UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Chancellor Boulevard / East Mall Intersection Redesign

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Executive Summary

The redesign of the Chancellor Boulevard and East Mall intersection at the University of British Columbia (UBC) addresses existing accessibility, safety, and sustainability challenges. The current highway-style layout encourages high vehicle speeds, lacks infrastructure for pedestrians and cyclists, and contributes to cliff erosion through inadequate stormwater management. With increasing campus development and a shift toward active transportation, a redesign was needed to meet future demands.

Urban Flow Engineering was tasked with delivering a comprehensive, context-sensitive solution meeting four primary objectives: (1) reduce vehicle speeds, (2) improve pedestrian and cyclist safety, (3) manage all stormwater on-site for a 100-year storm event, and (4) establish a defined gateway into UBC. The design process included traffic counts, site investigations, hydrological and geotechnical analysis, and Synchro-based traffic modelling. All designs adhered to CSA S16, CSA A23.3, and BCBC 2024 standards.

Three preliminary concepts were evaluated, and the selected semi-actuated signalized intersection best addressed safety, active transportation, and future scalability. Key features include four new crosswalks, continuous bike lanes, narrowed vehicle lanes, and signal phasing optimized for pedestrian and cyclist priority. A robust stormwater system was developed to manage a 100-year storm event, featuring a 968 m^3 underground detention tank and a 435 m^2 rain garden. Lastly, an 8-meter gateway sign, constructed from reinforced concrete and hollow steel, establishes a clear sense of arrival at the southwest corner of the intersection.

Construction will start on May 1st and finish on September 30th, 2025, minimizing disruption to road users and nearby residents. The total cost is estimated at $3.97 million, with major allocations to civil works, stormwater infrastructure, and structural elements. Long-term maintenance plans are included to ensure continued safety and performance. The proposed design meets UBC's transportation and sustainability goals through a balanced, forward-thinking engineering solution.

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1.0 Introduction

The intersection of Chancellor Boulevard and East Mall at the University of British Columbia (UBC) presents unique challenges due to its geometry and unconventional design. Urban Flow Engineering (U-Flow) aims to redesign this intersection to reduce vehicle travel speeds, prioritize active travel modes, provide a UBC gateway sign, and retain all rainwater on site, while delivering value engineering for the university and all stakeholders and rightsholders.

1.1 Project Background

Located on the traditional, ancestral, and unceded territories of the xʷməθkʷəy̓əm (Musqueam) peoples, Urban Flow Engineering acknowledges and respects the Indigenous lands on which the project is situated.

In alignment with the UBC's commitment to lead globally and locally in sustainability and wellbeing across their campuses and communities, UBC Campus and Community Planning has expressed interest in redesigning the Chancellor Boulevard and East Mall intersection to enhance safety and sustainability. The intersection serves as a gateway to the UBC Point Grey campus but incorporates highway-style elements that result in high travel speeds, user confusion, and safety concerns for active transportation modes. Additionally, the absence of a robust rainwater retention system worsens the erosion of nearby cliffs. With the increased student housing development in the northern campus area, coupled with the growing impact of severe storms due to climate change, traffic and rainwater runoff are exceeding original design expectations. Furthermore, the sustainable trend towards active transportation has led to an increase in pedestrians and cyclists. Given these challenges, a redesign of the intersection is seen as a practical solution to meet sustainability goals and better serve the local community, while also providing greater value to the university.

1.2 Site Overview

The intersection is located on the northern edge of the campus and residing on the University Endowment Lands. Several constraints influence the design process, particularly the intersection's proximity to a regional park, campus entrances, and nearby residential neighborhoods. These boundary conditions not only affect the planning of construction phasing but also the construction methods limited by available site spacing. As shown in Figure 1, a regional park in the northwest corner of the site separates the intersection from nearby cliffs. To the east, residential areas with houses, townhouses, and low-rise apartments are located. To the south, a large grass field separates UBC's Allard Hall from the intersection. These factors require careful consideration of environmental impacts and the project's life cycle. Stakeholder engagement will be a priority throughout the entirety of the project, along with environmental and life cycle assessments to ensure a sustainable design.

Figure 1: Map of Chancellor Boulevard and East Mall Intersection

The current unsignalized intersection is made up of two-way roads in four different directions, each with one lane of traffic per direction. The major road, a combination of Chancellor Boulevard and NW Marine Drive, runs east-west. Dedicated bike lanes are present, and a parking lane is situated along the south of Chancellor Boulevard. The minor road spans north-south and consists of East Mall and NW Marine Drive, with a dedicated bike lane along the western side. Wide turning lanes are also present, allowing for higher speeds to be taken through turns. Crosswalks stretch widely across all sides of the intersection except for the signalized crossing on NW Marine Drive, which is offset further west.

1.3 Team Member Contributions

A team of six have been employed to redesign this intersection to address the client's needs. Table 1 summarizes each team member's contributions leading up to the preliminary design report submission.

Additionally, the following software packages were used in the design: AutoCAD, Civil 3D, Synchro, SimTraffic, Gantt Project, Infraworks, Twinmotion, and MathCAD.

Table 1: List of Team Member Contributions

Team Member	Contributions
	Transportation Design - Traffic Simulation - Final Recommendation - Signal Timing - Pedestrian/Cyclist Conflicts - Design Rationale
	Transportation Design - 2D Modelling - CAD Drawings - Final Recommendation - Design Rationale - 3D Model - Typical Sections Drawings - Structural Drawings - Hydro Drawings
	Transportation Design - Topographic Modelling - Cost Estimate – Schedule - Final Recommendation - Design Rationale - Elevation Drawings
	Structural Design - Executive Summary - Project Objectives - Geotechnical Considerations - Cost Estimate - Design Rationale – Structural Drawings - Conclusion
	Structural Design - Stormwater Design - Introduction - Project Objectives - Construction - Schedule - Traffic Management Plans
	Design - Report Formatting - Project Objectives - Cost Estimate - Design Rationale - Conclusion

2.0 Project Objectives

For the intersection redesign of Chancellor Boulevard and East Mall, Urban Flow Engineering aims to exceed the client's needs and expectations through a sustainable design meeting the following project objectives:

- Prioritize active transportation
- Improve safety by reducing vehicle speeds
- Retain all rainwater on-site
- Provide a UBC gateway sign

2.1 Key Issues and Design Criteria

The purpose for the intersection redesign lies in UBC's need to address key issues listed below:

Speeding: The lack of traffic speed reduction measures, coupled with wide travel lanes and excessively large turning radii, has contributed to an ongoing issue with speeding through the intersection. Despite the posted speed limit of 50 km/h, many drivers continue to exceed this limit, significantly increasing the risk of accidents. Higher speeds not only exacerbate the severity of collisions but also reduce the ability of drivers to react to sudden changes in road conditions or traffic signals. Implementing measures to reduce speeds is crucial for enhancing safety, minimizing accident risk, and improving overall traffic flow at the intersection.

Pedestrian and cyclist safety: The current intersection design does not adequately accommodate pedestrians and cyclists, creating significant safety concerns. Without proper facilities or traffic-calming measures, pedestrians and cyclists are left vulnerable in a high-speed environment. Addressing this design issue is critical to ensure safer access for all road users, particularly vulnerable groups, and to promote a more balanced and inclusive transportation network on campus.

Not intuitive for motorists or active modes: The current design of the intersection is long and unconventional, resulting in confusion for both motorists and active modes of transport. This lack of clarity in navigation increases the likelihood of drivers becoming distracted or making unpredictable movements, which can compromise safety for all road users. Additionally, the non-intuitive layout makes it difficult for pedestrians and cyclists to navigate the intersection confidently, further increasing the risk of accidents. Addressing this design issue is essential to improve user understanding, reduce safety hazards, and ensure a more efficient and safer flow of all traffic types through the intersection.

Designed and used as a highway: The existing intersection features highway-style design elements which encourage speeds that are unsuitable for an entrance to a campus with high volumes of vulnerable road users, such as pedestrians and cyclists. This design fails to align with the context of a university environment, where safety and accessibility should be prioritized. The university has expressed the need for an urban roadway design that reflects the site's unique spatial context, fostering safer interactions between all road users. An intersection redesign is essential to reduce safety risks and create a more appropriate, context-sensitive environment for both motorized and non-motorized traffic.

No sense of arrival to UBC: The current site lacks clear and prominent signage to distinguish the campus from the surrounding city, creating a visual ambiguity for drivers. This absence of a clear campus entrance sign can lead to confusion for motorists unfamiliar with the area, potentially increasing the likelihood of distracted driving and reducing overall road safety awareness. Implementing a well-placed gateway sign would provide crucial directional guidance, improve navigational clarity, and enhance the sense of arrival, fostering a safer and more welcoming transition into the campus environment.

Insufficient rainwater retention system: Without a sufficient rainwater retention system, rainwater runoff continues to accelerate the corrosion on the nearby cliffs. Without proper drainage, stormwater flows freely across the site, contributing to erosion and negatively impacting the surrounding natural environment. This not only threatens the integrity of the cliffs but also increases the long-term maintenance costs of the infrastructure.

Implementing an effective rainwater management system is essential to protect the nearby cliffs from further damage, improve environmental sustainability, and reduce the risk of erosion-related hazards to both the campus and surrounding area.

2.1.1 Technical

All structural and construction elements must consider the existing geotechnical conditions of the site. The following design leverages the "Hydrogeological and geotechnical assessment of northwest area UBC Campus, Vancouver" study by Piteau Associates in 2002, BCBC 2024, CSA S16, and CSA A23.3 to govern the final design.

As elaborated in the report, the main considerations include allowable bearing capacity, concrete capacity, rebar detailing, and connection design. The design must adhere to the relevant structural design codes to maintain public safety.

2.1.2 Regulatory

The proposed intersection must accommodate WB-20 design vehicles and meet BC Ministry of Transportation and Infrastructure (MoTI) standards. Additionally, relevant codes and standards for roadway, structural, and stormwater design, as shown in Table 2, must be followed.

Table 2: Design Codes and Standards Consulted for the Project

Design Codes and Standards	Purpose
B.C Supplement to the TAC Geometric Design Guide for Canadian Roads (2021)	Roadway Design
British Columbia Active Transportation Design Guide	Transportation Design
TAC Manual on Uniform Traffic Control Devices for Canada	Traffic Design
City of Vancouver Integrated Stormwater Management Vision Principles and Actions Vol. 1	Stormwater Design
BC Building Code (BCBC) 2024	Structural Design
National Building Code (NBC) 2020	Geotechnical Considerations
CSA-S16 "Design of Steel Structures"	Structural Design
CSA A23.3 "Design of Concrete Structures"	Structural Design

2.1.3 Construction Planning

The Ministry of Transportation and Infrastructure places heavy emphasis on meeting minimum standards for a construction and traffic management plan. The construction and traffic management plan must consider multiple factors expanded upon in the Traffic Management Manual for the Work on Roadways from MoTI.

The construction and traffic management plan should be developed as a dynamic document, regularly updated to reflect any changes in the scope of work, roles, and responsibilities, with ongoing evaluations. Given the complexity of the project and its significant impact on the public, the plan must cover sub-plans for traffic control, incident management, public information, and implementation.

2.1.4 Economic

Cost is a key factor in the project that sets Urban Flow Engineering's design apart from competitors. The total project costs are driven by several components, each contributing to the overall financial investment. The type of intersection, whether roundabout, signalized, or unsignalized, has a significant impact on both construction and long-term maintenance costs. The inclusion of a gateway sign adds to the initial expenses while enhancing the project's visual appeal and branding. The rainwater retention system is essential for sustainability but introduces additional costs for design and implementation, especially when considering site-specific drainage requirements.

Additionally, construction costs encompass labor, material, and equipment, with potential variations depending on project's scale and complexity. Maintenance and operation costs will affect the long-term budget, including ongoing traffic management, signal maintenance and safety inspections. U-Flow's design minimizes these costs by incorporating cost-effective materials and innovative solutions, conducting cost analyses to determine value engineering and efficient alternatives, and ensuring long-term value for stakeholders and rightsholders.

2.1.5 Environmental

The major environmental issue regarding the existing intersection is the erosion of the adjacent Point Grey cliffs due to poor rainwater management. The proposed design must retain all rainwater on-site, with the capability to manage a 100-year storm event. The design must also account for all the rainwater that falls within the intersection as well as nearby runoff from surrounding catchment areas.

The proposed design should account for site footprint and construction impacts, this is especially relevant for any clearing or grubbing required. The proposed design should aim to minimize tree loss, especially given the proximity to the regional park and nearby trees. Tree protection will be set up prior to any construction activity related to the project such as excavation for the rainwater retention system. Further studies such as environmental life cycle assessments will be conducted to analyze the impacts of the proposed intersection, rainwater retention system, and gateway sign for the duration of the 100-year design span.

2.1.6 Societal

The current layout of the intersection is unintuitive for both drivers and active mode users alike, this poses safety concerns for users of the intersection. Thus, consideration of driver, pedestrian, and cyclist safety is paramount. The intersection must have an intuitive design that is easy to use and promotes user safety. It must also consider the local and spatial context pertaining to UBC, the University Endowment Lands, Indigenous Lands, and other relevant stakeholders/rightsholders. Stakeholder/rightsholder engagement will be readily pursued throughout the entirety of the project to encourage a collaborative approach. U-Flow's community engagement plan will consist of clear communication channels, open houses, consultation meetings, surveys, and other effective and innovative approaches. Dedicated meetings with the local First Nations will be held to better understand site issues and project concerns in order to work with the Indigenous rightsholders throughout the project duration. Additionally, social procurement for local Indigenous-led firms will be pursued to further explore options of Indigenous engagement and steps towards reconciliation.

3.0 Detailed Design

3.1 Traffic Analysis Methodology

To provide a basis for the new redesigned intersection, traffic counts of the current intersection and its usage were collected and analyzed at the highest utilization time. A traffic count was conducted to collect vehicle turning movement counts at the current intersection during the morning peak hour (8-9 am) and the afternoon peak hour (3-4 pm) periods. The current vehicle turning movement and pedestrian count data were then validated with historical vehicle count data of neighboring roads to crosscheck discrepancies. To determine the design volume of the intersection, the population growth rate of UBC was extrapolated from the UBC-Vancouver Campus Transportation Status Report Fall 2023 and was estimated at a linear increase of 1-2% per year. The current vehicle and pedestrian data was then scaled with the growth rate for analysis 30 years into the future, in line with the client's recommendation to design the intersection for the horizon year 2055.

Figure 2 illustrates the current traffic volume with the scaled traffic for the AM peak on the major roads. Additional diagrams for the scaled volumes and detailed count data are attached in Appendix E.

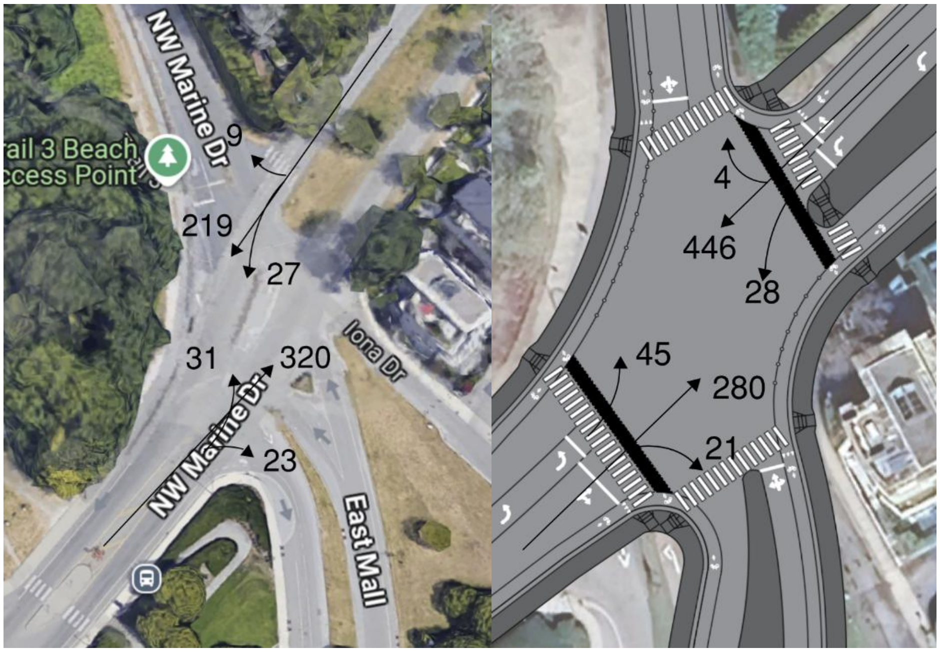


Figure 2: Current AM Major Road Counts (Left) Scaled AM Major Road Counts (Right)

3.2 Traffic Analysis Modelling

Traffic flow analysis was conducted to determine LOS and delay for the new redesigned intersection. Use of modelling software was essential in developing the final design of the intersection and to achieve the key project objectives. Macro modelling using Synchro 6 provided a comprehensive breakdown for lane configuration and signal timing for the final design.

Parameters input into Synchro for the analysis include the site collected data, calculated values, and assumed values based on credible industry resources. Calculations and assumptions were made following the design objectives of prioritizing active transportation and reducing intersection speed. The following table summarizes the assumptions made based on the City of Vancouver Guidelines for Using Synchro Version 10 (June, 2022) and the Canadian Capacity Guide for Signalized Intersections (February, 2008) for the traffic analysis in Synchro (see Appendix F for specific calculations).

Table 3: Assumed Synchro Inputs

City of Vancouver Guidelines for Using Synchro Version 10	Non-downtown ideal saturation flow: 1900 vphpl
	Typical approach grade: 0%
	Peak Hour Factor: 0.93 (AM), 0.94 (PM)
Canadian Capacity Guide / City of Vancouver Guidelines for Using Synchro Version 10	Pedestrian Walk Interval: Wmin (varies)
	Pedestrian Clearance Interval: Wclear (varies)

To accommodate and promote the growth of active transportation with the design, a higher minimum clearance time was considered for the minor road crossing in the simulation. The minimum clearance time was calculated following the equations in the City of Vancouver Guidelines for Using Synchro Version 10 (June, 2022) and the Canadian Capacity Guide For Signalized Intersections (February, 2008) Table 4 summarizes the design for longer active transportation crossing time.

Table 4: Minimum Pedestrian Clearance Time Design

Total Cycle Length	**75 s**
Walk Time	10 s
Minimum Pedestrian Clearance Time	23 s

A maximum vehicle delay of LOS C was targeted for the Synchro simulation to balance pedestrian and cyclist accommodation with anticipated vehicle queue length. To keep vehicle delay at LOS C, left turn lanes on Northwest Marine Dr. and Chancellor Blvd. were confirmed into the geometric design. Indicators that were considered when aiming for an intersection LOS C include all V/C ratios under 0.9 and a max 95th percentile vehicle queue length of under 100 meters. These indicators prove important, as vehicle congestion can be present at a V/C ratio greater than 0.9, and a queue length of over 100 meters can spill into neighboring intersections causing increased congestion. Table 5 summarizes the key indicators used in the traffic analysis, and detailed Synchro and SimTraffic reports of the analysis can be found in Appendix G.

Table 5: Key Indictors for Traffic Analysis

Max V/C Ratio	95th Max Queue Length(m)	Intersection LOS
0.76	90.6	C

3.3 Decision Making Process

Three potential designs were analyzed: a single-lane roundabout, an unsignalized intersection, and a semi-actuated signalized intersection. A weighted decision matrix guided the analysis, prioritizing active transportation, which was heavily weighted. The roundabout design struggled with accommodating active transportation, so it scored lower compared to the two other designs. Delay was another category implemented in analysis. While less heavily weighted, it was still important satisfy all road users. Additionally, safety, aesthetics, and costs were included in the decision-making process. Safety was heavily weighted since it aligned well with the project objectives of reducing vehicle travel speeds and user safety. The aesthetics category played a small factor in decision-making, though it was considered since placement of the gateway sign was important. Lastly, costs were evaluated including capital costs, maintenance, and project timeline with consideration to any additional changes that may be required to implement each design.

4.0 Key Design Components

4.1 Summary of Design Elements

The chosen design is a signalized semi-actuated intersection. It features traffic lights in all directions. The east-west signals operate in programmed phases and the north-south are semi-actuated, activated by pedestrians, cyclists, or vehicles. Key changes include four new pedestrian crosswalks and updated bike lanes on all approaches, removal of medians, and the southwest curb shifted to realign East Mall more parallel to NW Marine Drive. Other features include zebra crossings and adjusted medians to prioritize pedestrian safety and reduce travel speeds. Advantages of this design include higher user safety and visibility, as well as narrower lanes to encourage slow vehicles speeds. Signal phasing provides clear guidance on intersection use and the semi-actuated design minimizes delays. Although traffic signals may result in higher maintenance costs, this design is able to accommodate future growth as it doesn't require as many changes in existing infrastructure compared to the roundabout.

Other design components include a UBC gateway sign on the southwest curb, a rain garden on the south approach median, and a rainwater detention tank on the north approach. Figure 3 below illustrates a rendering of the intersection and its design elements, as modeled in Autodesk Infraworks.

Figure 3: Intersection Render (Pointing toward South Approach)

4.2 Signage

Intersection signage will include the following:

- No Right-Turn On rRed
- 50 km/h Speed Limit
- Shared Path
- Dedicated Bicycle Lane

- Turning Vehicles Yield To Bicycles Sign Right
- Bicycles Yield To Pedestrians
- Left Turn Only Lane
- Right or Left Turn Only Lane
- Do Not Enter
- Right and Left Side Pedestrian Crosswalk
- U-Turn Prohibited
- Keep Right
- Hazard Marker Right
- Stop
- No Parking (Existing)

In the design of an intersection, it's crucial to prioritize only essential signage to improve traffic flow, safety, and clarity for all road users. Too many signs can create visual clutter, leading to confusion, reduced driver compliance, and distraction from important instructions. This intersection primarily uses semi-actuated traffic lights and includes only the signs that add real value and enhance safety. By carefully choosing and strategically placing these signs, the intersection functions efficiently reducing unnecessary stops, delays, and potential hazards, while also improving the overall user experience. A detailed signage plan is provided in drawing S-003.

4.3 Traffic Signals

Traffic signal heads and active transportation push buttons will be installed to control all road users entering the intersection. The semi-actuated intersection has the eastbound and west bound approaches set on a continuous through phase as most traffic is travelling to and from UBC along Northwest Marine Dr. and Chancellor Blvd. The signal changes once a pedestrian, cyclist, or a queue of vehicles is detected on the northbound East Mall or southbound Northwest Marine Dr. approach.

Traffic signals will follow a two-phase cycle that will accommodate active transportation users while minimizing any unwanted congestion. The total cycle length for the intersection is 75 seconds split into a 39 second phase for the minor road and then back to a 36 second phase for the major road. Active transportation users will be allowed to cross the major and minor roads during the respective phase and are given priority over oncoming or turning vehicles. Figure 4 illustrates the green time and inter-green periods of the phases.

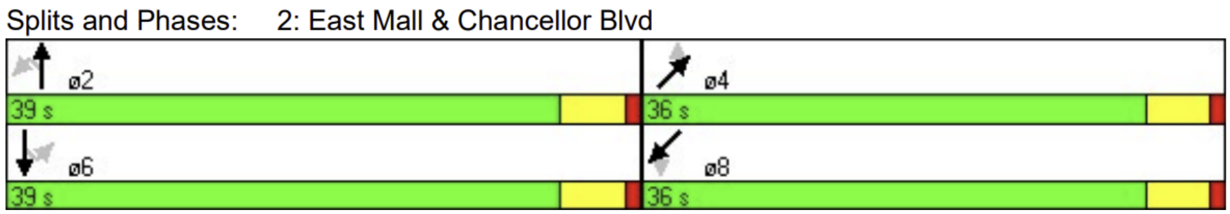


Figure 4: Intersection Splits and Phases

The first phase allows vehicles on the minor roads of Northwest Marine Dr. and East Mall to go straight, right, and left yielding to oncoming vehicles, cyclists, and pedestrians. The second phase allows vehicles on the major streets of Northwest Marine Dr. and Chancellor Blvd to go straight, right, and left yielding to oncoming vehicles, cyclists, and pedestrians. Instead of having a protected phase for left turning vehicles on the major roads, permissive left turns allow the intersection to operate with minimal vehicle delay delivering the new intersection a Level of Service of C.

The following figure shows the side-by-side comparison between the two phases. Phase one is marked in red, and phase two is marked in blue. Active transportation movements are detailed in green in both phases. For illustrative purposes, solid lines represent priority movements, and the dotted lines represent permissive movements.

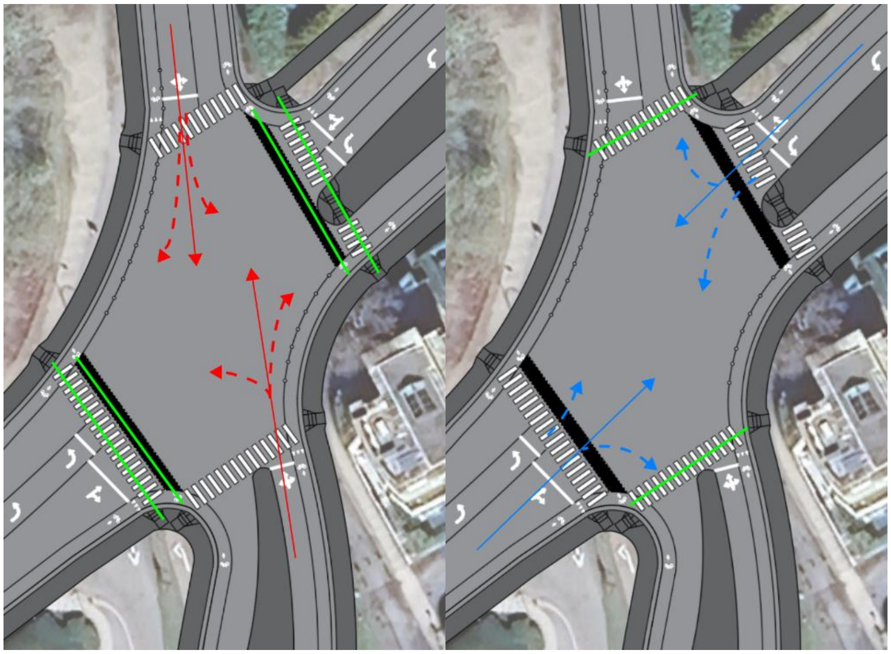


Figure 5: Phase 1 (left) Phase 2 (Right)

4.4 Active Transportation Accommodation

Our chosen preliminary intersection has been carefully designed from the ground up to accommodate active modes of transportation. Implementing a semi-actuated signalized intersection provides unique opportunities to design for active transportation use. The minor roads will have pedestrian and cyclist push buttons to control the signal and conveniently change the light for less active user delay. Intersection cycle length can also be changed to allow for longer minimum pedestrian clearance times to be more accommodating to vulnerable road users.

For easier pedestrian use, four new crosswalks will be installed on each corner of the intersection. Crosswalk lengths have been designed by enlarging boulevard sizes to minimize travel time for pedestrians providing a safer, convenient route. For added pedestrian safety, zebra crosswalk markings may be chosen later in the design process to add to pedestrian safety as zebra markings are much more visible than the standard twin parallel line markings.

New bike lanes have also been designed and will be painted on all four of the intersection approaches. Bike usage of the intersection has been observed to be overall moderate, with the exception that the north and south approaches are heavily used by cyclists arriving and leaving from UBC during peak hours. The new intersection design will have the north and south bike lanes painted through the intersection to provide a safer designated space for cyclists travelling through the intersection at the busiest times. Additionally, bollards have been strategically placed along the northwest and southeast bike lanes to further enhance cyclist safety during turning movements.

We aim to design an intersection that is not only accommodating to active transportation but intentionally promotes the use of active mobility for present and future users by showcasing safety and convenience with our design choices.

4.5 Pavement Markings

Pavement markings are to show new sign locations, sign removals, and relocations. Installation shall abide by the BC MOTT Manual of Standard Traffic Signs & Pavement Markings (2000) and the BC Active Transportation Design Guide (2019). Additionally, buffer markings are to be channelized and implemented to visually narrow the roadway enhancing driver guidance and promoting speed reduction. Yield lines on bike lanes will also be added to clarify that incoming traffic has the right-of-way which will improve safety and reduce speeds near conflict points. Likewise, it will be incorporated to create separation between cyclists and vehicles ensuring safer interactions. All pavement markings are assumed to be thermoplastic and temporary pavement markings are to be placed after new asphalt pavement laying.

4.6 Alignment

To better align through and turning movements for the proposed intersection, concrete medians and curb returns were adjusted to strategically narrow lane widths and provide better accessibility to and from campus. Removal of the center concrete island ensures smoother through movements heading north and southbound, along with tightening of the northwest curb. Most notably, the removal of Iona Drive allows the south approach to be shifted further north-eastward, with the concrete median sized to accommodate the rain garden and narrow adjacent lane widths, resulting in lower travel speeds. Figure 6 below illustrates the geometric change of the south leg to provide more intuitive movement from north to south.

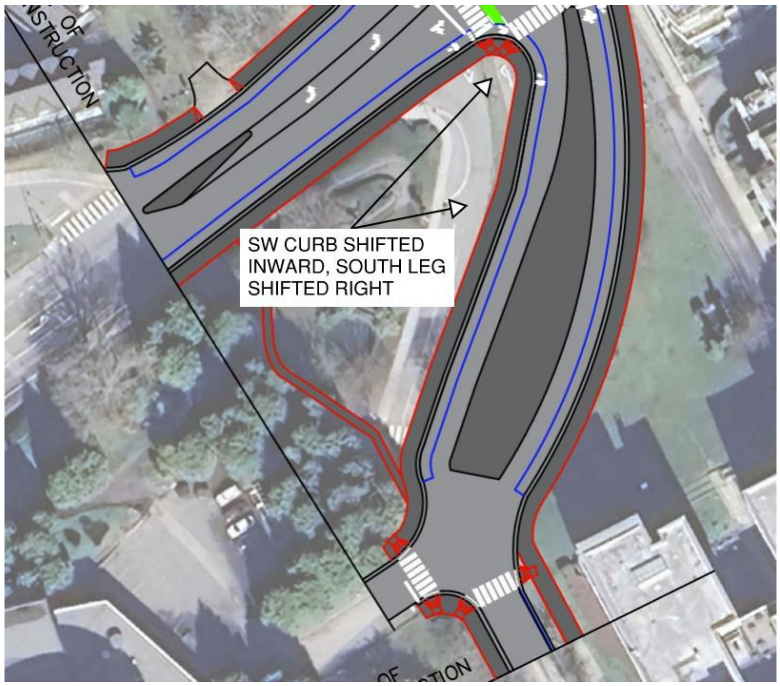


Figure 6: Geometric Alignment Design Changes

5.0 Technical Details

The following sections describe the technical details pertaining to the 3 major design components: geometric design, structural design, and hydrotechnical design.

5.1 Geometric Design

In accordance with the BC Supplement to the TAC Geometric Design Guide (2019), the recommended design vehicle for the signalized intersection is a WB-20 truck. This ensures that all smaller vehicles, including articulated buses, can traverse the intersection safely and efficiently. The dimensions of the WB-20 truck and an articulated bus, as specified in the TAC Design Vehicle Dimensions for Use in Geometric Design, are provided in figure below.

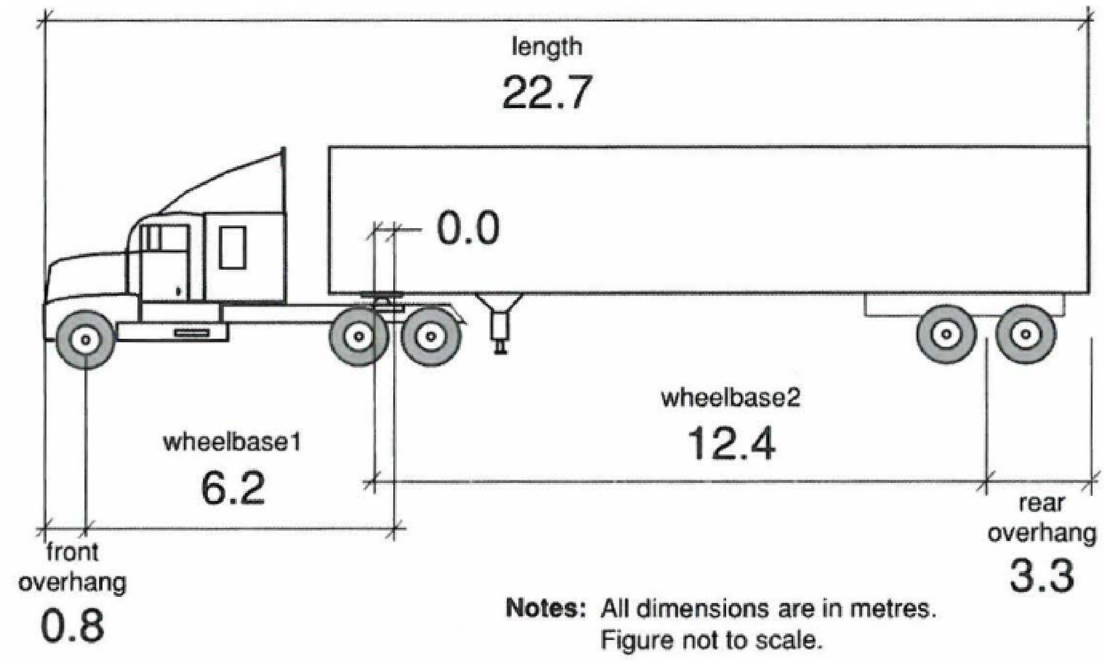


Figure 7: WB-20 Tractor-Semitrailer Dimensions

To accommodate this design vehicle, lane widths were designed to a minimum of 3.5 m and turning radius designed to a minimum of 17.7 m assuming that turning speed is 20 km/h in an urban environment. To reduce existing lane widths for decreased speed, the south-west curb was extended approximately 20 m. Likewise, the north-east and south-east curbs are extended and tapered. The minimum crosswalk width of 2.5 m in TAC's Manual of Uniform Traffic Control Devices is satisfied as all crosswalks are approximately 2.5 m, while all sidewalks are a minimum of 1.5 m. All bike lanes in all approaches are 1.5 m satisfying the minimum width of 1.5 m.

5.2 Geotechnical Considerations

5.2.1 Site Evaluation

Our team has thoroughly evaluated current geotechnical conditions as per the geotechnical assessments conducted by Piteau Associates in 2002 (Piteau Associates Engineering Ltd., (2002). Based on the assessments seen in Appendix B, the groundwater tables are significantly below the required development grade of the project, with anticipated excavation extending up to 5.0 meters below the existing grade level. The nearest drilled well in this investigation highlighted the potential soil profile on site to be a mix of "sand (with traces of clay or silt) and/or silt (or silty sand or layers)". The following table highlights this composition in more detail.

Table 6: Summary of Geotechnical Soil Profile

Depth Below Grade (m)	Soil Type
0 – 2.5	Sand (with trace clay or silt)
2.5 – 5.5	Silt (or silty sand or layers)
5.5 – 7.8	Sand (with trace clay or silt)
7.8 - 10	Silt (or silty sand or layers)
10 - 15.2	Sand (with trace clay or silt)

5.2.2 Bearing Capacity of Soil

However, it should be noted that surface till seems to also be present on site as per Appendix B. With all this information in consideration, and under Section 9.4.4.1 of BCBC 2024, the maximum allowable bearing pressure will be taken as 150 kPa for shallow foundations. This value could be considered conservative given the wide range of soils on site. These values will be considered for all built roads, sidewalks, and structures at the site.

5.3 UBC Gateway Sign

As aforementioned, to create a sense of community and arrival upon entering the intersection, a gateway sign must be erected on-site. The requirements outlined only limit the minimum height of the sign to 8.0 meters.

The proposed sign is situated on the southwest corner of the intersection, facing northeast as seen in the figure below in yellow. This orientation maximizes the number of intersection users who observe the sign upon arrival at the intersection, as per the collected traffic counts. The architectural design and overall placement can be seen in the figure below. It features an 8.0 m sign, in which the bottom 3.5 m is comprised of a concrete column, and the upper 4.5 m consists of the university letters made using lightweight hollow steel, paying homage to the original UBC sign at the bus loop.

Figure 8: Gateway Sign Design & Site Location

As seen above, the gateway sign is supported on a 5250 mm x 5250 mm square concrete slab which has a thickness of 800 mm. These dimensions consider the allowable pressure of the soil at 150 kPa. The relevant calculations for this design, alongside additional assumptions and considerations are outlined in Appendix A. Detailed drawings, including rebar detailing for the structural slab and column are in the drawing set, in particular S-019. For detailed drawings on the structural aspects of the steel sign portion, see drawing S-018.

5.4 Stormwater Management

The intersection design incorporates a robust stormwater management system capable of handling a 100-year storm event. This design decision ensures the system's resilience in the face of increasingly intense weather patterns, slowing down the erosion of the nearby cliffs.

5.4.1 Existing Infrastructure

Currently, there are catchment basins located along East mall and Chancellor Boulevard within the limits of construction. These catchment basins will be removed, and the existing storm water sewer will remain undisturbed, except for localized repairs at the points of removal.

There are multiple utility lines that run under the intersection, see Figure 9, which may cause crossing conflicts. To remedy this issue, the proposed pipes will be fitted with bends near the crossings to run underneath existing lines with a minimum vertical wall to wall distance of 300 mm. Steeper slopes further away from the crossings will also gradually lower the elevation of the proposed pipes to allow sufficient crossing clearances.

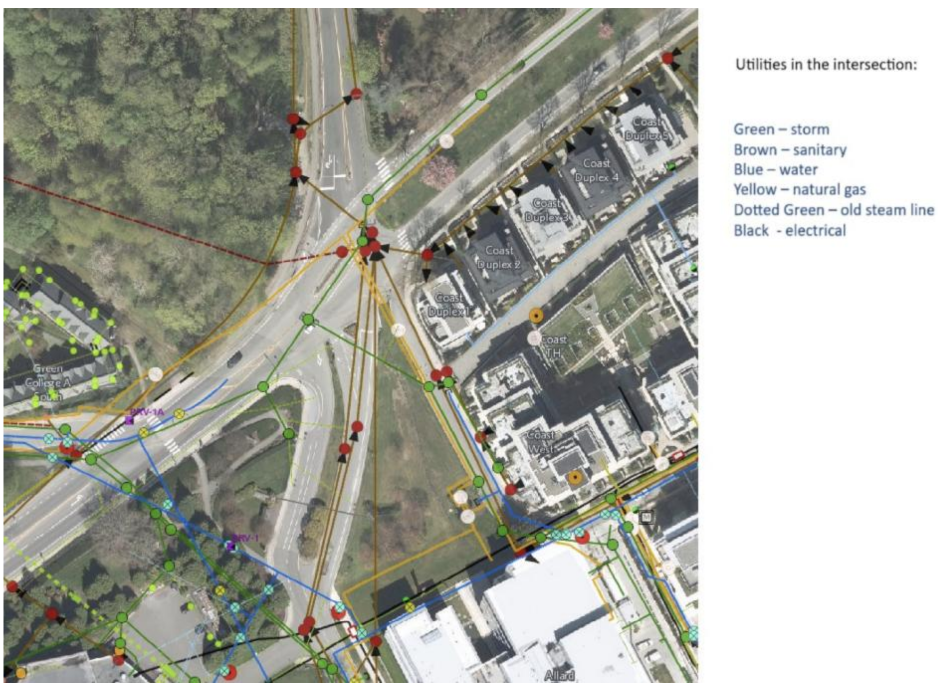


Figure 9: Existing Utility Lines Under Intersection

5.4.2 Rainfall Estimates

To determine the required capacity for the system, data from the City of Vancouver's Intensity-Duration-Frequency (IDF) data and graph was analyzed, *Figure* 10. The expected rainfall intensity for a 100-year return period was calculated to be 6.52 mm/hour for a 24-hour storm.

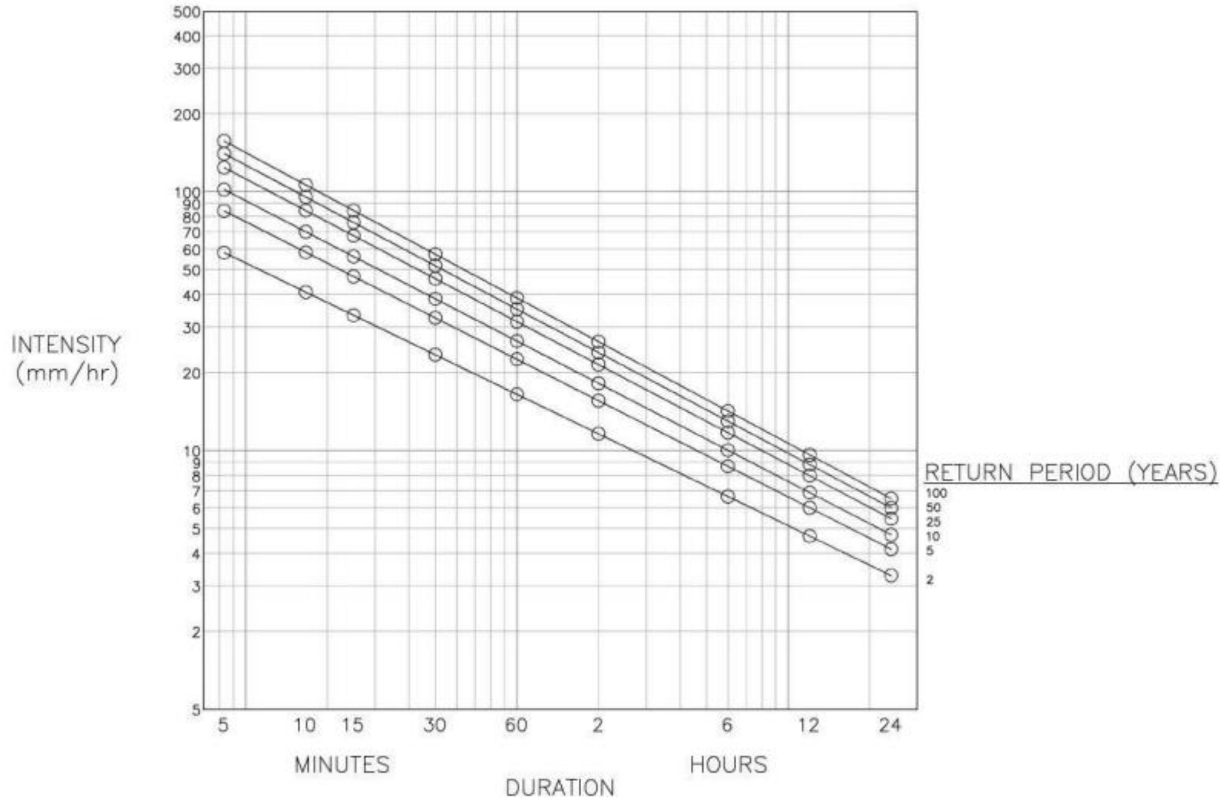


Figure 10: IDF Graph for the City of Vancouver (2050)

With the estimated intensity of rainfall, the water runoff and volume of rainfall was then determined based on the area and surface types that can be found around the intersection.

5.4.3 Storm Water Sewer

13 catchment basins are spaced along the lower edges of each approach. Connecting these basins are two 200 mm diameter PVC pipes that run on the left and right sides of the road. See Appendix C for more details on the hydro tables. Figure 11 outlines the typical trench details for the pipe. A minimum depth of cover of 1000 mm is provided along the length of the entire pipe system.

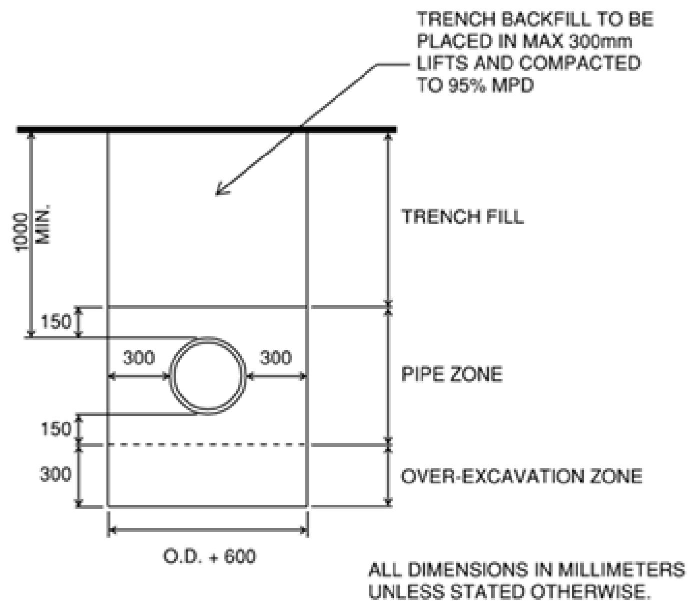


Figure 11: Storm Pipe Trench Detail with Uniform Backfill

All the pipes are between the minimum and maximum allowable slope of 0.5% and 15% and can handle flow rate of a 100-year storm with sufficient velocity. There are 10 maintenance holes placed at every terminal end, junction, bend, and grade change allowing for ease of maintenance for any length of pipe. See a diagram of the rainwater system in Figure 12 below.

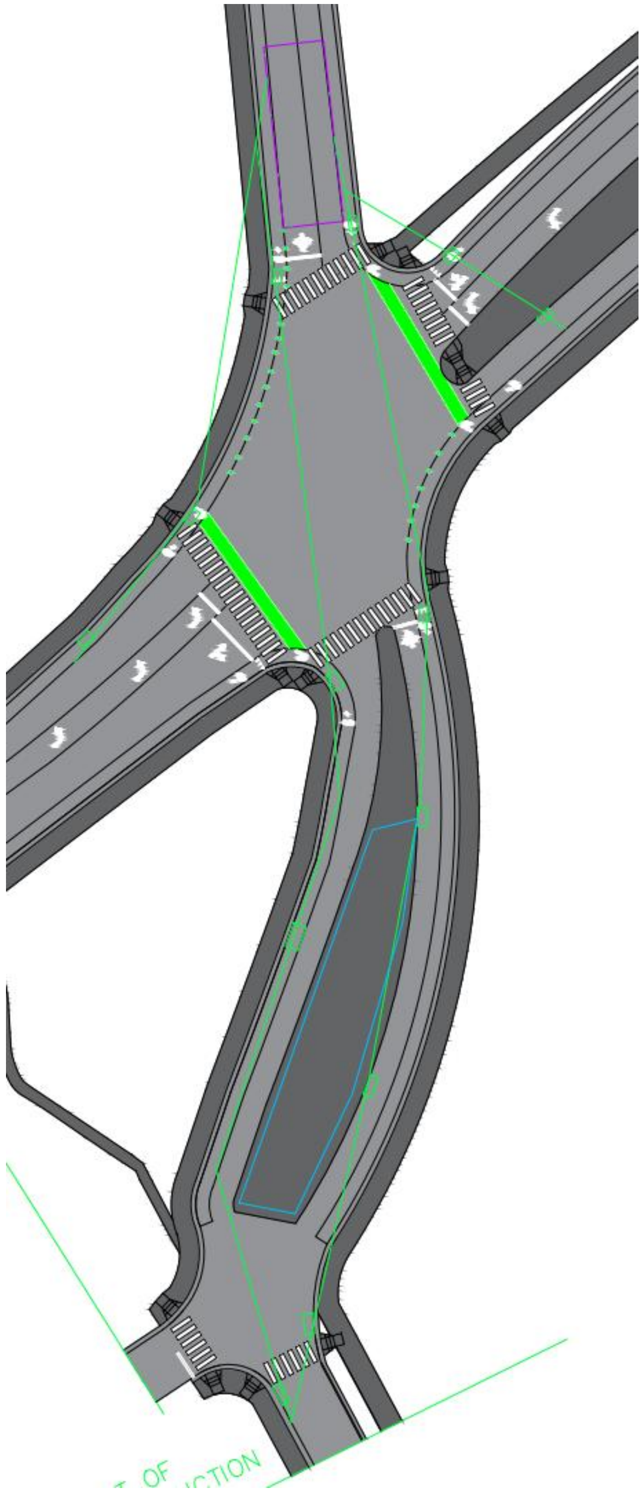


Figure 12: Proposed Pipe Network and Detention Tank

5.4.4 Detention Tank

Situated at the lowest elevation of the project site, beneath the northern approach along NW Marine Dr, a 24.9 m x 8.7 m x 5.7 m rectangular concrete detention tank will be constructed to store all rainwater collected by catchment basins. The tank will have a wall thickness of 350 mm with 200 mm cylindrical openings to connect with drainpipes. The tank will be centered on the road with the width constrained to minimize any impact to surrounding trees on either side of the planned excavation zone. The depth was kept rather shallow to eliminate the need for deep and wide trench shoring.

5.4.5 Rainwater Garden

The implementation of a rainwater garden will alleviate some storage demand on the water management system, and will slow the water from entering the system, allowing for ease of load management. The rainwater garden will cover 435 m^2 of the southern median as seen in Figure 13. Catching water from that falls on the southern approach as well as run off coming from campus, the expected catchment area of the rainwater garden spans 1919 m^2, pulling in approximately 300 m^3 of water.

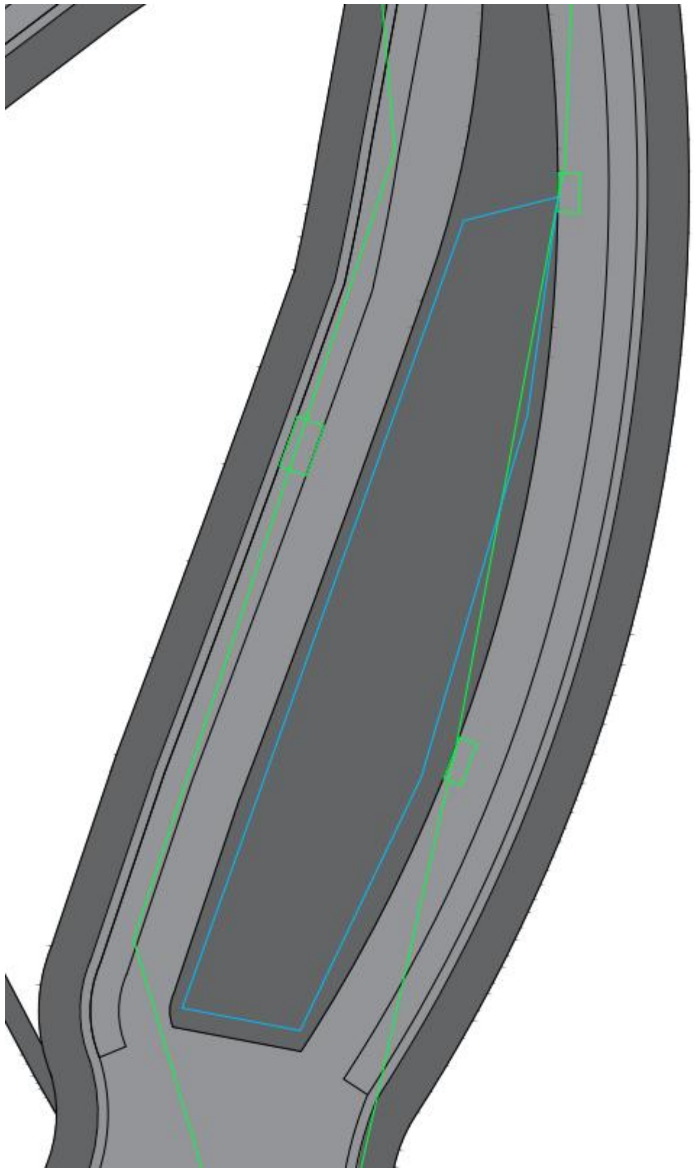


Figure 13: Rainwater Garden Location (Blue)

The capacity of the rainwater garden was calculated by summing the 24-hour evaporation, volume of growing medium, volume of rock pit, and volume of infiltration. To ensure the rainwater garden could hold the expected volume of water, the depth of growing medium and rock pit were set to 0.5 m and 1.4 m, respectively. The other values are derived from studies done on the northern area of campus, see *Table* 7. With these parameters, the rainwater garden has a maximum capacity of 302.99 m^3. See Appendix D for Rainwater Garden calculation tables.

Table 7: Design Parameters for Rainwater Garden

Parameter	**Value**	
Design Rainfall	156.48	mm
Total Area	435	m2
Depth of Growing Medium	0.5	m
Depth of Rock Pit	1.4	m
Rock Porosity	0.4	
Post Development Infiltration Rate	1.5	mm/hour
Field Capacity	0.25	
Wilting Point	0.05	

All rain gardens must use naturally occurring vegetation and a growing medium approved by the City of Vancouver. Each rain garden includes three planting zones with distinct conditions. Zone 1, located at the center, is designed to experience frequent water flow. Zone 2 becomes saturated during larger storm events, while Zone 3 typically remains dry and provides a transition between the rain garden and the existing landscape. Plants should be selected and arranged according to the specific conditions of each zone, with native species from the Lower Mainland recommended for all areas listed in *Table* 8.

Table 8: Planting Zones for Raingardens

Zone	Common Name	Scientific Name	Type
1	Western sword fern	Polystichum munitum	Perennials
1	Rush	Juncus effuse	Ornamental grass
1	Deer fern	Blechnum spicant	Groundcover
2	grassy-leaved sweet flag 'Ogon'	Acorus gramineus 'Ogon'	Ornamental Grass
2	toad lily	Tricyrtis formosana	Perennial
2	Ostrich Fern	Matteuccia struthiopteris	Fern
2	Rush	Juncus effuse	Ornamental grass
3	drumstick primrose	Primula denticulata	Perennial
3	false lily-of-the-valley	Maianthemum dilatatum	Ground Cover
3	roadside rock moss	Racomitrium canescens	Ground Cover

6.0 Rationale of Design

The chosen signalized semi-actuated intersection design was selected as it best fulfills the project objectives outlined in the report and aligns with the regulatory and societal needs of UBC Campus and Community Planning. Below is a detailed rationale supporting this decision.

6.1 Fulfillment of Design Objectives

The selected design provides improvements to the pedestrian and cyclist experience providing an intuitive and safer experience. New changes include implementing four new crosswalks with enhanced pavement markings which reduce crossing distances and enhance visibility. Bike lanes are also implemented on all routes, particularly on the heavily used north-south approaches, providing a safer space for cyclists. Semi-actuated signals minimize delays for pedestrians and cyclists by allowing them to trigger signal changes. This ensures efficient use and aligns with the primary objective to promote active transportation. Additionally, narrower lanes and curb extensions are implemented to discourage speeding and provide shorter crosswalk lengths for pedestrians. Signalized intersections also introduce controlled stopping points, which reduces travel speeds and aligns with the campus safety goals.

With an emphasis on rainwater retention, the design incorporates a robust stormwater management system which includes a retention tank to capture and manage runoff from a 100-year storm event. Rain gardens are also added to alleviate demand on the retention system, reduce runoff velocity, and contribute to local biodiversity. These measures directly address erosion concerns and align with UBC's sustainability goals. Furthermore, the design integrates an 8-meter-tall gateway sign at the southwest corner, marking the entrance to UBC and fostering a sense of arrival. Its placement maximizes visibility for both vehicular and non-vehicular traffic. Finally, future traffic modelling is done for Synchro modeling results indicate the intersection can accommodate anticipated traffic levels through 2035 with acceptable Levels of Service (LOS). The semi-actuated signals provide flexibility to adapt to future demand.

7.0 Construction

7.1 Required Construction Documents

The following required construction documents include:

- Construction and Other Related Permits
- Construction Schedule
- Traffic Management Plans (TMPs)
- Construction Design Drawings
- Traffic Impact Assessment
- Environmental Impact Assessment
- Health and Safety Plan

It is recommended that the Traffic Impact Assessment, Environmental Impact Assessment, and Health and Safety Plan be acquired through a licensed third-party entity approved to develop these documents to ensure alignment with relevant environmental and health and safety committees. These documents collectively support the design, approval, construction, and post-construction phases, ensuring that the intersection meets both engineering standards and legal requirements for safety, accessibility, and sustainability.

7.2 Construction Phasing

The construction of the project will be divided into 3 staggered phases to minimize disruptions to intersection users, with emphasis placed to accommodate active modes of transportation. As seen in Figure 14, Phase 1 in blue consists of the northern portion, Phase 2 in orange consists of the southern portion, and Phase 3 in purple consists of the central (east and west) portion of the intersection.

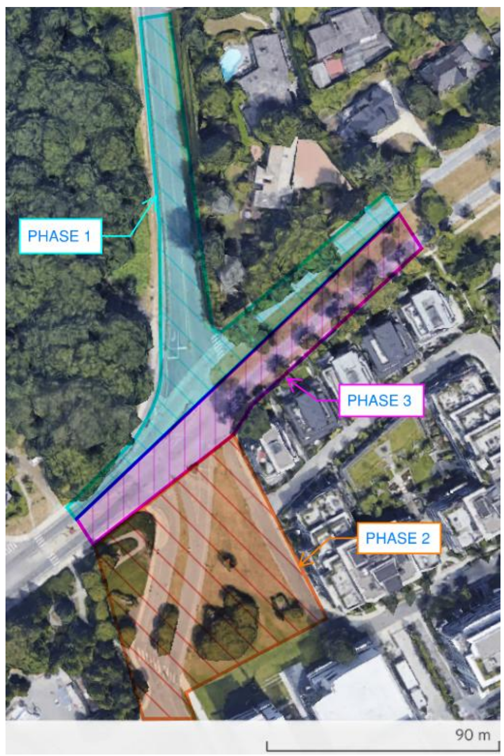


Figure 14: Construction Phasing Plan

7.2.1 Site Logistics

Site offices and laydown yards will be set up on NW Marine Dr and Iona Dr in areas just outside of the active work zone for ease of material transfer and efficient workflow. These areas will be restored to match existing conditions near the end of the project. Figure 15 provides an overview of the site logistics plan. Trucks and materials will arrive from the north and travel along NW Marine Dr. Laydown yards will be placed adjacent to work zones in the north and south for ease of access during each of the three phases. Site offices and crew parking will utilize the nearby grass field and Iona Dr with the closure of connecting roads from the residential neighborhood to the east and Chancellor Mews. The sidewalk along Iona Dr, however, will remain open to accommodate pedestrians and cyclists.

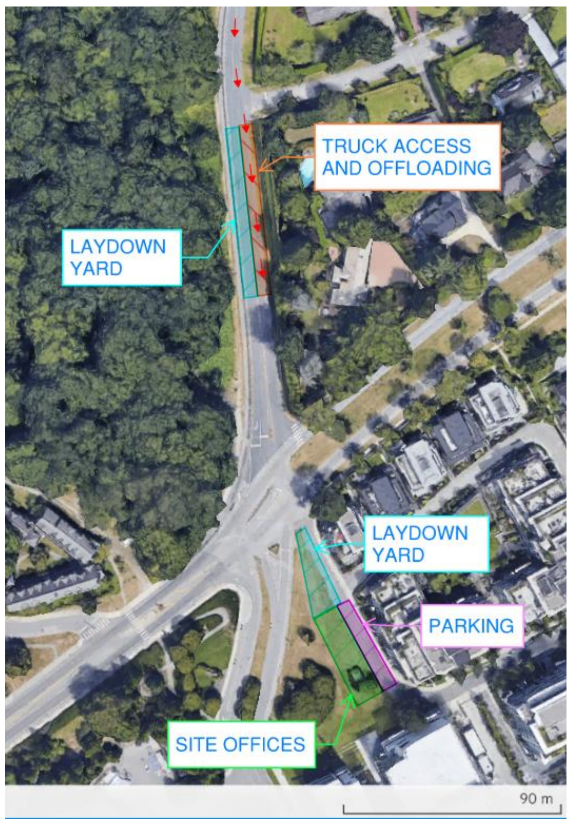


Figure 15: Site Logistics Plan

7.2.2 Phase 1

Phase 1 includes a full road closure of the less congested north approach along upper NW Marine Dr for the excavation and construction of the retention tank. Additional closures along the northern lanes of Chancellor Blvd and lower NW Marine Dr will be implemented as there are sufficient lane spacing in the south to accommodate traffic diversions. Once the tank is built, the rest of the sewer infrastructure consisting of sewer lines, catchment basins, and maintenance holes will be placed. This is followed by road paving and road infrastructure.

7.2.3 Phase 2

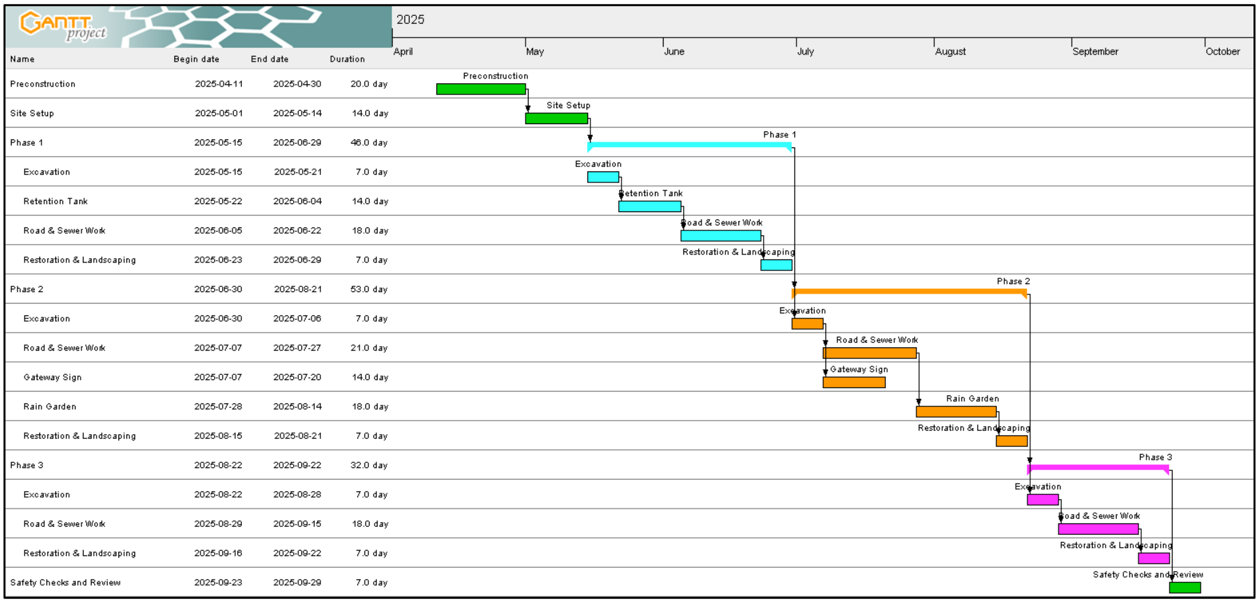
Phase 2 consists of the southern zone along East Mall and is divided into the right and left portions with alternating lane closures along East Mall. The right portion will be closed first to excavate the existing median and place new sewer infrastructure, followed by road infrastructure to align with the eastward shift of the south approach. Once the new median is constructed, work will begin on the rain garden. The left portion will be closed next to facilitate the construction of the gateway sign on the southwest corner of the intersection, and remaining sewer infrastructure.

7.2.4 Phase 3

Phase 3 involves lane closures in the southern lanes of Chancellor Blvd and lower NW Marine Dr to construct the east and west sewer infrastructure, as well as tie in the north and south sewer lines constructed in the phases prior. Road work will follow as the remaining road infrastructure is placed. As this phase involves various sections in and around the newly built intersection, existing and new TMPs will need to be analyzed and developed to better accommodate new traffic patterns.

7.3 Construction Schedule

Figure 16 below outlines the key milestones for the intersection's construction. The schedule has assumed an accelerated permitting process and a 6-day work week, with the exclusion of Sundays and statutory holidays. The pre-construction phase will begin 2.5 weeks before the construction start date of May 1, 2025, consisting of permitting and site preparation. The rest of the schedule can be divided into 3 distinct phases. The final week will be allocated for safety checks and reviews to ensure that all infrastructure is functioning properly, and no errors or defects are present. The project is anticipated to finish by September 30, 2025, for a total duration of just under 6 months. This schedule provides some additional float time at the end before the arrival of the winter months and harsher weather conditions. A full schedule can be found in Appendix I.



Name	Begin date	End date	Duration
Preconstruction	2025-04-11	2025-04-30	20.0 day
Site Setup	2025-05-01	2025-05-14	14.0 day
Phase 1	2025-05-15	2025-06-29	46.0 day
Excavation	2025-05-15	2025-05-21	7.0 day
Retention Tank	2025-05-22	2025-06-04	14.0 day
Road & Sewer Work	2025-06-05	2025-06-22	18.0 day
Restoration & Landscaping	2025-06-23	2025-06-29	7.0 day
Phase 2	2025-06-30	2025-08-21	53.0 day
Excavation	2025-06-30	2025-07-06	7.0 day
Road & Sewer Work	2025-07-07	2025-07-27	21.0 day
Gateway Sign	2025-07-07	2025-07-20	14.0 day
Rain Garden	2025-07-28	2025-08-14	18.0 day
Restoration & Landscaping	2025-08-15	2025-08-21	7.0 day
Phase 3	2025-08-22	2025-09-22	32.0 day
Excavation	2025-08-22	2025-08-28	7.0 day
Road & Sewer Work	2025-08-29	2025-09-15	18.0 day
Restoration & Landscaping	2025-09-16	2025-09-22	7.0 day
Safety Checks and Review	2025-09-23	2025-09-29	7.0 day

Figure 16: Summary Design Schedule

7.4 Traffic Management Plans

Phases 1 to 3 are accompanied by detailed TMPs and are attached in Appendix K. The TMPs were designed in accordance with the 2020 Traffic Manual for Work on Roadways from BC MoTI. Each TMP outlines the signage, intersection control, traffic diversions, work activity areas, and lane closures within each phase. Phase 1 incorporates a complete road closure of upper NW Marine Dr, with a single lane alternating traffic (SLAT) closure along the northern half of Chancellor Blvd. Phase 2 alternates between the closure of each direction of travel lanes along East Mall, incorporating the use of two-way roads. Phase 3 includes temporary lane closures along the southern half of Chancellor Blvd. Each TMP incorporates traffic control persons (TCPs) where necessary to minimize traffic confusion during intersection crossing. TCPs are also used to control protected pedestrian and cyclist detours and crossings such as through the SLAT closures to further enhance safety. Detours and protected crossing accommodating active modes of transportation can be found in Appendix J. For areas outside of the project scope, any traffic management must be designed in accordance with the 2020 Traffic Manual for Work on Roadways.

7.5 Construction Specifications

The intersection is designed based on the construction specifications found in Appendix M. All specifications must be followed to ensure compliance with relevant codes and standards for a successful construction project. The specifications include:

- Concrete Reinforcement Specifications
- Environmental Specifications
- Reinforced Cast-In-Place Concrete Specifications
- Roadworks Specifications
- Signage and Pavement Markings Specifications
- Site Earthworks and Engineered Fill Specifications
- Storm and Sewer Specifications

7.6 Risk Assessment

To ensure a timely delivery of the project, a comprehensive risk assessment was undertaken to outline a variety of risks the project team may encounter. Subsequently, control systems were allocated to each risk to effectively minimize them. These include:

Unexpected site and geotechnical conditions: Although detailed geotechnical analysis have been undertaken, unexpected subsurface conditions may still arise. Active monitoring and a flexible schedule will allow the team to quickly conduct additional site analysis or draft plans to accommodate new site conditions if necessary.

Political risk: To prevent any political risk, relevant stakeholder and rightsholder engagement will occur throughout the planning and construction durations of the project. We will work together with the client, First Nations, and other impacted stakeholders through clear and engaging communication channels to keep everyone up to date with the ongoing progress and any issues should they arise.

Cost overruns: A contingency fee has been developed to cover anticipated risks that may potentially arise. As with any large project, cost overruns can inevitably occur through unanticipated risks. Our strategy to address these challenges will include close monitoring of expenditure trends and cost savings opportunities and communicate any risks to the client early on and work with relevant stakeholders/rightsholders to develop optimal strategies to overcome these adversities.

Construction delays: Delays due to unforeseen weather conditions and site challenges such as delays in material delivery may lead to interruptions in the project schedule. To minimize these delays, meticulous planning and scheduling of activities has been undertaken to mitigate delays. This involved identifying and prioritizing critical path activities and establishing realistic timelines. Additionally, contingency plans and a sufficient buffer for the schedule have been considered to provide flexibility for unforeseen challenges.

Traffic management: Safety is our top priority, which is why much of the work is done during the summer months where weather and visibility conditions are optimal. TCPs will be employed to control the flow of traffic as much as possible to manage protected crossings. They have also been developed using a staggered approach to minimize delays and disruptions to existing road users. UBC and nearby residential neighborhoods will be given advance notice documenting the construction disruptions and available detours.

7.7 Maintenance Plan

Maintenance of the intersection will involve two major components: Stormwater (Table 9) and Roadway (Table 10).

Table 9: Stormwater Maintenance Plan

Item	Detail	Frequency
Rain Garden Maintenance	Cleaning and clearing drainage points and trimming vegetation to prevent overgrowth.	Semi-annually
Tank Pumping	Excess water to be pumped out to ensure sufficient volume for future storms.	Annually (dry season)
Tank Inspection	Inspection of structural integrity of tank.	Annually (dry season)
Catchment Basin Cleaning	Clearing drainage grates and cleaning trapped solids.	Monthly

Table 10: Roadway Maintenance Plan

Item	Detail	Frequency
Road Surface	Fixing potholes, cracks, and other deficiencies.	As necessary
Snow and Ice	Salting and clearing roads of any snow and ice buildup.	Annually (winter)
Landscaping	Maintaining vegetation and trees to clear sightlines and prevent overgrowth.	Semi-annually
Traffic Controls	Ensure signage and pavement markings are clear, replace/repaint if necessary.	As necessary
Gateway Sign	Inspection of structural integrity and impacts of weathering.	Annually

8.0 Cost Estimate

A Class A cost estimate has been developed, with the total costs of the project amounting to $3.97 million Canadian dollars. As seen in Table 11 and Figure 17, the majority of the project costs arise from the three construction phases, amounting to a total of $2.62 million.

Table 11: Cost Estimate Breakdown

Category	Cost
Pre-Construction	$280,000.00
Phase 1	$1,030,000.00
Phase 2	$970,000.00
Phase 3	$620,000.00
Contingency	$290,000.00
Engineering/Insurance/Tax	$780,000.00
Total Cost	**$3,970,000.00**

Aside from these costs, the pre-construction, including permitting, closure fees, traffic management fees, and environmental assessments will amount to $280,000. To minimize risk, a contingency of 7.3% of the overall project is used for unseen outcomes and costs.

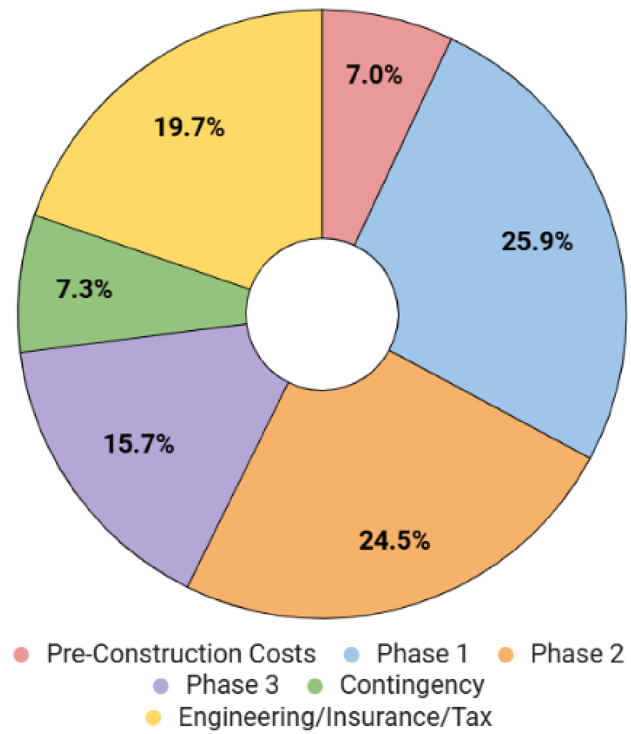


Figure 17: Pie Chart of Project Costs

Lastly, a fee of $780,000 has been estimated to cover miscellaneous items such as taxes, insurances required by contractors, as well as Urban Flow's consulting fees. For a more detailed cost estimate, see Appendix L.

9.0 Final Recommendations

In summary, Urban Flow Engineering recommends the implementation of the proposed semi-actuated signalized intersection at the Chancellor Boulevard and East Mall intersection. This design was selected as the optimal solution to meet the project's objectives of reducing vehicle speeds, improving pedestrian and cyclist safety, retaining all stormwater on-site, and enhancing the sense of arrival to the UBC campus.

The signalized intersection offers the best balance of safety, functionality, and long-term adaptability. It provides full signal control at all approaches, minimizes delays for active transportation users through push-button activation, and supports future growth with flexible signal timing. The key features include narrower travel lanes, curb extensions, dedicated bike lanes, and clearly marked pedestrian crosswalks which altogether improve user comfort and reduce conflicts at the intersection. These elements create a more intuitive and inclusive environment that supports UBC's shift toward sustainable transportation.

The design also integrates a robust stormwater management system, including an underground detention tank with a total capacity of 968 cubic metres, and a 435 m^2 rain garden. These components are designed to control runoff from a 100-year storm event, significantly reducing flow rates and minimizing erosion risks the nearby cliffs, supporting UBC's sustainability and climate resilience objectives. Additionally, the installation of an 8-meter-tall gateway sign at the southwest corner of the intersection enhances campus identity and creates a clear sense of arrival for those arriving at the intersection.

The construction approach prioritizes safety, efficiency, and minimal disruption in three carefully planned phases, allowing sections of the intersection to remain operational while new infrastructure is installed. Dedicated staging areas, clear detour routes, and active traffic control measures will ensure continued access for all users throughout the process. By starting in the spring and targeting completion before the fall academic term, the schedule is designed to reduce conflict with peak campus activity. This phased strategy supports a smooth implementation of the design while adhering to the project's budget of $3.97 million.

Urban Flow Engineering is confident that this report outlines how this design meets all the project objectives through a balanced, sustainable, and safety-focused solution. The proposed redesign addresses current challenges and supports future growth, and we hope it meets the expectations of UBC Campus and Community Planning.

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Appendices

Appendix A: Structural Slab & Column Calculations

CIVL 445: SLAB DESIGN

Note: assume cylindrical shape for steel sign

Hollow Light-Weight Steel Sign

$h_{steel} := 4500\ mm$

$d_{steel} := 1400\ mm$

$A_{steel} := \pi \cdot \frac{d_{steel}^2}{4} = 1.539\ m^2$

$X := 0.25$ % of volume as steel

$V_{steel} := X \cdot A_{steel} \cdot h_{steel} = 1.732\ m^3$

$\rho_{steel} := 78.5\ \frac{kN}{m^3}$

$F_{steel} := \rho_{steel} \cdot V_{steel} = 135.9\ kN$

Concrete Column

$w_{conc} := 1400\ mm$

$d_{conc} := 1400\ mm$

$h_{conc} := 3500\ mm$

$A_{conc} := d_{conc} \cdot w_{conc} = 1.96\ m^2$

$V_{conc} := A_{conc} \cdot h_{conc} = 6.86\ m^3$

$\rho_{conc} := 23.5\ \frac{kN}{m^3}$

$F_{conc} := \rho_{conc} \cdot V_{conc} = 161.2\ kN$

Factored Loading

$D := F_{steel} + F_{conc} = 297.2\ kN$

$1.4 \cdot D = 416\ kN$

Assumed Vancouver Snow Load (BCBC2024) $s := 1.8\ kPa$

$S := s \cdot A_{steel} = 2.8\ kN$

Loading Conditions

$P_u := D + S = 300\ kN$

$P_f := 1.25\ D + 1.5 \cdot S = 375.6\ kN$

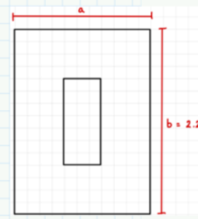
$P_f := 1.4 \cdot D = 416.0\ kN$

Column Dimensions

$col\_length := d_{conc} = 1.4\ m$

$col\_width := d_{conc} = 1.4\ m$

aspect ratio: $\beta_c := \frac{col\_length}{col\_width} = 1$



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Slab Parameters

$a := 5250\ mm$ $\quad b := a \cdot \beta_c = 5250\ mm$

$t := 500\ mm$ $\quad conc\_density := 23.5\ \frac{kN}{m^3}$

$Bar\_Size := 15M$ $\quad d_b := Bar\_Size \cdot mm = 15\ mm$

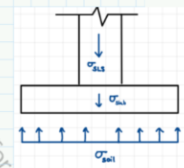
$f'_c := 25\ MPa$ $\quad A_{slab} := a \cdot b = 27.563\ m^2$

$cover := 75\ mm$ $\quad \sigma_{slab} := t \cdot conc\_density = 11.75\ kPa$

$\alpha := 0.85 - 0.0015 \cdot \frac{f'_c}{MPa} = 0.813$ $\quad \phi_c := 0.65$ $\quad f_y := 400\ MPa$

$\beta_1 := 0.97 - 0.0025 \cdot \frac{f'_c}{MPa} = 0.908$ $\quad \phi_s := 0.85$

Check 1: Satisfy Geotechincal Requirements



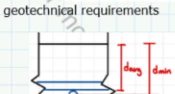
$\sigma_{SLS} := \frac{P_u}{a \cdot b} = 10.88\ kPa$ $\quad \sigma_{slab} = 11.75\ kPa$

$\sigma_{total} := \sigma_{slab} + \sigma_{SLS} = 22.6\ kPa$

$\sigma_{total} = 22.6\ kPa$ $\quad \sigma_{soil} := 150\ kPa$ PASS!

Since total stress is less that allowable bearing pressure, geotechnical requirements are passed.

Check 2: Depth of Footing / Shear Checks



$d_{avg} := t - cover - d_b = 410\ mm$

$d_{min} := t - cover - 1.5 \cdot d_b = 402.5\ mm$ $\quad d_v := 0.9\ d_{min} = 362.25\ mm$

Two Way Shear Check

$x := \min(col\_width + d_{avg}, a) = 1810\ mm$

$y := \min(col\_length + d_{avg}, b) = 1810\ mm$

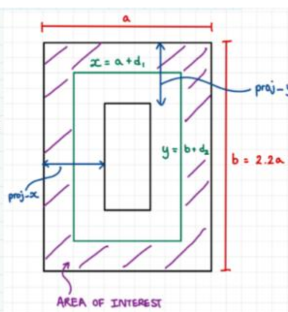
$area\_of\_interest := A_{slab} - (x \cdot y) = 24.286\ m^2$

$V_f := \frac{P_f}{A_{slab}} \cdot area\_of\_interest$

$V_f = 366.57\ kN$

$v_f := \frac{V_f}{(2 \cdot x + 2 \cdot y) \cdot t}$

$v_f = 0.1\ MPa$



Shear Capacity

$v_{c1} := \left(1 + \frac{2}{\beta_c}\right) \cdot 0.19 \cdot \phi_c \cdot \sqrt{f'_c \cdot MPa} = 1.853\ MPa$ $\quad a_s := 4$

$v_{c2} := \left(\frac{a_s \cdot t}{(2 \cdot x + 2 \cdot y)} + 0.19\right) \cdot \phi_c \cdot \sqrt{f'_c \cdot MPa} = 1.515\ MPa$

$v_{c3} := 0.38 \cdot \phi_c \cdot \sqrt{f'_c \cdot MPa} = 1.235\ MPa$

$v_c := v_{c1} = 1.853\ MPa$

Size Effect

$proj\_x := \frac{(a - col\_width)}{2} = (1.925 \cdot 10^3)\ mm$ $\quad proj\_y := \frac{(b - col\_length)}{2} = 1925\ mm$

$\frac{proj\_x}{d_{avg}} = 4.695$ $\quad \frac{proj\_y}{d_{avg}} = 4.695$

$size\_effect := \frac{1300}{1000 + \frac{t}{mm}} = 0.867$

$v_r := v_c = 1.85\ MPa$

$v_r = 1.853\ MPa$ > $v_f = 0.101\ MPa$ PASS!

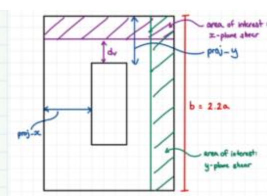
One Way Shear Check

$proj\_x = 1925\ mm$

$proj\_y = 1925\ mm$

$A_{shear\_x} := (proj\_y - d_v) \cdot a = 8.204\ m^2$

$A_{shear\_y} := (proj\_x - d_v) \cdot b = 8.204\ m^2$



x-plane factored shear: $V_{fx} := P_f \cdot \frac{A_{shear\_x}}{A_{slab}}$ $\quad V_{fx} = 123.8\ kN$

y-plane factored shear: $V_{fy} := P_f \cdot \frac{A_{shear\_y}}{A_{slab}}$ $\quad V_{fy} = 123.8\ kN$

One Way Shear Resistance

$\frac{proj\_y}{d_v} = 5.314$ $\quad \frac{proj\_x}{d_v} = 5.314$

$B := \frac{230}{1000 + \frac{d_v}{mm}} = 0.169$ since size effect should be considered, need to calculate this. $\quad \beta := 0.21$

x-plane shear resistance: $V_{rx} := \phi_c \cdot \beta \cdot \sqrt{f'_c \cdot MPa} \cdot a \cdot d_v$ $\quad V_{rx} = 1298\ kN$

y-plane shear resistance: $V_{ry} := \phi_c \cdot B \cdot \sqrt{f'_c \cdot MPa} \cdot b \cdot d_v$ $\quad V_{ry} = 1043.6\ kN$

One Way Shear Overview:

$V_{rx} = 1298\ kN$ > $V_{fx} = 124\ kN$ PASS!

$V_{ry} = 1044\ kN$ > $V_{fy} = 124\ kN$ PASS!

Check 3: Flexure Design

$A_{gx} := a \cdot t = 2.625\ m^2$ $\quad A_{gy} := b \cdot t = 2.625\ m^2$

$A_{sx} := 0.002 \cdot A_{gx}$ $\quad A_{sy} := 0.002 \cdot A_{gy}$

$A_{sx} = 5250\ mm^2$ $\quad A_{sy} = 5250\ mm^2$

$$A_{bar} := \frac{\pi \cdot (Bar\_Size)^2}{4}\ mm^2 = 176.715\ mm^2$$

Number of Reinforcement Bars Required

$n_x := \frac{A_{sx}}{A_{bar}} = 29.7$ $\quad n_y := \frac{A_{sy}}{A_{bar}} = 29.7$

$n_x := 30$ $\quad n_y := 30$

$\alpha = 0.813$

$f_y = 400\ MPa$

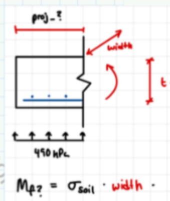
$spacing\_x := \frac{a}{n_x} = 175\ mm$ $\quad spacing\_y := \frac{b}{n_y} = 175\ mm$

$A_{sx} := n_x \cdot A_{bar} = (5.3 \cdot 10^3)\ mm^2$ $\quad A_{sy} := n_y \cdot A_{bar} = (5.3 \cdot 10^3)\ mm^2$

$\beta_1 c_x := \frac{\phi_s \cdot f_y \cdot A_{sx}}{\alpha \cdot \phi_c \cdot f'_c \cdot a}$ $\quad \beta_1 c_y := \frac{\phi_s \cdot f_y \cdot A_{sy}}{\alpha \cdot \phi_c \cdot f'_c \cdot b}$

$\beta_1 c_x = 26.004\ mm$ $\quad \beta_1 c_y = 26.004\ mm$

$M_{rx} := \phi_s \cdot f_y \cdot A_{sx} \cdot \left(d_{avg} - \frac{\beta_1 c_x}{2}\right)$ $\quad M_{ry} := \phi_s \cdot f_y \cdot A_{sy} \cdot \left(d_{avg} - \frac{\beta_1 c_y}{2}\right)$



$M_{rx} = 716\ kN \cdot m$ $\quad M_{ry} = 716\ kN \cdot m$

$M_{fx} := \frac{P_f}{A_{slab}} \cdot a \cdot \frac{(proj\_x)^2}{2}$ $\quad M_{fy} := \frac{P_f}{A_{slab}} \cdot b \cdot \frac{(proj\_y)^2}{2}$

$A_{slab} = 27.563\ m^2$

$M_{fx} = 147\ kN \cdot m$ PASS! $\quad M_{fy} = 147\ kN \cdot m$ PASS!

Check 4: Bearing stress at column-footing interface

$A_1 := col\_length \cdot col\_width = 1.96\ m^2$

since A2/A1 ratio > 4

$A_2 := A_{slab} = 27.563\ m^2$

$F := 0.85 \cdot \phi_c \cdot f'_c \cdot A_1 \cdot 2$ PASS!

$F = 54145\ kN \quad > \quad P_f = 416\ kN$

since F is larger than Pf, no dowels required to resist bearing force.

Column Design

$w_{conc} = 1400\ mm$

$d_{conc} = 1400\ mm$

$f'_c = 25\ MPa$ $\quad f_y := 400\ MPa$

$\alpha := 0.85 - 0.0015 \cdot \frac{f'_c}{MPa} = 0.813$

$\beta := 0.97 - 0.0025 \cdot \frac{f'_c}{MPa} = 0.908$

$A_{col} := w_{conc} \cdot d_{conc} = 1.96\ m^2$

$A_{s\_min} := 0.01 \cdot A_{col} = 19600\ mm^2$

$d_b := 35\ \ M$

$A_{bar} := \pi \cdot \frac{(d_b \cdot mm)^2}{4} = 962.1\ mm^2$

$\#\_of\_bars\_req := \frac{A_{s\_min}}{A_{bar}} = 20.372$

$n := 25$

$A_{steel} := n \cdot A_{bar} = 24053\ mm^2$

Minimum Clear Cover

Corrosion: 40 mm

Fire: 50 mm

Clear Spacing 50 mm

Column Ties: Use 10M bars for ties

$$s_{ties} := min\left(\frac{w_{conc}}{mm}, 16 \cdot d_b, 480\right) \cdot mm = 480\ mm$$

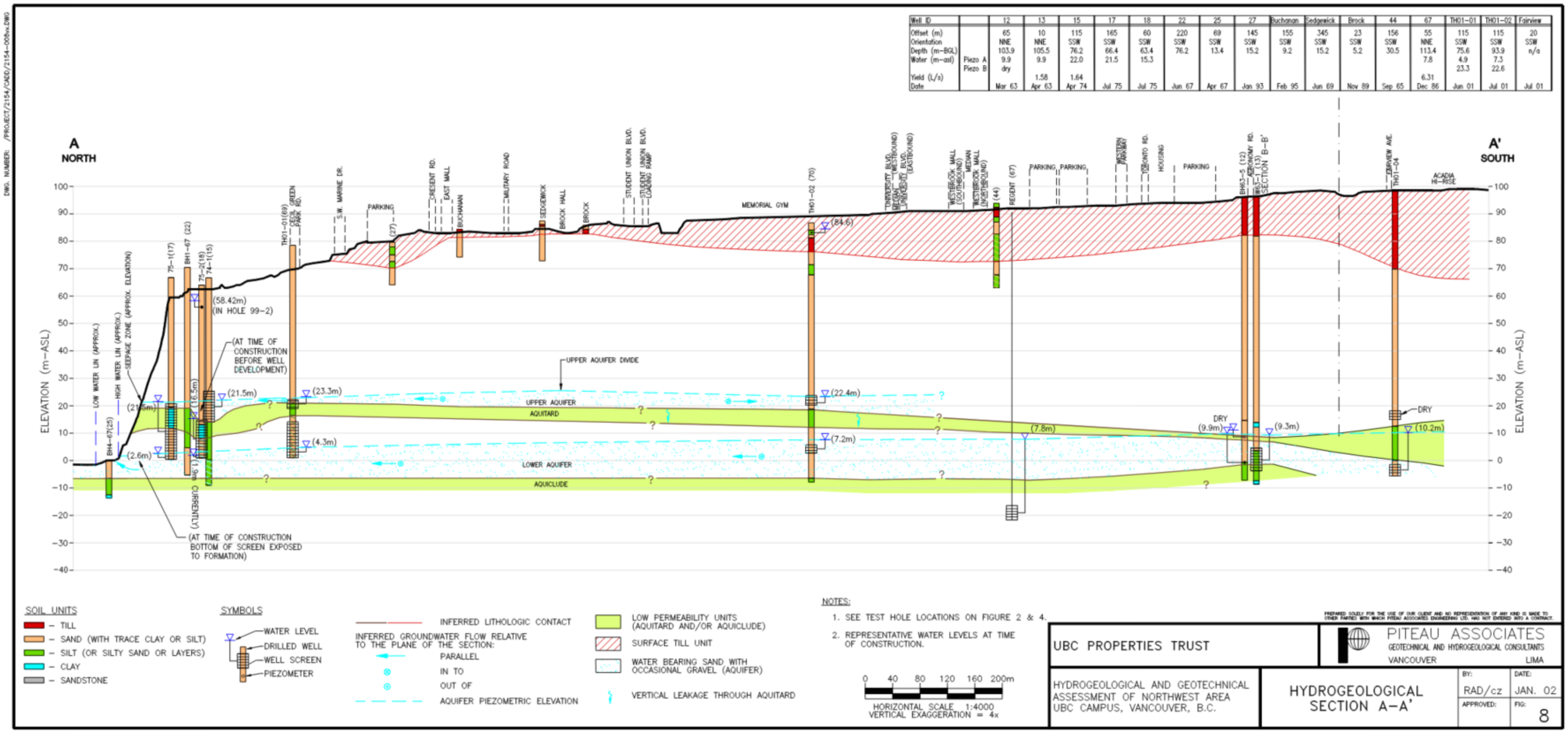
Lap Splice: $l_{lap\_splice} := 875\ mm$

Strength of Column:

$$P_{r0} := \alpha \cdot 0.65 \cdot f'_c \cdot (A_{col} - A_{steel}) + 0.85 \cdot f_y \cdot A_{steel} = 33739\ kN$$

Appendix B: Soil Profile On-Site

The following image is taken from Piteau Associates Engineering Ltd. (2002).



Appendix C: Hydro Tables

Pipe System Inlet Outlet Details

Pipe System										
Pipe #	**Pipe Diameter (m)**	**Q (m^3/s)**	**Max Q (m^3/s)**	**Max Q > Q**	**Inlet Location**	**Inlet Elevation (m)**	**Slope (%)**	**Length (m)**	**Outlet Location**	**Outlet Elevation (m)**
1	0.2	0	0.0733	TRUE	Man 1	83.26	5	4.935	Basin 1	83.03
2	0.2	0.000124	0.0733	TRUE	Basin 1	83.03	5	29.993	Man 2	81.6
3	0.2	0.000124	0.0733	TRUE	Man 2	81.6	5	33.585	Basin 2	80
4	0.2	0.001773	0.0733	TRUE	Basin 2	80	5	18.673	Man 3	79
5	0.2	0.001773	0.0803	TRUE	Man 3	79	6	15.313	Basin 3	78.1
6	0.2	0.001773	0.0803	TRUE	Basin 3	78.1	6	55.341	Basin 4	74.6
7	0.2	0.001960	0.0803	TRUE	Basin 4	74.6	6	17.084	Man 4	73.5
8	0.2	0.001960	0.0803	TRUE	Man 4	73.5	6	8.676	Man 5	73
9	0.2	0	0.0733	TRUE	Man 7	75.5	5	4.28	Basin 6	75.3
10	0.2	0.000493	0.0733	TRUE	Basin 6	75.3	5	22.506	Basin 5	74.1
10B	0.2	0.000680	0.0733	TRUE	Basin 5	74.1	5	0.867	Man 6	74.061
11	0.2	0.000831	0.0328	TRUE	Man 6	74.061	1	48.535	Man 4	73.5
12	0.2	0	0.0803	TRUE	Man 1	83.26	6	12.227	Basin 7	82.5
13	0.2	0.000108	0.0803	TRUE	Basin 7	82.5	6	34.568	Basin 8	80.5
14	0.2	0.000652	0.0803	TRUE	Basin 8	80.5	6	35.172	Basin 9	78.5
14B	0.2	0.000652	0.0803	TRUE	Basin 9	78.5	6	2.449	Man 8	78.35
15	0.2	0.001197	0.0984	TRUE	Man 8	78.35	9	25.531	Basin 10	76
15B	0.2	0.001741	0.0984	TRUE	Basin 10	76	9	1.965	Man 9	75.83
16	0.2	0.001741	0.0984	TRUE	Man 9	75.83	9	19.296	Basin 11	74.1

17	0.2	0.001892	0.0984	TRUE	Basin 11	74.1	9	5.446	Man 10	73.59
18	0.2	0.001892	0.0928	TRUE	Man 10	73.59	8	7.279	Man 11	73
19	0.2	0	0.0868	TRUE	Man 12	75.9	7	3.769	Basin 13	75.65
20	0.2	0.001263	0.0868	TRUE	Basin 13	75.65	7	14.911	Basin 12	74.63
21	0.2	0.001365	0.0868	TRUE	Basin 12	74.63	7	16.016	Man 10	73.59

Appendix D: Runoff & Rain Garden Calculations

Area/Design Flow Calculations				
Direction	**Section**	**Area (m^2)**	**C**	**Q (m^3/s)**
North Approach	Left Grass	331.852	0.13	0.000078
	Left Sidewalk	155.697	0.13	0.000037
	Road	505.429	0.83	0.000759
	Right Sidewalk	0	0.83	0.000000
	Right Grass	152.771	0.83	0.000230
East Approach	Top Road	618.308	0.83	0.000929
	Island	387.735	0.13	0.000091
	Bottom Road	37.528	0.83	0.000056
	Top Sidewalk	88.36	0.83	0.000133
	Top Grass	661.366	0.13	0.000156
Center	West Half of Intersection	793.417	0.13	0.000187
	East Half of Intersection	640.639	0.13	0.000151
South Approach	Left grass	1327.714	0.13	0.000312
	Left sidewalk	242.645	0.83	0.000365
	Left Road	593.298	0.83	0.000892
	Center island	685.192	0.13	0.000161
	Right Road	634.656	0.83	0.000954
	Right Sidewalk	237.545	0.83	0.000357
	Right Grass	684.213	0.13	0.000161
West Approach	Road	328.363	0.83	0.000493
	Bottom Sidewalk	0	0.83	0.000000
	Bottom grass	0	0.13	0.000000
Runoff From Campus	Right Grass	23.088	0.13	0.000005
	Right Sidewalk	31.651	0.83	0.000048
	Road	36.699	0.83	0.000055
	Left Sidewalk	41.925	0.83	0.000063
	Left Grass	25.583	0.13	0.000006
Total	-	9265.674	-	0.006501

Rainwater Garden Calculations

Tributary Area		
Catchment Area	1919.0	m^2
Garden Area	434.7	m^2
Intensity	6.52	mm/hr
Parameter Values		
Evaporation Rate	1	mm/day
Growing Medium Depth	0.5	m
Field Capacity	0.25	
Wilting Point	0.05	
Trench Depth	1.4	m
Rock Porosity	0.4	
Infiltration Rate	1.5	mm/hr
Input Volume		
Rainfall Capture	0.156	m^3
Input Volume	300.285	m^3
Output Volume		
Evaporation Volume	0.435	m^3
Growing Medium	43.470	m^3
Rock Trench Volume	243.432	m^3
Infiltration Volume	15.649	m^3
Capture Volume	302.986	m^3

Appendix E: Traffic Counts and Scaled Volumes

AM Counts

Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	PHF
South								
Straight								
Car	0	0	0	0	0	0	0	**0**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	0	0	0	0			
Pedestrian	0	2	1	1	4			
total # of vehicles (15)	0	0	0	0				
South								
Right								
Car	2	4	9	9	24	26	7.692307692	**0.7222222222**
Truck	1	1	0	0	2			
Bus	0	0	0	0	0			
Bike	0	0	0	0	0			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	3	5	9	9				
South								
Left								
Car	1	3	5	4	13	13	0	**0.65**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	0	0	0	0			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	1	3	5	4				
West								
Straight								
Car	31	49	57	46	183	200	7	**0.7936507937**
Truck	3	2	5	4	14			
Bus	0	1	1	1	3			
Bike	0	1	2	7	10			
Pedestrian	2	1	1	1	5			
total # of vehicles (15)	34	52	63	51				
West								
Right								
Car	1	2	1	3	7	15	26.66666667	**0.75**
Truck	1	1	1	1	4			

Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	PHF
Bus	1	1	1	1	4			
Bike	2	3	1	1	7			
Pedestrian	1	1	1	1	4			
total # of vehicles (15)	3	4	3	5				
West								
Left								
Car	2	3	6	12	23	32	15.625	**0.5714285714**
Truck	2	1	1	1	5			
Bus	1	1	1	1	4			
Bike	1	3	1	1	6			
Pedestrian	1	1	2	1	5			
total # of vehicles (15)	5	5	8	14				
North								
Straight								
Car	0	0	0	0	0	0	0	**0**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	3	3	3	4	13			
Pedestrian	0	0	1	2	3			
total # of vehicles (15)	0	0	0	0				
North								
Right								
Car	4	4	6	3	17	19	10.52631579	**0.7916666667**
Truck	1	1	0	0	2			
Bus	0	0	0	0	0			
Bike	4	4	4	1	13			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	5	5	6	3				
North								
Left								
Car	1	1	0	3	5	5	0	**0.4166666667**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	0	0	0	0			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	1	1	0	3				

Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	PHF
East								
Straight								
Car	64	59	89	95	307	319	2.507836991	**0.8137755102**
Truck	2	2	3	1	8			
Bus	1	0	1	2	4			
Bike	2	1	3	3	9			
Pedestrian	1	1	0	1	3			
total # of vehicles (15)	67	61	93	98				
East								
Right								
Car	0	1	0	2	3	3	0	**0.375**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	1	2	0	0	3			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	0	1	0	2				
East								
Left								
Car	1	2	5	11	19	20	5	**0.4545454545**
Truck	1	0	0	0	1			
Bus	0	0	0	0	0			
Bike	0	2	0	0	2			
Pedestrian	0	0	1	0	1			
total # of vehicles (15)	2	2	5	11				

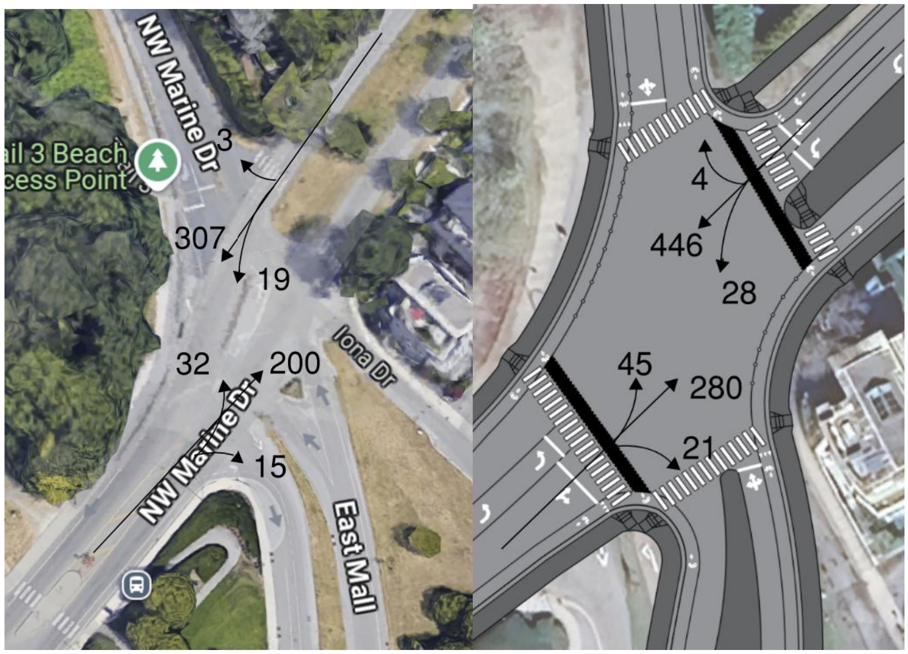
PM Counts

Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	# PHF
South								
Straight								
Car	0	0	0	0	0	1	100	0.25
Truck	0	1	0	0	1			
Bus	0	0	0	0	0			
Bike	3	4	3	1	11			
Pedestrian	1	0	1	1	3			
total # of vehicles (15)	0	1	0	0				
South								
Right								
Car	7	4	7	9	27	27	0	0.75
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	1	0	0	1			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	7	4	7	9				
South								
Left								
Car	7	1	5	4	17	17	0	0.6071428571
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	0	0	0	0			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	7	1	5	4				
West								
Straight								
Car	73	75	78	94	320	330	1.515151515	0.8776595745
Truck	0	4	1	0	5			
Bus	3	1	1	0	5			
Bike	2	1	1	1	5			
Pedestrian	1	4	0	1	6			
total # of vehicles (15)	76	80	80	94				
West								
Right								
Car	7	5	7	4	23	24	4.166666667	0.75
Truck	1	0	0	0	1			

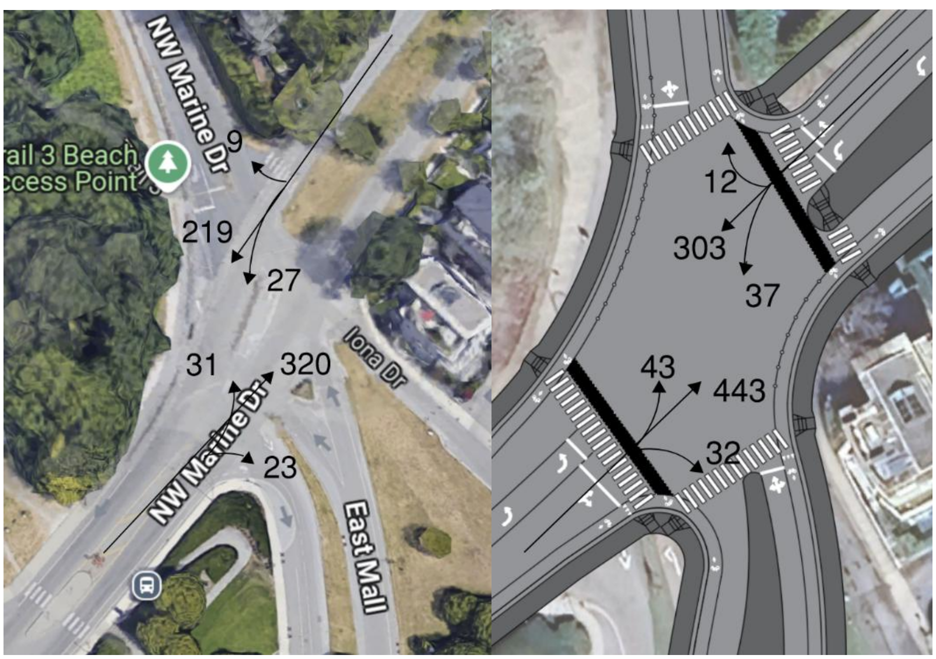
Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	# PHF
Bus	0	0	0	0	0			
Bike	1	0	1	0	2			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	8	5	7	4				
West								
Left								
Car	5	8	8	10	31	32	3.125	**0.8**
Truck	0	0	1	0	1			
Bus	0	0	0	0	0			
Bike	0	3	1	1	5			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	5	8	9	10				
North								
Straight								
Car	0	0	0	0	0	0	0	**0**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	1	0	1	0	2			
Pedestrian	2	1	0	5	8			
total # of vehicles (15)	0	0	0	0				
North								
Right								
Car	9	10	5	11	35	36	2.777777778	**0.8181818182**
Truck	0	1	0	0	1			
Bus	0	0	0	0	0			
Bike	4	8	4	9	25			
Pedestrian	0	0	1	2	3			
total # of vehicles (15)	9	11	5	11				
North								
Left								
Car	6	7	2	4	19	19	0	**0.6785714286**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	0	3	0	3			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	6	7	2	4				

Column 1	# 0	# 15	# 30	# 45	# total	# total vehicles	# truck %	# PHF
East								
Straight								
Car	63	56	49	51	219	225	1.777777778	**0.8653846154**
Truck	1	2	0	1	4			
Bus	1	0	1	0	2			
Bike	0	0	2	3	5			
Pedestrian	0	0	0	0	0			
total # of vehicles (15)	65	58	50	52				
East								
Right								
Car	2	2	2	3	9	9	0	**0.75**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	0	1	3	0	4			
Pedestrian	1	0	0	0	1			
total # of vehicles (15)	2	2	2	3				
East								
Left								
Car	10	3	6	8	27	27	0	**0.675**
Truck	0	0	0	0	0			
Bus	0	0	0	0	0			
Bike	1	0	0	2	3			
Pedestrian	1	1	0	0	2			
total # of vehicles (15)	10	3	6	8				

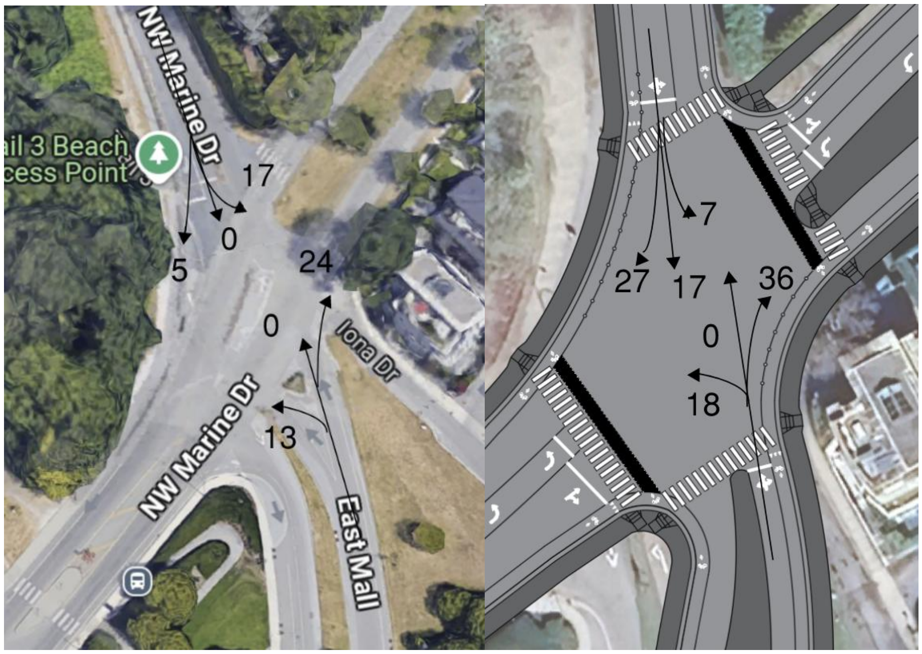
AM-Major Street Volume Current and Scaled



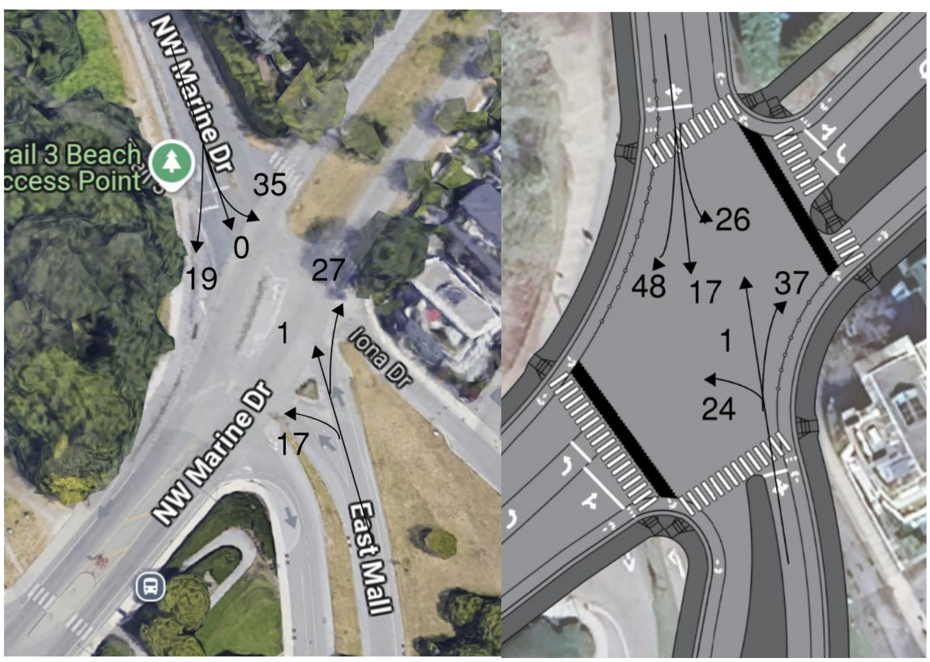
PM-Major Street Volume Current and Scaled



AM-Minor Street Volume Current and Scaled



PM-Minor Street Volume Current and Scaled



Appendix F: Minimum Clearance Time Sample Calculations

D = Curb-to-Curb Crossing Distance at the Middle of the Crosswalk (m)
S = Walk Speed (m/s) = 1 m/s
Y = Amber Interval (s)
AR = All-Red Interval (s)
FDW = Flash Don't Walk Time

$$D := 24\ \mathbf{m}$$
$$S := 1\ \frac{\mathbf{m}}{\mathbf{s}}$$

$$Y := 3\ \mathbf{s}$$
$$AR := 1\ \mathbf{s}$$

$$FDW := \frac{D}{S} - Y - AR$$

$$FDW = 20\ \mathbf{s}$$

Formula taken from the City of Vancouver GUIDELINES FOR USING SYNCHRO VERSION 10
https://vancouver.ca/files/cov/synchro-modelling-guidelines.pdf

Appendix G: Synchro and SimTraffic Reports

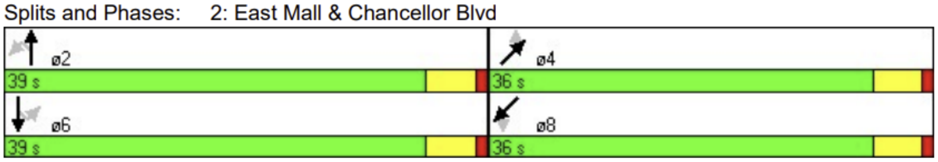
30-year AM Synchro Report

Queues
2: East Mall & Chancellor Blvd 2025-03-19

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	0	1561	0	0	1485	0	1539	1712	0	1700	1822	0
Flt Permitted		0.937			0.969		0.340			0.493		
Satd. Flow (perm)	0	1484	0	0	1453	0	548	1712	0	879	1822	0
Satd. Flow (RTOR)												
Volume (vph)	13	0	26	5	0	19	32	200	15	20	319	3
Lane Group Flow (vph)	0	54	0	0	34	0	45	301	0	28	450	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	36.0	36.0	0.0	36.0	36.0	0.0
Act Effct Green (s)		35.3			35.3		21.7	21.7		21.7	21.7	
Actuated g/C Ratio		0.54			0.54		0.33	0.33		0.33	0.33	
v/c Ratio		0.07			0.04		0.25	0.53		0.10	0.74	
Control Delay		9.5			9.5		18.6	20.6		14.7	26.9	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		9.5			9.5		18.6	20.6		14.7	26.9	
LOS		A			A		B	C		B	C	
Approach Delay		9.5			9.5			20.4			26.1	
Approach LOS		A			A			C			C	
Queue Length 50th (m)		3.0			1.8		4.0	30.0		2.4	49.3	
Queue Length 95th (m)		10.3			7.3		11.2	50.0		7.2	77.9	
Internal Link Dist (m)		64.1			84.0			169.4			131.8	
Turn Bay Length (m)							40.0			40.0		
Base Capacity (vph)		805			788		234	730		375	777	
Starvation Cap Reductn		0			0		0	0		0	0	
Spillback Cap Reductn		0			0		0	0		0	0	
Storage Cap Reductn		0			0		0	0		0	0	
Reduced v/c Ratio		0.07			0.04		0.19	0.41		0.07	0.58	

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 65.1	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.74	
Intersection Signal Delay: 22.3	Intersection LOS: C
Intersection Capacity Utilization 63.9%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 2: East Mall & Chancellor Blvd



Baseline
University of British Columbia

Synchro 6 Report
Page 1

30-year AM SimTraffic Report

Queuing and Blocking Report
Baseline 2025-03-19

Intersection: 2: East Mall & Chancellor Blvd

Movement	NB	SB	NE	NE	SW
Directions Served	LR	LR	L	TR	TR
Maximum Queue (m)	6.5	6.4	14.5	43.1	93.2
Average Queue (m)	2.5	1.7	4.9	31.3	53.0
95th Queue (m)	7.7	5.9	14.1	45.5	90.6
Link Distance (m)	62.0	82.2		169.3	131.8
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (m)			40.0		
Storage Blk Time (%)				2	9
Queuing Penalty (veh)				1	2

Nework Summary

Network wide Queuing Penalty: 3

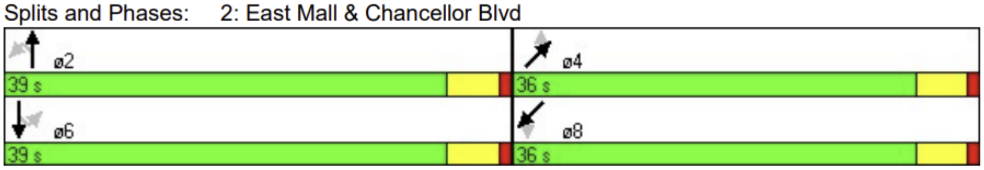
30-year PM Synchro Report

Queues
2: East Mall & Chancellor Blvd 2025-03-19

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Satd. Flow (prot)	0	1557	0	0	1618	0	1733	1818	0	1785	1830	0
Flt Permitted		0.911			0.919		0.478			0.316		
Satd. Flow (perm)	0	1444	0	0	1508	0	868	1818	0	594	1830	0
Satd. Flow (RTOR)												
Volume (vph)	17	1	27	19	0	35	31	320	23	27	219	9
Lane Group Flow (vph)	0	62	0	0	74	0	43	475	0	37	315	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Total Split (s)	39.0	39.0	0.0	39.0	39.0	0.0	36.0	36.0	0.0	36.0	36.0	0.0
Act Effct Green (s)		35.3			35.3		22.8	22.8		22.8	22.8	
Actuated g/C Ratio		0.53			0.53		0.34	0.34		0.34	0.34	
v/c Ratio		0.08			0.09		0.14	0.76		0.18	0.50	
Control Delay		10.0			10.0		15.2	27.4		16.6	19.6	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		10.0			10.0		15.2	27.4		16.6	19.6	
LOS		A			B		B	C		B	B	
Approach Delay		10.0			10.0			26.4			19.3	
Approach LOS		A			B			C			B	
Queue Length 50th (m)		3.6			4.3		3.7	52.9		3.3	31.3	
Queue Length 95th (m)		11.4			13.0		9.9	83.4		9.3	51.3	
Internal Link Dist (m)		64.1			84.0			169.4			131.8	
Turn Bay Length (m)							40.0			40.0		
Base Capacity (vph)		771			805		370	776		253	781	
Starvation Cap Reductn		0			0		0	0		0	0	
Spillback Cap Reductn		0			0		0	0		0	0	
Storage Cap Reductn		0			0		0	0		0	0	
Reduced v/c Ratio		0.08			0.09		0.12	0.61		0.15	0.40	

Intersection Summary	
Cycle Length: 75	
Actuated Cycle Length: 66.2	
Control Type: Semi Act-Uncoord	
Maximum v/c Ratio: 0.76	
Intersection Signal Delay: 21.7	Intersection LOS: C
Intersection Capacity Utilization 64.5%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 2: East Mall & Chancellor Blvd



Queuing and Blocking Report
Baseline

2025-03-19

Intersection: 2: East Mall & Chancellor Blvd

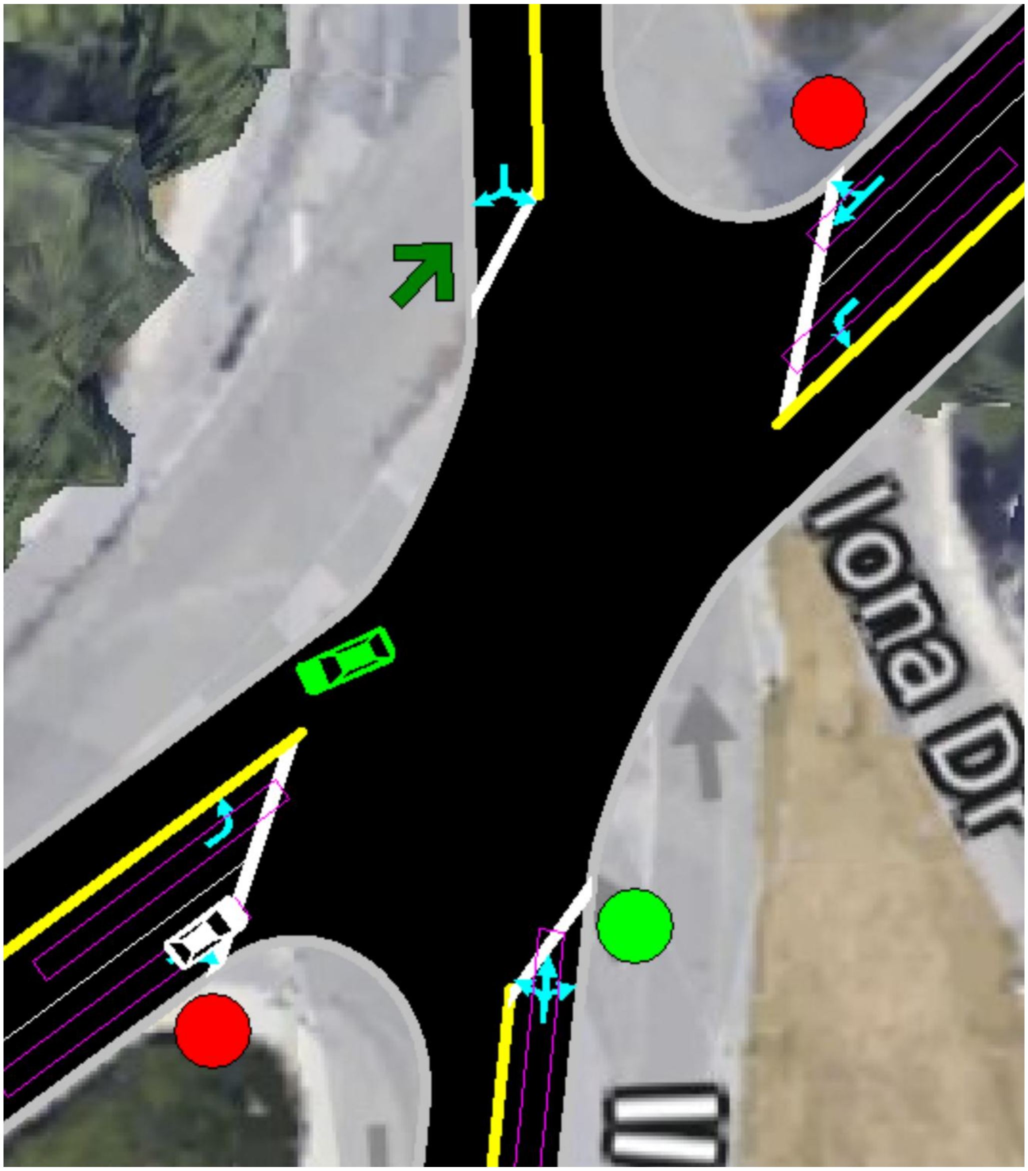
Movement	NB	NE	NE	SW	SW
Directions Served	LTR	L	TR	L	TR
Maximum Queue (m)	12.0	7.3	48.9	8.2	44.2
Average Queue (m)	3.5	2.1	41.9	3.5	38.1
95th Queue (m)	11.4	6.5	50.9	9.4	44.5
Link Distance (m)	62.0		169.3		131.8
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (m)		40.0		40.0	
Storage Blk Time (%)			6		6
Queuing Penalty (veh)			2		2

Nework Summary

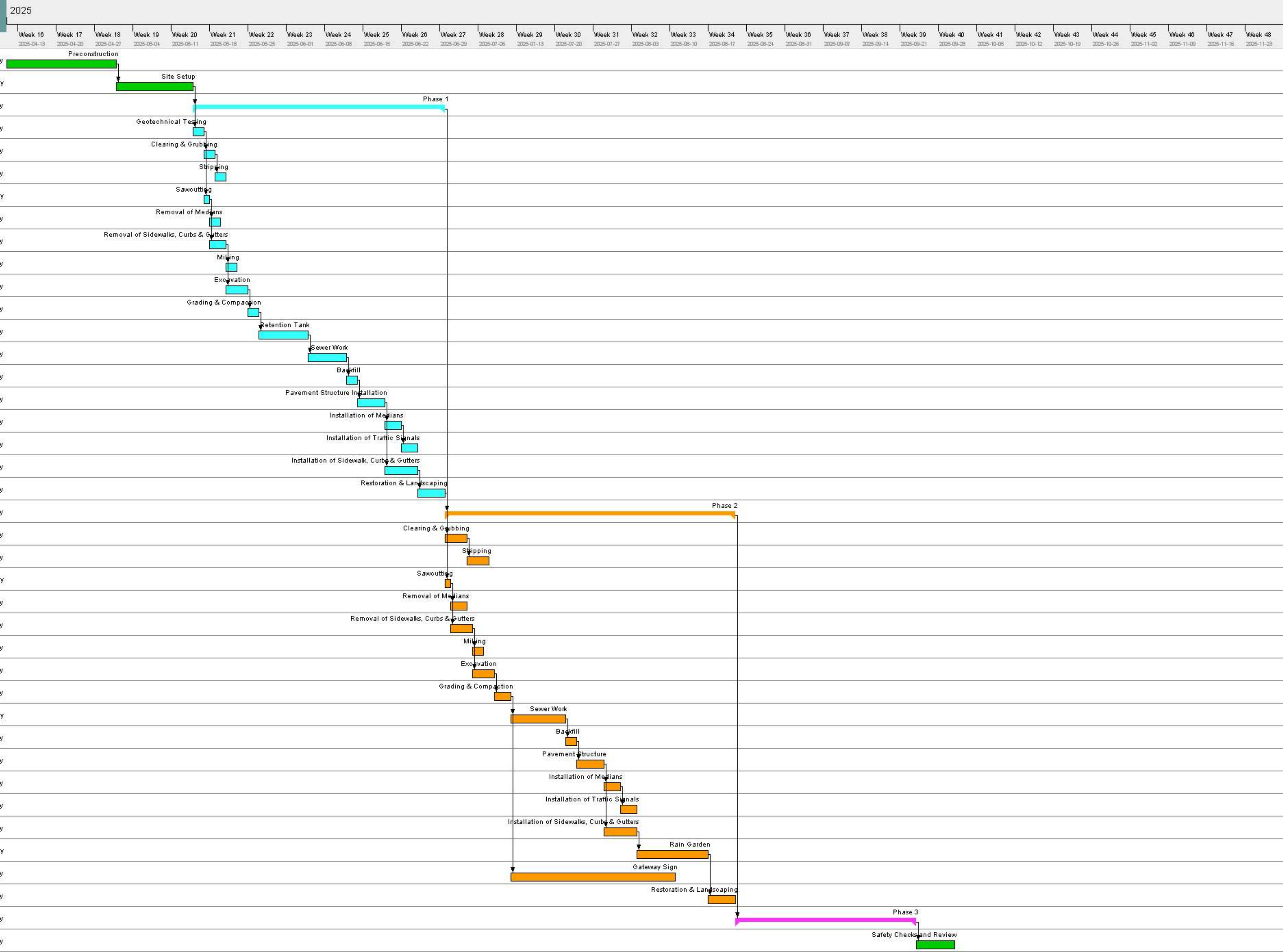
Network wide Queuing Penalty: 5

Appendix H: SimTraffic Simulation

The following is an image of the intersection as modelled in SimTraffic.

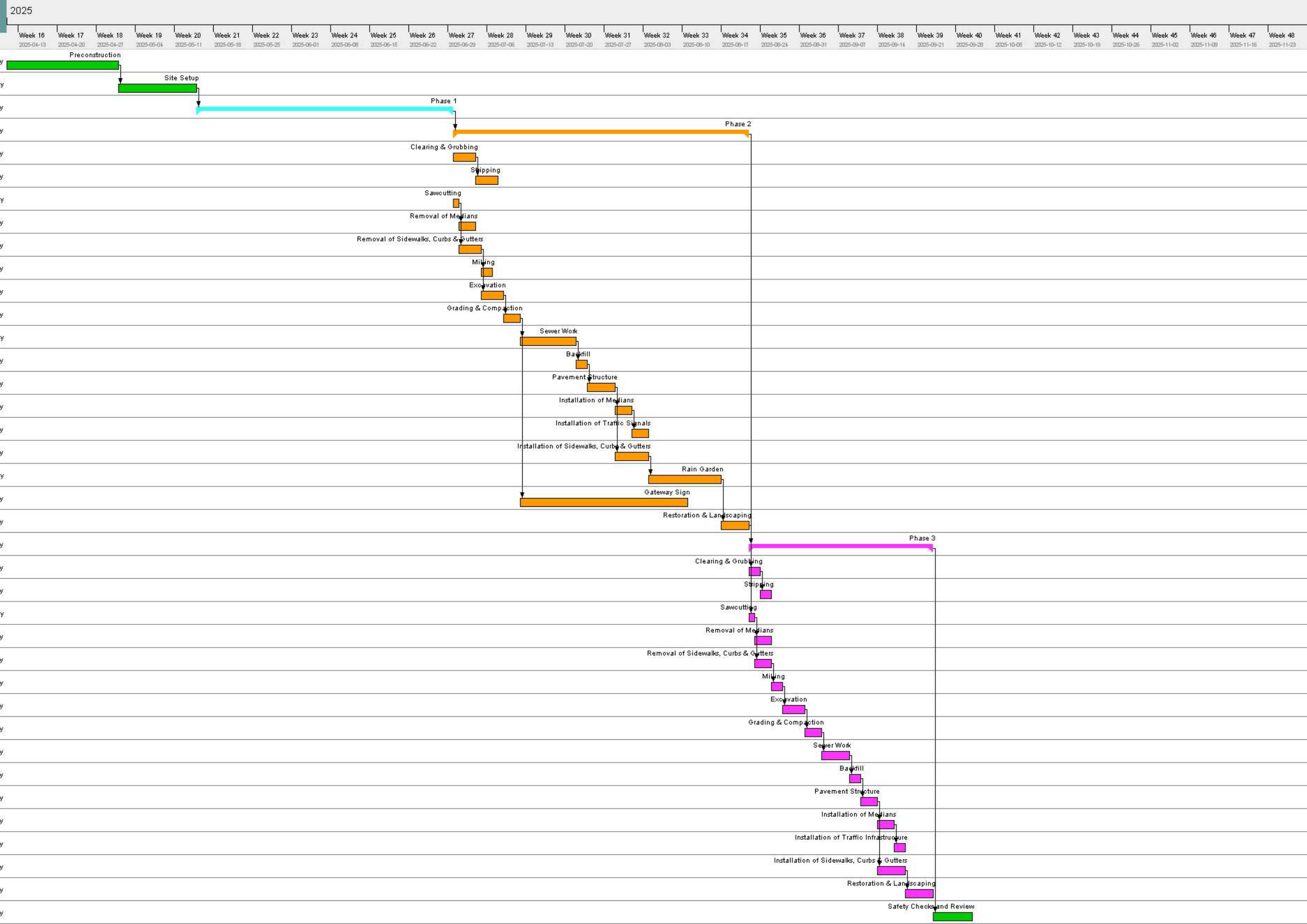


Name	Begin date	End date	Duration
Preconstruction	2025-04-11	2025-04-30	20.0 day
Site Setup	2025-05-01	2025-05-14	14.0 day
Phase 1	2025-05-15	2025-06-29	46.0 day
Geotechnical Testing	2025-05-15	2025-05-16	2.0 day
Clearing & Grubbing	2025-05-17	2025-05-18	2.0 day
Stripping	2025-05-19	2025-05-20	2.0 day
Sawcutting	2025-05-17	2025-05-17	1.0 day
Removal of Medians	2025-05-18	2025-05-19	2.0 day
Removal of Sidewalks...	2025-05-18	2025-05-20	3.0 day
Milling	2025-05-21	2025-05-22	2.0 day
Excavation	2025-05-21	2025-05-24	4.0 day
Grading & Compaction	2025-05-25	2025-05-26	2.0 day
Retention Tank	2025-05-27	2025-06-04	9.0 day
Sewer Work	2025-06-05	2025-06-11	7.0 day
Backfill	2025-06-12	2025-06-13	2.0 day
Pavement Structure Installation	2025-06-14	2025-06-18	5.0 day
Installation of Medians	2025-06-19	2025-06-21	3.0 day
Installation of Traffic Signals	2025-06-22	2025-06-24	3.0 day
Installation of Side...	2025-06-19	2025-06-24	6.0 day
Restoration & Landscaping	2025-06-25	2025-06-29	5.0 day
Phase 2	2025-06-30	2025-08-21	53.0 day
Clearing & Grubbing	2025-06-30	2025-07-03	4.0 day
Stripping	2025-07-04	2025-07-07	4.0 day
Sawcutting	2025-06-30	2025-06-30	1.0 day
Removal of Medians	2025-07-01	2025-07-03	3.0 day
Removal of Sidewalks...	2025-07-01	2025-07-04	4.0 day
Milling	2025-07-05	2025-07-06	2.0 day
Excavation	2025-07-05	2025-07-08	4.0 day
Grading & Compaction	2025-07-09	2025-07-11	3.0 day
Sewer Work	2025-07-12	2025-07-21	10.0 day
Backfill	2025-07-22	2025-07-23	2.0 day
Pavement Structure	2025-07-24	2025-07-28	5.0 day
Installation of Medians	2025-07-29	2025-07-31	3.0 day
Installation of Traffic Signals	2025-08-01	2025-08-03	3.0 day
Installation of Side...	2025-07-29	2025-08-03	6.0 day
Rain Garden	2025-08-04	2025-08-16	13.0 day
Gateway Sign	2025-07-12	2025-08-10	30.0 day
Restoration & Landscaping	2025-08-17	2025-08-21	5.0 day
Phase 3	2025-08-22	2025-09-23	33.0 day
Safety Checks and Review	2025-09-24	2025-09-30	7.0 day



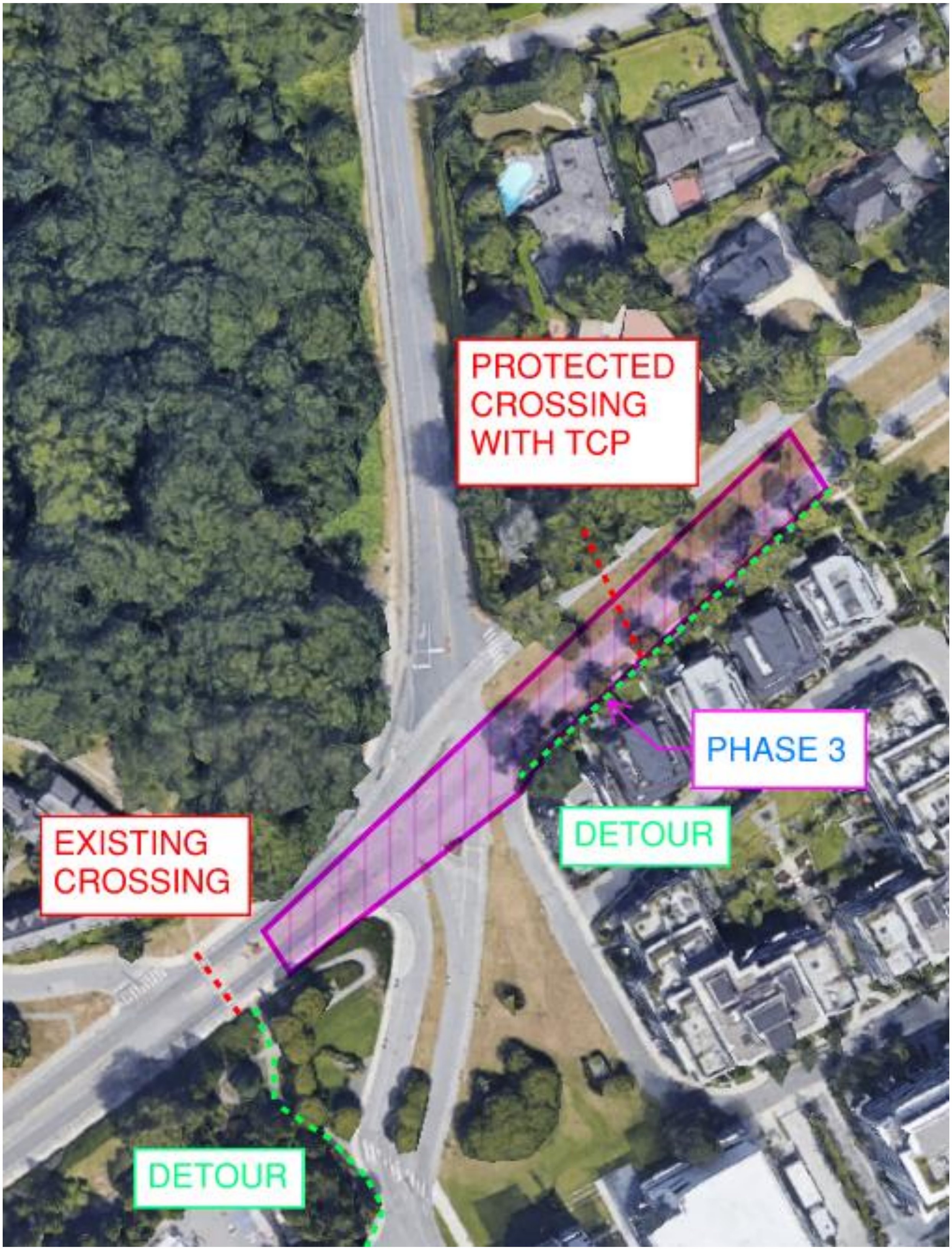
Appendix I: Construction Schedule

Name	Begin date	End date	Duration
Preconstruction	2025-04-11	2025-04-30	20.0 day
Site Setup	2025-05-01	2025-05-14	14.0 day
Phase 1	2025-05-15	2025-06-29	46.0 day
Phase 2	2025-06-30	2025-08-21	53.0 day
Clearing & Grubbing	2025-06-30	2025-07-03	4.0 day
Stripping	2025-07-04	2025-07-07	4.0 day
Sawcutting	2025-06-30	2025-06-30	1.0 day
Removal of Medians	2025-07-01	2025-07-03	3.0 day
Removal of Sidewalks...	2025-07-01	2025-07-04	4.0 day
Milling	2025-07-05	2025-07-06	2.0 day
Excavation	2025-07-05	2025-07-08	4.0 day
Grading & Compaction	2025-07-09	2025-07-11	3.0 day
Sewer Work	2025-07-12	2025-07-21	10.0 day
Backfill	2025-07-22	2025-07-23	2.0 day
Pavement Structure	2025-07-24	2025-07-28	5.0 day
Installation of Medians	2025-07-29	2025-07-31	3.0 day
Installation of Traffic Signals	2025-08-01	2025-08-03	3.0 day
Installation of Side...	2025-07-29	2025-08-03	6.0 day
Rain Garden	2025-08-04	2025-08-16	13.0 day
Gateway Sign	2025-07-12	2025-08-10	30.0 day
Restoration & Landscaping	2025-08-17	2025-08-21	5.0 day
Phase 3	2025-08-22	2025-09-23	33.0 day
Clearing & Grubbing	2025-08-22	2025-08-23	2.0 day
Stripping	2025-08-24	2025-08-25	2.0 day
Sawcutting	2025-08-22	2025-08-22	1.0 day
Removal of Medians	2025-08-23	2025-08-25	3.0 day
Removal of Sidewalks...	2025-08-23	2025-08-25	3.0 day
Milling	2025-08-26	2025-08-27	2.0 day
Excavation	2025-08-28	2025-08-31	4.0 day
Grading & Compaction	2025-09-01	2025-09-03	3.0 day
Sewer Work	2025-09-04	2025-09-08	5.0 day
Backfill	2025-09-09	2025-09-10	2.0 day
Pavement Structure	2025-09-11	2025-09-13	3.0 day
Installation of Medians	2025-09-14	2025-09-16	3.0 day
Installation of Traffic Infrastructure	2025-09-17	2025-09-18	2.0 day
Installation of Side...	2025-09-14	2025-09-18	5.0 day
Restoration & Landscaping	2025-09-19	2025-09-23	5.0 day
Safety Checks and Review	2025-09-24	2025-09-30	7.0 day

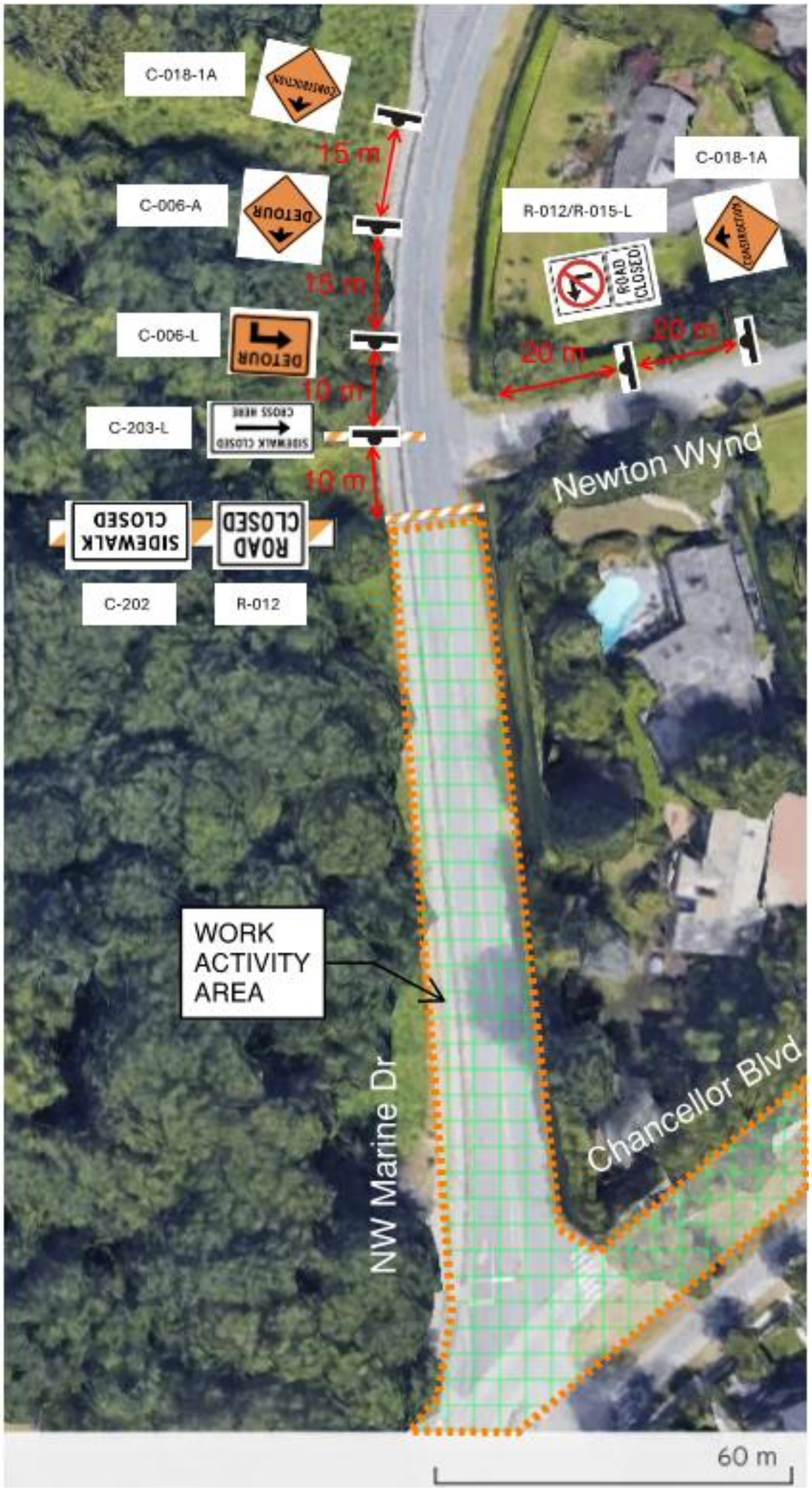


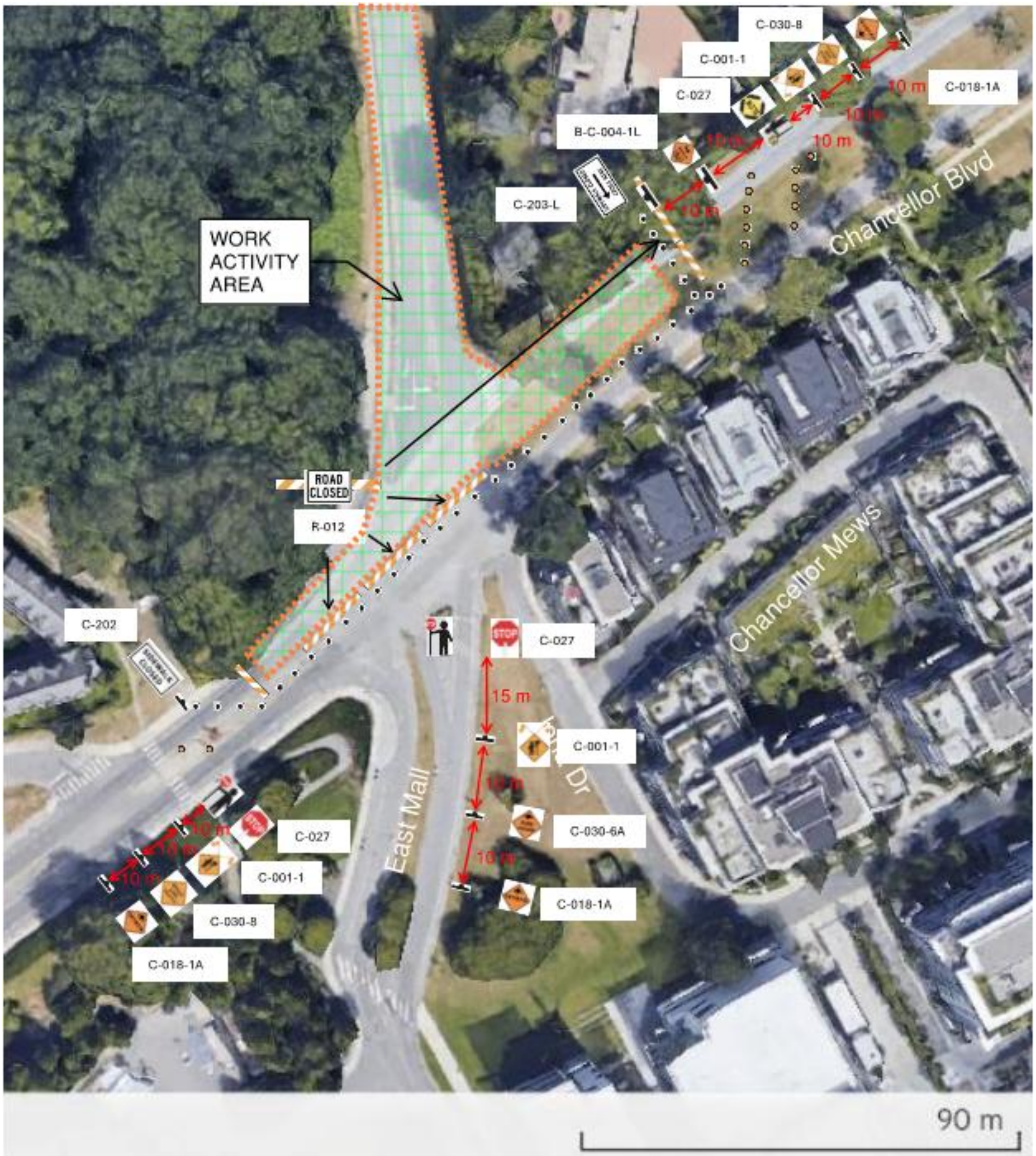
Appendix J: Site Phasing Diagrams for Active Transportation Accommodations

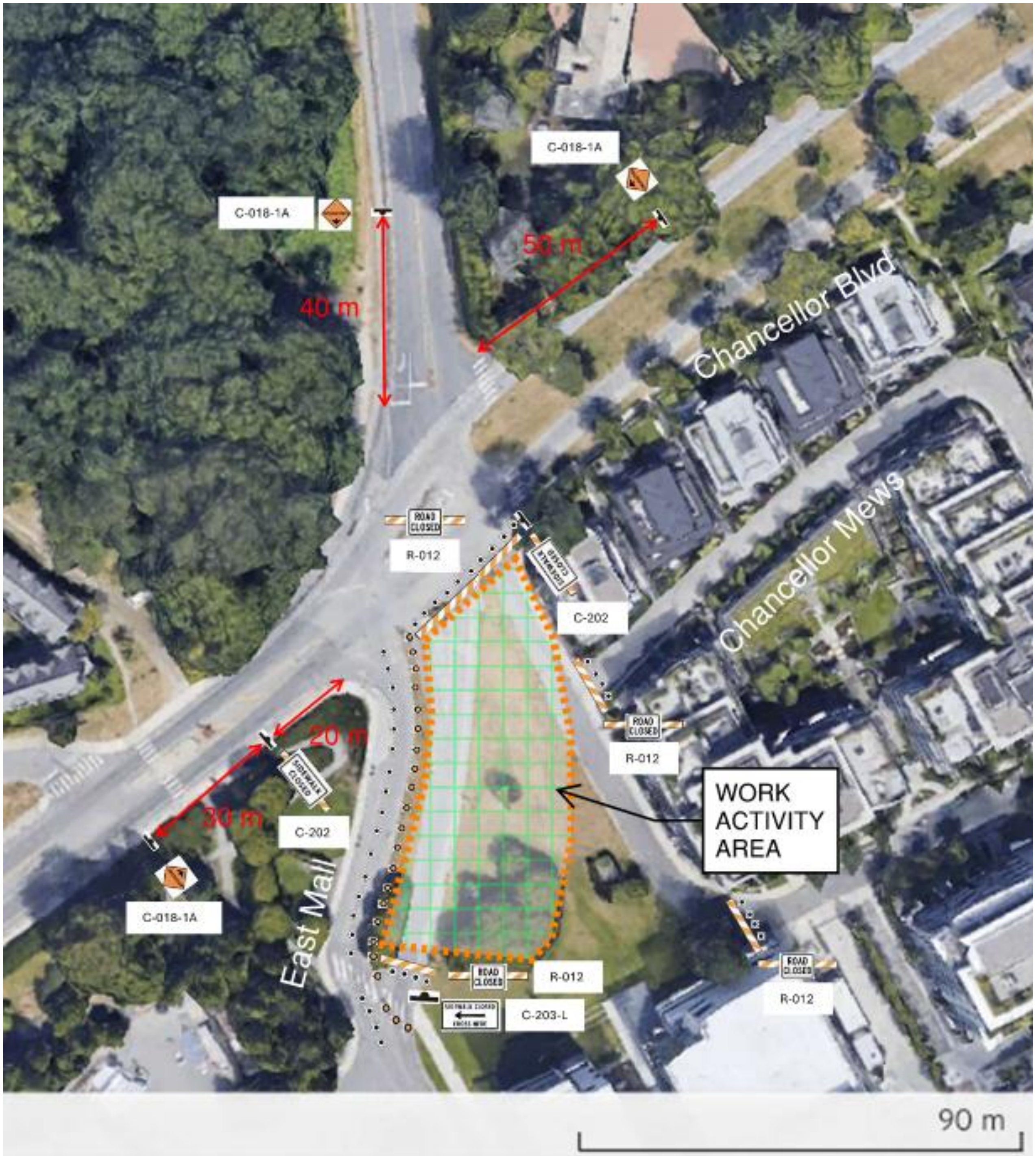

EXISTING
CROSSING
EXISTING
CROSSING
EXISTING
CROSSING
PHASE 2
DETOUR

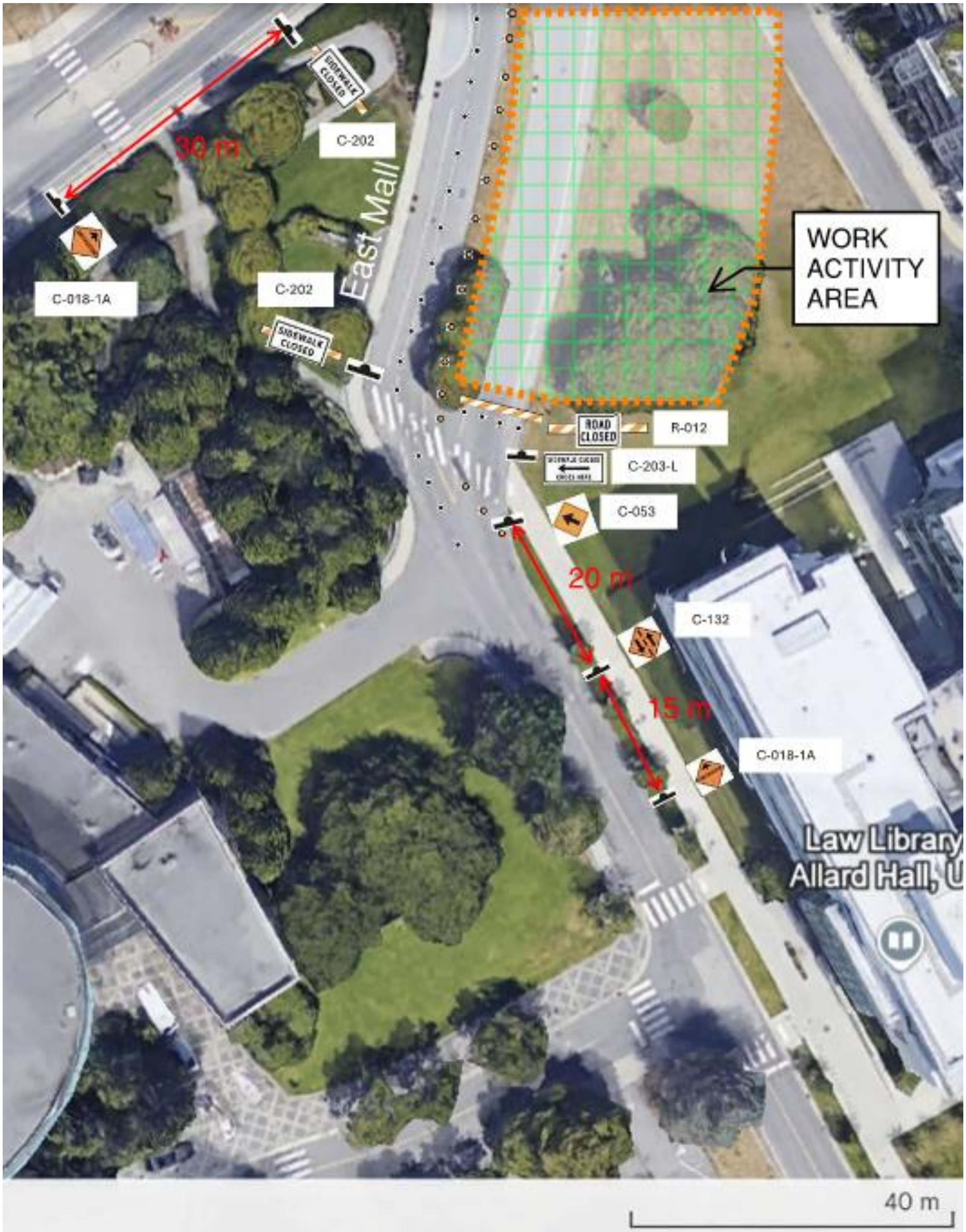

PROTECTED
CROSSING
WITH TCP
PHASE 3
DETOUR
EXISTING
CROSSING
DETOUR

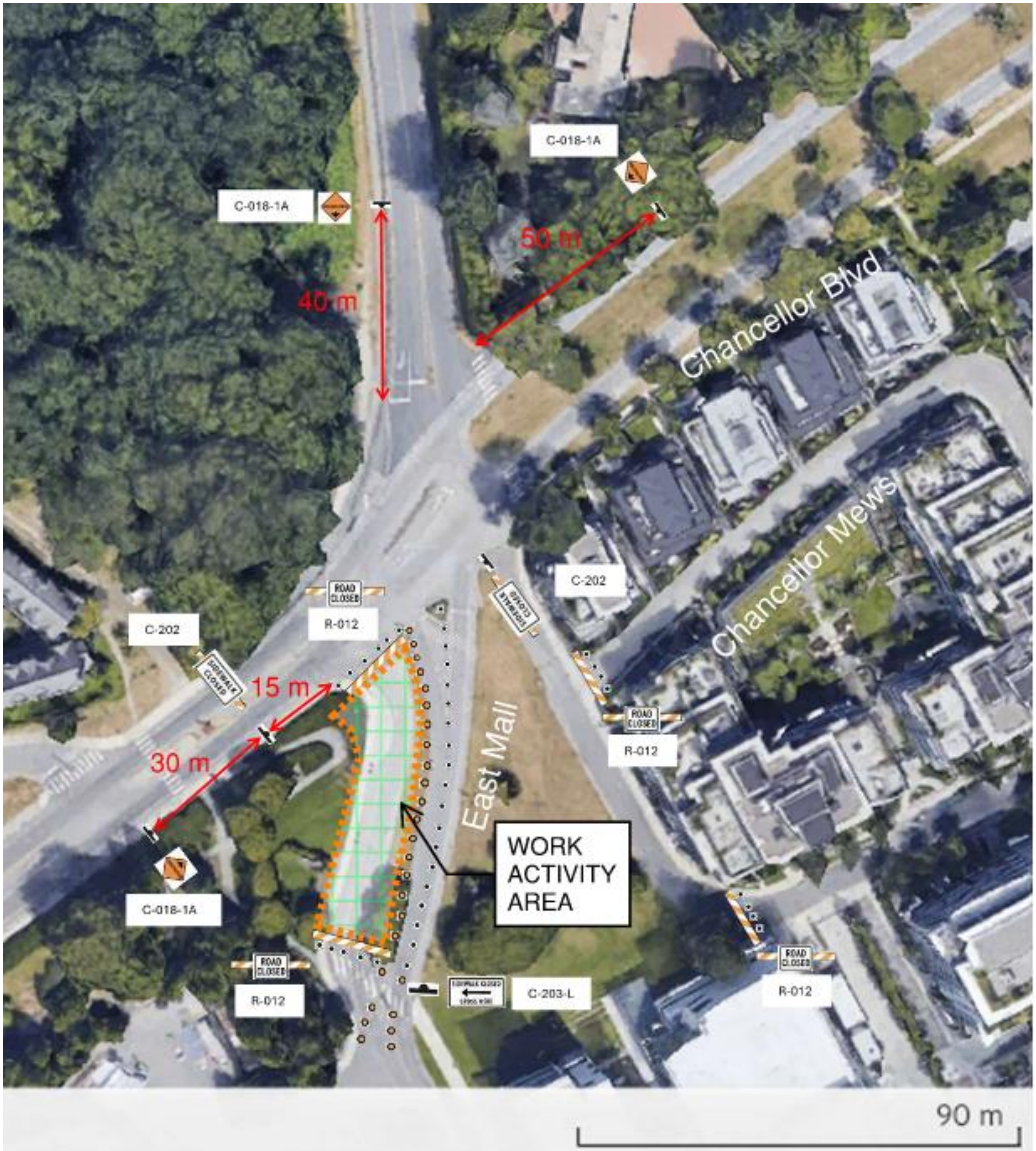
Appendix K: Traffic Management Plans (TMPs)

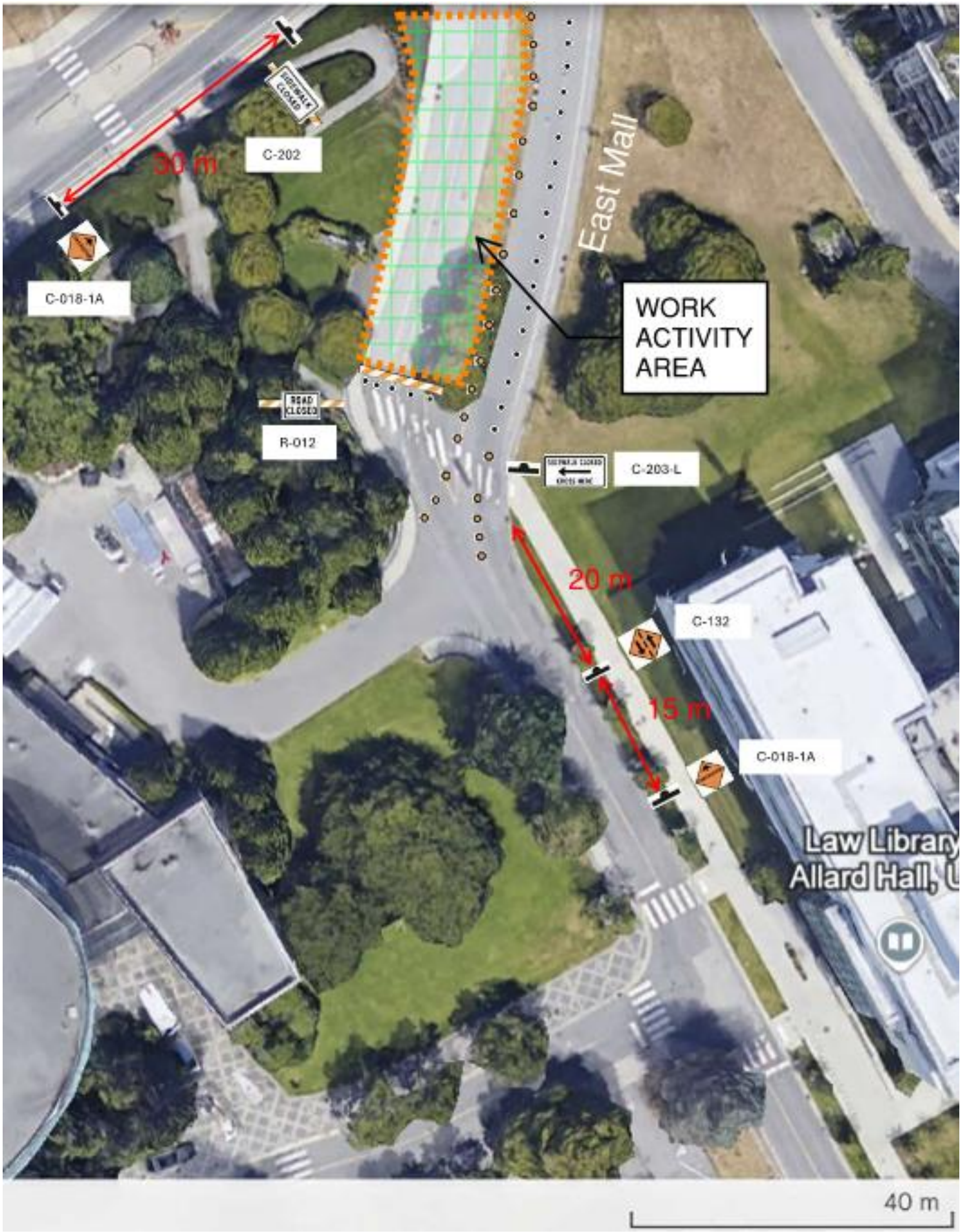



C-030-8
C-001-1
C-027
C-018-1A
B-C-004-1L
10 m
10 m
10 m
10 m
10 m
C-203-L
WORK
ACTIVITY
AREA
Chancellor Blvd
ROAD
CLOSED
R-012
Chancellor Mews
C-202
C-027
15 m
C-001-1
10 m
10 m
C-030-6A
C-018-1A
East Mall
10 m
10 m
10 m
C-027
C-001-1
C-030-8
C-018-1A
90 m


C-018-1A
C-018-1A
50 m
40 m
Chancellor Blvd
ROAD CLOSED
R-012
SIDEWALK CLOSED
C-202
Chancellor Mews
20 m
ROAD CLOSED
R-012
30 m
SIDEWALK CLOSED
C-202
WORK ACTIVITY AREA
C-018-1A
East Mall
ROAD CLOSED
R-012
ROAD CLOSED
R-012
C-203-L
90 m


SIDEWALK CLOSED
C-202
30 m
East Mall
C-018-1A
C-202
SIDEWALK CLOSED
WORK ACTIVITY AREA
ROAD CLOSED
R-012
C-203-L
C-053
20 m
C-132
15 m
C-018-1A
Law Library
Allard Hall
40 m


C-018-1A
C-018-1A
50 m
40 m
Chancellor Blvd
Chancellor Mews
C-202
C-202
ROAD CLOSED
R-012
15 m
30 m
East Mall
ROAD CLOSED
R-012
WORK ACTIVITY AREA
C-018-1A
ROAD CLOSED
R-012
C-203-L
ROAD CLOSED
R-012
90 m


SIDEWALK CLOSED
C-202
30 m
C-018-1A
East Mall
WORK ACTIVITY AREA
ROAD CLOSED
R-012
C-203-L
20 m
C-132
15 m
C-018-1A
Law Library
Allard Hall
40 m

WORK ACTIVITY AREA
C-018-1A
20 m
C-001-1
5 m
C-027
C-018-1A
10 m
10 m
C-030-8
5 m
C-001-1
C-027
ROAD CLOSED
R-012
C-027
20 m
C-001-1
25 m
C-018-1A
C-203-L
ROAD CLOSED
R-012
5 m
10 m
10 m
10 m
C-027
C-001-1
C-030-8
C-018-1A
B-C-004-1L
SIDEWALK CLOSED
C-202
90 m

Appendix L: Class A Cost Estimate

Cost Estimate for Redesign of Chancellor Boulevard / East Mall Intersection				
Description	**Units**	**Quantity**	**Unit Cost**	**Total Cost**
Pre-Construction Costs				
Environmental Assessment & Permitting	Lump Sum	1.00	$ 250,000.00	$ 250,000.00
BC Moti Road Closure Fee	Lump Sum	1.00	$ 15,000.00	$ 15,000.00
Traffic Management Fee	Lump Sum	1.00	$ 12,500.00	$ 12,500.00
	Total Pre-Construction Costs			**$ 277,500.00**
Phase 1				
Asphalt Pavement	Per Tonne	850.49	$ 250.00	$ 212,621.63
25mm Well-Graded Base	Per Cubic Meter	680.39	$ 100.00	$ 68,038.92
Select Granular Sub-Base	Per Cubic Meter	680.39	$ 80.00	$ 54,431.14
Traffic Signals	Per Unit	2.00	$ 20,000.00	$ 40,000.00
Street Lighting	Per Unit	47.00	$ 1,000.00	$ 47,000.00
Delineators	Per Unit	14.00	$ 135.00	$ 1,890.00
Paint Markings	Lump Sum	1.00	$ 500.00	$ 500.00
New Median	Per Square Meter	302.11	$ 150.00	$ 45,316.50
New Sidewalk	Per Square Meter	604.45	$ 160.00	$ 96,712.32
New Curb and Gutter	Per Meter	178.49	$ 220.00	$ 39,267.82

Clearing and Grubbing	Per Hectare	0.05	$ 30,000.00	$ 1,500.00
Full Depth Excavation	Per Cubic Meter	3802.27	$ 50.00	$ 190,113.29
Median Removal	Per Square Meter	200.80	$ 35.00	$ 7,027.98
Milling	Per Square Meter	209.63	$ 15.00	$ 3,144.48
Sawcutting	Per Meter	34.88	$ 20.00	$ 697.60
Sidewalk Removal	Per Square Meter	263.42	$ 22.00	$ 5,795.16
Pipes	Per Meter	131.42	$ 200.00	$ 26,284.02
Retention Tank	Lump Sum	1.00	$ 175,000.00	$ 175,000.00
Catchment Basins	Per Unit	4.00	$ 1,500.00	$ 6,000.00
Maintenance Hatches	Per Unit	2.00	$ 2,594.00	$ 5,188.00
Landscaping - Removal (Hydro Related)	Lump Sum		$ 50,000.00	$ -
Landscaping - Reinstatement (Transpo)	Lump Sum		$ 20,000.00	$ -
	Total Phase 1 Costs			**$ 1,026,528.86**
Phase 2				
Asphalt Pavement	Per Tonne	574.08	$ 250.00	$ 143,519.60
25mm Well-Graded Base	Per Cubic Meter	459.26	$ 100.00	$ 45,926.27

Select Granular Sub-Base	Per Cubic Meter	459.26	$ 80.00	$ 36,741.02
Traffic Signals	Per Unit	1.00	$ 20,000.00	$ 20,000.00
Street Lighting	Per Unit	25.00	$ 1,000.00	$ 25,000.00
Paint Markings	Lump Sum	1.00	$ 500.00	$ 500.00
New Median	Per Square Meter	677.01	$ 150.00	$ 101,551.50
New Sidewalk	Per Square Meter	644.19	$ 160.00	$ 103,069.70
New Curb and Gutter	Per Meter	190.22	$ 220.00	$ 41,849.09
Clearing and Grubbing	Per Hectare	0.21	$ 30,000.00	$ 6,274.42
Full Depth Excavation	Per Cubic Meter	4052.21	$ 50.00	$ 202,610.38
Median Removal	Per Square Meter	287.89	$ 35.00	$ 10,076.15
Milling	Per Square Meter	141.50	$ 15.00	$ 2,122.52
Sawcutting	Per Meter	23.54	$ 20.00	$ 470.88
Sidewalk Removal	Per Square Meter	280.73	$ 22.00	$ 6,176.11
Stripping	Per Cubic Meter	1070.17	$ 50.00	$ 53,508.50
Revegetation	Per Hectare	0.29	$ 15,000.00	$ 4,344.09
Pipes	Per Meter	140.06	$ 200.00	$ 28,011.81

Retention Tank	Lump Sum		$ 175,000.00	$ -
Catchment Basins	Per Unit	4.00	$ 1,500.00	$ 6,000.00
Maintenance Hatches	Per Unit	1.00	$ 2,594.00	$ 2,594.00
Excavation of Rain Garden	Lump Sum	1.00	$ 40,000.00	$ 40,000.00
Construction of Rain Garden	Lump Sum	1.00	$ 30,000.00	$ 30,000.00
Landscaping Allowance	Lump Sum	1.00	$ 5,000.00	$ 5,000.00
Concrete Foundation Slab	Per Cubic Meter	13.78	$ 275.00	$ 3,789.84
Concrete Column	Per Cubic Meter	7.84	$ 275.00	$ 2,156.00
Reinforcement Steel	Per Kilogram	339.45	$ 2.00	$ 678.91
Steel Base Plate (PL1200x1200x12)	Per Plate	1.00	$ 175.00	$ 175.00
Welding	Per mm	4000.00	$ 0.50	$ 2,000.00
Steel	Per Cubic Ton	13.60	$ 1,500.00	$ 20,394.30
Steel UBC Letters	Per Unit	1.00	$ 15,000.00	$ 15,000.00
Simpson Titen HD Anchors	Per Box	1.00	$ 150.00	$ 150.00
Excavation	Per Meter	0.98	$ 50.00	$ 49.00
Concrete Casting	Per Cubic Meter	21.62	$ 300.00	$ 6,486.38
Landscaping Allowance	Lump Sum	1.00	$ 5,000.00	$ 5,000.00
	Total Phase 2 Costs			**$ 971,225.46**

Phase 3				
Asphalt Pavement	Per Tonne	701.65	$ 250.00	$ 175,412.84
25mm Well-Graded Base	Per Cubic Meter	561.32	$ 100.00	$ 56,132.11
Select Granular Sub-Base	Per Cubic Meter	561.32	$ 80.00	$ 44,905.69
Traffic Signals	Per Unit	1.00	$ 20,000.00	$ 20,000.00
Street Lighting	Per Unit	23.00	$ 1,000.00	$ 23,000.00
Delineators	Per Unit	7.00	$ 135.00	$ 945.00
Paint Markings	Lump Sum	1.00	$ 500.00	$ 500.00
New Median	Per Square Meter	302.11	$ 150.00	$ 45,316.50
New Sidewalk	Per Square Meter	408.91	$ 160.00	$ 65,425.98
New Curb and Gutter	Per Meter	120.75	$ 220.00	$ 26,564.72
Full Depth Excavation	Per Cubic Meter	2572.24	$ 50.00	$ 128,611.83
Median Removal	Per Square Meter	169.18	$ 35.00	$ 5,921.14
Milling	Per Square Meter	172.95	$ 15.00	$ 2,594.20
Sawcutting	Per Meter	28.78	$ 20.00	$ 575.52
Sidewalk Removal	Per Square Meter	178.20	$ 22.00	$ 3,920.43

Pipes	Per Meter	88.91	$ 200.00	$ 17,781.17
Retention Tank	Lump Sum		$ 175,000.00	$ -
Catchment Basins	Per Unit	2.00	$ 1,500.00	$ 3,000.00
Maintenance Hatches	Per Unit	1.00	$ 2,594.00	$ 2,594.00
	Total Phase 3 Costs			**$ 623,201.14**
Total Costs (before additional items)				**$ 2,898,455.45**
Contingency				
Contingency	% of Total Costs	10.00%	$ 2,898,455.45	$ 289,845.54
	Total Contingency Costs			**$ 289,845.54**
Consultant Fees				
Consultant Fees	% of Total Costs	10.00%	$ 2,898,455.45	$ 289,845.54
	Total Consultant/Engineering Costs			**$ 289,845.54**
Mobilization / Demolition				
Mobilization/Demobilization	% of Total Costs	5.00%	$ 2,898,455.45	$ 144,922.77
	Total Contingency Costs			**$ 144,922.77**
Contractor's Bonding & Insurance				
Contractor's Bonding & Insurance	% of Total Costs	5.00%	$ 2,898,455.45	$ 144,922.77
	Total Bonding & Insurance Costs			**$ 144,922.77**

Tax				
PST Tax Consideration	% of Total Costs	7.00%	$ 2,898,455.45	$ 202,891.88
	Total Taxes Considered Costs			**$ 202,891.88**
Total Overall Costs				**$ 3,970,883.97**

Appendix M: Construction Specifications

Specifications for Reinforced Cast-in-Place Concrete

Scope of Work

The work shall consist of:

- Supplying materials and mixing and placing reinforced cast-in-place concrete as shown and described in the Drawings and this Specification, including placing, vibrating, finishing, and curing.
- Supplying, fabricating, constructing, maintaining, and removing temporary works, including falsework and formwork.
- Heating and cooling concrete, if necessary.
- Developing concrete mix designs that meet performance requirements, including trial batches.
- Performing quality control (QC) testing on all materials.
- Supplying and installing water seals and joint fillers (when applicable).
  Concrete supplied under this Specification shall comply with CSA A23.1/A23.2.

General Requirements

1. All concrete plant equipment and truck mixers shall comply with CSA A23.1 and this Specification.
2. All concrete materials shall meet the requirements of CSA A23.1 and this Specification.
3. All concrete mix designs must satisfy CSA A23.1/A23.2 and this Specification.
4. Concrete production and delivery must meet CSA A23.1 and this Specification.

Contractor's Performance Criteria

Submissions shall include performance criteria for each mix design:

- Placeability (e.g., pumping, buggies, truck chute)
- Workability
- Proposed slump and slump retention time
- Set time

References and Standards

All reference standards shall be current as of the date of the tender advertisement. Examples include:

- ASTM D75 – Sampling Aggregates
- ASTM D516 – Sulfate Ion in Water
- ASTM C494 – Chemical Admixtures for Concrete
- CSA A23.1/A23.2 – Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices

Materials

1. Fine Aggregate

Shall meet CSA A23.1 grading requirements, be uniformly graded, and have no more than 3% passing a 75 μm sieve.

2. Coarse Aggregate

Maximum nominal size: 20 mm. Must meet CSA A23.1, Table 11, Group I. Uniformly graded with ≤1% passing a 75 μm sieve.

3. Cementitious Materials

Shall conform to CSA A3000 (cementitious materials compendium). Use Portland cement Type GU or Type HS as required.

4. Water

Shall be potable and conform to CSA A23.1, free from oil, alkali, acid, organic materials, or deleterious substances.

5. Formwork

Shall comply with CSA S269.3 – Concrete Formwork. Use good-quality plywood in "like-new" condition. Must ensure uniform thickness and alignment.

Construction Methods

1. Mixing

Concrete shall be mixed until uniform in appearance. Minimum mix time: 1 minute for ≤1 m^3 capacity, plus 15 seconds for each additional 0.5 m^3. Timing starts when all materials are in the drum.

2. Hauling Time

Maximum delivery time is 90 minutes from batching, or 60 minutes for silica fume mixes.

3. Falsework and Formwork
Must meet CSA S269.1 (Falsework for Construction Purposes) and CSA S269.3 (Concrete Formwork). Falsework must support all loads without excessive settlement. Forms shall be treated for stripping and cleaned before use.

4. Pumping Concrete
Pumping must maintain continuous, uniform flow without segregation. Avoid vibration damage to placed concrete. Discharge remaining concrete without contamination.

Cold Weather Precautions

1. General
Heating is required when ambient temperature is below 5°C or forecasted to fall below within 24 hours. Backup heating must be available.

2. Aggregates
Max temperature: 65°C (40°C for silica fume mixes). Heating must be uniform with no hot spots.

3. Water
Max temperature: 65°C (40°C for silica fume mixes).

4. Concrete Placement Temperature
Concrete must be between 15°C and 25°C at the time of placement (10°C to 18°C for silica fume mixes).

5. Curing Requirements
Water curing must end at least 12 hours before freeze-risk period ends. Use approved water-based membrane-forming curing compound conforming to ASTM C309. Reapply if damaged or affected by rain. C-XL or C-1 class concrete must be wet cured for 7 days at ≥15°C until 50% of design strength is reached.

Quality Control

Concrete sampling shall follow CSA A23.2. Sample at pump hose outlet if applicable. Test cylinders must reach lab within 20–48 hours and be cast in CSA-approved molds.

Opening to Traffic

The structure shall not be opened to traffic until concrete has reached 100% of its design compressive strength. Contractor is responsible for additional testing if needed to verify strength compliance.

GENERAL NOTES:

1. READ ALL STRUCTURAL/CIVIL DRAWINGS IN CONJUNCTION WITH ALL CONTRACT DOCUMENTS, INCLUDING REFERENCED ELECTRICAL, MECHANICAL, VENDOR DRAWINGS, AND SPECIFICATIONS

2. THE CONTRACTOR FOR ANY PORTION OF WORK SHALL VISIT THE SITE AND SHALL BE THOROUGHLY FAMILIAR WITH ALL THE PHYSICAL FEATURES THAT MAY AFFECT THE WORK IN ANY WAY.

3. FIELD MEASURE AND MAKE ADJUSTMENTS TO SUIT EXISTING CONDITIONS.

4. THE CONTRACTOR SHALL KEEP WORK SITES CLEAN AND FREE OF ALL CONSTRUCTION DEBRIS DURING THE PROCESS OF CONSTRUCTION AND LEAVE THE SITE CLEAN UPON COMPLETION OF WORK OR PORTIONS OF THE WORK.

5. CONSULTANT MUST APPROVE ALL DEVIATIONS FROM THE WORKING DRAWINGS. THE CONTRACTOR MUST KEEP AN ACCURATE RECORD OF ALL CHANGES FROM THE ORIGINAL INFORMATION SHOWN ON THE CONSTRUCTION DRAWINGS.

6. FEATURES OF CONSTRUCTION NOT FULLY SHOWN ARE OF THE SAME CHARACTER AS THOSE NOTED FOR SIMILAR CONDITIONS.

7. ALL CONSTRUCTION SHALL CONFORM TO THE LATEST EDITION OF THE FOLLOWING:
   OCCUPATIONAL HEALTH AND SAFETY ACT
   ONTARIO REGULATION 213/91 - CONSTRUCTION PROJECTS
   THE ONTARIO BUILDING CODE AND THE NATIONAL BUILDING CODE

8. IF DISCREPANCIES EXIST BETWEEN THESE DWGS. AND THE SPECIFICATIONS, CONTACT ENGINEER FOR REVIEW AND APPROVAL PRIOR TO PROCEEDING.

9. DO NOT SCALE THESE DRAWINGS.

GENERAL MATERIALS:

1. DELIVER MATERIALS TO JOB SITE IN DRY CONDITION. KEEP MATERIALS DRY AND CLEAN UNTIL USE.

2. BACKFILL WITH GRANULAR A UNLESS OTHERWISE NOTED ON THE DRAWINGS, COMPACT IN ONE FOOT LIFTS TO A MINIMUM 95% S.P.D.D. TO SIX INCHES BELOW TOP OF CONCRETE.

3. ALL CEMENT TO BE PORTLAND BLAST FURNACE SLAG CEMENT TO CAN-A326 BLENDED HYDRAULIC CEMENTS CONSISTING OF 75% NORMAL TYPE 10 PORTLAND CEMENT AND 25% CEMENTITIOUS HYDRAULIC SLAG.

4. ALL REINFORCING STEEL TO BE GRADE 400 DEFORMED BARS TO CAN/CSA G30.18.

5. ALL BASE GROUT TO BE "MEADOWS V1" BY W.R. MEADOWS OR APPROVED EQUAL.

6. EPOXY GROUT FOR DOWELS TO BE ANCHORFIX 2CA BY SIKA CANADA OR APPROVED EQUAL.

7. DISPOSAL OF ALL EXCAVATED MATERIAL SHALL BE OFF-SITE OTHER THAN APPROVED BACKFILL

ABBREVIATIONS:

A.B. --- ANCHOR BOLT
A.F.F. --- ABOVE FINISHED FLOOR
ALT. --- ALTERNATE
ARCH. --- ARCHITECTURAL
B.C.E. --- BOTTOM CHORD EXTENSION
B.F.F. --- BELOW FINISHED FLOOR
B.L.L. --- BOTTOM LOWER LAYER
BOT. --- BOTTOM
B.U.L. --- BOTTOM UPPER LAYER
C.A. --- COLUMN ABOVE
C.B. --- COLUMN BELOW
CANT. --- CANTILEVER
C.I.P. --- CAST IN PLACE
CONC. --- CONCRETE
CONT. --- CONTINUOUS
C.P. --- COMPLETE PENETRATION
c/c --- CENTER TO CENTER
C.L. --- CENTER LINE
CRS. --- COURSE
c/w --- COMPLETE WITH
DET. --- DETAIL
D.L. --- DEAD LOAD
do --- DO OVER (DITTO)
DP. --- DEEP (DEPTH OF MEMBER)
DWG. --- DRAWING
DWLS. --- DOWELS
EA. --- EACH
E.E. --- EACH END
E.F. --- EACH FACE
EL. --- ELEVATION
ELEV. --- ELEVATION
ELEC. --- ELECTRICAL
EMBED.-- EMBEDMENT
E.S. --- EACH SIDE
E.W. --- EACH WAY
EXIST. --- EXISTING
EX. --- EXISTING
EXT. --- EXTERIOR
EXP. JT.-- EXPANSION JOINT
F.D. --- FLOOR DRAIN
F.S. --- FAR SIDE
FTG. --- FOOTING
GALV. --- GALVANIZED
G.L. --- GRID LINE
GRAN. --- GRANULAR
HK. --- HOOK
H&V --- HORIZONTAL & VERTICAL
HORZ. --- HORIZONTAL
I.J. --- ISOLATION JOINT
INT. --- INTERIOR
JT. --- JOINT
LG. --- LONG
L.B. --- LOAD BEARING
L.L. --- LIVE LOAD
L.L.H. --- LONG LEG HORIZONTAL
L.L.V. --- LONG LEG VERTICAL
L.S.H. --- LONG SIDE HORIZONTAL
L.S.V. --- LONG SIDE VERTICAL
MANUF. - MANUFACTURER
MAX. --- MAXIMUM
MECH. --- MECHANICAL
MIN. --- MINIMUM
MIR. --- MIRROR
N.I.C. --- NOT IN CONTRACT
N.L.B. --- NON-LOAD BEARING
N.S. --- NEAR SIDE
N.T.S. --- NOT TO SCALE
O/C --- ON CENTER
OPP. --- OPPOSITE
O.W.S.J. - OPEN WEB STEEL JOIST
PL. --- PLATE
P.L. --- POINT LOAD
P.L.A. --- POINT LOAD ABOVE
P.T. --- PRESSURE TREATED
R.D. --- ROOF DRAIN
R/W --- REINFORCED WITH
S.C. --- SAW CUT CONTROL JOINT
S.D.L. --- SUPERIMPOSED DEAD LOAD
S.D.F. --- STEP DOWN FOOTING
SECT. --- SECTION
SIM. --- SIMILAR
S.J. --- SNOW LOAD
S.O.G. --- SLAB ON GRADE
SPEC. --- SPECIFICATIONS
STAG. --- STAGGERED
STIR. --- STIRRUPS
SYM. --- SYMMETRICAL
THK. --- THICK
THRU --- THROUGH
T.L.L. --- TOP LOWER LAYER
TYP. --- TYPICAL
T&B --- TOP & BOTTOM
T&G --- TONGUE & GROOVE
T.J. --- TIE JOISTS
T/O --- TOP OF
T.O.S. --- TOP OF STEEL
T.U.L. --- TOP UPPER LAYER
U.N.O. --- UNLESS NOTED OTHERWISE
ULS --- ULTIMATE LIMIT STATE
SLS --- SERVICEABILITY LIMIT STATE
U/S --- UNDERSIDE
VERT. ---- VERTICAL
W.P. ---- WORK POINT

FOUNDATIONS:

1. BEARING SURFACES MUST BE APPROVED BY THE SOILS ENGINEER IMMEDIATELY PRIOR TO CONSTRUCTION.

2. REFER TO SOILS REPORT FOR OTHER SPECIFIC DESIGN REQUIREMENTS FOR FOOTING, SOIL SLOPES, FROST PROTECTION, MINIMUM COVER, ETC.

3. UNLESS OTHERWISE SHOWN, CENTER FOOTINGS BELOW COLUMNS AND WALLS.

4. DOWELS SHALL BE PLACED BEFORE CONCRETE IS PLACED. TEMPLATES SHALL BE USED TO ENSURE CORRECT PLACEMENT OF DOWELS.

5. FOOTINGS MAY HAVE TO BE LOWERED TO ACCOMMODATE MECHANICAL OR ELECTRICAL SERVICES. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR ELEVATIONS. FOOTINGS ARE NOT TO BE UNDERMINED BY EXCAVATIONS FOR SERVICES, PITS, ETC.

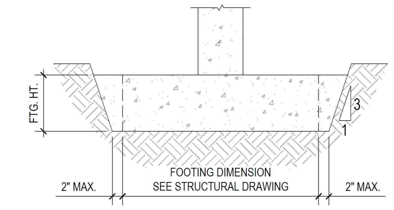
6. FOOTINGS ELEVATIONS, IF SHOWN, ARE FOR BIDDING PURPOSES ONLY, ARE NOT FINAL, AND MAY VARY ACCORDING TO SITE CONDITIONS OR AS REQUIRED BY SERVICES. ALL FOOTINGS MUST BE TAKEN TO A BEARING LAYER APPROVED BY THE SOILS ENGINEER.

7. BEARING SURFACES MUST BE PROTECTED FROM FREEZING BEFORE AND AFTER FOOTINGS ARE POURED.

8. SUB-BASE DESIGN OF THE SOIL UNDER THE SLAB ON GRADE SHALL BE IN ACCORDANCE WITH THE SOIL REPORT.

9. CONCRETE PLACED UNDER WATER SHALL CONFORM TO CAN/CSA-A23.1.

10. FOOTINGS CAST DIRECTLY INTO EXCAVATIONS (WITHOUT SIDE FORMS) SHALL NOT BE LARGER THAN SHOWN BELOW:



CONCRETE:

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

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

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

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

5. THE OWNER WILL EMPLOY A TESTING COMPANY TO CONDUCT STRENGTH, SLUMP, MATERIAL AND AIR ENTRAINED TESTS ONCE FOR EVERY DAY CONCRETE IS POURED. STRENGTH TEST SHALL INCLUDE THREE CYLINDERS, ONE TESTED AT 7 DAYS AND TWO TESTED AT 28 DAYS IN ACCORDANCE WITH CAN3-A23.2. SLUMP AND AIR CONTENT TESTS SHALL CONSIST OF ONE SAMPLE EACH IN ACCORDANCE WITH CAN3-23.1 AND CAN3-A23.2.

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

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

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

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

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

11. PROVIDE HOT OR COLD WEATHER PROTECTION WHEN REQUIRED AS SPECIFIED IN CAN3-A23.1.

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

13. ENSURE ALL REBAR IS CLEAN SECURELY HELD IN CORRECT LOCATION DURING PLACING.

14. FOR ALL NEW OPENINGS IN SLAB-ON-GRADE PROVIDE MINIMUM 10M DOWELS AROUND PERIMETER OF OPENING, 12" LONG x 4" EMBEDMENT (FRICTION-FIT) SPACED @ 16" c/c. THE NEW CONCRETE INFILL SHALL HAVE A MINIMUM REINFORCEMENT OF WWM 6x6x$\frac{6}{6}$ (U.N.O.)

CONCRETE PROPERTIES		
ELEMENT	COMPRESSIVE STRENGHT (MPa) 28 DAYS U.N.O.	EXPOSURE CLASS
FOOTINGS	25 MPa (56 DAYS)	N
CAST-IN-PLACE DRILLED FOOTING/CAISSON	32 MPa (56 DAYS)	F-2
SLAB-ON-GRADE (INTERIOR)	25 MPa	N
SLAB-ON-GRADE (EXTERIOR)	32 MPa	C-2
RETAINING/FOUNDATION WALLS	25 MPa	F-2
MECH./ HOUSEKEEPING PADS	20 MPa	N
GRADE BEAMS	30 MPa	N

CONCRETE FORMWORK:

1. THE DESIGN AND FIELD REVIEW OF FORMWORK, SHORING AND RE-SHORING IS THE RESPONSIBILITY OF THE CONTRACTOR. RE-SHORING DRAWINGS SHALL BE SUBMITTED TO HALLEX ENGINEERING LTD. FOR THE EFFECT ON THE BASE BUILDING STRUCTURE ONLY.

2. NO COLUMN OR WALL FORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 10 MPa FOR ARCHITECTURAL CONCRETE OR 8 MPa FOR OTHER COLUMNS OR WALLS.

3. NO SLAB FORMS OR BEAM FORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 75% OF THE 28 DAY STRENGTH BEFORE STRIPPING/RE-SHORING.

4. ALL SLABS, BEAMS, GIRDERS ETC. TO BE SHORED UNTIL CONCRETE REACHED DESIGN STRENGTH.

5. NO CONCRETE MAY BE REMOVED WITH PERCUSSIVE METHODS SUCH AS CHIPPING JACK-HAMMERING WITHOUT PRIOR APPROVAL OF HALLEX ENGINEERING LTD.

REINFORCING STEEL:

1. LAP ALL REINFORCING AS PER RSIO MANUAL, CLASS "B" TENSION LAP.

2. INTERSECTING REBAR SHALL BE TIED TOGETHER USING NO.16 U.S. WIRE GAUGE OR HEAVIER ANNEALED WIRE OR AN APPROVED PATENTED TYING SYSTEM.

3. ADEQUATELY SUPPORT REINFORCEMENT WITH PLASTIC CHAIRS, SPACERS OR HANGERS AND SECURE AGAINST DISPLACEMENT WITHIN THE TOLERANCES INDICATED IN LATEST EDITION CSA STANDARD A23.1. CONCRETE BRICKS MAY BE USED IN PLACE OF PLASTIC CHAIRS FOR SLABS ON GRADE.

4. NOTIFY THE CONSULTANT FOR SITE REVIEW OF REINFORCEMENT 24 HOURS PRIOR TO THE PLACEMENT OF CONCRETE.

5. MINIMUM COVER TO REINFORCEMENT SHALL BE 3" WHEN CONCRETE IS CAST AGAINST SOIL AND $1\frac{1}{2}$" FOR ALL OTHER APPLICATIONS. (UNLESS NOTED OTHERWISE)

STRUCTURAL STEEL:

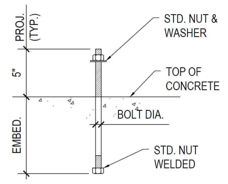
1. ALL WORK SHALL CONFORM TO CSA STANDARD S16 (LATEST EDITION) "LIMIT STATES DESIGN OF STEEL STRUCTURES". CONTRACTOR TO FABRICATE TO APPROVED SHOP DWGS. ONLY.

2. STEEL SHALL CONFORM TO CSA STANDARD G40.20 "GENERAL REQUIREMENTS FOR ROLLED OR WELDED STRUCTURAL QUALITY STEEL" AND TO CSA STANDARD G40.21 "STRUCTURAL QUALITY STEELS" TO THE FOLLOWING GRADES:
   HSS AND FLANGE SECTIONS - 350W (50 ksi)
   ALL OTHER HOT ROLLED SHAPES - 300W (44W)
   PLATES NOT GREATER THAN 1 1/2" THICKNESS - 300W (44W)

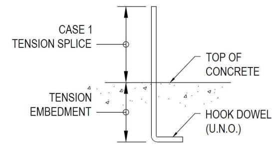
3. STRUCTURAL BOLTS TO BE ASTM-A325-02 SPECIFICATION FOR STRUCTURAL BOLTS. HEAT TREATED 120/105 KSI MIN. TENSILE STRENGTH. COMPLETE WITH HARDENED WASHERS AND HEAVY HEX NUTS.

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

TYP. ANCHOR BOLT (U.N.O.)



TYP. HOOKED DOWEL



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

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

7. ALL WELDING TO BE METAL-ARC TO CSA-W59-M1989-WELDED STEEL CONSTRUCTION. (METAL-ARC WELDING). ALL WELDS SHALL BE CONTINUOUS UNLESS NOTED. MINIMUM SIZE OF FILLET WELD TO BE $\frac{3}{16}$" (5mm) OR AS REQ'D BY MATERIAL THICKNESS OR PARTS JOINED.

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

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

10. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
    10.1 ALL SHOP DRAWINGS SHALL BEAR A SEAL OF A REGISTERED PROFESSIONAL ENGINEER.
    10.2 THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF ALL CONNECTIONS.
    10.3 UNLESS OTHERWISE DETAILED OR SPECIFIED, BEAM CONNECTIONS SHALL BE DESIGNED TO RESIST THE FULL BENDING CAPACITY OF THE MEMBER IN ITS FULLY BRACED CONDITION FOR THE APPROPRIATE SPAN AS LISTED IN THE CISC HANDBOOK BEAM LOAD TABLES.
    10.4 CONNECTIONS SHALL CONFORM TO THE DETAILS IN THE CISC HANDBOOK.
    10.5 NON-STANDARD CONNECTIONS AND CONNECTIONS TO EXISTING STRUCTURAL MEMBERS SHALL BE DESIGNED AND BEAR THE SEAL OF A PROFESSIONAL ENGINEER.
    10.6 BEAM END CONNECTION DETAILS SHOWN ON THESE DRAWINGS ARE INTENDED TO SERVE AS A GUIDE ONLY. IT IS THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL FINAL DIMENSIONS.

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

12. ALL EXTERIOR STEEL THAT IS EXPOSED TO WEATHER INCLUDING HANDRAILS AND GUARDS SHALL BE HOT-DIP GALVANIZED

13. BOLTED CONNECTIONS SHALL HAVE A MINIMUM OF TWO BOLTS IN EACH CONNECTED PIECE AND BE DESIGNED AS BEARING CONNECTIONS U.N.O.

14. U.N.O. COLUMN CAP PLATES SHALL BE $\frac{1}{4}$" THICK AND COLUMN BASE PLATES SHALL BE $\frac{3}{8}$" MINIMUM THICK.

15. PROVIDE $\frac{1}{4}$" CAP PLATES FOR ALL HSS MEMBERS U.N.O.

16. DESIGN DRAWINGS INCLUDE ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DRAWINGS. SEE ALSO ARCHITECTURAL DRAWINGS FOR ADDITIONAL DIMENSIONS AND DETAILS. WHERE ELEVATIONS, ROOF SLOPES, ETC. ARE SHOWN ON THE STRUCTURAL DRAWINGS, THEY MUST BE CONFIRMED WITH THE ARCHITECTURAL DRAWINGS.

17. MISCELLANEOUS MATERIALS AND ACCESSORIES ASSOCIATED WITH GOOD PRACTICE THAT ARE NOT SHOWN SHALL BE PROVIDED.

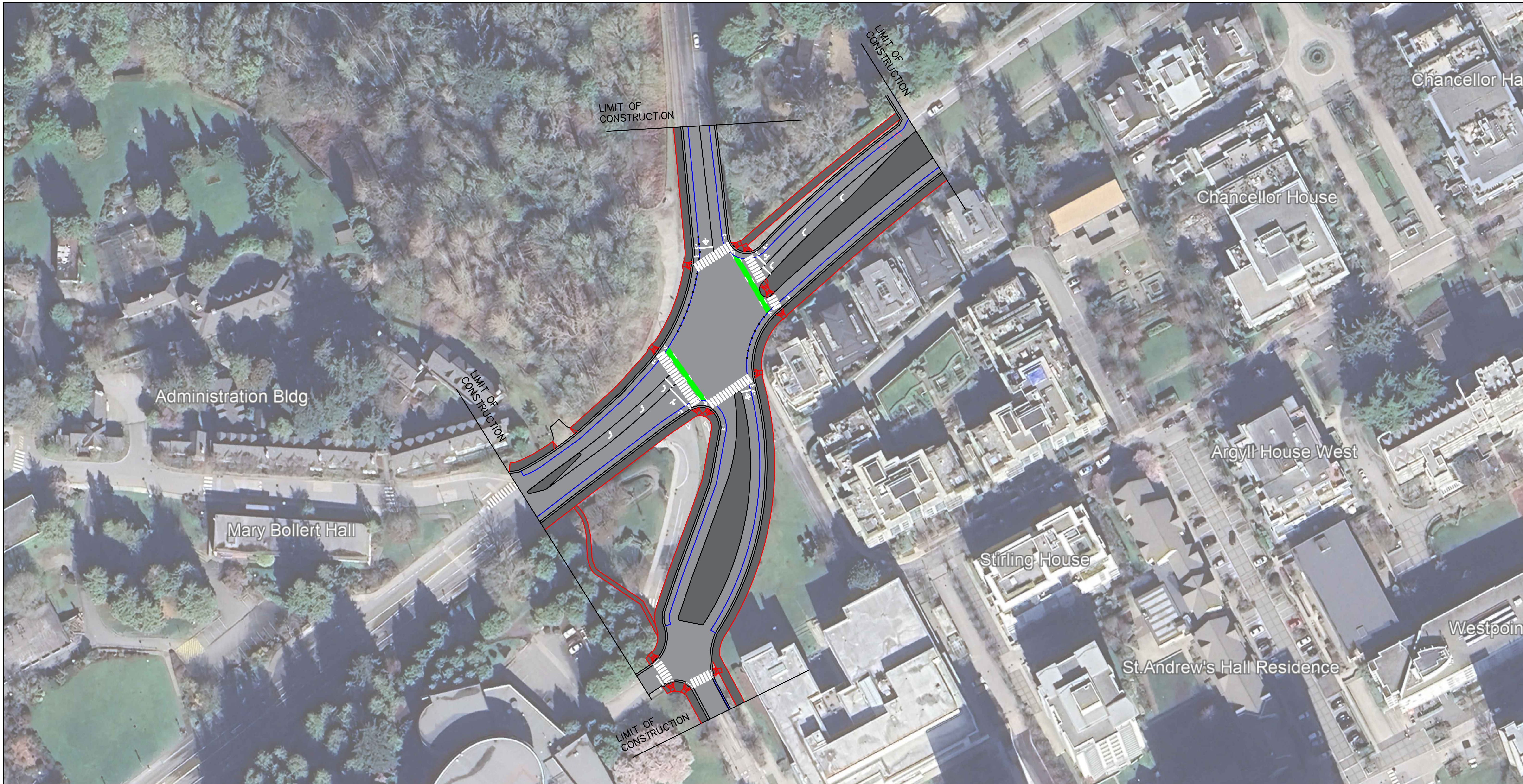
18. U.N.O. DO NOT OVERSIZE HOLES IN STEEL TO FIT ANY ANCHOR LOCATIONS, FOR COLUMN BASE PLATE HOLES, UNLESS NOTED OTHERWISE ON DRAWINGS, SEE TABLE BELOW.

HOLE SIZES FOR ANCHOR BOLTS	
BOLT SIZE (in.)	HOLE SIZE (in.)
$\frac{3}{4}$" UP TO INCLUDING 1"	DIAMETER + $\frac{5}{16}$"
OVER 1" UP TO INCLUDING 2"	DIAMETER + $\frac{1}{2}$"
OVER 2"	DIAMETER + 1"

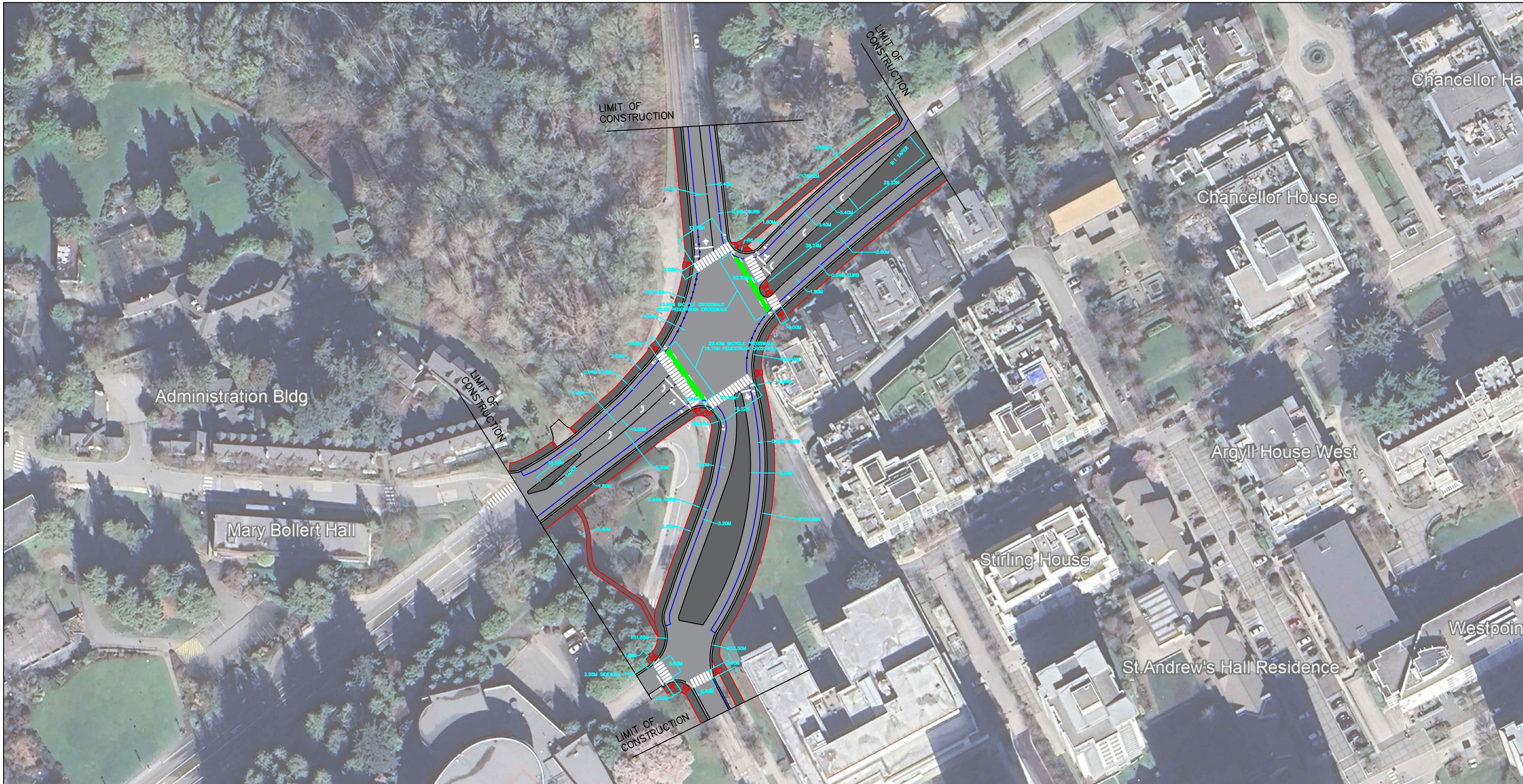
19. PROVIDE MINIMUM L2x2x$\frac{3}{16}$" TRIMMER ANGLE (U.N.O. ON DRAWING) FOR STEEL DECK SUPPORT TYPICAL AROUND PERIMETER OF BUILDING, WELDED TO OWSJ AND/OR STEEL BEAM.

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

DRAWING PACKAGE – ISSUED FOR CONSTRUCTION



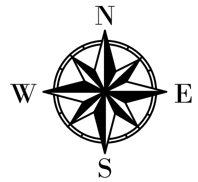
URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07 / REV: A / PAPER: B / 11x17 / SCALE: NTS	TITLE: PLAN VIEW / DRAWN: HG, ES, HL / CHECKED: HG / UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	DRAWING SHEET: S-001



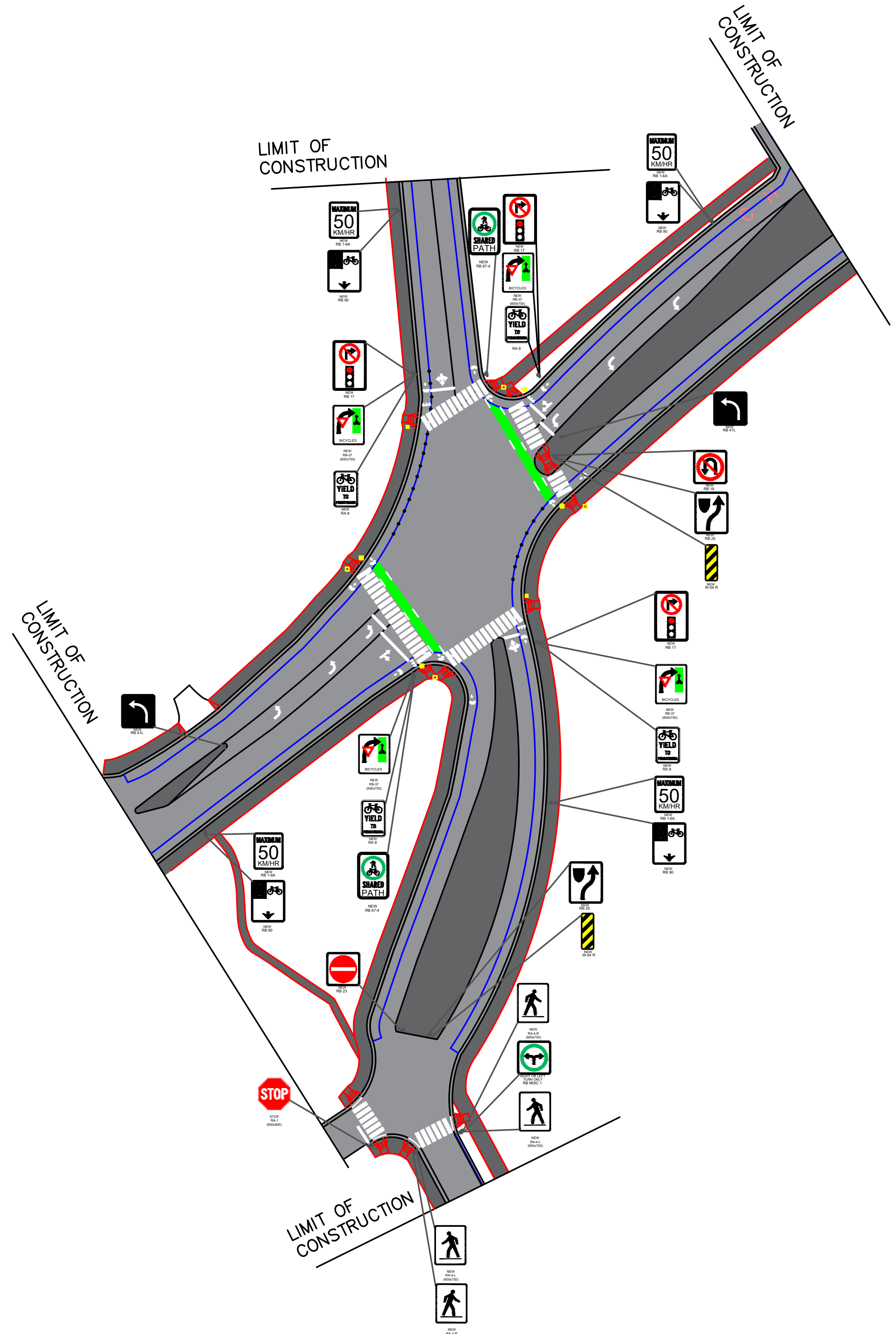
URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07	REV: A	TITLE: OVERVIEW OF KEY DESIGN ELEMENTS	DRAWN: HG, ES, HL	DRAWING SHEET: S-002
			PAPER: B / 11x17	SCALE: NTS	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG	

CONSTRUCTION NOTES:

PAVEMENT MARKINGS AND SIGNS TO FOLLOW BC ACTIVE TRANSPORTATION DESIGN GUIDE AND BC MOTT MANUAL OF STANDARD TRAFFIC SIGNS & PAVEMENT MARKINGS GUIDELINES.



LEGEND	
	TRAFFIC SIGNAL
	PUSH BUTTON
	NEW SIGNPOST



URBAN FLOW

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-06

REV: A

PAPER: B / 11x17

SCALE: VARIES

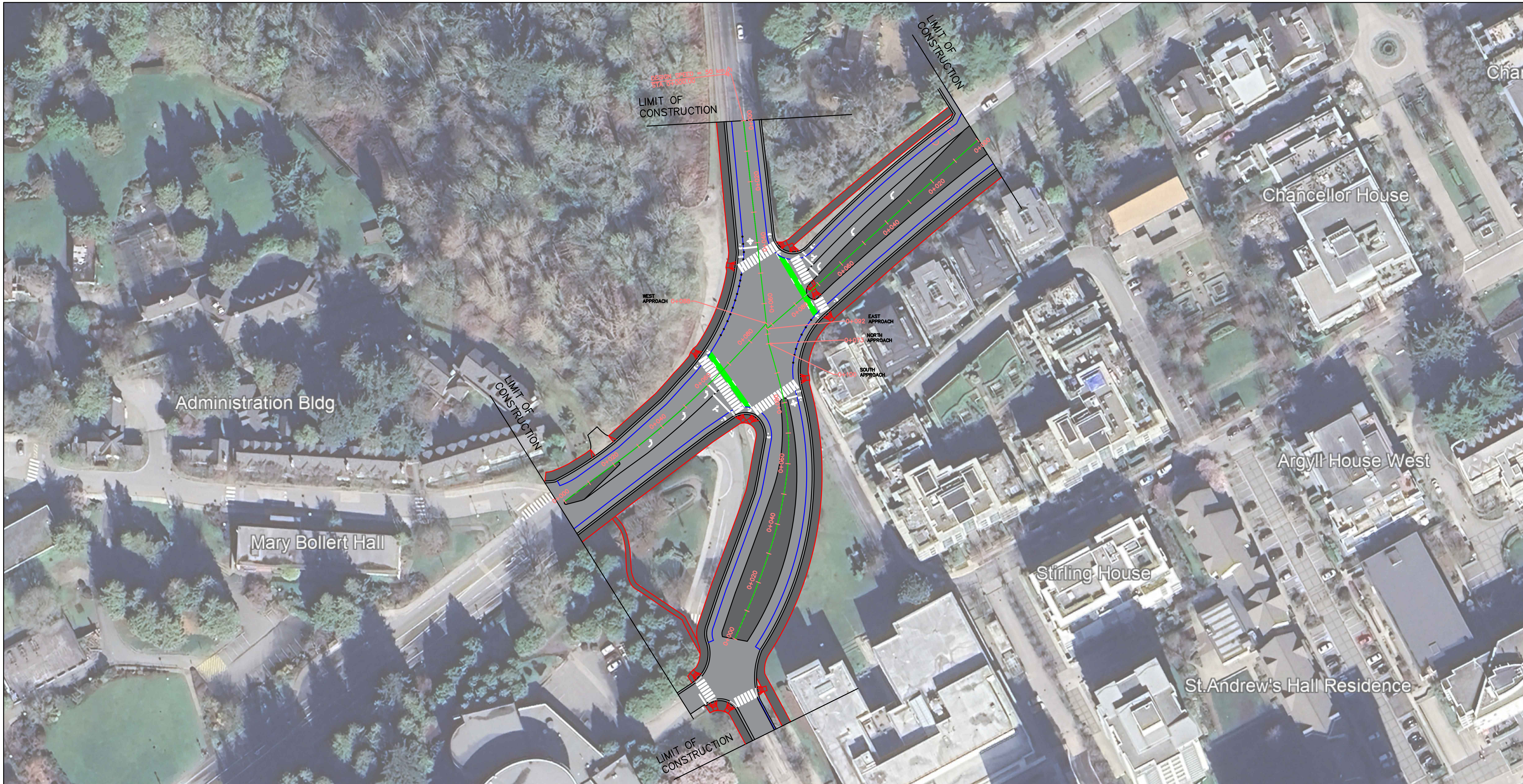
TITLE: SIGNAGE PLAN

DRAWN: ES

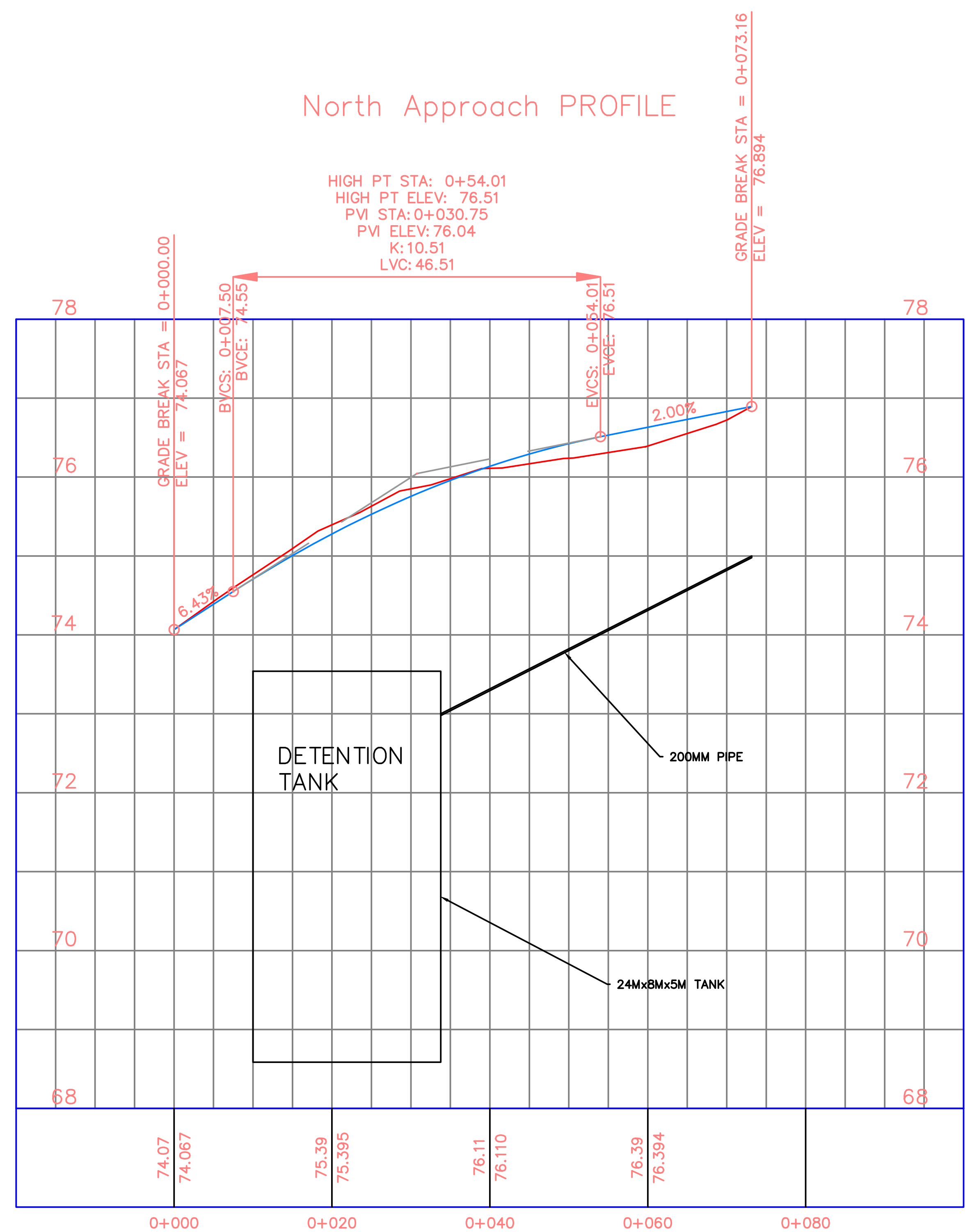
CHECKED: HL

UBC CAMPUS + COMMUNITY PLANNING
CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-003

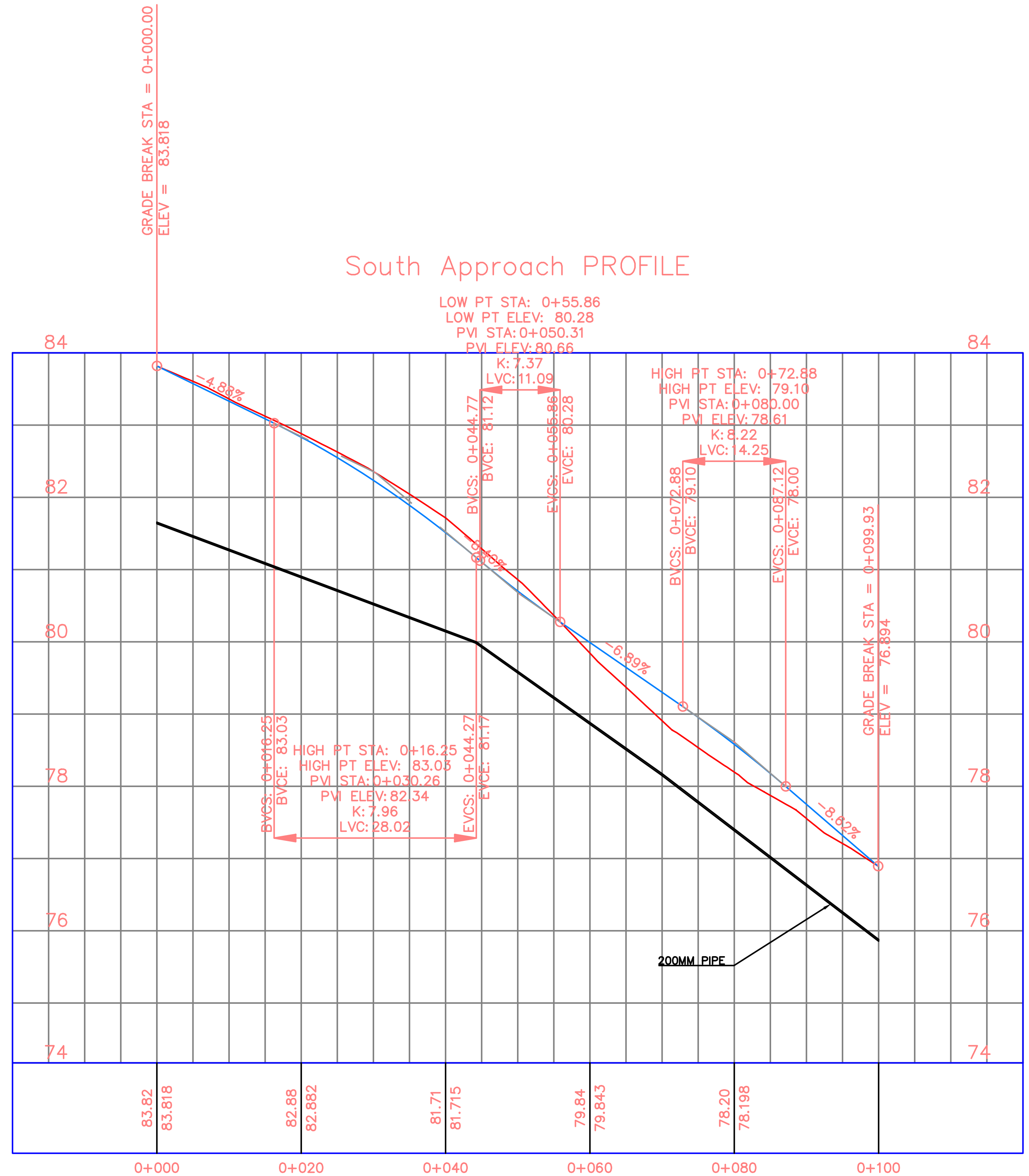


URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07	REV: A	TITLE: PROPOSED HORIZONTAL ALIGNMENTS	DRAWN: HL	DRAWING SHEET: S-004
			PAPER: B / 11x17	SCALE: NTS	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG	



URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07 / REV: A / PAPER: B / 11x17 / SCALE: VARIES	TITLE: NORTH PROFILE / DRAWN: HL,RS / CHECKED: HG	DRAWING SHEET: S-005

UBC CAMPUS + COMMUNITY PLANNING
CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4



URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07	REV: A
			PAPER: B / 11x17	SCALE: NTS

TITLE: SOUTH PROFILE

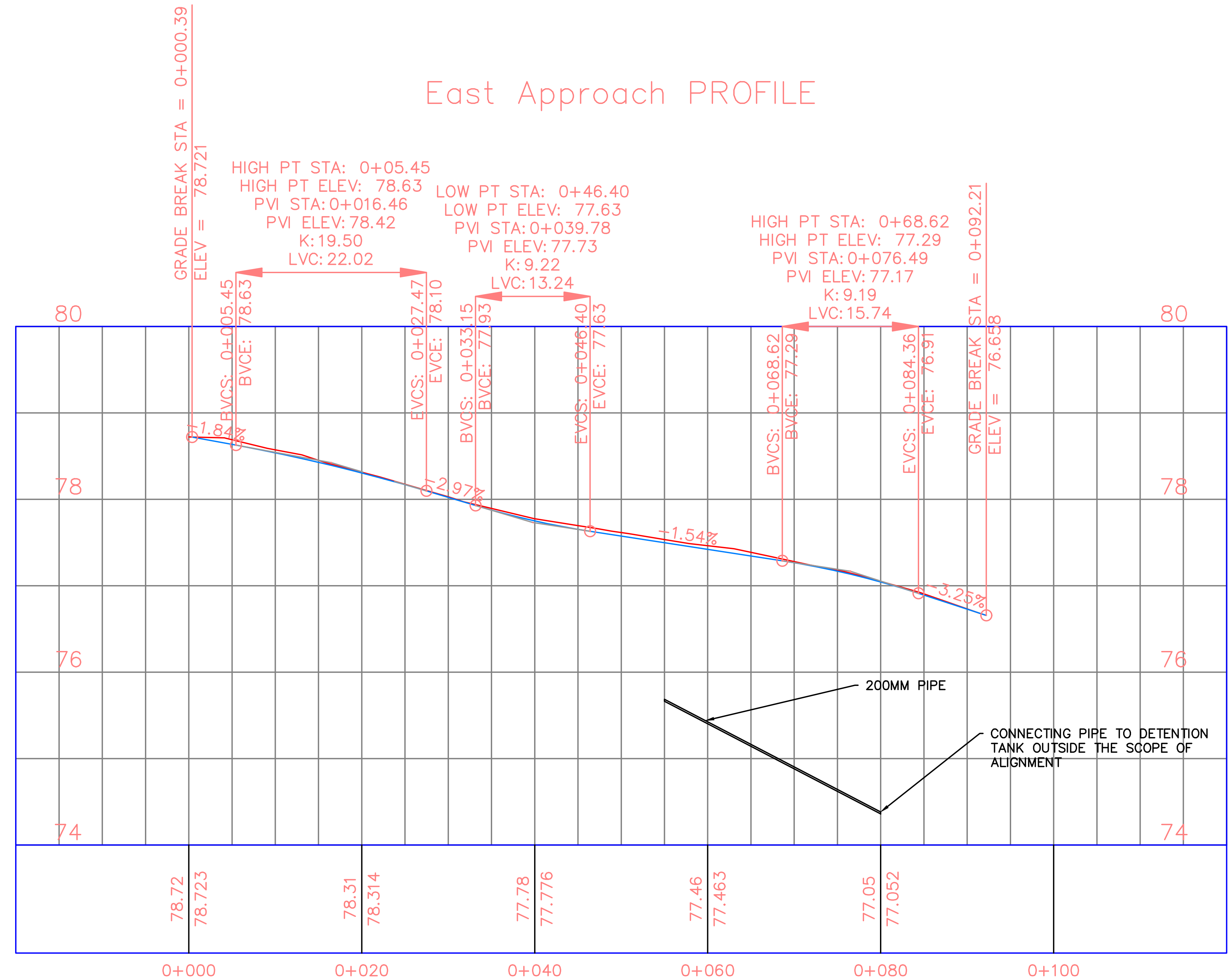
DRAWN: HL

CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING

CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-006



URBAN FLOW

CLIENT:

UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-07

REV: A

PAPER: B / 11x17

SCALE: VARIES

TITLE: EAST PROFILE

DRAWN: HL

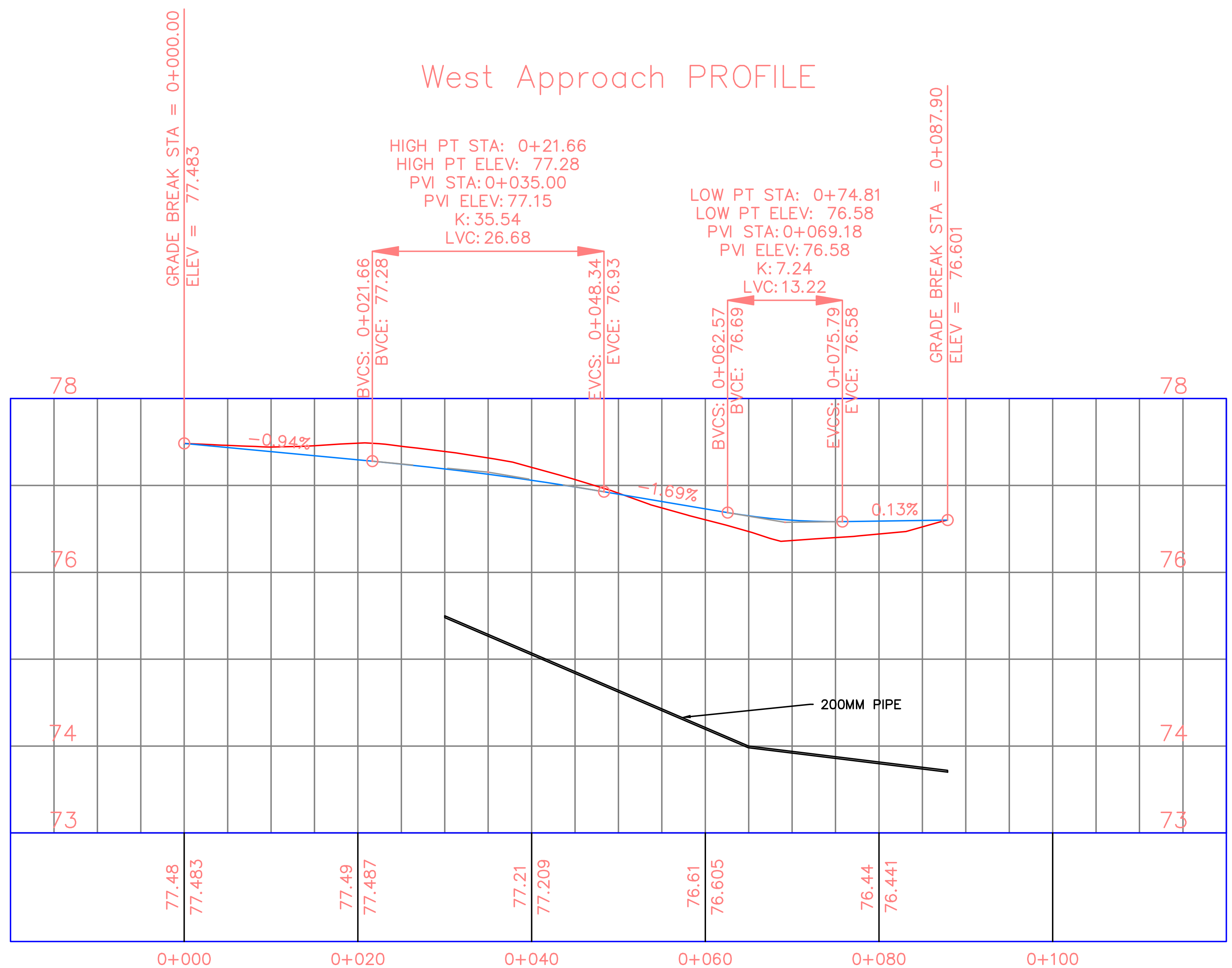
CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING

CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-007

West Approach PROFILE



URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07	REV: A	TITLE: WEST PROFILE	DRAWN: HL
			PAPER: B / 11x17	SCALE: VARIES	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG

DRAWING SHEET: **S-008**

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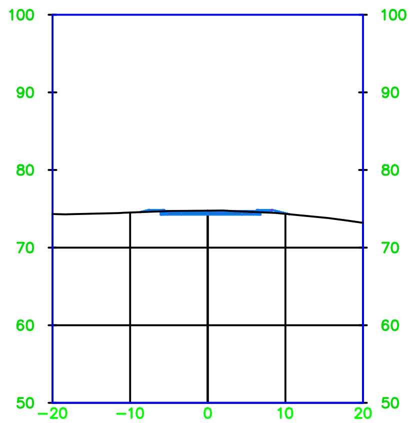

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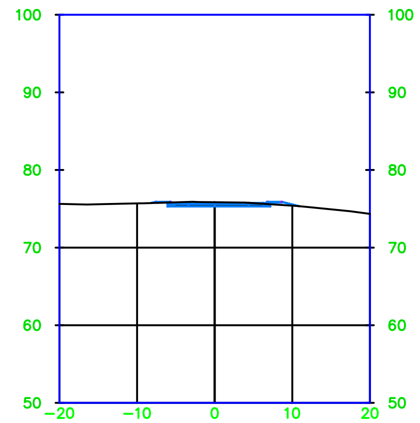

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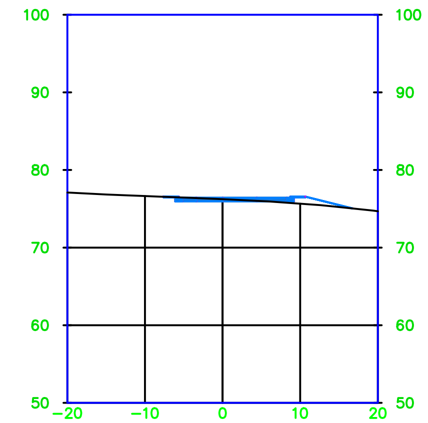

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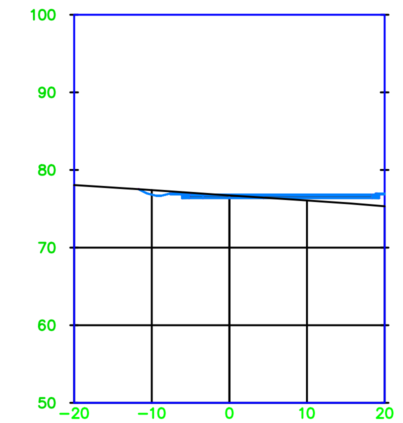

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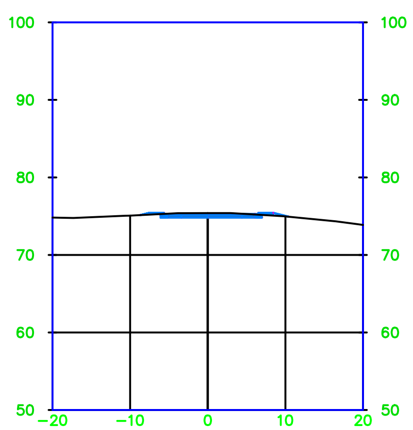

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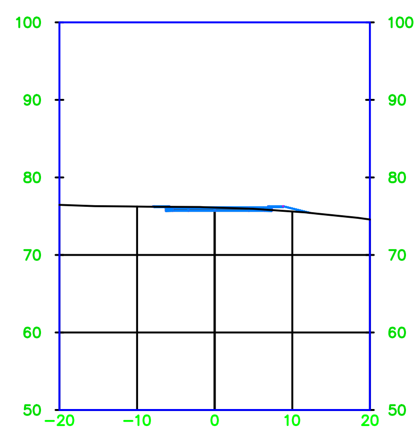

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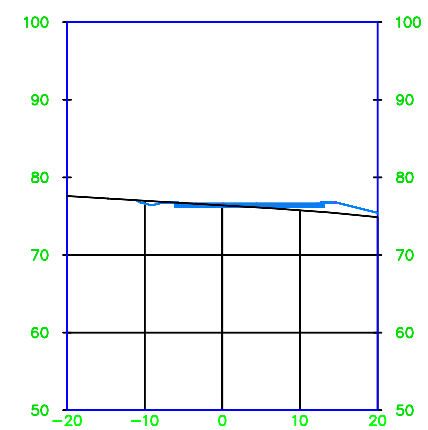


URBAN FLOW

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-07

REV: A

PAPER: B / 11x17

SCALE: VARIES

TITLE: NORTH CROSS SECTION

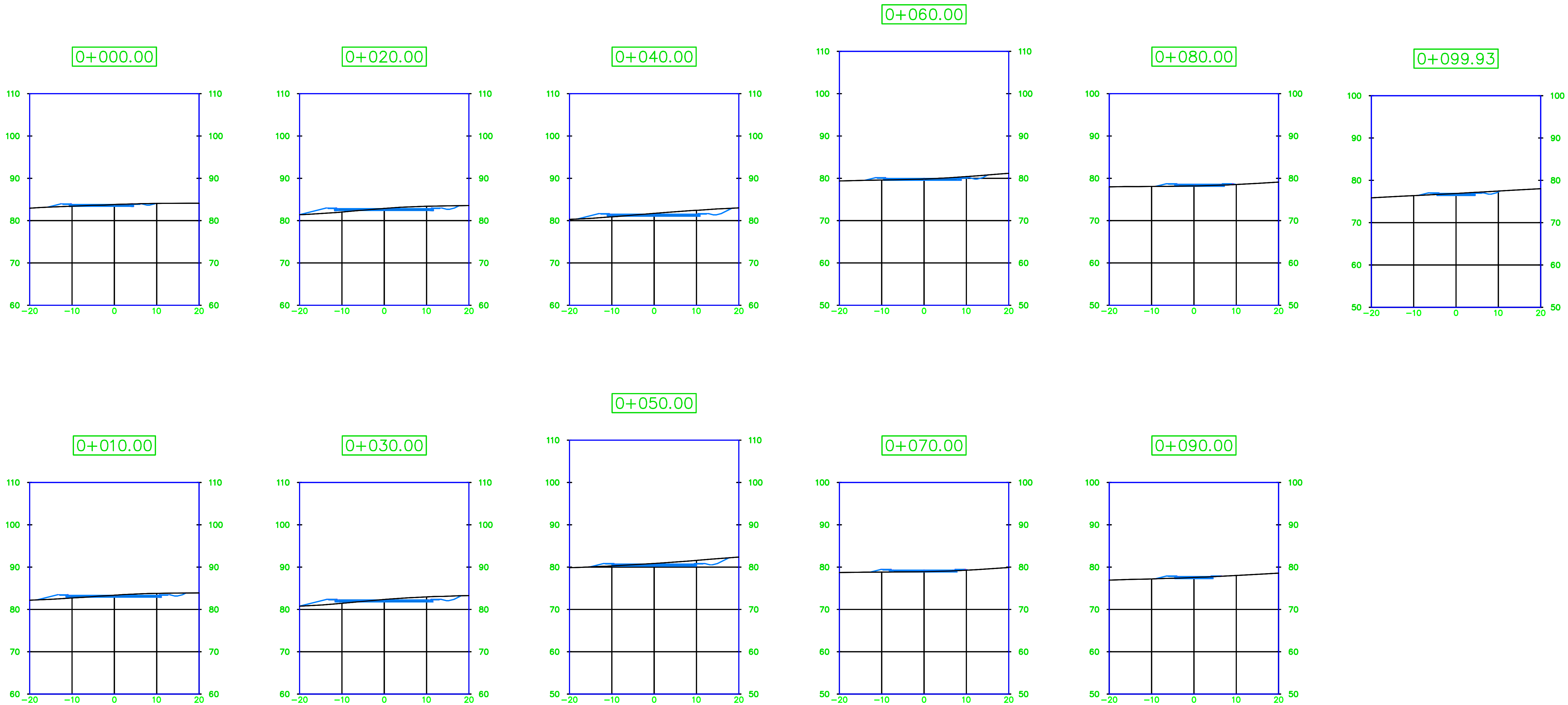
DRAWN: HL,RS

CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING

CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-009



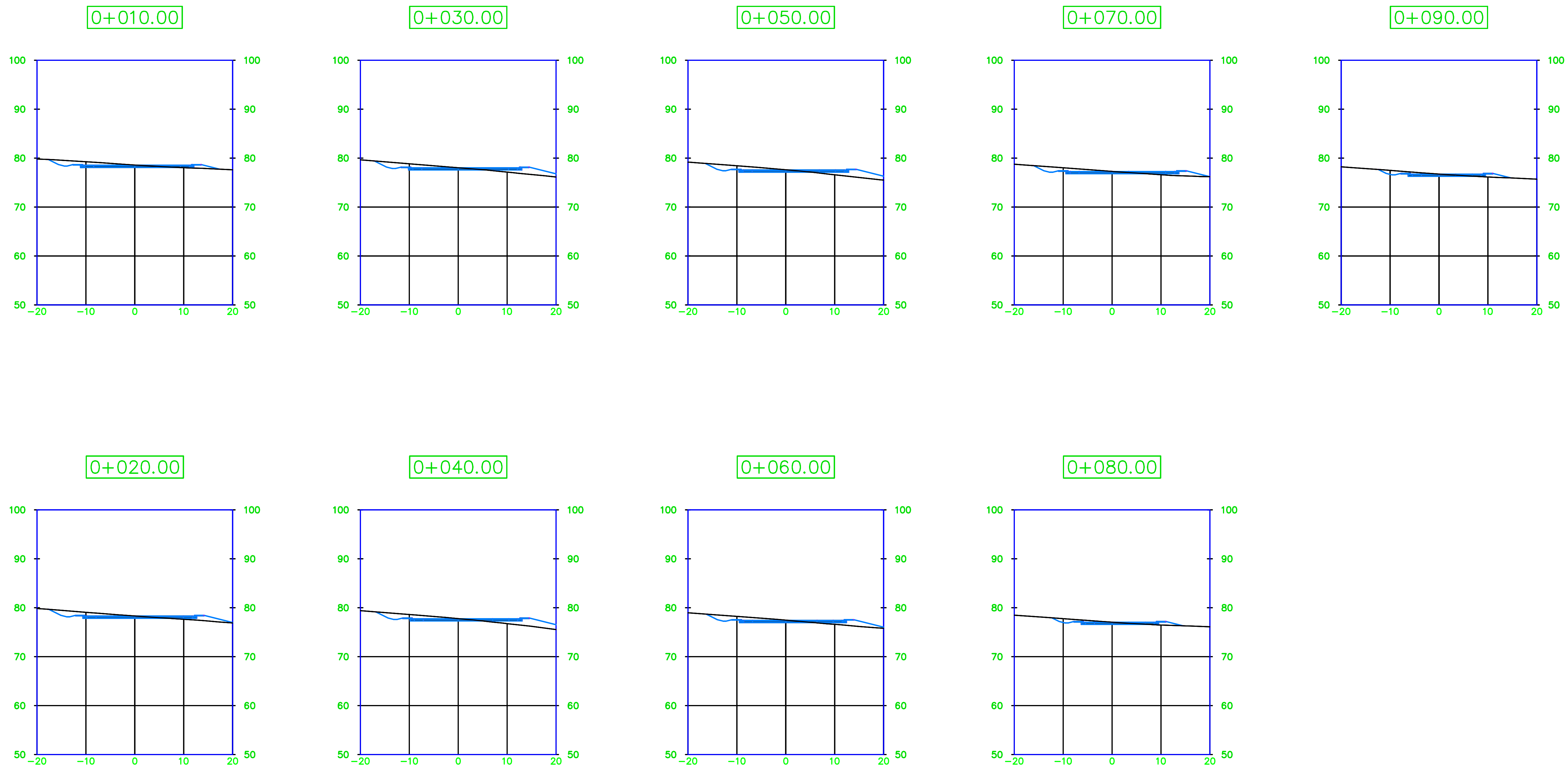
URBAN FLOW

CLIENT:

UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE:	REV:	TITLE:	DRAWN:	DRAWING SHEET:
2025-04-07	A	SOUTH CROSS SECTIONS	HL	S-010
PAPER: B / 11x17	SCALE: VARIES	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG	



URBAN FLOW

CLIENT:

UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-07

REV: A

PAPER: B / 11x17

SCALE: VARIES

TITLE: EAST CROSS SECTIONS

DRAWN: HL

CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING

CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-011

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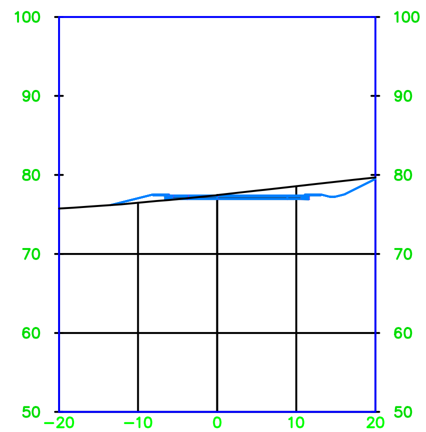

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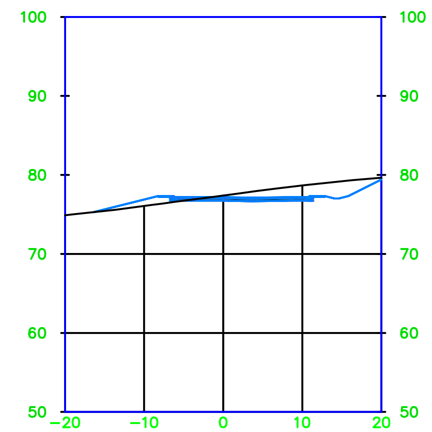

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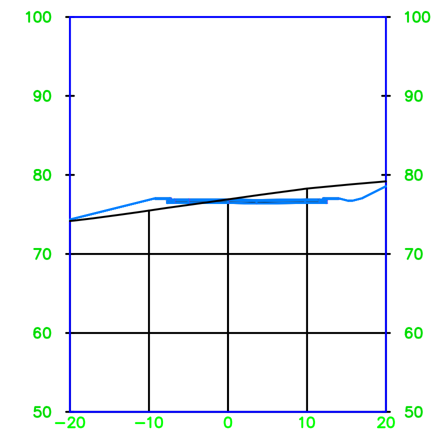

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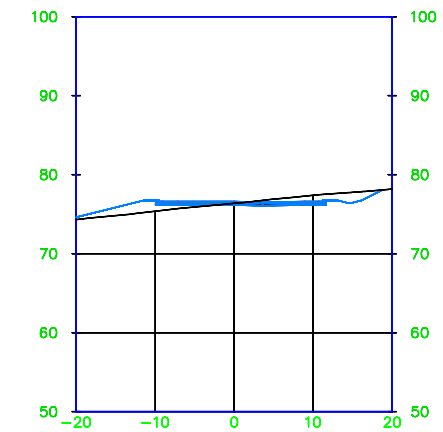

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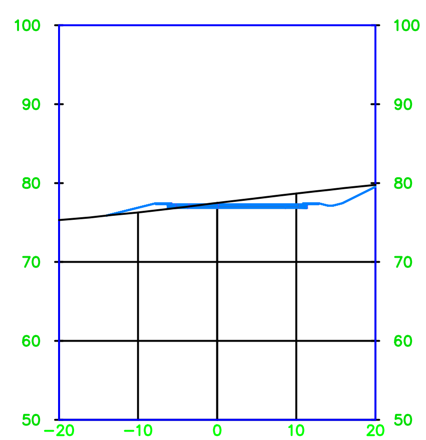

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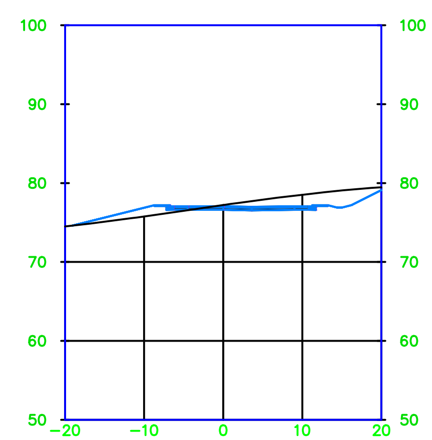

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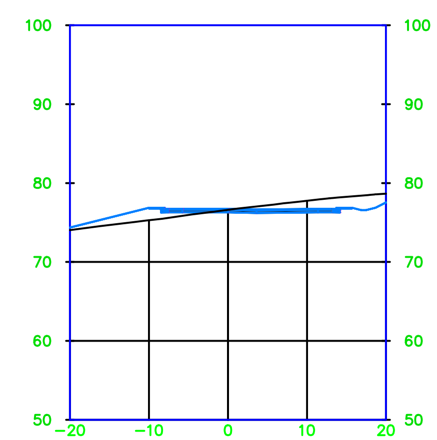

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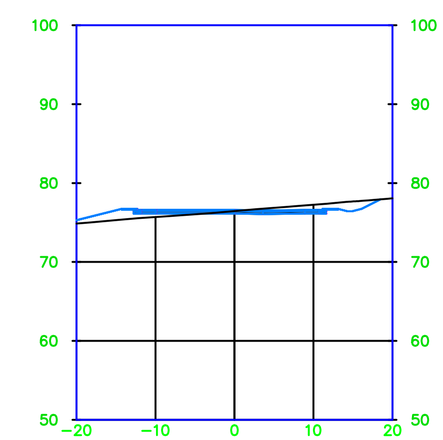


URBAN FLOW

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-07

REV: A

PAPER: B / 11x17

SCALE: VARIES

TITLE: WEST CROSS SECTIONS

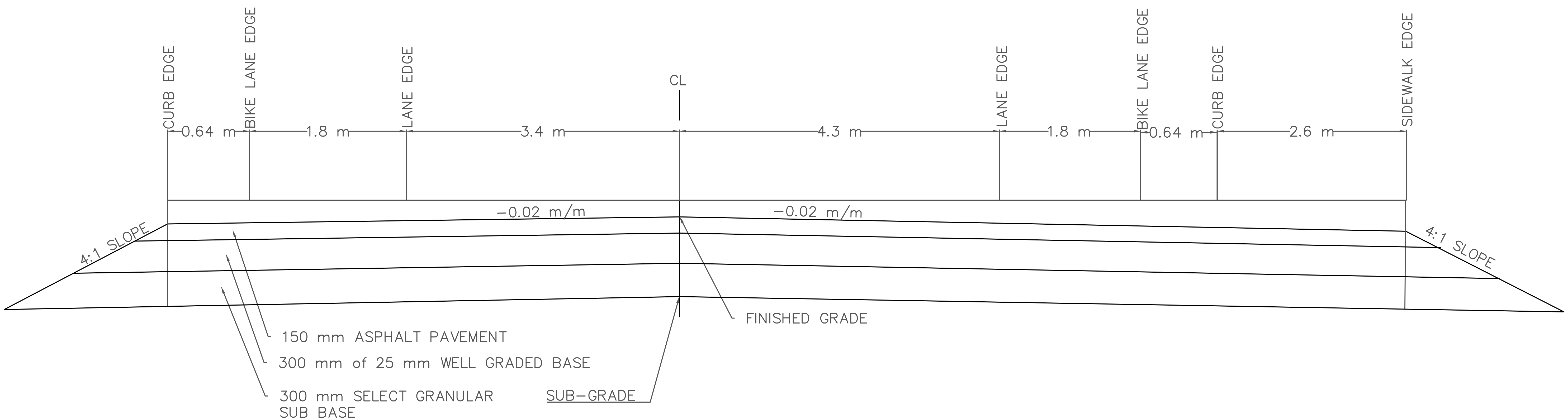
DRAWN: HL

CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING
CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-012

NORTH APPROACH

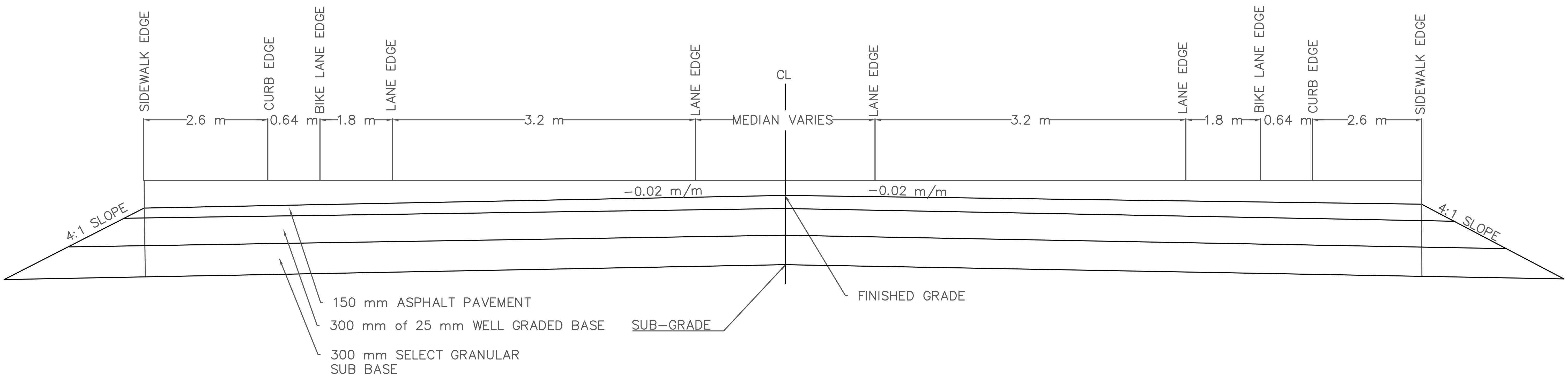


TYPICAL SECTION: NW MARINE DRIVE
0+000 to 0+073

URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-06	REV: A
			PAPER: B / 11x17	SCALE: VARIES

TITLE: TYPICAL CROSS SECTIONS	DRAWN: HG	DRAWING SHEET: S-013
	CHECKED: HL	
UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4		

SOUTH APPROACH



TYPICAL SECTION: EAST MALL
0+000 to 0+028

URBAN FLOW

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND
EAST MALL INTERSECTION
REDESIGN

DATE: 2025-04-06
REV: A
PAPER: B / 11x17
SCALE: VARIES

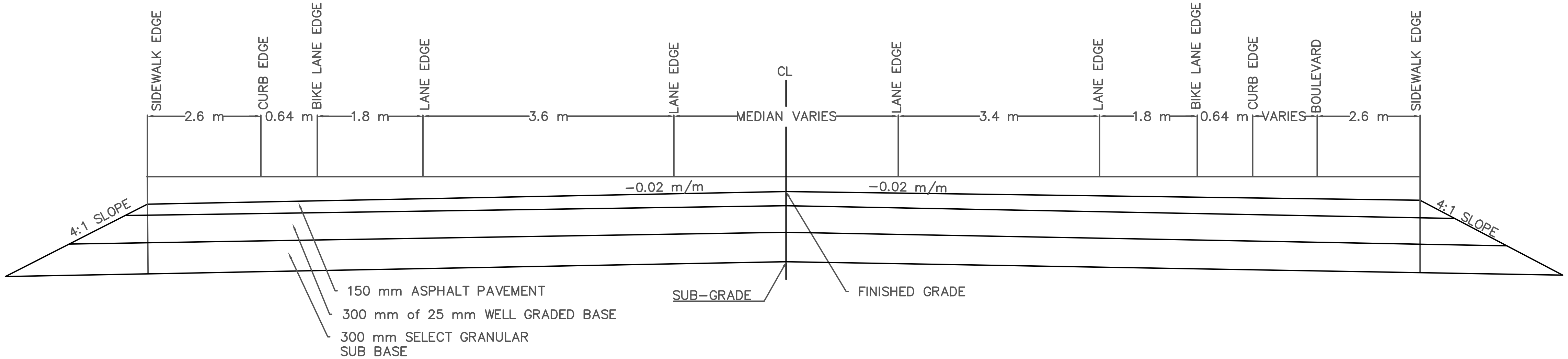
TITLE: TYPICAL CROSS SECTIONS

DRAWN: HG
CHECKED: HL

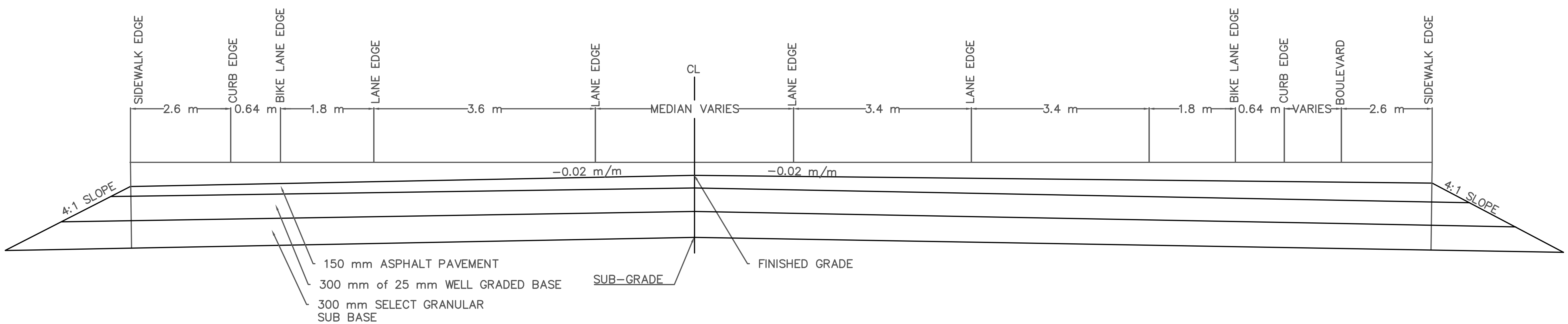
UBC CAMPUS + COMMUNITY PLANNING
CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-014

EAST APPROACH



TYPICAL SECTION: CHANCELLOR BOULEVARD
0+000 to 0+031



TYPICAL SECTION: CHANCELLOR BOULEVARD
0+031 to 0+092

URBAN FLOW

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE: 2025-04-06

REV: A

PAPER: B / 11x17

SCALE: VARIES

TITLE: TYPICAL CROSS SECTIONS

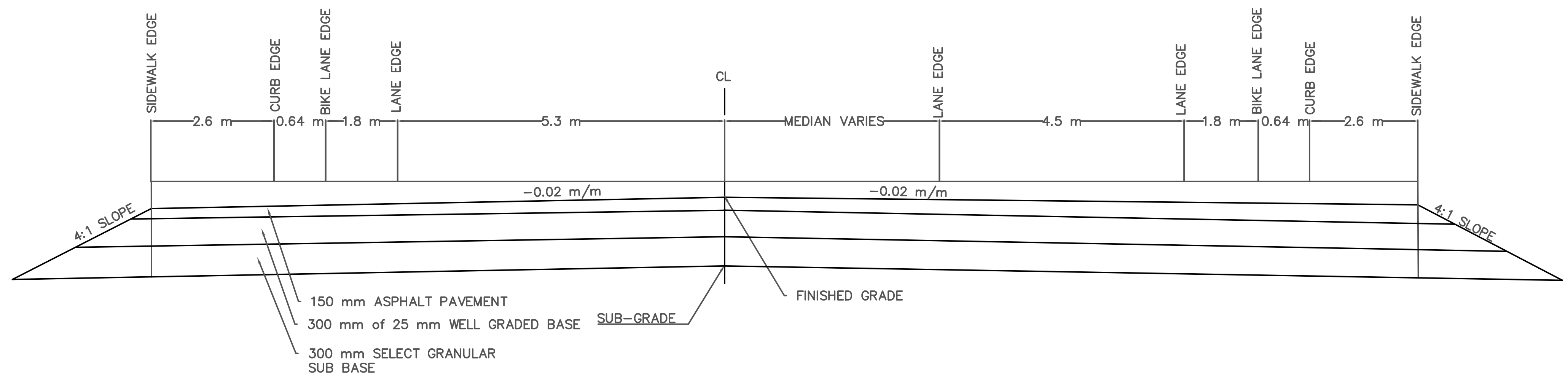
DRAWN: HG

CHECKED: HL

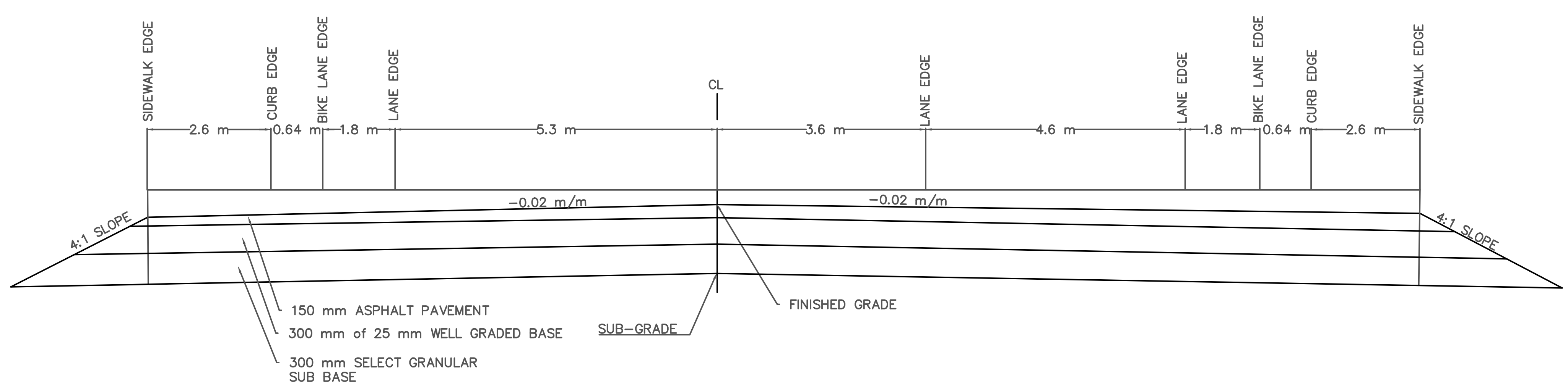
UBC CAMPUS + COMMUNITY PLANNING
CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET: S-015

WEST APPROACH

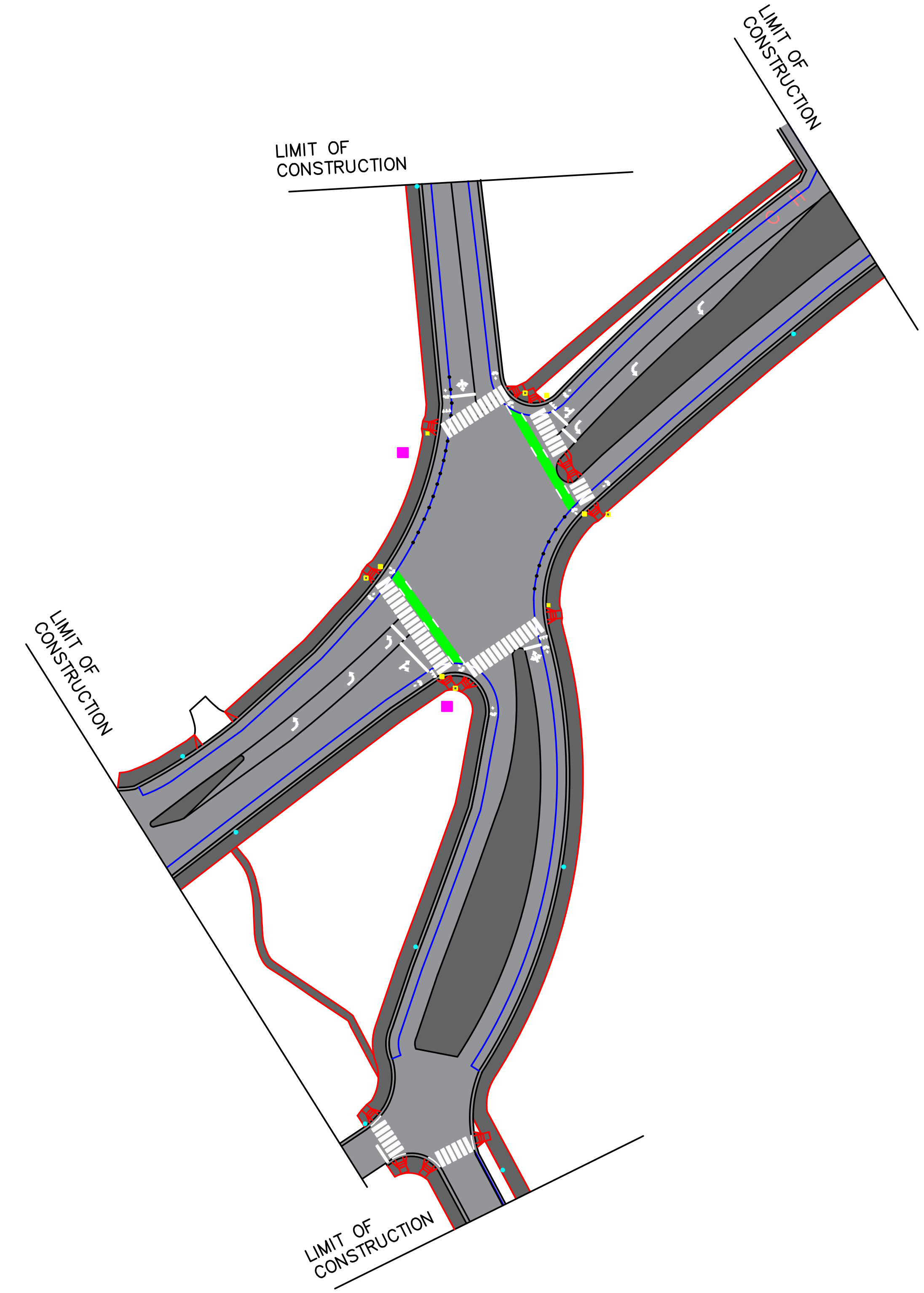


TYPICAL SECTION: NW MARINE DRIVE
0+000 to 0+021



TYPICAL SECTION: NW MARINE DRIVE
0+021 to 0+088

URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-06 / REV: A / PAPER: B / 11x17 / SCALE: VARIES	TITLE: TYPICAL CROSS SECTIONS / DRAWN: HG / CHECKED: HL / UBC CAMPUS + COMMUNITY PLANNING, CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	DRAWING SHEET: S-016

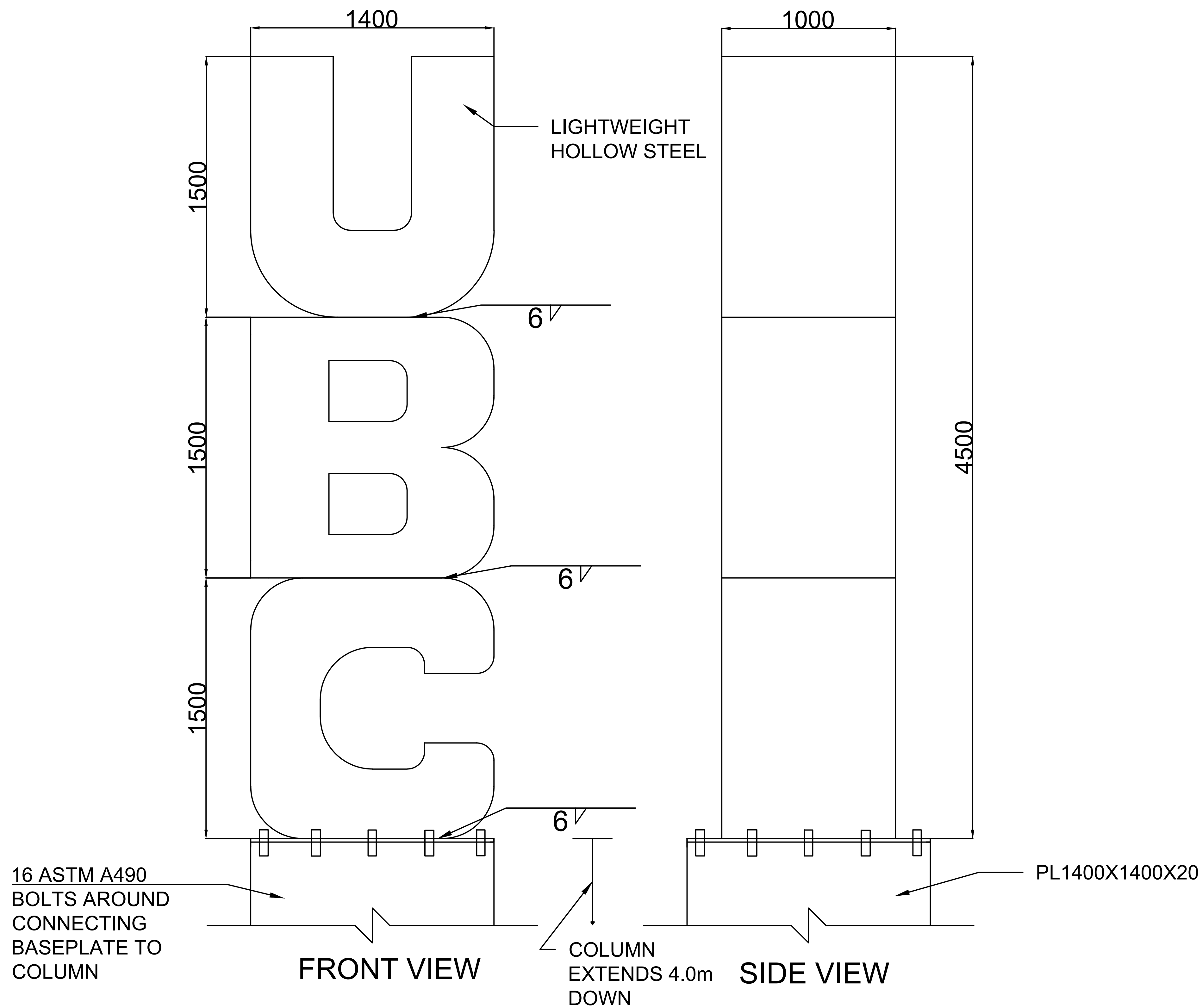


LEGEND	
(cyan circle)	STREETLIGHT
(magenta square)	ELEC. UTILITY

URBAN FLOW

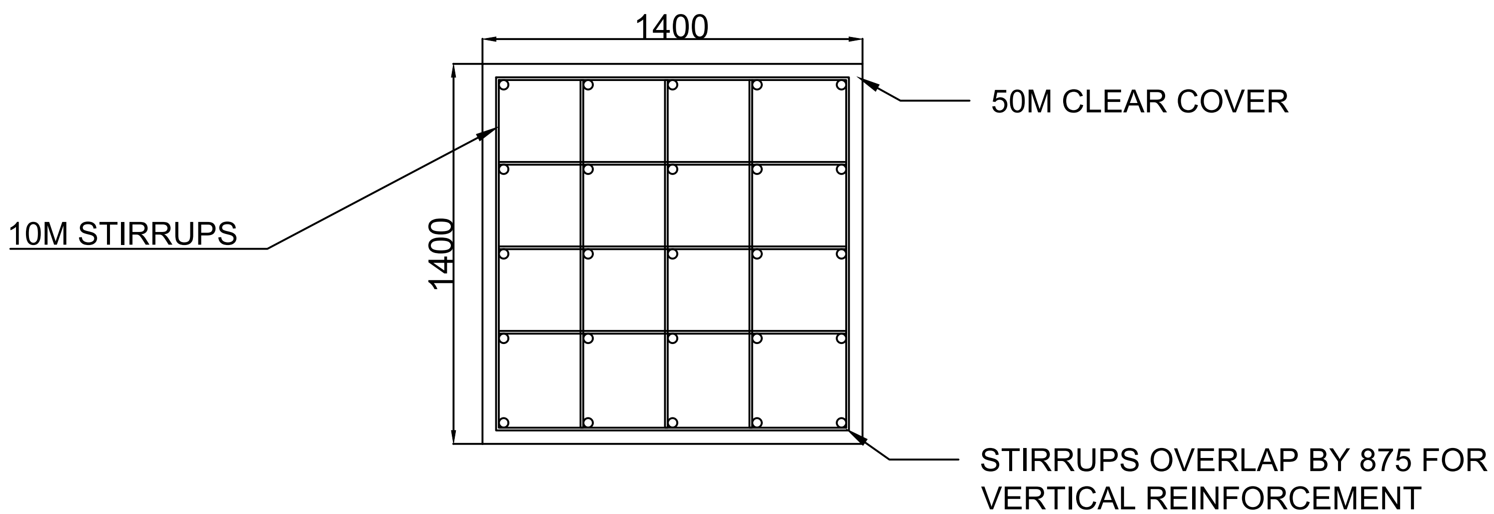
CLIENT:		DATE:	REV:	TITLE:	DRAWN:	DRAWING SHEET:
UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	2025-04-07	A	ELECTRICAL PLAN	ES	S-017
		PAPER: B / 11x17	SCALE: NTS	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG, HL	

NOTE:
- ALL DIMENSIONS IN MILLIMETERS
- FULLY WELD AROUND LETTERS

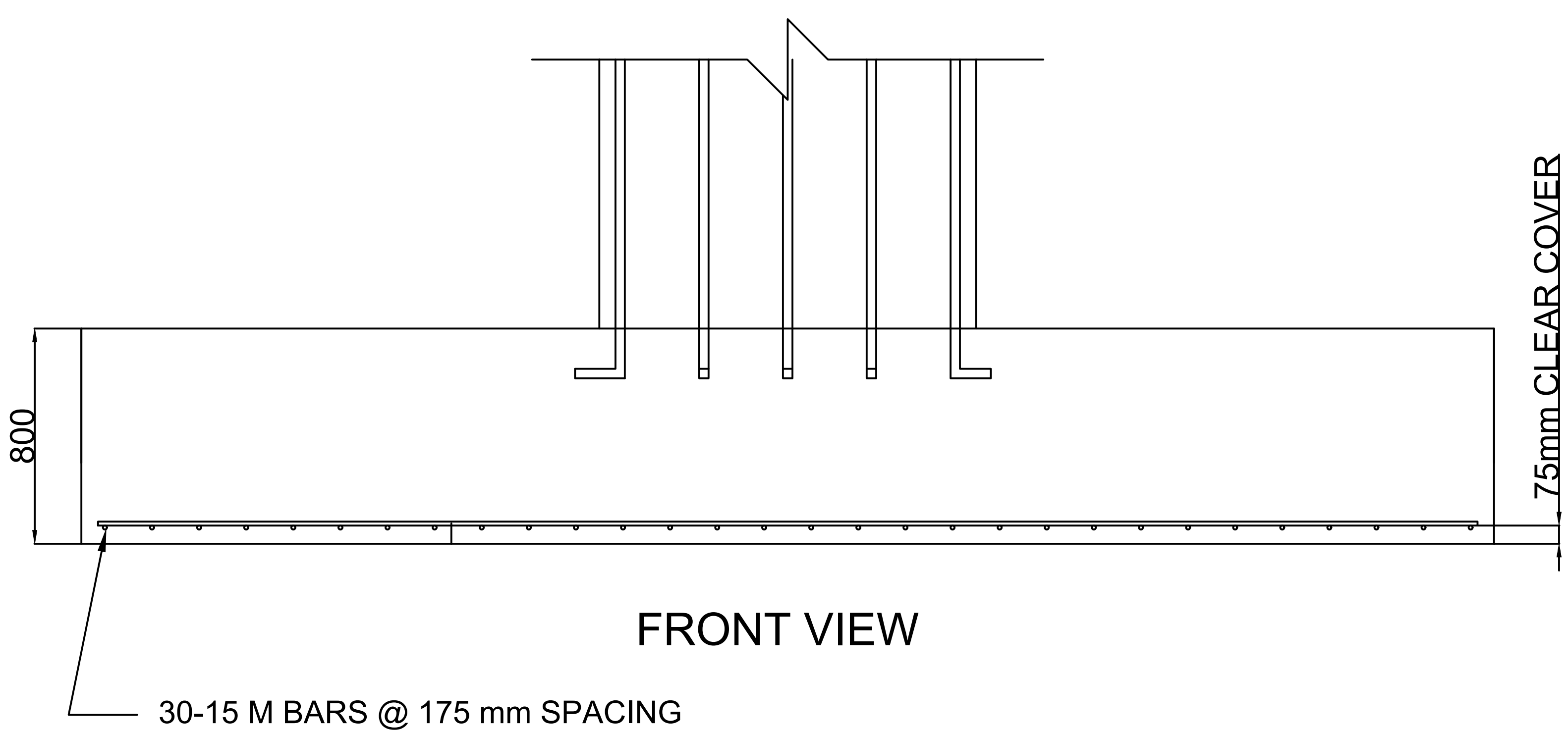


URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-06	REV: A	TITLE: GATEWAY SIGN DESIGN	DRAWN: JP,HG
			PAPER: B / 11x17	SCALE: VARIES	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG
						DRAWING SHEET: S-018

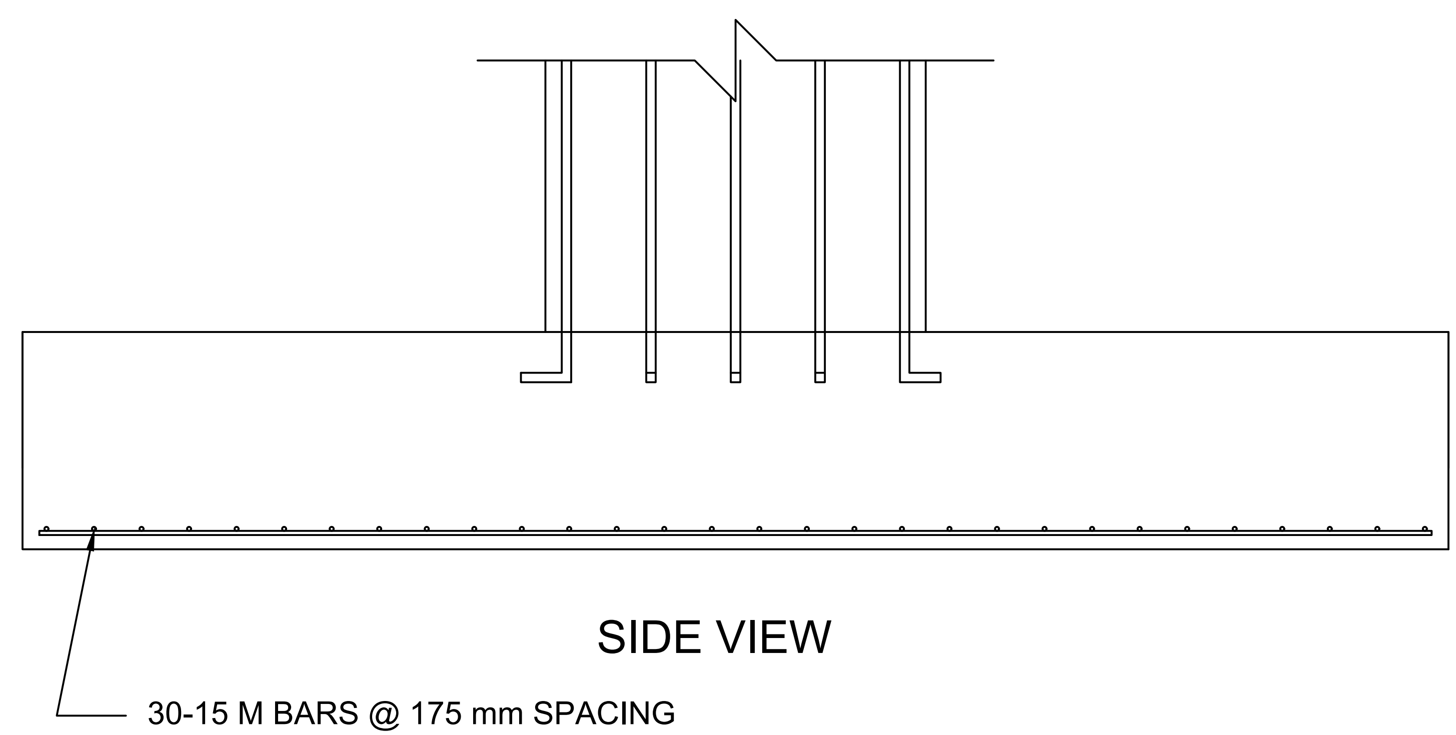
NOTE: ALL DIMENSIONS IN MILLIMETERS



TOP VIEW



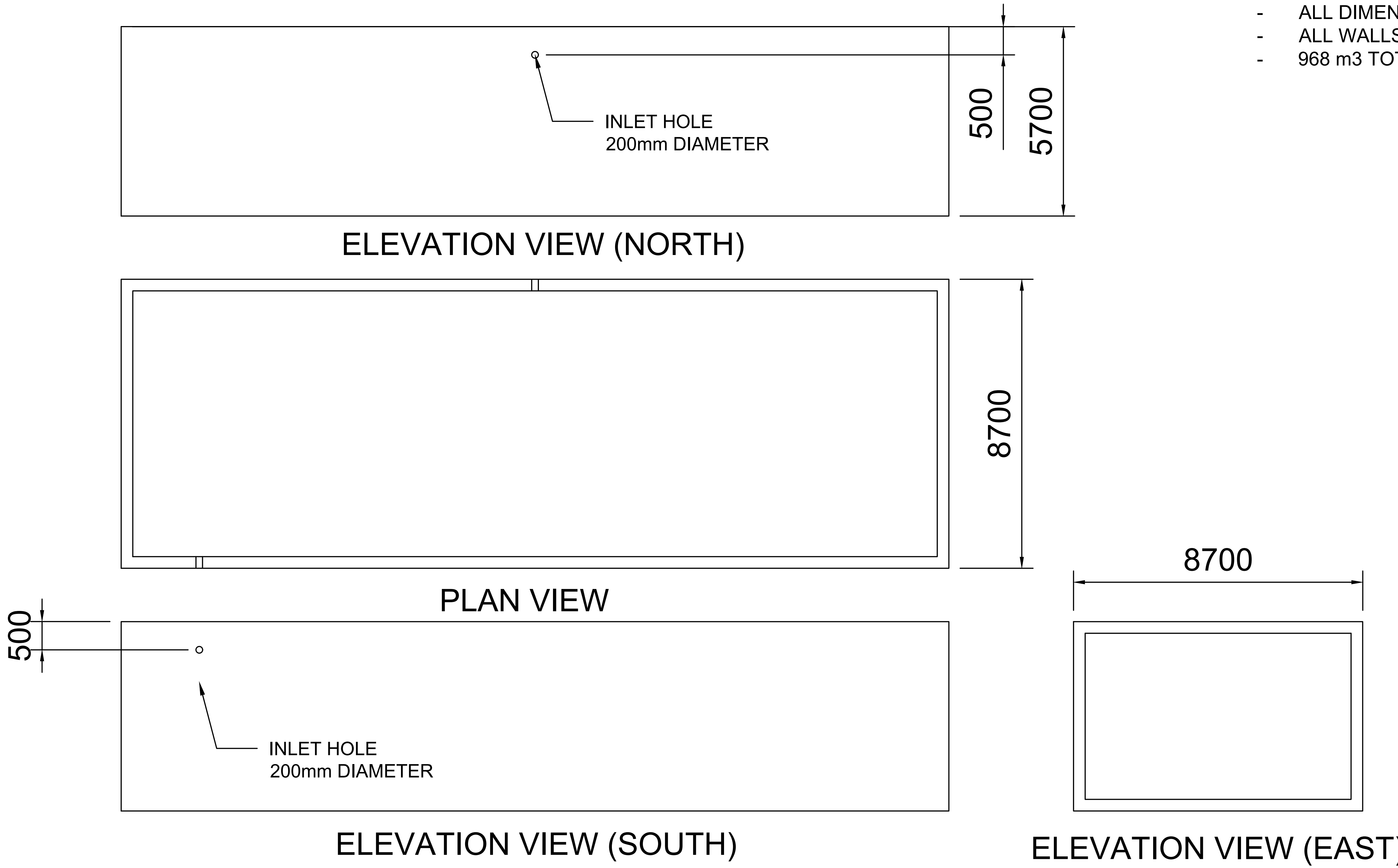
FRONT VIEW



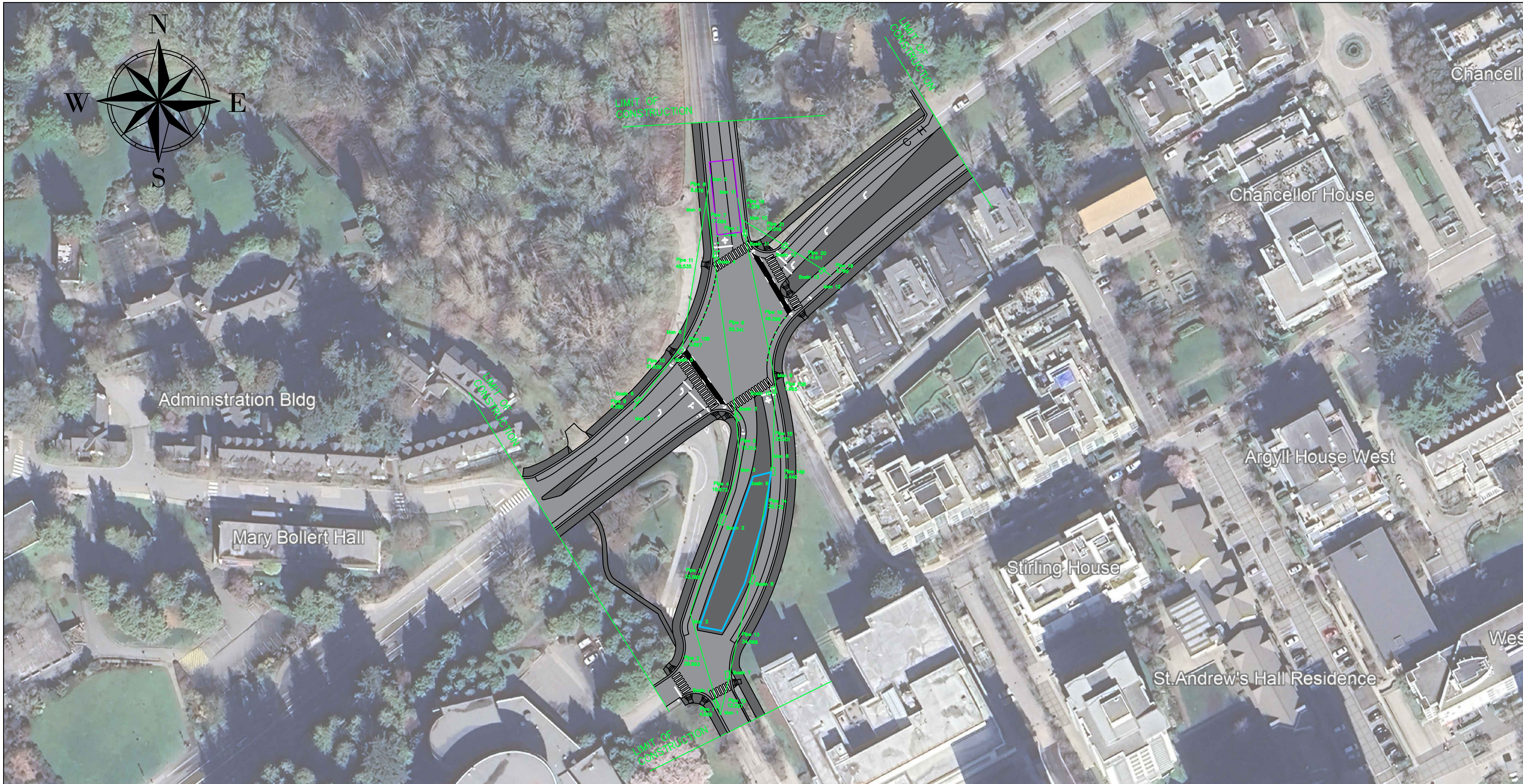
SIDE VIEW

URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-06	REV: A	TITLE: SLAB DESIGN	DRAWN: JP,HG
			PAPER: B / 11x17	SCALE: VARIES	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG
						DRAWING SHEET: S-019

NOTE:
- ALL DIMENSIONS IN MILLIMETERS
- ALL WALLS ARE 350MM THICK
- 968 m3 TOTAL VOLUME



URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: YYYY-MM-DD	REV: A	TITLE: DETENTION TANK	DRAWN: JP, HG
			PAPER: B / 11x17	SCALE: VARIES	UBC CAMPUS + COMMUNITY PLANNING CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	CHECKED: HG
						DRAWING SHEET: S-020



URBAN FLOW

CLIENT:

UBC CAMPUS AND COMMUNITY PLANNING

CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN

DATE:	REV:
2025-04-07	A

PAPER:	SCALE:
B / 11x17	NTS

TITLE:

STORMWATER PLAN

DRAWN: RL, HG

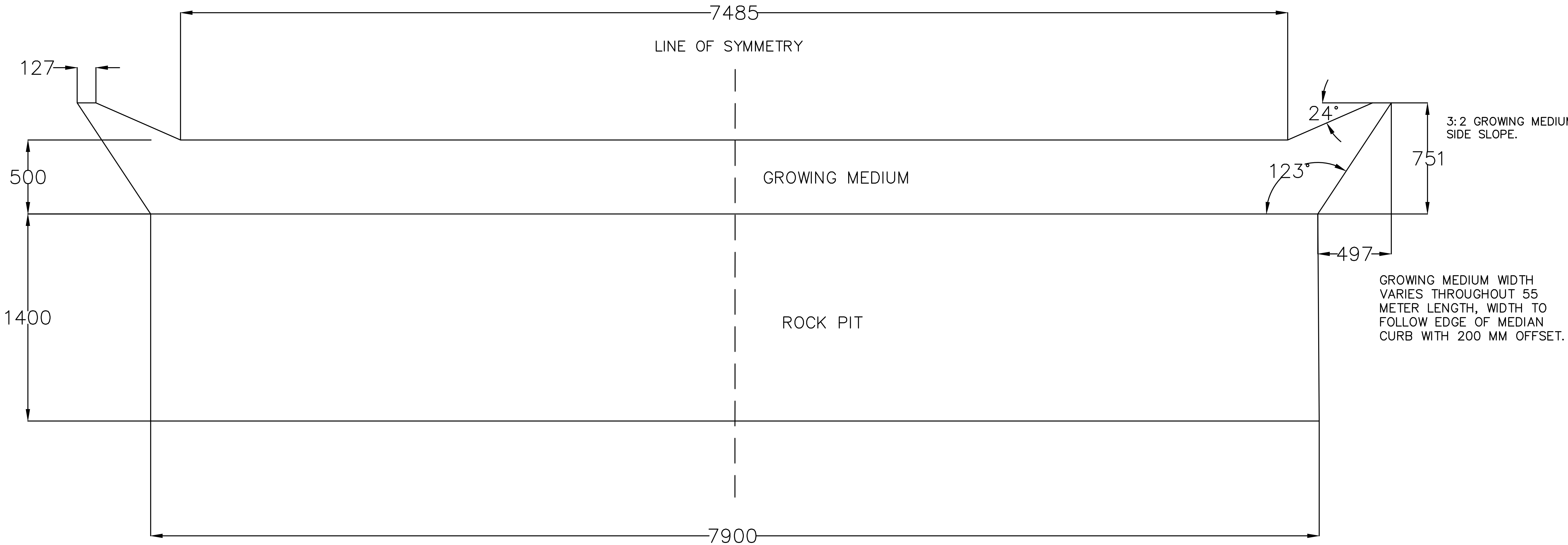
CHECKED: HG

UBC CAMPUS + COMMUNITY PLANNING

CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4

DRAWING SHEET:

S-021



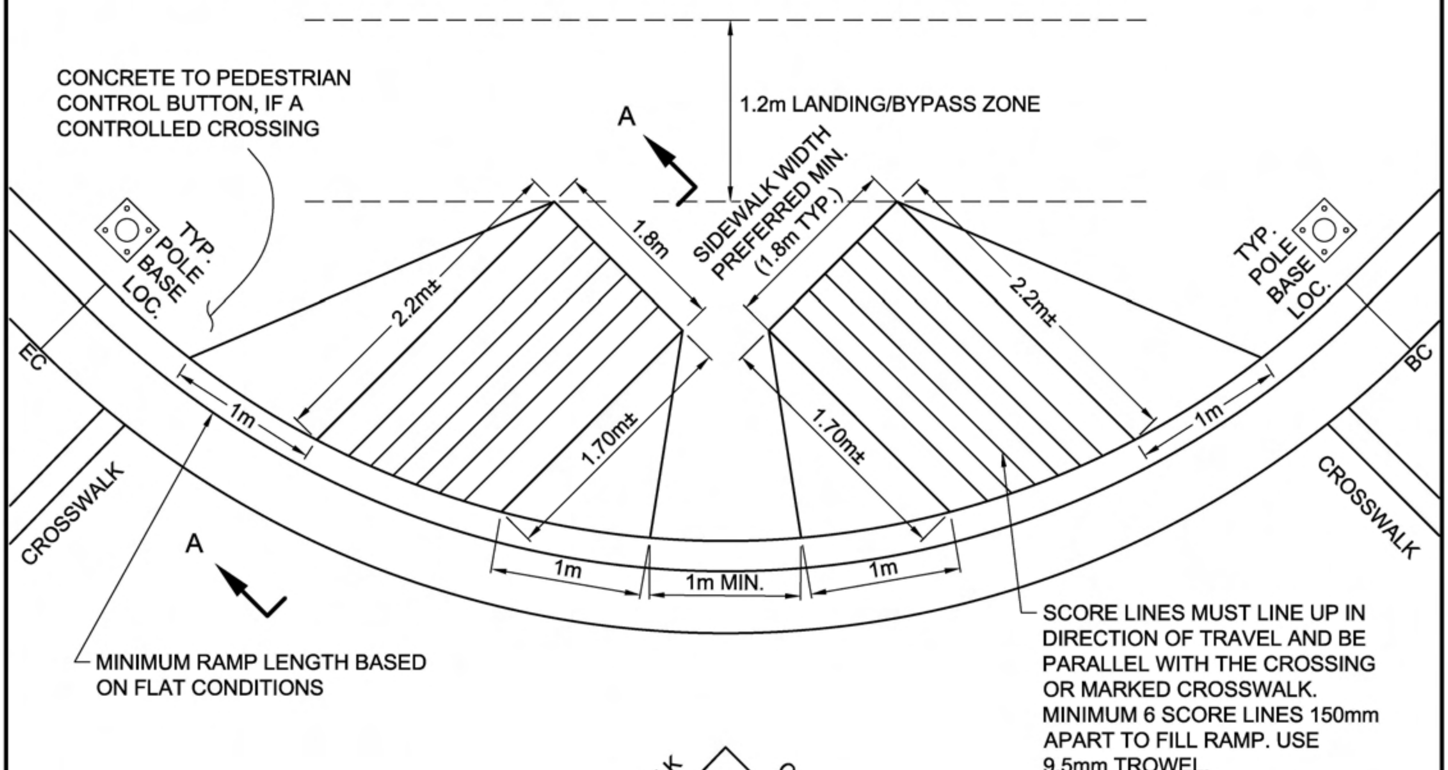
URBAN FLOW	CLIENT: UBC CAMPUS AND COMMUNITY PLANNING	CHANCELLOR BOULEVARD AND EAST MALL INTERSECTION REDESIGN	DATE: 2025-04-07 / REV: A / PAPER: B / 11x17 / SCALE: NTS	TITLE: RAIN GARDEN / DRAWN: RL, HG / CHECKED: HG / UBC CAMPUS + COMMUNITY PLANNING / CIRS, 2210 WEST MALL VANCOUVER, B.C., CANADA V6T 1Z4	DRAWING SHEET: S-022

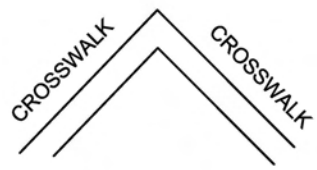
CITY OF VANCOUVER

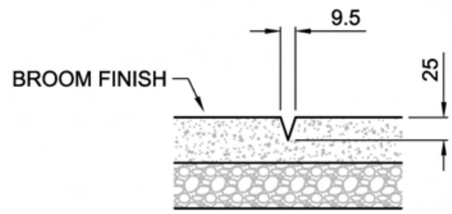
STANDARD DETAIL DRAWINGS

ENGINEERING SERVICES - VANCOUVER, B.C.

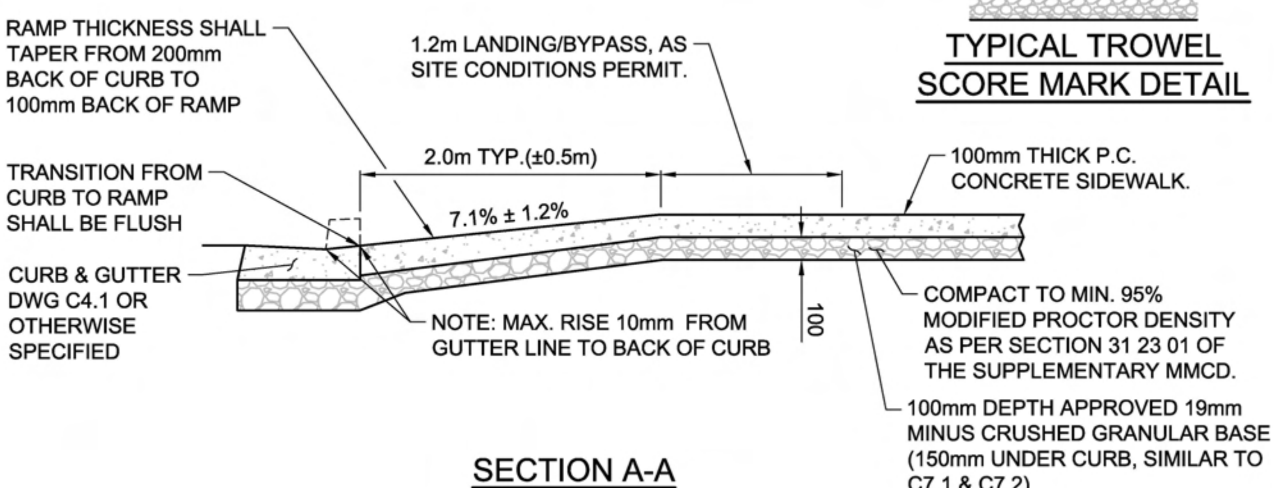
DRAWING No. **C8.1**







TYPICAL TROWEL SCORE MARK DETAIL



SECTION A-A
CURB RAMP

NOTES:

1. STANDARD RAMP LENGTH : 2.0m TYP.(±) AT CENTRE OF RAMP.
2. RECOMMENDED RAMP SLOPE: 7.1% ± 1.2%.
3. MAX. SLOPE 8.3% (1:12) WHERE TOPOGRAPHY PERMITS.
4. ADJUST LENGTH OF RAMP AS REQUIRED.
5. WHEN SITE CONDITIONS DO NOT PERMIT TYPICAL LAYOUT, CONTACT CITY ENGINEER FOR APPROVAL OF DESIGN.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

SCALE: N.T.S.

REV.	REVISION DATE	APPROVED

CURB RAMPS
DOUBLE CURB RAMP (PREFERRED)

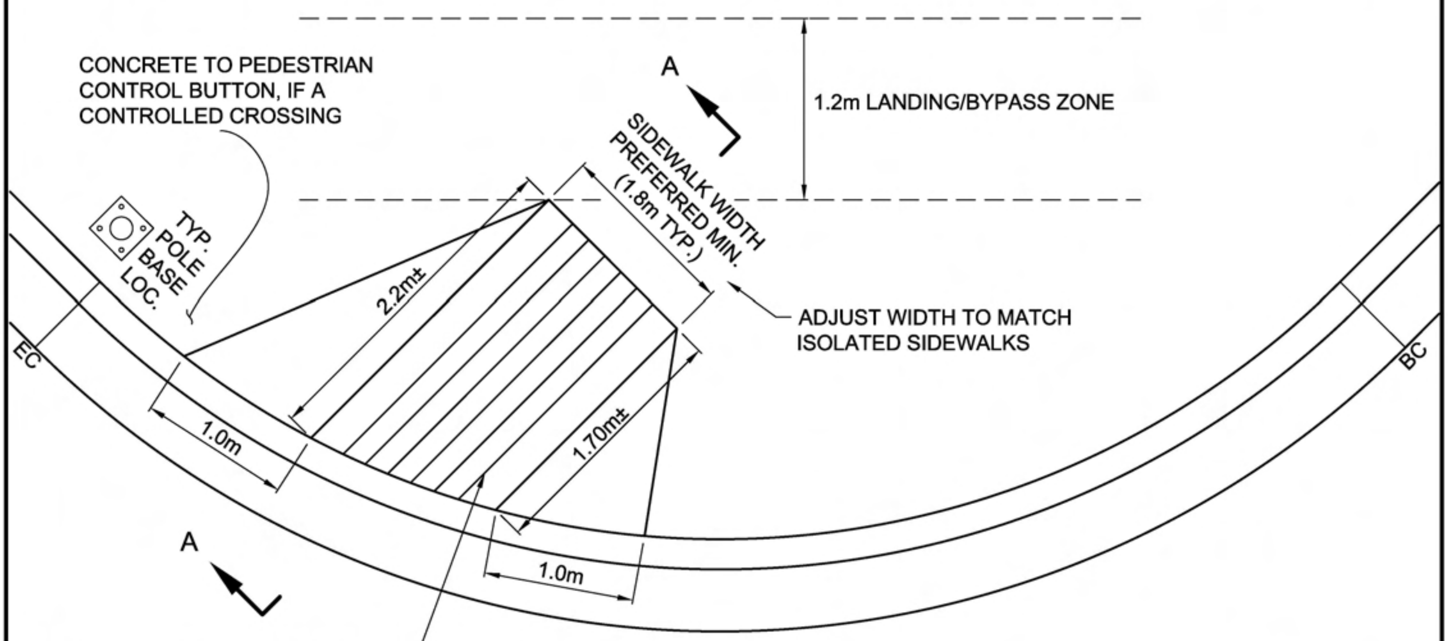
ISSUE DATE: SEPTEMBER 2018

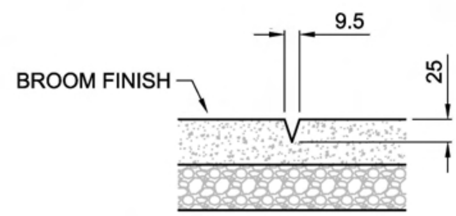
APPROVED BY: J. LEE

CITY OF VANCOUVER

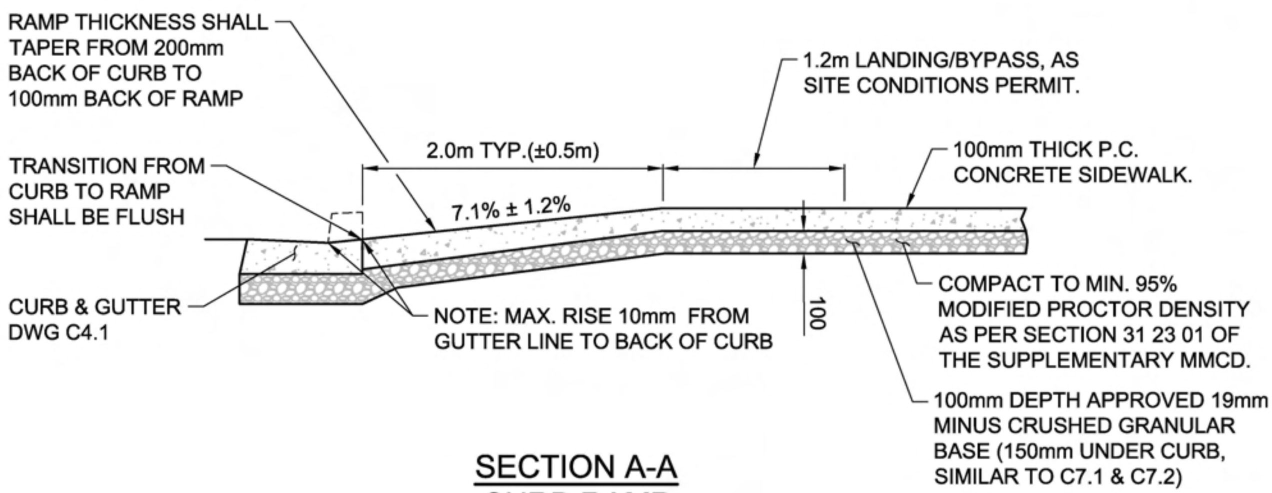
STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.

DRAWING No. **C8.3**





TYPICAL TROWEL SCORE MARK DETAIL



SECTION A-A CURB RAMP

NOTES:

1. STANDARD RAMP LENGTH : 2.0m TYP.(±) AT CENTRE OF RAMP.
2. RECOMMENDED RAMP SLOPE: 7.1% ± 1.2%.
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4. ADJUST LENGTH OF RAMP AS REQUIRED.
5. WHEN SITE CONDITIONS DO NOT PERMIT TYPICAL LAYOUT, CONTACT CITY ENGINEER FOR APPROVAL OF DESIGN.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

SCALE: N.T.S.

REV.	REVISION DATE	APPROVED

CURB RAMPS
SINGLE CURB RAMP

ISSUE DATE: SEPTEMBER 2018

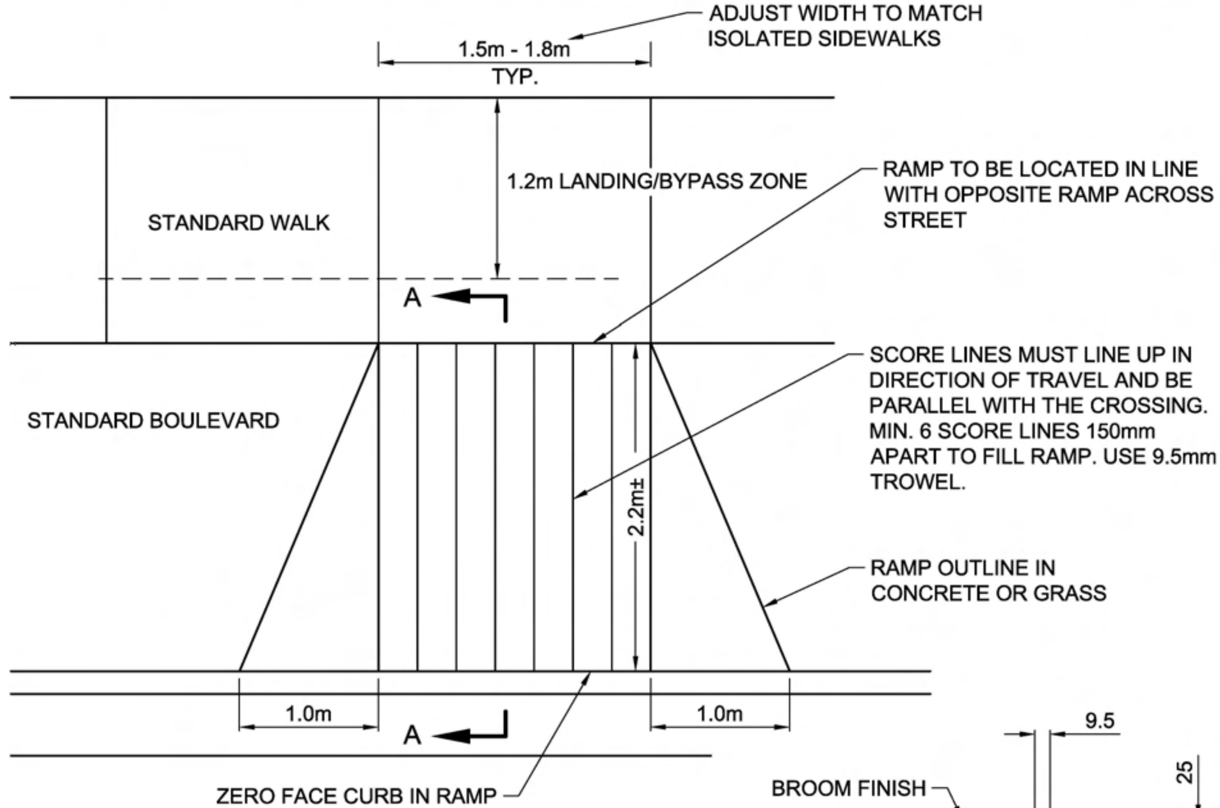
APPROVED BY: J. LEE

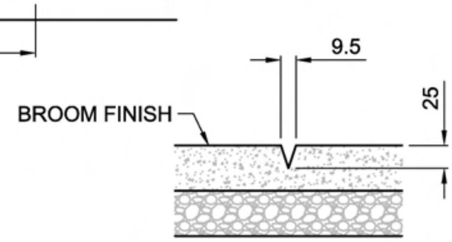
CITY OF VANCOUVER

STANDARD DETAIL DRAWINGS

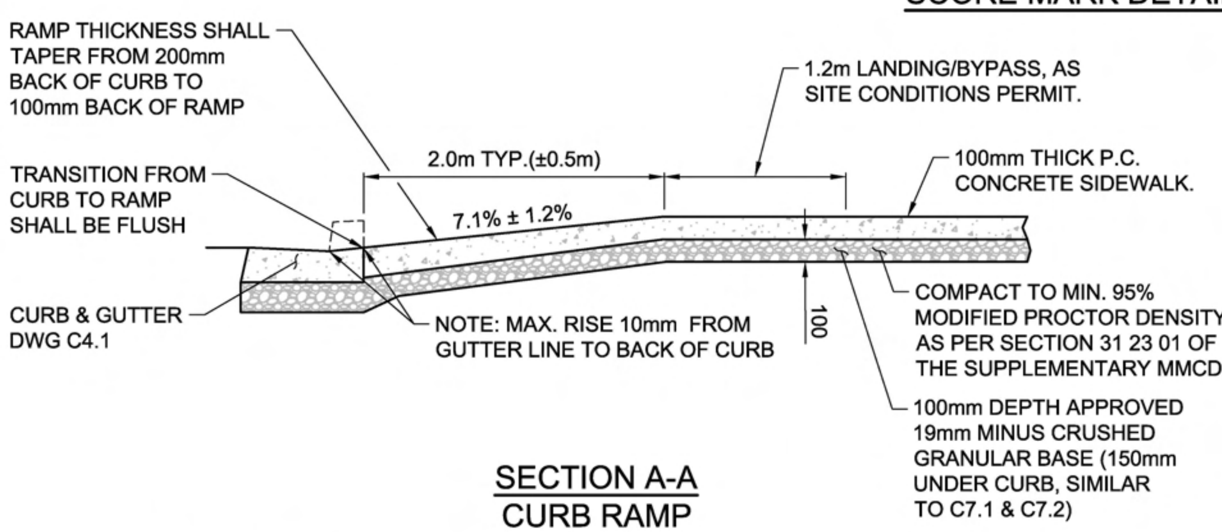
ENGINEERING SERVICES - VANCOUVER, B.C.

DRAWING No. C8.4





TYPICAL TROWEL SCORE MARK DETAIL



SECTION A-A
CURB RAMP

NOTES:
1. STANDARD RAMP LENGTH : 2.0m TYP.(±) AT CENTRE OF RAMP.
2. RECOMMENDED RAMP SLOPE: 7.1% ± 1.2%.
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6. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE.

SCALE: N.T.S.

REV.	REVISION DATE	APPROVED

CURB RAMPS
T-INTERSECTION CURB RAMP

ISSUE DATE: SEPTEMBER 2018

APPROVED BY: J. LEE