BLUTH ENGINEERING

DESIGN OF REMOTE VARYING SPAN FOOTBRIDGES
PROJECT PLAN REPORT

Submitted to:
Jewer Bailey Consultants
Dr. S. Bruneau

Submitted by:
Robyn O'Donnell
Sarah Kean
Vanessa Walsh
Ryan Roberts

February 4th, 2013

JBC JEWER BAILEY CONSULTANTS

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February 4th, 2013

Ray Bailey, P. Eng.
Jewer Bailey Consultants Ltd.
75 Tiffany Court
St. John's, NL T2H 7M8

Dear Mr. Bailey:

Regarding: Project Plan Report

We are pleased to submit a copy of the Design of Remote Varying Span Footbridges Project Plan Report. This work plan documents the project requirements of Jewer Bailey Consultants (JBC), our methodology, project tasks, and deliverables. We have included a proposed schedule for the preliminary design of the footbridges, which will be updated weekly.

We trust the enclosed report is satisfactory and will serve as a guide to how Bluth Engineering intends to efficiently complete the required deliverables set by JBC. If you have any questions or require further information, please contact the undersigned.

Sincerely,
Bluth Engineering

Vanessa Walsh
Project Manager

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1. PROJECT DESCRIPTION

There are a number of hiking paths located along the Avalon Peninsula of Newfoundland and Labrador. Typically each section of the trail is assigned a “difficulty rating” depending on its terrain either along the shoreline or through the wilderness. Both of these scenarios may encounter small water ways or swamp areas that require the use of a footbridge to cross. A footbridge is essentially a bridge designed for pedestrians. As part of upgrades and new trail development, Bluth Engineering has been contracted by Jewer Bailey Consultants to design various length bridges that can be easily constructed in remote locations. Due to access constraints to the majority of these paths one of the largest challenges will be providing module-type designs that can be easily constructed by unskilled workers.

Jewer Bailey Consultants have requested bridge designs for span lengths starting at 10 feet (3.05m), increasing by 10 foot intervals up to 60 feet (18.3m). Proper abutments will be designed upon implementation of each footbridge.

Figure 1: Typical Newfoundland Trail System

2. STATEMENT OF PROJECT REQUIREMENTS

Bluth Engineering was retained by Jewer Bailey Consultants to undertake the preliminary design of various span footbridges. The following deliverables are required by the Client:

- *Bridge Design and Analysis* – Provide all detail design calculations and structural analysis for each bridge alternative;
- *Full Drawing Set* – Provide Assembly drawings including all details and views, as well as a bill of materials for each span length;
- *Cost Estimate* – Cost break down of all materials used for each span length design (construction costs are negligible as the service is provided by volunteers);
- *Final Report* – Submit a written report outlining the process and reasoning each design was chosen, as well as further instruction on assembly for each respective design.

To complete the task at hand the National Building Code of Canada, Canadian Highway Bridge Design Code and the Wood Design Manual will be resourced to ensure all designs meet standards.

3. METHODOLOGY

3.1 Approach

For the design procedures Bluth Engineering plans to take this project and complete it in an organized and efficient manner. The first phase of the design is to determine all the necessary spans and calculate the vertical and lateral loads. Once all of these loads are calculated the team will begin the design of the shortest span, keeping the materials as cost efficient as possible. The shorter spans will be relatively straightforward and similar in design as the bridges will be transported to remote locations and will need to be easy to assemble. The team will create multiple solutions to give the client various choices when looking at different sites. Special care must be taken as the spans begin to increase due to the heavier dead loads that may require a different design than the shorter spans. Multiple selections will be analyzed to give the client choices in the bridges they want to choose for the different situations, which include but are not limited to girders, trusses and arches. Once all of the designs are finalized, drawings will be completed showing each individual component of the bridges and the order in which they must be assembled. During the design procedure all the assumptions made by Bluth Engineering will be documented with the appropriate references to the codes and manuals used. A project schedule will be provided which will further breakdown the tasks taken by the team for the design of each bridge.

3.2 Organization

During the course of this project most tasks will be undertaken as a group. Due to the years of experience as a team, the individual roles have been broken down into various tasks based on each team members' strengths, experience and interests. Since the formation of the team, each member has excelled in his or her role and this allows the team to work efficiently and provide a high quality product for the client. The team will meet informally throughout the course of the project to progress on the required tasks and to provide updates on what has been achieved on an individual level. The team roles are as follows:

Vanessa Walsh – Project Manager;

- Overseeing of planning and execution of project
- Main Communicator between team and Client
- Supervising tasks occurring in the project and organizing meetings
- Taking meeting minutes and ensuring the agendas are completed

Robyn O'Donnell – Design Lead;

- Research for various types of bridges
- Lead in STAAD/SFRAME analysis and structural calculations
- Final Design Input

Ryan Roberts – Drafting Lead;

- Creating templates and preliminary drawings
- Creating a step by step assembly drawing
- Completing drawings for each final design

Sarah Kean – Cost and Scheduling Lead;

- Overseeing unit pricing
- Project scheduling
- Documentation of group work

3.3 Client Interaction

Meetings with the Client will be scheduled by the project manager every week or as required to give updates on progress and scheduling. The Client is responsible for providing the spans for which Bluth Engineering is responsible to design as well as the preferred types of materials. During these meetings the Client will give feedback on the progress of the project and if there are any required changes. All agendas will be sent to the Client prior to meetings to inform them of the items to be discussed. Meeting minutes will be recorded and sent to the Client after being completed.

3.4 Design Principles

All the work completed by Bluth Engineering will follow the required codes and standards to ensure that the project has the highest quality of structural design. When designing each of the pedestrian bridges the teams engineers will follow the limit state design principals utilising the National Building Code of Canada and CSA Standards. The standards and codes that will be used by Bluth Engineering include:

- Wood Design Manual (CSA-086)
- National Building Code of Canada, 2010
- Canadian Highway Bridge Design Code (CAN/CSA-S6-06)

3.5 Cost Estimate Strategy

Bluth Engineering plans to contact local suppliers as a guide for pricing, as well as previous knowledge and experience. The team will keep an up-to-date spreadsheet recording all of the unit pricing and costs, without labour costs due to the work being volunteer based. The goal of this project is to keep the costs as low as possible, by using readily available materials. The material must be easily transported into remote areas with limited access and should be able to be assembled by a relatively small volunteer team to ensure costs are within budget. Once the designs are completed and final costs have been calculated it will be compiled into the final report and presented to the Client

3.6 Desired Outcomes

First and foremost Bluth Engineering strives to provide the Client with the highest quality of work, delivered on schedule and meeting all of the requirements. Bluth Engineering would also desire to have multiple design alternatives for various spans to allow the Client to choose different bridges for multiple areas. Since the team is also required to meet the conditions of the Engineering 8700 instructor they will ensure both parties are satisfied with the project results.

3.7 Reporting and Deliverables

Bluth Engineering has met with both the Client and the instructors of Engineering 8700 to create a list of deliverables needed to satisfy all the necessary requirements for both the project and the course. The list is as follows:

- Complete set of all final design drawings
- Cost Estimate and a breakdown of costs
- Quantity Calculations
- Structural Design Hand Calculations and Structural Analysis information and models extracted from S-Frame
- Final Report
- Final Presentation
- Individual Log Books (8700 Engineering Instructor)

3.8 Troubleshooting

In the event that a problem should arise, an internal review of each team member's log book will be conducted to try and indentify the origin of the problem so it can be addressed. The team members will work together to provide a solution to the problem, if possible, without external help from the Client or the Engineering Faculty. Should the issue need further expertise to resolve, the group will then seek out the help from one or both of the aforementioned.

4. TASKS

Six critical tasks have been identified to successfully execute the design and analysis of the six varying span pedestrian bridges. Each general task is broken down into a more detailed set of subtasks as discussed below. The projected durations, required resources and roles and responsibilities of each task, and subtask, can be found in more detail in *Section 5.0 - Project Schedule*.

4.1 Preliminary Work

Prior to commencing preliminary design, Bluth Engineering required appropriate background information, with regards to the applicable codes and standards that would be necessary to the design of pedestrian bridges. Information such as appropriate environmental loading, load combinations and standards for handrails, that would be common throughout the design process, would need to be determined prior to commencing design. Along with the appropriate codes and standards, research into common bridge configurations for various bridge spans will need to be determined. This will be performed through referencing sources online as well as the *Wood Design Manual*. The bridge types have been limited to: simple timber construction, girder or truss design with galvanized nails or bolted connections (based on client requirements).

Along with becoming familiar with the pertinent codes and standards a detailed project schedule will need to be created. The project schedule will show task durations and allocation of these tasks, and subtasks, throughout the course of the project. All team members will take part in the preparatory work leading up to the beginning of the design process.

4.2 Roles and Responsibilities

Determining set roles and responsibilities will help to ensure a focused and efficient execution of the project. Each team member's roles and responsibilities are briefly described below with a more detailed view of allocated tasks in the project schedule (Shown in *Section 5.0 – Project Schedule*).

Vanessa Walsh is assigned the duty of project manager. She will be responsible for project scheduling and editing of project deliverables. Vanessa is tasked with ensuring the team stay focused and on schedule when it comes to completing tasks on our timeline. For deliverables Vanessa will compile all appropriate information to provide the client and instructor with a concise and informative end product. It will be Vanessa's responsibility to delegate tasks as required as per the schedule.

Robyn O'Donnell is responsible for ensuring appropriate codes and standards are applied and researched throughout the course of the project. She will help to delegate design tasks throughout the course of the project as all members will be contributing to the various aspects of the design and analysis of the six bridges.

Ryan Roberts is tasked with the role of leading the drafting aspect of the project. He will ensure that all appropriate components are incorporated into each drawing and review each drawing as required throughout the course of the project.

Sarah Kean will take the lead on the cost estimate portion of the design. Throughout the course of the project, it will be Sarah's responsibility to ensure that economical choices are made during the design process. She will also be in charge of ensuring the appropriate bills of materials are indicated on each of the six bridge design drawings.

It is important to note that all members of the team will be contributing to design calculations, analysis and design drawings as well as the final report.

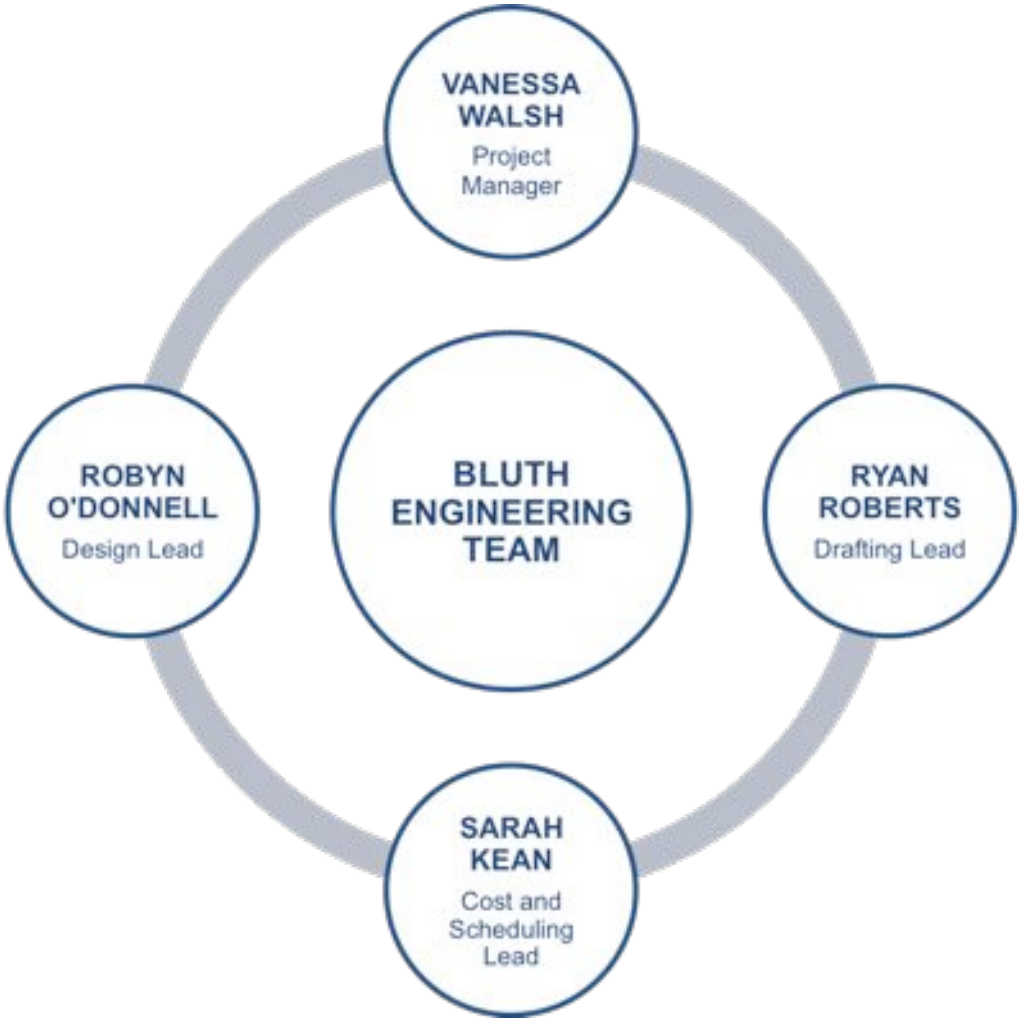


Figure 2: Bluth Engineering Team

4.3 Detailed Design and Analysis

4.3.1 Determination of Environmental Loading

The first task in the design process will be to determine the appropriate live, dead, snow and wind loads that will apply to the bridges. As these bridges are to be used in remote locations and will have limited traffic, a relevant importance factor along with appropriate load combinations will need to be determined as well. This information will be determined through the *Canadian Highway Bridge Design Code* as well as from the *National Building Code of Canada*.

4.3.2 Bridge Configurations

During the preliminary work stage, certain design concepts will be determined for both the shorter bridge spans as well as the long ones (i.e. truss or girder configurations etc.). Also, if truss designs are chosen, the most economical and efficient truss configuration will need to be assessed.

4.3.3 Design and Analysis of Bridge Elements

The structural elements of the bridges will be governed by the maximum member spans. These maximum spans will be governed by either loading or deflection criteria, of various timber sizes. Using either single or laminated timber members will also be an important design consideration depending on the span, if one of the two solutions may prove to be more economical than the other. For the design of the structural elements of the bridge, the *Wood Design Manual* will be used.

Analysis of structural elements of the bridges as well as the structures as a whole will be performed using S-Frame software. This will aid in the design process and ensure appropriate member selection to provide a safe and economical design.

Once the individual members of the bridge have been designed it will also be required to design the connections. Depending on the bridge configuration, the type of connections, either galvanized nails or bolted connections will be appropriate. Connection patterns and details are given in the *Wood Design Manual* which will be referenced for the design of the connections for all bridges designed for this project.

4.4 Drafting

Drafting will commence following the design of each bridge configuration and a detailed set of drawings will be produced for all individual bridge spans. Each drawing will consist of a plan, elevation and section view of the bridge, along with blow ups of connection details as required. A bill of materials will be included with each configuration to indicate the lumber sizes, lumber lengths and quantities as well as the type and number of nails/bolts required per connection details. The latest version of AutoCAD available to the team will be used to produce structural drawings.

4.5 Detailed Cost Estimate

A cost analysis of the proposed bridges will be completed by Bluth Engineering. The bill of materials for each bridge configuration will be added to the AutoCAD drawings and will show the associated amount of lumber to be supplied and the different sizes that will be used for each configuration. Costing will be provided based on current lumber prices.

4.6 Deliverables

Over the course of the project there will be various components to be prepared and submitted, either for approval or for final review. Some will be required weekly, as is the case with weekly progress updates and meeting minutes. Larger components, such as the Project Plan and the Final Report/Presentation will be submitted for final review at the end of the project to both the client and the course instructor. The final report is to include final drawings and associated cost estimates for each along with appropriate analysis results and design calculations. Both the weekly tasks as well as the final products will be ongoing throughout the course of the project. All members of the team will be involved in the completion of these tasks on a weekly basis throughout the course of this project.

5. SCHEDULE

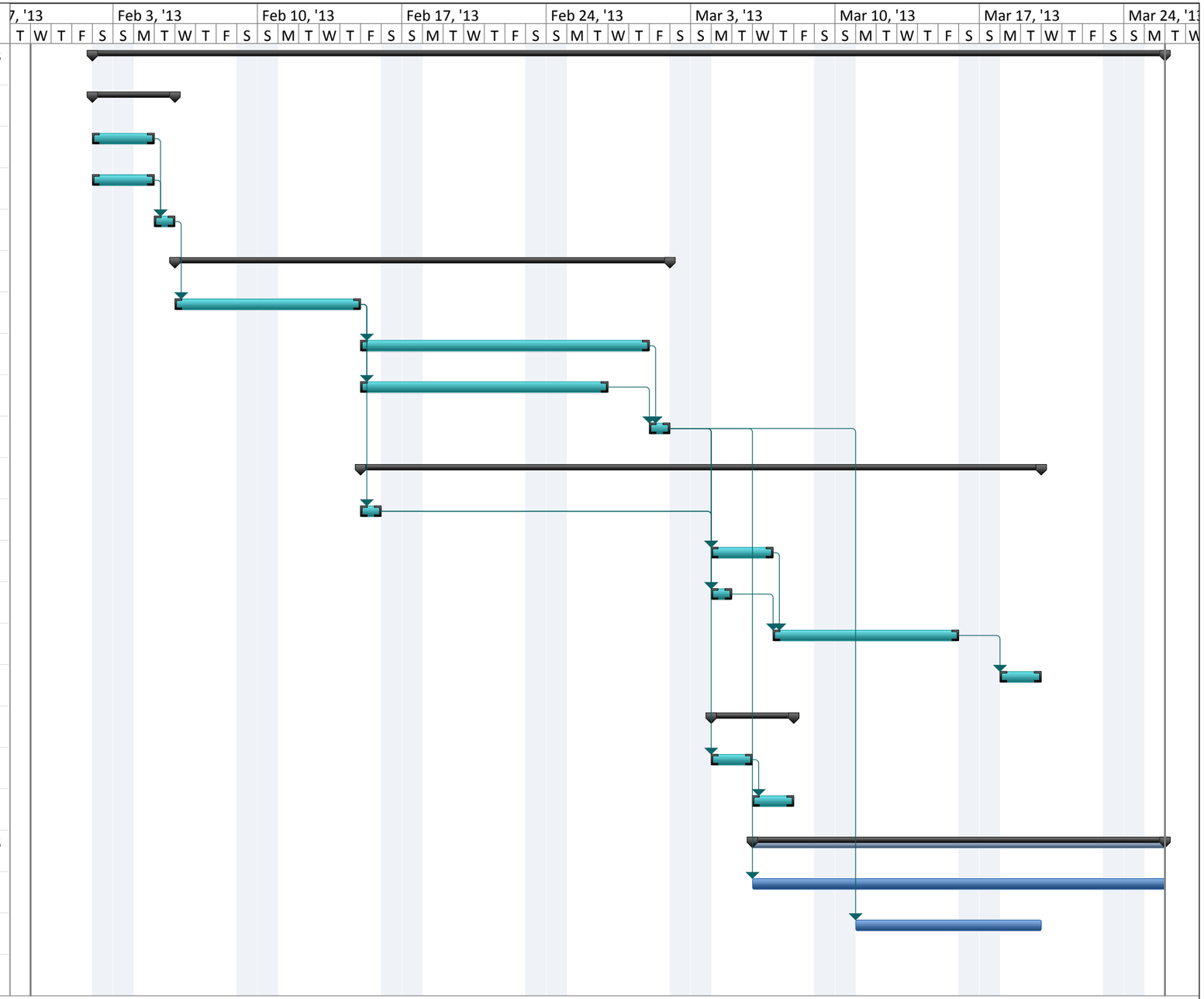
In order to ensure our project stays on schedule through the term, our team set important project milestones which have all strict deadlines we plan to meet.

- Completion of preliminary design – February 28th;
- Approval of preliminary design – March 1st ;
- Completion of drafting – March 15th;
- Approval of Drawings – March 19th;
- Completion of final report and presentation – March 25th;

In-between these milestones minor tasks will include but not limited to; research, preliminary design sketches, design calculations, schedule and cost updates, draft drawings, structural modeling. In order to assess whether the work involved in this project is progressing as expected, our team will discuss scheduling at each team meeting, have an updated schedule for each client meeting, as well as present the updated schedule each week to our civil design class. Once we have a schedule baseline, the team's project manager will then start to track against that baseline, marking off the project progress against the original plan.

The proposed project schedule is included on page 12.

ID	Task Name	Duration	Start	Finish
1	**East Coast Trail Footbridge Design**	**36 days**	**Sat 2/2/13**	**Mon 3/25/13**
2	**Preliminary Work**	**2 days**	**Sat 2/2/13**	**Tue 2/5/13**
3	Research Bridge Types	2 days	Sat 2/2/13	Mon 2/4/13
4	Choose Feasible Design Alternatives	2 days	Sat 2/2/13	Mon 2/4/13
5	Preliminary Sketches	1 day	Tue 2/5/13	Tue 2/5/13
6	**Design**	**18 days**	**Wed 2/6/13**	**Fri 3/1/13**
7	Load Calculations	7 days	Wed 2/6/13	Thu 2/14/13
8	Structural Analysis of Alternatives	10 days	Fri 2/15/13	Thu 2/28/13
9	Models completed in S-Frame	8 days	Fri 2/15/13	Tue 2/26/13
10	Approval of Preliminary Design	1 day	Fri 3/1/13	Fri 3/1/13
11	**Drafting**	**23 days**	**Fri 2/15/13**	**Tue 3/19/13**
12	General Template	1 day	Fri 2/15/13	Fri 2/15/13
13	Preliminary Assembly Drawings	3 days	Mon 3/4/13	Wed 3/6/13
14	Bill of Materials for each alternative	1 day	Mon 3/4/13	Mon 3/4/13
15	Final Drawing Set	7 days	Thu 3/7/13	Fri 3/15/13
16	Approval of Drawings	2 days	Mon 3/18/13	Tue 3/19/13
17	**Cost Estimation**	**4 days**	**Mon 3/4/13**	**Thu 3/7/13**
18	Quantity Take-off	2 days	Mon 3/4/13	Tue 3/5/13
19	Detailed Estimate	2 days	Wed 3/6/13	Thu 3/7/13
20	**Course Requirements**	**14 days**	**Wed 3/6/13**	**Mon 3/25/13**
21	Final Report	14 days	Wed 3/6/13	Mon 3/25/13
22	Presentation	7 days	Mon 3/11/13	Tue 3/19/13
23				



Project: Project1
Date: Wed 1/30/13

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

6. COST

The outline of the cost estimate included in the appendix will be further refined during the preliminary design phase. The costs will be adjusted using information gathered during design of the structure itself. No costing considerations were made for labour, due to the assumption that it will be built by volunteers. The detailed construction cost estimate will include an itemized schedule of quantities listing each item of construction and will conform to the necessary specifications. We will use unit prices from local suppliers for the lumber and equipment costs. Due to the remote location of the bridge, we are not expecting at this point to require any excavation or backfilling. Our team predicts the bulk of the costs will be from the following:

- Lumber material;
- Connection mechanisms (bolts, nails, screws, plates);
- Equipment; and
- Supplies;

The preliminary construction Cost Estimate outline is included in **Appendix B.**

7. DELIVERABLES

The following deliverables are to be submitted to both the client, and instructor in hardcopy and softcopy form:

- Project work plan,
- Multiple footbridge design options,
- Full engineering drawings of each design option (including plans, cross-sections, and elevations),
- Structural Models from S-Frame,
- Cost Estimate, and
- Final Project Report

All deliverables will be submitted to the Client and Instructor via email, and in person.

8. ASSOCIATED RISKS

Considering the remote location of the footbridge, there may be some risks involving the transportation of supplies and equipment required during construction. Bridge construction on the east coast could mean potential treacherous conditions, dangerous wildlife, and long commutes for site visits. Since the exact bridge locations are currently unknown, this could also pose problems when it comes to accessibility of the project location during construction.

Bluth Engineering is also aware that items such as time constraints, availability of software, and assumptions made during preliminary design may pose risks throughout the semester duration. We believe that proper planning, organization, and maintaining clear and consistent communication with our client is important to reduce any of these risks. Both team and client meetings will be scheduled regularly to discuss any potential issues or concerns.

9. REFERENCES

(1) Bruneau, S. E. (2013). *Final Year Capstone Design Project Course Guide for Students and Clients. Sixth Edition.*

Appendix A

Statement of Qualifications

BLUTH ENGINEERING

Providing Innovative and Forward-Thinking Solutions

FACULTY OF ENGINEERING& APPLIED SCIENCE; MEMORIAL UNIVERSITY OF NEWFOUNDLAND; ST. JOHN'S, NL; A1B 3X5

Mission Statement

Bluth Engineering utilizes our group's experience and synergy to provide our clients with innovative and unique solutions. We strive to deliver efficient and economic designs.

Core Values

Consistency
We take pride in continuously providing high quality work and maintaining healthy team relationships.

Efficiency
Our Company strives to deliver our services within the designated schedule.

Integrity
We are an honest and ethical company, keeping our commitments and treating others with respect and trust.

Safety
Our belief is to maintain a healthy workplace and ensuring that we do our best to preserve the environment.

Throughout the past six years our team has had the opportunity to work and grow together as a cohesive unit. Over many projects we have developed a strong group dynamic, always proud of the work we put forward. We pride ourselves in completing projects on time while maintaining a strong focus on a detailed end product.

Selected Project Experience

- Roncalli Elementary School Structural Design (DBA Consulting)
- Stoney Trail Steel Bridge Preliminary Design (AECOM)
- Shell MRM Debottlenecking Phase III (Fluor Canada)
- Mallard Cottage Preliminary Structural Design (DBA Consultants)
- Siemens 20t Crane Load Design (Tiller Engineering)
- 52nd Street Concrete Bridge Design (AECOM)
- Reclamation of Mildred Lake (North American Construction)

Our Team

Robyn O'Donnell

709.727.6581

Robyn is currently completing her last academic term in the Civil Engineering program at Memorial University. Through her work term opportunities she was able to gain valuable experience in structural design and analysis. Through both work experience and extra curricular activities her strong leadership skills are evident along with her ability to quickly learn new concepts in an efficient manner.

Notable Work Experience

- Preliminary design of Roncalli Elementary School and the MIX Condominium Building located in St. John's, NL, as well as other structural members
- Preliminary design of Gibraltar Office Building including timber, concrete, and steel member design and analysis
- Structural analysis and modeling using software such as S-Frame, S-Steel, and STAAD as well as other structural suits
- Drafting and editing using AutoCAD.

Vanessa Walsh

709.728.1690

Vanessa is a senior Civil Engineering student at Memorial University. Her work terms in Alberta have allowed her to gain diverse valuable experience in areas such as structural design, construction, and project management. In addition to her design experience, reviewing shop drawings and producing quantity take offs and cost estimates for various bridges were also major components of her work terms.

Notable Work Experience

- Preliminary and detailed design of steel and concrete bridges for the outer ring road located in Calgary, AB.
- Weekly Bridge inspections for multiple steel and concrete bridges in the Calgary region
- Field Engineer responsible for concrete inspections and contract administration in Banff National Park, AB.
- Structural analysis and modeling using software such as S-Frame, STAAD, and AutoCAD.

BLUTH ENGINEERING

Our Team

Ryan Roberts

709.727.6581

During his time with the co-op civil engineering program at Memorial University, Ryan has worked in many fields of engineering such as structural design, municipal engineering, and the oil and gas industry. This experience has brought him to gain valuable knowledge in programs such as S-Frame, STAAD and AutoCAD Civil 3D. Ryan's strength lies in his ability to work with others and his excellent work ethic.

Notable Work Experience

- Performed structural analysis and design of structures and beams for multiple projects using STAAD and S-Frame.
- Drafting and design using AutoCAD Civil 3D and AutoTURN for the Crowfoot Crossing shopping center located in Calgary, AB.
- Worked with the FES for damage assessment of municipal property after hurricane Igor.
- Experience in construction offers knowledgeable background in

Sarah Kean

709.769.6174

Throughout her career as a Civil Engineering student at Memorial University, Sarah has gained a broad range of work experience in structural, municipal, and management areas of the industry. She has a working knowledge of AutoCAD, SmartPlant Review, and RISA3D programs. From obtaining both office and site experience, one of her major strengths is communicating well with colleagues, contractors, and site tenants to complete a job or come to an agreement.

Notable Work Experience

- Completed structural analysis and design of steel structures using SmartPlant Review.
- Created and edited drawings of Civil/Municipal works using AutoCAD
- Responsible for tender packages, and generating both cost estimates and quantity calculations
- Acting site inspector on multiple civil work construction sites

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Appendix B

Outline of Preliminary Cost Estimate

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Design of Remote Varying Span Footbridges

Option A - XXXX

Item No.	Item Description	Unit	Estimated Quantity	Estimated Unit Price	Estimated Cost
1	**WOOD**				
1.1	(Size "A") Lumber	each			$0.00
1.2	(Size "B") Lumber	each			$0.00
1.3	(Size "C") Lumber	each			$0.00
1.4	(Size "D") Lumber	each			$0.00
3	**CONNECTIONS**				
2.1	Nails	each			$0.00
2.2	Connection Plates	each			
2.3	Bolts	each			$0.00
2.4	Screws	each			$0.00
4	**PROTECTIVE TREATMENT**				
3.1	Sealant	s.m.			$0.00
5	**EQUIPMENT AND SUPPLIES**				
5.1		each			$0.00
5.2		each			$0.00

Option B - XXXX

Item No.	Item Description	Unit	Estimated Quantity	Estimated Unit Price	Estimated Cost
1	**WOOD**				
1.1	(Size "A") Lumber	each			$0.00
1.2	(Size "B") Lumber	each			$0.00
1.3	(Size "C") Lumber	each			$0.00
1.4	(Size "D") Lumber	each			$0.00
3	**CONNECTIONS**				
2.1	Nails	each			$0.00
2.2	Connection Plates	each			
2.3	Bolts	each			$0.00
2.4	Screws	each			$0.00
4	**PROTECTIVE TREATMENT**				
3.1	Sealant	s.m.			$0.00
5	**EQUIPMENT AND SUPPLIES**				
5.1		each			$0.00
5.2		each			$0.00

BLUTH ENGINEERING

Option C - XXXX

Item No.	Item Description	Unit	Estimated Quantity	Estimated Unit Price	Estimated Cost
1	**WOOD**				
1.1	(Size "A") Lumber	each			$0.00
1.2	(Size "B") Lumber	each			$0.00
1.3	(Size "C") Lumber	each			$0.00
1.4	(Size "D") Lumber	each			$0.00
3	**CONNECTIONS**				
2.1	Nails	each			$0.00
2.2	Connection Plates	each			$0.00
2.3	Bolts	each			$0.00
2.4	Screws	each			$0.00
4	**PROTECTIVE TREATMENT**				
3.1	Sealant	s.m.			$0.00
5	**EQUIPMENT AND SUPPLIES**				
5.1		each			$0.00
5.2		each			$0.00

Option A - XXX	**$0.00**
Option B - XXX	**$0.00**
Option C - XXX	**$0.00**

Contact Information

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