Project No.
_____

CREATION OF A CONSTRUCTION MANAGEMENT PLAN FOR A CULVERT REPLACEMENT IN NORTH VANCOUVER, BC

Finished Replacement Corrugated Steel Culvert at Mission Creek on Evergreen Place (_____, 2019)

Prepared for:

_____, Industry Sponsor, _____
Industry Project Committee, BCIT Civil Engineering Department
Michael Baumert, Faculty Advisor, BCIT Civil Engineering Department
Jacquie Russell, Instructor, BCIT Communications Department

Prepared by:

_____

Submitted on:

April 13, 2022

Civil Engineering Department
British Columbia Institute of Technology
Burnaby, BC

DISCLAIMER

The work represented in this client report is the result of a student project at the British Columbia Institute of Technology. Any analysis or solution presented in this report must be reviewed by a professional engineer before implementation. While the student's performance in the completion of this report may have been reviewed by a faculty advisor, such review and any advice obtained therefrom does not constitute professional certification of the work. This report is made available without any representation as to its use in any particular situation and on the strict understanding that each reader accepts full liability for the application of its contents.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people for their help on this project:

- Michael Baumert, for answering my questions in detail, helping me figure out the scope of my project, and having bi-weekly check-ins with me
- _____, for explaining the project in detail, providing the data and information needed to complete the project, and answering all my question
- _____, for helping me understand construction terminology and helping me find material for the project

April 13, 2022

_____
_____
_____
_____
_____

Dear Mr. _____

Submission of Final Report on the Creation of a Construction Management Plan for a Culvert Replacement in North Vancouver, BC

This is the final report for my construction management plan for a culvert replacement in North Vancouver, BC. The original culvert was undersized and needed to be replaced. I was also tasked with creating a construction management plan that included creating a stakeholder matrix, traffic detour plan, work breakdown structure, schedule, quantity takeoff, and cost estimate for the project using a given set of drawings, cost data, and bylaws.

Using the drawings, cost data, and bylaw information given to me, I created a construction management plan while considering the environmental and stakeholder factors surrounding the project. A total of 130 hours was spent on the project.

The project allowed me to learn different software, bylaws, and how to create each of the deliverables I mentioned above. The software I learned to use were Bluebeam for the quantity takeoff and MS Project for the scheduling. Additionally, I read up on multiple bylaws related to municipal development and environmental protection. Finally, I learned the process of how an owner, like the _____ would create a stakeholder matrix, traffic detour plan, schedule, and cost estimate.

Thank you for sponsoring my project, meeting with me biweekly to answer any questions I had and providing the information and data I needed to complete my project. Also thank you for aiding in reviewing a draft copy of this client report to help fix terminology related errors and minor grammar errors like capitalization and comma placement.

If there are any questions, I can be reached by my email _____.

Sincerely,

_____

cc: Michael Baumert, Faculty Advisor
Jacquie Russell, Communications Instructor

Attachment: Project Report

SUMMARY

A construction management plan was made for the replacement of a culvert and the road area around it in Mission Creek at Evergreen Place, North Vancouver. This plan was recommended by my sponsor _____, _____ at the _____. The culvert will be reconstructed from a circular bell & spigot precast concrete pipe to an open bottom multiplate arch culvert. The management plan was created by meeting three main objectives: creation of a stakeholder matrix and traffic detour plan, identification of tasks and resources, and creation of project schedule and cost estimate.

The construction occurs within a riparian and salmonid habitat so environmental factors must be considered. The following environmental laws must be followed: DNV Environmental and Preservation Bylaw 6515, Water Sustainability Act (WSA), and Water Sustainability Regulations. The Reduced Risk Window is within the WSA and indicates that construction can only occur between July to September, but through an application to the Ministry of Forests, Lands, and Natural Resources, the window got extended to between May and October.

A stakeholder analysis matrix focused on community external stakeholders was created. There were three things that were both important to the stakeholders and impacted them during the construction: traffic, utilities, and the environment. The stakeholders were split into directly or indirectly affected and to consult or to inform. The stakeholders who were both directly affect and needed to be consulted were the residents living within the construction zone and Braemar Elementary.

A traffic detour plan was made for Braemar Elementary as the student drop off and pick up route would be disturbed by the construction.

After the completion of the traffic detour plan, a work breakdown structure was made wherein the project was broken into major project deliverables and then into work packages, a combination of related tasks that could be priced together. The major project deliverables were sequenced into a master schedule, and it showed that it would take the entirety of May to October to finish the project.

Following the creation of the schedule, a quantity takeoff (QOT) was done for the materials that were priced with unit rates using Bluebeam and Excel. The materials were first measured in Bluebeam, then calculated individual and added together into work packages in Excel. Some work packages had an associated lump sum value instead of associated unit rate value, so no quantities were needed in that case. After summing all the work packages together, an ending cost estimate of around $1 800 000 was achieved.

An Excel file containing the stakeholder analysis matrix, work breakdown structure, quantity takeoff, and cost estimate was completed for the project along with a Gantt chart schedule and a traffic detour plan.

The resources used to achieve the objectives is the issue for construction drawings provided by my industry sponsor, city records of past projects, District of North Vancouver Bylaws, Master Municipal Construction Documents, Excel, Bluebeam, and MS Project. The deliverables of the project are a stakeholder matrix, traffic detour plan, quantity takeoff, work breakdown structure, schedule, and cost estimate.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

TABLES

FIGURES

1.0 INTRODUCTION

The purpose of this project was to create a construction management plan for the replacement of an old, undersized circular concrete culvert and the road area around it. My sponsor _____ _____, _____ at the _____ recommended this project to develop my critical planning and practical problem-solving skills in the construction management field. As the real-world project is already completed, my work can be compared with the real results to help refine the _____'s construction management processes.

The culvert conveys Mission Creek at Evergreen Place, North Vancouver. The old culvert was installed in the 1964 as a circular bell & spigot precast concrete pipe using sparsely available climatic data and sized to the period's acceptable risk tolerance. The concrete culvert will be replaced with a new, bigger corrugated steel arch culvert. Figure 1 showcases the new culvert's design.

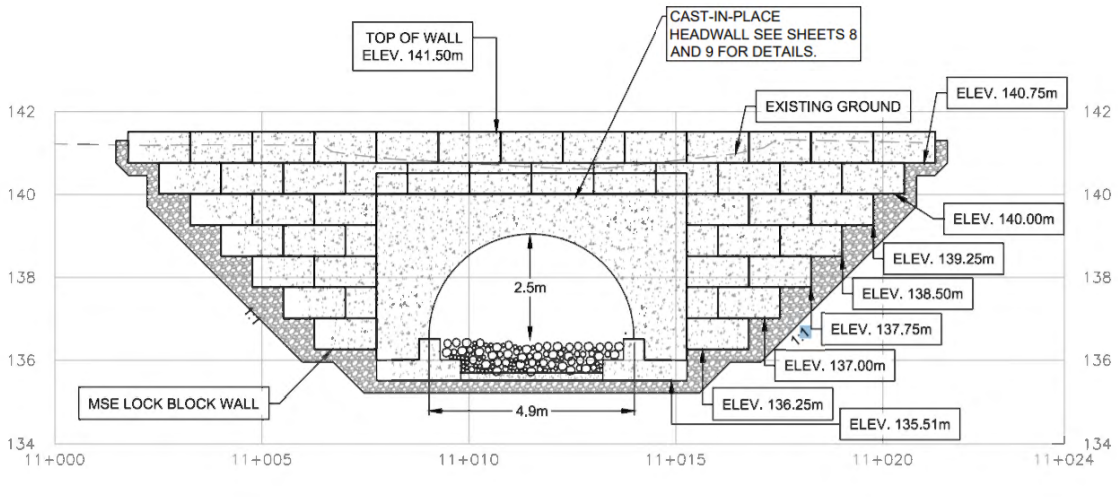

Figure 1. New culvert inlet section design

The new culvert will be 4.9 m wide and 2.5 m high. The new design will increase the creek's flow capacity and the open-bottom culvert design, which mimics natural stream beds and has a shorter overall length of culvert, will make the crossing more fish-passable (_____, personal communication, April 12, 2022). This will help restore the channel and increase fish passage.

This project covers the entire replacement process from start to finish. It covers the planning, demolition and construction of the culvert and road area, utilities reconstruction, and traffic management of the road.

There are three main objectives in this project:

- Creating a stakeholder matrix and traffic detour plan.
- Identifying the project's tasks for a work breakdown structure and materials for a quantity takeoff
- Creating a project schedule and cost estimate.

The project is only focused on the construction planning and execution phase of the project. It does not include the designing of the new culvert since it does not relate to the construction management process. Instead, completed issue for construction drawings were provided for reference. Additionally, all the deliverables were done in the owner's perspective and like it was for the original construction year of 2019.

All the deliverables mentioned in the proposal were completed. However, there were changes to how each deliverable was approached. The programs Heavy Bid, Primavera P6, and Microsoft Vision were not used because their features were not needed for an owner's construction management plan. RS Means and the *Handbook of Steel Drainage & Highway Construction (Canadian Edition)* were also not referred to because I got the information directly from my sponsor instead. The resources I used instead will be mentioned in their respective sections below.

All construction drawings used in the report were given by my sponsor, _____. All quantities, lump sum, and unit rate values were rounded to the nearest whole number. Additionally, all cost values are in Canadian dollars.

The report will provide background on the environmental considerations, and bylaws applicable to the project. Afterwards the stakeholder matrix and traffic detour plan of the project will be explained. Following that, the schedule of the project will be discussed which will also include the work breakdown structure (WBS). Finally, the process of constructing the cost estimate which will include the quantity takeoff process will be shown.

2.0 BACKGROUND

The background includes information on the old culvert, environmental considerations surrounding the project, bylaws, and permits required.

2.1 Environmental Considerations

The culvert's construction takes place in a creek that has resident and transient spawning salmonid populations recorded. All work must follow federal, provincial, and municipal laws on in-stream construction. The laws that need to be followed are

- DNV Environmental and Preservation Bylaw 6515
- Water Sustainability Act (WSA)
- Water Sustainability Regulations (WSR)

The selected contractor is compelled to engage the services of a Registered Professional Biologist as an environmental monitor to ensure construction meets all applicable regulations as well as to provide environmental reporting to regulatory agencies.

Construction must take place during the time where the risk of negative impact to organisms in the creek are low. Since the creek is considered riparian and salmonid habitat, any work in the stream must take place in a time where there is no fish spawning or any over-wintering eggs, alevins, or juveniles within and around the gravels. See Figure 2 for the reduced risk work window.

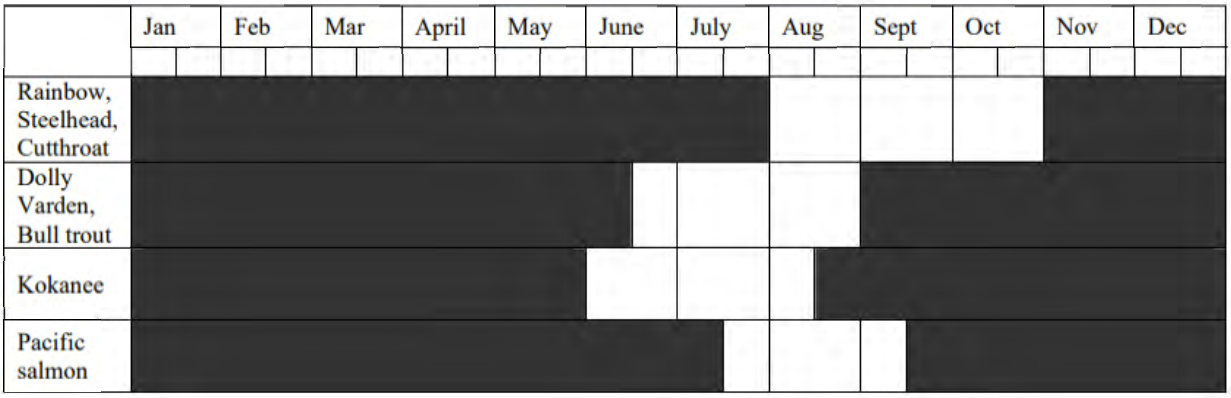

Figure 2. Reduced Risk Work Window for In-Stream Work (Ministry of Environment, 2006)

The reduced risk window for salmon is two months, spanning mid July to mid September. This is not enough time for the construction to take place as you will see in the Schedule of Construction Process section below (pg. 8). Therefore, an application to the BC Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) is recommended to extend the working window. An assumed extension from May to October is given through the application.

The WSA requires a bypass system to allow creek flows to continue running throughout the duration of project (British Columbia, 2022). The bypass system must maintain the flow upstream and downstream of the construction area. I chose a gravity bypass because it is less expensive, quieter, and does not require a 24-hour diesel pump to keep it working (_____, personal communication, November 24, 2021). The specifics on how the gravity bypass will be created is up to the contractor chosen for the project.

Additionally, according to British Columbia (2022), the WSR states that the culvert replacement is an authorized change meaning replacing the culvert does not need approval from the MFLNRO. But since a water diversion is needed to do the in-stream works, a Water Act Approval was submitted during the planning stage to make sure water would be allowed to be diverted during the construction process. A notice was also sent to a habitat officer in the MFLNRO.

There are also environmental concerns regarding the removal of trees to construct the new culvert. The tree removal will be hired out to a contractor, but a DNV arborist or environmental monitor must approve all removals (_____, 2019). For any tree removals within the bird nesting window of March 31 to September 1, a nesting survey must be performed within 48h prior to the start of tree removals (Government of Canada, 2018).

Lastly, dust control and cleaning measures must also be in place during construction. Dust is dangerous to the workers and is a pollutant to the environment (Donald, 2020). The Master Municipal Construction Documents (2019) recommends the application of calcium chloride to control dust. Additionally, all public roads must also be clean and free of equipment when construction activity is not in occurring (_____ _____, 2019).

Following the rules set out by British Columbia (2019) in the *Guidance for Applications or Notifications for Changes in and about a Stream under the Water Sustainability Act in the South Coast Region*, the Squamish First Nations were also consulted, and their needs accommodated, as the culvert replacement is within their traditional lands. Since the project digs deeper into undisturbed part of the brownfield, an Archaeological Overview Assessment (AOA) was done. It is a review of known knowledge on the site to figure out the possibility of it being an archeological site. An Archaeological Impact Assessment (AIA) may also be done depending on the results of the AOA.

2.2 Traffic Permits and Requirements

There are several permit and requirement that the selected contractor will need to apply for and follow respectively.

The contractor must follow DNV's traffic bylaw 7125 and apply for highways permits for all lane closures that are required for construction. The DNV also requires that a traffic control plan be submitted by the contractor ten working days in advance of construction start date.

3.0 STAKEHOLDER ANALYSIS MATRIX

A stakeholder analysis matrix is a chart that shows the stakeholders of the project. Stakeholders are the people affected by and who have influence on the project. As projects progress stakeholders may change (Smith, 2000). Due to lack of time, the report focuses on only the external community stakeholders that appear at the beginning of the construction of the project.

To create the stakeholder analysis matrix, all the stakeholders were found by looking at the area the construction of the culvert affects on google maps. The area highlighted in orange in Figure 3 shows where the stakeholders reside.

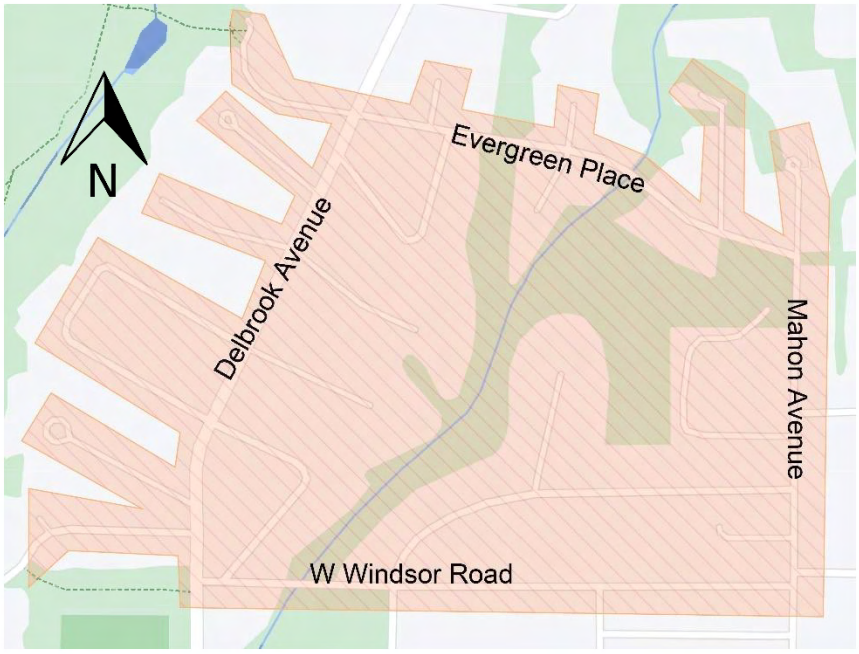

Figure 3. Area Where Stakeholders Reside (Google, n.d.), (____)

The shaded area showcases the residential and public users of the area affected by the construction. The stakeholders of the project are the people who use the area in and around Delbrook Avenue, Evergreen Place, Mahon Avenue, and W Windsor Road.

After figuring out the list of stakeholders, they were labeled as directly or indirectly affected by the construction and then were categorized into groups to consult and groups to inform. Any member in the consult group must be listened to as they have the power to prevent the project from proceeding. The three things that the stakeholders of the project will be affected by is traffic problems, utility stoppages, and environmental concerns due to the construction.

Any stakeholders that live on Evergreen Place between Delbrook Avenue and Mahon Avenue will not be able drive through the construction zone for most of the project, affecting their access into and out of their residence. Additionally, any stakeholders living 45 m from the edge of the creek will not have access to Evergreen Place Road as it will be turned into a construction zone which is shown in Figure 4.

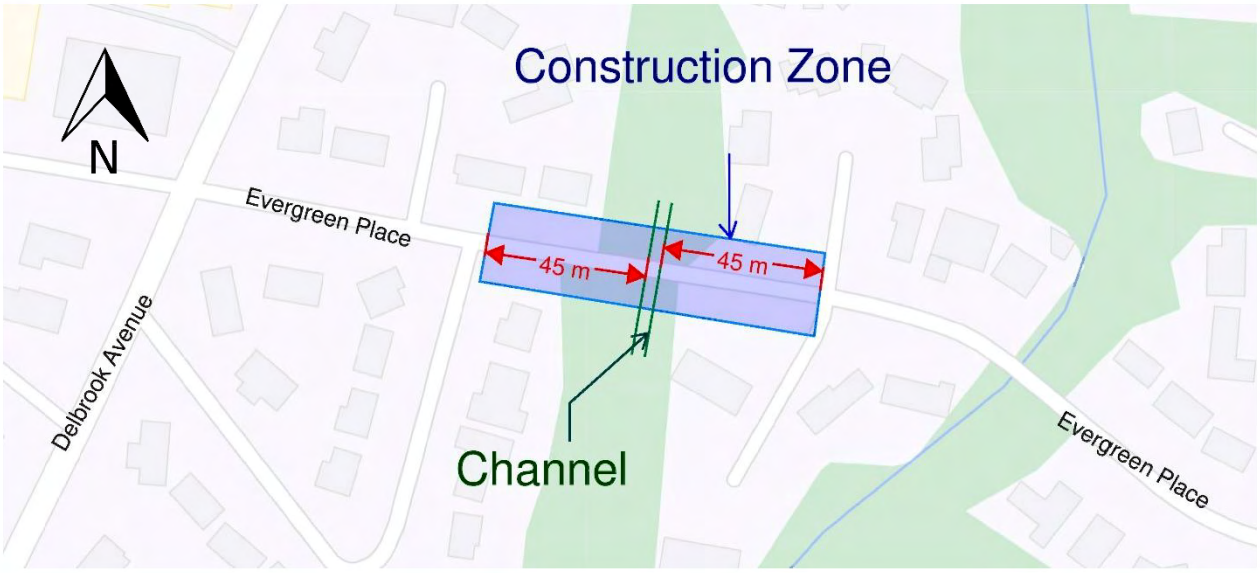

Figure 4. Construction Zone of the Project (Google, n.d.), (_____)

The stakeholders who live on Evergreen Place between Delbrook and Mahon and outside of the construction zone will be informed and the stakeholders living within the construction zone will need to be consulted. The location of the channel and culvert is shown in green, and the construction zone is shaded in blue.

Additionally, Braemar Elementary School is on Mahon Avenue. Many parents pass through the Evergreen Place to pick up and drop off students. The school will need to be consulted on the optimal time for the construction to occur so the students will be affected the least. Since I was unable to consult Braemar Elementary School, I assumed that they would want the project to occur during summer break.

A traffic detour plan was made for the parents of students of Braemar Elementary. The traffic detour plan is shown in Figure 5.

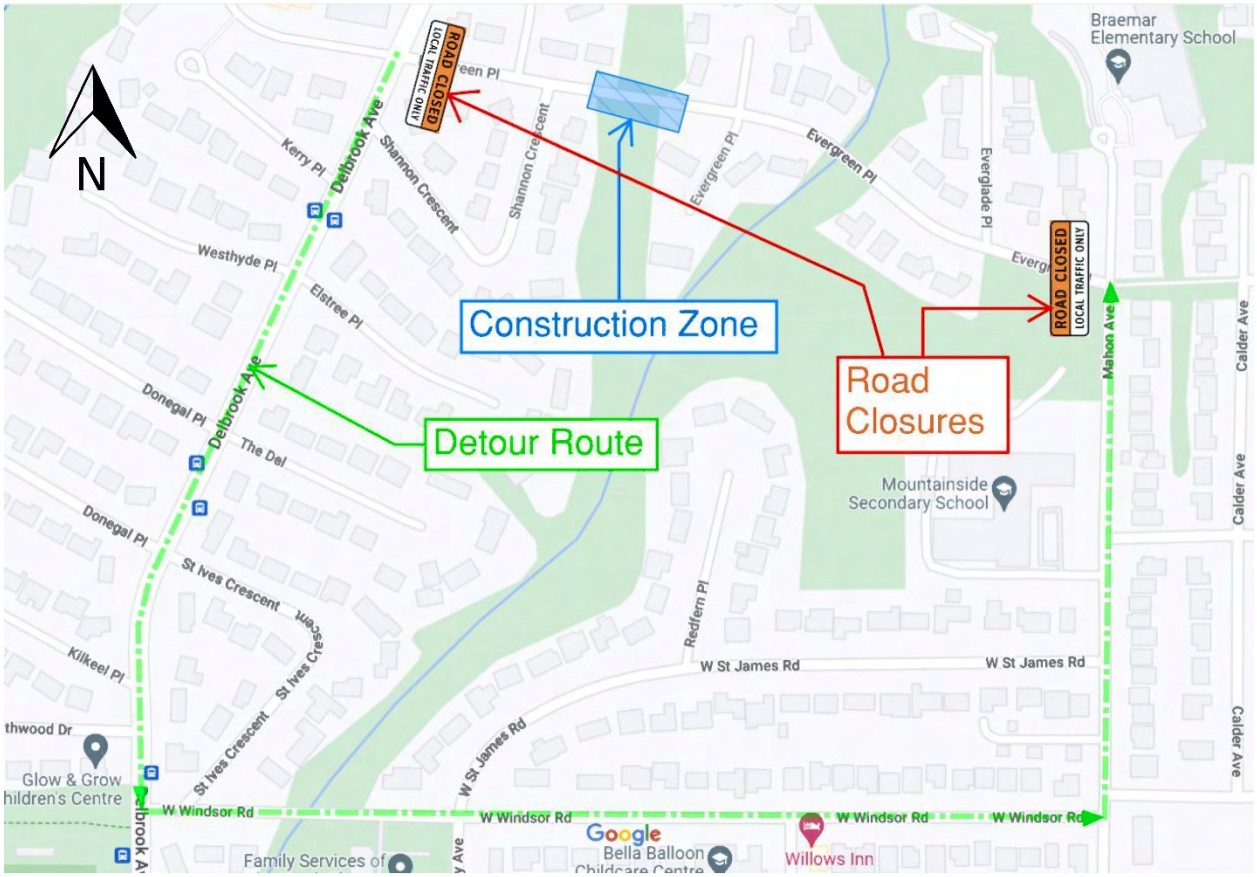

Figure 5. Traffic Detour Plan for Braemar Elementary (Google, n.d.), (_____)

The detour to Braemar Elementary is shown using green arrow. The construction zone is shown in blue and local traffic zones are labeled using a local traffic only symbol. The traffic detour route is for anyone who normally turn into Evergreen Place from the North. They will need to go south an additional 700 meters before turning into W Windsor Road, and then turning again into Mahon Avenue to get to their destination.

The construction will cause more traffic than normal to go through the above-mentioned roads, increasing traffic congestions to the residents living on or near the detour route. These residents will need to be informed of the construction and the possible increase in traffic.

There will also be utility replacement occurring. Throughout most of the construction the utilities will be kept running until the replacement occurs. The residents will be directly affected by the water main replacement during the tie-ins of the new water main to the existing one. The water main will need to be shut down for one day. Any stakeholder affected by the utility reconstruction will need to be informed.

Lastly, any stakeholders that live within the construction zone will have environmental concerns due to trees needing to be cut down and soil possibly being contaminated due to the construction

near or on their residence. These stakeholders will need to be consulted on the tree removal and replanting as well as informed of the measures that will take place to prevent contamination.

A summary of the stakeholders is shown in Figure 6.

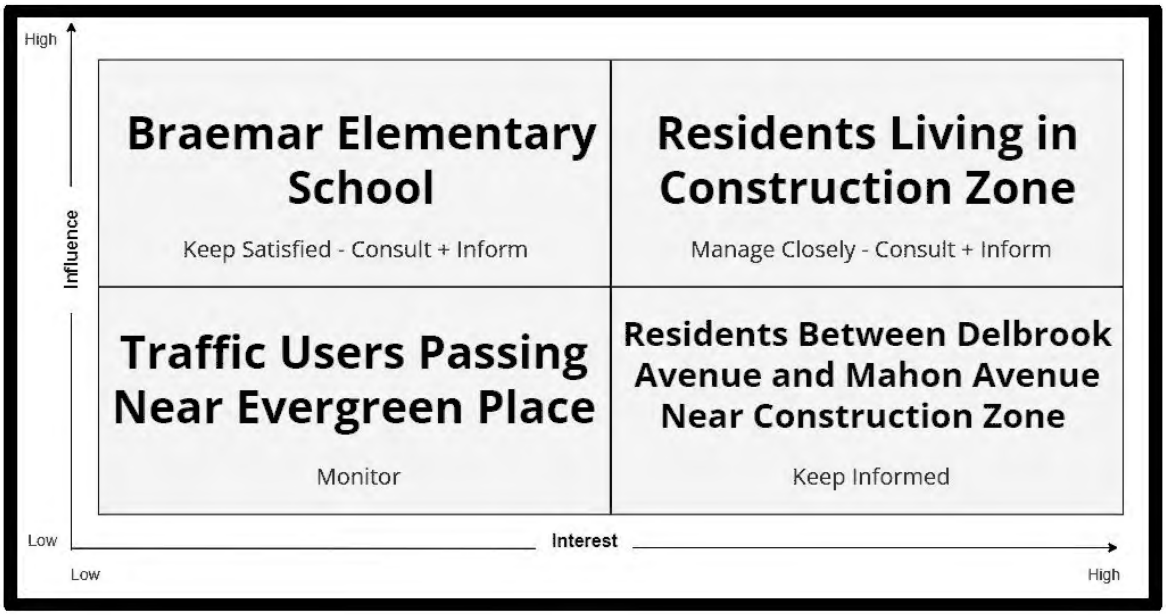

Figure 6. Power Interest Matrix for Stakeholders

The stakeholders living inside the construction zone and the administrators at Braemar Elementary are directly affected by the construction and must be consulted on how the construction should take place. The stakeholders living on Evergreen Place but outside of the construction zone are directly affected as well but to a lesser degree, so they will only be informed on the construction. Additionally, any residents living near the possible increased traffic zones will need to be informed of that possibility. For the full stakeholder analysis matrix, see Appendix A.

4.0 SCHEDULE OF CONSTRUCTION PROCESS

The creation of the schedule is in two parts: creating a work breakdown structure and the schedule itself. The WBS was made in Excel and the schedule was made in MS Project.

4.1 Work Breakdown Structure

A work breakdown structure deconstructs a project into work packages that are to the complexity required for the schedule and cost estimate. Work packages are a combination of related tasks within a project (Wrike, n.d.).

The top-down method where the project is split into smaller and smaller activities was used for the WBS. This method allows for all the activities that occur during construction to be found. Additionally, the outline style where the activities are put into a list was used to format the WBS instead of the hierarchical structure style where the activities are made

into a flow chart. This was because the outline style is quicker to make and easier to scroll through. The finished WBS was created on Excel.

According to the Project Management Institute (2019), to create a WBS, the project must be split into levels, with each level getting progressively more detailed. The first level is the major project deliverable, followed for the second level, a project deliverable, and then followed by an even smaller deliverable. The deliverables keep getting smaller until they reach the level of complexity necessary for the project, a work package.

I used the Master Municipal Contract Documents (MMCD) and the District of North Vancouver Development Servicing Bylaw 8145 to determine the Level 2, 3 and 4 activities. This allowed me to not miss any of the required tasks in the construction process.

This construction project was broken down into 9 major project deliverables:

1. Procurement
2. Field Mobilization and Site Preparation
3. Excavation and Backfilling
4. Riprap and Fish Habitat
5. Culvert Assembly
6. Footing, Headwalls, Debris Barrier, and Lock Blocks Construction
7. Utilities Replacement
8. Road and Sidewalk
9. Finishing Operations

Due to my lack of experience in the construction field, the major deliverables were figured out by reviewing pictures from the real-life construction of the culvert. In Figure 7, the Excavation and Backfilling deliverable is broken down into its work packages.

3	Excavation and Backfilling
	MMCD 31 23 01 - EXCAVATING, TRENCHING AND BACKFILLING
3.1	**Site Preparation for Excauvation**
3.1.1	Cut pavement and sidewalk neatly along limits of proposed excauvation
3.1.2	Strip topsoil and stockpile at designated location
3.2	**Excauvation**
3.2.1	Excauvate to grade
3.2.2	Hang utilities
3.2.3	Excauvate below grade
3.2.4	Provide trench drainage during excauation
3.2.5	Dispose of surplus spoil from excauvation
3.2.6	Dewater excauvation
3.3	**Backfill and Compaction**
3.3.1	Delivery of granular material
3.3.2	Place granular base on top of culvert
3.3.3	Place approved native backfill on the sides of granular base
3.3.4	Compact base and native backfill following Modified Proctor densities
	MMCD 31 23 17 - ROCK REMOVAL
3.4	**Rock Removal**
	MMCD 31 32 19 - GEOSYNTHETICS
3.5	**Placing Erosion Control Blanket**

Figure 7. Example of WBS of Excavation and Backfilling Deliverable

The major project deliverable of Excavation and Backfilling was broken down into work packages using three steps. First the MMCD codes that are related to excavation and backfilling were found. Then using the code as reference, the "Measurement and Payment" section and "Execution" sections of the code were used to find the Level 2 and Level 3 work. See Appendix B for full work breakdown structure of all the major project deliverables.

The WBS in Appendix B is to a more detailed level than necessary for either the schedule or the cost estimate.

4.2 Master Schedule

After a work breakdown structure (WBS) is done, a master schedule can be created. It is a document that gives a summary so that the owner understands how much and what kind of work needs to be completed for the project (PM Majik, 2021). This type of schedule is used by the _____ to understand how the project will proceed overall before putting out the project for bidding.

The most important part the schedule from the owner's perspective is the start and end date. This is because the start and end dates must be stipulated in the contract for the

contractors to use to estimate the duration of all the work required for the project. It is the contractor's responsibility to sequence the project in such a way to meet all milestones including completion of the project. Therefore, having a start and end date allows the contractors to use their in-house productivity rates to calculate the amount of crew and equipment required to complete the project on time and within costs.

The start and end dates of the project were decided using the *Guidelines for Reduced Risk Instream Work Windows* and school breaks for Braemar Elementary school. The construction must happen between May and October to avoid fish spawning. This window of time also lands during the summer break of Braemar Elementary, so there will not be traffic congestion due to student pick up and drop off during July to September.

The milestone schedule was made in MS Project and made using the Level 1, major project deliverables, activities in the WBS. I gave an estimated duration to each high-level activity and then sequenced them together in order produce an overview of how long the entire project will take. The schedule is shown in Figure 8.

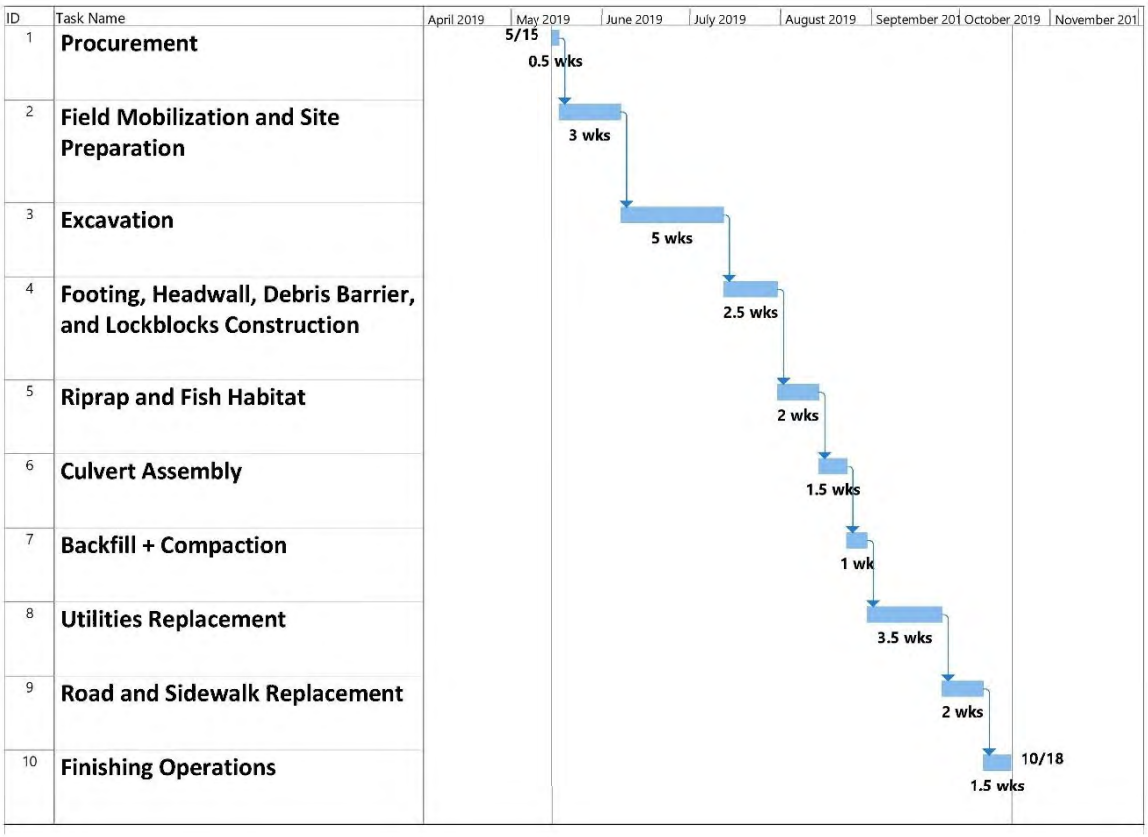

Figure 8. Master Schedule of Construction Process

The schedule starts on May 15, 2019, and after sequencing, it was found to end on October 18, 2019. There is one Level 1 work activity, Excavation and Backfill, that was split into two since it has two distinct parts with many activities occurring between them.

Master schedules are usually made by using data from previous projects and crew productivity rates. Due to my lack of construction experience and my inability to get hold of the past data, I was only able to create a schedule with personal assumptions of how long each part would take. This schedule is likely to have a high level of error.

5.0 COST ESTIMATE

An owner's estimate was created to make sure the project is within its budget. If this estimate is notably lower than the lowest bid, the project may need to be cancelled or redesigned as the owner will no longer be able to afford it (Faithful Gould, 2016). To create an owner's estimate, first a quantity takeoff (QOT) was done, then using the quantities found in the QOT a cost estimate was created.

5.1 Quantity Takeoff

A quantity takeoff (QTO) was done to figure out the quantities of material needed to construct the project. The Issue for Construction (IFC) drawing package in Appendix D for the culvert was used for the QTO with only items that could be easily quantified being taken off. The quantities are used in the cost estimate for items that have unit prices attached to the work packages that they are in.

The work packages found in the WBS do not directly relate to the work packages in the cost estimate. This is because the work packages in the cost estimate were given by my sponsor and the work packages in my WBS were done by me. I broke down items to a higher complexity for learning purposes. As most owners, _____ _____ (____) relies on higher-level information for big-picture planning with individual material supply quantities being more relevant to contractors performing the work.

The QOT done in this project only covers the quantity of materials and not equipment or labour as mentioned in the proposal. Initially, I assumed I had to create my own unit rate and lump sum values but discovered that the ____ hires a consultant that uses a database of past unit rate and lump sum values instead to create cost estimates. Therefore, a QOT of the equipment or labour is not required because it is already included in the unit rate and lump sum values in the database. Any indirect costs like project supervision would be included into the unit rate and lump sum values. Additionally, waste was not considered as it is an owner's takeoff.

I didn't receive the work packages from my sponsor until after I finished my QOT so there are some items that were measured but not used for the cost estimate. For example, I did a QOT for the reinforcement, but it ended up being included in the lump sum value of concrete, so the measurement was done but not used.

The QOT was done using both Bluebeam and a physical copy of the drawings. There were three steps to creating each QOT. First in Bluebeam, I would calibrate the scale to the scaled dimension and measure the length or area I needed. If a volume was needed, a depth could be manually added in. Some QOT required multiple dimensions from several drawings. If that occurred, the measurements were taken in Bluebeam then manually inputted in an equation in Excel. After an item was taken off, I would cross the section out in my physical copy so I would not accidentally take something off twice.

There were also times where I just used the figured dimensions to figure out the dimensioning. Additionally, the downwards slopping of the culvert was not considered to speed up calculations.

An example of a QOT I did was the Excavation Between Station 1+018 and 1+043. The first thing I did was measure the area excavated by following the original ground elevation lines. This can be seen in Figure 9.

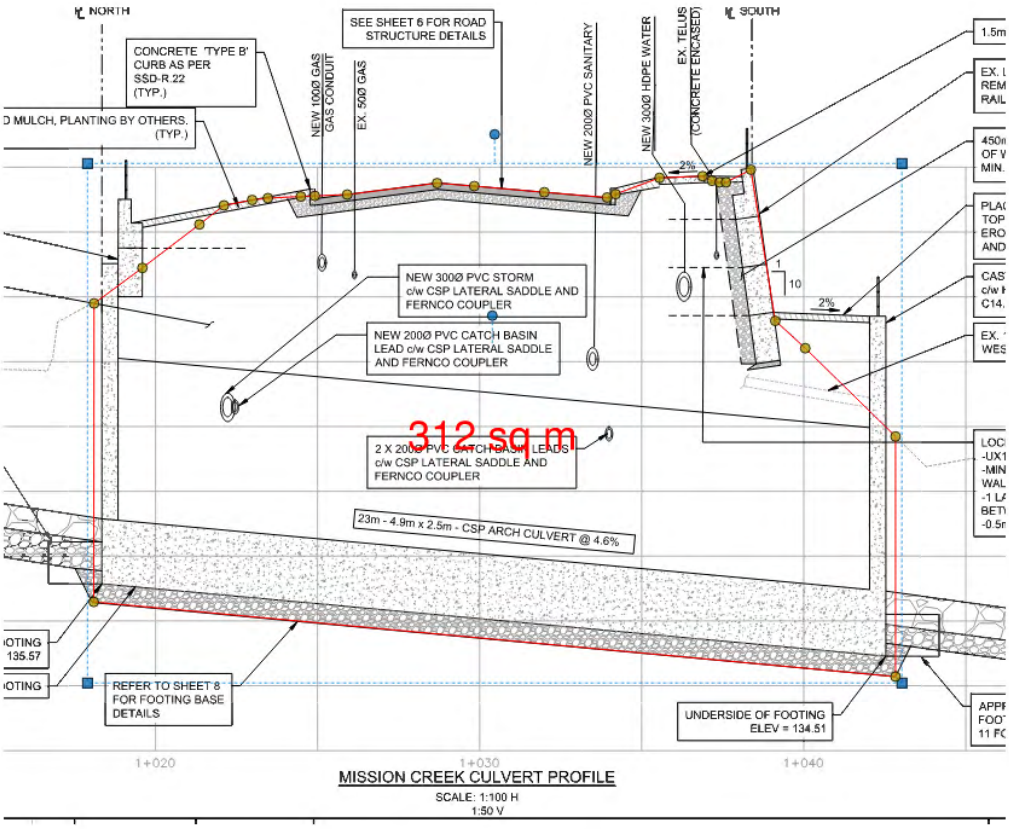

Figure 9. Area Calculation for Excavation Between Station 1+018 and 1+043

The drawing has a scale of 1:100 horizontal and 1:50 vertical. The area measurement of 312 sq m is incorrect because Bluebeam does not allow for different vertical and horizontal scaling so 312 sq m had to be divided by 2 to get the correct area dimension.

The area was then multiplied by the length of the excavated area shown in the plan view in Figure 10.

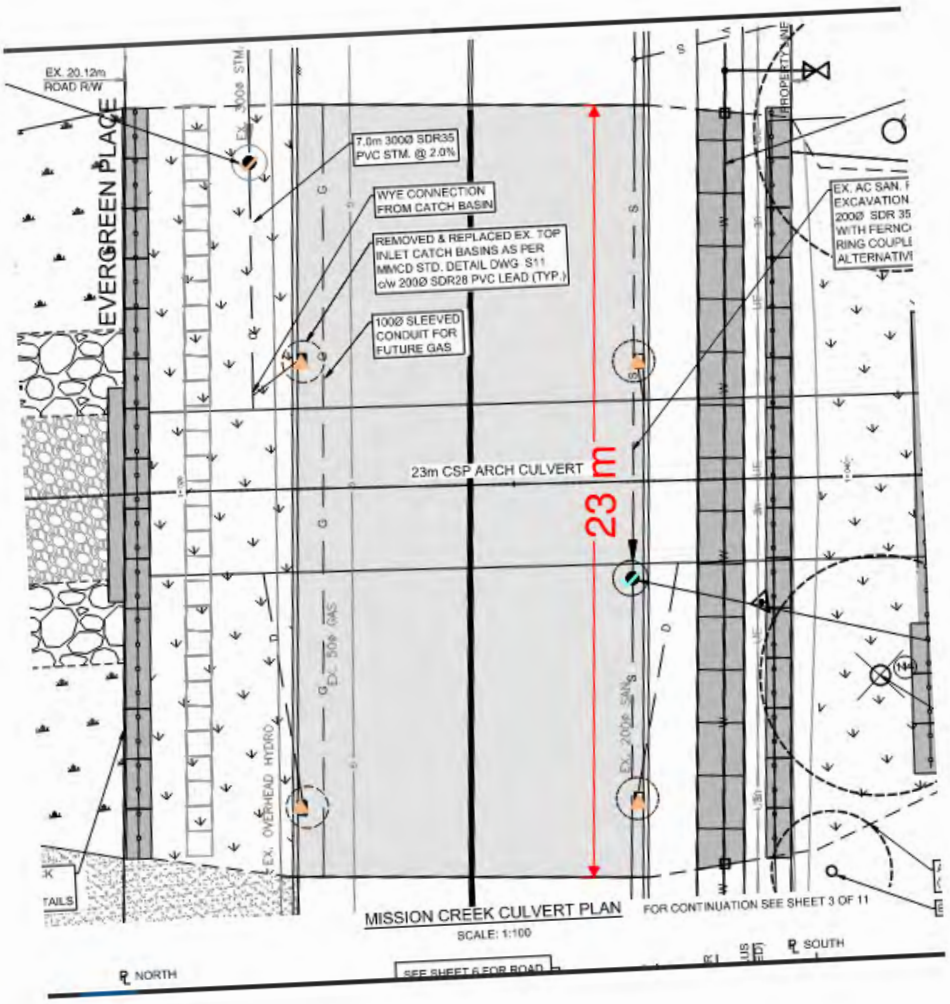

Figure 10. Length Calculation for Excavation Between Station 1+018 and 1+043

The length of excavation was found to be 23 m. Therefore, the total volume of construction was 312 sq m divided by 2 multiplied by 23 m, which comes out to 3588 cubic meters. See Appendix C for the full quantity breakdown.

5.2 Class B Cost Estimate

This is a Class B owner's estimate. According to the _____ (2019), it is the first initial detailed estimate of the project done in the planning and design phase of a construction project. It has an estimated accuracy between plus minus 10 to 20% and is produced using the quantities found in the quantity takeoff.

The quantities were added up into the given work packages and then placed into a spreadsheet along with unit prices to calculate the estimated price of each work package. For work packages that have hard to measure items, lump sum values were used instead of unit rate values. This cost estimate is used to get a general idea on how much the project will cost and the range of the bids that will come in from contractors.

Initially, I was going to do an estimate using RS Means, a database of cost estimates for different work activities. However, as mentioned in the quantity takeoff (QTO) section,

past unit and lump sum values from a database was given instead. These past values are better to use because they are more accurate than RS Means values. While RS Means gives values that are in broad categories and are averages from projects within North America, the past records in the ___ are specific for municipal projects and are based in North Vancouver.

The ___ does not have access to the consultant's wide database so instead my sponsor gave me the actual unit rate and lump sum values from three contractors that bid on the project when it was done in 2019. I averaged out each unit rate and lump sum value to use for my cost estimate. I am unable to disclose the unit rate and lump sum values given for each contractor because it is proprietary knowledge to the ___. The unit rates also came with associated work packages that I used for my cost estimate.

The work packages that had unit rates had their quantities multiplied by their associated average unit rate. Some of the quantities had to be converted from their measured amount in the issue for construction (IFC) drawings to the corresponding unit in their unit rate. For example, the cubic meter measurement in the rip rap had to be converted to cubic yards then to tons. The yards to tons conversion can be seen in Appendix E, and was used to convert the gravel, rip rap, and boulder cubic meter measurements into tons.

If the work packages had lump sums associated with them, then the averaged lump sum would be the value used for the cost estimate.

The averaged unit rate and lump sum values were rounded to the nearest one's digit. It was rounded using normal math conventions. It did not use the rounding method learned in CIVL 4033 to convert values that had decimal values to ones without because the unit rate and lump sum values were averages and not found through a quantity takeoff.

Table 1. Cost Estimate Summary

Cost Estimate Summary	
Mobilization, Demobilization, and Traffic Management	$96,455.00
Environment Control and Plant Management	81,992.00
Excavation, Backfilling, and Geosynthetics Placement	471,763.00
Rocks and Soil Removal and Placement	264,961.02
Culvert and Utilities Removal and Assembly	291,833.33
Concrete Related Construction	470,283.00
Subtotal	$1,677,287.35
GST 5%	$83864.37
Total (incl. taxes)	$1,761,151.72

The total cost of the project is estimated to be $1.8 million including taxes with the concrete related construction costing the most. This is the cost for the assembly of the footing, headwall, debris barriers, lock blocks, and road curbs. The full cost estimate can be seen in Appendix F.

6.0 CONCLUSION

The construction management plan was made for the replacement of an undersized culvert with a larger steel corrugated arch culvert. The plan covered the creation of a stakeholder matrix, a traffic detour plan, a work breakdown structure, a milestone schedule, a quantity takeoff, and a cost estimate for the project.

The main stakeholders that need to be consulted were found to be Braemar Elementary and the residents living within the construction zone. As part of dealing with the stakeholders, a traffic detour plan was made for the parents of Braemar Elementary as the construction affected their drop-off and pick-up route. Afterwards, the work breakdown structure was created using the top-down method and the major project deliverables found from it were used to produce the schedule. The schedule's start date was found through considering environmental and stakeholder factors. The start date found to be May 15, 2019, and through sequencing each work activity into a Gantt chart, an end date was found to be October 18, 2019

Following the schedule, the quantity takeoff was done using Bluebeam for materials that were part of unit price work packages. The cost estimate was then created by using given unit rate and lump sum values and multiplying them by the quantities found in the cost estimate. The quantity would be one for lump sum work packages. The cost estimate was found to be around $1.8 million.

REFERENCES

British Columbia. (2019, October 29). *Guidance for Applications or Notifications for Changes in and about a Stream under the Water Sustainability Act in the South Coast Region*. Retrieved April 12, 2022, from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/south_coast_cias_guidance.pdf

British Columbia. (2022, January 10). *A User's Guide for Changes in and About a Stream in British Columbia*. Retrieved April 11, 2022, from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-guidance_faqs.pdf .

_____ (2019). *In-Stream Works 545 Evergreen Place Culvert Replacement Record Drawings.*

Donald, D. (2020, May 22). *Why is it important to have dust control on work sites?* Novamen. Retrieved April 13, 2022, from https://www.novamen.ca/why-is-it-important-to-have-dust-control-on-work-sites/

Faithful Gould. (2016, March 15). *An Owner's Estimator March 15, 2016*. Faithful Gould. Retrieved April 13, 2022, from https://www.fgould.com/americas/articles/owners-estimator/#:~:text=The%20owner's%20estimator%20is%20responsible,the%20cancellation%20of%20the%20project.

Google. (n.d.). Google maps. Retrieved April 11, 2022, from https://www.google.com/maps/place/545+Evergreen+Pl,+North+Vancouver,+BC+V7N+2Z1/@49.3416327,-123.0845501,17z/data=!4m5!3m4!1s0x54866fdfe03e8773:0x1898bc56d3b3a19!8m2!3d49.3421257!4d-123.0833726

Government of Canada. (2018, October 30). *Government of Canada*. Canada.ca. Retrieved April 13, 2022, from https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html#toc1

Master Municipal Construction Documents. (2015) *MMCD: Master Municipal Construction Documents*. Association,

Ministry of Environment. (2006). *Terms and conditions Lower Mainland ... - british columbia*. Government of British Columbia. Retrieved April 11, 2022, from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/terms_conditions_low_main.pdf

PM Majik. (2021, October 20). *The 3 types of project schedules and when to use them* -. PM Majik. Retrieved April 13, 2022, from https://www.pmmajik.com/the-3-types-of-project-schedules-and-when-to-use-them/

Project Management Institute. (2019). *Practice standard for work breakdown structures*. Project Management Institute, Inc.

Smith, L. W. (2000). *Stakeholder analysis - Project Management Institute*. Stakeholder analysis a pivotal practice of successful projects. Retrieved February 25, 2022, from https://www.pmi.org/learning/library/stakeholder-analysis-pivotal-practice-projects-8905

Wrike. (n.d.). *What is a work package in project management?* Wrike. Retrieved March 1, 2022, from https://www.wrike.com/project-management-guide/faq/what-is-a-work-package-in-project-management/

Appendix A: Stakeholder Analysis Matrix

Stakeholder Analysis Matrix of External Community Stakeholders

STAKEHOLDER ANALYSIS MATRIX						
Stakeholders	**Power (1,2,3)**	**Direct/Indirect**	**Impact**	**Consult/Inform (Engagement Strategy)**	**Contact Information**	**Note/Log of Communication**
Educational Institutes						
Braemar Elementary	1	Direct	Interferes with drop off and pick up of students	Consult		
Mountainside Secondary	2	Indirect	Increased traffic	Inform		
Ecole Andre-Piolat	2	Indirect	Increased traffic	inform		
Little Rascals Preschool (3111 Stanley Ave, North Vancouver, BC V7N 4N6)	3	Indirect	Increased traffic	inform		
Businesses						
Family Services of North Shore Christmas Bureau (600 West Queens Road, Old Delbrook Rec Centre, North Building, North Vancouver, BC V7N 2L3)	3	Indirect	Increased traffic	Inform		
Canadian Red Cross (600 W Queens Rd, North Vancouver, BC V7N 2L3)		Indirect	Increased traffic	Inform		
Glow & Grow Children's Centre (705 Blythwood Dr, North Vancouver, BC V7N 2W8)		Indirect	Increased traffic	Inform		
XL Flooring (3721 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
3721 Delbrook Ave, North Vancouver, BC V7N 3Z4	3	Indirect	Increased traffic	Inform		
109-3711 Delbrook Ave, North Vancouver, BC V7N 3Z4	3	Indirect	Increased traffic	Inform		
J Casperson & Assoc (3721 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
105 - 3711 Delbrook Ave, North Vancouver, BC V7N 3Z4	3	Indirect	Increased traffic	Inform		
Delbrook Integrative Medical Centre (3711 Delbrook Ave #100, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
Delbrook Plaza (3721 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
Le Petit Café (105 - 3711 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
Skyline Veterinary Hospital (105 - 3711 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
New Woon Lee Inn (3751 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
Harry Grocery (3755 Delbrook Ave, North Vancouver, BC V7N 3Z4)	3	Indirect	Increased traffic	Inform		
Residents						
620 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Inform		
598 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
595 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
586 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
580 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
574 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
574 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	East road blocked	Consult		
556 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	Utility impact and east road blocked	Consult		
550 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	Utility impact, east road blocked, environmental concerns	Consult		
540 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked, environmental concerns	Consult		
534 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked, environmental concerns	Consult		
528 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked, environmental concerns	Consult		
522 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	West road blocked	Consult		
516 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	West road blocked	Consult		
510 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	West road blocked	Consult		
500 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	West road blocked	Consult		
480 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked	Consult		
468 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked	Consult		
456 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked	Consult		
444 Evergreen Pl, North Vancouver, BC V7N 2Z2	1	Direct	West road blocked	Consult		
3561 Everglade Pl, North Vancouver, BC V7N 3V1	1	Direct	West road blocked	Consult		
3583 Everglade Pl, North Vancouver, BC V7N 3V1	1	Direct	West road blocked	Consult		
3647 Everglade Pl, North Vancouver, BC V7N 3V1	1	Direct	West road blocked	Consult		
3586 Everglade Pl, North Vancouver, BC V7N 3T9	1	Direct	West road blocked	Consult		
3570 Everglade Pl, North Vancouver, BC V7N 3T9	1	Direct	West road blocked	Consult		
3566 Everglade Pl, North Vancouver, BC V7N 3T9	1	Direct	West road blocked	Consult		
3558 Everglade Pl, North Vancouver, BC V7N 3T9	1	Direct	West road blocked	Consult		
3526 Everglade Pl, North Vancouver, BC V7N 3T9	1	Direct	West road blocked	Consult		
3511 Mahon Ave, North Vancouver, BC V7N 3T8	2	Indirect	Increased traffic	Inform		
3529 Mahon Ave, North Vancouver, BC V7N 3T8	2	Indirect	Increased traffic	Inform		

Stakeholders	Power (1,2,3)	Direct/Indirect	Impact	Consult/Inform (Engagement Strategy)	Contact Information	Note/Log of Communication
3545 Mahon Ave, North Vancouver, BC V7N 3T8	2	Indirect	Increased traffic	Inform		
3540 Mahon Ave, North Vancouver, BC V7N 3T6	2	Indirect	Increased traffic	Inform		
3532 Mahon Ave, North Vancouver, BC V7N 3T6	2	Indirect	Increased traffic	Inform		
3514 Mahon Ave, North Vancouver, BC V7N 3T6	2	Indirect	Increased traffic	Inform		
3480 Mahon Ave, North Vancouver, BC V7N 3T6	2	Indirect	Increased traffic	Inform		
3476 Mahon Ave, North Vancouver, BC V7N 3T6	2	Indirect	Increased traffic	Inform		
3478 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3466 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3458 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3456 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3452 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3444 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3438 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3434 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3430 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3430 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3380 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3372 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3360 Mahon Ave, North Vancouver, BC V7N 3T6	3	Indirect	Increased traffic	Inform		
3348 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3338 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3328 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3324 Mahon Ave, North Vancouver, BC V7R 3T6	3	Indirect	Increased traffic	Inform		
3318 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3312 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3302 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3300 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3298 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3272 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3250 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
3242 Mahon Ave, North Vancouver, BC V7N 3T5	3	Indirect	Increased traffic	Inform		
417 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
419 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
421 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
433 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
445 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
451 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
463 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
475 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
487 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
501 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
517 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
529 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
533 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
547 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
565 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
571 W St James Rd, North Vancouver, BC V7N 2P6	3	Indirect	Increased traffic	Inform		
582 W Windsor Rd, North Vancouver, BC V7N 2N6	3	Indirect	Increased traffic	Inform		
675 W Windsor Rd, North Vancouver, BC V7N 2N9	3	Indirect	Increased traffic	Inform		
683 W Windsor Rd, North Vancouver, BC V7N 2N9	3	Indirect	Increased traffic	Inform		
683 W Windsor Rd, North Vancouver, BC V7N 2N9	3	Indirect	Increased traffic	Inform		
711 Blythwood Dr, North Vancouver, BC V7N 2W8	3	Indirect	Increased traffic	Inform		

Stakeholders	Power (1,2,3)	Direct/Indirect	Impact	Consult/Inform (Engagement Strategy)	Contact Information	Note/Log of Communication
725 Blythwood Dr, North Vancouver, BC V7N 2W8	3	Indirect	Increased traffic	Inform		
737 Blythwood Dr, North Vancouver, BC V7N 2W8	3	Indirect	Increased traffic	Inform		
753 Blythwood Dr, North Vancouver, BC V7N 2W8	3	Indirect	Increased traffic	Inform		
791 Blythwood Dr, North Vancouver, BC V7N 2W8	3	Indirect	Increased traffic	Inform		
3200 Bewicke Ave, North Vancouver, BC V7N 4B8	3	Indirect	Increased traffic	Inform		
3197 Bewicke Ave, North Vancouver, BC V7N 4B8	3	Indirect	Increased traffic	Inform		
3215 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3221 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3235 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3277 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3293 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3307 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3323 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3323 Wayne Dr, North Vancouver, BC V7N 4B9	3	Indirect	Increased traffic	Inform		
3404 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3382 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3336 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3330 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3322 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3296 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3270 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3234 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
3218 Wayne Dr, North Vancouver, BC V7N 4C1	3	Indirect	Increased traffic	Inform		
796 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
788 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
780 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
772 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
764 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
756 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
740 Blythwood Dr, North Vancouver, BC V7N 2W9	3	Indirect	Increased traffic	Inform		
3241 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
715 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
713 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
727 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
739 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
753 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
763 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
777 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
787 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
799 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
792 Kilkeel Pl, North Vancouver, BC V7N 2X2	3	Indirect	Increased traffic	Inform		
780 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
768 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
756 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
744 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
742 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
720 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
708 Kilkeel Pl, North Vancouver, BC V7N 2X1	3	Indirect	Increased traffic	Inform		
703 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
707 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
711 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
715 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
719 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
727 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
731 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
737 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
743 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
747 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
751 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
755 Donegal Pl, North Vancouver, BC V7N 2X6	3	Indirect	Increased traffic	Inform		
764 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
776 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
778 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
780 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
788 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
792 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
798 Donegal Pl, North Vancouver, BC V7N 2X7	3	Indirect	Increased traffic	Inform		
3467 Delbrook Ave, North Vancouver, BC V7N 3Y9	3	Indirect	Increased traffic	Inform		
3489 Delbrook Ave, North Vancouver, BC V7N 3Y9	3	Indirect	Increased traffic	Inform		
667 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		

Stakeholders	Power (1,2,3)	Direct/Indirect	Impact	Consult/Inform (Engagement Strategy)	Contact Information	Note/Log of Communication
675 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		
691 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		
707 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		
715 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		
724 Westhyde Pl, North Vancouver, BC V7N 2Y5	3	Indirect	Increased traffic	Inform		
716 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
706 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
698 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
680 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
672 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
668 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
656 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
650 Westhyde Pl, North Vancouver, BC V7N 2Y4	3	Indirect	Increased traffic	Inform		
651 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
659 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
667 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
675 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
683 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
691 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
695 Kerry Pl, North Vancouver, BC V7N 2Y6	3	Indirect	Increased traffic	Inform		
696 Kerry Pl, North Vancouver, BC V7N 2Y7	3	Indirect	Increased traffic	Inform		
688 Kerry Pl, North Vancouver, BC V7N 2Y7	3	Indirect	Increased traffic	Inform		
681 Evergreen Pl, North Vancouver, BC V7N 2Z4	3	Indirect	Increased traffic	Inform		
68 Evergreen Pl, North Vancouver, BC V7N 2Z4	3	Indirect	Increased traffic	Inform		
586 Evergreen Pl, North Vancouver, BC V7N 2Z2	3	Indirect	Increased traffic	Inform		
615 Evergreen Pl, North Vancouver, BC V7N 2Z3	3	Direct	Increased traffic	Consult		
575 Evergreen Pl, North Vancouver, BC V7N 2Y8	2	Direct	East road blocked	Consult		
566 Shannon Crescent, North Vancouver, BC V7N 2Y9	3	Indirect	Increased traffic	Inform		
574 Shannon Crescent, North Vancouver, BC V7N 2Y9	3	Indirect	Increased traffic	Inform		
582 Shannon Crescent, North Vancouver, BC V7N 2Y9	3	Indirect	Increased traffic	Inform		
622 Shannon Crescent, North Vancouver, BC V7N 2Y9	3	Indirect	Increased traffic	Inform		
3630 Shannon Crescent, North Vancouver, BC V7N 2Y9	3	Indirect	Increased traffic	Inform		
3650 Delbrook Ave, North Vancouver, BC V7N 2Z4	3	Indirect	Increased traffic	Inform		
561 Shannon Crescent, North Vancouver, BC V7N 2Y8	2	Direct	Increased traffic	Consult		
569 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
577 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
585 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
591 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
597 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
603 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
609 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
627 Shannon Crescent, North Vancouver, BC V7N 2Y8	3	Indirect	Increased traffic	Inform		
3578 Delbrook Ave, North Vancouver, BC V7N 3Z2	3	Indirect	Increased traffic	Inform		
3532 Delbrook Ave, North Vancouver, BC V7N 3Z2	3	Indirect	Increased traffic	Inform		
638 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
630 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
622 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
614 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
594 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
586 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
588 Elstree Pl, North Vancouver, BC V7N 2Y3	3	Indirect	Increased traffic	Inform		
575 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
583 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
605 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
611 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
619 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
627 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
635 Elstree Pl, North Vancouver, BC V7N 2Y2	3	Indirect	Increased traffic	Inform		
3496 Delbrook Ave, North Vancouver, BC V7N 3Z1	3	Indirect	Increased traffic	Inform		
3474 Delbrook Ave, North Vancouver, BC V7N 3Z1	3	Indirect	Increased traffic	Inform		
648 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
640 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
634 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
625 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
626 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
620 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
612 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
604 The Del, North Vancouver, BC V7N 2Y1	3	Indirect	Increased traffic	Inform		
601 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		

Stakeholders	Power (1,2,3)	Direct/Indirect	Impact	Consult/Inform (Engagement Strategy)	Contact Information	Note/Log of Communication
609 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
615 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
621 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
629 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
637 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
643 The Del, North Vancouver, BC V7N 2X9	3	Indirect	Increased traffic	Inform		
3420 Delbrook Ave, North Vancouver, BC V7N 3Y8	3	Indirect	Increased traffic	Inform		
3392 Delbrook Ave, North Vancouver, BC V7N 3Y8	3	Indirect	Increased traffic	Inform		
694 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
690 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
686 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
680 St Ives Crescent, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
674 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
670 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
666 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
662 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
658 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
654 St Ives Crescent, North Vancouver, BC V7N 2X3	3	Indirect	Increased traffic	Inform		
3370 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
693 St Ives Crescent, North Vancouver, BC V7N 2X4	3	Indirect	Increased traffic	Inform		
689 St Ives Crescent, North Vancouver, BC V7N 2X4	3	Indirect	Increased traffic	Inform		
685 St Ives Crescent, North Vancouver, BC V7N 2X4	3	Indirect	Increased traffic	Inform		
659 St Ives Crescent, North Vancouver, BC V7N 2X4	3	Indirect	Increased traffic	Inform		
655 St Ives Crescent, North Vancouver, BC V7N 2X4	3	Indirect	Increased traffic	Inform		
3220 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
3250 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
3288 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
3370 Delbrook Ave, North Vancouver, BC V7N 3Y5	3	Indirect	Increased traffic	Inform		
600 W Windsor Rd, North Vancouver, BC V7N 2N8	3	Indirect	Increased traffic	Inform		
592 W Windsor Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
584 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
574 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
564 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
558 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
550 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
542 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
534 W St James Rd, North Vancouver, BC V7N 2P7	3	Indirect	Increased traffic	Inform		
3305 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3323 Redfern Pl, North Vancouver, BC V7N 3W2	3	Indirect	Increased traffic	Inform		
3341 Redfern Pl, North Vancouver, BC V7N 3W2	3	Indirect	Increased traffic	Inform		
3359 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3377 Redfern Pl, North Vancouver, BC V7N 3W2	3	Indirect	Increased traffic	Inform		
3395 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3398 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3380 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3364 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3350 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3332 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3318 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
3302 Redfern Pl, North Vancouver, BC V7N 3W1	3	Indirect	Increased traffic	Inform		
498 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
490 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
482 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
470 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
458 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		

Stakeholders	Power (1,2,3)	Direct/Indirect	Impact	Consult/Inform (Engagement Strategy)	Contact Information	Note/Log of Communication
420 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
412 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
408 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
404 W St James Rd, North Vancouver, BC V7N 2P5	3	Indirect	Increased traffic	Inform		
439 Evergreen Pl, North Vancouver, BC V7N 2Z2	2	Direct	West road blocked	Consult		
441 Evergreen Pl, North Vancouver, BC V7N 2Z1	2	Direct	West road blocked	Consult		
453 Evergreen Pl, North Vancouver, BC V7N 2Z1	2	Direct	West road blocked	Consult		
466 Evergreen Pl, North Vancouver, BC V7N 2Z1	2	Direct	West road blocked	Consult		
503 Evergreen Pl, North Vancouver, BC V7N 2Z1	2	Direct	West road blocked	Consult		
521 Evergreen Pl, North Vancouver, BC V7N 2Z1	2	Direct	West road blocked	Consult		
539 Evergreen Pl, North Vancouver, BC V7N 2Z1	1	Direct	West road blocked, environmental concerns	Consult		
545 Evergreen Pl, North Vancouver, BC V7N 2Z1	1	Direct	West road blocked, environmental concerns	Consult		

I was not given access to the personal information of the residents due to privacy reasons, so the contact information column is empty. Additionally, there is an area labeled “Note/Log of Communication” which is placed to show that the stakeholder analysis matrix should include the information gained from consulting with stakeholders. This is a theoretical exercise so actual contact was not made.

Appendix B: Work Breakdown Structure

Work Breakdown Structure of Culvert Replacement

Culvert Replacement Work Breakdown Structure		
Task No	**Task Description**	***Assumptions + Constraints***
1	Procurement	
	MMCD - N/A	
		****delivery is only mentioned for large scale deliveries (excauvation, lock blocks, etc.)***
1.1	**Permits**	
1.1.1	Prepare permits (highway use, utilities, etc.) as required in contract documents	
1.2	**Issue for Tender Drawings**	
1.2.1	Prepare and accept shop drawings for required components in contract drawings	
1.3	**Site Tests**	*steel posts must be galvanized (additional info in drawings)*
1.3.1	Perform survey site: tree locations, old culvert, soil type, etc.	
1.3.2	Examine water table, soil and bearing capacity of ground, environmental tests	
2	Field Mobilization and Site Preparation	
	MMCD 01 20 01S - MOBILIZATION AND DEMOBILIZATION	
2.1	**Mobilization**	
2.1.1	Move In	
	MMCD 01 55 00 - TRAFFIC CONTROL, VEHICLE ACCESS AND PARKING	
2.2	**Temporary Access Roads**	
	Removal of exsting curb and install curb letdown	
	Install gravel access path	
2.3	**Traffic Control**	
	Install traffic control signage and equipment	
	MMCD 31 15 60 - DUST CONTROL	
2.4	**Dust Control**	
2.4.1	Apply calcium chloride at specified rate for dust control	
	MMCD 01 57 01 - ENVIRONMENTAL PROTECTION	
2.5	**Temporary Erosion and Sediment Control**	
2.5.1	Install creek bypass (gravity)	
2.5.2	Install silt fences	
	MMCD 01 57 01 - SHRUB AND TREE PRESERVATION	
2.6	**Tree Preservation**	
2.6.1	Establish barricades and flagging around trees that need to be preserved	
	MMCD 32 93 63 - JAPANESE KNOTWEED REMOVAL AND MANAGEMENT	
2.7	**Japanese Knotweed Removal and Management**	
2.7.1	Remove and stockpile of japanese knotweed	
2.7.2	Remove and dispose of japanese knotweed	
	MMCD 31 11 01 - CLEARING AND GRUBBING	
2.8	**Clearing and Grubbing**	
2.8.1	Clear or cut off trees, shrubs, uprooted stumps and surface debris no designated to remain	
2.8.2	Dispose of clear and grubbed material	
3	Excavation and Backfilling	
	MMCD 31 23 01 - EXCAVATING, TRENCHING AND BACKFILLING	
3.1	**Site Preparation for Excauvation**	
3.1.1	Cut pavement and sidewalk neatly along limits of proposed excauvation	
3.1.2	Strip topsoil and stockpile at designated location	
3.2	**Excauvation**	
3.2.1	Excauvate to grade	
3.2.2	Hang utilities	
		general grading for construction of culvert included in excauvation, more detailed grading occurs in Rip Rap section
3.2.3	Excauvate below grade	
3.2.4	Provide trench drainage during excauation	
3.2.5	Dispose of surplus spoil from excauvation	
3.2.6	Dewater excauvation	
3.3	**Backfill and Compaction**	
3.3.1	Delivery of granular material	
3.3.2	Place granular base on top of culvert	
3.3.3	Place approved native backfill on the sides of granular base	
3.3.4	Compact base and native backfill following Modified Proctor densities	
	MMCD 31 23 17 - ROCK REMOVAL	
3.4	**Rock Removal**	
	MMCD 31 32 19 - GEOSYNTHETICS	

Task No	Task Description	*Assumptions + Constraints*
3.5	**Placing Erosion Control Blanket**	
4	Riprap	
	MMCD 31 37 10 - RIPRAP	
4.1	**Delivery of Rip Rap, Boulders, Smooth Rocks, Granular base/subbase**	
4.2	**Surface Preparation for Riprap**	
4.2.1	Grade area to be rip-rapped to uniform, even surface	
4.2.2	Fill depressions with approved material and compact to firm bed	
4.2.3	Place geotexile in channel area to be riprapped	
4.3	**Placement of Riprap**	
4.3.1	Place side slope riprap	
4.3.2	Place channel boulders	
4.3.3	Place channel riprap and smaller boulders	
4.3.4	Place concrete between footings in channel to stablize boulders	
5	Culvert Assembly	
	MMCD 33 42 13 - PIPE CULVERTS	
5.1	**Culvert Assembly and Placement**	
5.1.1	Deliver multiplate culvert - in sections to site	
5.1.2	Install culvert as shown in contract drawings	
6	Footing, Headwall, Debris Barrier, and Lockblocks	
	MMCD 03 30 53 - CAST-IN-PLACE CONCRETE	
6.1	**Footing**	*both sides are done at once, so everything is doubled (formwork, reinforcement, sandblasting, etc.)*
6.1.1	Mix concrete for footing	
6.1.2	Foundation fine grade	
6.1.3	Crushed granualar base placed and compacted	
6.1.4	Fabricate footing formwork	
6.1.5	Erect and strip footing formwork	
6.1.6	Place footing reinforcement	
6.1.7	Pump concrete into footing formwork	
6.1.8	Wet finish for footing	
6.1.9	Cover curing footing	
6.1.10	Strip footing formwork for foundation	
6.1.11	Dry finish for footing	
6.1.12	Sandblasting area required for headwall + culvert connections	
6.2	**Headwall**	
6.2.1	Mix concrete for headwall	
6.2.2	Fabricate headwall forms	
6.2.3	Erect and strip formwork for headwall	
6.2.4	Place headwall reinforcement	
6.2.5	Pump concrete into headwall formwork	
6.2.6	Cover curing headwall	
6.2.7	Wet finish for headwall	
6.2.8	Strip formwork for headwall	
6.2.9	Dry finish for headwall	
6.3	**Debris Barrier**	*debris barrier = debris barrier and it's footing*
6.3.1	Mix concrete for debris barrier	
6.3.2	Fabricate forms for debris barrier	
6.3.3	Erect and strip formwork for debris barrier	
6.3.4	Place debris barrer reinforcement and steel posts	
6.3.5	Place concrete into debris barrier formwork	
6.3.6	Cover debris barrier during curing	
6.3.7	Wet finish for debris barrier	
6.3.8	Strip formwork for debris barrier	
6.3.9	Dry finish for debris barrier	
	MMCD 03 40 01 - PRECAST CONCRETE	
6.4	**Lock Block Wall**	
6.4.1	Deliver lock blocks	*rail included*
6.4.2	Place lock blocks	*geogrid and gravel placed between lock blocks*
7	Utilities Replacement	
	MMCD 33 11 01 - WATERWORKS	
7.1	**Water Main**	
7.1.1	Construct temporary bypass	
7.1.2	Construct replacement watermain constructed (300 mm HDPE DR11)	*next to old water main*
7.1.3	Remove and dispose existing water main at construction area	
7.1.4	Tie in to existing water main (part of water main that extends beyond construction zone)	*use HDPE Flange adaptor CI Coupler*
7.1.5	Install service connection	
7.1.6	Apply various necessary tests	

Task No	Task Description	*Assumptions + Constraints*
	MMCD 33 30 01 - SANITARY SEWERS	
7.2	**Sanitary Sewer**	
7.2.1	Construct bypass pump to maintain existing sewage flows and connect to nearest next sanitary main	*connected to nearest next sanitary main*
7.2.2	Construct replacement sanitary main (200 mm SDR PVC)	
7.2.3	Remove and dispose existing sanitary main at construction area	
7.2.4	Remove bypass pump	
7.2.5	Tie in new sanitary main to existing sanitary main	
7.2.6	Apply various necessary tests	
	MMCD 33 40 01 - STORM SEWERS	
7.3	**Storm Main**	
7.3.1	Core culvert for areas connected to storm main and catch basins	
7.3.2	Construct replacement storm main (300 diameter SDR35 PVC @ 2%)	
7.3.3	Remove and dispose existing storm main in construction area	
7.3.4	Add catch basin leads and storm connections to culvert (200 diameter SDR28 PVC lead)	*There are three catch basin leads and one storm connection to culvert*
7.3.5	Tie in new storm main to existing storm main	
7.3.6	Apply various tests	
	MMCD 33 44 01 - MANHOLES AND CATCHBASINS	
7.4	**Manhole and Catchbasin Disposal and Installation**	
7.4.1	Removing and disposing existing manhole and catch basins	
7.4.2	Dewater area prior to manhole concrete placing	
7.4.3	Place bedding gravel and compact to min. 95% Modified Proctor density	
7.4.4	Install manholes and catchbasins	*sanitary and storm manhole (2)*
7.4.5	Connect inlet and outlet pipes to manholes	
7.4.6	Interface grouting for installation of riser rings	
7.4.7	Perform leakage test on sanitary sewers	
	MMCD - N/A	
7.5	**Gas Line**	
7.5.1	add sleeved conduit for future gas line (100 mm diamter)	
8	Road and Sidewalk	
	MMCD 03 30 20 - CONCRETE WALKS, CURBS AND GUTTERS	
8.1	**Concrete Sidewalk Installation**	
8.1.1	Deliver Asphalt, granular base, and granular subbase	
8.1.2	**Subgrade Preparation**	
8.1.2.1	Excauvate and fill to design subgrade	
8.1.2.2	Compact subgrade to specified amount	
8.1.2.3	Granular Subbase and Base Preparation	
8.1.2.4	Place subbase and base to contract drawing design	
8.1.2.5	Compact subbase and base to min. 95% Modified Proctor density	
8.1.3	**Asphalt Preparation**	
8.1.3.1	Place warm-mix asphalt to contract drawing design	
8.1.3.2	Compact asphalt to min 97% of 75 Blow Marshall	
8.1.3.3	Clean and tack coat all asphalt surfaces and joints (joints per MMCD G5 - permanent restoration	
8.2	**Install Concrete Curb (DNV Type B)**	
8.2.1	Place formwork for curbs	
8.2.2	Place concrete for curbs	
8.2.3	Finish concrete for curbs	
8.2.4	Cure concrete for curbs	
9	Finishing Operations	
	MMCD 33 42 13 - PIPE CULVERTS	
9.1	Flushing the culvert to recirculate the water	
	MMCD 31 23 01 - EXCAVATING, TRENCHING AND BACKFILLING	
9.2	**Riparian Restoration**	
9.2.1	Restore topsoil in riparian zone as stated in contract drawings	
	MMCD 01 57 01 - SHRUB AND TREE PRESERVATION	
9.3	**Shrub and Tree Preservations**	
9.3.1	Remove all barricades and flagging around trees	
9.3.2	Replace trees	
	MMCD 32 93 01 - PLANTING OF TREES, SHRUBS AND GROUND COVER	
9.4	**Planting of trees, shrubs, and willow stakes**	
	MMCD 32 92 19 - HYDRAULIC SEEDING	
9.5	**Hydraulic seeding of boulevard**	

Appendix C: Quantity Takeoff

Quantity Takeoff of Culvert Replacement

Quantity Takeoff							
			Takeoff From Drawings		Takeoff for Work Packages		
Ref.	Item	Material/ Type	Quantity	Unit	Quantity	Unit	Assumptions
	Clearing and Grubbing						taken from chart
2	Big Leaf Maple - 400 mm	tree	1	count			
2	Alder - 60 mm	tree	1	count			
2	Alder - 3 x 320 mm	tree	1	count			
2	Big Leaf Maple - 300 mm	tree	1	count			
	Earthwork						
2	Excauvation 1+018 to 1+043	N/A	3588	cu m	3588	cu m	(Area of Excauvated Section)*(Length of Road) Excauvated volume is for road area only, other sections use lump sum. Sloping was not taken into account
2 and 6	Native Backfill	native backfill	773.72	cu m	773.72	cu m	(Height of Native Backfill - 1.2m)*(Width found using slope given)*Length of culvert
6	Coho gravel backfill in creek - overexcauvation	Coho Gravel	86.625	cu m	86.625	cu m	(Length of creek without culvert)*(assumed depth of overexcauvation from section F-F)*(average width of creek)*(is place between boulders - assumed volume occupied is 60%)
6	19 mm backfill in culvert - overexcauvation	300mm - 19mm MINUS CRUSHED GRANULAR BASE UNDER CONCRETE	33.81	cu m	33.81	cu m	(Depth of 19 mm crushed gravel)*(Area of culvert bottom)
2	Topsoil w/ Mulch	150 mm THICK w/ Planting (by others)	267	sq m	267	sq m	Area found using Bluebeam
2	Topsoil w/ Erosion Control	450 mm THICK Topsoil w/ NILEX SC150BN Erosion Control Blanket	152	sq m	152	sq m	Area found using Bluebeam
3	Access Path	varied	170	sq m	170	sq m	Area found using Bluebeam
6	19 mm gravel backfill culvert surrond	19 mm MINUS CRUSHED GRANULAR BASE AS CULVERT SURRONDS	175.67	cu m	284.43	tons	(Volume of rectangle 19 mm) - (Volume of culvert) See Culvert Trench detail
6	75 mm gravel backfill		579.61	cu m	938.46	tons	
	Inlet Headwall						
8	Inlet Headwall	Concrete	22.088	cu m			
8	Additional Headwall - Section C	Concrete	0.728	cu m			
8	Footing	Concrete	2.512	cu m			
8	CSP Strip Footing	Concrete	35.478	cu m			The length of this footing is approximately the distance between the two headwalls
	Outlet Headwall	Concrete					
9	Outlet Headwall	Concrete	18.32	cu m			
9	Footing	Concrete	3.31	cu m			
9	CSP Strip Footing Extra	Concrete	2.99	cu m			
	Inlet Lock Block Wall						
4	Lock Blocks (inlet)	Concrete	47	count	47	count	Counted from sheet
2 and 5	Lock Blocks (Outlet)	Concrete	42	count	42	count	Counted from sheet
4	Geogrid	UX1500MSE	1546	sq m			Width of geogrid into the soil is 4.6 m (found on sheet 4). There are approximately 16 layers counted from the drawing. The total length necessary was found on bluebeam using length measurement of all lockblock sections
	Handrail	steel	23138	mm			

			Takeoff From Drawings		Takeoff for Work Packages		
Ref.	Item	Material/ Type	Quantity	Unit	Quantity	Unit	Assumptions
	Chimney Drain	450 mm THICK - 19 mm Clear Crushed Gravels	160.065	cu m			
	Reinforcements						
	15 M	Reinforcing Steel	1546.706	m			
	15 M Stirrups	Reinforcing Steel	1386.72	m			
	20 M	Reinforcing Steel	26.254	m			
	25 M	Reinforcing Steel	2699.554	m			
	Anchor Bolts	M22 x 300 LG Galvanized	18	count			
	Rip Rap						ignoredpooling area depths, and footing in the culvert for simpler volume calculations when calculating anything other than the boulder and concrete stablizers
6	Boulder Stablizers	800 - 1000 mm	59	count	59	each	Counted 6 section in creek, 4 sections in culvert. Found the approximate amount of boulders per section by dividing average boulder width by culvert width or creek width.
6	Concrete Stablizer	concrete	17.48	cu m			depth*span of culvert-footing*length of culvert
6	Granular Base under Concrete (footing)	300mm - 19 mm MINUS CRUSHED GRANULAR BASE UNDER CONCRETE	35.28	cu m	35	cu m	depth*span of headwall*length of culvert+2m extra for account for slope on each side
6	Granular Base under Concrete (culvert)	300mm - 19 mm MINUS CRUSHED GRANULAR BASE UNDER CONCRETE	23.76	cu m	24	cu m	
6	Rip Rap set in concrete	400 - 500 mm	86.94	cu m	128	tons	
6	Boulders To Define Culvert + Channel	400 - 750 mm	117.36	cu m	258	tons	Is 60% voids
6	Boulders within channel thalweg	200-400 mm	81	cu m	178	tons	
6	Coho Gravel Culvert + Channel	50 -150 mm	208.44	cu m	337	tons	Fills in void section of "Boulders To Define Culvert + Channel" (60%)
2 and 6	Side Riprap		490	cu m	724	tons	sloping length from F-F * length of channel from sheet 2 * height of rip rap * both sides
2	Geotex	Nilex	490	sq m	490	sq m	
	Drainage						
	Water Main	300 diameter HDPE DR11	39809	mm			
	Water Main Coupler	HDPE Flange Adaptor CI Coupler	1	count			
		DI Coupler	1				
	Water Main Spool Piece	300 diameter DI	1				
	Gate Valve	300 diameter	1				
	Water Main Robar Coupler	300 diameter x 300 diamter AC	3				
	Saintary Sewer	200 diameter SDR 35 PVC	15580	mm			
	Saintary Sewer	Fernco stainless steel sheer ring souplers	2	count			
2	Storm Main	300 diameter PVC SDR35 Storm	7411	mm	7	m	Measured length using Blubeam
	Storm Main Coupler	CSP lateral saddle and fernco coupler	1	count			
	Gas Line	100 diameter sleeved conduit	23153	mm			
	Manholes						
	1200 diameter storm manhole	see MMCD Detail DWG S3	1	count			
	1050 diameter precast saintary manhole		1	count			
	Catch Basin						
	top inlet catch basins		4	count			
2	200 diameter SDR28 PVC Lead		16871	mm	17	m	Measured length using Bluebeam
	WYE connection		1	count			
	catch basin lead coupler	CSP lateral saddle and fernco coupler	3	count			
	Road/ Sidewalk						
2	Asphalt	100 mm Asphalt MMCD Upper Course #1	24	cu m	35	tons	Measured road area on Bluebeam*0.1 m depth
2	Asphalt Tack Coat	Tack Coat	240	sq m			
2	Base (road + sidewalk)	150mm - 19 mm minus crush granular base	39	cu m	63	tons	Measured road area on Bluebeam*0.15 m depth
2	Sub-base	300 mm - 75 mm minus crush granular sub	72	cu m	117	tons	Measured road area on Bluebeam*0.3 m depth
2	Sidewalk	1.5 m WIDE 100 mm THICK MMCD 'C2' Sidewalk	31	sq m	31	sq m	Measure sidewalk area on Bluebeam
2	Type B Curb	SSD-R.22	45.8	m	46	m	Measured length of curb on Bluebeam

Appendix D: Issue for Construction Culvert Drawings

_____ Drawings of Culvert Replacement

Source: _____ (2019). In-Stream Works 545 Evergreen Place Culvert Replacement Record Drawings.

Appendix E: Cubic Yards to Tons Conversion

Conversion from Cubic Yards to Tons for Gravel, Rip Rap, and Boulders

MATERIAL WEIGHTS

Approximate Weights of Various Construction Material Per Cubic Yard

Material	lbs./ cu. yd.	tons/ cu. yd.	Material	lbs./ cu. yd.	tons/ cu. yd.
Andesine Stone	4887	2.44	Earth & Sand, wet	3240	1.62
Ashes	1080	.52	Fire brick	3915	1.95
Asphalt	2700	1.35	Fire Clay	3510	1.75
Asphaltum	2349	1.17	Garbage	1150	.57
Basalt Rock	4887	2.44	Gravel, dry	2970	1.48
Brick, soft clay	2718	1.35	Gravel, out of water	1620	.81
Brick, hard clay	3397	1.69	Granite	4536	2.26
Brick, pressed	3806	1.90	Lime, quick, loose	1431	.71
Brick, paving	3694	1.84	Lime, quick, shaken	1485	.70
Block, paving	3694	1.84	Limestone, solid	4536	2.26
Bluestone	2970	1.48	Limestone, loose	2592	1.29
Cement, natural	1512	.75	Marble, solid	4455	2.22
Cement, Portland	2430	1.21	Marble loose	2592	1.29
Cement Portland, set	1863	.93	Mortar, set	2781	1.39
Cement Rosendale	1863	.93	Mud, dry	2430	1.21
Cinders	1080	.54	Mud, packed	3105	1.55
Clay, dry	1701	.85	Mud, wet	2916	1.45
Clay, wet	2970	1.48	Pitch	1863	.93
Clay & gravel, dry	2700	1.35	Plaster of paris	2646	1.32
Coal, Anthracite	1536	.76	Powder, blasting	1682	.84
Coal, Bituminous	1275	.64	Quartz	4374	2.18
Coke	837	.42	Rubbish	199.8	.09
Concrete, cinders	2970	1.48	Sand, dry, loose	2619	1.30
Concrete, gravel	4104	2.05	Sand, wet	3186	1.59
Concrete, limestone	4050	2.02	Sandstone	4023	2.01
Concrete, sandstone	3915	1.95	Slag, bank	1890	.94
Concrete, trap rock	4185	2.09	Slag, screenings	2700	1.35
Crush Stone	2700	1.35	Slag, machine	2592	1.29
Earth, dry, loose	1890	.94	Slag, sand	1485	.74
Earth, damp, loose	2106	1.05	Shale	4374	2.18
Earth, damp, packed	2592	1.29	Slate	4725	2.31
Earth & gravel, dry	2700	1.35	Tar	1674	.83
Earth & gravel, wet	3240	1.62	Tile	2970	1.43
Earth & sand, dry	2709	1.35	Trap stone	5849	2.52

Source: *Harmonys and Gravel. (n.d.). Landscaping and construction material weights. Harmony Sand & Gravel. Retrieved April 10, 2022, from https://harmonysandgravel.com/material-weights*

Appendix F: Cost Estimate

Legend of which MMCD is in each of the summary categories:

- Mobilization, Demobilization, and Traffic Management
    - Mobilization and Demobilization
    - Traffic Control, Vehicle Access, and Parking

- Environment Control and Plant Management
    - Environmental Protection
    - Hydraulic Seeding
    - Japanese Knotweed Removal and Management
    - Planting of Trees, Shrubs and Ground Cover

- Excavation, Backfilling, Geosynthetics
    - Excavating, Trenching, and Backfilling
    - Geosynthetics

- Rocks and Soil Removal and Placement
    - Aggregates and Granular Materials
    - Granular Base
    - Granular Subbase
    - Hot-Mix Asphalt Concrete Paving
    - Rock Removal
    - Riprap
    - Topsoil and Finish Grading

- Culvert and Utilities Removal and Assembly
    - Pipe Culverts
    - Waterworks
    - Sanitary Sewers
    - Storm Sewers
    - Manholes and Catch Basins

- Concrete Related Construction
    - Cast-In-Place Concrete
    - Concrete Walks, Curbs and Gutters
    - Precast Concrete

Cost Estimate of Culvert Replacement

SCHEDULE OF QUANTITIES AND PRICES
MISSION CREEK AT EVERGREEN PLACE CULVERT REPLACEMENT

ITEM	MMCD REF	DESCRIPTION	UNIT OF MEASURE	QTY.	Estimate UNIT RATE	Estimate TOTAL PRICE
	PART A – UNIT RATE ITEMS					
	MMCD 01 20 01S - MOBILIZATION AND DEMOBILIZATION					
0.1	1.1.1S	Mobilization and Demobilization	Lump Sum	1	~~0.00~~	$ 83,957.00
					Subtotal for Mobilization and Demobilization:	**83,957.00**
	MMCD 01 55 00 - TRAFFIC CONTROL, VEHICLE ACCESS AND PARKING					
-	-	CMS Board - monthly rental rate per one Changeable Message Sign board (Ver-mac PCMS-548 or approved equivalent). Includes delivery and set up at DNV-specified location and message updates. (Optional)	Each	6	2,083.00	12,498.00
					Subtotal for Traffic Control, Vehicle Access and Parking :	**12,498.00**
	MMCD 01 57 01 - ENVIRONMENTAL PROTECTION					
0.2	1.6.2S	Environmental Protection	Lump Sum	1	~~0.00~~	39,167.00
0.3	1.6.3S	Tree Removals	Lump Sum	1	~~0.00~~	7,333.00
					Subtotal for Environmental Protection :	**46,500.00**
	MMCD 03 30 20 - CONCRETE WALKS, CURBS AND GUTTERS					
0.4	1.4.3	Concrete Curb (DNV Type B)	Linear Meter	46	140.00	6,440.00
0.5	1.4.5	Concrete Sidewalk 100mm Thick (MMCD C2)	Square Meter	31	145.00	4,495.00
					Subtotal for Concrete Walks, Curbs and Gutters:	**10,935.00**
	MMCD 03 30 53 - CAST-IN-PLACE CONCRETE					
-	-	Inlet Debris Barrier. Includes all work to supply and construct as shown on the Contract Drawings.	Lump Sum	1	~~0.00~~	21,200.00
0.6	1.5.4S	Reinforced Culvert Spread Footings. Includes 19mm Minus Crushed Granular Base.	Cubic Metre	80	1,858.00	148,640.00
0.7	1.5.4S	Culvert Outlet Headwall (CIP Section). Reinforced concrete, includes railing, clear crushed gravel, non-woven geotextile, Crushed Granular Base, and all work to supply and construct as shown on the Contract Drawings.	Lump Sum	1	~~0.00~~	97,767.00
0.8	1.5.4S	Culvert Inlet Headwall (CIP Section). Reinforced concrete, clear crushed gravel, non-woven geotextile, Crushed Granular Base, and all work to supply and construct as shown on the Contract Drawings.	Lump Sum	1	~~0.00~~	95,800.00
0.9	1.5.6S	Non-reinforced Concrete Rock Bedding within Culvert. Includes 19mm Minus Crushed Granular Base.	Cubic Metre	111	455.00	50,505.00
					Subtotal for Cast-In-Place Concrete:	**413,912.00**
	MMCD 03 40 01 - PRECAST CONCRETE					
0.10	1.4.1	Culvert Inlet Headwall (Lock Block Section). Precast Lock Block includes railing, clear crushed gravel, non-woven geotextile, Crushed Granular Base, geogrid, and all work to supply and construct as shown on the Contract Drawings.	Each	47	578.00	27,166.00
0.11	1.4.1	Outlet Wall (Lock Block). Precast Lock Block includes clear crushed gravel, non-woven geotextile, Crushed Granular Base, and all work to supply and construct as shown on the Contract Drawings.	Each	42	435.00	18,270.00
					Subtotal for Precast Concrete	**45,436.00**
	MMCD 31 05 17 - AGGREGATES AND GRANULAR MATERIALS					
0.12	1.4.2	Placement - 50-150mm Coho Gravel - Placed in Culvert and Channel	Tonne	337	35.00	11,795.00
0.13	1.4.3	Supply Only - 50-150mm Coho Gravel - Placed in Culvert and Channel (Optional)	Tonne	337	49.00	16,513.00
					Subtotal for Aggregates And Granular Materials	**28,308.00**
	MMCD 31 23 01 - EXCAVATING, TRENCHING AND BACKFILLING					
0.14	1.10.1	Common Excavation - Culvert Inlet STA 1+000 to 1+018. Includes clearing, grubbing, excavation and removal of existing headwall, debris barriers, erosion matting, railing, rough channel forming and off-site disposal of unsuitable materials.	Lump Sum	1	~~0.00~~	46,333.00
0.15	1.10.1	Common Excavation - Culvert Outlet STA 1+043 to 1+060. Includes clearing, grubbing, excavation and removal of existing headwall, erosion matting, railing, rough channel forming and off-site disposal of unsuitable materials.	Lump Sum	1	~~0.00~~	42,000.00
0.16	1.10.1	Common Excavation - Existing Lock Block Headwall and Railing. Includes removal of railing and wall, on-site stockpile, offsite disposal as necessary, reinstatement, clear crushed gravel, PVC drain, and new railing.	Lump Sum	1	~~0.00~~	42,933.00
0.17	1.10.9S	Common Excavation - All Excavation STA 1+018 to 1+043. Includes sawcutting, excavation, offsite disposal of all materials within the Culvert Trench Detail section.	Cubic Metre	3588	77.00	276,276.00

ITEM	MMCD REF	DESCRIPTION	UNIT OF MEASURE	QTY.	UNIT RATE	TOTAL PRICE
0.18	1.10.10S	Approved Native Backfill includes placement, compaction and control of moisture content.(Optional).	Cubic Metre	774	27.00	20,898.00
0.19	1.10.10S	Common Excavation - Material Suitable for Reuse. Onsite stockpiling and sorting for reuse as approved by Contract Administrator. (Optional)	Cubic Metre	774	27.00	20,898.00
0.20	1.10.10S	Common Excavation - Stockpile and Relocation of Existing 500-1000mm Riprap at STA 1+060 (Approximately 10 Boulders).	Lump Sum	1	0.00	1,567.00
0.21	1.10.11S	Over-excavation - Creek. As approved by Contract Administrator. Includes Coho Gravel Backfill and offsite disposal (Optional).	Cubic Metre	58	157.00	9,106.00
0.22	1.10.11S	Over-excavation - Culvert. As approved by Contract Administrator. Includes 19mm Minus Crushed Granular Backfill and offsite disposal (Optional).	Cubic Metre	34	128.00	4,352.00
–	–	Common Excavation - Access Road. Includes clearing, grubbing, excavation and rough forming of road, off-site disposal of unsuitable materials, subbase and base to thickness shown on Contract Drawings, and compaction.	Square Meter	170	32.00	5,440.00
					Subtotal for Excavating, Trenching And Backfilling	**469,803.00**
	MMCD 31 23 17 - ROCK REMOVAL					
0.23	1.6.1	Rock Removal (Optional)	Cubic Metre	56	132.00	7,392.00
					Subtotal for Rock Removal	**7,392.00**
	MMCD 31 32 19 - GEOSYNTHETICS					
0.24	1.6.1	Nilex SC150BN Erosion Control Blanket (or Approved Alternative)	Square Meter	490	4.00	1,960.00
					Subtotal for Geosynthetics	**1,960.00**
	MMCD 31 37 10 - RIPRAP					
0.25	1.4.1	450-650mm Riprap Channel Armouring includes non-woven geotextile.	Tonne	724	83.00	60,092.00
0.26	1.4.1	400-500mm Riprap Set in Concrete within Culvert	Tonne	128	97.00	12,416.00
0.27	1.4.1	400-750mm Washed Round Boulders - Placed in Culvert and Channel	Tonne	258	95.00	24,510.00
0.28	1.4.1	200-400mm Washed Round Boulders - Placed in Culvert and Channel	Tonne	178	85.00	15,130.00
0.29	1.4.1	800-1000mm Stabilizer Washed Round Boulders - Placed in Culvert and Channel	Each	59	177.00	10,443.00
					Subtotal for Riprap	**122,591.00**
	MMCD 32 11 16.1 - GRANULAR SUBBASE					
0.30	1.4.2	75mm Minus Crushed Granular Subbase - Imported Material for Culvert Backilling and Downstream Bank Bulk Fill	Tonne	1938	35.00	67,830.00
					Subtotal for Granular Subbase	**67,830.00**
	MMCD 32 11 23 - GRANULAR BASE					
0.31	1.4.2	19mm Minus Crushed Granular Base - Culvert Surround, Road and Sidewalk Base	Tonne	348	40.00	13,920.00
					Subtotal for Granular Base	**13,920.00**
	MMCD 32 12 16 - HOT-MIX ASPHALT CONCRETE PAVING					
0.32	1.5.1	Machine Laid Warm Mix Asphalt (MMCD Upper Course #1) includes Tack Coat and Milled Lap Joint.	Tonne	35.4456	303.00	10,740.02
					Subtotal for Hot-Mix Asphalt Concrete Paving	**10,740.02**
	MMCD 32 91 21 - TOPSOIL AND FINISH GRADING					
0.33	1.4.1	Topsoil - 450mm thick - Riparian. Includes supply, placement, finish grading and light compaction.Crushed Granular Base, geogrid, and all work to supply and construct as shown on the Contract Drawings.	Square Meter	267	35.00	9,345.00
0.34	1.4.1	Topsoil - 150mm thick - Boulevard. Includes supply, placement, finish grading and light compaction.	Square Meter	152	19.00	2,888.00
					Subtotal for Topsoil And Finish Grading	**12,233.00**
	MMCD 32 92 19 - HYDRAULIC SEEDING					
0.35	1.8.2	Hydraulic Seeding - Boulevard	Square Meter	152	7.00	1,064.00
					Subtotal for Hydraulic Seeding	**1,064.00**
	MMCD 32 93 01 - PLANTING OF TREES, SHRUBS AND GROUND COVER					
0.36	1.9.1	Planting of Trees, Shrubs, and Willow Stakes.	Lump Sum	1	0.00	11,300.00
					Subtotal for Planting Of Trees, Shrubs And Ground Cover	**11,300.00**
	MMCD 32 93 63 - JAPANESE KNOTWEED REMOVAL AND MANAGEMENT					
0.37	1.3.1	Japanese Knotweed removal, stockpile and reuse on site. Refer to 32 93 63 for excavation and management specifications. (Optional).	Cubic Metre	98	78.00	7,644.00

ITEM	MMCD REF	DESCRIPTION	UNIT OF MEASURE	QTY.	UNIT RATE	TOTAL PRICE
0.38	1.3.1	Japanese Knotweed removal and disposal at a licensed and approved facility. Refer to 32 93 63 for excavation and management specifications. (Optional)	Cubic Metre	98	158.00	15,484.00
					Subtotal for Japanese Knotweed Removal And Management	**23,128.00**
	MMCD 33 11 01 - WATERWORKS					
0.39	1.8.2S	Watermain Replacement. Includes all work to cut existing watermain, temporarily bypass, couplers, CL50 ductile iron pipe, and backfill. Tie-ins to be completed by Contractor.	Lump Sum	1	~~0.00~~	41,000.00
					Subtotal for Waterworks	**41,000.00**
	MMCD 33 30 01 - SANITARY SEWERS					
0.40	1.6.1	Sanitary Sewer Replacement	Lump Sum	1	~~0.00~~	42,000.00
					Subtotal for Sanitary Sewers	**42,000.00**
	MMCD 33 40 01 - STORM SEWERS					
0.41	1.6.2	300mm SDR 35 PVC Storm Sewer. Includes culvert coring, connection to CSP with lateral saddle branch and Fernco coupler, backfill and all related work.	Linear Meter	7	520.00	3,640.00
0.42	1.6.5	200mm SDR 28 PVC Catch Basin Leads. Includes culvert coring, connection to CSP with lateral saddle branch and Fernco coupler, backfill and all related work.	Linear Meter	17	407.00	6,919.00
					Subtotal for Storm Sewers	**10,559.00**
	MMCD 33 42 13 - PIPE CULVERTS					
0.43	1.5.2	4.9m x 2.5m Corrugated Steel Culvert. Includes all work to supply and install as shown on Contract Drawings.	Linear Meter	23	7,967.00	183,241.00
					Subtotal for Pipe Culverts	**183,241.00**
	MMCD 33 44 01 - MANHOLES AND CATCHBASINS					
0.44	1.5.1	1200mm Overbuild Manhole. Includes base, benching, risers, lid, frame & cover, outside drop, excavation, removal and disposal of existing manhole, interface grouting, backfill and all related work.	Lump Sum	1	~~0.00~~	9,833.33
0.45	1.5.2	900mm Catch Basin. Includes frame and cover.	Each	4	1,300.00	5,200.00
					Subtotal for Manholes And Catchbasins	**15,033.33**

Subtotal	**$ 1,675,340.35**
GST @ 5%	**$ 83,767.02**
Total Tender Price (Incl. taxes)	**$ 1,759,107.37**