UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Redesign of Chancellor Boulevard / Wesbrook Mall Intersection at UBC

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Executive Summary

In September 2016, UBC SEEDS Sustainability Program tasked Jade Consulting with the re-design of the Wesbrook Mall and Chancellor Blvd intersection to provide a safe and comfortable travel experience for pedestrians, cyclists and motorists. The current design configuration does not promote safety and user friendliness in addition to the anticipated, increased traffic demands of UBC. The new design aims to mitigate issues arising from the current configuration with a roundabout intersection coupled with a vertical structure that prominently features the intersection as one of UBC's welcoming gateways.

The proposed intersection design features a single-lane roundabout consistent with the BC MoT roundabouts "first" policy to address existing safety and inefficiency concerns. For the structural component, a 9 meter tall, timber frame lookout tower with glass facade that supplements UBC's sustainability goals while maintaining driver sight line and intersection safety was designed.

The forecasted class B cost estimate which entails a 15% contingency for the construction of the intersection and lookout tower is **$1.3 million CDN**. To minimize disruption to the neighbourhood, staff, students and UBC's daily operations, construction will commence in **May 2017** and finish in **August 2017.**

The following report outlines the specific design features of the project as well as the design inputs and estimated costs.

Table of Contents

Table of Figures

List of Tables

1.0 INTRODUCTION

The design of the intersection at Chancellor Boulevard and Wesbrook Mall has been identified to be unsafe and inefficient. Jade Consulting has been tasked to develop an adequate design of the intersection as well as a welcoming structure to meet with UBC's requested criteria. These criteria include increasing user safety, sustainability, cost-effectiveness and the requirement of meeting the future traffic demand.

The project is located at Chancellor Boulevard and Wesbrook Mall, one of the main entry points to UBC from West 4th Avenue. Figure 1 below shows the location of the project:

Figure 1 Intersection of Chancellor Boulevard and Wesbrook Mall

This important intersection sees over 1,000 vehicles during the peak hour and serves the #44 and #84 busses. The current design configuration is unconventional and poses deficiencies for cyclists, pedestrians and motorists.

The main objective of the project is to design an intersection that improves the safety and provides a pleasant travel experience for all modes of traffic. The new design will:

- Meet future anticipated demands for all modes of transportation
- Improve safety for pedestrians, cyclists and vehicles
- Maximize operational efficiency

- Optimize project costs
- Promote sustainability
- Incorporate a welcoming gateway to the UBC campus

Table 1 below breaks down each team member's contribution to the preliminary design report. If the same section appears twice it means that those two team members collaborated on that specific section.

Table 1 Student Contribution

Student	Contribution	
Alexander Liaw	3	Transportation Design Analysis
Kellie Liu	8.1	Construction Safety Management
	9	Risk Management
	10	Environmental Management
Lorena Polovina	1	Introduction
	2	Design Components
Kimberly Subianto	6	Schedule Management
	7	Stakeholder Management
	8.2	Public Safety Management
	8.3	Traffic Management
	8.4	Emergency Response Plan
Howard Wong	4	Structural Design Analysis
Jordan Yang	5	Cost Management
	11	Conclusion & Recommendations

2.0 DESIGN COMPONENTS

2.1 Transportation Component

2.1.1 Roundabout Description

The proposed solution for the Wesbrook Mall and Chancellor Blvd intersection features a single-lane roundabout configuration, designed according to the British Columbia Ministry of Transportation (BC MOT) standards. This design targets the existing poor vehicle level of service by better controlling vehicle movement and also accommodates pedestrians and cyclists with marked crossing lanes that have flashing beacons to capture driver's attention. These modifications greatly increase the efficiency and safety of the intersection.

A drawing of the proposed roundabout design is presented in Figure 2.

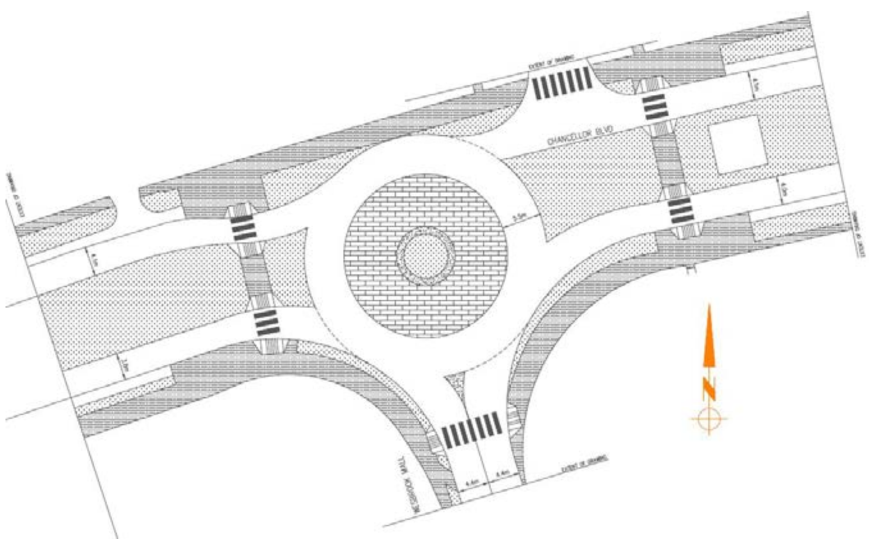

Figure 2 Proposed roundabout design at Wesbrook Mall & Chancellor Blvd.

Key components of the roundabout include:

- A shared path that facilitates safe pedestrian and cyclist movements
- A low profile mountable apron surrounding the central island to facilitate and accommodate bus and WB 17 semi-truck movements

- Preserved landscaping in existing boulevards along with new landscaping at reclaimed green space

2.1.2 Road User Accommodation

The roundabout enhances the overall pedestrian experience and improves accessibility with proper sidewalk, curb ramps, and truncated domes. Clear, well-marked crossings coupled with rectangular rapid flash beacons at all legs of the intersection inform motorists of their requirement to yield. The usage of short crossings allows pedestrians to cross a busy two-way street one section at a time, which greatly improves pedestrian safety. In addition to proper yield signage and zebra crossing, the roundabout road geometry naturally reduces vehicle speeds and contributes to pedestrian comfort at the intersection.

Figure 4 Short Pedestrian Crossings (Google earth)

Figure 3 Rectangular Rapid Flash Beacons (http://www.solar-traffic-controls.com)

The roundabout accommodates cyclists in two ways. Cyclists with more experience may share the roadway operating the intersection as a vehicle would and yielding to pedestrians. All other cyclists may use the 3m wide shared path and cross the intersection safely. The roundabout resolves many existing cycling issues, including the requirement to merge across an active vehicle through lanes to make a left turn.

As mentioned in the previous section, the roundabout design accommodates passenger vehicles, as well as busses and WB 17 semi-trucks. Key benefits of the roundabout include a reduction of conflict points and collisions for drivers. Furthermore, crash severity is reduced as roundabout eliminates head-on collisions. The roundabout also reduces delay and fuel consumption compared to other intersection treatments as drivers are not required to fully stop at the intersection.

2.2 Structural Component

As requested by UBC SEEDS Sustainability Program, a welcoming gateway component has been considered as part of the complete design. Through multiple criteria and constraints relating to spacing requirements, aesthetics and safety, a lookout tower composed of wood was designed.

The tower is a timber frame system comprising of glulam columns and beams with glass panels for the walls and CLT for the floors. The structure contains two cantilevered walkways, located on both floors, where visitors are welcome to appreciate the luscious surroundings. The structure complements the roundabout design which is located at the southeast corner of the roundabout. Most importantly, the lookout tower does not obstruct the sightlines of drivers. A rendering of the lookout tower can be shown on Figure 5 on the next page:

Figure 5 A Rendering of the Lookout Tower Located to the East of the Roundabout

3.0 TRANSPORTATION DESIGN ANALYSIS

The proposed single-lane roundabout adheres to the BC MOT "roundabouts first" policy that supports the Province's Climate Action Program of 2007. A drawing of the proposed design has been provided below in Figure 6. As seen and documented in many precedent examples, a roundabout design provides safety and accessibility benefits for all users. It also facilitates driver expectation by providing design consistency between the W 16th Avenue at Wesbrook Mall and East Mall intersections. The following sections outline the proposed roundabout's design criteria, traffic analysis and sightline analysis components.

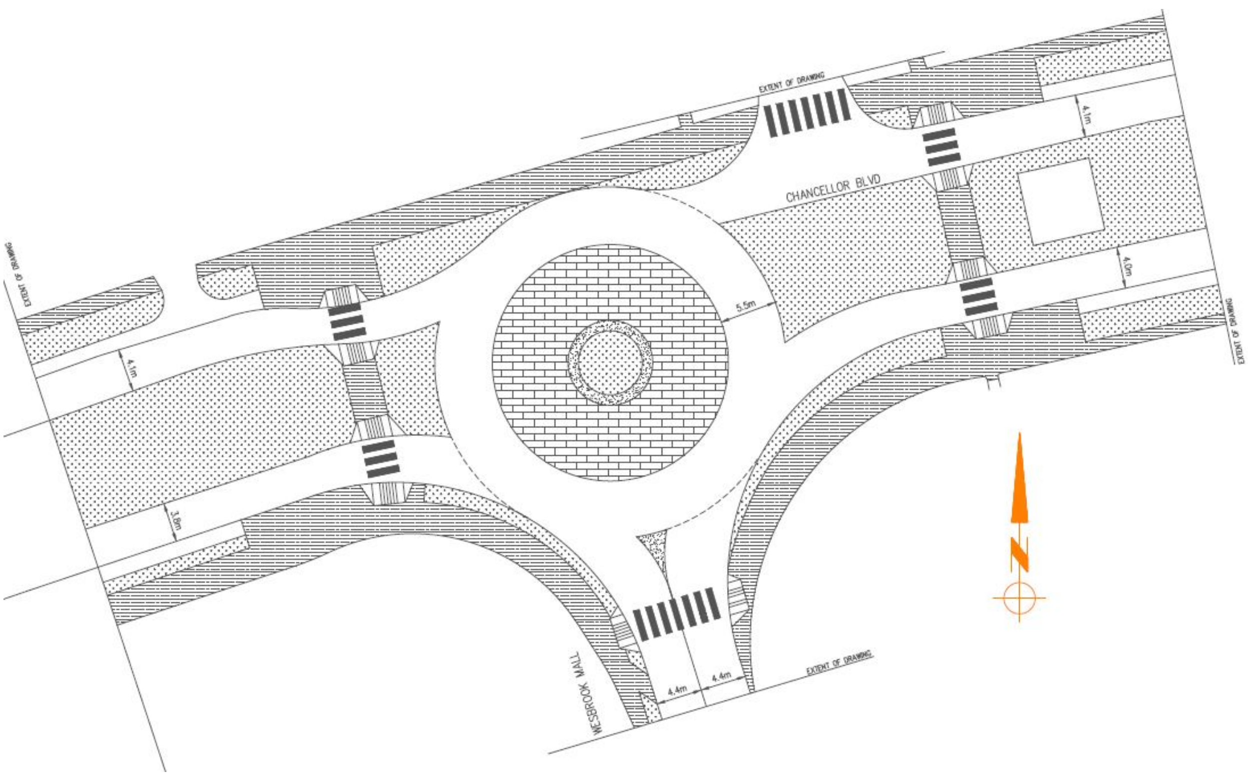

Figure 6 Proposed Single-lane Roundabout

3.1 Design Criteria

The proposed roundabout was designed to meet several criteria including safety, pedestrian accommodation, cyclist accommodation, vehicle accommodation, serviceability, sustainability, vehicle level of service (LOS) and aesthetics. The following table goes into detail with respect to each design criteria and explains how the proposed design meets the design criteria.

Table 2 Key Roundabout Design Criteria

Design Criteria	Significance
Safety	The most important criteria of the design were to ensure the safety of all modes of travel including pedestrians, cyclists and vehicles. The proposed design incorporates proper signage and utilizes driver expectancy by having a design like the Wesbrook Mall and W 16th Ave roundabout intersection. The roundabout also reduces collision severity as it eliminates all head-on-collisions associated with traditional intersections.
Pedestrian Accommodation	The existing intersection lacked proper crosswalks and curb ramps. The proposed design incorporates clear, well-marked crossings coupled with rectangular rapid flash beacons to inform motorists of their requirement to yield.
Cyclist Accommodation	The existing intersection is unsafe and proves very difficult for cyclists to make turns. The proposed design incorporates a 3m wide shared path that allows cyclists to operate the intersection as a pedestrian would safely and comfortably.
Vehicle Accommodation	The proposed roundabout accommodates passenger vehicles, articulated busses and WB17 semi-trucks.
Sustainability	The roundabout reduces greenhouse gas emissions as total vehicle delay time is reduced at the intersection.
Serviceability	The roundabout requires landscape maintenance with the introduction of landscaped medians.
Aesthetics	The roundabout design incorporates pleasing aesthetic components including landscaped boulevards and roundabout centre.

3.2 Standards and Software

The geometric design of the roundabout is governed by the TAC Geometric Design Guide and the BC MOT Roundabouts Supplement. In addition to the design standards, the UBC Transportation Plan was consulted to ensure that the design promotes and enables UBC's sustainability goals and mode share targets. Software used during the design process includes AutoCAD 2014 for the design drawing and Synchro 6.0 for traffic analysis.

3.3 Traffic Analysis

3.3.1 Traffic Volume Projection

2015 AM and PM peak hour traffic count data for the Wesbrook Mall and Chancellor Blvd intersection was provided by UBC. Given UBC's target to maintain or reduce daily private automobile traffic, a 1% growth rate was applied. The following table provides existing 2015 peak hour traffic volumes, projected 2017 opening day traffic volumes and a 30-year project of traffic volumes in 2047.

Table 3 Existing and Projected Vehicle Traffic Volumes

	Eastbound through	Eastbound Right	Westbound Left	Westbound Through	Northbound Left	Northbound Right
2015 AM Peak	124	75	428	404	71	114
2017 AM Peak	126	77	437	412	72	116
2047 AM Peak	167	101	577	545	96	154
2015 PM Peak	365	80	96	107	53	243
2017 PM Peak	372	82	98	109	54	248
2047 PM Peak	502	110	132	147	73	334

3.3.2 Synchro Model Output

Due to limitations of the Synchro 6.0 software provided, intersection delay and LOS for the proposed roundabout cannot be determined. The following table displays the volume to capacity ratio output based on applying a 1% growth rate as mentioned above.

Table 4 Roundabout Volume to Capacity Ratio Projection

	Eastbound	Westbound	Northbound
2017 AM Peak Hour	0.23	0.71	0.16
2017 PM Peak Hour	0.39	0.17	0.33
2047 AM Peak Hour	0.35	0.96	0.23
2047 PM Peak Hour	0.54	0.23	0.49

As expected, the AM volume to capacity ratio for the westbound leg is the highest as students and staffs commute to UBC in the morning. It should be noted that the 1% growth rate applied may represent a worse-case scenario. As UBC continues to work towards its sustainability goals of achieving two-thirds of all trips to and from UBC be made by walking, cycling or transit by 2040, traffic volumes may decrease and the roundabout will remain operational beyond its 30-year design life.

3.4 Sightline Analysis

Adequate sightline and stopping sight distance is paramount to the safe operation of the roundabout. Due to incomplete sightline analysis within the BC MOT Roundabouts Guideline, the Kanas Roundabout Guide Second Edition was consulted.

A complete sightline analysis was carried out based on the requirements outlined in the Kansas Roundabout Guide. Sight distances checked include the stopping sight distance on the approach, stopping sight distance on the circulatory roadway, sight distance to crosswalk on exit and the intersection sight distance. The following diagram illustrates sightlines required by vehicles to safely travel through the roundabout. It should be noted at that all areas shaded in green will be low growth landscaping to maintain driver sightlines.

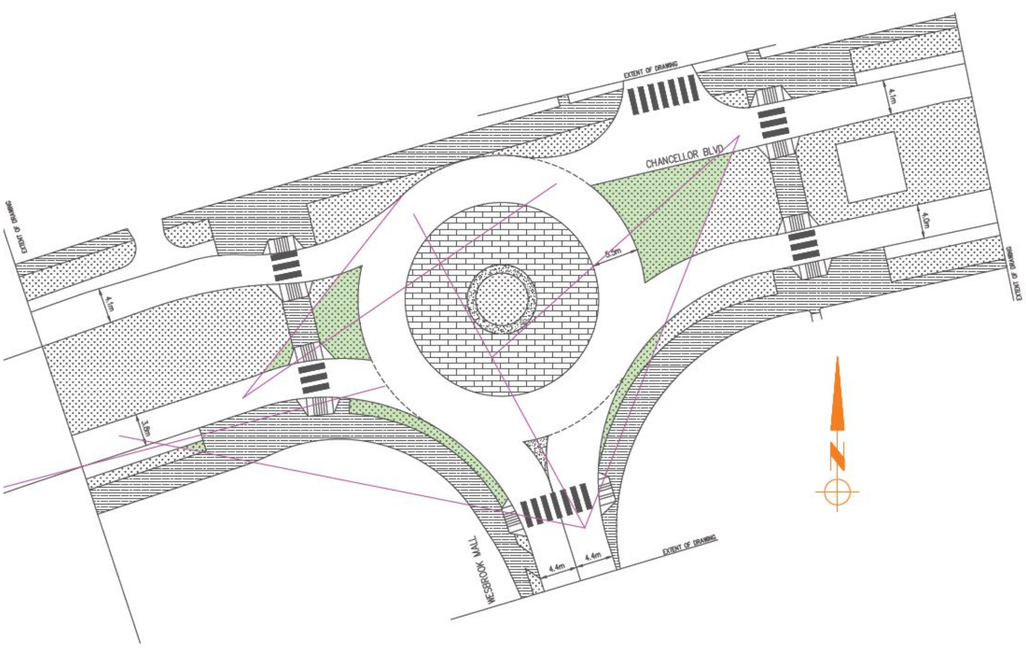

Figure 7 Roundabout Sightline Analysis

4.0 STRUCTURAL DESIGN ANALYSIS

4.1 Standards and Software

Standards including the National Building Code of Canada 2005 (NBCC) and Canadian Wood Council (CWC) Design Manual were followed for the design of the lookout tower. On top of the design standards, guidelines including the UBC Technical Guidelines outline the code of quality and performance of the design. SAP2000 was used for the finalized analysis approach for the building and to check member forces for adequate member sizing. Detailed sample hand calculations through the CWC Design Manual were used to verify limit states design of members with the obtained forces in SAP2000.

4.2 Design Criteria and Analysis

In compliance with the design standards, primary criteria that were considered in the lookout tower were the following:

1. Compliance to the load combination and used in structural analysis for sizing members.
2. Bracing system required for horizontal loads (Wind and Earthquake Loads).
3. Design checks and correct section properties in accordance to the Canadian Wood Council Design Manual.
4. Compliance of UBC Technical Guidelines for un-factored design loads.
5. Compliance of traffic sightline design issues

In the above design criteria, the design life was considered to be 1 in 50 year as this was common for most building structures and is a minimum for design load data for Vancouver in the NBCC.

As a part of the design of the structural lookout tower, the components must comply with the design loads. Therefore, a structural analysis on SAP2000 was performed. A simplified 2D frame analysis of the lookout tower was decided to represent one face of the lookout tower. The following table below represents the factored loads used in the analysis in SAP2000 in accordance to NBCC:

Table 5 Factored Loads for NBCC Load Cases

Component	Dead Load	Live Load	Snow Load	Wind Load	Earthquake Load
Roof	1.1 kN/m	2.25 kN/m	13 kN/m	4.65 kN/m	2kN
1st and 2nd Floor	1.38 kN/m	10.8 kN/m	-	4.65 kN/m	0.82kN & 1.64kN
Balcony	1.38 kN/m	10.8 kN/m	-	-	-

Factored load calculations for the above table can be found in Appendix B3. With the factored loads in the above table, two analyses were carried out. These were:

- Vertical Direction Load Analysis (Dead, Live, Snow Load) – NBCC Load Case 2& 3
- Horizontal Direction Load Analysis (Wind, Earthquake Load) – NBCC Load Case 4 or Case 5

In addition, while simplifying the tower into a 2D frame analysis, some assumptions were made during the modelling and analysis of the tower. The list of assumptions can also be found in Appendix B1.
For our lookout tower analysis, case 2 and case 4 were the governing cases and will be used in designing the structural members. After running the analysis in SAP2000, the two cases give the governing loads in each member type are as follows in the below table:

Table 6 Summary of Load Analysis

	Columns	Beams	Bracing
Shear Force (kN):	10	65	30
Axial Force (kN):	450	30	55
Bending Moments (kNm):	10	100	50

4.3 Foundation Design

4.3.1 Soil Conditions

For the design of the lookout tower foundation, a geotechnical investigation is required to obtain the soil profile and parameters. Due to the lack of site-specific information, available soil profiles for other parts of UBC are assumed for foundation calculations as seen in the Appendix B4. The assumed specific weight of the soil is 16 kN/m3. This value is based on variations of past geotechnical related report from past projects at UBC.

4.3.2 Bearing Capacity

Based on the assumed soil profile and soil parameters, 2m by 2m square concrete footings at 1.5m deep with a bearing capacity of 124 kPa is recommended. This total bearing capacity converts to an allowable force of 496 kN which is suitable for our structure thus extra piling reinforcement will not be required. The capacity is derived from using the formula found in Budhu's Foundation and Earth Retaining Structures and the Allowable Stress Design Method (Budhu, 2007). The following formula was used:

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

4.4 Bracing Design

With a moment released frame design, the emphasis on an effective bracing system is important as horizontal forces need to be resisted. For the lookout tower, full cross bracing is implemented in between the floor sections where space is opened. However, for floor sections with a balcony opening, a modified bracing is required. This is to resolve the accessibility issues if full cross braces were to be placed. Through careful considerations and research advice from UBC Professor Thomas Tannert, knee braces were chosen to be placed at the corners of the frames. To simplify calculations, capacities of these knee bracing should be equal to those of a full bracing.

4.5 Connection Design

Considering a moment released frame design, the connections of the entire structure will be pinned with steel bolts and plates. The required capacity for the bolts and plates for the frame is taken to be the governing axial force of the design members. This corresponds to 55 kN. The finalized connection design accordingly to CSA standards given in the CWC Wood Design Manual is (design calculations found in Appendix B5):

- Two 6 mm steel internal plates with 2 rows of 3 fasteners spaced at 80 mm

The resistance of the connection is 56 kN which is less than the member capacities resulting in a connection failure before member failure. This is consider to be ideal as the connection will provide ductile yielding effects in steel rather than a brittle failure mode due to the properties of wood products.

4.6 Member Design

Based on the structural analysis done in SAP2000, member design of the columns and beams have been performed based on CWC Wood Design Manual 2015 and Canadian Standards Association. The member design accounts for various capacity checks due to applied factored loads. Certain assumptions have been made during the member design which primarily involves service conditions of the members. These can be found in the Appendix B5 with detailed calculations of member design.

Member design comprised of checking serviceability limit state and ultimate limit state. These apply to columns and beam members of the lookout tower. For easy of construction and limiting repetition of work, the building is assumed to have the same column and beam members. The following are resistance forces and limit state conditions components for the building members that have been checked accordingly to the code:

For Column Members:

- Factored Compressive Resistance
- Factored Combined Loading (Axial and Moment)
- Shear Force Member Capacity
- Serviceability Deflection

For Beam Members:

- Moment Member Capacity
- Shear Force Member Capacity
- Serviceability Deflection
- Maximum Distributed Load

For Bracing Members:

- Row Shear Resistance
- Group Tear-Out Resistance

- Net Tension Resistance

After compiling together the design check, the finalized dimensions of the member are given below with the grade of wood:

- **COLUMN**: Glulam Douglas Fir Larch 24f-EX : 315mm x 380mm
- **BEAM**: Glulam Douglas Fir Larch 24f-EX : 365mm x 380mm
- **BRACING:** Glulam Douglas Fir Larch 24f-EX: 265mm x 342mm

5.0 COST MANAGEMENT

The estimated costs for the project were based upon the implementation of the roundabout under BC MOT standards and the installation of the new lookout tower. After the consideration of construction costs and engineering costs, project management and environmental factors were scaled on a percentage basis from those values as suggested by APEGBC and BC MOT standards.

A final cost of **$1.3 million** is forecasted under the assumption that it is class B cost estimation. This entails a 15% contingency for several aspects of the estimate which may be reduced further into the project as more certainty is developed in the detailed design stage. Roughly $50 thousand of the total value is allocated towards the creation of the lookout tower factoring in material, labour, and engineering costs to the owner.

5.1 Traffic Design Costs

Following the Ministry of Transportation's framework in cost estimating, we were able to follow a step-by-step process in the projected values given for this design project. The estimating process derived from precedent examples and unit costs of materials for this specific location and was the basis of where many of the assumptions are created. One of the more notable assumptions was that property values and levies would be assumed to be waived because the property is under the jurisdiction of UBC Endowment Lands as well as the Ministry of Transportation. Furthermore, any planning, project management, and environmental costs were appropriately scaled accordingly to construction costs of the project by certain percentages as suggested by APEGBC or the Ministry of Transportation samples. Refer to Appendix C for a more comprehensive list of project information and assumptions made for the intersection location.

5.1.1 Initial Capital Costs

The initial capital costs include a variety of elements which include

- Project Management
- Planning
- Design
- Environmental Factors
- Construction
- Past Costs

After applying contingency values, a mark-up was considered for outsourced contractors and applicable taxes which resulted in a sum of $602,267.40. A cost breakdown can be found in Appendix C.

5.1.2 Maintenance Costs

The yearly maintenance costs considered is very low because it lacks any traffic signals. Unlike other intersections, the use of those signals allows for lower cost and maintenance for only landscaping and electrical for the rectangular rapid flashing beacons. Please refer to Appendix C for the breakdown of yearly costs that sum up to a total of $1,655.81/year.

5.2 Structural Design Costs

The structural design portion of the project included the cost of engineering, skilled workers required, as well as material costs. Sigma estimates and the libraries of an RSMeans Database were used to project these costs to be $70,687 with the inclusion of the 15% contingency. All of the design measurements were provided through a building information model created in Revit to assume a more accurate estimate in both lengths and areas.

6.0 SCHEDULE MANAGEMENT

To ensure a smooth and timely project delivery, a project master schedule is developed with the aid of Microsoft Project software. In addition, the schedule management process allows project and construction managers to plan the construction of project more efficiently and smoothly.

6.1 Construction Planning

Construction is scheduled to begin in May 2017 and will commence for duration of 55 days up to August 2017. A 10%-time contingency has been included in the construction duration to address potential construction conflicts that may arise. This start date is selected due to the lower traffic volumes in and out of the UBC campus throughout the summer months. This mitigates the impact construction has on traffic and allows full closure of intersection. In addition to the lower traffic impact, the weather during the summer months is preferable for certain construction activities, such as concrete pour.

In the development of the construction schedule, precedent studies have been conducted and project scheduling workshops attended by design teams, construction operations and other key stakeholders have been held. All necessary Work Breakdown Structure (WBS) were created and the durations for each work were determined based on historical information and known project-specific conditions. It is also essential to determine the task dependencies between work activities and assess the possibility of scheduling simultaneous work to increase inefficiency and decrease project duration.

6.2 Construction Zones

For the purposes of progress tracking and effective management of physical works, the construction of the project at the intersection has been sectioned to the following construction zones (shown in Figure 8):

- **Zone A:** North of the intersection
- **Zone B:** South-East of the intersection
- **Zone C:** South-West of the intersection
- **Lookout Tower:** East of the intersection on the median

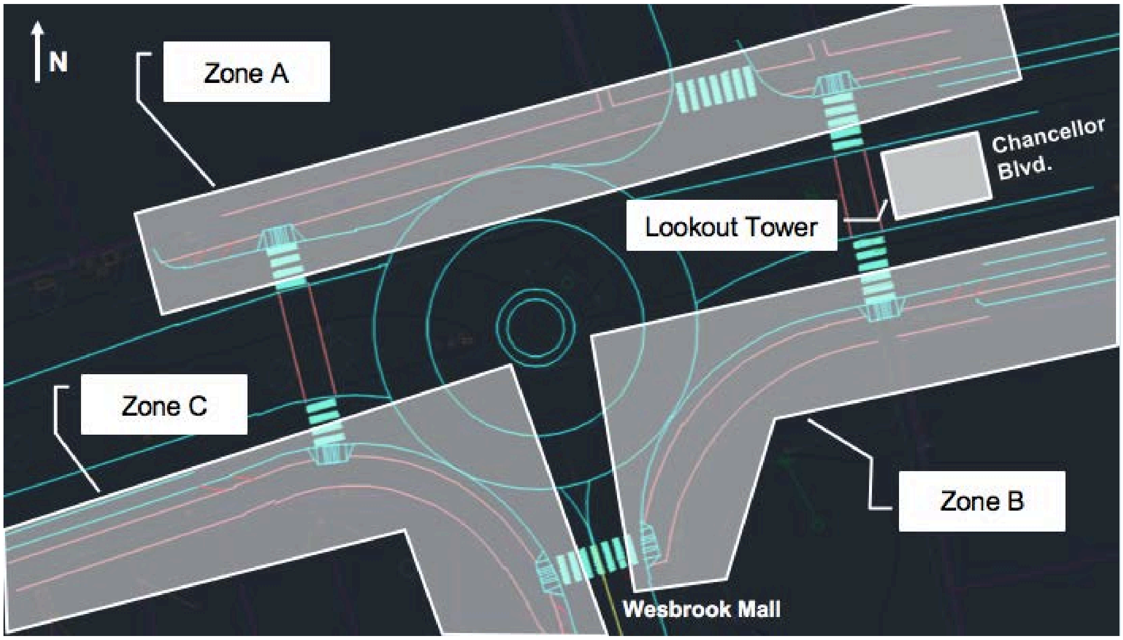

Figure 8 Construction zones at the intersection

6.3 Construction Schedule

Table 7 summarizes the targeted completion dates of different milestones throughout the construction phase. As seen in the table, the expected duration for all construction work is 64 working days, and it will proceed from May 5 to July 14, 2017. This is a reasonable duration for a project of such scale, however, to take into account the potential conflict that may arise, a 10% time contingency is added to the schedule. The duration of construction, with the added time float, is 61 days. For most activities, work is coordinated to commence simultaneously in order to decrease the project duration and therefore, the disruption of traffic.

Table 7 Targeted completion dates of project milestones

Activity	Start Date	Finish Date	Duration (days)
CONSTRUCTION	May 1	Jul 14	55
Site Preparation	May 1	May 12	10
Grading	May 15	May 30	12
Reinstallation	May 31	Jun 6	5
New Medians Build	May 31	Jun 15	12
Structural Lookout Tower Build	Jun 9	Jul 6	20
Curbs and Ramp Build	Jun 7	Jun 23	13
Sidewalks Build	Jun 26	Jun 27	2
Streets Paving	Jun 28	Jun 29	2
Roundabout Build	Jun 30	Jul 5	4
Finishing	Jul 6	Jul 11	4
Construction Close-Out	Jul 12	Jul 14	3

Because the lookout tower components are prefabricated off-site, a delivery date will be scheduled a week prior to installation to ensure a complete set of materials and resources are available in time for installation. In addition to the coordination of materials delivery, the following pre-construction requirements are expected to be completed to ensure a timely starting date for construction:

1. Issuance of IFC Drawings: March 1, 2017
2. Soil Contamination Test: March 31, 2017
3. Project Permit: April 14, 2017
4. First Nations Permit (if required): April 14, 2017
5. Geotechnical Assessment: April 14, 2017
6. Topographic Survey: April 19, 2017
7. WorkSafe BC Notice of Project: April 21, 2017
8. Delivery of Structural Component: June 9, 2017

A detailed project Gantt chart is attached in this report as Appendix E, with the critical path marked in red line.

6.4 Construction Progress Tracking

The project team is required to adhere to the schedule developed and commit resources as necessary to meet the target dates. The master schedule will be reviewed bi-weekly and actual site progress will be tracked against the baseline progress. The results of the progress updates will be reported on the project monthly report. In addition, to ensure that construction progresses in a manner that is timely, the following construction management processes are to be followed:

1. Hold weekly construction meetings to review progress, address issues, plan actions to be taken and develop a 3-week look ahead schedule
2. Hold bi-weekly project coordination meetings to be attended by design leads, construction superintendents, finance department and other key stakeholders to ensure coordination of all work on site
3. Maintain clear, complete and updated documentation of construction progress and productivity
4. Site superintendent to produce weekly schedule progress report to be submitted to project manager
5. Consistently update Master Schedule on Microsoft Project according to actual site progress

7.0 STAKEHOLDER MANAGEMENT

Stakeholder management is an essential aspect of the project as it considers the expectations and requirements of key stakeholders throughout the lifecycle of the project. There are four key activities that are associated with stakeholder management, as follows:

- Identification of stakeholders
- Assessment of interests and influence
- Development of communication management plan
- Engagement of stakeholders

7.1 Stakeholder Identification

Stakeholders are individuals who have a certain degree of interest in the project, as well as those who may be directly or indirectly impacted by the outcome of the project. Identification of stakeholders in this project was done through group brainstorming and studies on previous projects. The stakeholders identified to provide input to the project is shown in APPENDIX D. Stakeholder identification is a continuous process, and any additional stakeholders identified will be incorporated into the stakeholder management process.

7.2 Stakeholder Assessment

To achieve success in a project, it is important to understand the expectations each stakeholder has in the improvement made by the project. It is also important to assess the level of influence each of the project stakeholders has in the project, as it will affect the decision-making process. Each stakeholder will be classified based on their level of interest and influence in the project on a scale of low, medium and high. The level of interest and influence will then be used to identify the appropriate stakeholder engagement approach (i.e. consult, collaborate or inform) as shown in the stakeholder analysis map in Figure 9, which will be further explored in the next section. Appendix D presents the stakeholder register that outlines the stakeholders identified, along with the assessment of their interest and influence on the project.

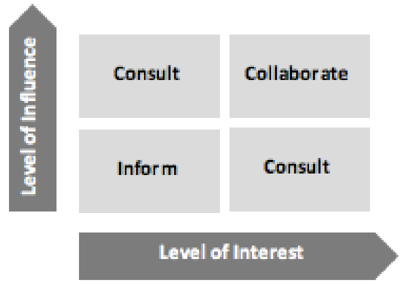

Figure 9 Stakeholder Analysis Map

7.3 Stakeholder Communication Plan

A stakeholder communication plan is required for the project to ensure relevant information is delivered to the right stakeholders through an appropriate means in a timely manner. The communication plan is developed to improve the overall operational effectiveness, build relationships with stakeholders and eventually achieve the project objectives. The project team will implement the communication strategies through the following channels throughout the project lifecycle to ensure stakeholders are well-notified:

- **Project Website**
  Content of website is to be updated regularly with announcements regarding any project changes, construction schedule and impacts. The website can also offer the public with opportunities to provide feedbacks on the project.
- **Notification Letters**
  Any impact from construction, such as detours, road closures and utility shutdown, is to be communicated to residents and the UBC communities through letters. These notification letters are expected to be delivered one week prior to the impact.
- **Media Releases**
  News release can be the most cost-effective way of gaining publicity for the project, as well as in educating the public about the project background and the outcome it wishes to accomplish.
- **Public Consultation and Open House**
  This provides stakeholders with opportunity to raise concerns, express support and ask questions regarding the project.

It is essential to develop an on-going and consistent communication with the stakeholders, to listen and consider any inputs they may have, as well as to maintain an appropriate level of transparency. Figure 10 briefly outlines the timeline of the implementation of the communication strategy throughout the project lifecycle.

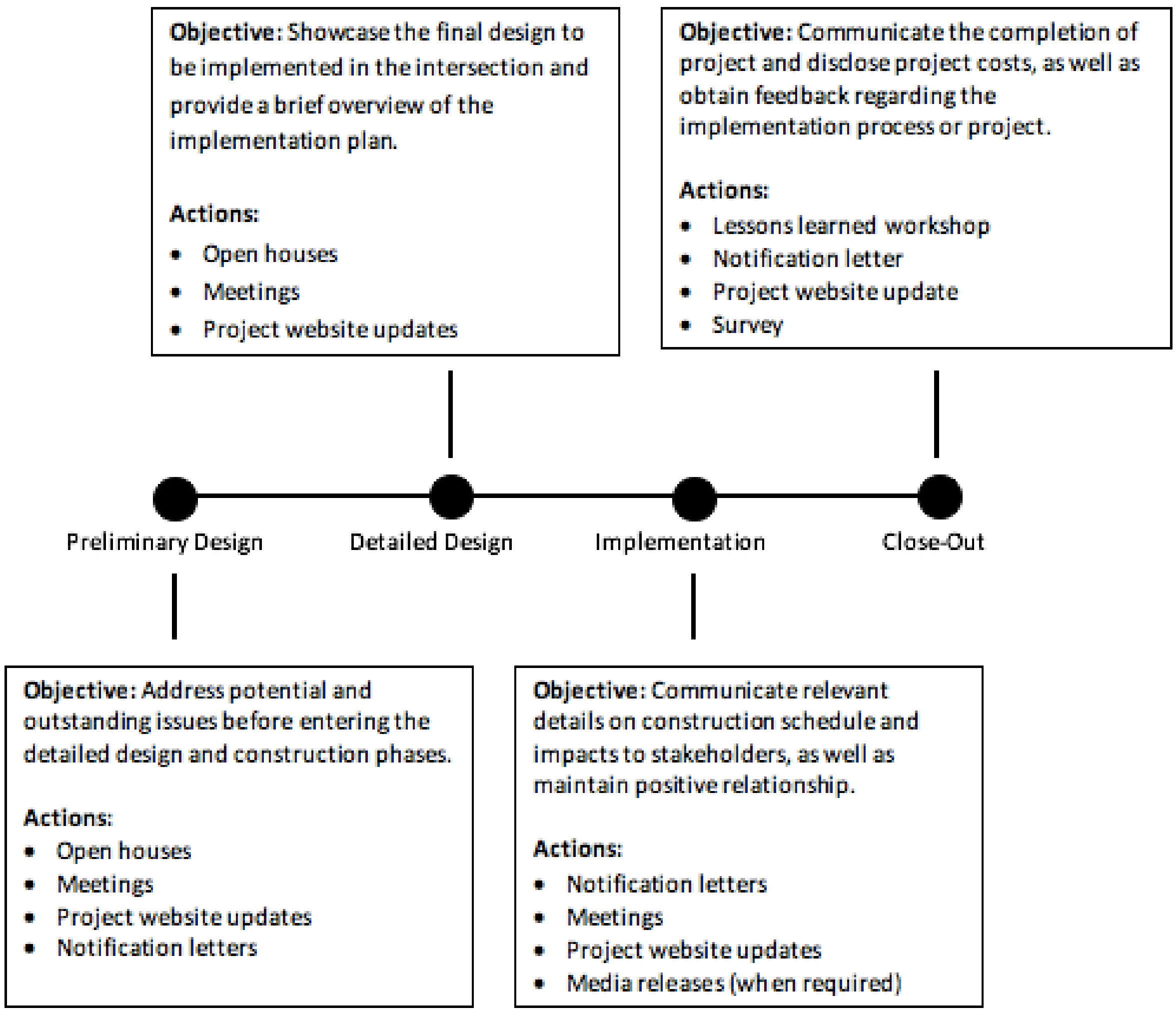

Figure 10. Timeline of Implementation of Communication Plan

Figure 10 Timeline of Implementation of Communication Plan

7.4 Stakeholder Engagement

As seen on the stakeholder analysis map, the stakeholders can be categorized into three levels of engagement based on their level of interest and influence. Table 8 below summarizes the goal, approach and methods for the three levels of engagement: inform, consult and collaborate. All efforts will be done to ensure healthy relationship is maintained throughout the lifecycle. The stakeholder engagement plan is to be continually maintained and updated as the project progresses.

Table 8 Methods of Stakeholder Engagement

	INFORM	CONSULT	COLLABORATE
GOAL	To notify stakeholders with relevant and necessary information regarding the project.	To obtain feedback from stakeholders with regards to the project's objectives, decisions and/or alternatives.	To cooperate with stakeholders in approaching design solution, developing alternatives and making decisions.
APPROACH	Stakeholders will be kept informed of any project's progress and changes.	Stakeholders' needs and concerns will be acknowledged and considered throughout the project lifecycle.	Stakeholders' input and expectations will be directly reflected in solutions developed, and any requirements will be incorporated to the maximum extent possible.
METHODS	• Open house • Notification letters • Project website	• Public consultation • Focus groups • Surveys	• Workshops • Joint planning • Decision-making meetings

8.0 CONSTRUCTION MANAGEMENT

8.1 Safety Management

A construction safety plan is a written document that describes the necessary procedures to prevent accidents and steps to take when accidents do occur. With acknowledgement to the Work Safe BC and OHS (Occupational Health and Safety) regulations, a construction safety plan can be constructed with the following components:

- Hire a superintendent who is in charge of all safety related issues on construction site during construction period
- Create a safety manual for the workers to strictly follow
- Organize weekly safety meetings for the employees and contractors
- Arrange mandatory worker orientation and training sessions
- Ensure the equipment are used in a safely manner
- Access to first aid on construction site
- Inform the public with a clearly labeled construction zone
- Understand and carry out emergency/accident response when necessary

Additionally, a traffic management plan, public safety management plan and an emergency response plan are discussed to further evaluate safety related concerns during the construction of a roundabout.

8.2 Public Safety Management Plan

The objective of the public safety management plan is to analyze the requirements in public safety. The public safety management plan evaluates all the activities associated with the construction of the project. The evaluation is conducted through a public safety risk assessment. The risk assessment examines the hazards to the public associated with the project construction. The hazards are then ranked and scored based on a combination of likelihood and consequence. *"Likelihood refers to the possibility that members of the public will suffer an injury from the activity. Consequence refers to the severity of injury as a result of the worst probable outcome." (Construction Safety Management Plan)* The risk rating can evaluate the grading of the score for the hazards and the table for the risk rating is shown below.

8.3 Traffic Management

According to UBC Campus + Community Planning requirements, a Traffic Management Plan (TMP) needs to be implemented when construction activities pose impact on the circulation and access on the UBC Campus for pedestrians, cyclists, public transit and motorists. It is our goal to best accommodate traffic while work is performed, while ensuring public safety is maintained at all times. A TMP has been developed for the implementation of the project with the consideration of accepted standards, safety, site-specific conditions and impacts on stakeholders.

Throughout the construction phase, a full intersection closure will be taking place, allowing local access only. Although this would result in disruption to the traffic flow and access on campus, a full intersection closure has been deemed most appropriate due to the following reasons:

- Limited work area to provide adequate safety zone for road users
- Road signage and pavement markings to be removed and replaced during construction
- Work area to be used for storage of prefabricated materials delivered by supplier
- Lower traffic volumes at UBC due to the summer season

With the full intersection closure taking place, transit and motor vehicles movement will be impacted. As such, alternate routes have been planned as follow:

1. **East-West Connection:** Motorists to use Acadia Road/NW Marine Drive in place of Chancellor Boulevard
2. **North-South Connection:** Motorists travelling on West 4th Ave to turn left at Blanca Street and proceed on University Boulevard for access to UBC
3. **Transit Detour:** Bus 84 and 44 to turn left at Blanca Street and proceed on University Boulevard for access to UBC Bus loop
4. **Shuttle Bus Provision:** To address the missed bus stops along Chancellor Boulevard, a shuttle bus will operate between the bus stop and the Blanca Loop
5. **Shuttle Bus Detour:** Bus C18 to use Iona Drive for access to Chancellor Boulevard and Wesbrook Mall

A complete detour plan for the intersection closure can be found in Appendix F**.**

In addition to the detour plans to be implemented, the project team will also station flaggers in various areas, as well as install road signage to direct road users. In coordination with Translink, the project team will develop a public information plan to ensure stakeholders are well informed of the traffic impact they can expect. To maintain healthy relationship with stakeholders, a proactive approach will be taken to address any issues and concerns from local residents and users who are directly impacted by the construction activity.

8.4 Emergency Response Plan

An emergency response plan provides a structure and guideline to how to respond and manage an emergency that may affect the public, employee or contractor during the construction process. The plan identifies and assesses the potential hazards and risks that may require emergency response. It then develops and implements an effective emergency management and response procedure relevant to the identified potential hazards and risks. The plan also includes a detailed contact list and communication and notification strategy for emergency situations. Lastly, the emergency response plan recommends all employees and contractors to attend worker orientation and training session to bring awareness and help prevent potential hazards and risks.

9.0 RISK MANAGEMENT

Risk management is an essential part of construction management. A risk management plan requires preparation to the unforeseen events that happen in construction. This is either through allocating the risk to the respective management team or referring to the contingency plan. Uncertainties in construction are oftentimes inevitable, therefore preparations to mitigate impacts on the overall construction is necessary. Throughout the construction phase of the project, the project team will closely monitor the progress and continually anticipate future tasks to maintain a timely schedule. Following are several considerations that were taken into account during the development of schedule and actions will be taken to manage them:

- *Health and Safety*
  Every effort will be made to maintain compliance to WorkSafeBC Standards and Occupational Health and Safety (OHS) Regulations and Guidelines. A more thorough construction safety plan can be found in Section 8 of the report.

- *Traffic Impacts*
  Being one of the main entry and exit points into and out of UBC, construction of this intersection is expected to disrupt traffic. As such, construction of project will be sequenced accordingly to avoid full intersection closure and to maintain roadway open to traffic. Traffic planning will be coordinated with a traffic control company to ensure all guidelines and requirements are satisfied. Road signage will be placed and flaggers will be stationed to direct traffic. Work that may require full closure of intersection, such as paving, will be scheduled on the weekends, and project team will ensure the designated stakeholders will be notified. Any information on detours and road closures will also be passed on to Translink, BC Ambulance, RCMP and Vancouver Fire and Rescue Services.

- *Critical Path*
  As seen in the schedule Gantt chart attached in Appendix E, the critical path of this project has been identified. A critical path is a network of activities sequence with little to no time float allocated. Any delay in one of the tasks will delay the entire project. The project team will monitor closely the tasks that lie on this path and ensure that all resources are made available in a timely manner.

- *Construction Progress*

  Weekly construction meeting is to be held on-site, in which superintendents and the project team may discuss any health and safety matter, review site progress, anticipate construction look-ahead schedule, record stakeholder issues and agree on actions to be taken. Any additional potential schedule conflict will also be discussed in meetings and appropriate actions will be taken. In addition, superintendents are also expected to issue weekly construction status reports to communicate the progress of project.

- *Potential Construction Conflict*

  An important aspect in construction management is to anticipate any potential conflict that may arise to allow the project team to take the necessary preventive or mitigating actions. Table 10 below outlines several conflicts that can be expected throughout the construction phase, along with the management strategy.

Table 9. Risk rating matrix

Risk Rating			**Incident Consequences**							
			Insignificant		**Minor**	**Major**	**Critic al**	**Fatality**	
			1		**2**	**3**	**4**	**5**	
Incident Likelihood	**Almost Certain**	**5**	Med	Low	High	High	High	High	
	Common	**4**	Low		High	High	High	High	
	Possible	**3**	Low		Medium	High	High	High	
	Unlikely	**2**	Low		Low	Medium	High	High	
	Rare	**1**	Low		Low	Low	Low	Low	Med

Table 10 Potential Conflicts and Management Strategy

Potential Conflicts	Risk Classifications	Level of Impact	Management Strategy
Scheduling related conflicts and delays	Operational	High	Adding adequate float to accommodate schedule changes; refer to the scheduling contingency
Budget and Cost	Financial	High	Refer to the cost contingency (15 percent) for any funding for any scope creep
Traffic Impacts	Operational	Medium	Consult traffic management team; refer to traffic management plan
Construction Methodology	Technical	High	Consult construction team; refer to the construction management plan
Poor weather condition	Health, Safety and Environmental	Low	Superintendents to monitor weather forecast regularly and have contingency plans in place
Differing site conditions (e.g. hard grounds)	Technical	Medium	Geotechnical assessment to be completed prior to construction
Third-party utilities	Operational	Medium	Designers and utilities department to thoroughly study and review the drawings to ensure no third-party utilities is in conflict with the construction zone
Stakeholder issues	Reputational	Medium	Project team to be proactive in adopting the stakeholder engagement plan
Archaeological finds	Environmental	High	Archaeological impact assessment to be completed prior to construction
Delay in IFC drawings issuance	Technical	High	Designers to meet the required timelines of design completion
Delay in material deliveries	Operational	Medium	Project manager and superintendent to ensure that all procurement and deliveries are scheduled in time for construction
Unexpected changes in project scope	Technical and Operational	Medium	Project manager to regularly update the construction Gantt schedule and actively communicate with the designers and owner of any project requirements changes

10.0 ENVIRONMENTAL MANAGEMENT

10.1 Greenhouse Gas Emission

The impacts of roundabouts on greenhouse gas emissions depend on the effect on traffic flow. The traffic speed, acceleration, deceleration and most importantly the traffic delay may all effect the greenhouse gas emission at an intersection. The roundabout design encourages slow and consistent traffic speed with minimum idling; all of which can reduce fuel consumption and/or greenhouse gas emission.

The greenhouse gas emission can be computed through the fuel consumption and total delay at the intersection. The total delay time can be converted to fuel consumption: an hour queue is equivalent to one gallon of gas at an intersection. The fuel consumption can then be converted to greenhouse gas emission through a conversion factor of 8,887 grams of CO_2 emissions per gallon of gasoline consumed. Following the mentioned calculation procedure, a greenhouse gas emission for the roundabout design at the intersection of Wesbrook Mall and Chancellor Blvd. at a one hour interval during AM Peak can therefore be computed:

$$\begin{aligned} &Roundabout\ Configuration\ (One\ hour\ interval) \\ &\qquad = 2.4\ hour \times 1\frac{gallon\ of\ gasoline}{hour} \times \left(8.887 \times 10^{-3}\frac{metric\ tons\ CO_2}{gallon\ of\ gasoline}\right) \\ &\qquad = 0.021\ metric\ tons\ CO_2 \end{aligned}$$

With the synchro analysis being able to analyze every type of intersection configuration, a comparison for the greenhouse gas from the different configurations can be evaluated. From the table below, signalized intersection projects the highest annual greenhouse gas emission due to the long total delay time. Although the total delay time difference on an hourly basis for the roundabout and stop sign is not significant, the projected annual emission difference between the two configurations is around 0.6 metric tons CO_2 which is considerably notable.

Table 11 Greenhouse Gas Emissions

Greenhouse Gas Emissions (One hour interval – AM Peak)			
Configurations	**Total delay time (hours)**	**GHG Emission (metric tons CO_2)**	**Annual Projection (metric tons CO_2)**
Roundabout	2.4	0.021	7.78
Signalized	9.6	0.056	20.44
Stop Sign	2.6	0.023	8.40

10.2 Storm Water Management and Landscaping

Storm water in UBC mostly refers to rain, however during winter season melted snow and ice can be a factor as well. The storm water usually runs off from roof, driveway and other hard surfaces into the municipal sewer system. As the water travels to sewers, it picks up pollution along the way; it can contain harmful substances and contaminates. If the storm water is not properly treated, the pollution from the water is released directly into the nearest body of water. This may harm the local water quality and aquatic habitat, therefore awareness to manage the storm water can be very beneficiary in a sustainability standpoint. A landscaping adjustment can be a solution to storm water management.

In terms of landscaping adjustment, a rain garden is a terrific option as it not only helps with the storm water runoff but it also provides an aesthetic appeal to the intersection. A rain garden is a planted/stone covered bed that is specifically designed to receive storm water as the soil absorbs all the storm water that comes in contact. Through the hydrologic cycle, the storm water that is infiltrating into the soil is naturally filtered and cleansed and used by the plants in the garden. The use of landscaping at a roundabout is one of the unique features that separate roundabouts with other traditional intersection configuration as it gives the roundabout design an aesthetic advantage.

10.3 Environmental Impacts Management

In unison with the goals of UBC, Jade Consulting commits to minimize the environmental impacts made on the surrounding by the redesign of Chancellor Boulevard and Wesbrook Mall intersection. Construction may have a negative impact on the environment; however, with proper planning and strategy, impacts can be mitigated. During construction stage, the project team will adopt proper environmental management techniques to meet several sustainability goals. The project team has identified several possible environmental issues associated with the construction of the project which are addressed in Table 12 on the following page.

Table 12 Management Strategies for Environmental Issues

Environmental Issues	Management Strategy
Carbon Footprint and Emissions	• Choice of less polluting materials will be preferred whenever possible • Proper planning and scheduling of materials sourcing will be done ahead to ensure an efficient transportation logistics
Management of Garbage and Recycling	• Comply with UBC's waste management regulations • Recycling bins to be placed on site
Dust	• Water to be sprayed regularly to damp down dust clouds generated from construction • All workers to wear masks or other respiratory protection equipment at all times
Wastewater	• Temporary site drainage to be constructed for collection of construction site wastewater • Stockpile of soil materials to be covered to avoid contamination of surface runoff
Hazardous Materials	• In the case where hazardous materials are found, no construction work will commence until all necessary assessment is conducted and approval to proceed has been given

11.0 CONCLUSIONS

In conclusion, Jade Consulting proposes to build a single lane roundabout system at the intersection of Chancellor Boulevard and Wesbrook Mall, along with a welcoming gateway structure. The design criteria of the roundabout include increasing user safety, sustainability, cost-effectiveness and the requirement of meeting the future traffic demand. The new design accommodates more modes of transportation, has an increased level of service and is safer.

The welcoming gateway structure is proposed to be a lookout tower composed of wood. Located towards the east of the roundabout, the tower is a nine-meter-tall, timber-frame system with glass panels. There are two cantilevered walkways, located on both floors where visitors can appreciate nature. The tower is designed to not obstruct the sightlines of drivers.

Under a "Class B" Cost Estimate with 15% contingency, the final cost of the roundabout and lookout tower will be $1.3 million. Approximately $50,000 of the total project is allocated to the lookout tower, taking things such as material labour and engineering costs into consideration.

Construction is scheduled to start in May 2017 and will last for approximately 55 days. This includes a 10%-time contingency to anticipate potential construction conflicts. The start date was chosen due to lower traffic volumes in and out of UBC during the summer months. A full closure of the intersection is planned during construction. A Traffic Management Plan will address the closure, such as rerouting bus routes, north-south connections, east-west connections and providing shuttle buses.

A detailed Stakeholder Management Plan outlines the steps for stakeholder identification, assessment, communication plan and engagement. There are three different levels of communicating with stakeholders and that includes: inform, consult and collaborate. Different communication methods will be used based on the level of involvement that a stakeholder has.

To take safety into consideration, a Construction Management Plan was written. A Risk Management Plan was also written to consider management strategies for conflicts that may occur on site. Jade Consulting also considers sustainability a priority and looked into greenhouse gas emissions and storm water management of the project.

12.0 RECOMMENDATIONS

Jade Consulting recommends the following action items to be complete before construction commences:

1. Further Site Assessments and Impact Analyses
2. Geotechnical Assessments and Topographic Surveys
3. Project Permits and Insurances Procurement
4. Finalize procurement on prefabricated materials
5. On-going stakeholder engagement as planned

These are to ensure all necessary ground conditions and stakeholders' concerns are considered before the hiring of construction workers and contractors to work on-site for implementation planning.

The construction processes are recommended to operate in sections to minimize interference with the intersection being altered. Excavations and all construction practices should follow the safety plan to ensure a more secure and protected working process.

Ongoing measures will take place to ensure the intended purposes of prioritizing safety and sustainable features will be pursued during construction. Any contingencies or unavoidable conflicts will be resolved with these aspects in mind. There will be regular consultation with all involved parties such as the stakeholders and professional working experts under MOTI guidelines as well as environmental experts.

REFERENCES

1. *Stakeholder Management,* APM Knowledge, http://knowledge.apm.org.uk/bok/stakeholder-management

   Accessed 1 Nov. 2016

2. British Columbia Government. (2016, July). *Engineering Standards & Guidelines*. Retrieved from Landmark Kilometre Inventory: http://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/landmark-kilometre-inventory

3. *CLT Milestone in Montana - Case Study*, Woodworks, http://www.woodworks.org/wp-content/uploads/CLT-Milestone-Montana.pdf

   Accessed 23 Nov. 2016

4. *Concrete Price List*, Oceanconcrete, http://oceanconcrete.com/price-list, Accessed 23 Nov. 2016

5. *Construction Safety Management Plan*, BC Hydro , https://www.sitecproject.com/sites/default/files/Construction%20Safety%20Management%20Plan.pdf. Accessed 24 Nov. 2016.

6. Environmental Issues in Construction, Green Building Solutions. https://greenbuildingsolutions.org/life-cycle-assessment/environmental-issues-construction/ Accessed 23 Nov. 2016

7. *Greenhouse Gas Equivalencies Calculator*, US Environmental Protection Agency , https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Accessed 24 Nov. 2016.

8. Handy, Susan. *Impacts of Roundabouts on Passenger Vehicle Use and Greenhouse Gas Emissions*, University of Southern California, https://www.arb.ca.gov/cc/sb375/policies/rndabt/roundabout_brief.pdf. Accessed 24 Nov. 2016.

9. *Level of Service*, Wikipedia, https://en.wikipedia.org/wiki/Level_of_service, Accessed 23 Nov. 2016

10. *Metals and Alloys - Densities*, The Engineering ToolBox, http://www.engineeringtoolbox.com/metal-alloys-densities-d_50.html, Accessed 23 Nov. 2016

11. Ministry of Transportation. (2013, September). *Highway Planning and Programming Applications*. Retrieved from Guidelines: https://www.th.gov.bc.ca/Publications/planning/index.htm

12. *Mississauga Scrap Metal Pricing*, Premier Recycling, http://www.premierrecycling.ca/contact/premier-recycling-mississauga-ltd/pricing/

    Accessed 23 Nov. 2016

13. Morris, J. & Baddache, F. (2012). Back to Basics: How to make stakeholder engagement meaningful for your company, BSR.https://www.bsr.org/reports/BSR_Five-Step_Guide_to_Stakeholder_Engagement.pdf.Accessed 6 Nov. 2016

14. *OHS Regulation & related materials*, Work Safe BC, https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation. Accessed 24 Nov. 2016.

15. Project Management Institute. (2013). *A guide to the project management body of knowledge (PMBOK guide) – Fifth Edition*. Newton Square, Pa: Project Management Institute.

16. *Roundabout Workshop Module 4: Construction & Maintenance*, NE Roundabouts. http://www.roundabouts.cc/2%20Day%20Roundabout%20Workshop%20-%20Part%202.pdf

    Accessed 9 Nov. 2016

17. *Supplement to TAC Geometric Design Guide*, BC MoT, www.th.gov.bc.ca/roundabouts/documents/740_roundabouts.pdf. Accessed 24 Nov. 2016

18. *Sustainable Development*, International Institute for Sustainable Development, https://www.iisd.org/topic/sustainable-development, Accessed 23 Nov. 2016

19. *Wastewater Management,* Environmental Protection Department The Government of Hong Kong, http://www.epd.gov.hk/epd/english/greenconstruction/poll_pro/wastewater_management.html

    Accessed Nov. 23, 2016

20. *Greenhouse Gas Equivalencies,* EPA United States Environmental Protection Agency, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

    Accessed Mar. 6, 2017

APPENDICES

APPENDIX A – TRANSPORTATION

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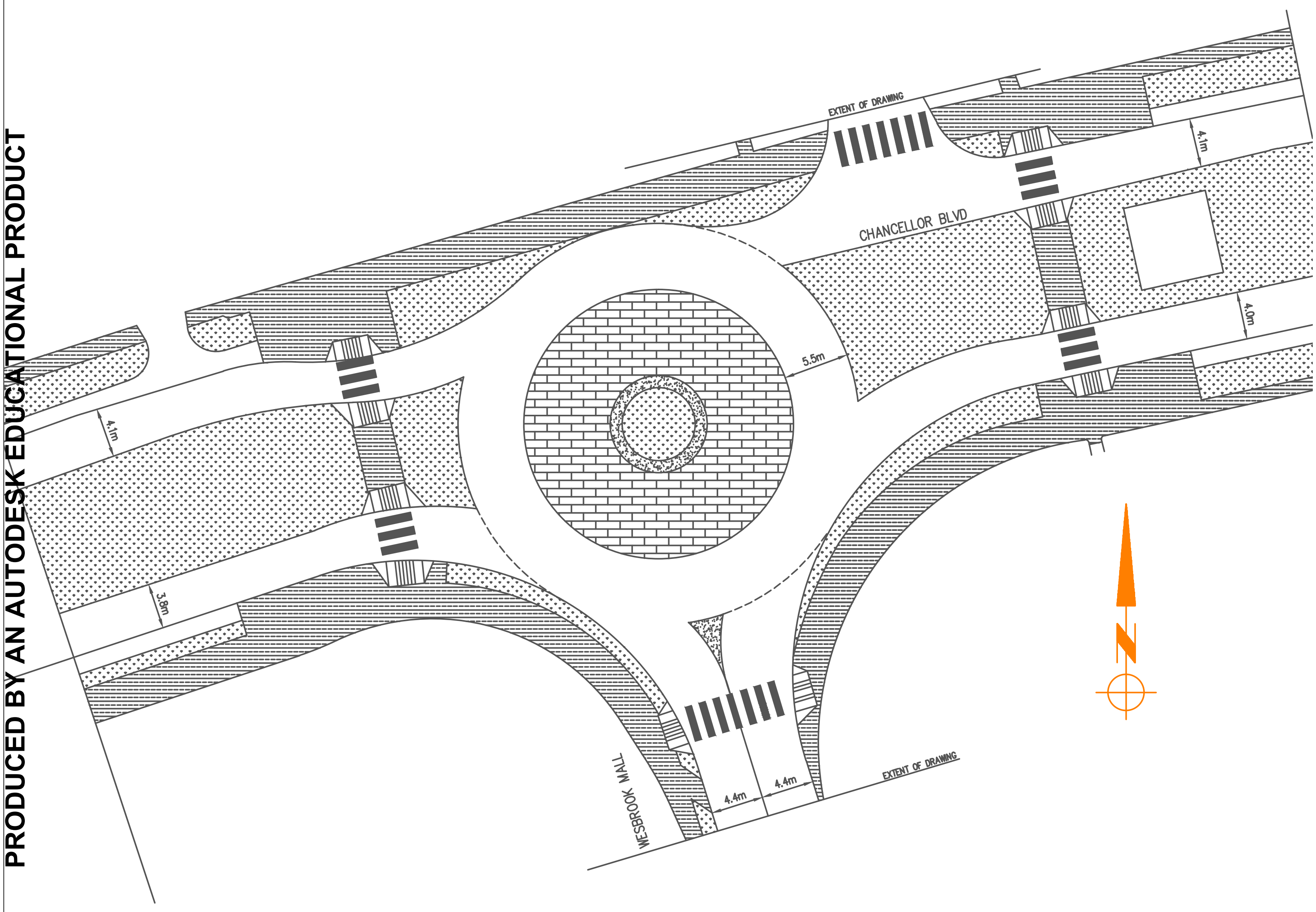

LEGEND

CONCRETE MEDIAN	BRICK PAVER
LANDSCAPING	CONCRETE SIDEWALK
ASPHALT ROAD	

JADE CONSULTING

6250 Applied Science Lane
Vancouver, BC V6T 1Z4
Phone: (604) 583 – 6443
www.jadeconsulting.ca

APPENDIX A

TRANSPORTATION CONSTRUCTION DRAWING

CHANCELLOR BLVD & WESBROOK MALL

ATTENTION

JADE CONSULTING ASSUMES NO RESPONSIBILITY FOR THE CORRECTNESS OF THE INFORMATION SHOWN.

ALL DIMENSIONS SHOWN ON THIS PLAN ARE AS DESIGNED AND NOT AS CONSTRUCTED AND SHOULD BE FIELD CHECKED BY USER OR THEIR AGENT.

Directory: 2017–143–G–00

Date: March 31, 2017

Drawn By: AL

Checked By: HW

T101

SCALE: 1:500

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APPENDIX B – STRUCTURAL

Appendix B1 - List of Assumptions for the Lookout Tower Analysis

For SAP2000

1. Structure is simplified into a 2D simply supported, moment released frame (pinned-pinned connection).
2. Model is analyzed in simplified 2D combined loads
3. Assume only dead loads and live loads contribute from the second, third and roof assembly members.
4. NBCC Design Manual is applied to each dead load, live load, snow load, earthquake load, wind load.
5. Douglas Fir Larch 24f-EX Material Properties used:
    a. Modulus of Elasticity: 13100 MPa
    b. Weight per Unit Volume: 4.8 kN/m3
    c. Poisson Ratio: 0 -> because it is assumed a brittle material
    d. Coefficient of Thermal Expansion:

For Load Hand Calculations

1. In the load hand calculations, assume even load distribution within the members of the frame to verify the load outputs in SAP2000.
2. Structure is considered "Normal" hazard in a likelihood of a disaster
3. Class C Soil Conditions
4. Ignore corner effects of wind load.

Appendix B2 - List of Assumptions for Member Design

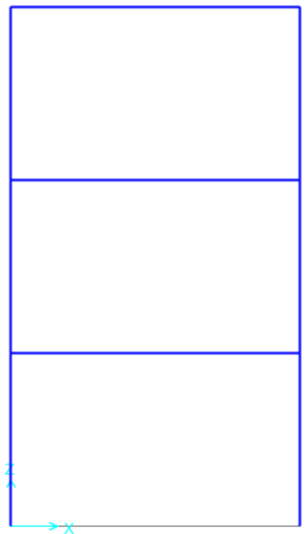
1. Dry Service Conditions
2. Load duration is based on standard term loading
3. Glulam will be untreated
4. Simply supported conditions
5. No eccentric loads applied

NBCC Load Combinations

Case 1: $1.4D$
Case 2: $1.25D + 1.5L$
Case 3: $1.25D + 1.5S$
Case 4: $1.25D + 1.4W$
Case 5: $1.0\,E$

APPENDIX B3 – NBCC Load Calculations

Dead Loads – Distributed Loads



Column and Beam

Douglas Fir Larch – Glulam: 4800 N/m3

Flooring and Façade

Cedar Wood: 3500 N/m3

Roofing

Skylight Glass: 580 N/m3

Loads on 2D Frame:

Roof Floor

$$Skylight\ Glass: 580\ N/m^3 \times \frac{(6\ meters\ \times 5\ centimeters)}{4} = 0.0435\ kN/m$$
$$Beams: 4800\ N/m^3 \times (0.365\ meters\ \times 0.38\ meters) = \ 0.666\ kN/m$$
$$Wall: 580\ N/m^3\ \times (6\ meters\ \times 5\ centimeters) = 0.174\ kN/m$$
$$Total\ Dead\ Load = Skylight\ Glass + Beams + Walls = 0.884\ kN/m$$

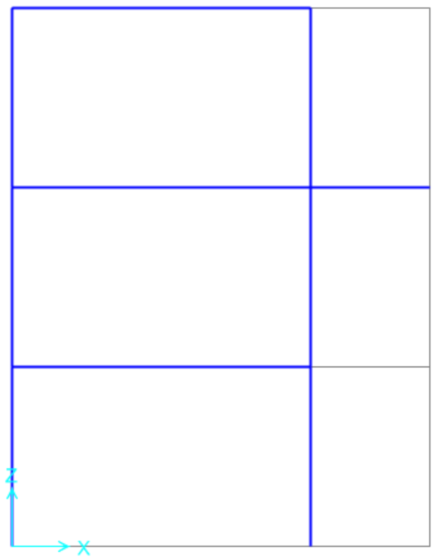
1st and 2nd Floor

$$Beams: 4800 \frac{N}{m^3} \times (0.365\ meters\ \times 0.38\ meters) = \ 0.666kN/m$$
$$Wall: 580\ N/m^3\ \times (6\ meters\ \times 5\ centimeters) = 0.174\ kN/m$$
$$Floor/Balcony: 3500\ N/m^3\ \times \frac{(6\ meters\ \times 50\ centimeters)}{4} = 0.263\ kN/m$$
$$Total\ Dead\ Load = Beams + Wall + Floor = 1.1\ kN/m$$

Assumptions:

- Beam sizes are 0.365m x 0.38m
- 2x4 area of façade

Live Loads – Distributed Loads



Per Minimum Specified Load (kPa) [NBCC T3.4]

Roof: 1.0 kPa

Exterior Balcony: 4.8 kPa

Interior Assembly: 4.8 kPa

Loads on 2D Frame:

$$Roof\ Load = 1\ kPa\ \times \frac{6\ meters}{4} = 1.5\ kN/m$$

$$Floor\ Load = 4.8\ kPa\ \times \frac{6\ meters}{4} = 7.2\ kN/m$$

$$Balcony\ Load\ (Cantilever) = 4.8\ kPa\ \times \frac{6\ meters}{4} = 7.2\ kN/m$$

Snow Loads – Distributed Loads

$$S = I_s[S_a(C_bC_wC_sC_a) + S_r] \;\; designed\ for \frac{1}{50}\ event$$

$$C_b = Basic\ Roof\ Snow\ Load\ Factor = 0.8$$
$$C_w = Wind\ Exposure\ Factor = 0.75$$
$$C_s = Roof\ Slope\ Factor = 1.0$$
$$C_a = Shape\ Factor = 1.0$$
$$I_s = Importance\ Factor = 1.0$$
$$S_a = Vancouver\ conditions = 1.9\ kPa$$
$$S_r = Vancouver\ conditions = 0.3\ kPa$$
$$S = 1.0 \times [1.9\ kPa \times (0.8 \times 0.75 \times 1.0 \times 1.0) + 0.3\ kPa = 1.44\ kPa$$
$$S = 1.44\ kPa \times 6\ meters = 8.64\ kN/m$$

Assumptions

- Building is exposed to wind in all directions
- Incline of roof is less than 15 degrees
- Structure is regarded as “Normal” hazard in a likelihood of a disaster

Wind Loads – External Pressure Loads

$$P = I_wqC_eC_gC_p$$

$$I_w = importance\ factor\ for\ wind\ load = 1.0$$
$$q = reference\ velocity\ pressure = 0.48\ for \frac{1}{50} year\ wind\ velocity$$
$$C_e = exposure\ factor = 0.97$$
$$C_g = gust\ effect\ factor = 2.0$$
$$C_p = external\ pressure\ coefficent\ factor\ over\ area\ of\ surface = 1.0$$
$$P = 1.0 \times 0.48 \times 0.97 \times 2 \times 1 = 0.93\ kPa$$
$$F_{wind} = P \times Floor\ Width = 0.93\ kPa \times 5\ meters = 4.65\ kN/m$$

Assumptions

- Structure is regarded as “Normal” hazard in a likelihood of a disaster
- Ignore corner effects of wind load

Seismic Loads – Horizontal Load per Floor

$$V = \frac{S(T_a)M_v I_E W}{R_d R_o}$$
$$I_E = Importance\ Factor = 1.0$$
$$R_d = Force\ Modification\ Factor = 3.0$$
$$R_o = Force\ Modification\ Factor = 1.7$$
$$I_E = Importance\ Factor = 1.0$$
$$S_a(0.5) = for\ Vancouver = 0.65$$
$$S_a(0.2) = for\ Vancouver = 0.95$$
$$F_a\ \&\ F_v = 1.0$$
$$T_a = Seismic\ Period = 0.05(h)^{3/4} = 0.05(5\ meters)^{3/4} = 0.17$$
$$S(T_a) = Spectral\ Response\ Acceleration = \min\{F_v S_a(0.5) | F_a S_a(0.2)\} = 0.65\ for\ wood\ structure$$
$$\frac{S_a(0.2)}{S_a(2.0)} = 5.33\ with\ T_a \leq 1.0\ then\ M_v = 1.0$$
$$V = \frac{0.65 \times 1.0 \times 1.0 \times W}{3.0 \times 1.7} = 0.125W\ where\ W = Dead\ Load\ [kN]$$
$$W = \left(0.844\frac{kN}{m} + 1.1\frac{kN}{m} + 1.1\frac{kN}{m} + 1.1\ \frac{kN}{m}\right) \times 6\ meters$$
$$+ \left(4.8\frac{kN}{m^3} \times 3\ meters \times 0.315\ meters\ \times 0.38\ meters\right) \times 6 = 35.2\ kN$$
$$V = 0.125W = 0.125\ \times 35.2\ kN = 4.4\ kN$$

Distribution of Base Shear

$$W_{roof} = 0.844\frac{kN}{m} \times 6\ meters = 5.1\ kN$$
$$W_{1st} = W_{2nd} = 1.1\ \frac{kN}{m} \times 6\ meters = 6.6\ kN$$
$$\sum(W \times h) = W_{1st} \times h_1 + W_{2nd} \times h_2 + W_{roof} \times h_{roof} = 106\ kNm$$
$$V_{1st} = V \times \frac{W_{1st} \times h}{\sum(W \times h)} = 4.4\ kN\ \times \frac{6.6\ kN\ \times 3\ meters}{106kNm} = 0.82\ kN$$
$$V_{2nd} = V \times \frac{W_{2nd} \times h_2}{\sum(W \times h)} = 4.4\ kN\ \times \frac{6.6\ kN\ \times 6\ meters}{106kNm} = 1.64\ kN$$
$$V_{roof} = V \times \frac{W_{roof} \times h_{roof}}{\sum(W \times h)} = 4.4\ kN\ \times \frac{5.1\ kN\ \times 9\ meters}{106kNm} = 2\ kN$$

Assumptions

- Structure is regarded as “Normal” hazard in a likelihood of a disaster
- Wood Diaphragms – ductile condition
- For Vancouver conditions only
- Class C Soil conditions

APPENDIX B4 – Foundation Design

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

$$q_{ult} = ultimate\ bearing\ capctiy$$

$$\sigma'_D = effective\ stress = 0.5*16+1(16\text{-}9.81) = 14.2\ kPa$$

$$N_q = e^{\pi tan\varphi'} tan^2\left(45 + \frac{\varphi'}{2}\right) = 18.4$$

$$\gamma' = \gamma - \gamma_w = 14.2 - 9.81 = 4.4\ kN/m^3$$

$$N_\gamma = 2(N_q + 1)tan\varphi' = 22.4$$

$$q_{ult} = 14.2 * 18.4 + .4 * 4.4 * 2 * 22.4 = 372\ kPa$$

$$q_{allowable} = \frac{q_{ult}}{FOS} = \frac{372}{3} = 124\ kPa$$

Assumptions

- 2x2m square footing at the depth of 1.5m
- Groundwater table depth of 1m
- Moist and saturated glacial till specific weight of 17 kN/m^3
- Glacial till angle of friction equal to 30^o
- FOS of 3

APPENDIX B5 - MEMBER DESIGN CALCULATIONS

COLUMN DESIGN

For Glulam

Member Size: 315 mm by 380 mm

b:	315	mm	d:	380	mm	L:	3000	mm

Factored Compressive Resistance

Pr = ϕ* Fc* A* Kzcg *Kc

ϕ* Fc = factored compressive resistance strength given in **TABLE 3.8**

Kzcg: 0.68 (Z)^-0.13 ≤ 1.0

Kc: [1 + Fc/E' *Kzcg * Cc ^3]^-1

where Z = member volume in m3

Cc = greater(Ke*Ld/d, Ke*Lb/b) < 50 Lb, Ld = unsupported length

Fc/E' = strength to stiffness ratio given in **TABLE 3.9**

Ke = effective length factor in **FIGURE 3.1**

A:	119700	mm2	
Z:	359.1	m3	
Fc/E':	0.0000667		
Ke:	1		
ϕ* Fc:	18.1	MPa	
Lb:	3000	mm	
Ld:	3000	mm	
Cc:	9.5238095		GOOD

Kzcg: 0.316468807

Kc: 0.982092246

Pr = 673373.339 N

673 kN > Pf GOOD

Combined Loading

(Pf / Pr)^2 + (Mf / Mr)*(1/(1-Pf/Pe)) ≤ 1.0

Mr = from Beam Selections Table

E05*I = 0.87*Es*I from Beam Selections Table

Pe: π^2 * E05 * I / (Ke *L)^2

Es*I:	1.84E+13
E05*I:	1.601E+13
L:	3000
Mr:	209
Pe:	17554736

(Pf / Pr)^2 + (Mf / Mr)*(1/(1-Pf/Pe)): 0.50 ≤ 1.0 GOOD

Shear Force Check

Vf < Vr

Vr = 1.15*Vr' Vr' = from Beam Selections Table

Vr': 144

Vr = 165.6 ≥ Vf GOOD

L/180 Deflection Check

Es*I > Es*Ireq Es*I from Beam Selections Table

Es*I:	1.84E+13	Nmm
Wind Load:	2	kN

Es*Ireq = 180*(Wind Load*L^2/48)

Es*Ireq: 67500000000 < Es*I GOOD

BEAM DESIGN

For Glulam

Member Size: 365 mm by 380 mm

b:	365	mm	d:	380	mm	L:	6000	mm

Moment Capacity

Mr = lesser of Mr'*K l or Mr'*Kzbg [Nmm]

Mr' = ϕ*Fb*S

Fb = fb*(Kd*Kh*Ksb*Kt) [MPa]

S = b*d^2/6

Cb = Sqrt(Le*d/b^2) K l = determine from Table 2.9 with Cb

Kzbg = (130/b)^0.1 * (610/d)^0.1 * (9100/L)^0.1 ≤ 1.3

fb:	19.5	Mpa
Kd:	1	
Kh:	1	
Ksb:	0.8	
Kt:	1	
Ke:	1	

Fb:	15.6	MPa		
S:	8784333.33	mm3		
Cb:	4.13689558	------->	K l:	1
Kzbg:	0.98584511	≤ 1.3	GOOD	

Mr' =	123.33204	kNm	
Mr =	121.59	> Mf	GOOD

Shear Capacity

Vr = ϕ*Fv*2*Ag/3 [N]

Fv = fv*(Kd*Kh*Ksv*Kt) [MPa]

Ag = b*d

fv:	1.5	Mpa
Kd:	1	
Kh:	1	
Ksv:	0.87	
Kt:	1	

Fv:	1.305	Mpa
Ag:	138700	mm2

Vr =	108.60	> Vf	GOOD

Deflection Check:

EsIreq 1 = 180 *(5wL^3/384) where w is the total load

EsIreq 2 = 360*(5w'L^3/384) where w' is the live load

Eslreq 1:	5.8725E+12	Nmm						
Eslreq 2:	7.29E+12	Nmm	------->	GOVERN:	7.29E+12	Nmm	< EsI	GOOD

Distributed Load Check:

Wr L^0.18 = ϕ*Fv*0.48*Ag*Cv*(bd)^-0.18 [Nm^0.18)

Fv:	1.305	Mpa
Ag:	138700	mm2
Cv:	3.69	

Wr L^0.18 =	34.2470622	kNm^0.18	
Wr =	24.67	> Wf	GOOD

BEAM DESIGN

For Glulam

Member Size: 265 mm by 342 mm

b:	265	mm	d:	342	mm	L:	6708	mm

Moment Capacity

Mr = lesser of Mr'*K l or Mr'*Kzbg [Nmm]

Mr' = ϕ*Fb*S

Fb = fb*(Kd*Kh*Ksb*Kt) [MPa]

S = b*d^2/6

Cb = Sqrt(Le*d/b^2)   K l = determine from Table 2.9 with Cb

Kzbg = (130/b)^0.1 * (610/d)^0.1 * (9100/L)^0.1 ≤ 1.3

fb:	19.5	Mpa
Kd:	1	
Kh:	1	
Ksb:	0.8	
Kt:	1	
Ke:	1	

Fb:	15.6	MPa			
S:	5165910	mm3			
Cb:	5.7157116	------->	K l:	1	
Kzbg:	1.01728733	≤ 1.3	GOOD		

Mr' =	72.5293764	kNm	
Mr =	72.53	> Mf	GOOD

Shear Capacity

Vr = ϕ*Fv*2*Ag/3 [N]

Fv = fv*(Kd*Kh*Ksv*Kt) [MPa]

Ag = b*d

fv:	1.5	Mpa
Kd:	1	
Kh:	1	
Ksv:	0.87	
Kt:	1	

Fv:	1.305	Mpa
Ag:	90630	mm2

Vr = 70.96 > Vf GOOD

Factored Compressive Resistance

Pr = ϕ* Fc* A* Kzcg *Kc

ϕ* Fc = factored compressive resistance strength given in **TABLE 3.8**

Kzcg: 0.68 (Z)^-0.13 ≤ 1.0

Kc: [1 + Fc/E' *Kzcg * Cc ^3]^-1

where Z = member volume in m3

Cc = greater(Ke*Ld/d, Ke*Lb/b) < 50

Fc/E' = strength to stiffness ratio given in **TABLE 3.9**

Ke = effective length factor in **FIGURE 3.1**

A:	90630	mm2	
Z:	607.96452	m3	
Fc/E':	0.0000667		
Ke:	1		
ϕ* Fc:	18.1	MPa	
Lb:	6708	mm	
Ld:	6708	mm	
Cc:	25.314		GOOD

Kzcg: 0.29553216

Kc: 0.75771877

Pr = 367335.873 N

367 kN > Pf GOOD

CONNECTION DESIGN

For Steel Bolts

Refer to: **Pg 320 CWC Design Manual, Double Shear, 6 mm Steel Internal Plate**

Interpolation	
Spacing:	Force:
88	11.8
74	16.2
80	**14.31429**

Required Force: 55 kN

From Bolt Selection Table:

PRf:	14.3	kN/bolt
Grt:	12.2	kN
Spacing:	80	mm

Try: 0.5" diameter bolts

PRrt = lesser[PRf*nc*nr*(Kd*Ksv*Kt), N'u*nc*nr*(Kdy*Ksf*Kt)]

PGrt = PRf*nc*(Kd*Ksv*Kt)+Grt*Jtr*(Kd*Kst*Kt)

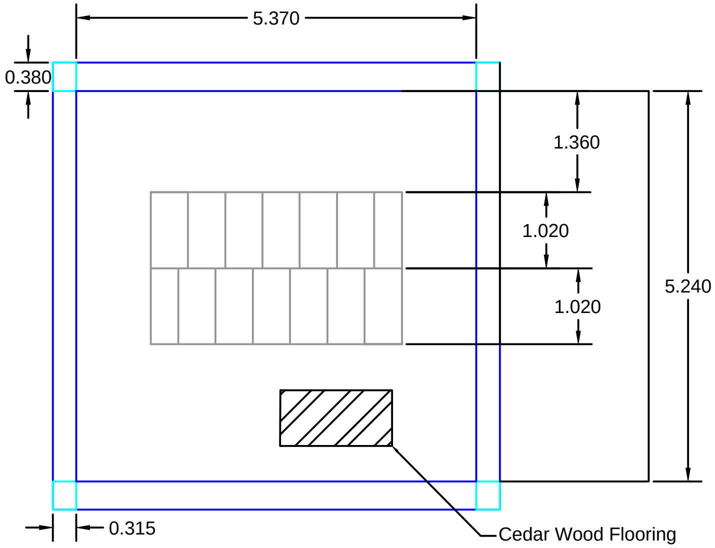
Kd:	1	nc:	3
Ksv:	1	nr:	2
Kt:	1	N'u:	14.3
Kdy:	1	Jtr:	1
Ksf:	1		
Kst:	1		

PRrt =	85.9	kN	>Pf	GOOD
PGrt =	55	kN	>Pf	GOOD

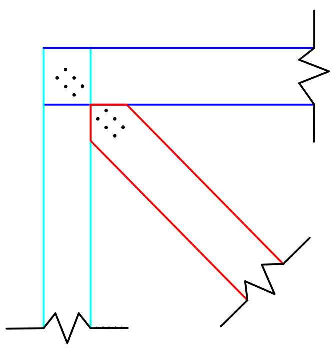
Net Tension:

Tr = 0.75*ϕb*Ab*Fu

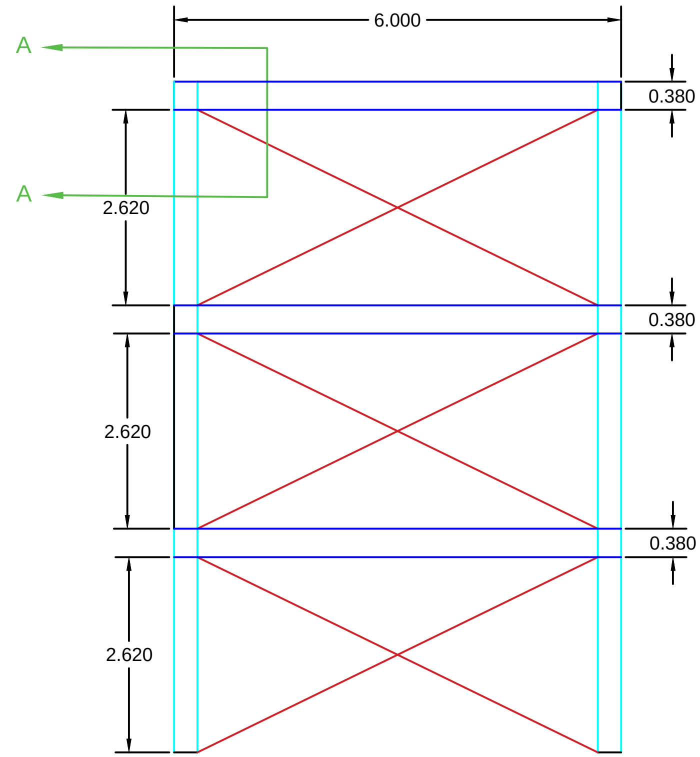
Tr = 188.7992 kN >Pf GOOD



Plan View



Section A - A
Connection
Scale: 1:250



Elevation View

315 mm x 380 mm D.Fir.L 24f-EX Columns	265 mm x 342 mm D.Fir.L 24f-EX Braces
365 mm x 380 mm D.Fir.L 24f-EX Beams	Double Shear, 6mm Steel Internal Plate 0.5" Bolts
Staircase	

JADE CONSULTING

6250 Applied Science Lane
Vancouver, BC V6T 1Z4
Phone: (604) 583 - 6443
www.jadeconsulting.ca

APPENDIX B6
Structural Drawing

PLAN & ELEVATION
DRAWING
CHANCELLOR BLVD
&
WESBROOK MALL

Wood Lookout
Tower

ATTENTION

JADE CONSULTING ASSUMES NO RESPONSIBILITY FOR THE CORRECTNESS OF THE INFORMATION SHOWN.

ALL DIMENSIONS SHOWN ON THIS PLAN ARE AS DESIGNED AND NOT AS CONSTRUCTED AND SHOULD BE FIELD CHECKED BY USER OR THEIR AGENT.

Directory: 2017-143-0-00

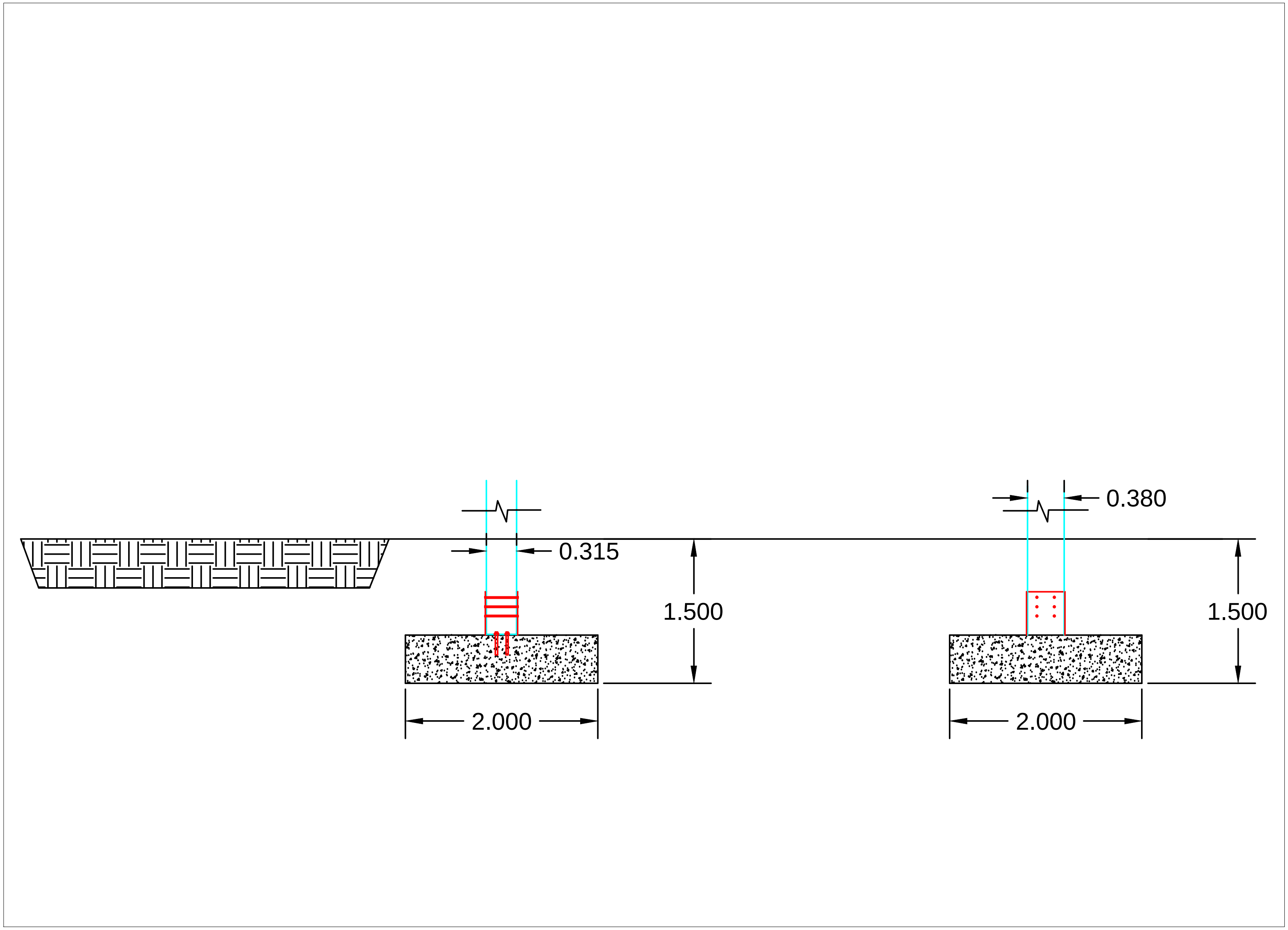
Date: March 31, 2017

Drawn By: HW

Checked By: AL

S101

SCALE: 1:500



315 mm x 380 mm D.Fir.L 24f-EX Columns

Soil Bed Material

2 m x 2 m Concrete Foundation

6mm Plate Anchor Connection with 0.5" Bolts

JADE CONSULTING

6250 Applied Science Lane
Vancouver, BC V6T 1Z4
Phone: (604) 583 - 6443
www.jadeconsulting.ca

APPENDIX B6
Structural Drawings

ELEVATION DRAWING
CHANCELLOR BLVD
&
WESBROOK MALL

Foundation Drawing

ATTENTION

JADE CONSULTING ASSUMES NO RESPONSIBILITY FOR THE CORRECTNESS OF THE INFORMATION SHOWN.

ALL DIMENSIONS SHOWN ON THIS PLAN ARE AS DESIGNED AND NOT AS CONSTRUCTED AND SHOULD BE FIELD CHECKED BY USER OR THEIR AGENT.

Directory: 2017-143-0-00

Date: March 31, 2017

Drawn By: AL

Checked By: HW

S102

SCALE: 1:500

APPENDIX C – COST

PROJECT COST ESTIMATE
Project No. XXXXX

Worksheet 1 of 3

Project Worksheet

Project Information

Project Description: Roundabout Intersection of Wesbrook Mall and Chancellor Boulevard

Project Location: Vancouver, BC

LKI: **914-0602**
Longitude: **49.273302**
Latitude: **9123.249109**

Scope Statement: The scope of the preliminary design report is to design an intersection that increases user safety, is sustainable, cost-effective, meets the future traffic demand and develops an inviting gateway to UBC.

Length of Roadway: 0.15 kms

Number of lanes: Two

Development Density: Suburban

Terrain Type: Flat

Key Plan/Sketch: attached

Other information: See Assumptions Worksheet <insert other relevent information to the cost estimate>

Estimate Information

Cost Estimate (excluding escalation): **$1,326,975**

Constant Year Dollars ($) : 2016$

Estimate Level: Conceptual

Date Prepared: 11/28/16

Prepared By: Jordan Yang

PROJECT COST ESTIMATE
Project No. XXXX

Worksheet 2 of 3

Assumptions Worksheet

NOTE: The Assumptions Worksheet may differ depending the 'Level of Estimate' being prepared (conceptual, planning, prelim, detailed, pre-tender) and the approach of the Estimator. This is a SAMPLE of areas and items to consider and include. It is not an exhaustive list and/or may include items not applicable to all estimates.

Overall Estimating Assumptions

How was the estimated developed ?	
i.e. elemental parametric method or using historical cost comparisons on relevant, similar projects	Precedent Example and Unit Costs
i.e. was the estimate developed by project team or independantly	Independently
Explain other assumptions and how they may influence or impact costs?	Flat
i.e. Type of terrain - extreme, mountainous, rolling, level.	UBC Endowment Lands
i.e. Geographic location within BC - Lower Mainland; Northern; Southern Interior; Vancouver Island etc.	Suburban
i.e. Development Density (ie.Urban, Suburban, Rural) impacts work complexity, traffic managment and utilities etc.	Information is provided by client and AutoCAD drawing from original creation of intersection
i.e. Scope Uncertainty: What is the quality/quantity of available project information? current, complete, & accurate?	Medium Complexity
i.e. Overall complexity and constructability issues	
Any other overall assumption or costing decisions to document ?	

Project Management and Planning Calculations

How is planning and project managment cost determined as a % of total cost or some other method?	Percentage Cost

Design Calculations

Is design amount determined as a % of Construction or some other method?	Percentage Cost
Example: Calculated as a 7% of Grade Construction and/or 8% of Structural	

Property Assumptions

What was the basis for determining property information and impacts?	
What types of properties are involved (residential, commercial, industrial) ? And how many?	Residential
How was market values of the property established?	
How are the variable costs determined? What's included? Is there an allowance for internal costs and legal fees?	These values ignored, under jurisdiction of UBC Endowment Lands
Attach property detailed sheets as necessary outlining calculations	

Environmental Assumptions

Is the work within an sensitive area? Is this a CEAA project?	No
How was compensation value determined?	Percentage of Costs
How much mitigation work is anticipated? How was it valued?	Floodwater Control/ Percentage

Construction Assumptions

What is the project delivery/procurement method? (Design-Bid-Build/Design-Build/Day Labour/P3/DBFO)	Design-Bid-Build
Is there a Design Criteria Sheet completed for the project?	Dirt
Geotechnical information: What were the significant material assumptions: solid rock, boulders, mixed, dirt ?	100mm Asphalt, 150mm base, 300mm sub-base
Were there any structures included? How many watercourses were identified or assumed?	Taken from AutoCAD
What was the assumed road cross-section? Material depths? Asphalt?	Under Cost Breakdowns
Detailed calculations for construction cost elements contained on estimate 'detail sheets'	
i.e include 'detail sheets' outlining **quantity calculations (based on most probable?)**	
i.e. provide **explanation of unit prices** (e.g. prices of similar projects, MOT cost data; labour, matr'l, equip)	
i.e traffic management considerations	
i.e mobilization and demobilization considerations	

Construction Supervision Calculation

How was the construction supervision determined?	
Example: Calculated as a % of each Construction component (including contingency) as follows:	Grading 7%, Operational and Other 8%, Structural and Paving 6.5%, and Environmental Compensation 8%

Risks Assessment

Was a comprehensive Risk Assessment conducted?	No
What are the major risk items? How were they identified and quantified?	A more comprehensive risk assessment will be implemented further into the project
How were these risks allowed for in the estimate? Are they covered by contingency or included in base Cost Elements	Covered by contingencies

Contingency Assumptions

Was contingency applied as a set % basis or was a Risk Assessment conducted identifying and quantifying Risks?	Percentage Basis	
Was contingency applied uniformly to all Cost Elements and project segments (Yes or No) ?	Yes	
What is the amount or % that was applied ?		30
Is contingency based on the current level of project knowledge and associated risk to deliver the project scope ?	Associated Risk/Preliminary Phase	

Inclusion and Exclusions

Is there **anything NOT included** in the estimate? (i.e. pre-project development costs etc.)	Property Value, Property Levies
Is there anything **specifically included** in the estimate that may be unusual or not normally be part of project cost?	No

PROJECT COST ESTIMATE
Project No. XXXX

Worksheet 3 of 3

Cost Element Worksheet

Notes:

Data Entry Cells = **Amounts entered are SAMPLES ONLY.** These cells are directly data entered and used as the basis for calulating amounts in other cells. The amounts shall be established by the Estimator based on knowledge and information available at the time the estimate is developed.

Contingency % Cells = **Percentage (%) shown is a SAMPLE ONLY** and should only be used as a guide. The actual %'ages used in these cells shall be set by the Estimator based on the assessed level of risk and uncertainty associated with each cost element at the time the estimate is developed.

Non-Data Entry Cells = **Amounts calculated are SAMPLES ONLY.** These cells contain formulas. The formulas should be used as a guide only. The calculated amounts for each cost element shall be reviewed, adjusted and established by the Estimator as necessary for each cost element based on their knowledge and information at the time the estimate is developed.

COST ELEMENT	BASE ESTIMATE	CONTINGENCY		TOTAL ESTIMATE	COMMENTS
		%	$		
PROJECT MANAGEMENT	30,000	15%	4,500	34,500	3.5% of Total Project Estimate
PLANNING	6,610	15%	991	7,601	1% of Construction Base Estimate
DESIGN					
PRELIMINARY DESIGN	13,219	15%	1,983	15,202	2% of Construction Base Estimate
DETAILED DESIGN SERVICES	60,000	15%	9,000	69,000	See Assumptions Worksheet
DESIGN TOTAL	**73,219**	**15%**	**10,983**	**84,202**	
PROPERTY					
MARKET VALUE OF LAND	0	15%	0	0	
VARIABLE COSTS	0	15%	0	0	25% of Market Value
LESS: SURPLUS LAND RECOVERIES	0	15%	0	0	Residual land sales from surplus property
PROPERTY TOTAL	0	**0%**	**0**	***0***	
ENVIRONMENT					
ENVIRONMENTAL COMPENSATION	48,141	15%	7,221	55,362	
ENVIRONMENT TOTAL	**48,141**	**15%**	**7,221**	**55,362**	
CONSTRUCTION					
ROAD CONSTRUCTION					
GRADE CONSTRUCTION	76,243	15%	11,436	87,679	
PAVING CONSTRUCTION	53,606	15%	8,041	61,647	
UTILITY CONSTRUCTION	161,500	15%	24,225	185,725	
OPERATIONAL CONSTRUCTION	29,000	15%	4,350	33,350	
ROADSIDE CONSTRUCTION	59,880	15%	8,982	68,862	
OTHER CONSTRUCTION	219,256	15%	32,888	252,144	
ROAD CONSTRUCTION SUB-TOTAL	***599,485***	***15%***	***89,923***	***689,408***	
STRUCTURAL CONSTRUCTION	61,467	15%	9,220	70,687	
CONSTRUCTION TOTAL	**660,952**	**15%**	**99,143**	**760,095**	
CONSTRUCTION SUPERVISION	**60,000**	**15%**	**9,000**	**69,000**	See Assumptions Worksheet
OTHER COSTS					
<INSERT ITEMS>	0	15%	0	0	describe each item in detail
OTHER COSTS TOTAL	**0**	**15%**	**0**	**0**	
PAST COSTS (prior to <insert date>)	19,500	0%	0	19,500	
MANAGEMENT RESERVE (if applicable)					maintained by CPB (5% of total estimate)
TOTAL	***898,422***	**15%**	***131,838***	***1,030,260***	
Contractor Mark-up	154,539	15%		$ 1,184,798.76	
PST+GST	$142,175.85	12%		$ 1,326,974.61	

Initial Costs					
Task Type	Task	Quantity	Unit of Measurement	Unit Rate	Price
Site Assessment	Overall Site Assessment	1		$ 6,000.00	$ 6,000.00
Construction	Construction Crew Mobilization	1		$ 2,000.00	$ 2,000.00
	Traffic Control	64	day	$ 2,000.00	$ 128,000.00
	Traffic Management	1	tmp	$ 1,000.00	$ 1,000.00
	Removal of Asphalt	2500	m^2	$ 8.00	$ 20,000.00
	Removal of Curb	108.2	m^3	$ 80.00	$ 8,656.00
Grading	Excavation	461.5	m^3	$ 50.00	$ 23,075.00
	Prepare/Compact Sub-base	1476.9	Tonnes	$ 26.00	$ 38,399.40
	Place and Compact Gravel	492.3	Tonnes	$ 30.00	$ 14,769.00
New Medians Build	Form Pour Finish Meeting Curbs				
	Pour Concrete	220	LM	$ 35.00	$ 7,700.00
Reinstallations	Catch Basin	5		$ 1,800.00	$ 9,000.00
	Rectangular Rapid Flashing Beacons	10		$ 15,000.00	$ 150,000.00
	Hydrants	1		$ 2,500.00	$ 2,500.00
Welcome Sign	Installation	1		$ 2,782.00	$ 2,782.00
Curbs and Ramps	Forms/Concrete and Finish	533	LM	$ 60.00	$ 31,980.00
Sidwalks	Pour Concrete	558	m^2	$ 50.00	$ 27,900.00
Streets	Paving	536.06	Tonnes	$ 100.00	$ 53,606.00
Finish	Install Road Signage and Paintlines	1		$ 3,500.00	$ 3,500.00
	Landscaping	848	m^2	$ 50.00	$ 42,400.00
Construction Close-Out	Site Clean-Up	1		$ 2,000.00	$ 2,000.00
	Crew Demobilization	1		$ 2,000.00	$ 2,000.00
Electrical	Electrical Use	1		$ 25,000.00	$ 25,000.00
				Sub Total	$ 602,267.40

Maintenance Costs					
Task Type	Task	Quantity	Unit of Measurement	Unit Rate	Price
Landscaping	Mowing, Weed Control, Fertilizing	848	M^2	0.8	678.4
Electrical	Electrical Recalibrations/Maintenance	1		800	800
				Total	1478.4
				PST+GST	1655.808

Calculation

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
	Observation Tower						**70,687.81**		**70,687.81**	
	Total supplement (15.00% of 61,467.00)							9,220.05		9,220.05
1.	**Cost by Assembly**						**61,467.76**		**61,467.76**	
1.1.	**Curtain wall, aluminum, stock, double glazed, including glazing, average**	**22-08 44 13 10**		**S.F.**	**54**	**81.46**	**4,398.98**	**81.46**	**4,398.98**	**1**
1.1.1.	Curtain wall, aluminum, stock, double glazed, including glazing, average	084413100150	Materials	S.F.	1	71.00	71.00	69.08	69.08	0.973
1.1.2.	**Crew**	**H-1**		**S.F.**	**1**	**12.38**	**12.38**	**12.38**	**12.38**	**1**
1.1.2.1.	Glaziers	GLAZ	Labor	Hours	0.0889	47.80	4.25	62.06	5.52	1.298
1.1.2.2.	Structural Steel Workers	SSWK	Labor	Hours	0.0889	54.30	4.83	77.21	6.86	1.422
1.2.	**Exterior wood door frames, oak, 5/4" x 4-9/16" deep, incl. exterior trim**	**22-06 48 13 10**		**L.F.**	**24**	**26.97**	**647.32**	**26.97**	**647.32**	**1**
1.2.1.	Exterior wood door frames, oak, 5/4" x 4-9/16" deep, incl. exterior trim	064813100600	Materials	L.F.	1	21.00	21.00	23.92	23.92	1.139
1.2.2.	Carpenters	CARP	Labor	Hours	0.0457	49.25	2.25	66.77	3.05	1.356
1.3.	**6" x 6" wood, column framing**	**22-06 11 10 14**		**M.B.F.**	**4.806**	**3,636.92**	**17,479.04**	**3,636.92**	**17,479.04**	**1**
1.3.1.	6" x 6" wood, column framing	061110140460	Materials	M.B.F.	1	1,750.00	1,750.00	1,993.25	1,993.25	1.139
1.3.2.	Carpenters	CARP	Labor	Hours	24.6154	49.25	1,212.31	66.77	1,643.67	1.356
1.4.	**Beam and girder framing, single, 2" x 8", pneumatic nailed**	**22-06 11 10 10**		**M.B.F.**	**3.844**	**1,823.34**	**7,008.92**	**1,823.34**	**7,008.92**	**1**
1.4.1.	Beam and girder framing, single, 2" x 8", pneumatic nailed	061110103525	Materials	M.B.F.	1	660.00	660.00	751.74	751.74	1.139
1.4.2.	Carpenters	CARP	Labor	Hours	16.0481	49.25	790.37	66.77	1,071.60	1.356
1.5.	**2" x 4" wood joist, framing**	**22-06 11 10 18**		**M.B.F.**	**0.2**	**1,987.70**	**397.54**	**1,987.70**	**397.54**	**1**
1.5.1.	2" x 4" wood joist, framing	061110182650	Materials	M.B.F.	1	615.00	615.00	700.49	700.49	1.139
1.5.2.	Carpenters	CARP	Labor	Hours	19.2771	49.25	949.40	66.77	1,287.21	1.356
1.6.	**Wood block flooring, end grain, natural finish, fir, 1" thick**	**22-09 64 16 10**		**S.F.**	**108**	**9.44**	**1,019.82**	**9.44**	**1,019.82**	**1**
1.6.1.	Wood block flooring, end grain, natural finish, fir, 1" thick	096416100400	Materials	S.F.	1	3.76	3.76	5.05	5.05	1.344
1.6.2.	Carpenters	CARP	Labor	Hours	0.064	49.25	3.15	68.59	4.39	1.393

Pos	Text	Num	Category	Unit	Quantity	Unit Cost	Cost	Total UC	Total Cost	Reg.
1.7.	**Stair, industrial ships ladder, aluminum, grating treads, 24" wide, incl 2 line pipe rail, per riser**	**22-05 51 33 16**		**Riser**	**34**	**514.72**	**17,500.33**	**514.72**	**17,500.33**	**1**
1.7.1.	Stair, industrial ships ladder, aluminum, grating treads, 24" wide, incl 2 line pipe rail, per riser	055133164000	Materials	Riser	1	299.00	299.00	420.99	420.99	1.408
1.7.2.	**Crew**	**E-4**		**Riser**	**1**	**93.72**	**93.72**	**93.72**	**93.72**	**1**
1.7.2.1.	Structural Steel Workers Outside Fore-man	SSWKO	Labor	Hours	0.2667	56.30	15.01	85.69	22.85	1.522
1.7.2.2.	Structural Steel Workers	SSWK	Labor	Hours	0.8	54.30	43.44	82.64	66.11	1.522
1.7.2.3.	Welder, Gas Engine, 300 amp	015433408000	Equipment	Days	0.0333	129.80	4.33	142.78	4.76	1.1
1.8.	**Doors, glass, sliding, vinyl clad, 8'-0" x 6'-10" high, 1" insulated glass**	**22-08 32 19 15**		**Opng.**	**3**	**2,227.76**	**6,683.29**	**2,227.76**	**6,683.29**	**1**
1.8.1.	Doors, glass, sliding, vinyl clad, 8'-0" x 6'-10" high, 1" insulated glass	083219150100	Materials	Opng.	1	2,025.00	2,025.00	1,970.33	1,970.33	0.973
1.8.2.	Carpenters	CARP	Labor	Hours	4	49.25	197.00	64.36	257.44	1.307
1.9.	**Railing, ornamental, aluminum, 3'-6" high, posts @ 6' O.C., panelized, fancy**	**22-05 73 23 50**		**L.F.**	**42**	**109.36**	**4,593.31**	**109.36**	**4,593.31**	**1**
1.9.1.	Railing, ornamental, aluminum, 3'-6" high, posts @ 6' O.C., panelized, fancy	057323500300	Materials	L.F.	1	25.50	25.50	35.90	35.90	1.408
1.9.2.	Structural Steel Workers	SSWK	Labor	Hours	0.8889	54.30	48.27	82.64	73.46	1.522
1.10.	**Buillding footings and foundations demolition, floors, concrete slab on grade, plain concrete, 6" thick, excludes disposal costs and dump fees**	**22-02 41 16 17**		**S.F.**	**54**	**0.92**	**49.46**	**0.92**	**49.46**	**1**
1.10.1.	**Crew**	**B-13L**		**S.F.**	**1**	**0.92**	**0.92**	**0.92**	**0.92**	**1**
1.10.1.1.	Equipment Operators, Crane or Shovel	EQHV	Labor	Hours	0.004	55.70	0.22	90.43	0.36	1.623
1.10.1.2.	Hyd. Excavator, 1.5 C.Y.	015433200200	Equipment	Days	0.0003	965.00	0.24	1,061.50	0.27	1.1
1.10.1.3.	Hyd. Hammer, 5000 ft-lb	015433200347	Equipment	Days	0.0003	376.20	0.09	413.82	0.10	1.1
1.10.1.4.	Hyd. Excavator, .75 C.Y.	015433200140	Equipment	Days	0.0003	674.20	0.17	741.62	0.19	1.1
1.11.	**1" x 6" board bracing, studs @ 24" O.C., let-in**	**22-06 11 10 04**		**L.F.**	**530**	**3.19**	**1,689.75**	**3.19**	**1,689.75**	**1**
1.11.1.	1" x 6" board bracing, studs @ 24" O.C., let-in	061110040202	Materials	L.F.	1	0.76	0.76	0.87	0.87	1.139
1.11.2.	Carpenters	CARP	Labor	Hours	0.0348	49.25	1.71	66.77	2.32	1.356

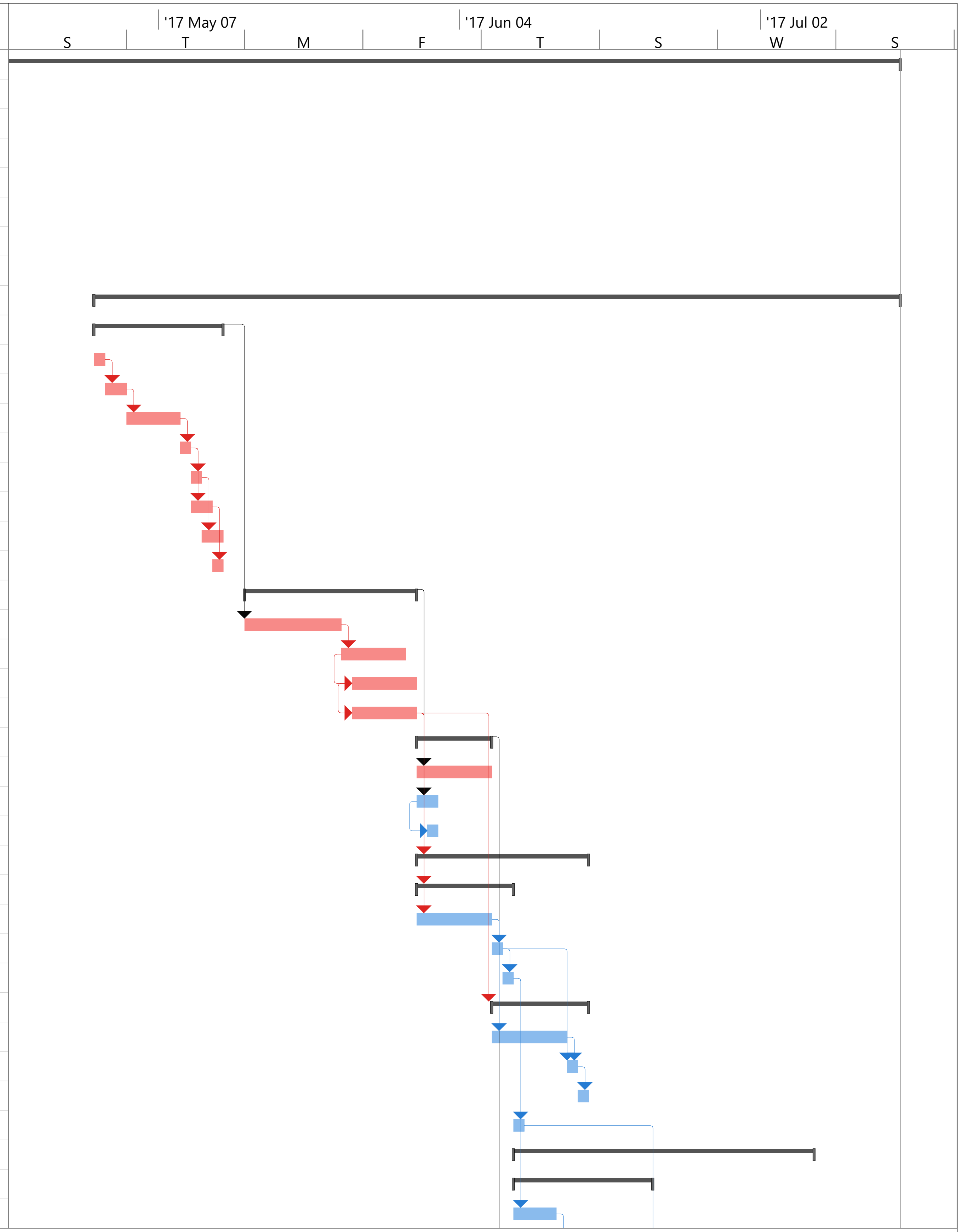
APPENDIX D – STAKEHOLDER REGISTER

STAKEHOLDER REGISTER

Stakeholders	Expectations	Level of Interest	Level of Influence	Engagement Method
UBC Transportation Planning	• Ensure intersection will meet future traffic demands in a safe manner for all modes of transport	High	High	Collaborate
UBC Sustainability	• Promote alternative modes of transport in UBC • Incorporate sustainable features in design	High	High	Collaborate
UBC Community (Faculty, staff, students, Alma Mater Society)	• Ensure safety to all road users (motorists, pedestrians and cyclists)	Medium	Medium	Consult
University Neighbourhood Association (i.e. Chancellor Place residents)	• Construction impacts to be minimized and coordinated	High	Medium	Consult
University Endowment Lands	• Redesign of intersection to respect existing property line	High	High	Collaborate
First Nations	• Ensure any archaeological impacts are assessed and dealt with accordingly	Medium	High	Consult
Vancouver Fire and Rescue Services	• Detour to be coordinated during construction	Low	High	Consult
BC Ambulance	• Detour to be coordinated during construction	Low	High	Consult
RCMP	• Detour to be coordinated during construction	Medium	Medium	Consult
Translink	• Ensure feasible design for bus turns • Detour to be coordinated during construction	Medium	Low	Inform
Residents	• Construction impacts and disturbance to be minimized	Medium	Low	Inform

APPENDIX E – GANTT CHART

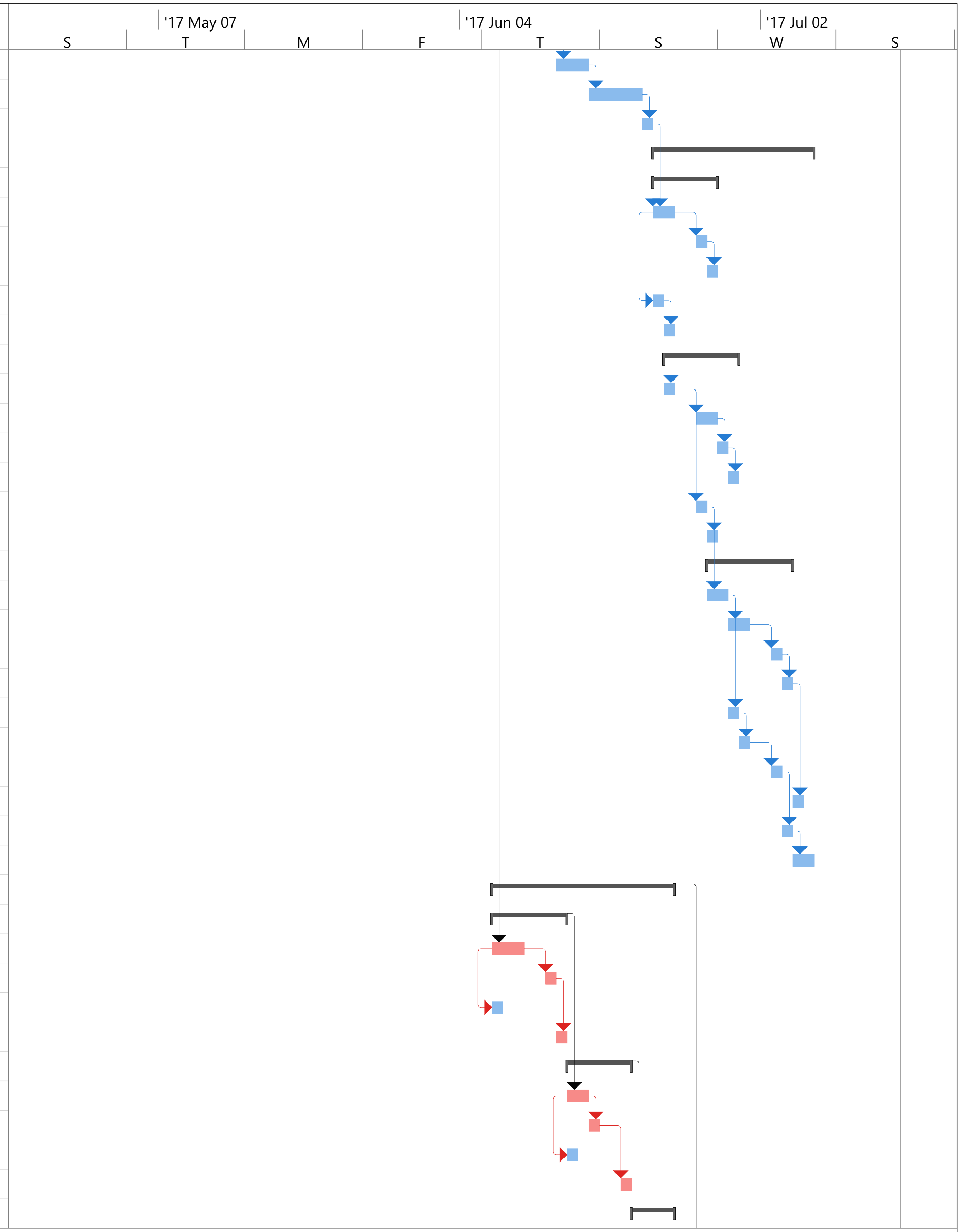
ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1			**Redesign of Chancellor Blvd and Wesbrook Mall Intersect**	**95 days**	**Mon 17-03-06**	**Fri 17-07-14**	
2			**SITE ASSESSMENT (PRE-CONSTRUCTION)**	**35 days**	**Mon 17-03-06**	**Fri 17-04-21**	
3			First Nations Archaeological Impact Assessment	30 days	Mon 17-03-06	Fri 17-04-14	
4			Project Permitting	30 days	Mon 17-03-06	Fri 17-04-14	3SS
5			Geotechnical Assessment	30 days	Mon 17-03-06	Fri 17-04-14	3SS
6			Soil Contamination Test	20 days	Mon 17-03-06	Fri 17-03-31	3SS
7			Topographic Survey	3 days	Mon 17-04-17	Wed 17-04-1	4
8			Health and Safety Assessment	5 days	Mon 17-04-17	Fri 17-04-21	4
9			**CONSTRUCTION**	**55 days**	**Mon 17-05-01**	**Fri 17-07-14**	
10			**Site Preparation**	**10 days**	**Mon 17-05-01**	**Fri 17-05-12**	
11			Construction Crew Mobilization	1 day	Mon 17-05-01	Mon 17-05-0	
12			Set Up Traffic Control	2 days	Tue 17-05-02	Wed 17-05-0	11
13			Removal of Trees	3 days	Thu 17-05-04	Mon 17-05-0	12
14			Removal of Signage	1 day	Tue 17-05-09	Tue 17-05-09	13
15			Removal of Medians	1 day	Wed 17-05-10	Wed 17-05-1	14
16			Removal of Street Lights	2 days	Wed 17-05-10	Thu 17-05-11	14
17			Removal of Catch Basins	2 days	Thu 17-05-11	Fri 17-05-12	15
18			Removal of Hydrants	1 day	Fri 17-05-12	Fri 17-05-12	16
19			**Grading**	**12 days**	**Mon 17-05-15**	**Tue 17-05-30**	
20			Excavation	7 days	Mon 17-05-15	Tue 17-05-23	10
21			Prepare Sub-base	4 days	Wed 17-05-24	Mon 17-05-2	20
22			Place Gravel	4 days	Thu 17-05-25	Tue 17-05-30	21SS+1 day
23			Compact	4 days	Thu 17-05-25	Tue 17-05-30	22SS
24			**Reinstallation**	**5 days**	**Wed 17-05-31**	**Tue 17-06-06**	
25			Reinstallation of Catch Basin	5 days	Wed 17-05-31	Tue 17-06-06	19
26			Reinstallation of Street Lights	2 days	Wed 17-05-31	Thu 17-06-01	19
27			Reinstallation of Hydrants	1 day	Thu 17-06-01	Thu 17-06-01	26SS+1 day
28			**New Medians Build**	**12 days**	**Wed 17-05-31**	**Thu 17-06-15**	**23**
29			**East of Wesbrook Mall**	**7 days**	**Wed 17-05-31**	**Thu 17-06-08**	**23**
30			Form	5 days	Wed 17-05-31	Tue 17-06-06	23
31			Pour Concrete	1 day	Wed 17-06-07	Wed 17-06-0	30
32			Strip Forms	1 day	Thu 17-06-08	Thu 17-06-08	31
33			**West of Wesbrook Mall**	**7 days**	**Wed 17-06-07**	**Thu 17-06-15**	**23**
34			Form	5 days	Wed 17-06-07	Tue 17-06-13	30
35			Pour Concrete	1 day	Wed 17-06-14	Wed 17-06-1	34,31
36			Strip Forms	1 day	Thu 17-06-15	Thu 17-06-15	35
37			Delivery of Structural Component	1 day	Fri 17-06-09	Fri 17-06-09	32
38			**Structural Lookout Tower**	**20 days**	**Fri 17-06-09**	**Thu 17-07-06**	
39			**Foundation**	**9 days**	**Fri 17-06-09**	**Wed 17-06-2**	
40			Foundation Excavation	2 days	Fri 17-06-09	Mon 17-06-1	32



Project: CIVL 446 Detailed Desig
Date: Mon 17-03-20

Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress
Split	Inactive Milestone	Manual Summary	Deadline	
Milestone	Inactive Summary	Start-only	Critical	
Summary	Manual Task	Finish-only	Critical Split	
Project Summary	Duration-only	External Tasks	Progress	

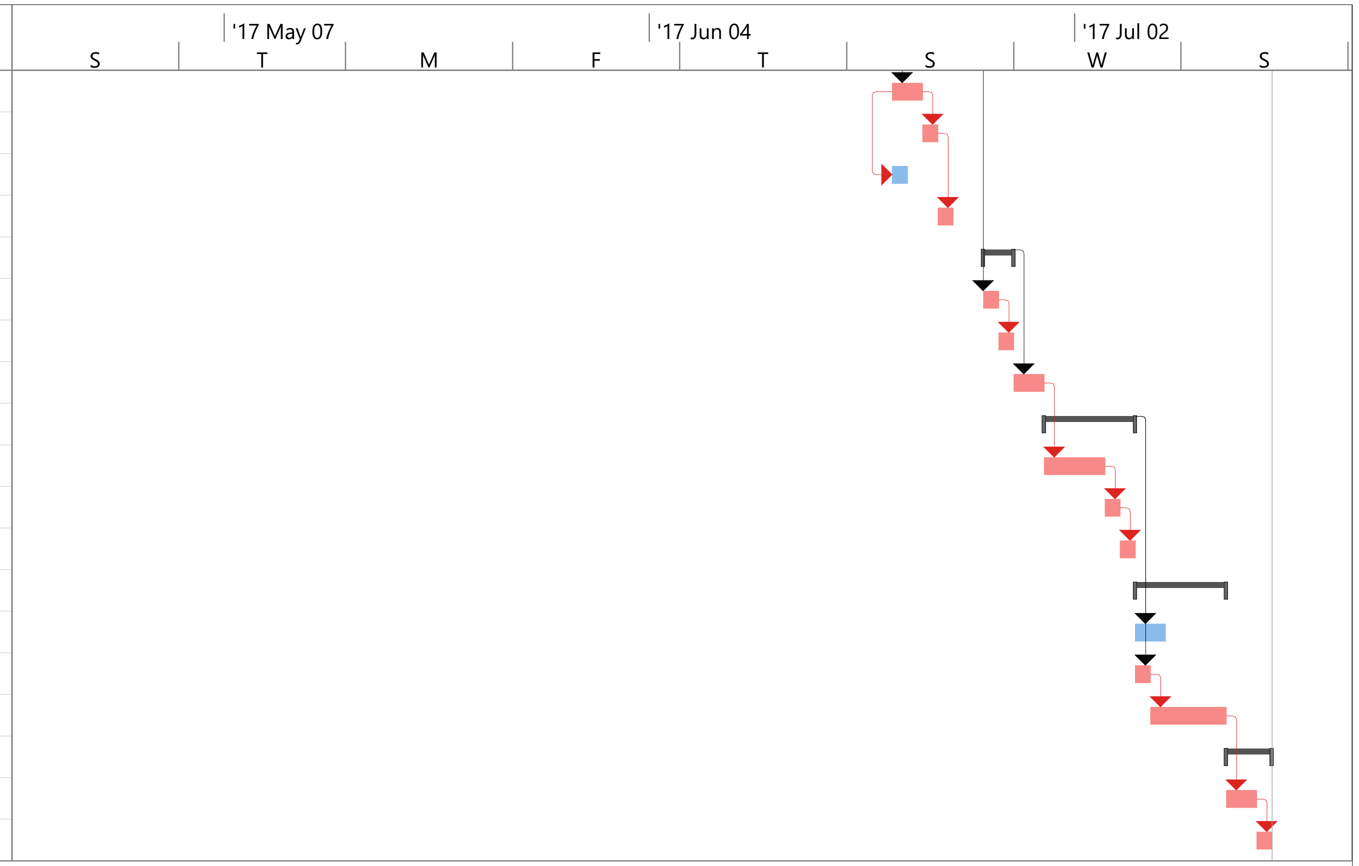
ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors
41			Foundation Preparation and Reinforcement	3 days	Tue 17-06-13	Thu 17-06-15	40
42			Foundation Construction	3 days	Fri 17-06-16	Tue 17-06-20	41
43			Backfilling and Grading	1 day	Wed 17-06-21	Wed 17-06-2	42
44			**Tower**	**11 days**	**Thu 17-06-22**	**Thu 17-07-06**	
45			**Level 1**	**4 days**	**Thu 17-06-22**	**Tue 17-06-27**	
46			Forming of Stairwell	2 days	Thu 17-06-22	Fri 17-06-23	43,37
47			Pour Concrete for Stairwell	1 day	Mon 17-06-26	Mon 17-06-2	46
48			Strip Form of Stairwell	1 day	Tue 17-06-27	Tue 17-06-27	47
49			Erection of Column 1, 2, 3, 4	1 day	Thu 17-06-22	Thu 17-06-22	46SS
50			Installation of Bacing	1 day	Fri 17-06-23	Fri 17-06-23	49
51			**Level 2**	**5 days**	**Fri 17-06-23**	**Thu 17-06-29**	
52			Installation of Platform	1 day	Fri 17-06-23	Fri 17-06-23	49
53			Forming of Stairwell	2 days	Mon 17-06-26	Tue 17-06-27	52
54			Pour Concrete for Stairwell	1 day	Wed 17-06-28	Wed 17-06-2	53
55			Strip Form of Stairwell	1 day	Thu 17-06-29	Thu 17-06-29	54
56			Erection of Columns 1, 2, 3, 4	1 day	Mon 17-06-26	Mon 17-06-2	52
57			Installation of Brancing	1 day	Tue 17-06-27	Tue 17-06-27	56
58			**Level 3**	**6 days**	**Tue 17-06-27**	**Tue 17-07-04**	
59			Installation of Platform	2 days	Tue 17-06-27	Wed 17-06-2	56
60			Forming of Stairwell	2 days	Thu 17-06-29	Fri 17-06-30	59
61			Pour Concrete for Stairwell	1 day	Mon 17-07-03	Mon 17-07-0	60
62			Strip Form of Stairwell	1 day	Tue 17-07-04	Tue 17-07-04	61
63			Erection of Columns 1, 2, 3, 4	1 day	Thu 17-06-29	Thu 17-06-29	59
64			Installation of Brancing	1 day	Fri 17-06-30	Fri 17-06-30	63
65			Installation of Roof Platform	1 day	Mon 17-07-03	Mon 17-07-0	64
66			Installation of Stairs Guardrails	1 day	Wed 17-07-05	Wed 17-07-0	62
67			Glass Façade Finishing	1 day	Tue 17-07-04	Tue 17-07-04	65
68			Finishing	2 days	Wed 17-07-05	Thu 17-07-06	67
69			**Curbs and Ramp Build**	**13 days**	**Wed 17-06-07**	**Fri 17-06-23**	
70			**North Side (Zone A)**	**5 days**	**Wed 17-06-07**	**Tue 17-06-13**	
71			Form	3 days	Wed 17-06-07	Fri 17-06-09	24
72			Pour Concrete	1 day	Mon 17-06-12	Mon 17-06-1	71
73			Finish	1 day	Wed 17-06-07	Wed 17-06-0	71SS
74			Strip Forms	1 day	Tue 17-06-13	Tue 17-06-13	72
75			**South East Side (Zone B)**	**4 days**	**Wed 17-06-14**	**Mon 17-06-1**	
76			Form	2 days	Wed 17-06-14	Thu 17-06-15	70
77			Pour Concrete	1 day	Fri 17-06-16	Fri 17-06-16	76
78			Finish	1 day	Wed 17-06-14	Wed 17-06-1	76SS
79			Strip Forms	1 day	Mon 17-06-19	Mon 17-06-1	77
80			**South West Side (Zone C)**	**4 days**	**Tue 17-06-20**	**Fri 17-06-23**	



Project: CIVL 446 Detailed Desig
Date: Mon 17-03-20

Task	Inactive Task		Manual Summary Rollup		External Milestone		Manual Progress	
Split	Inactive Milestone		Manual Summary		Deadline			
Milestone	Inactive Summary		Start-only		Critical			
Summary	Manual Task		Finish-only		Critical Split			
Project Summary	Duration-only		External Tasks		Progress			

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
81		Form	2 days	Tue 17-06-20	Wed 17-06-2	75
82		Pour Concrete	1 day	Thu 17-06-22	Thu 17-06-22	81
83		Finish	1 day	Tue 17-06-20	Tue 17-06-20	81SS
84		Strip Forms	1 day	Fri 17-06-23	Fri 17-06-23	82
85		**Sidewalks Build**	**2 days**	**Mon 17-06-26**	**Tue 17-06-27**	
86		Pour Concrete	1 day	Mon 17-06-26	Mon 17-06-2	69
87		Finish	1 day	Tue 17-06-27	Tue 17-06-27	86
88		Streets Paving	2 days	Wed 17-06-28	Thu 17-06-29	85
89		**Roundabout Build**	**4 days**	**Fri 17-06-30**	**Wed 17-07-0**	
90		Form	2 days	Fri 17-06-30	Mon 17-07-0	88
91		Pour Concrete	1 day	Tue 17-07-04	Tue 17-07-04	90
92		Strip Forms	1 day	Wed 17-07-05	Wed 17-07-0	91
93		**Finishing**	**4 days**	**Thu 17-07-06**	**Tue 17-07-11**	
94		Install Paintlines	2 days	Thu 17-07-06	Fri 17-07-07	89
95		Install Road Signage	1 day	Thu 17-07-06	Thu 17-07-06	89
96		Landscaping	3 days	Fri 17-07-07	Tue 17-07-11	95
97		**Construction Close-out**	**3 days**	**Wed 17-07-12**	**Fri 17-07-14**	
98		Site Clean Up	2 days	Wed 17-07-12	Thu 17-07-13	96
99		Construction Crew Demobilization	1 day	Fri 17-07-14	Fri 17-07-14	98



Project: CIVL 446 Detailed Desig
Date: Mon 17-03-20

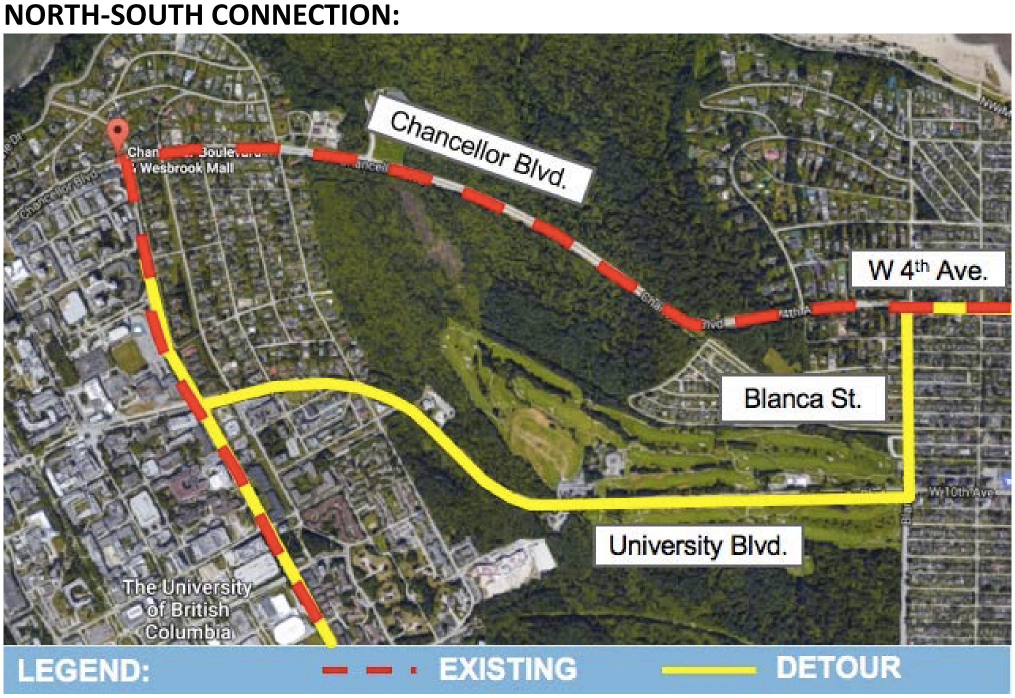
Task	Inactive Task	Manual Summary Rollup	External Milestone	Manual Progress
Split	Inactive Milestone	Manual Summary	Deadline	
Milestone	Inactive Summary	Start-only	Critical	
Summary	Manual Task	Finish-only	Critical Split	
Project Summary	Duration-only	External Tasks	Progress	

APPENDIX F – TRAFFIC MANAGEMENT PLAN

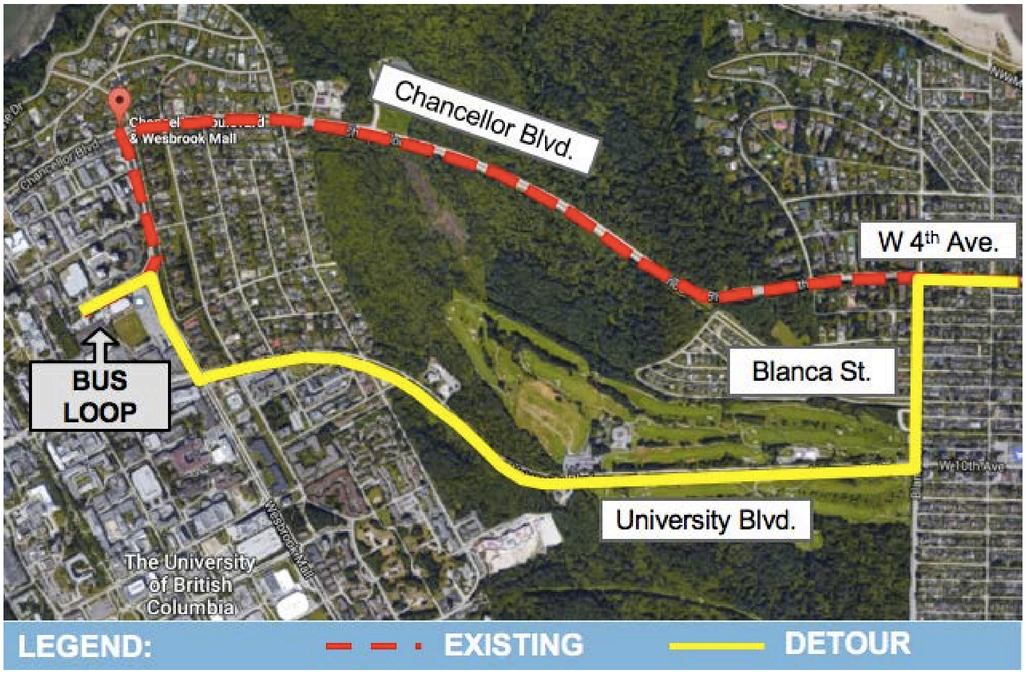
TRAFFIC MANAGEMENT PLAN

EAST-WEST CONNECTION:

NORTH-SOUTH CONNECTION:



TRANSIT DETOUR (BUS 84 & 44):



SHUTTLE BUS PROVISION FOR MISSED BUS STOP:

SHUTTLE BUS DETOUR (BUS C18):