529 |
| Vehicles Exited | 38 | 187 | 299 | 524 |
| Hourly Exit Rate | 38 | 187 | 299 | 524 |
| Denied Entry Before | 0 | 0 | 0 | 0 |
| Denied Entry After | 0 | 0 | 0 | 0 |

## Total Network Performance

| | |
|---|---|
| Total Delay (hr) | 2.0 |
| Delay / Veh (s) | 14.0 |
| Total Stops | 231 |
| Stop/Veh | 0.44 |
| Travel Dist (km) | 117.2 |
| Travel Time (hr) | 4.8 |
| Avg Speed (kph) | 25 |
| Fuel Used (l) | 39.1 |
| HC Emissions (g) | 32 |
| CO Emissions (g) | 1529 |
| NOx Emissions (g) | 120 |
| Vehicles Entered | 529 |
| Vehicles Exited | 526 |
| Hourly Exit Rate | 526 |
| Denied Entry Before | 0 |
| Denied Entry After | 0 |

## Intersection: 3: Int

| Movement | NE | SW |
| --- | --- | --- |
| Directions Served | TR | T |
| Maximum Queue (m) | 41.5 | 80.8 |
| Average Queue (m) | 22.2 | 35.7 |
| 95th Queue (m) | 39.8 | 66.5 |
| Link Distance (m) | 107.3 | 92.0 |
| Upstream Blk Time (%) | | |
| Queuing Penalty (veh) | | |
| Storage Bay Dist (m) | | |
| Storage Blk Time (%) | | |
| Queuing Penalty (veh) | | |

## Nework Summary

Network wide Queuing Penalty: 0

## Intersection: 3: Int

| Phase | 1 | 4 |
|---|---|---|
| Movement(s) Served | Ped | NESW |
| Maximum Green (s) | 45.0 | 294.0 |
| Minimum Green (s) | 45.0 | 56.0 |
| Recall | Ped | Min |
| Avg. Green (s) | 45.0 | 69.3 |
| g/C Ratio | 0.36 | 0.55 |
| Cycles Skipped (%) | 0 | 0 |
| Cycles @ Minimum (%) | 100 | 18 |
| Cycles Maxed Out (%) | 100 | 0 |
| Cycles with Peds (%) | 100 | 0 |

Controller Summary

Average Cycle Length (s): 126.3
Number of Complete Cycles : 28

# Appendix F - Stormwater Management Plan Calculations

# UBC Intersection Design

# Site Strom Drainage

| Storm Sewer Location | | | Tributary Area | | Runoff Coeff./Area | | | Flow Time | | | Rainfall | Runoff | Storm Sewer Design | | | | | Capacity Check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Incremental | | Runoff | Runoff | Cumulative | | | | Intensity | Design Flow | Pipe | Pipe | Mann | Pipe | Pipe | |
| | | | Area | | Coeff. | Inc. Area | Runoff | | | | Rate | RAIN/360 | Cap | Dia | n | Slope | Length | |
| Location | From | To | No. | A | R | RA | Sum(RA) | Ti | Tt | Tc | I_100 | Q_100 | $Q_c$ | | | | | |
| | MH | MH | | (ha) | | (ha) | (ha) | (min) | (min | (min) | (mm/hr) | ($m^3/s$) | ($m^3/s$) | (m) | | (%) | (m) | |
| Catchment Area 1 | MH-1 | MH-2 | 1-Roadways | 0.096 | 0.55 | 0.053 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.193 | 0.25 | 0.048 | 0.101 | 8 | 0.744 | 8.744 | 65.30 | 0.01833751 | 1.03 | 0.35 | 0.013 | 0.5 | 47.82 | 1.78% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 2 | MH-2 | MH-3 | 1-Roadways | 0.160 | 0.55 | 0.088 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.157 | 0.25 | 0.039 | 0.228 | 8.744 | 0.686 | 9.430 | 62.80 | 0.03980822 | 1.03 | 0.35 | 0.013 | 0.5 | 44.08 | 3.86% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 3 | MH-2 | MH-3 | 1-Roadways | 0.144 | 0.55 | 0.079 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.023 | 0.25 | 0.006 | 0.313 | 8.744 | 0.686 | 9.430 | 62.80 | 0.05467351 | 1.03 | 0.35 | 0.013 | 0.5 | 44.08 | 5.30% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 4 | MH-2 | MH-3 | 1-Roadways | 0.144 | 0.55 | 0.079 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.074 | 0.25 | 0.019 | 0.411 | 8.744 | 0.686 | 9.430 | 62.80 | 0.07171586 | 1.03 | 0.35 | 0.013 | 0.5 | 44.08 | 6.95% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 4 | MH-3 | MH-4 | 1-Roadways | 0.144 | 0.55 | 0.079 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.074 | 0.25 | 0.019 | 0.411 | 9.430 | 0.296 | 9.726 | 61.90 | 0.07066917 | 2.81 | 0.35 | 0.013 | 3.71 | 51.79 | 2.52% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 5 | MH-4 | MH-5 | 1-Roadways | 0.109 | 0.55 | 0.060 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.052 | 0.25 | 0.013 | 0.484 | 9.726 | 0.179 | 9.905 | 61.30 | 0.08239657 | 2.81 | 0.35 | 0.013 | 3.71 | 31.36 | 2.93% |
| | | | | | | | | | | | | | | | | | | |
| Catchment Area 6 | MH-5 | MH-6 | 1-Roadways | 0.090 | 0.55 | 0.050 | | | | | | | | | | | | |
| | | | 2-Grasslands | 0.042 | 0.25 | 0.011 | 0.544 | 9.905 | 0.380 | 10.285 | 60.10 | 0.09080025 | 2.53 | 0.35 | 0.013 | 3 | 59.78 | 3.59% |
| | | | | | | | | | | | | 0.42840107 | | | | | | |

Total Runoff Flow (Q_100) 0.42840107 (m3/sec)
Q_100 (per hour) 1542.243865 (m3/hr)

**Intensity Formula Calculations**

| Time (mins) | Intensity (mm/hr) | Parameters | |
|---|---|---|---|
| 5 | 86.6 | M | B |
| 15 | 49.7 | -0.5054512 | 195.349862 |

For 100 year storm event

*y=Bx^m*    y = Intesnity mm/hr
x = Time min

| | | |
|---|---|---|
| Ti = | 8 | mins |
| n = | 0.013 | |

*(urban resedintial from MMCD Design manual)*

***Assuming full pipe for Hydraulic Radius :*** ***R=r/2***

| | |
|---|---|
| N = | 0.0027778 |

(no roofs consideration)

The required storm sewer capacity shall be calculated using the Manning Formula under free flow (non-surcharged) condition. The Manning formula is:

$$Q = \frac{AR^{0.667}S^{0.5}}{n}$$

Where
$Q$ = flow capacity ($m^3/s$)
$A$ = cross sectional area ($m^2$)
$R$ = hydraulic radius (m)
$S$ = slope of hydraulic grade line (m/m)
$n$ = roughness coefficient

**From CoV Engineering Design Manual:**

2.4 RATIONAL METHOD

The Rational Method calculates the peak flow using the formula:

$$Q = RAIN$$

Where
$Q$ = flow in cubic metres per second ($m^3/s$)
$R$ = runoff coefficient × soil adjustment factor (SAF)
$A$ = drainage area in ha
$I$ = rainfall intensity in mm/h
$N$ = 0.00278

### 4.9.1 Runoff Coefficients

The following runoff coefficients are for use with the Rational Formula. These coefficients are for general application only. Design values are subject to verification by the designer and approval by the local authority.

Higher values may be applicable in those areas which experience rainfall during the winter when the ground is frozen. These values may reach 0.80 to 0.95.

Table 4.9.1 Runoff Coefficients

| Land Use | Percent Impervious | Runoff Coefficient 5/10 Year Storm | Runoff Coefficient 100 Year Storm |
|---|---|---|---|
| Suburban Residential (Lots>0.4 ha) | 20 | 0.35 | 0.40 |
| Low Density Residential | 45 | 0.50 | 0.55 |
| Medium Density Residential | 65 | 0.60 | 0.65 |
| High Density Residential | 80 | 0.75 | 0.80 |
| Commercial | 90 | 0.80 | 0.85 |
| Industrial | 90 | 0.80 | 0.85 |
| Institutional (e.g. Schools) | 80 | 0.75 | 0.80 |
| Parks/Grasslands | 10 | 0.15 | 0.25 |
| Cultivated Fields | 30 | 0.30 | 0.40 |
| Woodlands | 5 | 0.10 | 0.30 |

### 4.9.4 Time of Concentration

The time of concentration is the time required for runoff to flow from the most remote part of the catchment area under consideration to the design node. The time of concentration can be calculated using the following formula:

$$Tc = Ti + Tt$$

Where: Tc = time of concentration (minutes)
Ti = inlet or overland flow time (minutes)
Tt = travel time in sewers, ditches, channels or watercourses (minutes).

Inlet or Overland Flow Time (Ti)

a) Typical inlet times for urban areas are as follows under the assumption that BMP's are not applied. These values assume direct runoff:

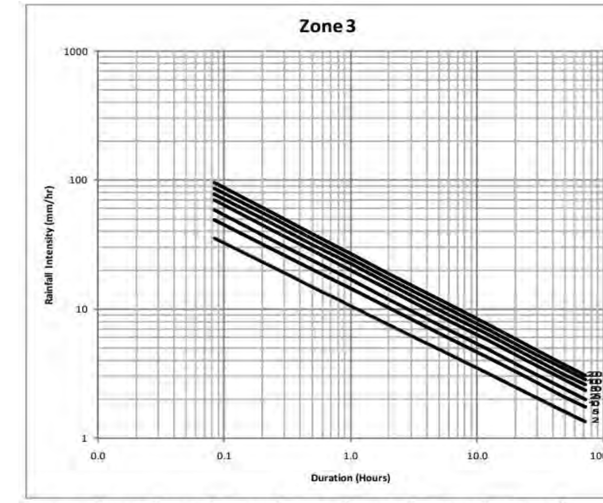
| | | |
|---|---|---|
| Single Family Lot | 10 | minutes |
| Multi-Family Lot | 8 | minutes |
| Commercial/Industrial/Institutional | 5 | minutes |

b) For relatively flat areas, the inlet time for larger areas can be calculated using the "Airport Method" as follows:

$$Ti = \frac{3.26(1.1 - C)L^{0.5}}{S^{0.33}}$$

Where: Ti = inlet time (minutes)
C = runoff coefficient (See above)
L = travel distance (m). Maximum length = 300 m
S = slope of travel path (%)

**IDF CURVE:**




log scale

| Duration | 2 year | 5 year | 10 year | 25 year | 50 year | 100 year | 200 year |
|---|---|---|---|---|---|---|---|
| 5 min | 35.3 | 49.2 | 58.3 | 69.7 | 78.2 | 86.6 | 95.0 |
| 15 min | 20.7 | 28.6 | 33.7 | 40.2 | 44.9 | 49.7 | 54.4 |
| 30 min | 14.8 | 20.3 | 23.9 | 28.4 | 31.7 | 35.0 | 38.3 |
| 1 h | 10.6 | 14.4 | 16.9 | 20.0 | 22.3 | 24.6 | 26.9 |
| 2 h | 7.6 | 10.2 | 12.0 | 14.1 | 15.7 | 17.3 | 18.9 |
| 6 h | 4.5 | 5.9 | 6.9 | 8.1 | 9.0 | 9.9 | 10.8 |
| 12 h | 3.2 | 4.2 | 4.9 | 5.7 | 6.4 | 7.0 | 7.6 |
| 24 h | 2.3 | 3.0 | 3.5 | 4.1 | 4.5 | 4.9 | 5.4 |
| 48 h | 1.6 | 2.1 | 2.5 | 2.9 | 3.2 | 3.5 | 3.8 |
| 72 h | 1.3 | 1.7 | 2.0 | 2.3 | 2.6 | 2.8 | 3.1 |

Travel Time (Tt)

The travel time in sewers, ditches, channels or watercourses can be estimated using the Modified Manning formula:

$$Tt = \frac{L\,n}{60R^{0.667}S^{0.5}}$$

Where: Tt = travel time (minutes)
L = length of flow path (m)
n = Manning roughness coefficient:
0.050 Natural channels
0.030 Excavated ditches
0.013 Pipe and concrete lined channels.
R = Hydraulic radius (area/wetted perimeter) in m
S = slope in m/m

Other formulae are available for calculation of Ti and Tt. Obtain local authority approval.

**Area 1**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 959 | 0.096 |
| Grasslands | 1934 | 0.193 |
| Total | 2893 | 0.289 |

**Area 2**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 1596 | 0.160 |
| Grasslands | 1573 | 0.157 |
| Total | 3169 | 0.317 |

**Area 3**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 1443 | 0.144 |
| Grasslands | 234 | 0.023 |
| Total | 1677 | 0.168 |

**Area 4**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 1439 | 0.144 |
| Grasslands | 742 | 0.074 |
| Total | 2181 | 0.218 |

**Area 5**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 1089 | 0.109 |
| Grasslands | 520 | 0.052 |
| Total | 1609 | 0.161 |

**Area 6**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 900 | 0.090 |
| Grasslands | 420 | 0.042 |
| Total | 1320 | 0.132 |

**Total Area**

| | Area (m2) | Area (Ha) |
|---|---|---|
| Roads | 7426 | 0.7426 |
| Grasslands | 5423 | 0.5423 |
| Tota | 12849 | 1.2849 |

# Appendix G - Structural Gateway Calculations

Wind load using static procedure (4.1.7.3)

$p = I_w\, q\, C_e C_t C_g C_p$

$I_w = 0.75$ using SLS (table 4.1.7.3)
$q = 0.45$ KPa for Vancouver

$C_e = (h/10)^{0.2} < 0.9$ for open terrain (4.1.7.3.5.a)
mid-height of structural element exposed to wind $h = \frac{8}{2} = 4\text{m}$

$C_e = (4/10)^{0.2} = 0.833$
$C_t = 1$ (4.1.7.4.1)
$C_gC_p = -2.1$ for wind force away from surface
$C_gC_p = +1.8$ for wind force towards surface (4.1.7.6-B)

$\therefore\ p = I_w q C_e C_t C_g C_p = (0.75)(0.45)(0.833)(1.0)(-2.1) = -0.59$ KPa
$\approx 0.6$ KPa

Dead load

Concrete $\gamma_{plain} = 23.5\ \text{KN/m}^3$
Weight $= (23.5\ \text{KN/m}^3)(8\text{m}) = 188$ KPa

Try 4 wide $\times$ 0.6m thick $= 2.4\ \text{m}^2$
$DL = 188\ \text{KPa} \times 2.4\text{m}^2 = 451.2$ KN
$P_f = 1.4\,DL = 1.4\,(451.2) = 632$ KN $= W$

Earthquake load

Design a moderately ductile shear wall $R_d = 2.0$
$R_o = 1.4$

minimum lateral earthquake force $V = S(T_a) M_v I_E W / R_d R_o$

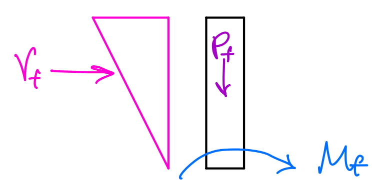
must not be greater than $\begin{cases} \frac{2}{3} S(0.2)\, I_E W / R_d R_o \\ S(0.5)\, I_E W / R_d R_o \end{cases}$

assuming Site class D : $S(0.2) = 0.840$ $I_E = 1.0$
to be conservative $S(0.5) = 0.871$ $T_a = 0.05\,(h_n)^{3/4} = 0.238\text{s}$

Should expect : $V = 31\%$ of $W = 195.6$ KN

$\frac{2}{3} S(0.2)\, I_E W / R_d R_o = 126.4$ KN
$S(0.5)\, I_E W / R_d R_o = 196.6$ KN $\leftarrow$ max earthquake force to be conservative

$V_f = 196.6$ acting @ $\frac{2}{3}$ height
$M_f = (\frac{2}{3} \times 8\text{m})(196.6\ \text{KN}) = 1048.3$



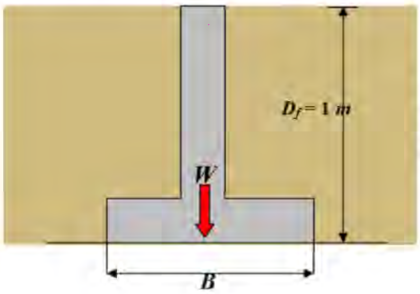

min wall thickness to prevent buckling $= \frac{L_u}{14} = \frac{8}{14} = 0.57\text{m} < 0.6\text{m}$ ✓

min concentrated reinforcement at each end $= 0.00075\, b_w l_w = 1800\ \text{m}^2$
$\therefore$ 8 - 20 M reinforcement

min distributed vertical reinforcement $= 0.0025\, A_g = 6000\ \text{mm}^2$
$\therefore$ 30 - 15 M reinforcement

# Appendix H - Foundation Calculations

MEYERHOF - STRIP FOOTING




$N_q = \tan^2(45 + \frac{\phi'}{2})\, e^{\pi \tan\phi}$ (Meyerhof, 1963)

$N_c = (N_q - 1)\cot\phi'$ (Meyerhof, 1963)

$N_c = 5.14 \cdots$ when $\phi = 0$

$N_\gamma = 2(N_q + 1)\tan\phi$ (Vesic, 1973)

$N_\gamma = 0 \cdots$ when $\phi = 0$

$FOS = \frac{q_{ult}}{q_{all}}$ $FOS = 3$

W = 632 kN (dead load from gateway structure calcs)

(from Trow report)
$\rho = 2000\ kg/m^3$
$\therefore \gamma = 19.6\ kN/m^3$
$\phi = 38°$
$c = 0$ ( top 5m is SAND)

Use Factor of Safety = 3 and take depth of footing, $D_f$, to be 1m.

Use Meyerhof's Bearing Capacity Formula to determine footing width (square footing): $q_{ult} = c N_c s_c i_c d_c + \sigma_D N_q s_q i_q d_q + 0.5 \gamma B N_\gamma s_\gamma i_\gamma d_\gamma$

$N_q = \tan^2(45 + \frac{\phi'}{2}) e^{\pi \tan\phi}$ $N_q = \tan^2(45 + \frac{38}{2}) e^{\pi \tan(38)} = 48.93$

$N_c = (N_q - 1)\cot\phi'$ $N_c = (48.93 - 1)\cot(38) = 61.35$

$N_\gamma = 2(N_q + 1)\tan\phi'$ $N_\gamma = 2(48.93 + 1)\tan(38) = 78.02$

$\therefore N_q = 48.93$
$N_c = 61.35$
$N_\gamma = 78.02$

$i_c = i_q = i_\gamma = 1.0$

→ take B/L to be $\frac{1m}{5m} = 0.2$ for strip footing

$s_q = 1 + \frac{B}{L}\tan\phi = 1 + (\frac{1}{5})\tan(38) = 1.16$

$s_\gamma = 1 - 0.4\frac{B}{L} = 1 - 0.4(\frac{1}{5}) = 0.92$

$d_q = 1 + 2\tan\phi(1 - \sin\phi)^2 \frac{D_f}{B} = 1 + 2\tan(38)(1 - \sin 38)^2 (\frac{1}{B}) = 1.23$

$d_\gamma = 1.0$

| Shape Factors | Depth Factors | Inclination Factors |
|---|---|---|
| $s_q = 1.16$ | $d_q = 1.23$ | $i_q = 1.0$ |
| $s_\gamma = 0.92$ | $d_\gamma = 1.0$ | $i_\gamma = 1.0$ |

{ load is vertical }

$c' = 0$ (no cohesion & sand ∴ $s_c, i_c, d_c$ not req'd.)

$q_{all} = q_{ult}/3$

$\frac{P}{BL} = \frac{1}{3}\left[(19.6\,kPa)(48.93)(1.16)(1.0)(1.23) + (0.5)(19.6\,kN/m^3)(B)(78.02)(0.92)(1.0)(1.0)\right]$

$\frac{632\,kN}{5B} = \frac{1}{3}\left[1368.34 + 703.43B\right]$

$632 = 2280.55B + 1172.4B^2$

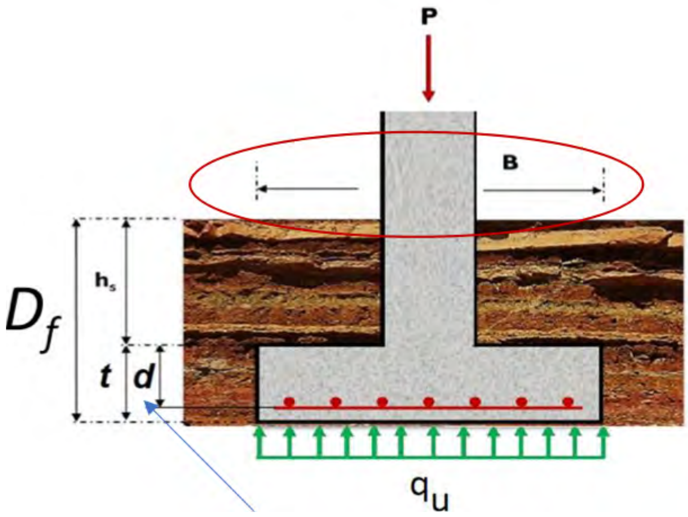
minimum footing width:

→ $B = 0.246013\,m$

$\boxed{\therefore B = 0.25\,m}$

$$\boxed{\begin{array}{l} \text{using } B = 1m \\ q_{ult} = 2071.769\ kPa \\ q_{all} = \frac{P}{BL} = \frac{632kN}{5m \times 1m} = 126.4\,kPa \\ FOS = 16.4 \end{array}}$$

Minimum footing width is 0.25m, however, shear wall is 0.6m wide. Therefore, strip footing will be 1m wide and 5m long to accommodate shear wall gateway structure with length 4m and 0.6m wide. This gives a much higher FOS (~16) and will also work to resist overturning.

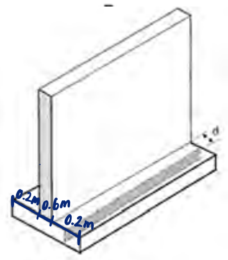



**Footing Thickness**. The minimum thickness allowed by the ACI 318 Building Code for footing is:

- 200mm (8 in) for **plain concrete footings** on soil,
- 150mm (6 in) above the bottom reinforcement for **reinforced-concrete footings** on soil,
- 300mm (12 in) above the bottom reinforcement for **reinforced-concrete footings on piles**.

**Concrete Cover**. The minimum concrete cover required by the ACI 318 Building Code for reinforcement concrete cast against and permanently exposed to earth **is 75mm** (3 in).

**Shear rather than flexural moment** commonly governed in determining the minimum required thickness of footing.




Wall footing

For **wall footings**, one way shear is checked for the maximum overhang along the **long direction** per meter length of the footing.

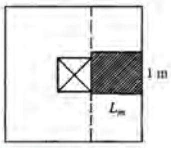
$$\boxed{\begin{aligned} q_{ult} &= 2071.769 \text{ kPa} \\ \text{using } B &= 1 \end{aligned}}$$

**The critical section for bending locates at face of column, or wall.**

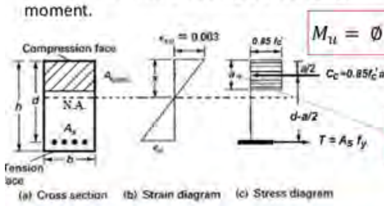
The bending moment at the critical section for the length $L_m$ is the ultimate bending moment/unit width :

$$M_u = \frac{q_u\, L_m^2}{2}$$

Due to net acting soil pressure



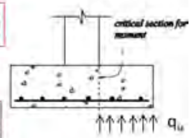

Then the thickness of footing is checked against flexural moment.




$$M_u = \emptyset\, A_s\, f_y \left(d - \frac{a}{2}\right)$$

$$\Phi = 0.9$$

$$a = \frac{A_s\, f_y}{0.85 f_c'\, b}$$




*Minimum $A_s$ = **0.002 bd** for temperature and shrinkage control*

*As = Area of Reinforcements*
*fy = 400 -500 MPa*
*fc' = 20 – 50 MPa*
*b = 1.0m (per unit length)*

$$M_u = \frac{q_u L_m^2}{2} = \frac{(2071.769)(0.2\text{m})^2}{2} = 41.44 \text{ kN}$$

$$M_u = \emptyset A_s f_y \left(d - \frac{a}{2}\right)$$

400 MPa = $f_y$

$$41.44 = (0.9)(0.002\,d)(400)\left(d - \frac{\left[\frac{(0.002\,d)(400\text{ N/mm}^2)}{(0.85)(30\text{ N/mm}^2)(1\text{m})}\right]}{2}\right)$$

$$41.44\text{kN} = (0.9)(0.002\text{ m} \times d)(400{,}000{,}000\text{ N/m}^2)(0.984\,d)$$

$$41440\text{ N} = 708705.88\,d^2$$

$$d = 0.2418\text{ m}$$

$$\boxed{d = 0.24\text{m}}$$

$$d = 240\text{mm}$$

$$t = 240\text{ mm} + \underbrace{25\text{mm}}_{\text{reinforcement}} + \underbrace{75\text{ mm}}_{\text{cover}} = 340\text{ mm}$$

Concrete Volume

$t = 0.34\text{m}$

$w = 1.0\text{m}$

$l = 5.0\text{m}$

$twl = 1.7\text{m}^3$ of 30 MPa concrete

# Reinforcement Calculations

Dead Load: 632 kN

FoS = 3

Footing Depth = 1m

Soil: Sand ($c' = 0$)

Bearing Capacity Factors

$N_c = 48.93$

$N_q = 61.35$

$N_\gamma = 78.02$

Moments

Ult. Moment ($M_u$) = 41.44 kN m

Concrete Strength ($f'_c$) = 30 MPa

Steel Yield Strength ($f_y$) = 400 MPa

Effective Depth ($d$) = 240 mm

Total Depth ($h$) = 335 mm

(assuming cover and bar diameter = 95mm)

## Required Reinforcement

$$M_u = A_s f_y d \left(1 - \frac{A_s f_y}{\phi f'_c b d}\right)$$

approximate, using: $A_s = \dfrac{M_u}{\phi f_y d}$

$M_u = 41.44 \times 10^6$ Nmm

$\phi = 0.9$

$f_y = 400000 \text{ N/m}^2$

$d = 240$ mm

$b = 1000$ mm

(width of strip footing)

$$A_s = \frac{41.44 \times 10^6}{(0.9)(400)(240)} = 479.52 \text{ mm}^2$$

Using 25 M bars ($A_s = 500 \text{ mm}^2/\text{bar}$) the required number of bars $= \dfrac{A_s}{A_{bar}} = \dfrac{479.52}{500} \sim 1$ which is not sufficient as reinforcement must be distributed across the width of the footing:

## Minimum Reinforcement

From code:

$$A_s = 0.002bd$$

$$A_s = 0.002 \times 1000 \times 240$$

$$A_s = 480 \text{ mm}^2$$

Required $A_s$ just below minimum required reinforcement.

Opt for 4-20M bars -

Area of 1-20M bar = $300\ mm^2$

Total area: $A_s = 4 \times 300\ mm^2 = 1200\ mm^2$

greater than $479.52\ mm^2$ and minimum requirement of $480\ mm^2$

Check for over-reinforcement:

$$\rho = \frac{A_s}{bd} = \frac{1200}{1000 \times 240} = 0.005$$

balanced reinforcement ratio:

$$\rho_{bal} = 0.85 \times \frac{f'_c}{f_y} \times \frac{600}{600 + f_y/(0.85 f'_c)}$$

$$\rho_{bal} = 0.85 \times \frac{30}{400} \times \frac{600}{600 + 400/(0.85 \times 30)} = 0.062$$

$\rho = 0.005 < \rho_{bal} = 0.062$ $\therefore$ not over-reinforced.

Depth Reduction Factor

$$\text{Depth Factor} = 1 - \frac{A_s f_y}{\phi f'_c\, bd} = 1 - \frac{1200 \times 400}{(0.9)(30 \times 10^6)(1000)(240)} = 1 - 0.000074 \sim 1$$

$\therefore$ Effective depth remains valid.

Therefore, 4-20M bars satisfy flexural design while meeting reinforcement requirements.

## Shear Demand

Factored Load = 1.4 (632 kN) = 884.8 kN = $P_u$

Shear Force at critical section : $V_u = \frac{P_u}{B} = \frac{884.8\text{ kN}}{1.0} = 884.8\text{ kN}$

Shear resistance of concrete :

one way : $V_c = 0.17\lambda\sqrt{f'_c}\,bd$

$\lambda = 1.0$

$f'_c = 30$ MPa

$b = 1000$ mm

$d = 240$ mm

$V_c = (0.17)(1)(\sqrt{30})(1000)(240)$

$V_c = 223.4$ kN

Factored Shear Force = 884.8 kN

Concrete Shear Capacity = 223.4 kN

$V_u > V_c$ $\therefore$ shear reinforcement necessary

Stirrup Properties :

10M bars

$A_b = 100\text{ mm}^2$

2 legged stirrups : $2 \times 100 = 200\text{ mm}^2 = A_v$

$f_y = 400$ MPa

$d = 240$mm

Stirrups Design ( $\phi$ strength reduction factor = 0.75)

$$V_s = V_u - \phi V_c = 884.8 - (0.75 \times 223.4)$$

$$V_s = 717.25 \, kN$$

Stirrup Spacing

$$V_s = \frac{A_v f_y d}{s} \rightarrow s = \frac{A_v f_y d}{V_s}$$

$$s = \frac{(200)(400)(240)}{717.25 \times 10^3} = 26.8 \, mm$$

This is too small — as per code, minimum spacing is 100mm

$\therefore s = 100mm$

Number of Stirrups

footing depth = 340 mm

cover = 75 mm

d = 240 mm

S = 100 mm

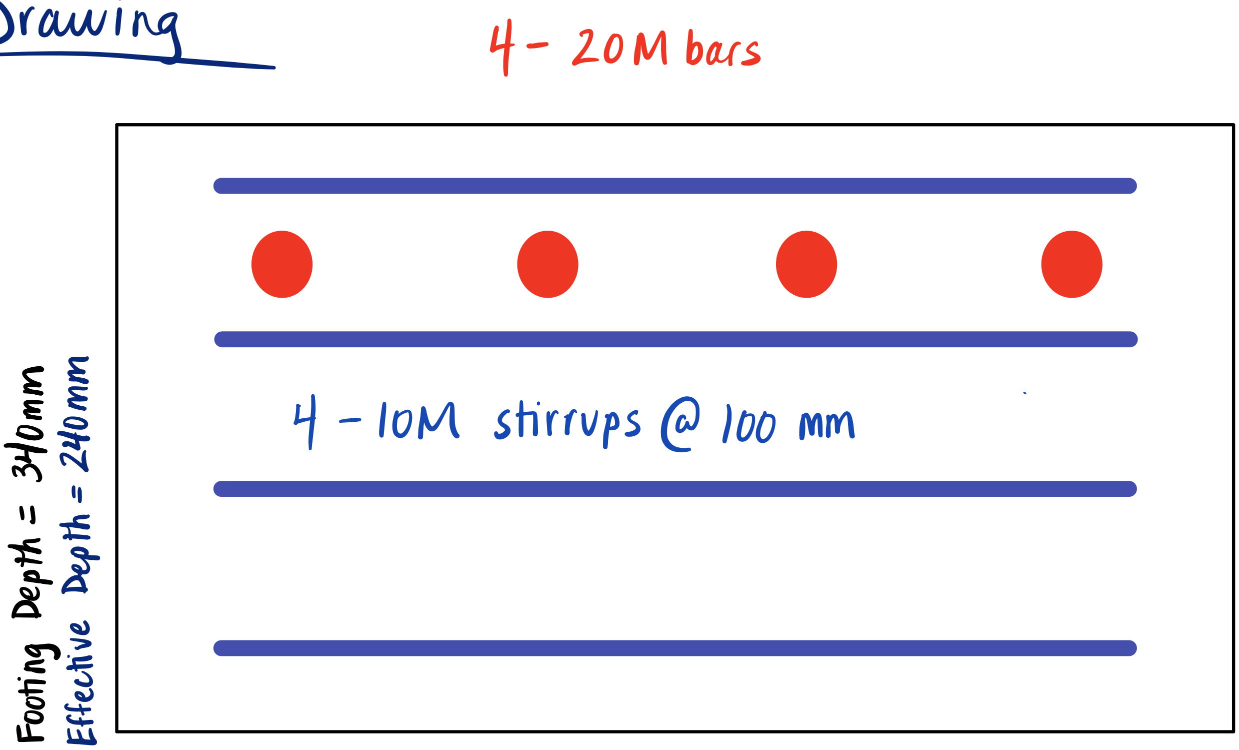
$$h_{stirrups} = 340 - 2(75) = 190 \, mm$$

$$N_{stirrups} = \frac{h_{stirrups}}{s} + 1$$

$$= \frac{190}{100} + 1 = 2.9 + 1 = 3.9 \sim 4$$

$\rightarrow$ Use 4 stirrups

## Drawing



4 - 20M bars
4 - 10M stirrups @ 100 mm
Footing Depth = 340mm
Effective Depth = 240mm

# Appendix I - Vancouver Bike Lane Map

Route Legend

Most Comfortable

**Protected Bike Lane**

People cycling are protected from motor vehicles by physical barriers such as planters, curbs or bollards; also includes off-street paths.

**Local Street Bikeway**

People cycling share the roadway with motor vehicles on a relatively quiet neighbourhood street.

**Painted Bike Lane**

People cycling have a dedicated painted lane, typically between the curb or parking lane and a driving lane.

**Shared Use Lane**

People cycling share a lane with motor vehicles on a busy street; these lanes fill network gaps but are not comfortable for most.

Least Comfortable

**Map Symbols**

- Connected All Ages and Abilities (AAA) Network
- Moderate Uphill Route
- Steep Uphill Route
- One-Way Bike Route
- Temporary Closures
- Mobi Station Zone (boundary contains all public bike share stations, including downtown & Stanley Park)
- SkyTrain Station/Bus Loop
- Bike Parkade
- Train Station
- Bus Station
- SeaBus
- Passenger Ferry
- Hospital
- Community Centre
- School

## Connected AAA Network

The Connected All Ages and Abilities (AAA) Network is a connected network of bicycle lanes that are mostly separated from traffic and include some streets with lower traffic volume, making them more comfortable for people of all ages and abilities to ride on.


## Mobi by Rogers

**Mobi by Rogers** is Vancouver's public bike share system where users can unlock and return regular or electric bicycles to 250+ stations.

- The **Mobi Station Zone** is highlighted in light red on this main map.
- Scan the QR code or visit **mobibikes.ca** to get started today.

***Did you know?***
*Mobi has extended its service westward to the University of British Columbia (UBC).*

mobi | ROGERS

**Disclaimer of responsibility:** This map is produced as a guide to cycling routes in the City of Vancouver.
The City, its employees, officers, directors and representatives do not guarantee the accuracy of the information contained therein nor warrant the safety of any route, highway, road, street, designated cycling route or other shown in the map or information.

# Appendix J - City of Vancouver Synchro Guidelines

| Interval Type | Convention |
|---|---|
| Minimum Vehicle Green Intervals | - Protected/Permissive Turn Phase: 5.0 seconds<br>- Protected Only Phase (Left/Right): 8.0 seconds<br>- Main Street Through at a Fully Actuated Intersection: 10.0 seconds<br>- Main Street Pedestrian/Bicycle Signal: 16.0 seconds<br>- Main Street Through at a Semi-Actuated Signal: 16.0 seconds<br>- Side Street Through: 10.0 seconds<br>- Side Street Through without Cyclist Actuation: 8.0 seconds |
| Amber Clearance Intervals[1] | - Left-Turn or Right-Turn (Protected Only): 3.5 seconds<br>- Left-Turn or Right-Turn (Protected/Permissive): 4.0 seconds<br>- Through: 3.5 seconds |
| All-Red Clearance Intervals[1] | - Pedestrian / Bicycle Signal: 2.5 seconds<br>- Full Intersection / Protected Only Phase: 1.5 seconds<br>- Protected/Permissive Phase: 0.0 seconds<br>- Leading Pedestrian Interval: 5.0 seconds<br>(Recommend coding a 5.0 second dummy phase instead of an all-red interval) |

| Parameter | Convention |
|---|---|
| Pedestrian Walk Times | A minimum of 7.0 seconds of initial walk time shall be provided for pedestrian/bicycle signals unless rationale is provided to City Staff. In areas with higher pedestrian volumes and/or where pedestrian storage is an issue, the walk duration can extend beyond 7.0 seconds. |
| Bike Signal Phasing and Timing | Generally, bike/vehicle intergreen phases coincide, and the intergreen period does not need to be modified for cyclist facilities. However, the minimum green time for bike phases is 10 seconds. To increase safety, throughput, and/or convenience of cyclists, a protected-only phase must be implemented. Please see the Signal Timing Guideline for details. |
| Pedestrian Clearance Timing / Interval | Pedestrian Flash Don't Walk (FDW) time, in seconds, is 7 seconds or calculated by subtracting the vehicle intergreen period from the crosswalk midpoint pedestrian walk time as shown in the formula below, whichever is greater: |
| | FDW = (D / S) - Y - AR<br>Where:<br>- D = Curb-to-Curb Crossing Distance (m)<br>- S = Walk Speed (1 m/s)<br>- Y = Amber Interval (s)<br>- AR = All-Red Interval (s) |

# Appendix K - Data Analysis Spreadsheet

**Pacific Urban Consulting**

**Traffic & Population Analysis: Intersection of NW Marine Dr & Chancellor Blvd**

Historical Data Part:

| | |
|---|---|
| **Title:** | Transportation All Motor Vehicle Traffic by Route UBCV |
| **Last Upated:** | October 18, 2024, 2:24 PM (UTC-07:00) |
| **Source:** | Krista Falkner, UBC Campus and Community Planning |

| Calendar Year | NW Marine Dr. (average weekday traffic volume) (UBCV) | Chancellor Blvd. (average weekday traffic volume) (UBCV) |
|---|---|---|
| 1997 | 2040 | 11660 |
| 1998 | 2190 | 11340 |
| 1999 | 1970 | 11760 |
| 2000 | 1620 | 10650 |
| 2001 | 1670 | 11170 |
| 2002 | 1610 | 11450 |
| 2003 | 2020 | 10670 |
| 2004 | 1310 | 10980 |
| 2005 | 1540 | 8550 |
| 2006 | 1310 | 10250 |
| 2007 | 1640 | 10540 |
| 2008 | 1220 | 10500 |
| 2009 | 1250 | 9990 |
| 2010 | 1200 | 9860 |
| 2011 | 1230 | 9670 |
| 2012 | 950 | 9360 |
| 2013 | 1120 | 9350 |
| 2014 | 1010 | 9220 |
| 2015 | 1280 | 9020 |
| 2016 | 1040 | 10320 |
| 2017 | 1140 | 10320 |
| 2018 | 1160 | 10300 |
| 2019 | 1220 | 9860 |
| 2020 | 1440 | 4610 |
| 2021 | 1440 | 8190 |
| 2022 | 1630 | 8370 |
| 2023 | 1220 | 8670 |

[1997 - 2023]

**Compund Annual Growth Rate**

| | |
|---|---|
| CAGR (NW Marine Dr) | -1.96% |
| CAGR (Chancellor Blvd) | -1.13% |

Since these are the 2 main roads for our intersetion, we take an average value

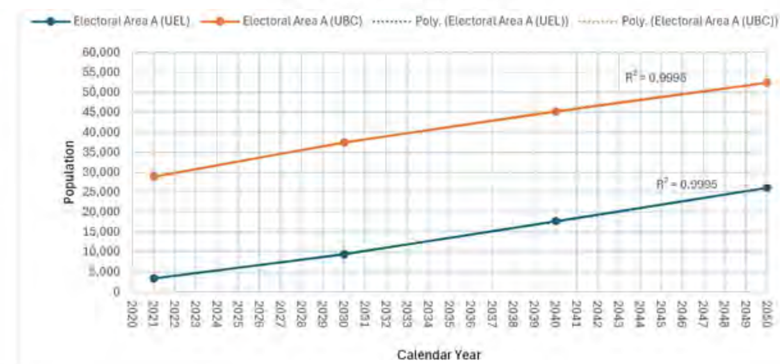
**Average CAGR** -1.55%

for 2050 | **Traffic Growth Factor** 0.6775 | (at the intersection)

**Population Projections** (from MV Data)

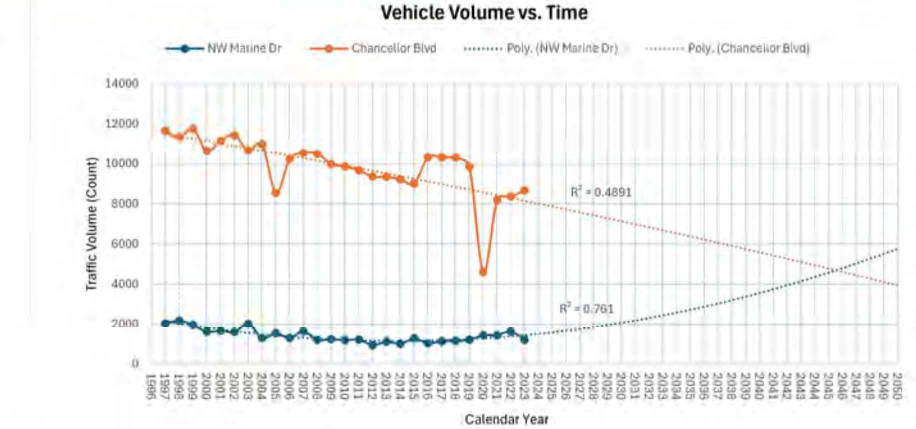
| Year | 2021 | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| Electoral Area A - UEL | 3,390 | 9,400 | 17,730 | 26,050 |
| Electoral Area A - UBC | 28,910 | 37,490 | 45,240 | 52,410 |
| Combined Area | 32,300 | 46,890 | 62,970 | 78,460 |

| 2021-2050 Growth/Year | 2021-2050 Annual Growth Rate |
|---|---|
| 781.38 | 7.28% |
| 810.34 | 2.07% |
| 1591.72 | 3.11% |




We will consider the combined area for calculating the Growth Factor

**Population Growth Factor** 2.1492 (for UEL+UBC Area)




**Current Traffic Data:**

| Year | 2024 |
|---|---|

**Vehicles:**

| From | Going straight | Taking a left turn | Taking a right turn |
|---|---|---|---|
| Eastbound NW Marine Drive | 253 | 12 | 25 |
| East Mall | 2 | 19 | 50 |
| Chancellor Blvd | 450 | 57 | 7 |
| Northbound NW Marine Drive | 4 | 12 | 33 |

**Cyclists:**

| From | Count |
|---|---|
| Eastbound NW Marine Drive | 10 |
| East Mall | 2 |
| Chancellor Blvd | 15 |
| Northbound NW Marine Drive | 20 |

**Pedestrians:**

| Crossing | Eastbound NW Marine Dr | Northbound NW Marine Dr | Chancellor Blvd | East Mall |
|---|---|---|---|---|
| Pedestrians Encountered | 34 | 15 | 12 | 6 |

| | Eastbound NW Marine Dr | Northbound NW Marine Dr | Chancellor Blvd | East Mall |
|---|---|---|---|---|
| ratio of cyclists to vehicles | 0.03 | 0.41 | 0.03 | 0.03 |

**Future Traffic Data:**

Design Year: 2050

**Vehicles:**

| From | Going straight | Taking a left turn | Taking a right turn |
|---|---|---|---|
| Eastbound NW Marine Drive | 171 | 8 | 17 |
| East Mall | 1 | 13 | 34 |
| Chancellor Blvd | 305 | 39 | 5 |
| Northbound NW Marine Drive | 3 | 8 | 22 |

**Cyclists:**

| From | Count |
|---|---|
| Eastbound NW Marine Drive | 4 |
| East Mall | 1 |
| Chancellor Blvd | 6 |
| Northbound NW Marine Drive | 8 |

**Pedestrians:**

| Crossing | Eastbound NW Marine Dr | Northbound NW Marine Dr | Chancellor Blvd | East Mall |
|---|---|---|---|---|
| Pedestrians Encountered | 73 | 32 | 26 | 13 |

| Calendar Year | SOV Trips (daily average) (UBCV) | HOV Trips (daily average) (UBCV) | Transit Trips (daily average) (UBCV) | Bicycle Trips (daily average) (UBCV) | Pedestrian Trips (daily average) (UBCV) | Daytime Campus Population (UBCV) |
|---|---|---|---|---|---|---|
| 1997 | 46000 | 36100 | 19000 | 2700 | 1400 | 42250 |
| 1998 | 49300 | 31600 | 19400 | 3900 | 1600 | 43450 |
| 1999 | 48000 | 35700 | 23400 | 3100 | 2000 | 44650 |
| 2000 | 47200 | 29600 | 24300 | 3200 | 1600 | 38350 |
| 2001 | 52600 | 26000 | 27700 | 2900 | 1200 | 39200 |
| 2002 | 48400 | 29100 | 29700 | 3300 | 1600 | 41850 |
| 2003 | 45000 | 21700 | 45400 | 2800 | 1500 | 43200 |
| 2004 | 43800 | 22400 | 49900 | 1600 | 600 | 43450 |
| 2005 | 37700 | 21600 | 45600 | 2400 | 900 | 44000 |
| 2006 | 40600 | 17600 | 41500 | 1200 | 700 | 45450 |
| 2007 | 39700 | 22800 | 54100 | 2100 | 900 | 45850 |
| 2008 | 43100 | 17900 | 51000 | 1600 | 1000 | 47200 |
| 2009 | 40200 | 21800 | 58500 | 1700 | 700 | 49450 |
| 2010 | 44500 | 18300 | 63300 | 1300 | 800 | 50050 |
| 2011 | 39600 | 20100 | 74800 | 1600 | 1200 | 50950 |
| 2012 | 39000 | 19400 | 75600 | 1800 | 1000 | 51950 |
| 2013 | 40200 | 18800 | 78300 | 2400 | 1000 | 53000 |
| 2014 | 44300 | 11300 | 74000 | 1700 | 800 | 54000 |
| 2015 | 40100 | 20600 | 72000 | 3500 | 1800 | 54700 |
| 2016 | 51300 | 11400 | 73300 | 1300 | 1000 | 55800 |
| 2017 | 46300 | 22100 | 81400 | 2800 | 2000 | 57500 |
| 2018 | 48100 | 16700 | 76600 | 2100 | 700 | 58700 |
| 2019 | 47300 | 16000 | 80200 | 2500 | 1300 | 60250 |
| 2020 | 30900 | 10500 | 16800 | 2800 | 800 | 60700 |
| 2021 | 49500 | 15000 | 65500 | 1300 | 600 | 63250 |
| 2022 | 54500 | 12600 | 66600 | 1300 | 600 | 62800 |
| 2023 | 53200 | 11400 | 77100 | 1100 | 400 | 64200 |

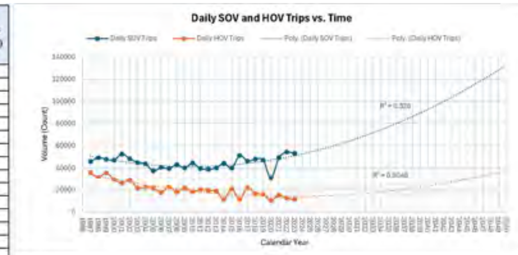
| | |
|---|---|
| **Years to Design Year** (2050-2025) | 25 |

**Compound Annual Growth Rates**

| | |
|---|---|
| CAGR (SOV) | 0.561% |
| CAGR (HOV) | -4.337% |
| CAGR (Transit) | 5.535% |
| CAGR (Bicycle) | -3.396% |
| CAGR (Pedestrian) | -4.704% |
| CAGR (Daytime Campus Population) | 1.622% |

**Growth Factors**

| | |
|---|---|
| GF (SOV) | 1.1501 |
| GF (HOV) | 0.3301 |
| GF (Transit) | 3.8451 |
| GF (Bicycle) | 0.4217 |
| GF (Pedestrian) | 0.2998 |
| GF (Daytime Campus Population) | 1.4953 |

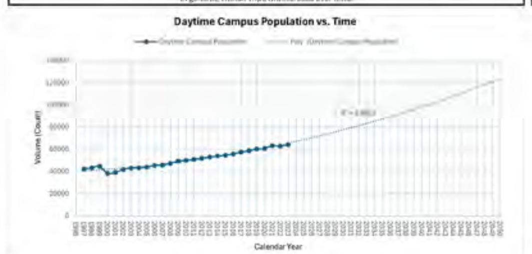



Trendline indicates daily SOV Trips will increase significantly more than daily HOV Trips over time.
Also noteworthy is the R^2 value of each trendline. R^2 value closer to 1 is more accurate.

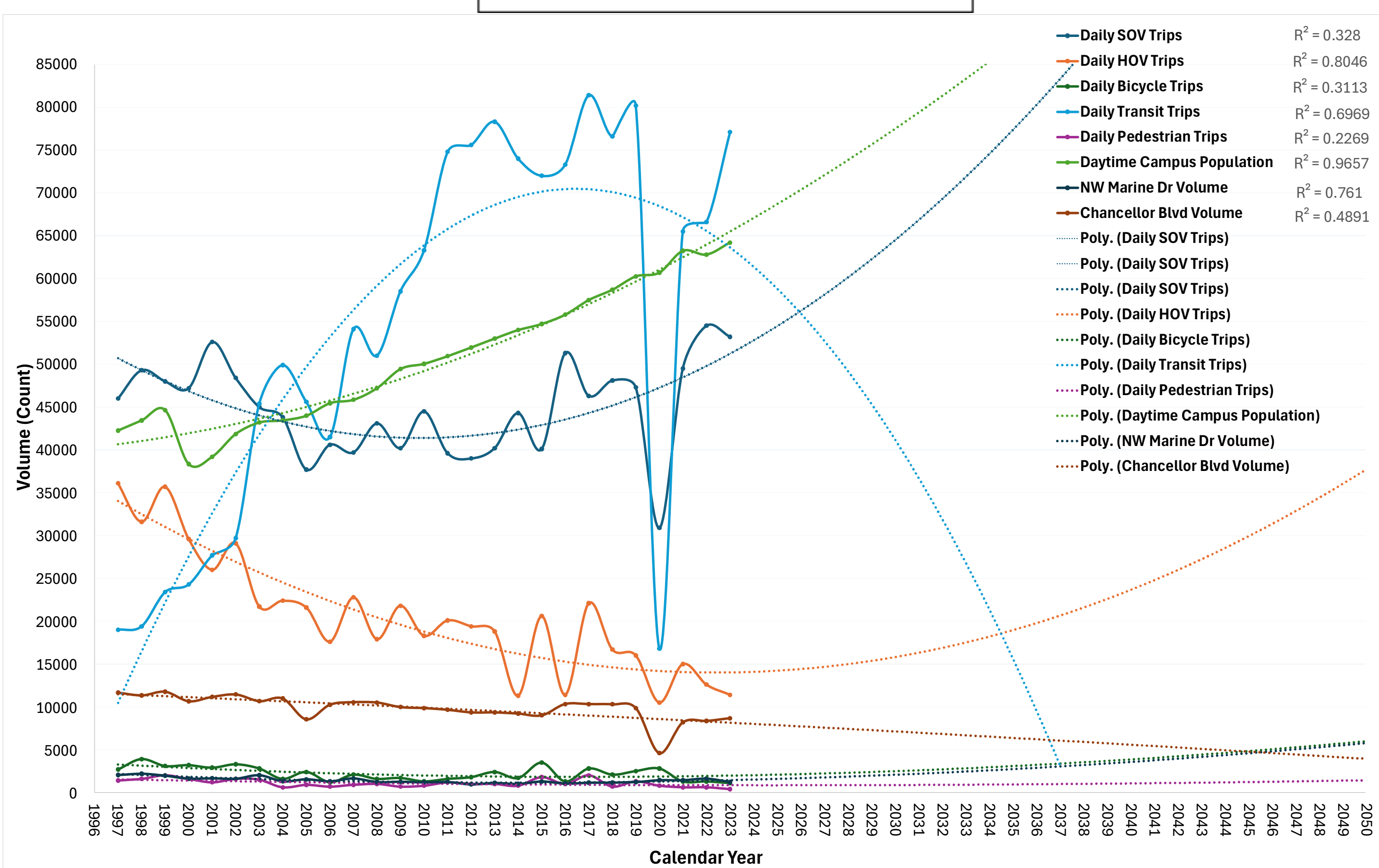

GF < 1


The large plummet in Transit Trips from the Years 2019-2022 can be explained by the COVID-19 global pandemic.
In this case the R^2 value can be ignored as the data trend was deviated due to the pandemic.
In general, Transit Trips will increase over time.


GF < 1




High R^2 value and positive trendline suggest steady campus population growth.



# Appendix L - Weighted Decision Matrix

| Criteria | Weights | Traffic Signalized Intersection Design | | Protected Bike Lane Design | | Roundabout Design | |
|---|---|---|---|---|---|---|---|
| | | Raw | Weighted | Raw | Weighted | Raw | Weighted |
| Ease of Traffic Congestion | 2 | 3 | 6 | 5 | 10 | 4 | 8 |
| Ease of Maintenance | 2 | 2 | 4 | 3 | 6 | 4 | 8 |
| Cost | 5 | 4 | 20 | 5 | 25 | 2 | 10 |
| Environmental Impacts | 3 | 3 | 9 | 5 | 15 | 3 | 9 |
| Reducing Vehicle Speeds | 4 | 4 | 16 | 1 | 4 | 5 | 20 |
| Prioritizing Active Travel Modes | 4 | 3 | 12 | 5 | 20 | 3 | 12 |
| Protecting Point Grey Cliffs | 5 | 4 | 20 | 5 | 25 | 3 | 15 |
| Safety of Pedestrians and Cyclists | 5 | 4 | 20 | 5 | 25 | 3 | 15 |
| Aesthetic Appeal | 2 | 3 | 6 | 4 | 8 | 5 | 10 |
| **Total** | | **113** | | **138** | | **107** | |

Weighted Decision Matrix (WDM)