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PENSTOCK TRESTLE REPLACEMENT TORS COVE HYDRO PLANT

TORS COVE, NL

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Table of Contents

1.0 Project Description

The Tors Cove hydroelectric plant is located approximately 40km south of St. John's, NL on the Avalon Peninsula. The small plant was built in 1941 by Newfoundland Power (NL Power) and can generate up to 6.5 MW of electricity. Water is carried to the generating facility from Tors Cove Pond by a 2,590mm wood stave penstock.

The wood stave penstock is supported by a 10-metre long trestle structure (Figures 1&2) as it crosses a small river. In a condition assessment conducted by a consultant, it was noted that significant corrosion (Figure 3) had affected several of the structural members and that repairs would be required within one year. These repairs were completed in late 2012. A follow up report issued by the same consultant noted that the completed repairs were adequate to extend the life of the structure by three to five years.

CASC Consulting will focus on developing and designing concepts that will allow either replacement or rehabilitation of the structure. The most feasible option will be recommended based upon several considerations including, but not limited to, cost, effect on river hydrology, constructability, safety, and risk.

Figure 1 – Tors Cove Trestle Location

Figure 2 – Trestle

Figure 3 – Corrosion of Trestle Members

2.0 Project Requirements

Over the course of the following months, CASC Consulting will participate in weekly progress meetings with the Engineering 8700 Capstone Project course and will meet with the client, NL Power, as required. Upon completion of the project, a final report will be issued to the client and a presentation will be given as a requirement of the Capstone Project.

The team requirements for this project, as specified by the client, are as follows:

- Complete research on potential designs and concepts for replacing the penstock trestle in Tors Cove
- Complete preliminary design and cost estimates for various replacement/ rehabilitation options
- Assess flood-carrying capacity of each option
- Complete comparison of the options and provide a recommendation on the most suitable option

3.0 Methodology

3.1 PROJECT APPROACH

NL Power has asked CASC Consulting to provide a concept evaluation for the replacement of the Tors Cove penstock trestle structure. CASC Consulting is responsible for the review of potential design concepts, assessment of feasibility and constructability, and a final concept design along with cost estimation.

During the initial stages of the project, it is important to have a clear understanding of project goals and expectations set out by NL Power. Regular meetings and frequent email correspondence will be used to ensure all project requirements are clear to both NL Power and CASC Consulting. CASC Consulting has accumulated several sources of information to commence a literature review of possible concepts and a detailed schedule has been composed to keep all work on track. Once sufficient information has been gathered and the review process started, team members will begin concept design and evaluation.

The following sections will further describe the organizational structure of CASC Consulting and outline the main tasks to be undertaken for this project.

3.2 INTERNAL ORGANIZATION

In order to ensure a high standard of quality and efficiency in completing project deliverables, members of the CASC Consulting team have been organized into distinct roles. While all members will be engaged in high-level aspects of the project, individuals will be responsible for overseeing specific tasks, which will ensure comprehensive coverage and quality control of the project scope. These roles were selected based on individual interest, comfort and past work experience. In addition to the primary areas of responsibility, all members of the team will work together during the research, design, and cost estimating activities to produce the project deliverables. The breakdown of roles and responsibilities are as follows:

Member	Title	Primary Role(s)	Secondary Role(s)
William Carson	Project Manager	Team Lead	Structural Design
Steven Collins	Structural Engineer	Structural Design	Drafting
Jessica Sinclair	Project Engineer	Estimating	Safety and Risk
Maria Adey	Project Engineer	Hydrology	Estimating

Table 1 – Roles and Responsibilities

William Carson, Project Manager

As the Project Manager, William is responsible for managing the project on a high level in order to guarantee successful execution. William will oversee the completion of all major tasks while ensuring deliverables are on time and meet or exceed the quality expectations of the team and client. As a secondary role, William will also assist with the structural design aspects of the project.

Steven Collins, Structural Engineer

As structural engineer, Steven will be responsible for checking primary designs of concepts along with structural analysis of their components. He will also work to ensure all work conforms to appropriate codes and standards. Steven will oversee any relevant S-Frame modeling analysis and associated deliverables. As a secondary role, Steven will handle the production and interpretation of any technical drawings by use of AutoCAD.

Jessica Sinclair, Project Engineer

As project engineer, Jessica will be responsible for monitoring cost estimating procedures in order to ensure consistency and quality. Jessica will also be in charge of safety and risk considerations and will also participate in concept generation and design.

Maria Adey, Project Engineer

As project engineer, Maria will be responsible for ensuring hydrological aspects of the project are in order. She will also assist with concept generation and will work closely with Jessica in preparing cost estimates for concepts. Maria will also be in charge of document control for the project and will help with formatting of reports and presentations.

3.3 MEETINGS

CASC Consulting will participate in three separate types of meetings in an effort to ensure open and effective communication is established with all interested parties.

Internal Meetings

Internal meetings will be held on a weekly basis in order to plan, delegate responsibilities, and troubleshoot any issues that arise. Internal meetings will be scheduled for 2-3:30 on Mondays, as well as during the Capstone Project lab slots on Monday and Thursday afternoons. Additional meetings may be scheduled on weekends or other afternoons as required.

Client Meetings

CASC Consulting will meet as required with NL Power, tentatively set at their office on Kenmount Road. The purpose of these meetings is to discuss project details as well as exchange documents. Issues and concerns that cannot be solved internally will be brought to the client for additional information or recommendations. CASC Consulting will request periodic feedback on work completed and interact with the client to ensure their expectations are met or exceeded.

Class Business Meetings

Each Monday, at 3:30pm, a board meeting will be held for all groups in the Capstone Engineering course time slot. The instructor will chair this meeting, with an assigned secretary for minute keeping. A representative from each student group will outline progress for the past week, plans for the upcoming week, and discuss any issues encountered. This meeting will serve as an opportunity for project instruction and clarification of course requirements by the instructor. This meeting will also provide a time slot to have questions answered and troubleshoot other issues.

3.4 DESIGN PRINCIPLES

CASC Consulting will deliver quality structural designs in a logical and efficient process. All design concepts that are developed will be subjected to the same derived loading conditions. Hand calculations will be used in the preliminary stage; however, if a large number of load cases are to be considered, a model of the structure may be created and analyzed using software (S-Frame). Depending on the results of the analysis, the design may be revised as required. Once acceptable results are achieved, the design will then be conveyed by detailed drawings illustrating a typical plan and cross section. Design procedures will follow the most appropriate building, concrete, wood, and steel design codes. The following codes will be used:

- CISC Handbook of Steel Construction, 10th Edition (CSA S16-09)
- CAC Concrete Design Handbook , 3rd Edition (CSA A23.3-04)
- National Building Code of Canada (2010)
- Engineering Design in Wood (CSA-086)

Other relevant engineering texts and manuals will be referenced during the design process.

3.5 COST ESTIMATION

After concept generation and design, CASC Consulting will calculate a cost estimate for each viable concept. Unit prices will be developed by contacting vendors for material prices and by use of RS Means to obtain the costs of installation. NL Power will also assist in unit prices, where necessary, based on past project experience. Caution will be necessary when using RS Means as accuracy of prices can be a cause for concern. Therefore, developed unit prices will be vetted by contacting local contractors for comparison. CASC Consulting will aim for cost estimates to be within an accuracy of plus or minus twenty percent (±20%).

3.6 DESIRED OUTCOMES

As the engineering consultant for NL Power, it is CASC Consulting's obligation to recommend a concept for the Tors Cove trestle. CASC Consulting will seek to meet the following outcomes:

- Recommended concept must meet specifications set by relevant codes and must allow for cost effective construction.
- Recommended concept must be safe and reliable such that the structure shall meet the desired design life.
- Recommended concept should be simplistic in nature such that on-site construction can be completed with ease.
- Recommended design must take into consideration environmental and social implications.
- Proper documentation of concepts will be required. The recommended concept may be put to use by the client and appropriate documentation of the design will be essential for future construction efforts.
- Effective reporting of project will take form as a final report and presentation. CASC Consulting will supply a detailed, but concise, report to the class and client, summarizing the characteristics, challenges and outcomes of the recommended concept.
- Establish a strong working relationship with client.

3.7 REPORTING AND DELIVERABLES

CASC Consulting intends to track and present its progress on this project using weekly status reports. These reports will be presented and passed in to Justin Skinner, instructor for the Engineering 8700 course and will consist of:

- A summary of the previous week's activities.
- A summary of the forthcoming week's activities.
- Current issues related to the project (delays, missing data, cancelled meetings, etc).

- Status of current project schedule and any changes made to schedule.

3.8 TROUBLESHOOTING

When issues or uncertainty arise during any point of the project, CASC Consulting will aim to overcome them systematically, by way of discussion and research. When design or analysis issues cannot be resolved internally in this manner, the team will then consult Memorial University's Faculty of Engineering members for advice and guidance. Any issues regarding technical details and specific requirements will be brought to the client during scheduled meetings for clarification. Additional assistance may be sought by networking with past co-workers and students studying in other disciplines.

4.0 Tasks

The entire team will be responsible for conducting initial research on potential concepts for design. Approximately 5-10 preliminary design concepts will be considered, but only 3-4 will be selected for detailed design work. The concepts will then be divided amongst the team, with the Lead Structural Engineer overseeing the entire process. This organizational structure will also be used for the cost estimation and documenting stages of the project.

Task	Sub Task	Primary Personnel	Duration	Resources
Information Gathering	- Site Visit - Research	All	2 weeks	
Preliminary Concept Development	- Concept generation - Primary concept design - Elimination process	All	1 week	Relevant Codes
Design Work	- Detail Design - Modeling - Drafting	SC, WC	4 weeks	AutoCAD, S-Frame, Relevant Codes
Cost Estimation	- Unit Pricing - Material Take-offs	JS	2 weeks	RS Means
Final Analysis	- Cost comparison - Risks and benefits analysis	WC, JS	1 week	
Documenting and Reporting	- Final report - Final presentation	MA	2 weeks	

Table 2 – Work Breakdown

5.0 Schedule

A Gantt chart has been completed, detailing the work to be conducted by CASC Consulting over the course of the project and is located in Appendix A. The project activities included in the chart are based on the Work Breakdown Structure shown in Section 4 (Table 2).

The major milestones that we have set to control our progress are:

- 10-Feb-13: Preferable design concepts selected (Preliminary round)
- 17-Feb-13: Preferable design concepts selected (Secondary round)

The deadlines for our project are also marked on the chart:

- 4-Feb-13: Project work plan due
- 4-Apr-13: Final project report and presentation due

The initial project activities include a visit to the site and related research. This is followed by the research and generation of concept designs and concurrently, the preparation of the work plan document. Concepts will then be evaluated based on a decision matrix and certain designs eliminated. The preliminary design and cost estimation of selected concepts will then take place. Designs will be evaluated again, before the final design and cost estimation period. Once the design of concepts is completed, the structures' flood carrying capacities will be evaluated. Finally, the comparison of design options and final recommendations will take place, as the preparation of the project document is ongoing. The preparation of the project presentation will commence once the comparison has taken place and recommendations are made.

This Gantt chart will be updated weekly to show the team's progress. Activities such as the "Design of options" and "Cost estimate" may be scheduled in more detail as concepts are selected and the design progresses. Additional schedule changes may be made based on project progress but will be subject to approval by the team lead. The project progress will be reported with an updated Gantt chart at weekly business meetings.

6.0 Cost

Costs incurred by the project team will be minimal. The main costs will include printing and binding for client and course reports, as well as costs associated with transportation to client meetings and site visits. The project team will incur the following costs:

Activity	Budgeted Cost
Transportation (Fuel)	$50.00
Printing Costs - **Printing** - **Binding and covers** - **Project binder**	$50.00
Logbooks	$20.00
TOTAL	$120.00

Table 3 – Budgeted Costs

7.0 Deliverables

Below is a list and description of deliverables CASC Consulting intends to provide to Newfoundland Power upon completion of the project.

Item	Approximate Completion Date	Status
Statement of Qualifications	January 11th, 2013	Complete
Project Work Plan	February 4th, 2013	Complete
Project Binder		
Structural Calculations	March 12th, 2013	-
Structural Design Sketches	March 12th, 2013	-
3D Models	March 12th, 2013	-
Hydraulic Analysis	March 17th, 2013	-
Environmental Hazard Report	March 17th, 2013	-
Cost Estimates	March 17th, 2013	-
Final Report	March 31st, 2013	-
Presentation	April 3rd, 2013	-

Table 4 – Project Deliverables

Statement of Qualifications

The statement of qualifications (SOQ) is a brochure created by the personnel of CASC Consulting describing the services and expertise that the firm can provide to their clients. This portion of the project is required by the Engineering 8700 Capstone Project course and had been completed prior to the beginning of the project.

Project Work Plan

The project plan details the methodology and process to be used by CASC Consulting throughout the course of the project. The project plan consists of a variety of information such as a project description, project schedule, the roles of each member, costs, tasks, and design procedure. This document is a requirement of the Engineering 8700 Capstone Project course.

Project Binder

The project binder will hold all work documents related to the project and will be delivered to the client upon completion of the project (Thursday, April 4th, 2013). The project binder will contain, but is not limited to, the following items:

- Structural Calculations - All hand and computer calculations for chosen designs, including structural analysis and code checks (steel, concrete, timber, etc).
- Structural Design Sketches - Preliminary sketches of design concepts and detailed AutoCAD drawing of final design.
- 3D Models - Three-dimensional visual models of the selected designs.
- Hydraulic Analysis - A complete hydraulic analysis (by way of the Rational Method) of the river passing under the penstock trestle to confirm that the opening is wide enough to withstand the required design flood from NL Power.
- Environmental Report - A brief report on any potential environmental hazards related to the project and selected designs.
- Cost Estimates - A cost estimate and comparison of all design concepts.

Final Report

A final report, including a recommendation to the client regarding the design concepts chosen by CASC Consulting, will be delivered to both the Engineering 8700 Capstone Project course instructor and the client on Thursday, April 4th, 2013.

Presentation

A final presentation, about the project in its entirety, will be delivered to the civil engineering students of the Engineering 8700 Capstone Project course, the instructors for the aforementioned course, and the client on Thursday, April 4th, 2013.

8.0 Risk

Project execution risks are identified in the following Table. These risks will be considered and mitigated throughout the life of the project in order to produce valuable and timely deliverables.

Risk	Description	Mitigation
Project Schedule Risks		
Client availability	The client may be unavailable for meetings or e-mail due to reasons such as travel or a busy schedule.	Maintain regular communication with the client so that the team will be aware of any upcoming issues.
Constraints due to weather	Poor weather conditions may result in the inability to hold team meetings, client meetings, or work with software that is only available at Memorial University's Engineering building.	Continuous monitoring of weather conditions so that meetings may be scheduled around large events.
Timely availability of cost data (material and construction costs)	The project cost estimates will be based on pricing obtained from external sources. It is uncertain how long it will take to obtain pricing.	Early identification of materials and construction methods, so that pricing sources may be identified early in project.
Design challenges	The team may be dependent on expertise from the client, or University professors, if a difficult design challenge is encountered.	Communicate any design challenges with the client or professor. May be able to use other resources such as textbooks, classmates, or other engineers to solve problems.
Resource Risks		
Computer hardware issues	Problems may arise with personal and/or university computers and printers.	Ensure that project documents are backed up on at least one other computer or hard drive. Allow extra time for document printing.
Computer software issues	Problems may arise with software that we will be using, such as AutoCAD and S-Frame.	Continuously save project work.
Availability of cost data	Pricing information is dependent on the design options that will be chosen. It is uncertain where we will obtain our pricing information for all materials.	Early identification of materials and construction methods, so that pricing sources may be identified early on.

Table 5 – Risk Identification and Mitigation

9.0 Environmental Considerations

There are several important environmental factors to be considered throughout the project. These issues will be evaluated during primary concept development and in the cost estimate. Each concept for development will be ranked during the elimination process based on environmental effects.

The biggest environmental concern is the river passing underneath the penstock trestle structure. During replacement and demolition the existing structure, special care must be taken to ensure that no paint or coating from the steel members falls into the river. It is also likely that site clearing will be required in order to ensure access to the trestle structure. Therefore, it is important to keep debris out of the river and minimize impacts on erosion.

Finally, proper procedures must be in place to ensure no leaking of fuel or other contaminants into the river from any machinery that might be used throughout construction.

10.0 References

Bridger Design Associates Ltd., 2010, *Penstock Truss Repairs*, Newfoundland Power

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Bruneau, S., 2012, *ENGI 8700 – Civil Engineering Course Archive*, Retrieved from http://www.engr.mun.ca/~sbruneau/teaching/8700project/archive/

Bruneau, S., 2010, *Guide to Writing an Engineering Project Plan*, Retrieved from http://www.engr.mun.ca/~sbruneau/teaching/8700project/classof2013/project%20plan%20guide.pdf

Appendix A – Project Schedule

Contact Information

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