NEC

NOVA ENGINEERING CONSULTANTS

HIBERNIA FLARE TIP REPLACEMENT - PROJECT PLAN 2012

Prepared for: Wood Group PSN & ENGI 8700

Nova Engineering Consultants:

Andrew Pike

Andre Wells

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St. John's, NL
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January 27, 2012

D. Whiffen and E. Kavanagh
Wood Group PSN
277-281 Water Street, St. John's, NL
A1C 6L3

Subject: Hibernia Flare Tip Replacement Project Plan

Dear Mr. Whiffen and Ms. Kavanagh,

Nova Engineering Consultants (NEC) is pleased to provide the attached project plan for the replacement of the flare tips at the Hibernia Platform. This work plan lays out how NEC intends to proceed in order to efficiently complete the project, and is a requirement of ENGI 8700.

The work plan gives an overview of the project and the requirements of PSN Wood Group. All tasks are listed and described as well as methodology to be used for their completion. We have also included an initial schedule of major task items and milestones, which will be periodically updated as the project progresses.

If there are any questions or any part of this work plan requires clarification, please do not hesitate to contact us.

Sincerely,

Nova Engineering Consultants

Andrew Pike

Andre Wells

Jon Alexander

Stephen Nicholas

cc. Dr. S. Bruneau

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1.0 Project Description

Hibernia is an off shore oil production platform situated approximately 315 kilometres off the coast of St. John's, Newfoundland. During production, natural gas is extracted along with the oil. The vast majority of the natural gas encountered is re-injected into the well, however a small portion of the natural must be burned off, or flared. The flare system is composed of two separate flare tips (high pressure and low pressure) located on a platform atop the 114 meter long flare boom. These tips experience very harsh conditions including temperatures reaching upwards of 500 degrees Celsius while in use. These circumstances lead to the necessity of having the tips replaced as they become worn or damaged. The current tips were installed in 2006, using a helicopter to hoist and place them. Both the high pressure and low pressure tips have reached the end of their service lives and now require replacement.

Replacement of the flare tips will occur in the summer of 2012 when the Hibernia Platform is scheduled for a three week shutdown. The flare tips will likely be removed and replaced using a helicopter. However, in the summer months it is not uncommon to have several consecutive days or even weeks of high fog and low visibility conditions. In these conditions it is unsafe to perform the replacement using a helicopter, and a contingency plan must be in place. The design of a viable second option for the replacement of the flare tips is the basis of this project. Nova Engineering Consultants (NEC) has been retained by Wood Group PSN to complete the design and analysis.

2.0 Project Requirements

Nova Engineering Consultants will work under the guidance of engineers at Wood Group PSN to design a method of replacing the flare tips. The existing flare tips are to be lowered from the flare platform to an N-Class supply vessel and the replacements are to be lifted from the same vessel and secured to the flare platform. The method which is used must be fully removable upon completion. All designs for a lifting mechanism are to meet standards CSA S16 and CSA Z1990. A lifting analysis will be performed in accordance with Lloyds Register Lifting Appliances in a Marine Environment. Suitable winch(s) and rigging configurations will be established to match the application. In making these selections it must be considered that the flare tips will be lowered to and hoisted from the deck of a supply vessel located below the flare boom. The supply vessel will be subject to additional movements caused by the sea states at the time of lifting, adding a level of complexity to analysis required. A dynamic analysis of the flare boom itself will be performed in order to ensure the structural integrity is not compromised during the lift. Once the design has been completed and all analysis accepted, a plan will be put together for project execution.

The entire project must be planned for completion in less than three weeks including all possible delays. A labour and materials estimate will also be completed to determine the probable cost of the entire flare tip replacement. Due to the extreme environment in which this project is to take place, several other constraints apply; these will be discussed in detail in the methodology section of this project plan.

3.0 Methodologies

3.1 Organization and Roles

In order to deliver the project efficiently with a high standard of quality, members of the NEC team have been organized into distinct roles. Each member is responsible for overseeing certain aspects of the project, ensuring total coverage and quality control of the work scope. The breakdown of roles and responsibilities are as follows:

Andrew Pike – *Project Manager*

Andrew has been selected as the Project Manager due to his previous project coordination work experiences in Alberta. As the Project Manager, Andrew is responsible for overseeing the project as a whole and ensuring successful execution. He will oversee all project components and ensure that each integrates effectively to produce deliverables that meet or exceed the quality expectations of our team and of the client. Andrew has also been tasked to manage client relations, and will direct communication and any other interactions with them.

Stephen Nicholas – *Structural Engineer*

Stephen's past work experience with provincial bridges and interests in structural analysis are the rationale for his selection as Structural Engineer. Stephen will be responsible for primary design of the rigid portions of the lifting frame, and the structural analysis of its components. Stephen will oversee S-Frame modeling analysis and associated deliverables. He will work jointly with the lifting and rigging engineer to combine the frame structure with the rigging mechanism requirements, and to produce a dynamic analysis of the flare boom during lifting.

Jon Alexander – *Planning and Estimating Lead*

Jon has previous experience with estimating and is familiar with using the RS Means Guide to obtain estimate values. Jon will be primarily responsible for producing material and cost estimates, including research and communication with vendors to obtain required data. Jon will be managing the schedule, and updating it as the project progresses. Jon will develop a detailed work plan to ensure project execution runs smoothly and safely. Jon will also be managing drafting, ensuring that all required drawing deliverables are complete and are of professional quality.

Andre Wells – *Lifting and Rigging Engineer*

Andre has past experience with lifting and rigging, and an aptitude for structural analysis making him the ideal candidate for Lifting and Rigging Engineer. Andre will be primarily responsible for the design of all rigging equipment and ensure adherence to LAME design standards. Andre will also be responsible for cost efficient winch and cable selections. Andre will work closely with the structural engineer and will be jointly responsible for dynamic analysis of the flare boom.

3.2 Meetings and Client Interaction

3.2.1 Internal Meetings

NEC will hold internal meetings to plan and delegate project efforts, and troubleshoot any issues that arise. Internal meetings are scheduled during the project course class timeslot on Wednesdays and Fridays at 10:00am, as well as the lab slots on Monday and Thursday afternoons. Additional meetings may be scheduled on weekends or other afternoons as necessary.

3.2.2 Client Meetings

In addition to internal meetings, NEC has scheduled weekly meetings with Wood Group PSN, tentatively set for Wednesday afternoons from 4:00-5:00pm at their office on Water St. The purpose of these meetings is to interact with the client 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. NEC will request periodic feedback on work completed, and work with the client to ensure their expectations are met or exceeded.

3.2.3 Class Business Meetings

At 10:00am Monday of each week a board meeting will be held for all groups in the course time slot. This meeting will be chaired by the instructor with an assigned secretary for minute keeping. A representative from each student group will outline progress for the past week, plan for the upcoming week and issues encountered. This meeting will serve as an opportunity for project instruction, and clarification of Requirements by the course instructor. This meeting will also provide a time slot to have questions answered and troubleshoot other issues.

3.3 Design Principles and Codes

All design work will be completed using the following codes and standards:

- CSA S16-09 Design of Steel Structures
- CSA-Z19902-09 Petroleum and Natural Gas Industries - Fixed Steel Offshore Structures
- Code for Lifting appliances in a Marine Environment (LAME) – Lloyd's Register 2008

Design is to be attached to the existing structure, and to be temporary and modular in nature. No modification to the existing structure is permitted. Design must be modular and lightweight in nature since structure's components will be carried up an inclined, enclosed safety ladder along the flare boom. Welding is not permitted in the design as the high temperature environment at the flare tip may have caused unpredictable changes in the structural integrity of the existing steel. We aim for simplicity in our design, as the harsh working environment will already challenge assembly and operation.

3.4 Cost Estimating Strategy and Accuracy

After completion of the frame and rigging design NEC will compile a cost estimate for project execution. We plan on contacting vendors to price materials, and to use the RS Means Guide to obtain the costs of installation. The remote marine environment of the project will increase installation difficulty and costs. Through research and data obtained from the client we will attempt to properly account for this increase, however due to changing environmental factors accuracy will be decreased and contingency values likely will be relatively large.

3.5 Troubleshooting Strategies

When issues or uncertainty arise during any point of project development our first strategy to overcome them is discussion and research internally within the NEC team. When design or analysis issues cannot be resolved in this manner, we will consult Memorial University's Engineering faculty members for advice and guidance in their respective specialties. Some manners concerning items such as technical details and specific requirements will be brought to Wood Group PSN representatives for clarification. Additional assistance may be sought from others we have encountered throughout our engineering careers, such as past co-workers and students studying other disciplines.

3.6 Desired Outcomes

We desire to work efficiently and effectively with Wood Group PSN personnel as well as Memorial's Engineering Faculty, and provide them with a quality design presented in a professional manner. At the end of the project NEC will submit a final report as well as other requested deliverables, as outlined in section 7.0. We aim to provide a realistic and viable solution that could be used to remove and replace both the high pressure and low pressure flare tips on the Hibernia Platform. Our solution is intended to be a contingency plan in case weather delays prevent the currently planned helicopter lift method.

4.0 Tasks

To effectively complete the project requirements for ENGI8700 - Civil Project and Wood Group PSN as a client, the project has been divided into a series of tasks. The tasks range from detailed design and analysis to scheduling and reporting, however all are considered equally important to complete the project effectively and on time. The individual tasks are as follows. Figure 1 shows a summary of allocation of time, personnel, and resources for each task:

TASK	SUB TASK	PERSONNEL	TIME ALLOCATION	RESOURCES
Research and Analysis	N/A	All	1 week	Internet Client Feedback
Design of Lifting Apparatus	Design of Attachment Points	SN AP	1 week	Relevant Design Codes Client Support Analysis Software Client Supplied Drawings
	Design of Lifting Frame	SN AP	2 weeks	Relevant Design Codes Client Support Analysis Software
	Design of Rigging Supports	SN JA	1 week	Relevant Design Codes Client Support Analysis Software
Design of Rigging	N/A	AW AP	1 week	ACAD Relevant Design Codes Client Supplied Drawings
Dynamic Analysis of Flare Boom	N/A	SN AW	2 weeks	Analysis Software Dr. Hussein Client Support Client Supplied Drawings
Drafting and Modeling	N/A	JA AW	4.5 weeks	ACAD Solid Works Printing Services
Cost Estimating and Execution Plan	N/A	JA AP	2 weeks	RS Means MS Word MS Excel
Documentation and Reporting	Weekly Meetings and Reports	AP	N/A	MS Word
	Schedule Tracking	AW	N/A	MS Project
	Final Report	All	2 weeks	MS Word
	Final Presentation	All	1 week	MS Power Point

Figure 1: Project Task Resource Allocation

4.1 Analysis and Selection of Lifting Apparatus

Prior to beginning the design of the lifting apparatus, research will be conducted through the internet to see what options have been used in the past by others completing the same type of work. Several possible solution types will be compared and the best candidate will be selected through discussion within the group and client, as well as analysis of the existing platform. At this point we will begin designing and drafting our initial concept. Further analysis and selection of final design details will be made and confirmed by consultation with Wood Group PSN.

4.2 Design of Lifting Apparatus

After narrowing down the general type of lifting apparatus, we will begin designing and drafting our initial concept. The design of the lifting apparatus will be carried out according to relevant codes, standards, and design principles (see section 3.3). The apparatus will be broken into parts for ease of design and will also incorporate the need for it to be carried to the top of the flare boom and assembled in place. Further analysis and selection of final design details will be made and confirmed by consultation with Wood Group PSN. The apparatus will be broken up into the following components:

4.2.1 Points of Attachment to Flare Boom

At locations where the lifting apparatus will be connected to the flare boom platform, special considerations must be given to the design. Our design must not require modification of the existing structure, so supports will need to be designed to attach on to the existing support beams without welding or cutting.

4.2.2 Main Lifting Frame

Design of the main lifting frame will need to meet the structural requirements of lifting, removing, and replacing the high pressure and low pressure flare tips of the flare boom. The key components of the design will be ease of in place construction and mobility of its components to bring them up the access ladder.

4.2.3 Rigging Supports

Rigging supports will be provided on the frame where winches, sheaves, and cable supports require them. They will be designed as necessary after rigging details are drafted and finalized.

4.3 Design of Lifting and Rigging Arrangements

Design of the rigging will include the selection of winches, sheaves, cables, shackles, and their arrangement for both flare tips so that they can be rigged on the supply vessel and then hoisted into place. Design will be such that the time and effort required to install the new tips will be minimized. Special considerations will need to be addressed due to the dynamic nature of the marine environment and the supply vessel to be used for transportation of the new and old tips.

4.4 Dynamic Analysis of Flare Boom

A dynamic analysis of the Flare Boom will be completed taking into account the effects of hoisting the flare tips up and down from the deck of a supply vessel located below. Since the Flare Boom was not designed to be used as a hoisting device this will be an important part of the design process.

4.5 Drafting and Modeling

Drafting for the project will include fabrication drawings of individual components of the lifting frame as well as a plan for assembly and it's placement on the flare boom. Further drawings will detail rigging arrangements for the lifting frame, and rigging arrangements for the hoisting of the individual flare tips. For purposes of showing the motion of the lifting frame and hoisting capabilities, a SolidWorks digital model will be created.

4.6 Cost Estimate and Execution Plan

A detailed cost estimate and execution plan will be developed for the fabrication, assembly and completion of the work associated with the replacement of both flare tips.

4.7 Documentation and Reporting

4.7.1 Weekly Minutes and Reports

Meetings with clients, weekly group meetings and business meetings with class will require recorded minutes into short reports. These will be completed weekly and will include an updated project schedule.

4.7.2 Schedule Tracking

In order to track progress, a project schedule will be updated weekly and will be included with our weekly reports. Time allocated for individual tasks will be modified as necessary to keep the project on time to be completed by April 2, 2012.

4.7.3 Drafting of Final Report

A final report will be submitted on April 2, 2012 which will include all documentation of the final design, cost estimate, drawings, and other relevant information related to the project.

4.7.4 Final Presentation

A final presentation will be created to report to the class on April 3, 2012. This will include a detailed description of our final design and the processes used to obtain it.

5.0 Schedule

A project schedule for completing NEC's work for Wood Group PSN has been created and is shown in the following Gantt chart. The schedule outlines and main tasks in completing the project and where applicable, some of the sub tasks have been incorporated. Due to the periodic nature of some of the tasks, and although they are necessary to the completion of the project, they do not have definite times in which they must be completed and have therefore been omitted from the schedule.

The schedule will enable NEC to track its progress of the work and complete the project on time. It will be tracked and updated on a weekly basis. The schedule will be used as a working copy to be tracked and modified as necessary to complete the project work.

Currently the final date of the project is the submission of the final project report on April 2, 2012 and final presentation on April 3, 2012. Although timelines have been set for each tasks of the project, as the project progresses more or less time may be allocated to individual tasks to keep the project delivery date on schedule.

ID	Task Name	Duration	Start	Finish
1	Submission of Project Plan	1 day?	Fri 1/27/12	Fri 1/27/12
2	Analysis and Selection	1 wk	Mon 1/30/12	Fri 2/3/12
3	Design of Lifting and Rigging Arrangements	1 wk	Mon 2/6/12	Fri 2/10/12
4	**Design of Lifting Frame**	**20 days**	**Mon 2/13/12**	**Fri 3/9/12**
5	Design of Flare Boom Attachments	1 wk	Mon 2/13/12	Fri 2/17/12
6	Design of Lifting Frame	2 wks	Mon 2/20/12	Fri 3/2/12
7	Desing of Rigging Supports	1 wk	Mon 3/5/12	Fri 3/9/12
8	Dynamic Analysis of Flare Boom	2 wks	Mon 2/13/12	Fri 2/24/12
9	Drafting and Modeling	4.5 wks	Mon 2/13/12	Wed 3/14/12
10	Cost Estimating and Exectuion Plan	2 wks	Mon 3/12/12	Fri 3/23/12
11	Preparation of Final Report	2 wks	Mon 3/19/12	Sun 4/1/12
12	Preparation of Final Presentation	1 wk	Mon 3/26/12	Sun 4/1/12
13	Final Report Due	1 day?	Mon 4/2/12	Mon 4/2/12
14	Final Presentations	1 day?	Mon 4/2/12	Mon 4/2/12

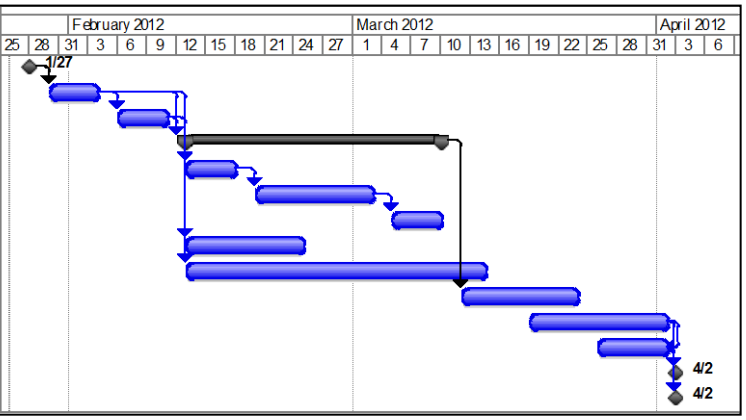

Figure 2: Project Schedule

6.0 Costs

The estimated costs associated with this project are displayed in Figure 1. The bulk of the cost is associated with the creation of a physical model of the lifting system design. The cost for the physical model is a rough estimate only at this stage and is subject to change. In addition to the physical model, costs include printing of drawings and color printing of deliverable reports, costs associated with transportation related to the project, and other miscellaneous supplies including binders and logbooks. All project costs will be covered upfront by a group member. Receipts will be maintained and at the end of the project all costs will be totalled to ensure equal contribution amongst group members.

ITEM	FORECAST COST AT COMPLETION ($)	COST TO DATE ($)
Printing/Plotting	90	12
Transportation/Parking	30	-
Physical Model	240	-
Supplies	40	-

Figure 3: Estimated project Costs

7.0 Deliverables

Several deliverables will be required as part of this project, either as requested by the client or as requirements for the course work. In this section each individual item to be delivered is listed and described briefly.

7.1 Project Plan

The project plan is required for the course and serves to keep the project on schedule. The project plan will be delivered (hard and soft copies) to the client and course instructor on January 27th.

7.2 Fabrication Drawings

The final design will be modeled using AutoCAD. Digital as well as hard copies of these fabrication drawings will be provided to the client.

7.3 Rigging Drawings

A set of detailed drawings demonstrating the arrangement of cables, and attachments for the lifting device will be developed using AutoCAD. These will be made available to the course instructor and client electronically as well as physical copies.

7.4 3D Model

The final design for a lifting mechanism will be modeled using SolidWorks. Digital as well as physical copies of the model will be provided. SolidWorks will be also be used to create an animation showing the device functioning.

7.5 Dynamic Analysis

Once the final design for the lifting mechanism has been reached, a dynamic analysis of the flare boom will be performed using S-Frame. The analytical output from S-Frame will be compiled in a report and submitted to the client and course instructor along with the final report on April 2nd.

7.6 Cost Estimate

Once the final design for the lifting mechanism has been reached, a cost estimate will be developed. The estimate will be delivered as a report (hard and soft copies) to the client and course instructor as part of the final report on April 2nd.

7.7 Project Execution Plan

Following the design of the lifting device and development of a cost estimate, a detailed plan of the project execution will be prepared. This will ensure that the project is executable in the required time frame. It will be delivered in the form of a report in soft and hard copy.

7.8 Final Report

A final report encompassing all other deliverables as well as other project documentation (i.e.: hand calculations) will be made available to the client and course instructor (hard and soft copies) on April 2nd.

8.0 Risks

Through extensive planning, Nova Engineering Consultants aims to minimize risks and vulnerabilities associated with this project. Nonetheless, certain risks have been identified which may hinder the completion of the project as it is intended. Potential risks include:

- **Difficulty obtaining data such as drawings and pictures** – If specific data we require for the development of our design is unavailable from PSN, we have no other direct source for information.
- **Unavailability of a site visit** – due to the location of the project, a site visit will not be possible for NEC. This will lead to potential difficulties visualizing the project setting. We will rely on structural drawings and images for design guides.
- **Differences of the actual structure from drawings provided** – All the drawings we have been provided are construction drawings rather than as-built drawings. This leads to the assumption that the structure was constructed exactly as designed; if any discrepancies are encountered potential difficulties may arise.
- **Software familiarity** – Software which is planned to be used for specific functions such as animations and fabrication drawings is relatively unfamiliar to group members. Learning this new software may prove more time consuming than anticipated, causing delays in project progress.
- **Lost time** – Unforeseen circumstances, such as weather, could result in lost time throughout the course of the project resulting in further constraints on the schedule.

Appendix A

Statement of Qualifications

NEC

NOVA ENGINEERING CONSULTANTS

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OUR VALUES

MISSION STATEMENT

To provide engineering support to our clients with the highest standards of quality and professional integrity. We strive to deliver projects effectively, efficiently and safely with innovative solutions tailored to meet our client's needs. We aim to exceed expectations and become a leader in the consulting industry.

COMPANY PROFILE

Nova Engineering Consultants (NEC) is a team of four engineering students, who collectively have a wide array of knowledge in the civil engineering field, gathered through diversified work experiences. Our team of consulting engineers has been involved with many projects located across Newfoundland and Labrador and Northern Alberta. These involvements have lead to proficiency in a variety of areas including, heavy civil construction, road building, wharf construction, reinforced concrete construction, bridge rehabilitation, piling, structural steel and water and sewer networks.

NEC provides a range of services such as project management, estimating, design, production and cost tracking, quality assurance and control, scheduling, field inspections and investigations and system efficiency optimization.

PROJECT INVOLVEMENT

- **Trans Labrador Highway Upgrading and Paving**
- **Holyrood Marina and Breakwater Upgrade**
- **Conception Bay South Water and Sewer Installation**
- **St. John's Harbour Interceptor Sewer Project**
- **Rattling Brook Big Pond Pumphouse**
- **Syncrude Aurora Mine Reclamation**
- **Albian Sands Brine Containment Pond Construction**
- **Iron Ore Company of Canada Pellet Plant Roof Remediation**
- **Clarenville Inn Renovation**
- **Shell Jackpine Khahago Creek Diversion**
- **Canadian Natural Resources Limited Tailings Dyke Construction**
- **Shell Jackpine Thickened Tailings Drying Phase I and II**
- **Albian Sands Combined Booster Pumphouse Piling and Foundation**

"Delivering projects effectively, efficiently and safely"

NEC

NOVA ENGINEERING CONSULTANTS

OUR TEAM

Jonathan Alexander

Jonathan Alexander is a civil engineering student at Memorial University in his final term. Over his work terms he has gained valuable experience in project management, scheduling and contractor supervision. In addition Jon worked with the Newfoundland federal government designing and maintaining wharf structures. He also has extensive knowledge of municipal services including road building and sanitary sewer and water systems.

Jonathan's main areas of interest are project design and management.

Stephen Nicholas

Stephen is currently a senior civil engineering student at Memorial University. His primary area of experience is with the Heavy Construction and Mining Industry in Alberta. Stephen has spent much time in the field coordinating major earthworks projects such as a 102 acre tailings drying zone, heavy hauler road construction, and earthworks material extraction and stockpiling. Stephen has much experience with production and budget tracking to ensure efficient equipment usage and quality control. In addition, Stephen has also spent time working for the Newfoundland Provincial government inspecting bridge infrastructure across the province for damage and initiating rehabilitation projects.

Stephen’s interests include mining and geotechnical civil works, as well as structural design and construction.

OUR TEAM

Andrew Pike

Andrew is a Term 8 civil engineering student set to graduate in April. Through six work terms Andrew has obtained a great deal of experience in the construction industry. Working for contractors as well as consultants has provided him with insight to the expectations of the client on a construction project. The bulk of Andrew's experience has been in a project management role in production based industries and he has become familiar with the demands of efficiency, quality and safety placed on projects. He has worked on a variety of projects throughout his career including construction of a 20 km long tailings dyke for Canadian Natural Resources Limited, upgrading of the Trans Labrador Highway and St. John's Harbour Interceptor Sewer project.

Andrew's main fields of interest are geotechnical engineering and heavy civil construction.

Andre Wells

Andre is a Term 8 civil engineering student at Memorial University. He has experience in both field engineering and project management roles, giving him a keen eye for project constructability and risk analysis, as well as an understanding of the importance of efficient and effective communications and safe work practices. His experiences in the civil construction industry have enabled him to gain knowledge in road building, earthworks construction, cast-in-place and pre-cast reinforced concrete construction, HDPE pipe fusion, water distribution and drainage piping, and structural steel remediation. In addition he has experience in geotechnical engineering, in particular, soils testing and quality assurance of aggregates for road building.

Andre's interests lie mainly in heavy civil construction and piping installation.

Contact Information

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