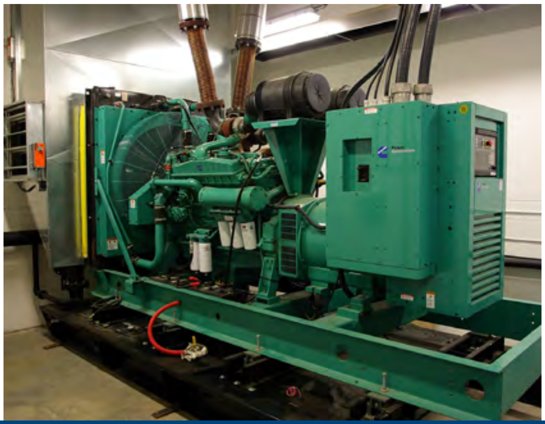
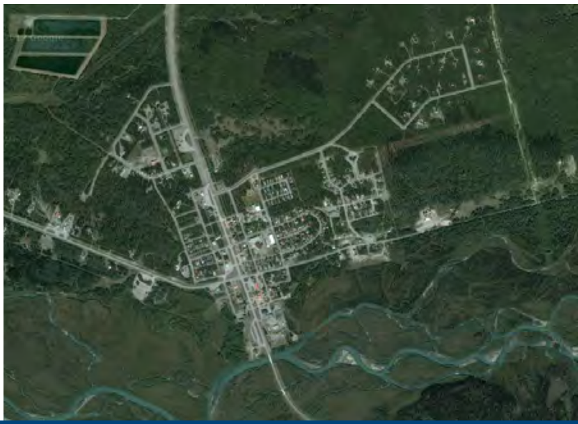




REPORT

Final FEED Report

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

October 18, 2013

Disclaimer

This document entitled Final Report - Front End Engineering Design (FEED) Study, Yukon Bioenergy Demonstration Project in Haines Junction, Yukon was prepared by Stantec Consulting Ltd. for the account of Yukon Energy. The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This version of the report is to support Yukon Energy's public release of the document. Due to the sensitive nature of the feedstock costing information and proprietary and confidential information provided by the equipment vendors, some information has been omitted. Omitted information was deemed to represent breaches of trust related to information transfer during the course of the study, and would impact the competitive advantage of the new company's operations, equipment vendors, and feedstock suppliers.

Executive Summary

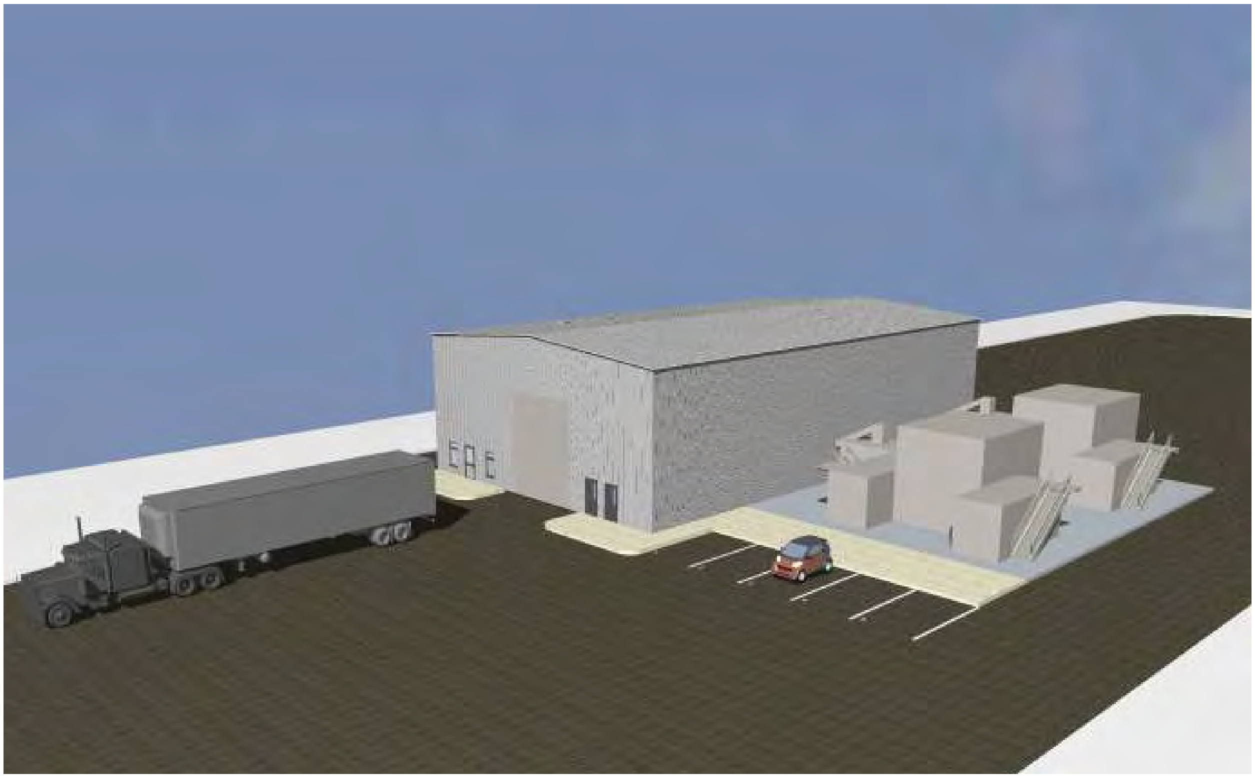
Stantec Consulting Ltd. (Stantec) has been contracted by a Steering Committee led by Yukon Energy Corporation (YEC) and the Champagne and Aishihik First Nations (CAFN) to complete a Front End Engineering Design (FEED) Study for the Yukon Bioenergy Demonstration Project in Haines Junction, Yukon. The focus of the study was to evaluate available biomass gasification technologies for application in the North in the range of 2 MW_e – 4 MW_e and determine its potential viability. The primary objectives were to complete a preliminary design of the facility, define its business case, draft baseline conditions and an impact assessment to form part of a submission to the Yukon Environmental and Socio-Economic Assessment Board (YESAB), and develop and support the engagement of CAFN members and members of the public.

The first steps in the study were to review the available gasification technologies and conduct site visits with members of the Steering Committee. The cursory technology review revealed that although available around the world, gasification technology using a reciprocating engine (as required for the project) is not developed to a high level of commercialization seen with conventional technologies. Any installation made for this project would be one of only a few in Canada, and one of only a handful in comparable cold climates. Furthermore, for most of the vendors contacted for quotations, this installation would represent one of only a few supplying their technology in conjunction with a reciprocating engine.

After narrowing the technology search by those applicable to the study's requirements, three vendors were approached to conduct site visits. Stantec and members of the Steering Committee visited Nexterra, Entropic, and Community Power Corporation (CPC) installations in Canada. Following the site visits, giving consideration to the technology review and waste heat usage, the facility's preliminary design would focus on a smaller generation capacity (0.5 MW_e to 2.0 MW_e) to better align with heating requirements of the village (for combined heat and power production) and to facilitate consideration of smaller gasification technology vendors.

Using the CPC units as a basis, Stantec prepared a preliminary design for a 500 kW_e gasification plant to be located near the centre of Haines Junction to facilitate heating local buildings. Given the smaller installation capacity, the focus of the design was to allow for future expansion for the facility once it is proven at the 500 kW_e scale as a demonstration project. Therefore, the preliminary design incorporated the ability to expand by an addition 500 kW_e, and increase in size to 2.0 MW_e to meet the study objectives. Opinions of probable capital cost and a rendering of the potential facility are presented below:

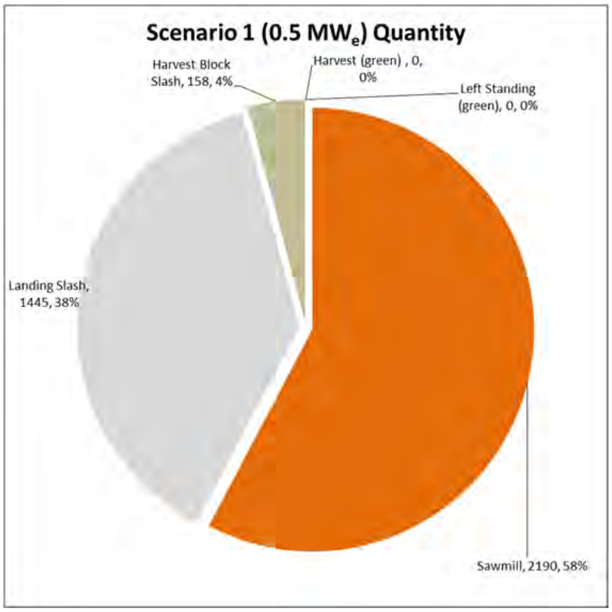
Option	Description	Opinion of Probable Capital Cost
1	500 kWe – Full Building Enclosure	$ 12.7 M
2	500 kWe – Architectural Building Enclosure	$ 13.5 M
3	500 kWe – Fuel Handling Enclosed	$ 11.4 M
4a	1,000 kWe – 500 kWe Expansion	(Exp = $ 9.8 M) $ 22.5 M
4b	2,000 kWe – 1,500 kWe Expansion	$ 45.0 M

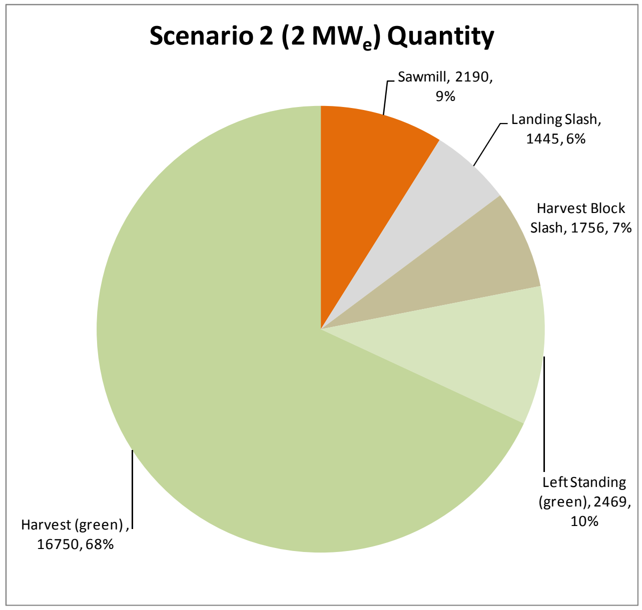


500 kW_e – Fuel Handling Enclosed – Artistic Concept

With any biomass installation, the two greatest ongoing costs are those to fuel the plant, and those for operation and maintenance (O&M). Stantec developed an opinion of operating costs, using the minimum number of operators requested for CPC's equipment, while AGFOR conducted a feedstock assessment to support determining the plant fuel costs as well as the development of the impact assessment. AGFOR's assessment determined that based on existing harvesting operations, a plant capacity of 500 kW_e could likely be supplied with minimal impact to existing operators/policies. This supply would be primarily sawmill residues and forest harvesting residues at the landing and in the harvest block; mostly dead trees from the spruce beetle infestation until that supply runs out. The larger plant capacities would require additional biomass supplied from new harvesting operations/policies and would extend into harvesting green trees sooner. Based on meeting with local regulators and harvesting operators, an opinion of probable supply costs below were determined, including sourcing breakdown.

Option	Description	Opinion of Probable Cost ($/GMT)
500 kWe	Roadside Chipping and Supplied Directly to Plant	Omitted
	Secondary Storage and Chipping	Omitted
2,000 kWe	Roadside Chipping and Supplied Directly to Plant	Omitted
	Secondary Storage and Chipping	Omitted

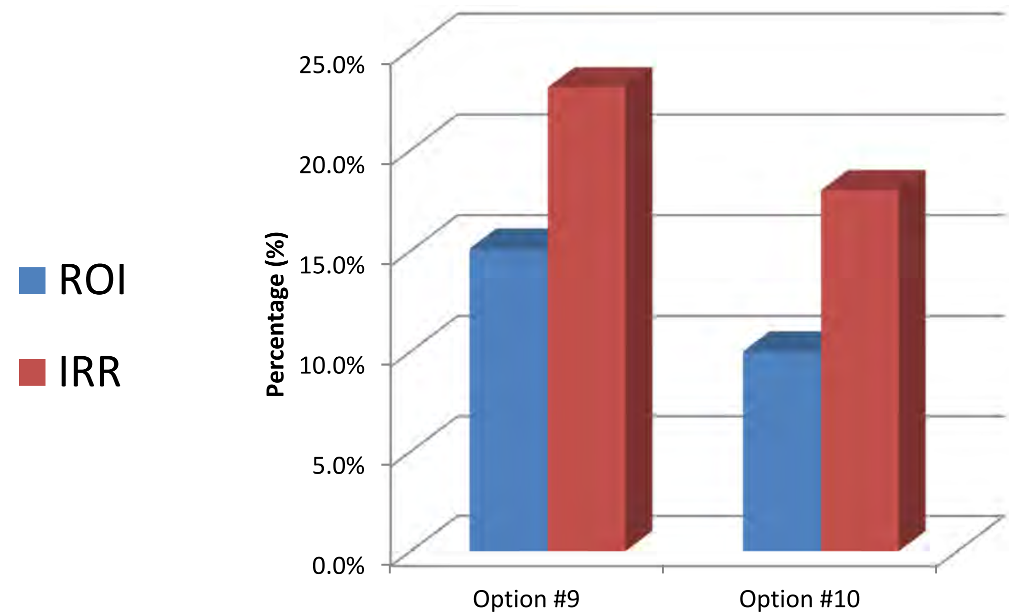




With a preliminary plant and feedstock supply concept established, a draft Environmental and Socio-economic Impact Assessment (IA) was prepared based on information currently available on the project and existing conditions in the area. The report includes an overview of the effects assessment and regulatory regimes associated with permitting the project, scoping of the assessment to include relevant Valued Components (VC), summaries of baseline conditions for each VC and expected effects and proposed mitigation. Determination of significance was based on residual effects after implementation of mitigation. Adaptive management and monitoring activities are also outlined where deemed applicable. The environmental and socio-economic impact assessment report draft is included in an appendix and is drafted to support a complete project submission to YESAB at a later date. The public and First Nation consultation activities are covered in the IA, with the draft engagement plan presented in a separate appendix.

The final aspect of the study was a review of the business model, funding opportunities and assessment of financial viability. Options for owning and operating different aspects of the plant are presented and weighed. The most suitable approach will be dependent on the technology and vendor selected, and the level of involvement in fuel supply the New Company (NEWCO) wishes to assume. A number of avenues for project funding are available, but will again depend on the technology and approach taken on the project; more risky, new technologies that do not have a commercial offering would likely qualify for additional funding, but more commercial technologies likely will not qualify. Continued funding through NRCan, which has funded this study in part, is a top candidate.

The financial analysis focused on ten (10) different plant options that varied with respect to generation capacity, building enclosure design, and vendor selection. To determine the potential viability of these options, financial cases were prepared for each installation taking into account the plant life span, capital and operation costs, and feedstock costing among other key parameters. Without any initial capital subsidization, none of the options were viable. Project viability was achieved for a select number of options assuming the project partners could successful receive capital subsidies from one or more sources. Impacts of electricity pricing in conjunction with capital subsidy were also explored to assess viability. The highest returns came from switching technology vendors to Proton Power from CPC with the financial results shown in the table below due to their lower quoted price.



	Item	Option #9 – 500 kW$_e$ Fuel Enclosed $50/GMT, $200/MWh, 67% Capital Subsidy
500 kW$_e$	Return on Investment (ROI)	15.1%
	Internal Rate of Return (IRR)	23.1%
2.0 MW$_e$	**Item**	**Option #10 – 2000 kW$_e$ Fuel Enclosed $50/GMT, $200/MWh, 67% Capital Subsidy**
	Return on Investment (ROI)	10.0%
	Internal Rate of Return (IRR)	18.0%

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1.0 Project Definition

At the project's onset, it was necessary to define the technology base that would be applicable to the project and the community that would house it. To this end an initial catalogue of technologies was prepared, reviewed and ranked, and ultimately used to determine the project's path forward. This section covers an overview of the findings of this effort as was presented in the project's Interim Report #1. The interim report is attached in Appendix A for further information and reference.

1.1 CATALOGUE OF TECHNOLOGIES

The production of electricity through the conversion of biomass can be accomplished using a variety of different processes and a multitude of feedstocks. The production of bioenergy not only employs a previously underutilized fuel source, but also mitigates the effects of energy production on the environment. When selecting the appropriate technology, it is important to keep in mind the available feedstocks, required amount of generated electricity, environmental standards, capital cost, and process efficiency (McKendry, 2001). Accordingly, with timber being the sole feedstock at the present time, and the target energy production range at the time of the interim report being 2 - 4 MW_e, three different types of biomass conversion options will be investigated: gasification, pyrolysis and an externally fired gas turbine.

1.1.1 Conversion Options

Each of the conversion options, along with their different reactor types and/or arrangements are described in detail in the report presented in Appendix A. Summary tables for the main advantages and disadvantages for the host of technologies are presented in Table 1.1 and 1.2. Of all the technologies, the updraft and downdraft gasifiers were the most applicable to the requirements of the project from the standpoint of complexity, power generation capacity, feedstock acceptance, and level of development.

Table 1.1 Properties of Gasification Reactor Types (McKendry, 2001)

Reactor Type	Advantages	Disadvantages
Fixed bed, updraft	Simple, inexpensive process Exit gas temperature about 250°C Operates satisfactorily under pressure High carbon conversion efficiency Low dust levels in gas High thermal efficiency	Large tar production Potential channeling Potential bridging Small feed size Potential clinkering
Fixed bed, down draft	Simple process Only traces of tar in product gas	Minimum feed size Limited ash content allowable Limits to scale up capacity Potential for bridging and clinkering
Fluidized bed, circulating	Flexible process Up to 850°C operating temperature	Corrosion and attrition problems Poor operational control using biomass
Fluidized Bed, bubbling	Flexible feed rate and composition High ash fuels acceptable Able to pressurize High CH_4 in product gas High volumetric capacity Easy temperature control	Operating temperature limited by ash clinkering High product gas temperature High tar and fines content in gas Possibility of high C content in fly ash

Table 1.2 Advantages and Disadvantages of Biomass Pyrolysis Systems (Vamvuka, 2011)

Reactor Type	Advantages	Disadvantages
Fluid type	Good solids mixing High heat transfer rates Good temperature control Ease of scaling	Heat transfer to bed must be proven at large scale Max particle sizes up to 6 mm If circulating, increased complexity of system, char attrition and reactor wear
Entrained flow	None	Low heat transfer rates Limited gas/solid mixing Small particle sizes required
Rotating cone	Good solids mixing No carrier gas required Ease of scaling Small investment cost	Heat transfer to bed must be proven at large scale Small particle sizes required
Vacuum reactor	No carrier gas required Lower temperature required Can process larger particles	Low heat transfer rates Solids residence time high Liquid yield rather low
Ablative reactor	Heat transfer gas not required Lower temperature required Can process larger particles Compact design and intensive system	Reaction rates limited by heat transfer to the reactor Char abrasion Scaling is costly

1.2 TECHNOLOGY REVIEW AND RANKING

Throughout the world one can find biomass gasification taking place from a scale suitable to heat a home, to that to capable of generating electricity to supply the grid. The focus of this study was to concentrate on a gasification technology capable of producing a syngas for cleanup that could then be introduced to a reciprocating engine in the initial capacity range of 2 – 4 MW_e. Although the technology could be innovative, it must be at or near commercialization to facilitate its installation in a northern community (i.e., not for research but practical/reliable use). Several technologies also require the use of steam, which is not available through co-locating near an existing facility, nor considered for self-generation. Two other biomass technologies were showcased for comparison (external fired gas turbine and pyrolysis-oil/ethanol/bio-oil).

To facilitate screening of the technologies, a ranking or scoring system was established to support the technology recommendation. The criterion used for the ranking system as well as the points awarded by criterion are outlined in Table 1.3. The ranking system does not include items affecting all the biomass systems, such as feedstock availability, socio-economic viability, job creation, or permitting requirements as these are common to all the systems at this level of evaluation.

Table 1.3 Interim Report Screening Criterion

Level of Development	R&D / Pilot – 0 Pts.	Demonstration – 3 Pts.	Commercial – 5 Pts.
Capacity Range	Outside 2-4 MW_e – 0 Pts.		Within 2-4 MW_e* - 5 Pts.
Use of Engine for Power	No – 0 Pts.		Yes – 5 Pts.
Gasification Complexity**	Advanced – 0 Pts.	Standard – 3 Pts.	Direct Comb. – 5 Pts.
Installation Base	1 Installation – 0 Pts.	2 Installations – 3 Pts.	More than two – 5 Pts.
Steam Required	Yes – 0 Pts.		No – 5 Pts.
Achievable Score	**Minimum – 0 Pts.**		**Maximum – 30 Pts. (100%)**

* Includes modular units capable of entering range (i.e. if maximum size is 1 MW_e, two units could be installed to enter desired range). Units significantly larger than the range would be excluded due to uncertainties regarding scale-down.

** Complexity is based on system design. Advanced is representative of dual bed or pressurized gasifiers, BFBs, and CFBs; Standard represents draft gasifiers (low to medium Btu syngas) to clean-up and the engine; and Direct Combustion is for the externally fired gas turbine.

1.2.1 Catalog of Technologies

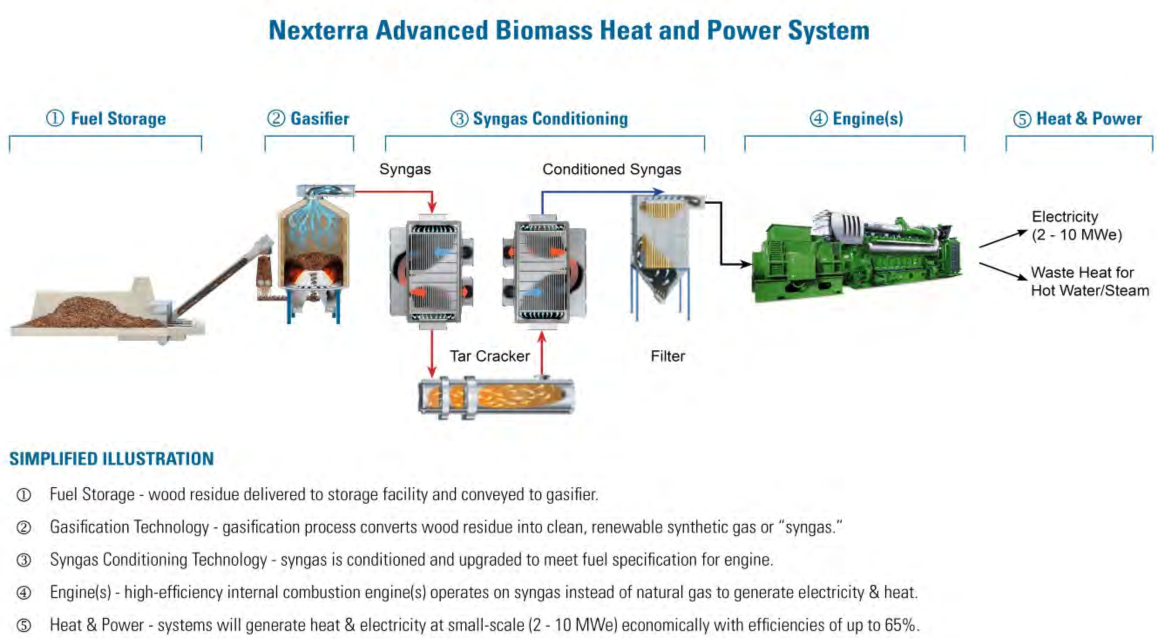
In the interim report, each technology was ranked according to the screening criterion presented in Table 1.3. A sample of the scorecard developed for each technology considered is presented on the following page in Table 1.4. Please refer to Appendix A for the scorecards prepared for the other technology vendors.

Table 1.4 Sample Technology Screening Scorecard

Developer / Company:	Nexterra Systems Corp.	**Location:**	Multiple – Oak Ridge, Vancouver, Victoria, North Carolina, New Westminster, UBC
Owner:	Various	**Status:**	Operational
Technology:	Dual Bed (BFB & CFB)	**Tech Status:**	Demonstration CHP
Capacity:	UBC: 2 MW_e, 3 MW_{th}	**Application:**	CHP w/ District Heating

Nexterra is the most recognizable Canadian gasification vendor. With installations of their gasifier throughout Canada and the USA, they have developed a solid platform for biomass gasification (low-medium calorific value syngas). Their most recent installation on the University of British Columbia campus is their first CHP using a reciprocating engine. The complexity of the system is Standard with an updraft gasifier and syngas clean-up. Nexterra's gasifier is a proven technology (for heating and steam turbine applications, but not in conjunction with an engine) and does not require steam.

Level of Development	Demonstration – 3 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Standard – 3 Pts.
Installation Base	1 Installations – 0 Pts.
Steam Required	No – 5 Pt.
Score	**21 Pts. (70%)**



1.3 TECHNOLOGY SELECTION

A summary of the technology scorecards determined in the interim report is presented in Table 1.5 on the following page. In reviewing each vendor's score, the top scores, greater than 20 pts., were ranked from one (1) to six (6). Given the criteria considered, the smaller, modular systems in the smaller capacity ranges took the top two rankings: (1) Community Power Corp., and (2) Biomass Engineering Ltd. The other downdraft unit, Pyroforce ranked third (3) followed by the alternative external fired gas turbine unit (4) Talbott's/Entropic. The final two rankings represent the larger updraft systems: (5) Nexterra, and (6) B&W Vølund. As a select number of vendors were used to represent each category, the groupings in the table highlight which has the best potential to be applicable to this project. This approach was selected with the understanding that bids from additional vendors would be considered later in the project.

1.3.1 Interim Report #1 Technology Recommendation

The technology summary in the previous subsection ranked three (3) technologies as front-runners based on their current installation base and applicability to general project requirements. In order to make a meaningful recommendation at the time the interim report was completed, it was also important to assess as many known considerations as possible. Additional consideration was given to feedstock supply (or lack of secure supply), the availability of trained operators, and plant efficiencies (or production of waste heat). These additional considerations lead to the recommendation to consider a smaller sized plant (or small capacity units) as they require less fuel (easier to secure feedstock), typically required a lower skillset operator (ex-electricians/mechanics compared to stationary engineers), and scored higher on the screening assessment. Part of this recommendation also served to match the plant capacity to the building heating load available in the village.

Table 1.5 Summary of Vendor Scorecards

Technology	Developer/ Owner	Level of Develop.	Capacity Range	Engine	Complexity	Installation Base	Steam Req.	Score	Rank	Elec. Eff.*	Enivron
‘Large Scale” Gasification											
Bubbling Fluidized Bed (5,500 kW_e)	Andritz-Carbona (EU – Denmark)	5	0	5	0	0	0	10 (33%)			
2 – 4 MW_e Gasification											
Updraft Gasifier (2,000 kW_e)	Nexterra (CAN – BC)	3	5	5	3	0	5	21 (70%)	5	26%	
Updraft Gasifier (2,000 kW_e)	B&W Vølund (EU – Denmark)	5	5	5	0	5	0	20 (67%)	6		
Dual Bed (2,700 kW_e)	FICFB (Repotec) (EU – Austria)	3	5	5	0	3	0	16 (53%)			
Small Scale / Modular Gasification											
Downdraft Gasifier (100 kW_e)	Community Power Corp. (NA – USA)	5	5	5	3	5	5	28 (93%)	1	20%	California Certified
Downdraft Gasifier (300 kW_e)	Biomass Engineering (EU – UK)	5	5	5	3	3	5	26 (87%)	2		
2-Zone Downdraft (150 kW_e)	Pyroforce (EU – Swiss)	3	5	5	3	3	5	24 (80%)	3		

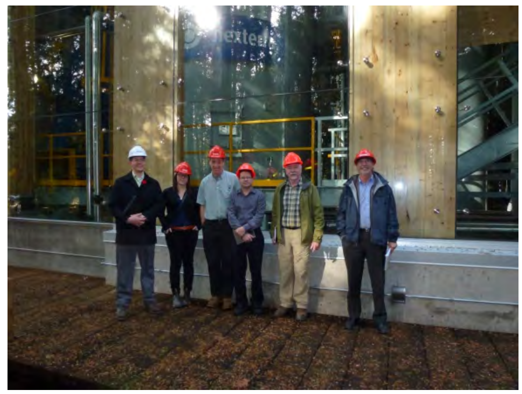
* Approximate based on published information

1.4 FACILITY VISIT OF SELECT TECHNOLOGIES

Based on the results of technology assessment it was desired to see a number of units in operation. Interim Report #2, available in Appendix B, covers the results of the vendor visits in detail. The next two sub-sections present the overall results of the Nexterra and CPC site visit.

1.4.1 Nexterra Visit

The site visit for Nexterra took place at 10:00 am on Monday, November 5, 2012 on the UBC campus. Phil Beaty, Vice President, Strategic Relationships, for Nexterra, and Brent Sauder, Director, Strategic Initiatives for UBC facilitated the visit. Initially the group met in a conference room on campus to discuss the university's experience during the project's development and execution. This was followed by a guided tour of the facility with the Nexterra representative and operating staff only. During the visit, the plant was operational.



1.4.1.1 Project Overview

This project was kick-started by John Grace of UBC based on his academic research into gasification and more specifically gas conditioning/clean-up. UBC and Nexterra wanted a demonstration-sized plant to prove the concept and facilitate R&D at the university. Based on the UBC concept, GE came in as a partner and supported the development.

UBC is unique in that it is its own municipality with its own substation. The challenge in BC is the low power rates brought on by their hydro resources. That said, UBC still had the desire to demonstrate a BC technology in BC. On the waste heat side, they are also in the process of converting their existing steam district heating system over to hot water.

For UBC the social license was the first step, with five (5) sites initially under consideration. Faculty members were quick to get onboard for the research ability, and the community soon adopted a “yes, in my backyard” mentality. In the end, the unit was located on the edge of the campus in order to reduce truck traffic for fuel deliveries. During full operation, UBC receives three (3) trucks a day, with enough storage for a three (3) day weekend.

On the permitting side, UBC requested the strictest emission regulations be met. To that end, UBC requested that the system be designed and will be tested to meet Metro Vancouver requirements, as well as those in the USA jurisdictions of San Joaquin Valley and the state of Massachusetts. The facility is further equipped with a local and external air shed monitoring system.

Building construction was initially completed using standard steel building formats. During the project's development UBC worked with FP Innovations and selected a new construction method – cross-linked timber or CLT. The current facility uses CLT for the roof and walls of the building.

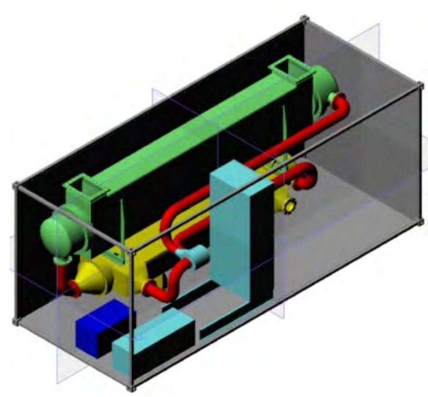
The Nexterra system does require trained operators to run the facility. Operators would require similar skills to that of boiler operators, and if a hot water system was installed, they would not require steam tickets. That said, a 4^{th} to 3^{rd} class ticket would be a starting point for skilled operator requirements. Although the system is automated, skilled operators are required to react quickly in an upset condition. As a minimum, the system requires two (2) full-time staff on-site 24 hours a day / 7 days a week. Currently the UBC plant operates in eight (8) hours shifts, requiring a minimum of eight (8) trained operators to support the plant.

1.4.1.2 Overall Impression

General impression of the group following the visit was that the installation was very large and more complex than expected. The size of the facility, number of operators, and perceived complexity of operation did not seem appropriate for a unit to be located in Haines Junction. The capital cost, maintenance requirements, parts availability, and service technician/operator skill set were also of concern. Mr. Beaty re-iterated that the UBC unit was the first of its kind for Nexterra and they are not actively marketing it. It will be more than a year before annual performance numbers are available, and only then would Nexterra begin to entertain installing their second unit. Further discussion revealed that Nexterra is not interested in a northern site for their second installation.

1.4.2 Entropic Visit

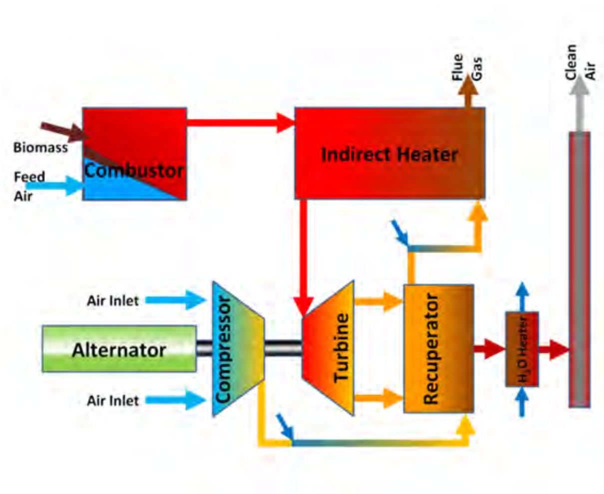
The site visit for Entropic took place at 9:00 am on Tuesday, November 6, 2012 on the University of Manitoba (U of M) campus. Dr. Eric Bibeau, NSERC/Manitoba Hydro Industrial Research Chair in Alternative Energy and co-founder of Entropic, facilitated the visit. Initially the group met in Dr. Bibeau's office on campus to discuss Entropic's technology and product development. This was followed by a guided tour of the installation with Dr. Bibeau. During the visit, the plant was not operational and it was unclear when it would achieve demonstration status.



1.4.2.1 Project Overview

Entropic is in the R&D stages of their technology. The concept is to design a biomass system with a small footprint that can compete on a conventional technology's price point of $4M/MW$_e$.

Using the price point as a basis Dr. Bibeau and this team are trying to apply a hybrid Brayton Cycle to achieve high efficiency power generation in a modular package of 250 kW_e.



The Entropic design builds upon that of the indirect fired Brayton Cycle. The principle difference is in the thermodynamics in that they inject water at critical points in the process to increase unit efficiency. Although only currently theoretical in models, the team at U of M are trying to get their unit up and running. Should they be successful, the hybrid design touts the benefits of maximized energy transfer through increase mass through the turbine, decreased turbine inlet temperature (therefore reduced stress on the unit), maximize equipment capacities, and overall increase in efficiency – to double that of a standard externally fired unit.

1.4.2.2 Overall Impression

General impression of the group following the visit was that this technology/vendor was not appropriate for future consideration. The technology is not near a viable status for consideration on this project, though appears promising.

1.4.3 CPC Visit

The site visit for Community Power Corporation (CPC) took place at 1:00 pm on Tuesday, November 6, 2012 at Pineland Forest Nursery in Hadashville, Manitoba. Carl Peterson, Field Engineer, facilitated the visit for CPC. This unit is located on, and integrated to Pineland's operations, but is owned by Manitoba Hydro. Jeremy Langner is the Project Manager for Manitoba Hydro (MH), but was unavailable at the time of the site visit. Mr. Langner did provide Stantec with some information on the project as a follow-up to the visit. The General Manager of Pineland, Trevor Stanley, was also unable to attend the site visit, but joined the group later in the evening to answer questions and discuss the project. The tour of the unit took place immediately upon arrival, with questions & answers carrying the group through until departure. During the visit the plant was operational.

1.4.3.1 Project Overview

The following overview was developed from follow-up information provided by Mr. Langner.

The CPC system is manufactured in a series of five (5) 20 ft. shipping containers. Shipping the unit in this containerized form allows the majority of the work to be performed at the manufacturer's facility. The Pineland system was installed in June and July 2012, and Manitoba Hydro/CPC/Pineland have been testing it ever since. The unit has been run to peak capacity and has been able to generate a maximum of approximately 120 kW_e of electricity gross, with about 20 kW_e of parasitic loss. Pineland is also recovering heat off of the engine's cooling jackets and exhausts, and sending this to a thermal loop to heat greenhouses. The heat supplements Pineland's existing 2 MW_{th} biomass boiler, located in an adjacent building.

The CPC system uses a stainless steel downdraft gasifier with air injection points throughout the fixed bed. A vibrating grate can dump material if required. The temperature profile is precisely controlled throughout the bed to insure good gas quality. This allows the filtration system to be very simple – filter bags with backup carbon safety filters. This filters out a very fine carbon dust from the gas. The gas is then sent to two (2) 8.1 L V8 spark-ignition engines, each connected to a 65 kW_e alternator. Another feature of the system is the biomass dryer that uses heat from the gas cooling heat exchanger to dry the feedstock. This allows MH/Pineland to accept up to 45% moisture content, and dry down to approximately 15% moisture.

With regards to fuel rates and flows, MH currently pays in the range of $55 to $65 per tonne as delivered for their biomass supply. The wood chips come from several sources within 2 hours or less of the project site. The fuel consumption is stated by CPC as 90 kg of dry biomass per hour, however, MH have not been running consistently enough to determine a more accurate figure. The CPC system can accept ¼" x ¼" through 2" x 2" chips.

As far as maintenance costs are concerned, MH does not have enough data to provide concrete figures. It will highly depend on the number of oil changes per month. CPC has specified an oil change every 10 days. MH are also budgeting the equivalent of 1 hour per day of daily checks, and two (2 to 3 man-days per month spent on gasifier maintenance. During this initial start-up phase, these numbers are expected to be higher.

Operating efficiency is also difficult to determine giving the limited operating hours. Assuming MH/Pineland are burning 90 kg/hr for 100 kW of output (net), and the biomass has a higher heating value of 20 MJ/kg (dry), MH would have a net electrical efficiency of approximately 20%. MH believes that the total efficiency will be at least double when they include the heat.

In a discussion with the Mr. Peterson, CPC typically provides four weeks of commissioning and start-up services. This includes two (2) weeks on-site to commission the unit and systems, one (1) week of full-time training for site personnel, and one (1) week of field supervision following the training. Beyond the four (4) weeks, Mr. Peterson indicated that CPC monitor the unit remotely for any system warnings or errors. As for the level of skill required to operate the units, Mr. Peterson indicated that the majority of operators are ex-electricians or ex-mechanics. Ex-electricians are preferred give the system electronics and potential advantage when troubleshooting problems, but both have been successful at operating the units.

1.4.3.2 Overall Impression

General impression of the group following the visit was that this technology/vendor was the most appropriate of those visited for Haines Junction. Apart for the small capacity (100 kW_e) the plant's simplicity of operation, level of operator skill required, and proven heat recovery potential make it a strong candidate for installation in the Yukon.

2.0 Preliminary Design

The following subsections outline the preliminary engineering for the FEED study. The first subsection reviews information on the vendors contacted as part of the RFQ process. Vendor information packages are presented in Appendix C for the Steering Committee's review and reference. Not all information requested is available and follow-up requests and questions have been made to the vendors.

The final two subsections outline the facility siting exercise as well as aspects of the preliminary design and opinions of probable cost. The costing presented covers the preliminary options to utilize the CPC 500 kW_e (2 x 250 kW_e) units both inside a building (Option #1) and outside a building (Option #3). An option to have the building exterior completed with an architectural design is also provided (Option #2). As the intent would be to expand the demonstration project in the near future, a fourth option is presented to expand the initial 500 kW_e plant by an additional 500 kW_e in Option #4.

Each option is reviewed briefly in this report with additional information available in Appendix D (Option #1), Appendix E (Option #2), Appendix F (Option #3), and Appendix G (Option #4). Appendices contain the engineering drawings created to support the costing effort as well as the more detailed line item opinions of probable capital cost.

2.1 VENDOR RESPONSE TO RFQ

Each of the vendors contacted as part of the RFQ process are reviewed in the following subsections with their detailed packages contained in Appendix C. Information contained here and in the appendix represents vendor proprietary information and costing. This should not be considered for distribution outside the project team.

2.1.1 B&W Volund

Despite initially being a promising technology source, discussions with B&W Volund revealed otherwise. Upon conversing about the project details, particularly the feedstock characterization, it was determined that the moisture content present in the feedstock was too low for use in B&W Volund's technology. They therefore declined to provide a quotation/information package.

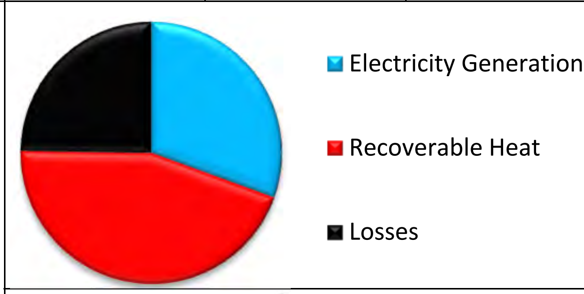
2.1.2 Nexterra

As mentioned previously during the site visit of their facility at UBC, while being an appropriate technology it is not being actively marketed. Nexterra wishes to operate the UBC unit for at least a year before pursuing a second installation. Even after a year, the general impression provided by Nexterra was that the next installation is not likely to be in the North.

2.1.2.1 Vendor Summary

To quickly highlight key aspects of the vendor's response, Table 2.1 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section.

Table 2.1 Nexterra Summary

<table>
<tr><td colspan="2">nexterra</td><td>Headquarters:</td><td colspan="2">Vancouver, British Columbia</td></tr>
<tr><td colspan="2">Developer / Company:</td><td>Nexterra</td><td>Vendor Rep:</td><td>None</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="3">System Information</td><td>Quoted Capacity:</td><td colspan="3">2.0 MW_e</td></tr>
<tr><td>Model Number:</td><td colspan="3">Standard CHP System</td></tr>
<tr><td>System Configuration:</td><td colspan="3">1-Stage Updraft Gasifier, 1x IC Engine</td></tr>
<tr><td colspan="2">*denotes scaled values</td><td>As Quoted</td><td>500 kW_e</td><td>2.0 MW_e</td></tr>
<tr><td rowspan="3">Fuel Requirements</td><td>Moisture Content as Fired:</td><td colspan="3">20%</td></tr>
<tr><td>Feedstock Consumption (dry basis):</td><td>1,474 kg/hr
3,250 lb/hr</td><td>N/A</td><td>1,474 kg/hr
3,250 lb/hr</td></tr>
<tr><td>Feedstock Size:</td><td colspan="3">N/A</td></tr>
<tr><td rowspan="7">Unit Performance</td><td>Net Electric Generating Capacity:</td><td>2.0 MW_e</td><td>N/A</td><td>2.0 MW_e</td></tr>
<tr><td>Operating Parasitic Load:</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Availability:</td><td colspan="3">91%</td></tr>
<tr><td>Recoverable Heat:</td><td>2.93 MW_{th}</td><td>N/A</td><td>2.93 MW_{th}</td></tr>
<tr><td></td><td colspan="3">
</td></tr>
<tr><td>Cogeneration Efficiency:</td><td colspan="3">75%</td></tr>
<tr><td>Electrical Efficiency:</td><td colspan="3">31%</td></tr>
<tr><td rowspan="2">Commercial</td><td>Delivery Lead Time:</td><td colspan="3">N/A</td></tr>
<tr><td>Published Equipment Price:</td><td>$18M - $20M</td><td>N/A</td><td>$18M - $20M</td></tr>
</table>

2.1.3 Community Power Corporation

In response to our RFP, Community Power Corporation responded with a budgetary proposal for the design, supply, transportation to site, and supervision of erection and startup, of a demonstration bioenergy system. The proposal outlined several risks that CPC was concerned with that may have a significant impact on the project. These included:

- Long-term bioenergy system reliability and availability (downtime) have not yet been confirmed in a remote, cold climate community.
- Impact of cold climate is not yet known on system performance.
- Operation and maintenance costs need to be verified.
- Sustainable biomass harvesting plan needs to be confirmed.
- Impact of biomass variability on system performance needs to be confirmed (biomass type, heating value, cleanliness, moisture content, etc.).
- Requirements for and impact of permitting and environmental performance requirements are not fully understood.
- Availability of local operators with appropriate maintenance skills.

Given the number and importance of these risk areas, CPC strongly recommends consideration of an initial, single BioMax 100 (kW_e) demonstration system that can address the risk areas at lower cost while still providing all of the insight needed to design and implement the larger follow on 500 kW_e to 2 MW_e deployment. Therefore, based on CPC's experience in bioenergy and renewable energy demonstration projects in remote communities throughout the world, they propose consideration of one, 100 kW_e BioMax bioenergy as described in their proposal.

2.1.3.1 Vendor Summary

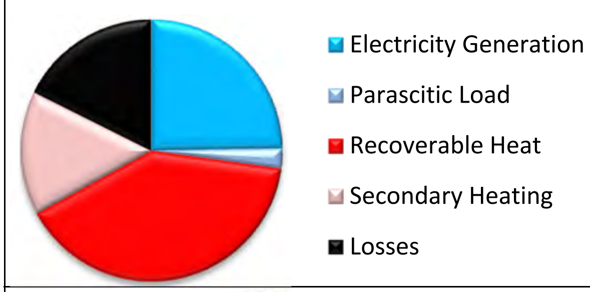
To quickly highlight key aspects of the vendor's response, Table 2.2 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section.

2.1.3.2 Vendor Response

A copy of CPC's response to the RFQ is included in Appendix C for reference as received.

Table 2.2 Community Power Corporation Summary

Community Power Corporation — A Wholly Owned Subsidiary of Afognak Native Corporation		**Headquarters:**	Littleton, Colorado
Developer / Company:	Community Power Corporation	**Vendor Rep:**	None

System Information	**Quoted Capacity:**	100 kW_e		
	Model Number:	BioMax 100 CHP System		
	System Configuration:	1-Stage Downdraft Gasifier, 2x IC Engines		
	**denotes scaled values*	**As Quoted**	**500 kW_e**	**2.0 MW_e**
Fuel Requirements	**Moisture Content as Fired:**	15%		
	Feedstock Consumption (dry basis):	91 kg/hr 200 lb/hr	363 kg/hr* 800 lb/hr*	1,452 kg/hr* 3,200 lb/hr*
	Feedstock Size:	Chip size: <51 mm		
Unit Performance	**Net Electric Generating Capacity:**	100 kW_e	2x 250 kW_e	8x 250 kW_e
	Operating Parasitic Load:	10 kW_e	40 kW_e^*	160 kW_e^*
	Availability:	80%		
	Recoverable Heat:	161 kW_{th}	644 kW_{th}^*	2,576 kW_{th}^*
	Secondary Heat for Drying:	62 kW_{th}	248 kW_{th}^*	992 kW_{th}^*
				
	Cogeneration Efficiency (with / without Secondary Heat Recovery):	80% / 65%		
	Electrical Efficiency:	25%		
Commercial	**Delivery Lead Time:**	7-8 months		
	Quoted Equipment Only Price:	$ Omitted	$ Omitted	$ Omitted

BioMax100 in Manitoba

BioMax250 from Quotation

2.1.4 WEISS

To achieve the targeted 2 MW$_e$ production capacity, WEISS and Scan American presented their standard 500 kW$_e$ unit modular form. This size supported the RFQ requirements and aligned with the concept design change to only 500 kWe capacity.

2.1.4.1 Vendor Summary

To quickly highlight key aspects of the vendor's response, Table 2.3 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section.

2.1.4.2 Vendor Response

A copy of Weiss' response to the RFQ is included in Appendix C for reference as received.

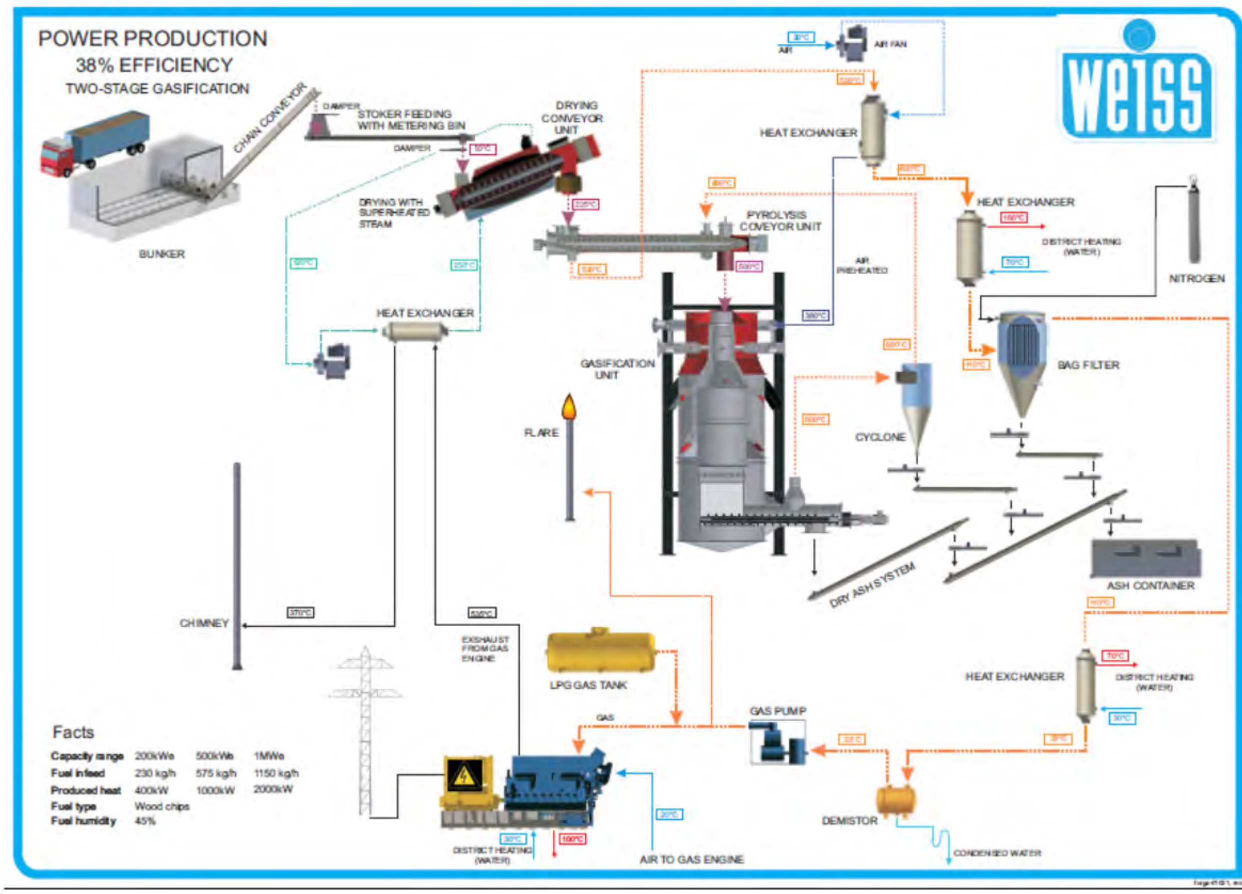
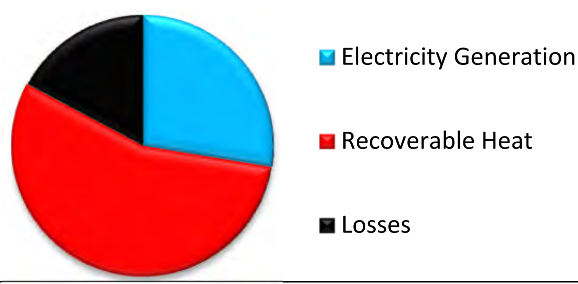


Table 2.3 Weiss (Scan America) Summary

		Headquarters:	Copenhagen, Denmark
Developer / Company:	Weiss Envikraft A/s	**Vendor Rep:**	Barry Griffith, Kansas City, MO

System Information	**Quoted Capacity:**	1000 kW$_e$ (1000kW$_e$, 2000kW$_t$)		
	Model Number:	Not specified		
	System Configuration:	1xGasification Unit, 1x 800 amp Genset		
		As Quoted	**500 kW$_e$**	**2 MW$_e$**
Fuel Requirements	**Moisture Content as Fired:**	35-55%		
	Feedstock Consumption (dry basis):	1150 kg/hr 2535 lb/hr	575 kg/hr 1268 lb/hr	2300 kg/hr 5071 lb/hr
	Feedstock Size:	Chip size: G100		
Unit Performance	**Net Electric Generating Capacity:**	2x500 kW$_e$	500 kW$_e$	4x500 kW$_e$
	Operating Parasitic Load:	N/A	N/A	N/A
	Availability:	Not specified		
	Recoverable Heat:	2000 kW$_{th}$	1000 kW$_{th}$	4000 kW$_{th}$
				
	Cogeneration Efficiency:	83%		
	Electrical Efficiency:	28%		
Commercial	**Delivery Lead Time:**	9-12 months		
	Quoted Equipment Only Price:	$ Omitted	$ Omitted	$ Omitted

2x 500 kW$_e$ Plant Model

2.1.5 Proton Power

The system provided by Proton Power, in response to the RFQ, utilizes the CHyP (Cellulose to Hydrogen Power) product built by Proton Power Inc. to produce up to 2.0 MW_e of electricity using woody biomass as the fuel source. Each CHyP unit that makes up the system is an electrical resistance, multi-zone reactor system specifically designed for the continuous reaction of cellulosic feed materials to a maximum operation temperature of 1200 °C in a non-oxidizing atmosphere. The quotation includes preassembly, mounting, test operation and customer operational witness inspection of all supplied system components and controls prior to shipment to the installation site.

The 250 kW_e system will consist of the following unit operations:

- Automatic biomass processing and feed hoppers.
- CHyP reactor to produce high content hydrogen syngas.
- Automatic solids removal station to collect biochar for packaging, burial or resale.
- Gas cooling and gas cleanup stages.
- Gas composition monitoring for process control.

2.1.5.1 Vendor Summary

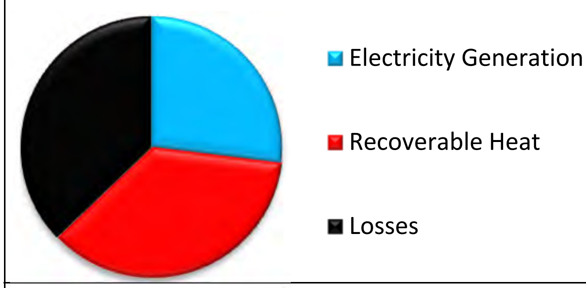
To quickly highlight key aspects of the vendor’s response, Table 2.4 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section.

2.1.5.2 Vendor Response

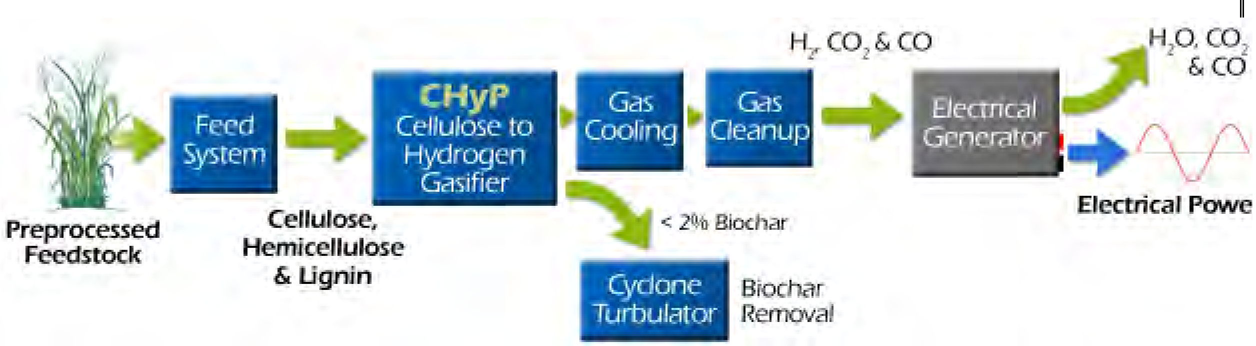
A copy of Proton Power’s response to the RFQ is included in Appendix C for reference as received.

Table 2.4 Proton Power Summary

		Headquarters:	Lenoir, TN	
Developer / Company:	Proton Power, Inc.	**Vendor Rep:**	K. Burnham, Kelowna, BC	
System Information	**Quoted Capacity:**	2.0 MW_e (8x 250 kW_e)		
	Model Number:	250 kW_e CHyP (Cellulose to Hydrogen Power)		
	System Configuration:	1x Multi-zone Reactor, 1x IC Engines		
		As Quoted	**500 kW_e**	**2.0 MW_e**
Fuel Requirements	**Moisture Content as Fired:**	15%		
	Feedstock Consumption (dry basis):	1,670 kg/hr 3,673 lb/hr	417 kg/hr 919 lb/hr	1,670 kg/hr 3,673 lb/hr
	Feedstock Size:	Chip size: <6 mm		
Unit Performance	**Net Electric Generating Capacity:**	8x 250 kW_e	2x 250 kW_e	8x 250 kW_e
	Operating Parasitic Load:	N/A	N/A	N/A
	Availability:	92.5%		
	Recoverable Heat:	2,664 kW_{th}	666 kW_{th}	2,664 kW_{th}



Unit Performance	**Cogeneration Efficiency:**	63%		
	Electrical Efficiency:	27%		
Commercial	**Delivery Lead Time:**	12-18 months		
	Quoted Equipment Only Price:	$ Omitted	$ Omitted	$ Omitted

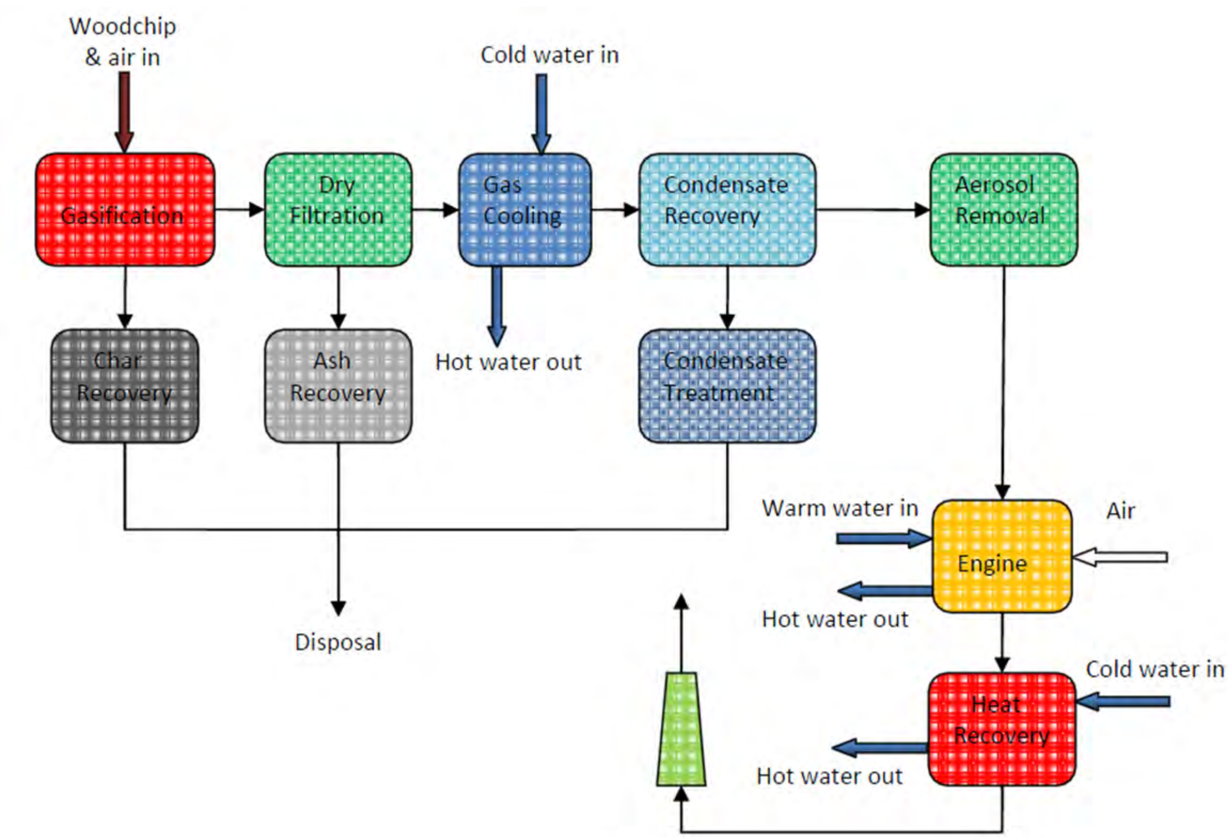


CHyP Process from Quotation

2.1.6 Biomass Engineering Ltd.

In response to our RFQ, Biomass UK responded with a proposal comprising the technical specifications and a budgetary estimate of the design, supply, delivery, installation, testing and commissioning of a 500 kW gasification plant.

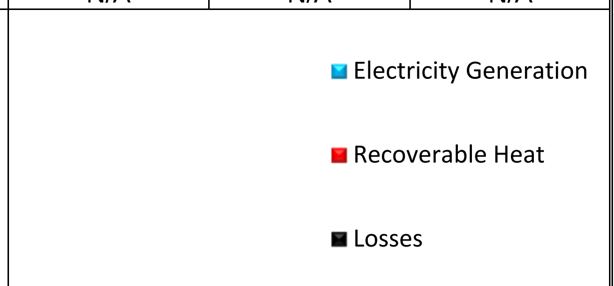
Biomass Engineering Ltd. was established over 10 years ago and since that time has specialized in the design, development and supply of advanced gasification systems and the necessary ancillary equipment. Biomass Engineering specializes in the design, manufacture, installation and commissioning of compact gasification plants and equipment for converting the energy stored in wood into electricity and heat. The Biomass Engineering gasifier is designed to convert wood fuel into a steady stream of syngas, seen below:

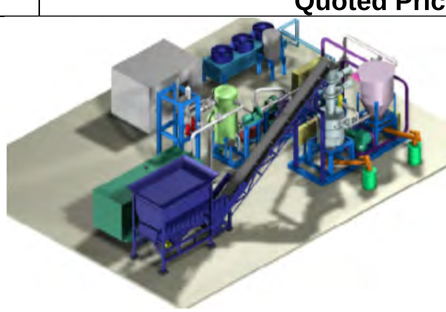


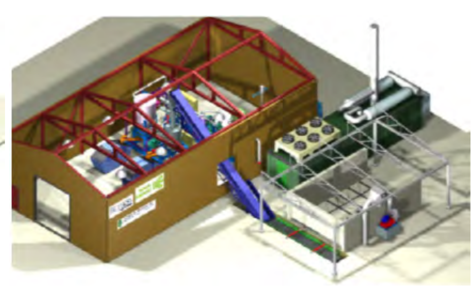
2.1.6.1 Vendor Summary

To quickly highlight key aspects of the vendor's response, Table 2.5 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section. Beyond the system price, many detailed on the system operation were omitted.

Table 2.5 Biomass Engineering (UK) Summary

Biomass engineering		**Headquarters:**	Newton-le-Willows, England	
Developer / Company:	Biomass Engineering UK	**Vendor Rep:**	Dave Clitheroe	
System Information	**Quoted Capacity:**	500 kW$_e$ (500kW$_e$, 2000kW$_t$)		
	Model Number:	Not specified		
	System Configuration:	1x Gasification Unit, 1x 500kW Gas Engine		
		As Quoted	**1 MW$_e$**	**2 MW$_e$**
Fuel Requirements	**Moisture Content as Fired:**	<20%		
	Feedstock Consumption (dry basis):	N/A	N/A	N/A
	Feedstock Size:	Chip size: < 100x100x30 mm		
Unit Performance	**Net Electric Generating Capacity:**	2x250 kW$_e$	4x250 kW$_e$	8x250 kW$_e$
	Operating Parasitic Load:	N/A	N/A	N/A
	Availability:	Not specified		
	Recoverable Heat:	N/A	N/A	N/A
				
	Cogeneration Efficiency:	Not specified		
	Electrical Efficiency:	24%		
Commercial	**Delivery Lead Time:**	Not specified		
	Quoted Price:	$ Omitted	$ Omitted	$ Omitted

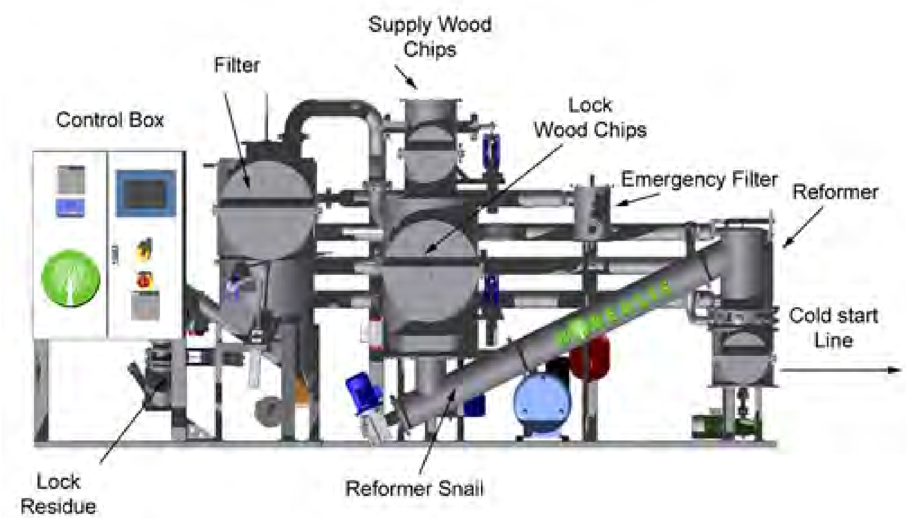




2.1.7 Borealis Wood Power Corporation (Spanner Re2 GmbH)

Technology Background

Borealis Wood Power Corporation is a Canadian company established in 2012, dedicated to marketing the Borealis CHP wood-plant system in Canada. Its focus is on both the market development and technical support for this system developed by Spanner Re2 GmbH of Germany and licensed to Borealis Wood Power Corporation. The system is marketed under the Borealis name and customized to the needs of the Canadian marketplace.



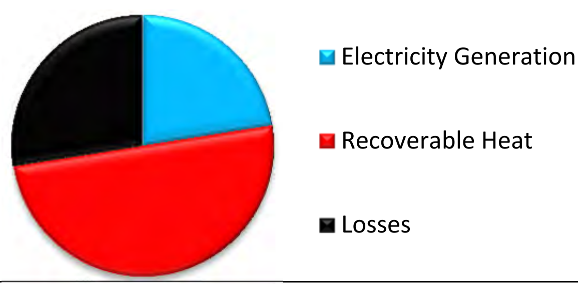
The reactor supports changing the wood chip fuel into wood gas. At the pyrolysis zone, the wood decomposes and begins reducing from its visible wood state. The fuel is then converted to a coal-like hydrocarbon and transported to the oxidation zone where part of the carbon is burned with injected air at approximately 800°C. As the gases move over the hot ember bed (oxidation zone) the tar and hydrocarbons are separated from the gas, resulting in a gas with very low tar.

2.1.7.1 Vendor Summary

To quickly highlight key aspects of the vendor's response, Table 2.6 has been prepared to summarize data provided. A comparison table of all vendors is available in the next sub-section.

Table 2.6 Borealis Wood Power Corporation (Spanner) Summary

		Headquarters:	Burlington, Ontario
Developer / Company:	Borealis Wood Power Corp.	**Vendor Rep:**	Kevork Sevadjian

System Information	**Quoted Capacity:**	45 kW_e (45kW_e, 100kW_t)		
	Model Number:	SPANNER 45 kW Wood Power Plant CHP Model 50GH-8 AP		
	System Configuration:	1xGasification Unit, 1xPSI 5.7 Vortec Engine		
		As Quoted	**495 kW_e**	**2.03 MW_e**
Fuel Requirements	**Moisture Content as Fired:**	15%		
	Feedstock Consumption (dry basis):	45 kg/hr 99 lb/hr	495 kg/hr 1091 lb/hr	2025 kg/hr 4464 lb/hr
	Feedstock Size:	Chip size: G30-G40		
Unit Performance	**Net Electric Generating Capacity:**	45 kW_e	11x 45 kW_e	45x 45 kW_e
	Operating Parasitic Load:	N/A	N/A	N/A
	Availability:	Not specified		
	Recoverable Heat:	100 kW_{th}	1100 kW_{th}	4500 kW_{th}
				
	Thermal (CHP) Efficiency:	73%		
	Electrical Efficiency:	23%		
Commercial	**Delivery Lead Time:**	Not specified		
	Quoted Price:	$ Omitted	$ Omitted	$ Omitted

2.1.8 E-Rational (ORC –Technology)

After re-assessing the amount of heat that can be utilized, it was found that a very high percentage would go unused during the summer months. It was therefore determined that the implementation of an Organic Rankine Cycle (ORC) might be beneficial by converting the remaining heat into electricity. E-Rational was selected as the most appropriate technology provider as it has the ability to utilize hot water, although only at 8-10% efficiency.

2.2 VENDOR COMPARISON

The Table 2.7 summarizes various parameters as they relate to each of the selected vendors (with little information available from Nexterra, it was excluded from this comparison). An initial assessment of the table information reveals several obvious omissions, denoted as "N/A". In many circumstances, this lack of data can be accredited to the specific vendor, whereby much of this information could only be provided following a definitive order or down payment, or with vendors stating that more investigation would be required on their part into many project aspects before more accurate information could be provided. Therefore, vendor comparisons could not be adequately made across all fields, however much of the information provided gives a good general impression of the technology capabilities as a whole.

Table 2.7 Vendor Comparison

		nexterra		Community Power Corporation			Weiss			Proton Power		Biomass engineering			Borealis Wood Power Corp.		
System Information	Quoted Capacity:	2.0 MW$_e$		100 kW$_e$			1000 kW$_e$			2.0 MW$_e$ (8x 250 kW$_e$)		500 kW$_e$			45 kW$_e$		
	Model Type/Number:	Standard CHP System		BioMax 100 CHP System			N/A			250 kW$_e$ CHyP (Cellulose to Hydrogen Power)		N/A			SPANNER 45 kW$_e$ Wood Power Plant CHP Model 50GH-8 AP		
	System Configuration:	1-Stage Updraft Gasifier		1-Stage Downdraft Gasifier, 2x IC Engines			1xGasification Unit, 1x 800 amp Genset			1x Multi-zone Reactor, 1x IC Engines		1x Gasification Unit, 1x 500kW Gas Engine			1xGasification Unit, 1xPSI 5.7 Vortec Engine		
**denotes scaled values*		**500 kW$_e$**	**2.0 MW$_e$**	**As Quoted**	**500 kW$_e$**	**2.0 MW$_e$**	**As Quoted**	**500 kW$_e$**	**2 MW$_e$**	**500 kW$_e$**	**2.0 MW$_e$**	**As Quoted**	**1 MW$_e$**	**2 MW$_e$**	**As Quoted**	**495 kW$_e$**	**2.03 MW$_e$**
Fuel Requirements	Moisture Content as Fired:	20%		15%			35-55%			15%		<20%			15%		
	Feedstock Consumption (dry basis):	N/A	1,474 kg/hr 3,250 lb/hr	91 kg/hr 200 lb/hr	363 kg/hr* 800 lb/hr*	1,452 kg/hr* 3,200 lb/hr*	1150 kg/hr 2535 lb/hr	575 kg/hr* 1268 lb/hr*	2300 kg/hr* 5071 lb/hr*	417 kg/hr* 919 lb/hr*	1,670 kg/hr 3,673 lb/hr	N/A	N/A	N/A	45 kg/hr 99 lb/hr	495 kg/hr* 1091 lb/hr*	2025 kg/hr* 4464 lb/hr*
	Feedstock Size:	N/A		Chip size: <51 mm			Chip size: G100			Chip size: <6 mm		Chip size: < 100x100x30 mm			Chip size: G30-G40		
Unit Performance	Net Electric Generating Capacity:	N/A	2.0 MW$_e$	100 kW$_e$	2x 250 kW$_e$	8x 250 kW$_e$	2x500 kW$_e$	500 kW$_e$	4x500 kW$_e$	2x 250 kW$_e$	8x 250 kW$_e$	2x250 kW$_e$	4x250 kW$_e$	8x250 kW$_e$	45 kW$_e$	11x 45 kW$_e$	11x 45 kW$_e$
	Operating Parasitic Load:	N/A	N/A	10 kW$_e$	40 kW$_e$*	160 kW$_e$*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Availability:	91%		80%			N/A			92.5%		N/A			N/A		
	Recoverable Heat:	N/A	2.93 MW$_{th}$	161 kW$_{th}$	644 kW$_{th}$*	2,576 kW$_{th}$*	2000 kW$_{th}$	1000 kW$_{th}$*	4000 kW$_{th}$*	666 kW$_{th}$*	2,664 kW$_{th}$	N/A	N/A	N/A	100 kW$_{th}$	1100 kW$_{th}$*	4500 kW$_{th}$*
	CHP Efficiency:	75%		80% (w/secondary heat recovery) 65% (w/o secondary heat recovery)			83%			63%		N/A			73%		
	Electrical Efficiency:	31%		25%			28%			27%		24%			23%		
Commercial	Delivery Lead Time:	N/A		7-8 months			9-12 months			12-18 months		N/A			N/A		
	Quoted Equipment Only Price:	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted

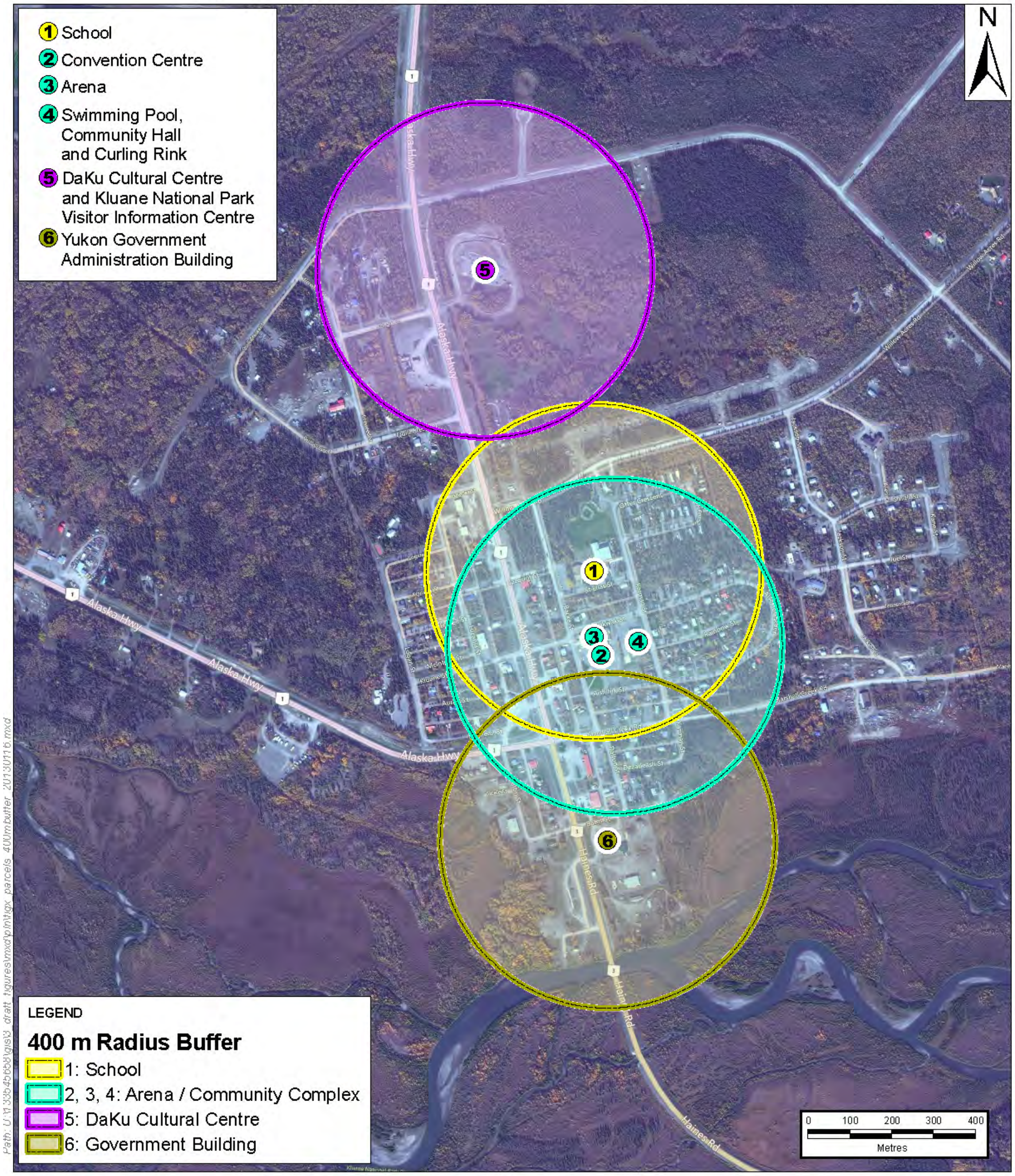
2.3 FACILITY SITING ASSESSMENT

In order to progress preliminary engineering it was necessary to select a site for the biomass plant. In parallel to the Stantec FEED study, Clean Technology Community Gateway (CTCG) was conducting an Evaluation of Waste Heat Potential study (CTCG, 2013). The results of the study were provided in mid-December and indicated that of all the potential waste heat uses, building heat would be the recommend usage (in particular heating only the school if a 500 kW_{th} plant was used). Further to their recommendation, CTCG referred Stantec to a previous Morrison-Hershfield (MH) district heating study for the village as a basis for potential building connection.

Using the results of the CTCG and MH study, Stantec developed a map using our in-house GIS capabilities to outline potential areas to locate the biomass plant. The map excerpt presented in Figure 2.4 shows 400 m buffer zones around buildings that could use the biomass plants waste heat. The buffer zone was established based on viable distance from heat loads determined by CTCG.

Based on the results of the waste heat study and the map areas indicated in Figure 2.4, Stantec recommended proceeding with a location near the school (see Figure 2.5) to capture the school heating load. This location had several advantages associated with it, including

- Being located near the existing diesel generator site.
- Close to the school but off school property – there is a tree line and road between the school and the plant.
- The district heating pipeline from the plant can run down the existing road to the school.
- Future expansion of the line further south would allow the plant to pick up the other buildings identified by CTCG/MH.
- If a greenhouse was of interest now (or becomes of interest in the future), it can be located on school property and fed from the network.
- Truck traffic would be kept to main traffic arteries (out of residential neighborhoods) – potential to receive fuel from the Alaska Highway entrance to the existing diesel site or new entrance.
- Tie in to the grid would be less complicated as the unit would be right next to the switchyard.
- Allows for the possibility of supplying syngas to the existing diesel generators – something CPC has indicated is a possibility.
- Potential exists to tie into the cultural centre to the North.

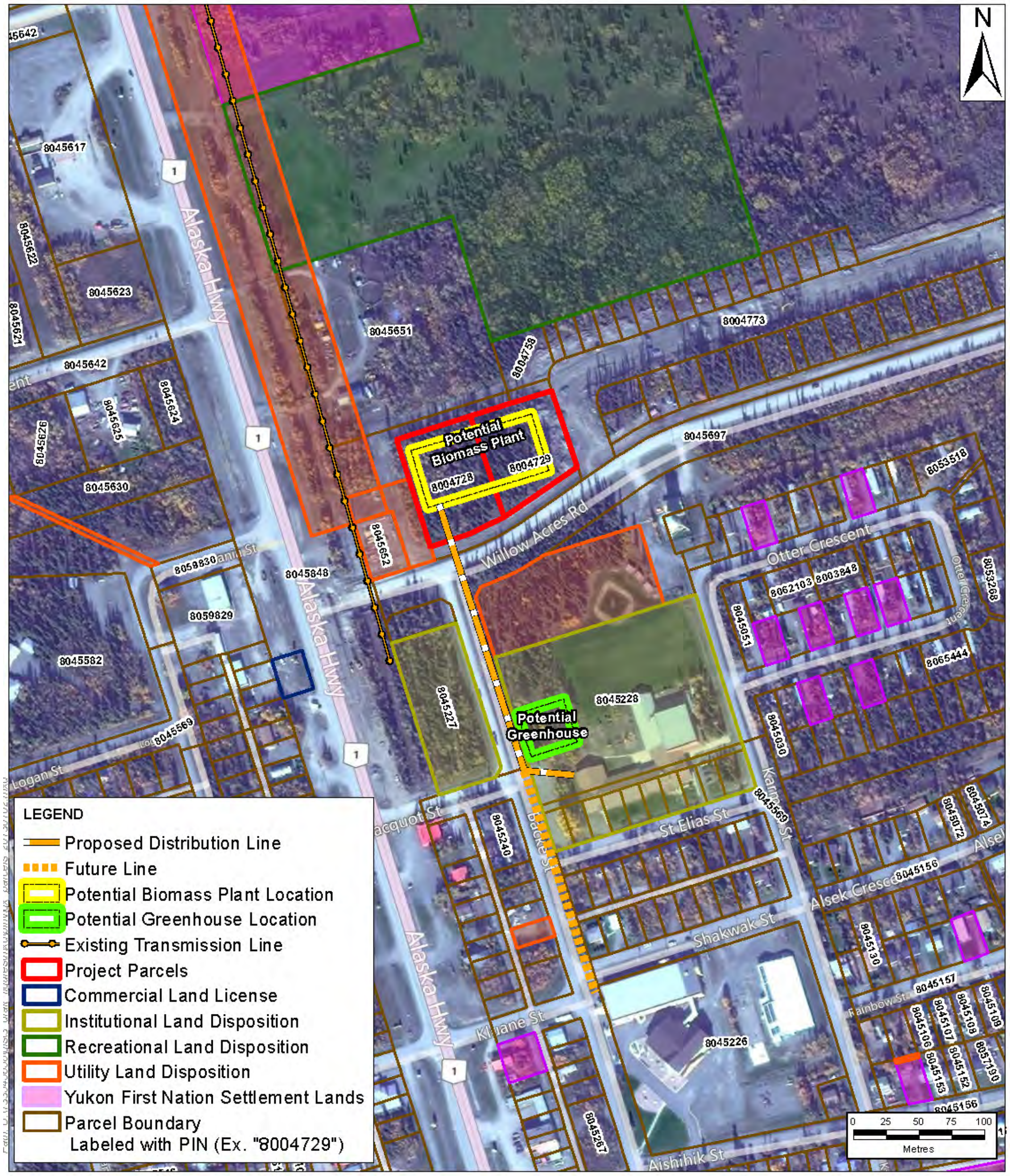


NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Properties near the Project Feed Study for Yukon Bioenergy Haines Junction, Yukon	Scale: 1:12,500		Project No.: 133545658	Data Sources: Geomatics Yukon Imagery: (c) 2010 Microsoft Corporation and its data suppliers	Fig. No.: 1	Stantec
Client: Yukon Energy Corporation	Date: (dd/mm/yyyy) 16/01/2013	Dwn. By: JAB	Appd. By: VLC			

Stantec Consulting Ltd. © 2013 — Map: NAD83 CSRS Yukon Albers

Figure 2.1 Building Heating Locations with 400 m Buffers



NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC PROJECT AND SHOULD NOT BE USED FOR OTHER PURPOSES.

Properties near the Project Feed Study for Yukon Bioenergy Haines Junction, Yukon	Scale: 1:4,000	Project No.: 133545658		Data Sources: Geomatics Yukon	Fig. No.: 1
	Date: (dd/mm/yyyy) 07/01/2013	Dwn. By: JAB	Appd. By: VLC		
Client: Yukon Energy Corporation					

Stantec Consulting Ltd. © 2013

Map: NAD83 CSRS Yukon Albers

Figure 2.2 Biomass Potential Plant Location

2.4 PRELIMINARY DESIGN AND CAPITAL COST

As mentioned previously, the overall intent of the project is to demonstrate the viability of biomass power generation in the Yukon. For the purposes of the FEED design, it was assumed that the demonstration plant would start as a 500 kW_e power plant, and expand in the future once its operation and financial viability are confirmed. Using this approach, three (3) options to initiate the project were considered: Option #1 includes enclosing the entire plant in the power plant building, Option #2 provides a more aesthetically pleasing building enclosure (architecturally designed), and Option #3 reduces the enclosure to only include the fuel storage facility, locating the gasification plant outside in shipping containers.

Option #4 is presented to highlight the ability of the design to facilitate future expansion to 1.0 MW_e (500 kW_e addition) and 2.0 MW_e. This approach can also be used when the project starts off, if a larger capacity plant is desired. Please refer to Appendix D, E, F, & G for information regarding the design and opinion of capital cost for the biomass plant options described in the following sub-sections.

2.4.1 Option #1 – Full Building Enclosure – 500 kW_e

To support the development of the business case, and based on the preliminary design described herein, Stantec has prepared a Class IV Opinion of Probable Construction Cost (OoPCC) to install 2 x 250 kW_e wood gasification units supplied by Community Power Corporation (CPC) in Haines Junction. Option 1 OoPCC is based on preliminary planning in a new building in Haines Junction near the existing stand-by diesel substation

2.4.1.1 Scope Summary

The scope of work would include:

- Construction of new 37.4 m x 36.4 m pre-engineered building.
- Construction of new service roads.
- Installation of 2 X 250 kVA wood gasification generators.
- Installation of electrical power equipment, including step-up transformer and switchgear, to connect generator output to the existing 25 kV distribution system.

2.4.1.2 Detailed Project Scope Definition

CIVIL / STRUCTURAL

The civil/structural scope includes:

- Site Work. Clearing and grubbing, site grading, road and parking, building foundation preparation, buried water and sewer services.
- Concrete Work. Building foundations, building slab, door aprons, transformer pad, and elevated slab.
- Pre-Engineered Building (37.4 m x 36.4 m = 1360 m^2). Building steel, insulated walls, insulated roof, doors, openings for louvers and vents.
- Building Internals. Interior rooms (with storage above), chip bin areas, divider wall between chip handling and gasification/generation.

MECHANICAL

The mechanical scope includes:

- A 500 kW_e modular wood biomass CHP system.
- Radiant in-floor heating for entire building using boiler thermal energy as heat source with electric circulation heater backup.
- Combination of wall fans and roof gravity ventilators to provide necessary building minimum ventilation airflow as required by applicable standards for occupancy, oxygen levels, and airborne contaminants such as CO and combustion gases.
- Pressurization air units for the electrical and mechanical rooms.

- Split heat pump system covering the office / meeting room and the lunchroom.
- Small humidifier.
- Plumbing of one washroom and one kitchen sink.
- Fire protection provisions including dry sprinkler, standpipe, fire extinguishers, and pull stations for the entire building. Provision for a manual deluge fire suppression line is also included for each biomass conveyor.

ELECTRICAL

The electrical scope includes:

- Utility power for the building services loads and backup power source for the generator auxiliaries. This includes transformer, fused disconnect, and customer metering. Connections and material up to the meter assumed to be supplied by the utility but an allowance has been made in the estimate to cover the costs associated with this work.
- A 480 V / 400 A power distribution panel (complete with main breaker) feeding utility power to building services loads and aux power to the generators when required.
- Transfer switches at each generator allowing choice of auxiliary power source from either the online generators or the utility feed.
- 480 V switchgear to parallel the outputs of the generators.
- An oil filled 600 kVA step up transformer 480 V / 25 kV to connect generator outputs to the utility line. An oil containment system allowance has been carried.
- Allowance for the utility to connect the generator output from the step-up transformer to the line including fused disconnect.
- Allowance for utility to install revenue metering on the secondary of the step-up transformer.
- Allowance for grounding the building and equipment.
- Building services including low voltage distribution panels, lighting, fire alarms, receptacles, communications, etc.
- Allowance for a contractor to make electrical connection between the shipping splits of Vendor supplied equipment.

- A PLC based control system for miscellaneous building services and heating loop indicators and alarms.
- Communication connections between the Vendor's supplied equipment, the PLC controller, and a main network switch. This will allow remote monitoring of building and equipment alarms and allow remote configuration and monitoring of the CPC supplied units.
- All power, control, and communications wiring and raceway required to service the units and the surrounding infrastructure.

2.4.1.3 Detailed Basis of Estimate

ENGINEERING

The preliminary engineering allowance is 3.0% of capital, which would include a Class III estimate for project appropriations.

The detailed engineering allowance is 10% of capital for the purposes of this capital estimate. Should the project move forward and Yukon Energy solicit a proposal for further engineering by Stantec, an Opinion of Probable Engineering Costs (OoPEC) would be prepared and included in that proposal. This allows for typical engineering costs for the purposes of budget appropriations.

PROCUREMENT

Major equipment is assumed to be purchased by Yukon Energy and supplied to the installation contractor on site. In this particular study, that would include the switchgear, the step-up transformer, transfer switches, and Vendor supplied generators. This approach is advantageous in that:

- It ensures adherence to the utility standards for equipment where many options and additions are commonly available.
- It does not delegate away the responsibility of expediting these items to site. By maintaining responsibility, the Owner can exercise greater control of delivery on these critical items.
- It avoids the standard contractor markup of ~10% being added to large value line items.

All other items, including cable, cable tray, and all other commodity items required for the installation shall be supplied by the contractor as part of their lump sum installation pricing. This eliminates the need for utility engineers, managers, or consultants to be responsible or concerned with inventory levels of items that are extremely hard to track on a busy construction site.

PRODUCTIVITY FACTORS

Labour factor adjustments have been applied to this estimate based on the following:

- Distance from Whitehorse as it applies to accessing supplies.
- Distance from Whitehorse as it applies to accessing skilled labour.
- Estimated inventory levels at local supply houses.
- Working outdoors or in non-serviced building.

CONSTRUCTION

This OoPCC is based on the following sources of data for labour and materials:

- In-house databases built from historical or manufacturer’s listed prices.
- Direct contact with vendor for switchgear.
- NECA (National Electrical Contractor’s Association) Manual of Labour Units 2011-2012 for specific items covered by that publication.

- Historical labour costs for other items not specifically listed or requiring special consideration.

DIRECT CONSTRUCTION AND INSTALLATION COSTS

Civil / Structural

Site Work

Site work includes clearing and grubbing, site grading for the initial two unit arrangement, preparation of roadway and parking areas by replacement of 1 m of material with compacted pit run gravel, building foundation excavation and backfill, underground water and sewer services, and a fire water loop with two hydrants. For the purpose of this estimate, it has been assumed that water and sewer services exist under the adjacent streets with sufficient supply pressure for building fire protection.

Quantities were calculated and cost opinions were developed using costs from other jobs, with reference to the RS Means cost database, and with partial input from Jon Schmidt of JTS Cost Consulting, Whitehorse.

Concrete Work

Concrete work includes reinforced cast-in-place concrete for building foundations, grade and elevated slabs, door aprons, and transformer pad. Preliminary design has the building on spread footings founded below frost, with a full perimeter wall that extends 2500 mm above grade in the chip handling area to act as chip bins. Grade slab is 200 mm thick both for truck traffic and to support the gasification/generation equipment.

Stantec provided partial quantities and preliminary building layouts to JTS Cost Consulting who developed the cost opinion raw data.

Pre-Engineered Building

The 1360 m^2 building includes a structural steel frame with girts and purlins, wall panels insulated to R30, roof panels insulated to R50, man doors, overhead doors, and openings for louvers and vents. The roof is symmetrically peaked with a 1:12 slope. The east gable end structure has been designed to allow future expansion of the building in this direction.

Quantities and cost opinion for the building was provided by a pre-engineered building supplier (Varco Pruden Buildings).

Building Internals

Building internals include interior rooms for electrical, mechanical, storage, lunchroom, washroom, and administration. As presently proposed, the rooms would be masonry with a concrete roof slab on metal deck to create a storage area above. A wall aligned with the building peak would provide working separation between the chip storage area and the gasification/generation equipment.

Stantec provided partial quantities and preliminary building layouts to JTS Cost Consulting who developed the cost opinion raw data.

General Conditions

JTS Cost Consulting has provided a cost opinion for General Condition items, including:

- Bond, insurance, and permits.
- Temporary office, power, heat, phone, data, fencing, and toilets.
- Safety.
- Layout.
- Clean-up, snow clearing, and waste management.
- Freight and deliveries, materials handling and protection.
- Vehicles and fuel (vehicle and equipment).
- Hoisting, zoom boom, sky reach, and scaffolding.
- Tools.
- Supervision, project management, and foreman surcharge.
- Room and board, including travel.
- Mobilization, and demobilization.
- Close out, as-builts, and manuals.
- Winter works premium.

These items have been included in the civil-structural estimate although they apply to the entire construction activity and sequence.

Mechanical

The mechanical scope for Option 1 includes:

Wood Biomass CHP System

The assumed CHP system size is 500 kW_e nominal electrical and 644 kW_{th} thermal generation capacity.

Equipment cost based on scaling up base budget proposal from CPC for a 100 kW_e system by a factor of four. Efficiencies of scale are gained to achieve the additional output adding up to 500 kW_e total electrical generation capacity.

This system is installed by assembling 14 container type modules which include feedstock handling end, dryer module, gasifier module, genset module, filter module, and controls module.

HVAC

Radiant In-Floor Heating

Allowances cover the entire building concrete floor slab, including ancillary rooms. The primary source of heat for the in-floor heating will be provided by tapping into some of the thermal energy available from the boiler flow supplying the district heating system output from the plant. The fluid will be circulated to the various areas of the building by two circulation pumps (one backup). Control valves will distribute the flow as necessary to maintain the demand requirements of each temperature zone. The design intent is currently to maintain a floor temperature of 1 °C for the fuel delivery and storage building section, 10 °C for the generator house building section, electrical room, mechanical room, and storage room, and 21 °C for the lunchroom, office/meeting room, and washroom.

An allowance for a pair of electric circulation heaters was provided as a source of backup building heat when the boilers are not in operation.

Welded wire mesh for attaching tubing, vapour barrier, and insulation costs carried under civil estimate.

Radiant concrete slab heating cost estimate includes (2) slab temperature sensors for each temperature zone.

Ventilation

The design approach for ventilation of the areas of the building other than the ancillary rooms is to utilize wall mounted ventilation fans with insulated motorized dampers in conjunction with roof mounted low profile gravity ridge natural ventilators with manual chain operators. Those systems would provide necessary building minimum ventilation airflow as required by applicable standards for occupancy, oxygen levels, and airborne contaminants such as CO and combustion gases.

Roof curbs and flashing for the roof gravity ventilators included as part of the civil estimate.

An allowance has been made for the mechanical room and electrical room to have their own pressurization ventilation unit.

An allowance has been made for a small humidifier.

An allowance was made for rental of equipment required to install the HVAC components.

An allowance was made for HVAC related floor / piping penetrations.

An allowance has been made for a ductless split heat pump system covering the office / meeting room and the lunchroom.

Plumbing

A plumbing allowance has been made for a washroom sink, water closet, kitchen sink, water heater, heating system fill line, floor drain in mechanical room, and sewer line inside building.

Potable water supply assumed to be coming from the street.

Sewer piping from building to street covered in the civil estimate.

Fire Protection

For the purposes of determining fire protection requirements for the building, a cursory review of applicable 2010 NBC (National Building Code of Canada) requirements was conducted:

Preliminary building classification per 2010 NBC is high hazard industrial occupancy F-1 for the fuel delivery and storage building section and generator house building sections.

The generator house section is classified as high hazard F-1, as opposed to F-3 normally allowed by code, to avoid the need for a 2 hour rated fire separation, which would normally be required between the fuel delivery and storage section and generator house section as per NBC Section 3.1.3.1.

The reason to classify the entire building as a Type F-1 occupancy is that it is not practical to maintain a 2 hour fire separation at the biomass conveyor penetrations at the wall. The F-1 building falls under Group F Division 1 up to two storeys, under NBC Section 3.2.2.70 which requires sprinklers throughout.

A standpipe system is also required for the F-1 building since its classification does not fall under the exceptions listed under NBC Section 3.2.5.8.

The building requires stations and fire extinguishers.

Fire detection and alarm covered under electrical section.

In addition to specific NBC requirements, conveyors systems handling this amount of combustible material normally require a few manual deluge connections to provide local suppression from a risk mitigation standpoint. The insurer for the plant typically drives this requirement.

Electrical

General Methodology

The power distribution transformer and associated power system components and cabling have been sized for 250 kW_e output from each unit with a worst-case power factor of 0.85. The CPC supplied equipment is shipped to site in several shipping splits. Although the units are prewired by CPC, the installation contractor will make final connection between shipping splits as per CPC instructions.

General Description of Major Products

All new cable tray installed will be aluminum, B-Line series 25, and industrial cable tray. Typical tray grounding and supports are included.

All new power cables up to the low voltage side of the power distribution step-up transformer are 1 kV rated, Teck cable. Allowances have been made to allow the utility to make the 25 kV connections.

Transfer switches are manual type switches with make before break contacts when moving from utility to generator power after the generator has synchronized to the line.

Switchgear is based on GE LV switchgear with one main breaker and two unit breakers. Allocation has been made for two prepared spaces for future expansion.

The power distribution transformer used to connect the generator output to the grid is a liquid filled type installed outside with a containment system.

Electrical Installation Costs

Service Entrance

Allowances have been made for the utility to supply and install a pole mounted transformer and fused disconnect. Allowances have been made for a metered entrance and it is assumed that the utility preforms all work up to the line side of the meter.

A 400 A, 480 V, 3 phase power distribution panel complete with a main breaker will be installed inside the electrical room to supply building services and unit startup power.

Transfer Switches

Transfer switches will be installed to transfer generator auxiliary loads to the utility power feed for start-up. When the generators are online, the auxiliary loads would be switched back to the unit internal power.

Grounding

Allowance has been made to allow typical grounding of the service entrance, the generators, and the building itself.

Building Services

Power Distribution

Allowances have been made for lighting and miscellaneous power requirements for the building. This includes transformers, panels, and wiring for all building services loads.

Heating and Ventilation

Allowances have been made to connect heating and ventilation equipment.

Lighting

Allowances have been made for lighting in all areas of the building. Allowance has been made for the installation of roadway lighting along the service road.

Communications Including Remote Monitoring and Configuration Links

Combination data and telephone outlets are to be in the office area and several telephone outlets throughout the rest of the facility. Everything will be wired back to an incoming line within the electrical room. The CPC system will also be connected to allow remote monitoring, alarming, and configuration from CPC facilities.

Equipment will be installed to allow remote monitoring of indicators and alarms for major equipment in the building. This includes allowance for a small programmable logic controller and network switch. In addition, this connectivity will serve the CPC supplied equipment to allow for monitoring and configuration from their headquarters.

Fire Alarm

A fire alarm system has been included with smoke detectors, thermal detectors, heat detectors and manual pull stations to provide initiating protection. Horn strobes provide audio and visual signaling. There is an allowance for several flow and tamper switches for a sprinkler system. Control relays were also considered with the fire alarm system for equipment shut downs.

Generator Output

The owner-supplied switchgear will be installed by the electrical contractor. Switchgear pricing is based on information received from GE for budgeting purposes. The switchgear includes a main breaker, two unit breakers and two prepared spaces in the pricing. All cabling, including raceway, required from the units to the switchgear have been included.

The electrical contractor will install the step-up transformer on a concrete pad outside the building. Pad to be provided by the civil contractor. Transformer pricing is based on review of pricing of similar transformers normalized to a value per kVA and scaled to 600 kVA.

Allowance has been made for the utility to make all connections beyond the secondary of the step-up transformer including a pole mounted fused disconnect and revenue-metering unit.

Instrumentation and Control

Allowances have been made for several poisonous gas detectors to be installed. Alarms will be relayed through the fire alarm panel.

Connections of the Vendor Supplied Equipment

There is an allowance of two men for one week for each unit intended to cover the interconnection of vendor supplied shipping splits. All material for this work is assumed to be supplied by the vendor.

MISCELLANEOUS CONSTRUCTION DIRECTS

Most construction directs have been accounted for in a blended labour rate. This would include small tools and consumables.

Allowances for required equipment rentals used as part of a normal installation are included in the blended labour rate.

Supervision, crew trailer, and personal PPE are also included.

Freight is included in the material / equipment pricing.

INDIRECT CONSTRUCTION COSTS

Construction Staff & Consultants

An allowance of 2.5% of capital has been carried for an onsite construction manager. An allowance of 1% of capital has been carried for site engineering services to support construction.

Owner's Staff Costs

No allowance has been made for Owner's personnel to support this work.

Commissioning Costs

Commissioning costs are carried as 1.5% of capital. This includes allowances to bring vendor representatives to site.

Escalation Costs

An escalation allowance of 5% has been allowed based on lead-time required before construction begins.

Capital Spares

A capital spares allowance of 5% of the equipment cost has been included.

Indirects Specifically Not Included

The indirect costs associated with the following have not been considered and are assumed to be supplied by Owner. No costs have been assigned to these services that will be associated with this project unless specifically noted in the OoPCC.

- Security.
- Lock-out tag-out (LOTO) coordination.
- Waste removal.
- Snow removal.
- Warehousing and utilities including temporary power supply.
- Temporary lighting.
- Taxes.

- Interest charges during construction.
- Owner's administration costs, including:
  - Legal fees.
  - Insurance.
  - Salaries of Owner's project staff.
  - Allowance for operators hours during training, commissioning, and start up.

Special costs to dispose from site construction waste.

2.4.1.4 Opinion of Probable Capital Cost

The Opinion of Probable Capital Cost for this option is $12.7 M. Table 2.7 provides a breakdown of the probable cost with a detailed line item list included in Appendix C.

Table 2.8 Option #1 Opinion of Probble Capital Cost

Line	Description	Labour Cost	Material Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
1	PROJECT TOTAL, BASE SCOPE					$12,727,154
2	Civil - Structural	$562,428	$1,001,238	$195,250	$1,235,200	$3,528,066
3	Mechanical & HVAC	$168,520	$199,500	$5,205,000	$192,476	$5,816,052
4	Electrical	$371,089	$172,531	$238,465	$74,197	$948,827
5	**Sub Total**	**$1,102,037**	**$1,373,269**	**$5,638,715**	**$1,501,873**	**$10,292,945**
6	Preliminary Engineering @ 3% (Class III Estimate)					$152,647
7	Detail Engineering @ 10% Direct Construction Cost					$508,824
8	Construction Management @ 2.5% Direct Construction Cost					$127,206
9	Site Construction Support by Engineering @ 1% Direct Construction Cost					$50,882
10	Commissioning Costs @ 1.5%					$76,324
11	Escalation Allowance @ 5%					$254,412
12	Capital Spares - 5% of CPC equipment cost					$250,000
13	**Sub Total**					**$11,570,140**
14	Contingency @ 10%					$1,157,014

Capital Cost Risk Analysis

No detailed risk analysis has been made on this Class IV OoPCC. A contingency of 10% has been allocated. As per AACE guidelines, a Class IV OoPCC is accurate to a range between -20% and +40%.

2.4.2 Option #2 – Full Architectural Enclosure – 500 kW_e

Option #2 retains the technical and operational characteristics of Option #1, while providing a superior aesthetic presence to the biomass facility to be located in the village.

2.4.2.1 Architectural Details

Accessed from the Alaska Highway the proposed biomass facility forms bold and angular shapes, establishing a powerful icon against the distant mountains. Elevated roof segments and strong, vertical glazing will serve to provide natural daylight and become a 'beacon' at night for travellers along the highway.

Backing on to boreal forest the building is designed to work with the natural surroundings and take advantage of the environmental conditions.

Sustainability and energy efficiency is modeled within LEED criteria and include:

- Use of natural and recyclable materials.

- Energy efficient building systems.
- Abundance of natural day lighting to reduce energy consumption and provision of a pleasant work environment.
- Use of low VOC materials and adhesives.
- Occupancy sensors to control electrical light fixtures operation.
- Rainwater will be diverted back into the soils.
- Combination wood and steel structure for recycling purposes.

Working within close proximity to the Alaska Highway the roadway entry leads into the clearly defined Main Entry for office personnel. As one approaches the building the single sloped roof, in concert with the 'V'-shaped structure, provides an intriguing form juxtaposed against the dominant, large biomass structure behind. Cladding materials will be a combination of smooth, cementitious, panels and corrugated metal cladding.

The facility is designed to support both the biomass plant function and administrative / office staff in one modern facility that is energy efficient and pleasant to work in. Programmatically the two-storey turbine plant is tucked in behind the one-storey offices and administration spaces. The soaring ceiling, in concert with natural materials, select bright colours and abundance of day lighting provides staff with a strong connection to the natural surroundings. Additionally, the project is designed to allow for future expansion of both specific programs.

Technically the spaces are supported by a thermally superior building envelope complete with coincident air/vapour barrier and polyisocyanurate insulation in the construction assemblies that exceed minimum thermal insulation code requirements.

2.4.2.2 Opinion of Probable Capital Cost

The Opinion of Probable Capital Cost for this option is $13.5 M. Table 2.8 provides a breakdown of the probable cost with a detailed line item list included in Appendix D.

Table 2.9 Option #2 Opinion of Probble Capital Cost

Line	Description	Labour Cost	Material Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
1	**PROJECT TOTAL, BASE SCOPE**					**$13,494,160**
2	Civil - Structural	$617,073	$1,094,838	$203,150	$1,631,800	$3,528,066
3	Mechanical & HVAC	$168,520	$199,500	$5,205,000	$192,476	$5,816,052
4	Electrical	$371,089	$172,531	$238,465	$74,197	$948,827
5	**Sub Total**	**$1,156,682**	**$1,466,869**	**$5,646,615**	**$1,898,473**	**$10,292,945**
6	Preliminary Engineering @ 3% (Class III Estimate)					$169,654
7	Detail Engineering @ 10% Direct Construction Cost					$565,514
8	Construction Management @ 2.5% Direct Construction Cost					$141,378
9	Site Construction Support by Engineering @ 1% Direct Construction Cost					$56,551
10	Commissioning Costs @ 1.5%					$84,827
11	Escalation Allowance @ 5%					$282,757
12	Capital Spares - 5% of CPC equipment cost					$250,000
13	**Sub Total**					**$12,267,418**
14	Contingency @ 10%					$1,226,742

Capital Cost Risk Analysis

No detailed risk analysis has been made on this Class IV OoPCC. A contingency of 10% has been allocated. As per AACE guidelines, a Class IV OoPCC is accurate to a range between -20% and +40%.

2.4.3 Option #3 – Fuel Handling Enclosed – 500 kW_e

Option #3 retains the technical and operational characteristics of Option #1, but attempts to reduce costs by only enclosing the fuel handling area. This option would only be available for the CPC and Proton Power units as they are self-contained in standard shipping containers (CPC units depicted in the rendering).

2.4.3.1 Opinion of Probable Capital Cost

The Opinion of Probable Capital Cost for this option is $11.4 M. Table 2.9 provides a breakdown of the probable cost with a detailed line item list included in Appendix E.

Table 2.10 Option #3 Opinion of Probble Capital Cost

Line	Description	Labour Cost	Material Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
1	**PROJECT TOTAL, BASE SCOPE**					**$11,402,782**
2	Civil - Structural	$399,213	$714,346	$167,750	$846,626	$3,528,066
3	Mechanical & HVAC	$205,634	$117,600	$5,204,000	$84,301	$5,816,052
4	Electrical	$463,036	$151,271	$238,235	$85,447	$948,827
5	**Sub Total**	**$1,067,883**	**$983,217**	**$5,609,985**	**$1,016,374**	**$10,292,945**
6	Preliminary Engineering @ 3% (Class III Estimate)					$122,831
7	Detail Engineering @ 10% Direct Construction Cost					$409,438
8	Construction Management @ 2.5% Direct Construction Cost					$102,359
9	Site Construction Support by Engineering @ 1% Direct Construction Cost					$40,944
10	Commissioning Costs @ 1.5%					$61,416
11	Escalation Allowance @ 5%					$204,719
12	Capital Spares - 5% of CPC equipment cost					$250,000
13	**Sub Total**					**$10,366,165**
14	Contingency @ 10%					$1,036,617

Capital Cost Risk Analysis

No detailed risk analysis has been made on this Class IV OoPCC. A contingency of 10% has been allocated. As per AACE guidelines, a Class IV OoPCC is accurate to a range between -20% and +40%.

2.4.4 Option #4 – Options for Expansion – 500 kW_e, 1000 kW_e, & 2000 kW_e

A potential path forward for the project is to first install a 500 kW_e plant as a proof-of-concept demonstration for the North, and then expand the facility in the near future. The design described for Option #1 facilitates the expansion of the power plant by an additional 500 kW_e without the need for added auxiliary services (i.e., sufficient space mechanically and electrically have been left to support the expansion). Beyond the 1.0 MW_e capacity, additional building services will be required. From a cost perspective, the first incremental 500 kW_e expansion will see cost savings compared to the initial installation, whereas achieving a 2.0 MWe would be equivalent to double the cost of the 1.0 MW_e plant. This is depicted in Figure 2.3.

To expand the plant in 500 kW_e blocks without incurring increased costs (i.e., each expansion costs the same) is possible, but would require a higher upfront capital cost to ensure the auxiliary services could support three future expansions. The owner needs to weigh the benefit of having the added infrastructure installed upfront for an expansion that may not take place.

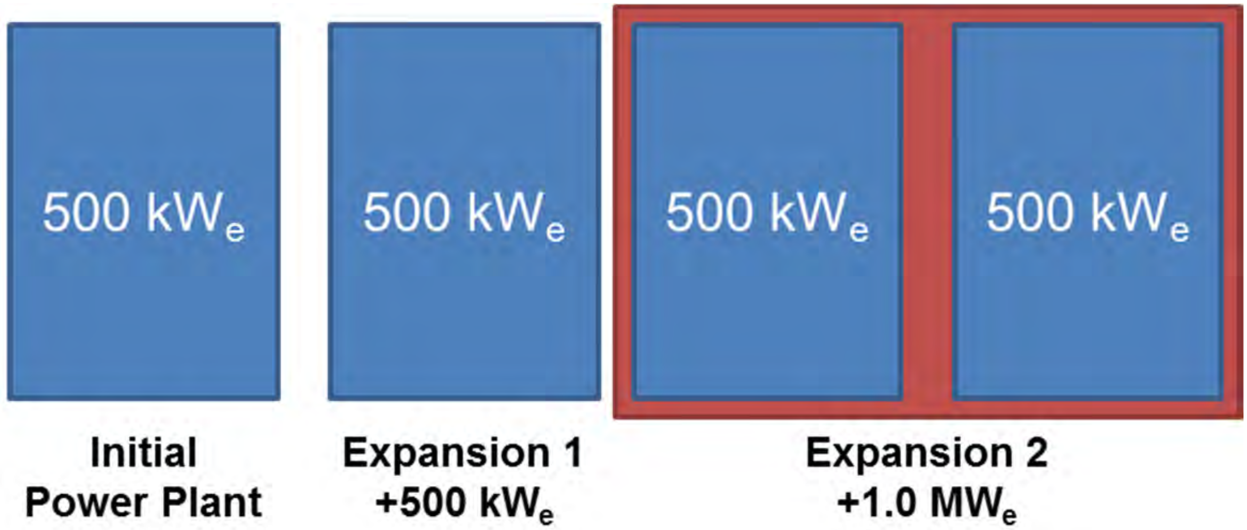


Figure 2.3 Expansion Incremental Costing

2.4.4.1 Opinion of Probable Capital Cost

The Opinion of Probable Capital Cost for this option is an additional $9.8 M on top of the base plant cost to achieve a total 1.0 MW_e capacity, or $22.5 M if 1.0 MW_e is installed initially. To achieve a 2.0 MW_e capacity, the combined figure would double to $45.0 M. Based on equipment costing for the gasification systems, to start the plant with a 2.0 MW_e capacity would be approximately the same budget, $45.0 M.

Table 2.10 provides a breakdown of the probable cost with a detailed line item list included in Appendix G.

Table 2.11 Option #4 Opinion of Probble Capital Cost

Line	Description	Labour Cost	Material Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
1	**PROJECT TOTAL, BASE SCOPE**					**$22,484,173**
2	Civil - Structural	$648,841	$1,226,438	$229,250	$1,390,000	$3,528,066
3	Mechanical & HVAC	$408,694	$376,500	$10,210,000	$302,428	$5,816,052
4	Electrical	$658,369	$283,829	$320,748	$101,033	$948,827
5	**Sub Total**	**$1,715,905**	**$1,886,767**	**$10,759,998**	**$1,793,461**	**$10,292,945**
6	Preliminary Engineering @ 3% (Class III Estimate)					$368,538.46
7	Detail Engineering @ 10% Direct Construction Cost					$1,228,461.54
8	Construction Management @ 2.5% Direct Construction Cost					$307,115.39
9	Site Construction Support by Engineering @ 1% Direct Construction Cost					$122,846.15
10	Commissioning Costs @ 1.5%					$184,269.23
11	Escalation Allowance @ 5%					$614,230.77
12	Capital Spares - 5% of CPC equipment cost					$250,000
13	**Sub Total**					**$20,440,157**
14	Contingency @ 10%					$2,044,016

Capital Cost Risk Analysis

No detailed risk analysis has been made on this Class IV OoPCC. A contingency of 10% has been allocated. As per AACE guidelines, a Class IV OoPCC is accurate in a range between -20% and +40%.

2.5 OPERATING COST

The operation and maintenance estimated cost is based on the use of an outside Operation & Maintenance (O&M) contractor. Operations and maintenance costs for the biomass plant consists of several components:

- Labor.
- Maintenance and materials.
- Major Equipment Repair reserve fund.
- Annual Environmental Testing.
- Consumables and chemicals.

- Miscellaneous supplies.

The items included in each category are explained below:

- **Labor** - The labor component, excluding fuel cost and renewal fund, is the largest cost in an O&M budget. It consists of the salaries and benefits for the operators and admin staff. The size of the staff can vary significantly depending on the size and complexity of the plant. For a 0.5 MW_e biomass plant, the operation will consist of five (5) full-time operators. Staff will have one plant manager and four (4) operators. The staffing compliment could be lower if based on CPC's operator requirements of two (2) trained operators.

- **Maintenance and Materials** - The cost for maintenance and materials reflects normal daily, weekly, monthly costs for regular plant maintenance.

- **Major Equipment Repair Reserve Fund** - The major equipment in a biomass power plant needs to be overhauled and repaired on a regular basis in accordance with the vendor's recommended procedures. This fund is primarily associated with the gasifier and engine but also includes other major pieces of equipment, particularly rotating equipment and heat exchangers. A reserve fund is established so that money is available to cover the significant costs of the equipment overhaul several years in the future. This cost is carried separately in the business case as the Capital Renewal Annual Rate, see Table 4.14.

  In lieu of planning and reserving for major equipment overhauls and inspections, owners sometimes establish a Long Term Service Agreement (LTSA) with the vendor. The LTSA provides annual performance guarantees from the suppliers as well as responsibility for all repairs and overhauls for a fee. The term of the LTSA can vary from 10 to 15 years. Note this approach was not taken for this O&M estimate.

- **Environmental Testing** - Most environmental operating permits require annual testing for any air, water or wastewater discharges from a plant to verify compliance with the permit conditions.

- **Consumables and Chemicals** - The cost of lubricants, oils, chemicals and misc. consumables used during normal plant operation is included in this line item.

- **Misc. Supplies** - This item covers the general administrative cost of running the power plant. It includes phones, office supplies, computers, etc.

2.5.1 Opinion of Probable O&M Costs

The following table, Table 2.11, is a summary of estimated O&M costs for the two biomass plants:

Table 2.12 Opinion of Probable Conventional Biomass O&M Costs

Description	0.5 MW	2 MW
Labor	$200,000	$350,000
Maintenance & Materials	$50,000	$200,000
Environmental Testing	$15,000	$25,000
Consumables & Chemicals	$15,000	$45,000
Misc. Supplies	$5,000	$10,000
Total O&M Estimated Cost	**$285,000**	**$630,000**

The estimate cost for O&M reflects the estimated average annual cost. It does not include cost normally incurred by the owner. These costs include fuel; insurance; property taxes or asset management fees.

2.6 FEEDSTOCK CHARACTERIZATION (AGFOR)

In order to develop an understanding of the potential for local feedstock for the plant at any capacity, several aspects need to be considered. Of primary interest is the current level of harvesting around Haines Junction, Yukon. Second is the industry the current harvest is serving, and potential synergies with the proposed biomass facility. Finally an assessment of the available fuel characteristics (moisture content, heating value), quantities available/required by the plant, and preliminary costing are provided.

2.6.1 Harvesting and Existing Industries

Overall harvest activity is low with little economy of scale; most equipment is bought used to keep costs down. Harvesting is regulated by permit based on experience and capacity.

New personal use entrants with no harvesting track record are issued permit volumes up to 25 m^3 within specified location in a common area; successive permits can be issued upon successful completion of a permit. Harvesting is by chainsaw and a variety of small scale forwarding equipment from manual, ATV, and snowmobile to pick-up truck.

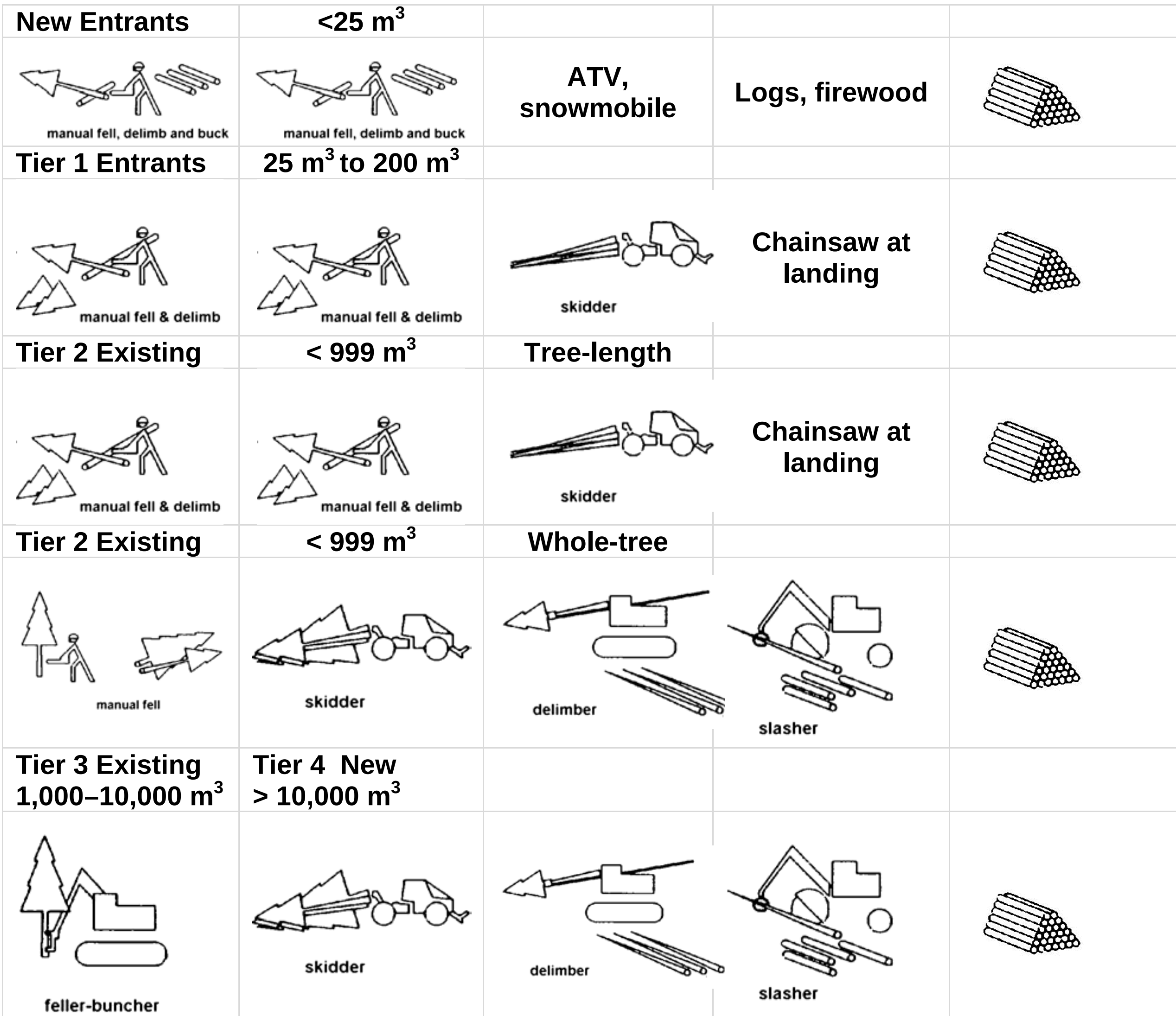
Commercial harvesting activities listed in the Wood Allocation Strategy for Haines Junction are presented in four (4) tiers as follows and depicted in Figure 2.6 on the following page.

Tier 1 – New entrants with no recent Yukon harvest experience (in the past three years) are issued permit volumes from 25 m^3 to 200 m^3. This Tier is for operators who aspire to a Tier 2 permit. Successive permits can be issued. Ten Tier 1 opportunities are made available for a given time period. Harvesting is by chainsaw and a variety of small scale forwarding equipment such as ATVs, snowmobiles, farm tractors and skidders.

Tier 2 – Operators with recent Yukon harvest experience are provided with two years wood supply permits up to 999 m^3 per year within a three-year license period; successive permits can be issued upon successful completion of the current permit. Operators are encouraged to participate in the license design and YESAB screenings. Harvesting is mainly is by chainsaw and a variety of small scale forwarding equipment such as farm equipment and skidders.

Tier 3 – Existing operators with recent Yukon harvesting history (in the past three years) are provided with 1,000 m^3 to 10,000 m^3 per year permits for a maximum of a four-year supply within a five-year period. Operators are required to complete the license design and YESAB screenings. Harvesting is by mechanical felling and bunching, forwarding is by grapple skidder, delimbing ranges from operational limbing (breakage and chainsaw) to cut-to-length processor to produce delimbed logs at the landing ready for loading; alternatively, this is done with chainsaws and or a firewood processor.

Tier 4 – Initiatives requiring significant investment are usually issued a harvest volume greater than 10,000 m^3 per year linked to a capital investment. A five to 10-year term may be considered, depending on availability and the annual allowable cut (AAC). The operator would be responsible to prepare the Timber Harvest Plans (THPs), license area design assessment and YESAB screening and follow the entire process to completion of harvest. Harvesting is by mechanical felling and bunching, forwarding is by grapple skidder, delimbing ranges from operational limbing (breakage and chainsaw) to cut-to-length processor to produce delimbed logs at the landing ready for loading; alternatively, this is done with chainsaws.



Source: AGFOR Inc.

Figure 2.4 Harvesting Tiers

During the course of the FEED, in addition to desktop level assessments, AGFOR spent eleven (11) days (during two separate trips) in the Yukon meeting with key individuals in the Yukon forestry sector including harvesters, sawmill operator, other forest professionals, and Forestry Management Branch staff.

Initially AGFOR met with the three principal harvesting operators in the region. For each operation, AGFOR sought to gain an appreciation of the following:

- Harvest volume of shipped product (firewood, sawlogs) in the recent year – all tenures considered.
- The quantity of wood left standing after harvest excluding regulatory requirements, expressed as percentage of volume of product shipped - as a precautionary measure, AGFOR reduced the volume left standing by 50% to ensure that the requirement to leave 25% of the original standing volume is not compromised.
- The quantity of wood left lying in the harvest block – all species, expressed as percentage of volume of product shipped.
- The quantity of wood left at the landing after product has been shipped – all species expressed as percentage of volume of product shipped.

The same questions were asked of the forestry professionals familiar with the harvesting practices in the Haines Junction area; responses were consistent with those of the operators. For the most part, their answers were comparable with responses in other jurisdictions (AGFOR in-house).

In the Yukon, there are two principle uses of biomass feedstock: firewood and two small sawmills (one in Dawson and one near Haines Junction). The Haines Junction firewood and sawmill industries are serviced by three principal harvesters who collectively harvest and deliver approximately 25,000 m^3 per year, all tenures considered (>90% of the Haines Junction harvest).

For the sawmill, it was important to estimate bark, sawdust, and shavings left after sawing merchantable lumber, and the mill's current recovery factor (m^3 of logs per thousand board feet – MFBM). Subtracting the sawn lumber volume from the gross log volume delivered to the sawmill allowed for an approximation of the sawmill recovery and residuals

Estimated residues, in green metric tonnes (GMT), for each of the above assessment (i.e., sawmill residues, biomass left standing, left lying in block, and left lying at the landing) are summarized in Table 2.12; these are the forest harvesting residuals after product is shipped and the sawmill residuals from producing lumber – they reflect local practices and conditions.

Table 2.13 Opinion of Probable Harvest and Sawmill Residues (GMT)

Known Sources :	Tonnes/year
Sawmill residues	2,000
Left at landing (slash)	1,450
Left in block (slash)	1,750
Left Standing (- Reduced by 50%)	2,400
Total	**7,600**

2.6.2 From the Forest

With estimates of the potential residues and standing residuals from the three larger forest harvesters in the region and the sawmill totaling approximately 7,600 tonnes/year, it should be possible to supply the biomass to a generating facility capacity of approximately 1 MW_e. The business case for the three larger harvesters should be explored to ensure the validity and longevity of any commitment. The business case for other smaller harvesters and possible new entrants should also be explored to provide forest residuals adding a layer of security of capacity and of supply.

As the biomass plant capacity begins to exceed this level of existing supply (>1 MW_e), it becomes important to appreciate the availability of the required feedstock in relation to the forest resource. A plant capacity larger than 1 MW_e will require green stands to be harvested.

Some of the forest characteristics provide a first indication of the resource:

- Age class distribution and stage of development: Age class distribution is the area of the forest for each age class (10, 20, 30 age classes). This is a gross portrait of the forest landscape and its age. Approximately 40% of the Forest Resource Management Zone (Green Zone) is between 100 and 200 years of age (source: Forest Management Branch data).
- The gross volume (cubic meters of wood per hectare) of timber typically available at each age class is found on a yield curve.
- A significant portion of the forest is mature. Forest stand maturity shifts to over-maturity at just over 200 years when the stand volume begins to decrease. The January 17, 2013 flight over the Haines Junction area suggested that there are no great areas of significant stand volume decrease. The preliminary conclusion is there is mature standing timber.

- A focus on forest stands in the Forest Management Zone (Green Zone) that have more than 75 m^3 per hectare (the lower end of economic operability for many operators) provide the known operable standing volume. This where the requirement should be met. A new forest inventory will provide a better idea of the harvest potential and its geographical distribution.

The first three bullets provide an indication that the overall forest should support the harvest of a small volume of forest biomass. While the final bullet provides an idea of the operable inventory and its location, it should be noted that the current harvest levels with the additional biomass would be below the 2006 temporary salvage harvest. The salvage annual allowable cut ends in 2016. The new Timber Supply Review should identify new areas of potential supply

2.6.3 Moisture Content

Moisture content is a weight-based value; wood from operations is typically quantified on the volume basis, usually by the cord. That means that costs are constant for a given volume regardless of the moisture content. The lower the moisture content, the less wood needs to be harvested. This is operationally significant and contributes to maintaining the overall landscape.

AGFOR heard anecdotal comments of low moisture contents, especially in standing dead trees; a moisture meter reading at the sawmill in October 2012 seemed to confirm that. Reports from other jurisdictions also suggested low moisture contents.

AGFOR undertook to have the moisture contents of wood samples from both freshly harvested live and dead trees. The samples were taken on January 17, 2013. The Yukon Research Centre did the moisture content determinations in their laboratories. The results, shown in Table 2.13 for the dead trees were consistent with expectations, although the results for the live trees were higher than expected.

Table 2.14 Feedstock Moisture Content

Attribute	Moisture Content
Dead spruce	14.8%
Live spruce	47.0%

Chipping to size and moisture content are two key components. The challenge will be the green moisture content and the availability of standing dead (dry) trees. There are indications that the inventory and salvage of standing dead trees will begin to drop with time - when the supply of dead standing spruce becomes unattractive to the firewood business, a move to standing green trees with higher average moisture content is necessary. Moisture content (MC) of 35% is used for standing green trees. When this change occurs during the life of the plant more green wood will enter the feedstock and other pre-processing techniques and measures should be considered. Calculations are based on AGFOR’s original assumptions, which are 15% for residues and 35% for standing green wood.

Several factors could affect moisture content at the time of harvest and sampling. Regular moisture content sampling of harvested dead and green trees over a year on different site conditions could provide a better appreciation of the variability.

Measures to reduce moisture content should be explored during the detailed feedstock study following the FEED study; as such, measures could offset the apparent higher than expected moisture content of a limited sample from a few sites. Based on the unit performance outlined previously and 15% moisture content of the immediate feedstock, the feedstock requirements at the bookend capacities are presented in Table 2.14

Table 2.15 Summary of Feedstock Requirement

Scenarios:	0.5 MW_e	2 MW_e
Oven dry tonnes	3,000	15,900
With15% moisture	3,789	20,081
Cubic meters (m^3)	7,293	38,652
Cords	3,241	17,178
Cords per week	62	330
Truck loads/week	2-3 /week	11-15/week

The cubic meter is a solid measure that excludes air spaces and is equivalent to a solid volume of wood one meter wide, one meter high and one meter long

The cord is an apparent volume of stacked bolts of wood including the air spaces between bolts, hence apparent volume. A cord is 128 cubic feet, often described as a pile of wood measuring four feet wide, four feet high and eight feet long or some variation that equals 128 cubic feet.

2.6.4 Feedstock Cost

Feedstock costs are based on the local operating conditions and products that form the operator's business case.

Harvesting Cost

From each operator, AGFOR obtained an indication of their charge-out rate for each function/piece of equipment. This is the cost of harvesting equipment including labour, profit and overhead. In the absence of a charge out rate, AGFOR obtained the roadside selling price of firewood at the forest-roadside landing. From that, the current applicable stumpage and fees are deducted to arrive at a value that approximates their equipment costs with labour, profit and overhead. These are values used on local operations. They were compared to earlier reference studies and to AGFOR in-house studies and cost models.

Transportation and Handling

Where possible AGFOR obtained local rates and found that they were similar to other sources. They were compared to earlier reference studies and to AGFOR in-house studies. Distances where adjusted to reflect average haul distances over time at 50 km for the sawmill residues and 70 km for the forest harvesting residues and dedicated feedstock harvest. The new forest inventory will provide a better idea of the harvest potential and geographical distribution.

Loading and handling costs rely on in-house data with some adjustment to reflect the small scale of the project. These would need to be validated once the siting and feedstock delivery logistics begin to firm-up during the detailed feedstock analysis.

Chipping costs need to be confirmed. There are approaches, such as roadside (landing) storage and chipping, which could provide value to the plant. These would need to be validated once the amount of feedstock, siting and delivery logistics are finalized.

The costs are competitive by many standards. The extent to which these might be considered will occur in a detailed feedstock procurement exercise.

It is anticipated for either scenario (0.5 MW_e or 2 MW_e), that 50% of the winter harvest would be put into inventory for approximately six months at a storage yard eight kilometers away and then reclaimed for consumption. Interest charges would have to be added to that half of the feedstock. Alternatively, the feedstock could be chipped at roadside and delivered directly to the plant.

Several measures should be explored during the final site selection and feedstock procurement to mitigate the extra handling and inventory costs of an off-site intermediate off-site log yard:

- Explore the possibility of a summer harvest to reduce inventory, and provide work for the harvest crew during the summer – this would need the CAFN/Forest Management Branch's approval and any roads would trigger a review process.
- Store wood at the harvest landing and only reclaim it during the summer for immediate processing and consumption – this would need CAFN/Forest Management Branch's approval and any roads would trigger a review process. We would expect the wood to dry while in storage.
- Using a mobile chipper at the harvest landing and chipping whole trees has significant advantages:
    - Logging cost will be reduced because no limbing or limited limbing would be involved; if chainsaws and skidders are used there is a significant reduction in the risk of injury.

- While the trees are in storage, the moisture content should reduce, and possibly offset the extra handling and storage costs.
- There is a gain in volume/weight by not topping the tree.

Both chipping and whole tree chipping (or with intermediate limbing) at the landing would require the CAFN/Forest Management Branch's approval and likely require regulatory approval.

SCENARIO 1 - 0.5 MW$_e$

Scenario 1 produces 0.5 MW$_e$ and requires approximately 3,789 GMT at 15% moisture content (green basis). The sources are sawmill residues, logging debris at the landing (slash) and debris left in the harvest block. Little or no standing live trees are anticipated in this scenario. Should dead standing spruce no longer be available at a future date, a shift to standing live trees would occur. Note that residues make up the majority of the Scenario 1 feedstock which are at 15% MC, which aligned with the assumed moisture content required for use of the CPC system (denoted as 'as fired').

Scenario 1 - 0.5 MW$_e$	
GMT 'as fired'	**GMT @ 15% MC**
3,000	3,789

The following are the combined delivered and chipped costs of sawmill residues, harvest residues at the landing, and in the harvest block.

Scenario 1 costs as fired (bin)		
	$ GMT as fired	**GMT @ 15%**
(a) Direct to plant	Omitted	Omitted
(b) With secondary yard	Omitted	Omitted

Scenario 1(a), 0.5 MW$_e$, has an expected direct delivery wood cost of ($ Omitted) per GMT at 15% MC as fired (in the bin) without transitioning through an off-site log yard.

Scenario 1(b), 0.5 MW$_e$ has an expected wood cost via an off-site storage yard eight kilometers away of ($ Omitted) per GMT at 15% MC as fired (in the bin).

SCENARIO 2 – 2.0 MW$_e$

Scenario 2 produces 2 MW$_e$ and requires approximately 20,081 GMT at 15% MC (green basis). The sources are sawmill residues, logging debris at the landing (slash) and debris left in the harvest block and the harvest of standing live trees in this scenario. Should dead standing spruce no longer be available, the harvest of standing live trees would increase to possibly 78%

of the feedstock; this percentage is used in the Scenario 2 cost estimate with wood at 35% MC. This level of harvest would likely require regulatory approval.

Scenario 1 – 2.0 MW_e	
GMT 'as fired' @ 35% MC	**GMT @ 15% MC**
24,610	20,081

The following are the combined delivered and chipped costs of sawmill residues, harvest residues at the landing and in the harvest block, the harvest of standing residuals and the harvest of live trees for feedstock.

Scenario 2 costs as fired (bin)		
	$ GMT as fired	**GMT @ 15%**
(a) Direct to plant	Omitted	Omitted
(b) With secondary yard	Omitted	Omitted

Scenario 2(a), 2 MW_e, has an expected direct delivery wood cost of ($ Omitted) per GMT at 15% MC and ($ Omitted) per GMT as fired (in the bin) without transitioning through a log yard eight kilometers away.

Scenario 2(b), 2 MW_e, has an expected delivered wood cost via a storage yard of ($ Omitted) per GMT at 15% MC and ($ Omitted) per GMT as fired (in the bin).

2.6.5 Pre-Processing Implications of Biomass Properties

Costs (harvesting, handling, transport and chipping) are essentially constant regardless of moisture content as harvesters are paid on a volume basis. The facility operates in green metric tonnes (GMT) and benefits from any reduction in moisture content. The use of sawmill and harvest residues of dead wood is currently an advantage for all of Scenario 1 feedstock requirements and a portion of the Scenario 2 feedstock requirement. The remainder of the Scenario 2 feedstock will rely mostly on live trees (green). Opportunities to reduce the moisture content of live trees needs to be explored and integrated into the procurement practices.

It is anticipated that 50% of the winter harvest would be put into inventory for approximately six months at a storage yard eight kilometers away (assuming the experimental farm is used) and then reclaimed for consumption. Yard inventories of drier dead spruce and the green live spruce should be kept apart and dated for inventory control. The green live spruce should be reclaimed on a first in first out basis to capitalize on any moisture content reduction. Interest charges would have to be added.

Two off-site storage (inventory) opportunities should be explored:

- Leave the wood decked at the roadside landing in the woods that is accessible to a truck year-round, especially in the summer months, and remove for consumption as needed. This would need to be developed in the next phase (during the detailed feedstock analysis) and would likely require regulatory approval.
- Transport wood to an intermediate off-site yard and then reclaim for processing and consumption. This is the current Scenario 1b and 2b.

The first opportunity involves less handling and is less costly than the second.

A minimum operating feedstock inventory equivalent to two or three weeks supply should be sought. Off-site storage is needed for weekly deliveries of wood during the regular season and in the off-season months. The storage area needs to accommodate basic site access infrastructure and right-of way access for trucks and equipment to and from the piles all year including during the spring break-up. The site should have good drainage to support the traffic all year.

The approximate area required is presented below:

Scenario	Storage Capacity (m^3 - cords)	Area (hectares - acres)
1b	3,122 m^3 (1,388 cords)	0.9 hectares (2.1 acres)
2b	18,302 m^3 (13,700 cords)	5.2 hectares (13 acres)

Harvest of Green Trees (Scenario 2)

Harvest and delivery costs (as-fired) of green trees currently left standing and as a dedicated harvest including harvest, transport to plant and chipping are presented below (rounding differences occur).

In Scenario 2(a) direct delivery (no intermediate storage yard) to the plant for Live Trees - are as follows:

$ / m^3 @ 35% MC	GMT @ 35%	$/GMT @ 35%	Factor to 0%	$ /ODT
Omitted	0.639	Omitted	1.76	Omitted

In Scenario 2(b) indirect delivery via an off-site yard for Live Trees - are as follows:

$ / m^3 @ 35% MC	GMT @ 35%	$/GMT @ 35%	Factor to 0%	$ /ODT
Omitted	0.639	Omitted	1.76	Omitted

Potential Employment

Looking at the potential impact to existing employment, either scenario will require an increase both harvesting by local contractors and new employment to support the plant. Based on the fuel quantities expected, the breakdown for added employment is outlined in Table 2.15. This high-level assessment shows the need for increased activity by the local harvesters (Contractor) and the biomass facility (New Corporation (NEWCO)).

Table 2.16 Employment Impacts from Biomass Plant

Employment / Scenario	Scenario 1a	Scenario 1b	Scenario 2a	Scenario 2b
Person Days	265	343	1464	1612
Person Years Total	1.20	1.56	6.65	7.33
Contractor* Person Yrs	0.70	0.70	4.57	4.57
NEWCO Person Yrs + yard-site maintenance	0.50	0.86	2.08	2.76

*Scenario 2 includes part-time conventional chainsaw and skidder volume

3.0 Environmental Assessment and Permitting

3.1 REGULATORY APPROVALS STRATEGY

A draft Environmental and Socio-economic Impact Assessment (IA) has been prepared based on information currently available on the Project and existing conditions in the area. This report includes an overview of the effects assessment and regulatory regimes associated with permitting the Project, scoping of the assessment to include relevant Valued Components (VC), summaries of baseline conditions for each VC and expected effects and proposed mitigation. Determination of significance has been based on residual effects after implementation of mitigation. Adaptive management and monitoring activities are also outlined where deemed applicable. The environmental and socio-economic impact assessment report draft completed to date is attached as Appendix F.

As the plant site has not yet been confirmed, collection of data to provide an understanding of baseline conditions associated with the plant site has been done at a high level for Haines Junction and the surrounding area. Data available at a desktop level indicate that there are no major environmental constraints on the preliminary site (used in the FEED study). Field studies are required to confirm findings once the site has been selected and are suggested to include (but may not be limited to) heritage resource assessment, vegetation and wildlife surveys and an existing sound pressure level survey. Targeted meetings or interviews with CAFN members and the public should also be held to confirm the plant site should not cause any significant effects on traditional and current land use and culture.

The Project team has drafted the effects assessment thus far with the intent to meet the requirements of an Executive Committee level screening. This route was chosen as the full scope of the Project is not yet confirmed, and thus the volumes of harvesting required are not known. These depend on the plant size and the outcome of the preliminary feedstock harvesting study (now complete). The client has also indicated it is likely that an Executive Committee submission is required based on initial consultation with YESAB. At this time, it is important to note that the level of submission required under Yukon Environmental and Socio-economic Assessment Act (YESAA) has not been confirmed with YESAB. The YESAA trigger for Executive Committee assessment of this Project is based on harvesting of 20,000 m^3 or more of standing or fallen trees. If a plant size of 500 kW_e is chosen it is estimated to consume 10,500 m^3 per year with existing harvesting areas having the potential to supply all of this volume (6,000 m^3 in logging residues from current harvesting operations and 4,500 m^3 (2,200 GMT) of sawmill residues not currently being used). Therefore, this size of plant could potentially be permitted through a Designated Office (DO) level submission (assuming DO level proposals are submitted separately by existing operators for ongoing harvesting). This would reduce the level of detail required in the assessment and importantly the potential timelines for approval. These potential timelines for approval (to receive a Decision Document) of an

Executive Committee proposal are 1 to 2.5 years, whereas the DO process timeline is less than 1 year. Note that on occasion, regulators may require an assessment for a project that is otherwise exempted (although this mechanism has never been applied). There is also a possibility that a Project requiring a DO level submission (as per the requirements of YESAA) could be referred to the Executive Committee at either the onset or following initial review of the DO submission. This referral would primarily be based on the potential for adverse effects even with proposed mitigation as well as stakeholder concerns or use of unknown technologies. Therefore, consultation with YESAB is required to confirm the Project's stream and scope of assessment. This strategy is further discussed in Section 4.3.

3.2 DESKTOP FEEDSTOCK HARVESTING ANALYSIS

Key potential environmental and socio-economic issues associated with using beetle kill and potentially green feedstock in the Yukon have been described in the draft IA (Appendix F). Mitigation options have been identified based on the preliminary information available. The feedstock harvesting environmental analysis included consideration of:

- Long-term sustainability of supply (discussion of the overall sustainability of supply for expansion of biomass use).
- Responsible treatment of ecosystem and environment.
- Legislative and regulatory requirements for the timber resources.
- Fire Management.
- Respect of other uses and users of forests.

Some consideration for Traditional Activities and Culture as well as social, recreational, and commercial use has been included however, this is recommended as an area for further study, now that volumes of required harvest are better understood. For the smaller plant, these are not critical considerations in the event that existing harvesting activities are contracted to supply the Project. Very limited documentation exists to support this type of socio-economic assessment at a desktop level and the social aspect requires consultation to ensure current values and uses are considered.

Supply for a 500 kW_e plant has been determined to be sustainable with no change over existing harvest areas expected. The additional requirement for a 2 MW_e plant is also a low percentage of the overall resource; in consideration of the Green zones as denoted in the Integrated Landscape Plan, the current use and the Timber Harvest Level for the Champagne and Aishihik Traditional Territory (2006). Both the availability of supply and the harvest level are subjects for review as part of the new forest inventory of dead and live forests.

Key guiding documents and plans are highlighted as follows:

2004 – Strategic Forest Management Plan for the Champagne and Aishihik Traditional Territory (CATT) provides direction to the planning process presenting the values and objectives for the CATT necessary to ensure sustainability in the broadest terms and reflecting the traditional and non-traditional values and objectives of the community. It provides the indicators and the processes for involvement of the community in the planning process. It addresses the entire land base in the study area.

2006 - The Timber Harvest Level for the Champagne and Aishihik Traditional Territory spells out the harvest level determination of spruce bark beetle affected forest stands and timber harvesting opportunities. This agreement set a harvest ceiling of 1,000,000 m^3 annually for the spruce beetle affected forest over a ten-year period. The harvest level is being updated with the in progress forest inventory.

2007 – Integrated Landscape Plan for the Champagne and Aishihik Traditional Territory (CATT) originally made available publically in March 2006. It is a subordinate plant to the 2004 Strategic Forest Management Plan (SFMP) and introduces land use Zones and availability for forest harvesting. These zones include both CAFN Settlement Lands and non-Settlement Land. Three Zones are presented:

- Forest Management Zone shown in green (aka the Green zone – 93,700 ha) is the zone currently considered for Timber Harvest Project Planning. Most of the wood harvesting would be in this zone with accommodation for site-specific wildlife and habitat.
- Provisional Forest Management Zone (aka the Yellow Zone – 70,000 ha) is not currently targeted in Timber Harvest Project Planning.
- Conservation Forest Management Zone (aka the Orange Zone – 83,150 ha) in which no commercial harvesting is currently allowed. Significant amendments to the SFMP and the ILP would be required to allow harvesting in this zone.

These documents provide the forest planners with the scope for planning and wood supply analysis, their rules of engagement and are referenced in the *Forest Resources Act* 2008 (FRA) which came into effect in 2011 along with the regulations. The FRA applies to non-Settlement Land where as CAFN Settlement Land falls under the authority of CAFN and is regulated via the *Traditional Activities and Protection Act*.

During this time, inventory estimates were developed to allow a level of forest harvesting activity to occur in the Green Zone. The background data used in this timber supply analysis stemmed from earlier photo interpretation to provide a rough and broad estimate of standing timber. The Timber Harvest Level for the Champagne and Aishihik Traditional Territory is a binding agreement on the allowable salvage harvest that was established in 2006 based on this analysis.

Spruce Bark Beetle, Yukon Forest Health – Forest Insect and Disease Bulletin 19 provides a recent history of the spruce bark beetle infestations and its dynamics - The most recent outbreak began in 1990 caused significant yet unquantified mortality. Large tracts of dead and dying mature white spruce were observable while the infestation was in progress. The harvest/salvage of this wood was made possible with a time limited salvage harvest (10-year period from 2006 to 2016). The extent that this salvage will continue to be available is now a key question as the standing dead trees are beginning to fall.

A Timber Supply Review or new forest inventory is in progress based on recent aerial photo interpretation at a finer resolution. This will provide better data on the volumes, distribution and condition of both dead and live trees.

2009 – Forest Health Report, Yukon Energy Mines and Resources uses a risk based approach to forest health; 2009 is the first year of publication. It provides an expanded history of various forest health issues. The spruce bark beetle is the most damaging forest pest targeting mature spruce in the Yukon. The Yukon outbreak began in 1990 and is (at the time of the report) still underway "It is by far the largest and longest lasting spruce beetle outbreak ever recorded in Canada." "The intensity and duration of the current infestation are related directly to climatic stress …by the significant increase in temperature during the late 1980s and into the 1990s.

2012 Champagne and Aishihik - Yukon Forest Management Implementation Agreement "reaffirms the provisions included in the Strategic Forest Management Plan for the Champagne and Aishihik Traditional Territory and the Integrated Landscape Plan for the Champagne and Aishihik Traditional Territory (CATT) confirming guidance to the new Timber Supply Review.

The new Timber Supply Review will provide useful information on both dead and live trees and will be the object of public engagements before a revised final annual allowable cut (AAC) is set. The AAC will then be apportioned according to the types of use and license categories in accordance with the objectives of the Forest Management Implementation Agreement. Public consultation would also be conducted before allocations are made.

Current interim allowable harvest volume estimates are based on the earlier inventory and the salvage of dead white spruce. The allocations on non-Settlement Lands follow the process outlined in the **Wood Allocation Strategy (see Operational Policy Procedure June 2012 – Wood Allocation Strategy for Haines Junction):**

- A License is issued and provides the rights to a volume in the licensed area.

- A Timber Harvest Plan (THP) is prepared in accordance with the Act and is approved by Forest Management Branch.
- A Timber Cutting Permit is issued in accordance with the Act.
- YESAA applies to areas over 1,000 m^3 and is engaged.
- A site plan is prepared in accordance with the above and in accordance with the Act.
- A Cutting Permit is issued with the terms and conditions specifying time frames, stumpage and fees and reporting and completion requirements.
- A post assessment conducted by the Compliance Branch provides Closure to the license.

On Settlement Lands, the *Traditional Activities and Protection Act, The Timber Harvest Level for the Champagne and Aishihik Traditional Territory, the Forestry Implementation Agreement* as well as the SFMP and ILP provide some framework and legislation for harvesting activities. CAFN is currently in the process of developing additional forest policy framework, scheduled to be in place by 2015. This was one of the key objectives of the 2012 Forestry Implementation Agreement. (Per. Comm. Roger Brown CAFN 2013).

3.3 RISK MANAGEMENT STRATEGY FOR ENVIRONMENTAL/SOCIO-ECONOMIC AND REGULATORY APPROVALS

This risk management strategy for environmental and socio-economic regulatory approvals builds on the preliminary work undertaken as part of the environmental assessment and permitting phase. The objective is to define environmental and regulatory approval risks to the project. A summary of gaps and uncertainties and recommendations for further study and potential approvals schedules are provided.

Based on our preliminary work, we consider the overall risk to the Project to be low in relation to attainment of environmental/socio-economic regulatory permitting requirements.

3.3.1 Gaps and Uncertainties

Although some information from the FEED Study has been made available to the environmental team prior to release of the draft study, the effects assessment completed to date (January 31) does not incorporate the information provided in the draft FEED Study or the findings of the preliminary feedstock assessment as these activities were conducted and finalized concurrently. As these studies have been conducted concurrently, some updates to the effects assessment are required to reflect the conclusions of these studies (such as the plant site area, construction periods and activities, volumes of waste generated, water consumed). Further updates are likely to be required depending on the decision of the steering committee on whether to proceed with the Project and at what size or scale.

At this stage (as directed by the Project team), no directed consultation with the Yukon Environmental and Socio-economic Assessment Board (YESAB) has been conducted. It is recommended that potential strategies and timelines be reviewed with YESAB prior to financial and board decisions to move forward so that their input can be considered.

Assessment of cumulative effects has not been completed in detail, as the Project will not be registered with YESAA until a decision to move forward is made by the steering committee and those providing financial support to the Project. Additional activities or projects could be initiated prior to that time. Based on preliminary review, no other activities or projects currently exist that would combine with this Project to cause a significant adverse environmental or socio-economic effect. Further study in relation to socio-economic effects on existing forest harvesting and traditional and current land use, activities and culture may be warranted, depending on the magnitude of harvesting proposed.

Further study of noise/sound quality effects from chipping should be completed once this activity's location and equipment/technology are defined. A set back from the nearest residence or other sensitive receptor (such as the school) of 500 m to 1,000 m is expected to be required to avoid annoyance from noise due to this operation. The preliminary air quality assessment indicates that the Project should comply with regulatory requirements, however this will need to be confirmed based on the emissions profile of the Project from the selected vendor.

3.3.2 Feedstock Harvesting

With regards to moisture content of green trees, limited samples were taken during a one-day field visit on January 17, 2013. The preliminary moisture contents of the green wood determined based on this sampling were higher than expected; these findings should be considered preliminary in nature. More volume of harvest would be needed to supply the feedstock using green wood; this has been partially adjusted in calculations presented in this report by assigning a 35% moisture content to all standing trees left in a block (to be harvested to meet the 2.0 MW_e feedstock needs). Further in-season moisture content analysis should provide a better indication of variability. Moisture content reduction strategies have also been identified for further study.

This is considered a concern as fewer large areas of standing dead wood (beetle kill) may be economically available over time than previously suspected. The new forest inventory of dead and live forests is intended to address that issue. In the event that current harvesters agree to supply the required feedstock for a 500 kW_e facility, minimal planning on the part of the Proponent would be required in harvesting operations. While harvesting for a 500 kW_e facility requires detailed planning of wood harvesting, storage and chipping location and activities to ensure compliance with procedures and continuous feedstock availability, the contracted harvesters could be expected to manage the majority of this planning. Depending on the methods for hauling, storage and chipping, the effects assessment would be revised accordingly.

Harvesting feedstock for a plant larger than 500 kW_e would require an increase in harvesting, beyond current levels. Further study should be undertaken to define the activities and timelines for this harvesting (*e.g*., types of equipment, blocks required annually and planned field studies, seasonality of harvesting required, wood storage and chipping locations). Once the activities and areas are defined, the additional scope of assessment of socio-economic and environmental effects will be modified.

The assumption that existing fuel wood harvesting will continue to operate as per the status quo and thus could supply the Project as part of this activity presents some risk. The risk to this assumption is that current harvesters could leave the Haines Junction area once the dead wood is depleted. Risk to supply may also increase as the dead wood is depleted, as the economic efficiency of using greenwood volumes is known to be less due to the requirement for drying. This has been accounted for in calculations by assigning a 35% moisture content to all standing trees left in a block and trees to be harvested to meet the 2.0 MW_e feedstock needs. A review of the harvester's business case and of operational moisture content reducing strategies are noted for further study.

3.3.3 Next Steps

The following steps are provided under the assumption that a decision to go forward with the Project is made. No environmental constraints have been identified in the desktop review. Preliminary consultation has indicated that there is community interest and support for the Project.

In consideration of the plant site itself, no environmental constraints are expected for the range considered (500 kW_e to 2.0 MW_e) that would result in denial of approval of the Project for environmental or socio-economic reasons. When the feedstock harvesting activities are combined with the plant operation, there is more uncertainty with the larger plant size in terms of scope of assessment and timeline for completion. However, as the requirements are still a small fraction of the previously estimated forest resource and when combined with current harvest levels, are well within the 2006 Timber Harvest Level for the Champagne and Aishihik Traditional Territory, the inclusion of the forest harvesting activities in the overall assessment is not expected to result in significant adverse environmental effects that cannot be mitigated (for the sizes of plant being considered).

It is recommended that the plant size be selected in consideration of FEED results (economics and technical constraints) and input from consultation with First Nations and the public as well as the expected timelines for permitting of the facility under different scenario (500 kW_e to 2.0 MW_e). Field studies should be defined for this site, as required, in order to finalize the impact assessment in relation to the plant.

Confirmation of the emissions profile and dispersion modeling should be completed during the vendor selection process. Modeling may need to be redone if emissions are higher than those estimated based on Community Power Corporation's (CPC) proposal or stack parameters are substantively different (much lower stack or lower velocity would result in worse ambient air quality predictions).

A strategy for regulatory permitting, which should allow for more timely consumption of beetle-killed wood, is to proceed with permitting of a 500 kW_e facility with minimal additional analysis of environmental issues associated with feedstock harvesting (assuming existing forest harvesting operations can provide the required feedstock and YESAB agrees to a DO level proposal for the plant). This may be justifiable and agreeable to YESAB and the public for the following reasons:

- In accordance with the CAFN strategic plan, CAFN is interested in pursuing regional economic development within its Traditional Territory by exploring opportunities in all economic sectors. CAFN has been actively investigating Biomass potential for 18-months prior to this FEED study.
- The Public and First Nations have not communicated any concerns that cannot be resolved and mitigated through planning.
- Some members of the community and CAFN leadership have expressed their desire to use the beetle killed wood before a catastrophic forest fire occurs or the resource loses its usefulness due to rot (although it is understood that not all members of the community may align with this view).
- Based on the FEED study, the feedstock supply for a 500 kW_e plant should be attainable through existing harvesters without increasing annual harvest area (by using waste from sawmill operations, slash being left in the blocks and at the landing).
- CAFN and the Yukon Government have developed a Strategic Forest Management Plan and Integrated Landscape Management Plan, which is applicable to Settlement and non-Settlement Lands. These plans as well as the Yukon *Forest Resources Act* and the Haines Junction Wood Allocation Strategy Operational Policy and Procedures (non-Settlement Lands) would be followed in harvesting for the Project.
- CAFN does not consider current regulatory/legislative tools to be sufficient to adequately manage forest resources on Settlement Lands and is thus in the process of developing a forest policy framework, scheduled to be in place by 2015. This was one of the key objectives of the 2012 Forestry Implementation Agreement. (pers. Comm. Roger Brown CAFN 2013).

As explained in the FEED study, modular designs are available for the plant. Following the installation and operation of the 500 kW_e plant, sufficient time would be allowed to monitor operational issues related to the plant and/or feedstock acquisition (either operational or environmental/socio-economic). Subsequent to this, a proposal could be submitted to the DO

for expansion. Assuming operation of the initial 500 kW_e plant is shown to cause no significant effects, permitting of an expansion may be relatively straightforward.
Additional studies surrounding feedstock-harvesting activities should be defined in consultation with the Forest Management Branch, Environment Yukon, The Alsek Renewable Resource Council (ARRC), CAFN and YESAB. Based on our work to date, we suggest the following may be warranted:

- Review of Heritage Resource Assessment process currently being undertaken in association with forest management.
- Development of a Heritage Resource Assessment plan for the life of the Project.
- Focused public, stakeholder and Aboriginal and First Nations consultation to discuss existing land use, traditional activities and culture, and local knowledge of the areas in terms of ecological and heritage resources (in relation to potentially harvestable areas).
- Bird surveys should be designed in consultation with Canadian Wildlife Service, Environment Canada, Environment Yukon, and ARRC. Multiple surveys may be required to target various bird species (e.g., Common Nighthawk, owls, early surveys for woodpeckers, breeding bird surveys).
- Rare plant surveys should be designed in consultation with Environment Yukon, multiple surveys may be required to ensure that early ephemeral species are captured as part of the survey.
- Additional wildlife surveys may be required depending on consultation with Environment Yukon. Surveys targeting bats and/or small mammals may be required.
- Fish and fish habitat surveys may be required depending on the location of the feedstock sites. Design of the survey would be conducted in association with input from regulatory agencies.

3.3.4 Preliminary Field Study and Permitting Schedule

Consultation with YESAB is recommended prior to a go decision on size of plant. This will help to ensure that any input from the regulators on required scope of assessment can be considered in the decision process. The schedule from that point is dependent on the required permitting path. Consultation with CAFN and the community of Haines Junction to confirm plant siting should be completed prior to finalizing the site. Site field surveys for wildlife and vegetation should be completed in 2013. Certain species (such as Woodpecker and owl surveys) are done early in the spring (likely May) while the regular breeding bird surveys would be done in June. Depending on the level of detail required by the regulators, some of the plant surveys may need to be done early in the spring to catch early ephemeral species. All wildlife and plant surveys and their timing depend on consultation with the regulators to confirm required scope.

Timing for a field heritage resource assessment could be as early as spring 2013, provided assessments are conducted in snow-free conditions. Following completion of these activities and assuming a DO proposal is possible, the initial proposal could be submitted by mid-2013. If additional environmental and socio-economic study of feedstock harvesting is required by YESAB (likely for 2.0 MW_e plant, may be required for smaller plant), these studies should be scoped and initiated following a go decision on the Project and are expected to take 6 to 12 months to complete depending on the scope. The overall schedule and YESAA process is summarized in Figure 3.1.

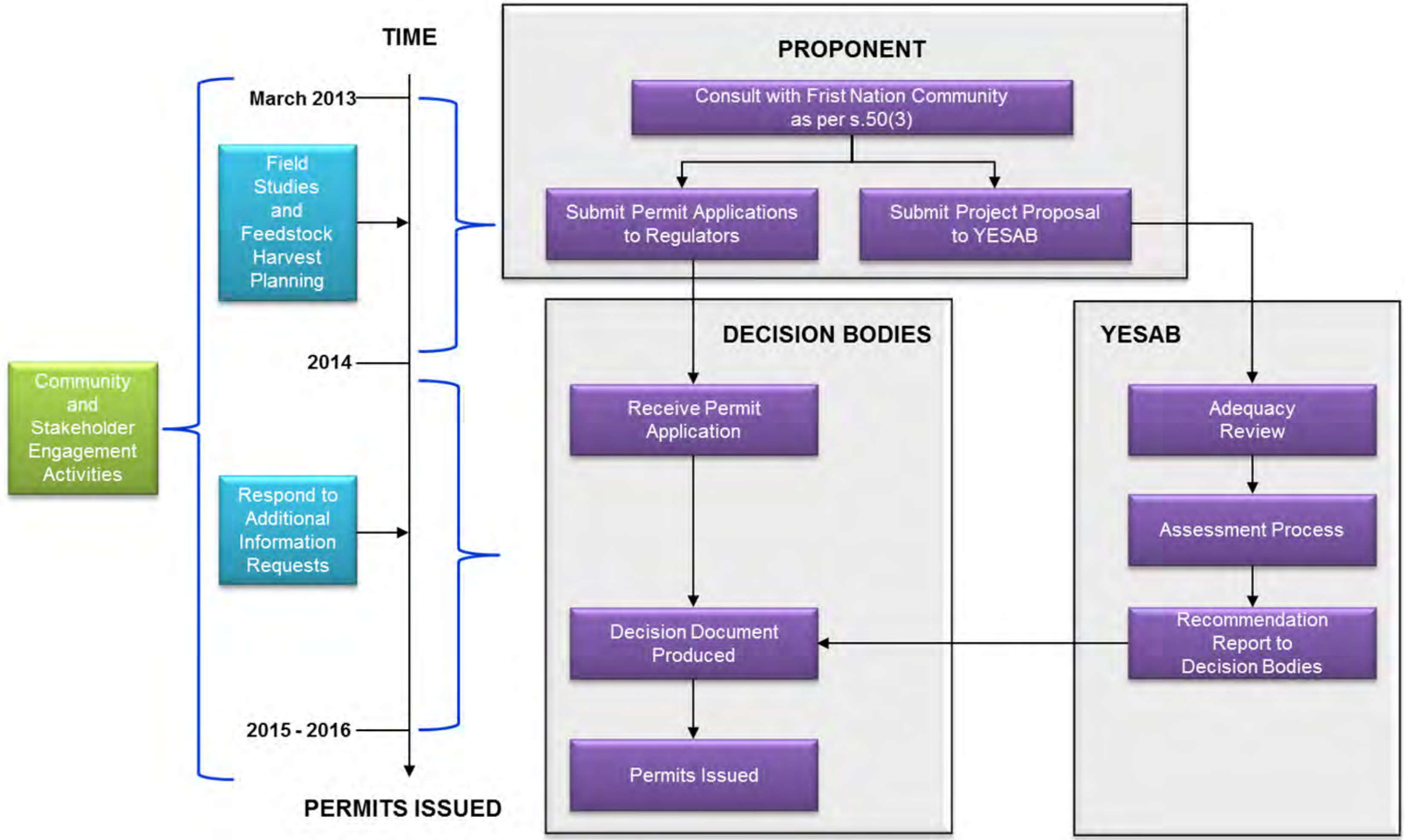


Figure 3.1 YESAA Simplified Process Flow Diagram for 2.0 MW Capacity

4.0 Risk, Financial & Operations Analysis

The Risk, Financial, and Operations Analysis section of the FEED focused on three critical areas, including: sources for project financing/funding, options for different business models for the formation of the new company (NEWCO), and financial assessment of the biomass plant (ROI, NPV, and sensitivities). Each of these topics is presented in the following subsections.

4.1 SOURCES OF PROJECT FINANCING

As part of the Phase 5 – Project Financing task, Stantec has conducted preliminary research into potential sources for project funding. At the kick-off meeting in Whitehorse on September 19, one potential source of funding discussed was Sustainable Development Technology Canada (SDTC). Stantec reviewed the workshop presentation for SDTC with the following comments.

4.1.1 Sustainable Development Technology Canada

SDTC operates two funds intended to stimulate investment in sustainable technologies. The first fund is the "SD Tech Fund™" which is 10 years old and aimed at development of emerging clean technologies. The key here is the word "emerging". To be eligible, the Yukon biomass would have to be considered "unproven"[1].

The second fund managed by SDTC is the "NextGen Biofuels Fund™". This fund is aimed at "large demonstration-scale facilities for next-generation renewable fuels and co-products.

Both of these funds were discussed with Paul Austin (SDTC, Vancouver office), to determine potential eligibility for the Yukon project.

Unfortunately, this project is likely to not qualify for either funding. The SD Tech Fund is strictly for new technologies or innovative use of clean technologies, and a proven biomass technology / waste heat application is not what SDTC is looking for in new applications. With regard to the NextGen Fund, it is for "first of a kind" type biofuel projects already in a continuous operation mode.

4.1.2 The ecoENERGY Innovation Initiative

"The ecoENERGY Innovation Initiative (ecoEII) received funding in Budget 2011, the Next Phase of Canada's Economic Action Plan, for a comprehensive suite of research and development (R&D) and demonstration projects. The program's objective is to support energy technology innovation to produce and use energy in a cleaner and more efficient way. This

[1] SDTC states in the presentation materials under the heading "SOI Don'ts" – Proven Technology = no need for SDTC

Initiative is a key component of the Government of Canada's actions to achieve real emissions reductions, while maintaining Canada's economic advantage and its ability to create jobs for Canadians. The ecoEII will also help in the search for long-term solutions to reducing and eliminating air pollutants from energy production and use."[2]

This funding source is currently engaged under the 'demonstration' division to support this FEED study. Continued funding from NRCan on the next phases of this project is possible and negotiations are ongoing.

4.1.3 Potential Funding Sources

Research indicates that there are other funding programs that may be applicable to the project. These will require direct follow-up with the applicable government agencies to determine if it is worthwhile to apply. Furthermore, once (if) a waste heat option is finalized, this may also lead to other funding opportunities.

From the Canadian Northern Economic Development Agency, there are the following programs:

4.1.3.1 Strategic Investments in Northern Economic Development (SINED)

SINED has been allocated $22 million funding per Territory for the years 2009-2014 as part of its Targeted Investment Program (TIP). The four areas of focus for TIP are building the knowledge base, enhancing the economic infrastructure base, capacity development, and economic diversification. It is possible that the Yukon project could qualify for funding as an economic diversification plan.

4.1.3.2 Community Economic Opportunities Program (CEOP)

The CEOP and CEDP funding provides project-based support and core operational support for First Nation communities for projects that lead to more community employment, greater use of land and resources, enhanced community infrastructure etc. The Yukon biomass project certainly will provide these economic benefits and may be a good candidate for this funding.

4.1.3.3 Community Infrastructure Improvement Fund (CIIF)

The CIIF program provides up to $1 million in funding for projects that improve community infrastructure. Recipients of the program must be not-for-profit entities, local/territory governments or First Nations. Infrastructure must be directly accessible to the public (i.e. district heating) and must be materially completed by March 31, 2014. There is some question whether the Yukon project would qualify due to restrictions pertaining to commercial activities.

[2] http://www.nrcan.gc.ca/energy/science/2003

Natural Resources Canada (NRCan), who is funding this Yukon feasibility study via its ecoEnergy Initiatives Program, may also have possible funding availability under grant programs as follows.

4.1.3.4 Aboriginal Economic Development in Forestry

The Canadian Forest Service (CFS) has been mandated by AFI to provide knowledge and facilitate coordination of federal support programs for Aboriginal economic forestry development, of which bioenergy is a priority focus. Limited multi-year funding may be available from AFI where it is determined that critical gaps exist in support from other programs that may pose a risk to project success. There is no formal application process involved. Instead, any funding will be subject to the CFS identifying the need and strategic value of the project as well as availability of the funding from AFI.

4.1.3.5 Biomass for Energy Program

Established in 2000, the Biomass for Energy Program focuses on research and development related to technologies used in the growing, harvesting and transportation of biomass feedstock. The program is also funded through the Canadian Forest Service.

The federal government Office of Energy Research and Development (OERD) offers another potential research and development grant program focusing on biomass technologies.

4.1.3.6 Bio-based Energy Systems and Technologies (BEST) Program

This program supports the research and development of technologies used to improve the supply, conversion and utilization of both existing and new biomass feedstock supply.

Finally, for taxable entities, accelerated Capital Cost Allowance provisions are available for capital assets used in the production of energy using renewable fuel sources. The provisions allow for an increased depreciation of equipment at a rate of 30% annually.

4.2 NEWCO BUSINESS MODELS

The purpose of this subsection is to provide a risk and qualitative analysis of the options available to NEWCO (Champagne and Aishihik First Nations, Yukon Energy and the Village of Haines Junction (VHJ)) for the ownership and operations of a 0.5 - 2.0 MW_e biomass energy system. The analysis is provided separately for both the feedstock harvesting (e.g. feedstock storage yard/wood chipping and logging) operations and the biomass plant operations.

Options:

Three ownership and operations options have been considered for each of the feedstock yard/logging operation and the biomass plant operation, resulting in a combined total of six options. These six possible options are provided in the following table.

Table 4.1 Business Model Options Analysis

	Feedstock Yard/Logging		**Biomass Plant**	
	Ownership	Operations	Ownership	Operations
Option 1	NEWCO	CAFN	NEWCO	NEWCO
Option 2	NEWCO	ISP	NEWCO	NEWCO
Option 3	NEWCO	CAFN	NEWCO	ISP
Option 4	NEWCO	ISP	NEWCO	ISP
Option 5	ISP	ISP	NEWCO	NEWCO
Option 6	NEWCO	CAFN	ISP	ISP

CAFN Champagne and Aishihik First Nations
ISP Independent Service Provider
NEWCO CAFN/Yukon Energy/Village of Haines Junction (a private entity)

Assumptions:

As part of this analysis, specific base assumptions have been made as follows:

- For options where an ISP is the owner, it is assumed that NEWCO will retain an option to acquire all assets at fair market value after a twenty-year period.
- For options where an ISP is the owner, it is assumed they will also be the primary operator. CAFN members will be used to the greatest extent possible and trained for eventual assumption of full operations over a maximum twenty-year period.
- Yukon Energy will hold a minority interest in NEWCO. They are interested in the plant operations but are not interested in the operations of the logging business.
- The Village of Haines Junction will hold a minority interest in NEWCO but will not participate in any of the operations.

4.2.1 Risk Analysis

The risk analysis used has been developed to show areas where actual results may differ from predicted. The risk analysis is semi-quantitative, with lower scores signifying a lower probability of occurrence and a lower severity of risk. Risk criteria have been broken out into two life-cycle categories reflecting the periods before and after the assets are placed into operations. The two categories are the "*design and construction period*" and the "*operations and transfer period*". The feedstock yard/logging operations and the biomass plant operations have been evaluated separately due to the distinctiveness of each of these project components.

Scoring:

The risk assessment considers both the probability of the risk occurring and the severity of impact if the risk does occur. The scoring uses a scale where 1=Low, 2= Medium and 3=High which can generally be interpreted as follows:

Table 4.2 Scoring Structure

Score	Probability	Severity
1 (Low)	*Unlikely* to occur for this project	Low impact unlikely to result in a loss that cannot be easily mitigated
2 (Medium)	*Possible* to occur for this project	Medium impact where the loss can mostly be mitigated
3 (High)	*Likely* to occur for this project	High impact where the loss may be significant

The total risk for each option is calculated as: **Total Risk = Probability x Severity**.

4.2.1.1 Feedstock Yard/Logging Analysis

The total risk scores for the feedstock yard/logging operations are:

Table 4.3 Risk Score Summary – Feedstock Yard/Logging

	NEWCO Owns/ NEWCO Operates	NEWCO Owns/ ISP Operates	ISP Owns/ ISP Operates
Design and Construction Period	16	18	14
Operations and Transfer Period	16	11	19
Total Risk Score	**32**	**29**	**33**

With the lower score reflecting lowest risk, Option 2 is the lowest risk option for feedstock yard/logging.

The following table shows the detailed scoring for the feedstock and logging ownership and operations options followed by a short narrative of the scoring rationale for each criterion.

Table 4.4 Risk Assessment – Feedstock Yard/Logging

FEEDSTOCK YARD / LOGGING RISK ASSESSMENT (Low-1 , Medium - 2 , High - 3)	OPTIONS								
	NEWCO / CAFN			NEWCO / ISP			ISP / ISP		
	Prob-ability	Sever-ity	Risk	Prob-ability	Sever-ity	Risk	Prob-ability	Sever-ity	Risk
DESIGN & CONSTRUCTION PERIOD									
Under or over designed (changes required to meet performance criteria or capex higher than necessary)	1	1	**1**	1	1	**1**	1	1	**1**
Constructability	2	2	**4**	2	2	**4**	1	1	**1**
Insufficient interest in RFP to stimulate competitive forces	1	3	**3**	1	3	**3**	1	3	**3**
Complexity of processes leading to increased time and cost	1	2	**2**	2	2	**4**	3	2	**6**
Permit/zoning risks	1	1	**1**	1	1	**1**	1	1	**1**
Scope / schedule creep	2	2	**4**	2	2	**4**	1	1	**1**
Default/breach of T&C's by consultants/contractors	1	1	**1**	1	1	**1**	1	1	**1**
Average Score			**16**			**18**			**14**
OPERATIONS & TRANSFER PERIOD									
Operational reliability standards not met	3	2	**6**	1	2	**2**	1	2	**2**
Operating cost variances	3	2	**6**	1	2	**2**	1	2	**2**
Electricity demand risk	1	1	**1**	1	2	**2**	1	2	**2**
Energy cost (feedstock) variation	0	0	**0**	0	0	**0**	0	0	**0**
Default/breach of T&C's by operator	1	1	**1**	1	3	**3**	1	3	**3**
Required maintenance not performed, diminishing value of asset	1	1	**1**	1	1	**1**	2	2	**4**
Market conditions change, increasing market value of the assets	1	1	**1**	1	1	**1**	3	2	**6**
Average Score			**16**			**11**			**19**
TOTAL RISK SCORE (**Lower** is better)			**32**			**29**			**33**

Following is an explanation of scoring for each life-cycle category:

Design and Construction Period:

The three options have close risk levels pertaining to the design and construction period. The risk of over or under designing the required facilities is quite low for all options primarily due to the requirements being low complexity. This is also true for overall constructability. Regarding tendering, the potential risk of there being insufficient interest in the project is again low as most consultants and contractors should have adequate capability to provide design and construction requirements. The risk level does differ between options when considering the complexity of processes. This is due primarily to the asset transfer back to NEWCO after twenty years if an ISP is owner, which can significantly increase time for contractual negotiations compared to a more standard arrangement. This option does, however, provide the lowest overall risk to NEWCO during the construction phase. Although permitting risk is not likely to be any different, the risks associated with scope and scheduling are lower where an ISP is owner. As the ISP is ultimately responsible for most construction risks, NEWCO will be effectively sheltered from this risk. Although there is possibly increased risk from a breach of terms and conditions by an ISP as an owner and/or operator, the fact that the project represents a longer term project with larger cash flows effectively makes it less likely that an ISP would default or breach contract than would a contractor in a design-build option with less at stake.

Operations and Transfer Period:

During the operating stage, the most significant period in the life cycle, the options where ISP is operator provide a lower risk exposure for NEWCO. The operating risk is primarily attributable to the entity responsible for operating the logging and feedstock operations. With NEWCO as operator, the lack of experience in these areas represents a high risk. The risk of electricity demand is low regardless of who is the owner. However, the severity of this risk will be greater where the ISP is operator as there is likely to be some form of contractual guarantee by NEWCO such as a take-or-pay agreement. This is not likely to be high however, due to the ability to keep workers active and stockpile feedstock if necessary. Other areas where an ISP operator provides a greater risk to NEWCO is the possibility, although small, that an ISP could default and/or breach the terms and conditions of the operating agreement. Although the operating agreement would most certainly contain recourse protection if a default or breach were to occur, the problems and lost time by key NEWCO personnel could be significant. Accordingly, this risk is likely to have serious impact if it were to occur.

Where the ISP is owner, it is assumed that the asset will be transferred back to NEWCO at fair market value (assumed net book value) after twenty years of operations. Due to potential, inaction, or uncontrollable market conditions, the eventual fair market value is likely to be different from predicted. The probability of this occurring is high, however the impact is considered only moderate at worst, especially if taking into consideration the impact in today's dollars. The condition of the asset at transfer is also highly dependent on the capital renewal and maintenance plan of the ISP. The greater influence that NEWCO has over these areas, the more likely the asset condition will maintain a higher value. Therefore, where the ISP is owner (and NEWCO has least control) the risk will be greatest.

4.2.1.2 Biomass Plant Analysis

The total risk scores for the biomass plant operations are:

Table 4.5 Risk Summary – Biomass Plant

	NEWCO Owns/ NEWCO Operates	NEWCO Owns/ ISP Operates	ISP Owns/ ISP Operates
Design and Construction Period	24	24	15
Operations and Transfer Period	13	12	20
Total Risk Score	**37**	**36**	**35**

With the lower score reflecting lowest risk, Option 3 is the lowest risk for the biomass plant. The following table shows the detailed scoring for the logging and feedstock ownership and operations options followed by a short narrative of the scoring rationale for each criterion.

Table 4.6 Risk Assessment – Biomass Plant

BIOMASS PLANT RISK ASSESSMENT (Low -1 , Medium - 2 , High - 3)	OPTIONS								
	NEWCO / NEWCO			NEWCO / ISP			ISP / ISP		
	Prob-ability	Sever-ity	Risk	Prob-ability	Sever-ity	Risk	Prob-ability	Sever-ity	Risk
DESIGN & CONSTRUCTION PERIOD									
Under or over designed (changes required to meet performance criteria or capex higher than necessary)	2	3	**6**	2	2	**4**	1	1	**1**
Constructability	2	2	**4**	2	2	**4**	1	1	**1**
Insufficient interest in RFP to stimulate competitive forces	2	3	**6**	2	3	**6**	1	3	**3**
Complexity of processes leading to increased time and cost	1	2	**2**	2	2	**4**	3	2	**6**
Permit/zoning risks	1	1	**1**	1	1	**1**	2	1	**2**
Scope / schedule creep	2	2	**4**	2	2	**4**	1	1	**1**
Default/breach of T&C's by consultants/contractors	1	1	**1**	1	1	**1**	1	1	**1**
Average Score			**24**			**24**			**15**
OPERATIONS & TRANSFER PERIOD									
Operational reliability standards not met	2	2	**4**	1	2	**2**	1	2	**2**
Operating cost variances	2	2	**4**	1	2	**2**	1	2	**2**
Electricity demand risk	1	1	**1**	1	2	**2**	1	2	**2**
Energy cost (feedstock) variation	1	1	**1**	1	1	**1**	1	1	**1**
Default/breach of T&C's by operator	1	1	**1**	1	3	**3**	1	3	**3**
Required maintenance not performed, diminishing value of asset	1	1	**1**	1	1	**1**	2	2	**4**
Market conditions change, increasing market value of the assets	1	1	**1**	1	1	**1**	3	2	**6**
Average Score			**13**			**12**			**20**
TOTAL RISK SCORE (**Lower** is better)			**37**			**36**			**35**

Following is an explanation of the scoring for each life-cycle category:

Design and Construction Period:

The options where NEWCO is owner has a considerably higher risk level than does the ISP as owner option. This is primarily attributable to NEWCO having minimal knowledge and experience related to biomass generation systems. Although Yukon Energy has generation expertise, they do not have specific biomass experience. This fact impacts the risk that the project is over or under designed and constructability of the project. It is also quite likely that risk pertaining to insufficient interest in the RFP tender will be higher where NEWCO is operator. Where an ISP is owner, the project represents a longer term project with larger cash flows making it more attractive. Where the risk level is higher for an ISP owned project is regarding the complexity of processes, due primarily to the asset transfer back to NEWCO after twenty years. This can significantly increase the time required and complexity of contractual negotiations compared to a more standard arrangement. Where the risk associated with scope and scheduling is concerned, the ISP owned project is much less risky due to the ISP having the responsibility for most construction risks. There is however the possibly with an ISP operated project that they breach some terms and conditions. However, as the project is of a longer term nature, and with larger overall cash flows (as owner and operator), it is less likely that an ISP would default or breach contract.

Operations and Transfer Period:

Converse to the design and construction period, the option where ISP owns the biomass plant is riskier than where NEWCO is owner. This is largely a result of the requirement for the plant to be transferred back to NEWCO after twenty years, and the uncertainty regarding the condition and value of the asset at that time. Potential, action or inaction, or uncontrollable market conditions, can cause the eventual fair market value of the plant to be different from predicted. The probability of this occurring is high, however the impact is considered only moderate especially considering the impact in today's dollars. With the condition of the asset at year twenty being highly dependent on capital renewal and maintenance of the plant, the more control NEWCO has over these areas, the more likely the asset condition will maintain a higher value, making an ISP owned project riskier than a NEWCO owned project. Other areas where an ISP owner/operator provides a greater risk to NEWCO is regarding a potential default and/or breach of the terms and conditions of the operating/transfer agreements. Although the agreements would most certainly contain recourse protection for NEWCO, a default or breach could still create problems and lost time by key NEWCO personnel.

The option where the ISP is the operator does provide a lower risk exposure for NEWCO where operational reliability and cost variances are concerned attributed to the ISP greater knowledge and experience with biomass systems. The risk of electricity demand is low regardless of who the owners is, due mainly to the small size of generation output. However, the severity of this risk will be greater where the ISP is operator as there is likely to be some form of contractual guarantee by NEWCO such as a take-or-pay agreement.

4.2.2 Risk Analysis Summary

The following table combines the three feedstock yard/logging and three biomass plant risk scores into a summary of the six possible options considered for these operations and ranks each option in terms of lowest risk.

Table 4.7 Risk Summary

	Feedstock Yard/Logging		Biomass Plant			
	Owner	Operator	Owner	Operator	TOTAL	RANKING
Option 1	NEWCO	CAFN	NEWCO	NEWCO		5
Risk Score	32		37		69	
Option 2	NEWCO	ISP	NEWCO	NEWCO		2
Risk Score	29		37		66	
Option 3	NEWCO	CAFN	NEWCO	ISP		4
Risk Score	32		36		68	
Option 4	NEWCO	ISP	NEWCO	ISP		1
Risk Score	29		36		65	
Option 5	ISP	ISP	NEWCO	NEWCO		6
Risk Score	33		37		70	
Option 6	NEWCO	CAFN	ISP	ISP		3
Risk Score	32		35		67	

Based on the analysis, Option 4 has the lowest risk profile. This option combines the benefits of NEWCO ownership control with the ISP industry specific operational expertise. Following very closely is Option 2, which substitutes NEWCO as operator for the biomass plant.

The deviation in scoring between the lowest and highest scores is five points (roughly 7%) suggesting that the risk profile deviation is not significant. Because of this, decision-making should be based on two criteria:

- Criteria 1 - The ability to control/mitigate the risks.
- Criteria 2 - The scale of the operation (0.5 MW versus 2.0 MW).

Referring back to the risk score summary previously provided in Table 1, it is clear that the risk profiles for NEWCO versus ISP as operator differ greatly between the design and construction and the operations and transfer periods. Where NEWCO is operator the greatest risk is during the design and construction stages while with an ISP as operator the greatest risk is during the latter (and longer) operations and transfer stages. The greatest risks for NEWCO in the design and construction stage are the unfamiliarity with both the feedstock yard/logging and biomass requirements whereas the greatest risks where an ISP is operator are primarily due to not having control over operations. Much of the design and construction risk can be effectively mitigated by contracting the project and construction management to consultants with specific expertise. However, countering this is the increase in operations risk, which occurs as the scale of the operations increase. For example, with a smaller scale 0.5 MW operation the risks of NEWCO operating the plant is relatively low whereas for a larger scale 2.0 MW plant this risk is much higher. For the feedstock yard and logging operations, where NEWCO has no experience, the risk is high regardless of the plant size.

4.2.3 Financial and Operational Analysis

The qualitative financial and operations analysis used has been developed as a complimentary extension of the risk analysis to highlight NEWCO/CAFN and ISP specific strengths or weaknesses in knowledge and experience that are important to both the feedstock yard/logging operations and the biomass plant operations. The analysis is

Scoring:

The financial and operations criteria are scored using a simple scale from 1 to 3 as follows:

1 = *Low* level of knowledge and/or experience.

2 = *Medium* level of knowledge and/or experience.

3 = *High* level of knowledge and/or experience.

A separate evaluation was done for both the feedstock yard/logging operations and for the biomass plant operations due to the distinctive nature of each. Both evaluations used the same seven criteria as follows:

- Design and construction experience.
- Operations and maintenance experience.
- Industry and regulatory experience.
- Environmental and sustainability experience.
- Access to experienced labor.
- Administrative requirements (impact on NEWCO).

- Management and control (impact on NEWCO).

4.2.3.1 Feedstock Yard/Logging Analysis

The total qualitative financial and operations score for the feedstock yard/logging operations are:

Table 4.8 Financial and Operations Analysis – Feedstock Yard/Logging

FEEDSTOCK YARD / LOGGING FINANCIAL AND OPERATIONS ANALYSIS	OPTIONS Score (Low -1 , Medium - 2 , High - 3)		
	NEWCO / CAFN	NEWCO / ISP	ISP / ISP
Design and construction experience	1	2	3
Operations and maintenance experience	1	3	3
Industry/regulatory experience	2	3	3
Environmental/sustainability experience	1	3	3
Access to experienced labor	1	3	3
Administrative requirements (to NEWCO)	3	2	1
Management and control (to NEWCO)	3	2	1
TOTAL SCORE (**Higher** is better)	**12**	**18**	**17**

Following is an explanation of the scoring for each criterion:

<u>Design and Construction Experience:</u>

Design and construction of the feedstock yard/logging is an area where a slight advantage is held by the ISP due to their significant knowledge and experience specific to the industry. Although NEWCO will procure the design and construction from outside sources, they will still be required to ultimately oversee and approve design and construction. Where the ISP is operator but not owner, there could be benefit with them providing their experience as part of the design stage, but likely not during construction.

<u>Operations and Maintenance Experience:</u>

The ISP, with specific industry knowledge and experience will have a very significant advantage over NEWCO/CAFN who has minimal knowledge and experience in logging and biomass feedstock operations.

Industry Regulatory Experience:

The ISP, with specific industry knowledge and experience will have a significant advantage over NEWCO/CAFN who has minimal knowledge and experience in regulations pertaining to logging.

Experience in Environmental/Sustainability:

The ISP, with specific industry knowledge and experience will have a significant advantage over NEWCO/CAFN who have very minimal knowledge and experience in environmental and sustainability matters related to logging. Knowledge and experience in environmental and sustainability matters is fast becoming a critical requirement for businesses of all types.

Access to Experienced Labor:

The ISP, due to their presence in the feedstock yard/logging industry will also have good access to experienced labor while it is very unlikely that NEWCO/CAFN will have access to this type of skilled labor. Having access to skilled operators and maintenance staff is critical to reliability and efficient operations of the logging and feedstock operations. An advantage for a large ISP will be access to their own overall labor pool which may be deeper and more specialized. This provides added assurance where training, specialization and emergency staff replacement requirements are concerned.

Lower Administrative requirements (to NEWCO)

A disadvantage to outsourcing operations to an ISP is the increased administration burden required to oversee initial negotiations and the ongoing management of the contractual terms and conditions and the general relationship with the ISP. For the NEWCO owns and CAFN operates option there is minimal partnering so this is not a big issue. Where NEWCO owns and an ISP operates there is added administration for the ISP operating agreement. Where the ISP both owns and operates the transfer of assets back to NEWCO will require the most administrative resources for NEWCO.

Management and Control (to NEWCO):

The more ownership and responsibility for operations that NEWCO undertakes, the more management and control they will have. For the ISP own and operate option, NEWCO has little or no control over the physical assets and operations, however they do have contractual control inherent in the terms and conditions of the operations and transfer back agreements.

4.2.4 Biomass Plant Analysis

The total qualitative financial and operations score for the biomass plant operations are:

Table 4.9 Financial and Operations Analysis– Biomass Plant

BIOMASS PLANT FINANCIAL AND OPERTIONS ANALYSIS	OPTIONS Score (Low -1 , Medium - 2 , High - 3)		
	NEWCO / CAFN	NEWCO / ISP	ISP / ISP
Design and construction experience	1	2	3
Operations and maintenance experience	1	2	3
Energy industry/regulatory experience	2	3	3
Environmental/sustainability experience	2	3	3
Access to experienced labor	1	2	3
Administrative requirements (to NEWCO)	3	2	1
Management and control (to NEWCO)	3	2	1
TOTAL SCORE (**Higher** is better)	13	16	17

Following is an explanation of the scoring for each criterion:

Design and Construction Experience:

Design and construction of the biomass plant is an area where a slight advantage is held by the ISP due to their significant knowledge and experience specific to the biomass industry. Although NEWCO has generation experience and will procure the design and construction from outside sources, they will still be required to ultimately oversee and approve design and construction. In the option where NEWCO owns and an ISP operates there could be some benefit with an ISP providing their experience as part of the design stage, but likely not during construction. Under Option 3, an ISP who has designed and constructed numerous biomass plant systems to satisfy many different requirements undoubtedly will have greater advantage and can be relied on to “get it right” with little to no risk.

Operations and Maintenance Experience:

NEWCO has good in-house capabilities via Yukon Energy but biomass systems would be new to the existing team. An ISP will draw on their significant capabilities to provide greater knowledge, innovation and solutions to problems that may arise.

Energy Industry/Regulatory Experience:

NEWCO has no energy and regulatory experience but is assisted by having Yukon Energy as a partner. The option where an ISP partners with NEWCO adds additional experience. Finally, an ISP, with specific biomass knowledge and experience is best equipped in specific biomass matters.

Experience in Environmental/Sustainability:

Knowledge and experience in environmental and sustainability matters has become a critical requirement for businesses of all types. In the utilities sector, an ISP brings the breadth and depth of knowledge and experience in these areas that NEWCO has only by way of the partnership with Yukon Energy. Adding the ISP experience to NEWCO would provide a similar level of expertise as an ISP can offer in these important areas.

Access to Experienced Labor:

Having access to skilled operators and maintenance staff is critical to reliability and efficient operations of utility systems. NEWCO has a well-trained staff via Yukon Energy. An advantage for an ISP will be their access to their own overall labor pool which may be deeper and more specialized, especially with biomass systems. This provides added assurance where training, specialization and emergency staff replacement requirements are concerned.

Lower Administrative Requirements (to NEWCO):

A disadvantage to outsourcing operations to an ISP is the increased administration burden required to oversee initial negotiations and the ongoing management of the contractual terms and conditions and the general relationship with the ISP. For the NEWCO owns and CAFN operates option there is minimal partnering so this is not a big issue. Where NEWCO owns and an ISP operates there is added administration for the ISP operating agreement. Where the ISP both owns and operates the transfer of assets back to NEWCO will require the most administrative resources for NEWCO.

Management and Control (to NSUH):

The more ownership and responsibility for operations that NEWCO undertakes, the more management and control they will have. For the ISP own and operate option, NEWCO has little or no control over the physical assets and operations, however they do have contractual control inherent in the terms and conditions of the operations and transfer back agreements.

Financial and Operations Analysis Summary:

The following table combines the three feedstock yard/logging and three biomass plant financial and operations analysis scores into a summary of the six possible options considered for these operations and ranks each option in terms of lowest risk.

Table 4.10 Financial and Operations Summary

	Feedstock Yard/Logging		Biomass Plant			
	Owner	Operator	Owner	Operator	TOTAL	RANKING
Option 1	NEWCO	CAFN	NEWCO	NEWCO		6
Score	12		13		25	
Option 2	NEWCO	ISP	NEWCO	NEWCO		2
Score	18		13		31	
Option 3	NEWCO	CAFN	NEWCO	ISP		5
Score	12		16		28	
Option 4	NEWCO	ISP	NEWCO	ISP		1
Score	18		16		34	
Option 5	ISP	ISP	NEWCO	NEWCO		3
Score	17		13		30	
Option 6	NEWCO	CAFN	ISP	ISP		4
Score	12		17		29	

Similar to the risk analysis, Option 4 places highest with Option 2 again being second. This is a confirmation of the importance of having industry experience specific to the feedstock yard/logging and biomass industries. Overall the deviation in scoring between the lowest and highest scores is ten points (roughly 29%) indicating that the industry experience is very critical to success. The difference between Option 4 and Option 2 is a much lower three points (8%) which indicates that NEWCO operating the biomass plant is less critical than having an ISP operate the feedstock yard/logging operations. This is logical as NEWCO has power generation knowledge, which, although not biomass specific, is at least beneficial where a smaller 0.5 MW operation is concerned, but would be less so where the plant size increases to 2.0 MW.

4.2.5 Summary of Analyses

Option 4 (NEWCO owns/ISP operates) ranks first in both the risk analysis (Table 5) and the financial and operations analysis (Table 8). However, following closely is Option 2 where NEWCO operates the plant. This is especially applicable where a smaller 0.5 MW plant is concerned.

The risk and financial and operations analysis demonstrates that “control”, “experience” and “scale” have the greatest impacts on risk and ultimately project success. NEWCO benefits greatly where they have most control over operations. However, total control also comes at the expense of not having the benefit of the ISP industry experience. Option 4 provides a trade-off where the lack of experience is addressed via an ISP. However, if the operation will be a smaller scale 0.5 MW plant, the benefit of an ISP operating the plant will not be as great, meaning that NEWCO should be able to operate the plant without much risk.

4.2.6 Conclusion

Applying this analysis to the size and scale of the biomass operation, the following ownership and operations models are the most appropriate for a smaller (0.5 MW) and larger (2.0 MW) plant operation.

Table 4.11 Recommended Owner/Operator Model

	Feedstock Yard/Logging		Biomass Plant	
Plant Size	**Owner**	**Operator**	**Owner**	**Operator**
0.5 MW	NEWCO	ISP	NEWCO	NEWCO
2.0 MW	NEWCO	ISP	NEWCO	ISP

As stated in the assumptions earlier in the report, where the ISP is the operator, the intention would be to increasingly employ workers from CAFN and provide training over a set period of time (i.e. 20 years).

4.3 FINANCIAL ANALYSIS

Using the preliminary engineering designs, financial analyses were prepared to determine the financial viability of the various installation scenarios. The results of these analyses are presented and explained in the following tables and charts.

It is important to note that the financial analyses do not currently include the capital cost for the district heating network. The capital cost for the installation of the network has been assumed to be covered under a separate project to be completed in conjunction with the biomass plant. The financial analyses do account for the O&M and revenue from operating the biomass plant in conjunction with the network (i.e., selling heat through the network)

The financial analyses were performed on multiple scenarios based on biomass plant size, building architecture, and vendors. Although only four options have been outlined in previous sections, ten different options were investigated for the financial analyses. Options #1 through #6 are all based on the technology offered by Community Power Corporation using the preliminary engineering parameters discussed previously. The details of Options #1 through #6 are detailed below:

- Option #1 – Full Building Enclosure – 500 kW_e (Community Power Corp.).
- Option #2 – Full Architectural Enclosure – 500 kW_e (Community Power Corp.).
- Option #3 – Fuel Handling Enclosed – 500 kW_e (Community Power Corp.).
- Option #4 – Options for Expansion – 1 MW_e (Community Power Corp.).
- Option #5 – Options for Expansion – 2 MW_e (Community Power Corp.).
- Option #6 – Options for Expansion – 3 MW_e (Community Power Corp.).

Due to the savings in capital costs, the equipment provided by Proton Power was also analyzed, as described in Options #7 through #10 below. Options #7 through #10 are based on the replacing the CPC equipment with that provided by Proton Power. It should be noted that Proton Power has indicated it has the ability to provide containerized systems, but has not completed a project using this format to date (see Figure 4.1).

- Option #7 – Full Building Enclosure – 500 kW_e (Proton Power).
- Option #8 – Full Architectural Enclosure – 500 kW_e (Proton Power).
- Option #9 – Fuel Handling Enclosed – 500 kW_e (Proton Power).
- Option #10 – Options for Expansion – 2 MW_e (Proton Power).

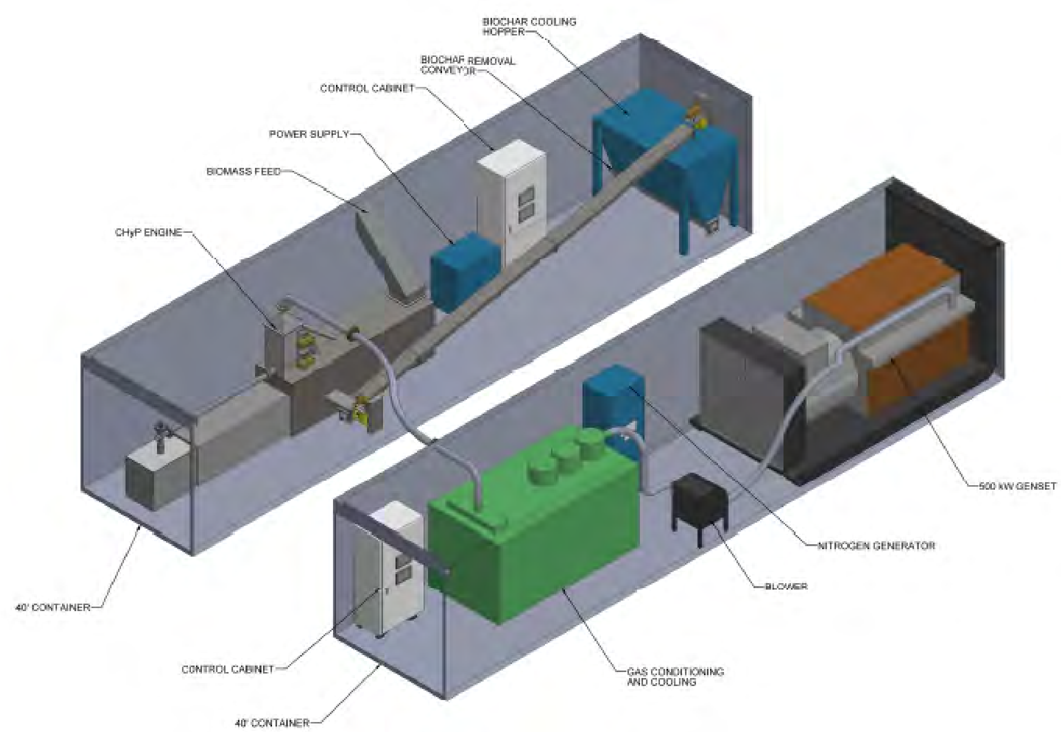


Figure 4.1 Potential Proton Power Containerized 500 kW_e Units

The primary difference between the inputs associated with CPC (Table 4.12) and those associated with Proton Power (Table 4.13) are the equipment costs and capacity factors (CPC has an 80% factor, Proton 92.5%). All other inputs remain the same, though in reality some variances may occur regarding the O&M costs.

Table 4.12 Financial Inputs: Options #1 - #6

Item	Option #1 500 kW_e	Option #2 500 kW_e	Option #3 500 kW_e	Option #4 1000 kW_e	Option #5 2000 kW_e	Option #6 3000 kW_e
CAPEX ($ Million)	$12.7	$13.5	$11.4	$22.5	$45.0	$67.5
Annual Fuel Consumption (ODT/yr)	3,000	3,000	3,000	6,000	12,000	18,000
Power (MWh/yr)	3,500	3,500	3,500	7,000	14,000	21,000
OPEX ($)	$285,000	$285,000	$285,000	$400,000	$630,000	$800,000

Table 4.13 Financial Inputs: Options #7 - #10

Item	Option #7 500 kW_e	Option #8 500 kW_e	Option #9 500 kW_e	Option #10 2000 kW_e
CAPEX ($ Million)	$8.5	$9.2	$7.3	$26.6
Annual Fuel Consumption (ODT/yr)	3,472	3,472	3,472	13,888
Power (MWh/yr)	4,052	4,052	4,052	16,208
OPEX ($)	$285,000	$285,000	$285,000	$630,000

In order to complete the financial analysis, several financial parameters needed to be defined. The financial assumptions outlined in Table 4.14 were employed to support this study. Assumptions for amortization, tax rate, and escalation are made on a consistent basis for all scenarios to facilitate comparison (Table 4.14). NEWCO's discount rate and electricity purchase price were assumed for the study.

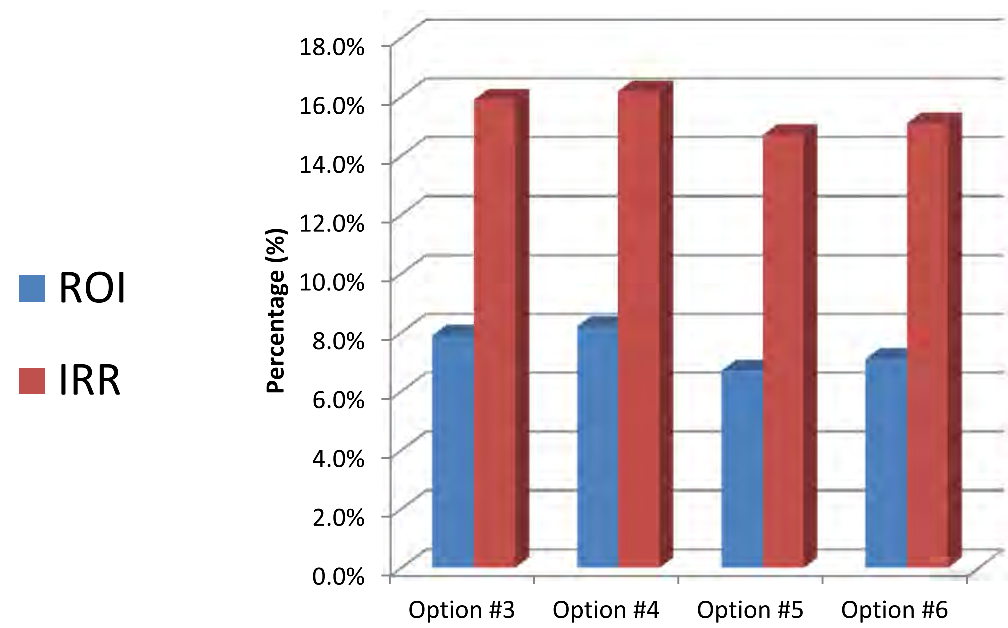
Using the base financial assumption, none of the ten (10) options proves viable. Each has ROE/ROI/NPVs that are negative. The main opportunity explored to make the options viable was to add a capital subsidy with could be achieve through funding grants. The amount of capital subsidy was taken as a percentage of total project costs to conduct this sensitivity.

Table 4.14 Financial Assumptions

Financial Assumptions			
Amortization:	Declining Balance:	20	Years
	Plant:	50.0	% (w/accelerated CCA class 43.2)
	Buildings:	4.0	% (w/CCA class 1)
	Equipment:	30.0	% (w/CCA class 43)
Capital Renewal Annual Rate:	Plant:	4.0	%
	Buildings:	2.0	%
	Equipment:	6.0	%
Weighted Average Cost of Capital:	WACC:	8	%
Inflation:	Annual Escalation:	3.0	%
	Feedstock Inflation Rate:	1.0	%
Equity:	NEWCO:	30	%
Long Term Debt :	Interest Rate :	5	%
Capital Subsidy (as % of Total Project):			
	Funding Low:	0	%
	Funding High:	80	%
Base Fuel Pricing:			
	Biomass:	Omitted	$/GMT
Biomass Power Sale Price:			
	Base:	$200	$/MWh
Biomass Heat Sale Price :			
	Base:	$185	$/MWh

The results of the financial analysis are provided in Table 4.15 in graphical and tabular form. The values of ROI and IRR were estimated using an assumed feedstock price of $50/GMT, 80% capital subsidy and an electricity selling price of $0.20/kWh, for a select number of options.

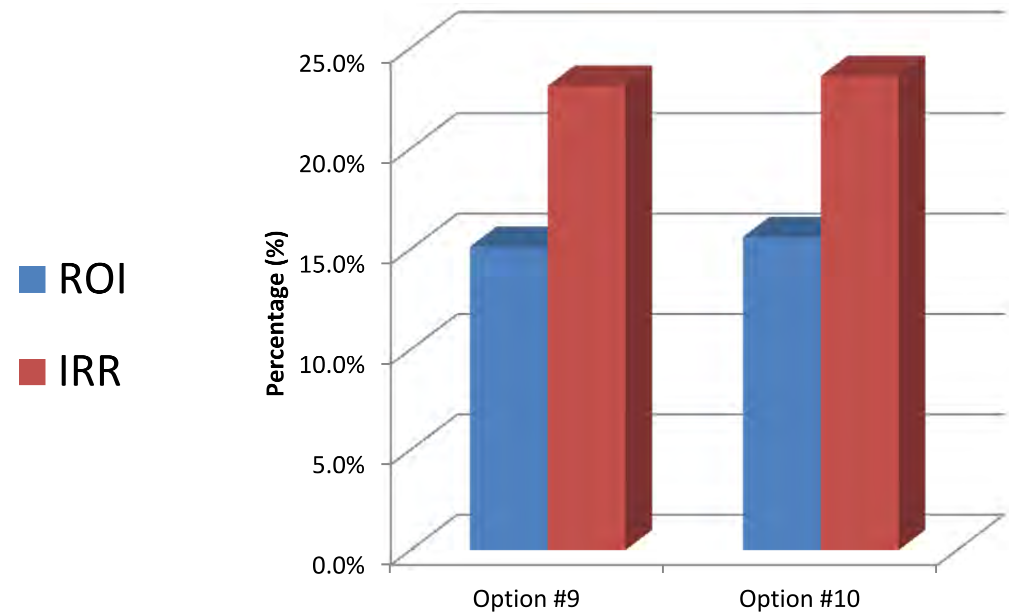
Table 4.15 Biomass Plant Return on Investment Performance: CPC



	Item	Option #3 – 500 kW_e Fuel Enclosed $50/GMT, $200/MWh, 80% Capital Subsidy
500 kW_e	Return on Investment (ROI)	7.9%
	Internal Rate of Return (IRR)	15.9%
1.0 MW_e	**Item**	**Option #4 - 1 MW_e Fully Enclosed $50/GMT, $200/MWh, 80% Capital Subsidy**
	Return on Investment (ROI)	8.2%
	Internal Rate of Return (IRR)	16.2%
2.0 MW_e	**Item**	**Option #5 - 2 MW_e Fully Enclosed $50/GMT, $200/MWh, 80% Capital Subsidy**
	Return on Investment (ROI)	6.7%
	Internal Rate of Return (IRR)	14.7%
3.0 MW_e	**Item**	**Option #6 - 3 MW_e Fully Enclosed $50/GMT, $200/MWh, 80% Capital Subsidy**
	Return on Investment (ROI)	7.1%
	Internal Rate of Return (IRR)	15.1%

Similar to the CPC ROI performance, the Proton Power could also reach positive ROIs with capital subsidy, although require significantly less due to their lower capital cost (note that only the 2 MW_e system was investigated for Proton Power and not 1 MW_e or 3 MW_e).

Table 4.16 Biomass Plant Return on Investment Performance: Proton Power



	Item	Option #9 – 500 kW_e Fuel Enclosed $50/GMT, $200/MWh, 67% Capital Subsidy
500 kW_e	Return on Investment (ROI)	15.1%
	Internal Rate of Return (IRR)	23.1%
2.0 MW_e	**Item**	**Option #10 – 2000 kW_e Fuel Enclosed $50/GMT, $200/MWh, 67% Capital Subsidy**
	Return on Investment (ROI)	15.6%
	Internal Rate of Return (IRR)	23.6%

As seen in the following two figures (Figures 4.2 and 4.3), the most viable options from each vendor in terms of ROE at the 0.5 MW_e capacity are CPC's Option #3 and Proton's Option #9. These refer to the plants with only fuel enclosure which have the lowest capital cost for this capacity. Therefore, the sensitivity analyses will only concentrate on these two options as book ends for project viability.

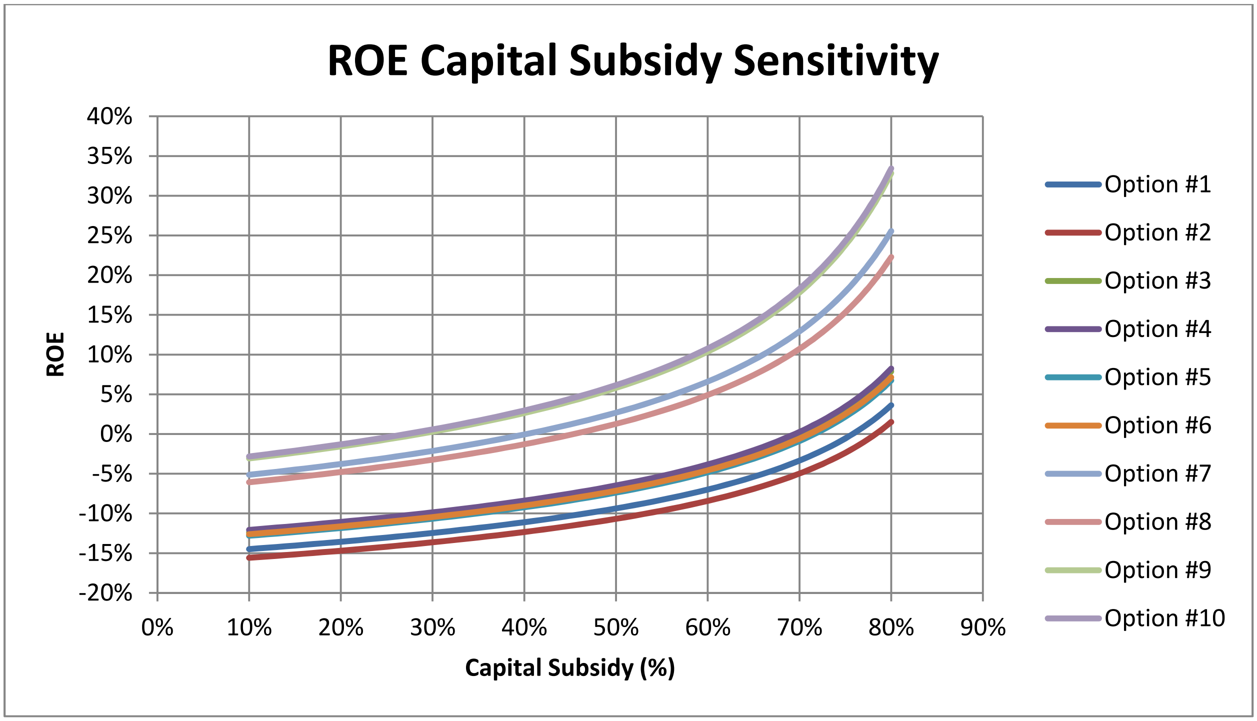


Figure 4.2 ROE Capital Subsidy Sensitivity

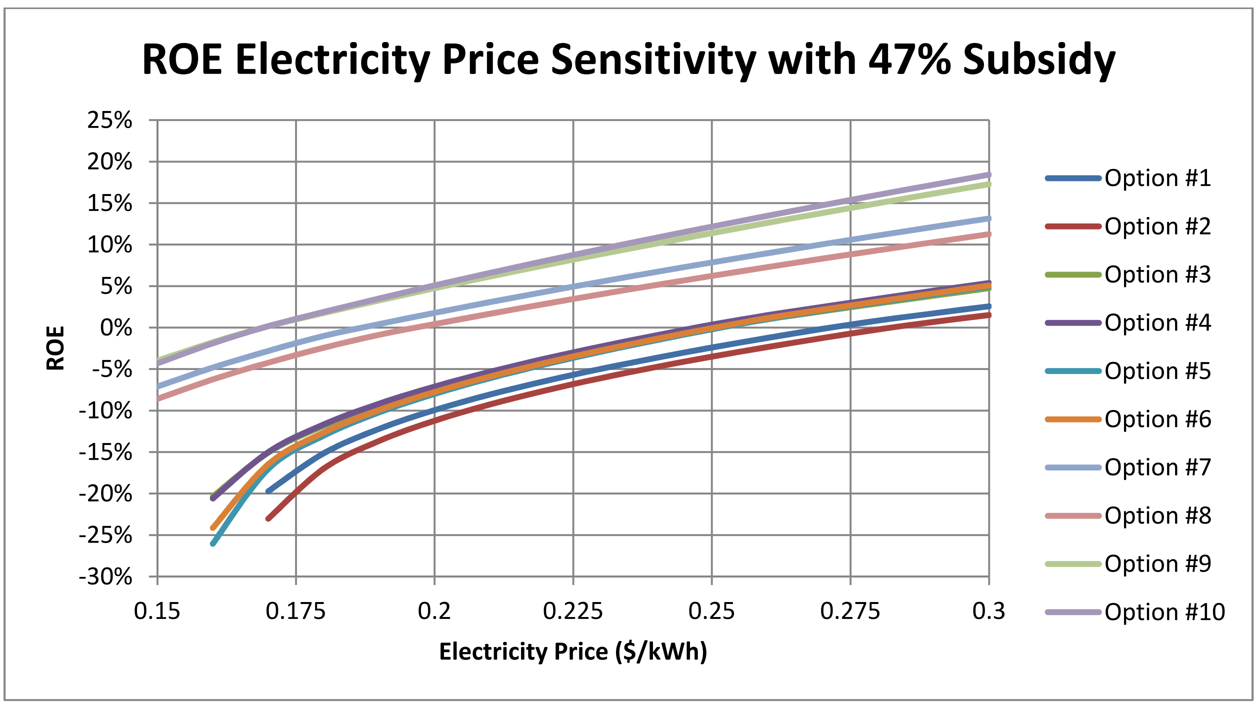


Figure 4.3 ROE Electricity Price Sensitivity

The previous figures also indicate the level of capital subsidy and/or electricity sale price required to achieve a desired ROE of 15%. In Figure 4.2, each option has no capital subsidy, and each option shows its lack of an ROE. As subsidies are increased, the Proton Power options pass over the 0% ROE mark with 30-40%subsidy, and achieve a 15% ROE at 67% for Option #9 and #10. The CPC options only start into positive ROE territory beyond the 70% subsidy mark.

In Figure 4.3, a combination of capital subsidy and increase in electricity sale price are considered to achieve a 15% ROE. The curves are based on the project achieving a 47% capital subsidy, and highlighting the impact of increasing the electricity sale price. For the best case scenario with Proton Power's Option #9, the electricity sale price would have to increase from $200/MWh to $280/MWh, to achieve the 15% ROE. For CPC, the project would only achieve a 5% ROE with 47% subsidy and a $300/MWh sale price.

4.3.1 Sensitivity Analyses

Four (4) additional variables affecting the success of biomass plant are fuel costs, O&M costs, district heating sales, and the district heating sale price. In order to understand the impact of these four (4) variables on the successful outcome of the installation, a range for each was considered and plotted based on impact to ROI and NPV. Each sensitivity analysis is presented in the following sub-section by variable, for each vendor.

4.3.1.1 Feedstock Price

For the two cases with fuel enclosures, Figure 4.4 was prepared to highlight the ROI and NPV for fuel costs from $50/GMT to $175/GMT. Fuel costs are market driven and subject to change outside the control of the facility design.

Similar to capital subsidy and electricity pricing, the project viability is strongly related to the feedstock pricing. Although there is no feedstock price that helps any option achieve a better financial viability, an increase to feedstock prices higher than would be available from existing operations (low end of the sensitivity, $50/GMT) would be detrimental to any gains from capital subsidy – doubling feedstock cost reduces ROE of Proton Power by half, to 7.5%.

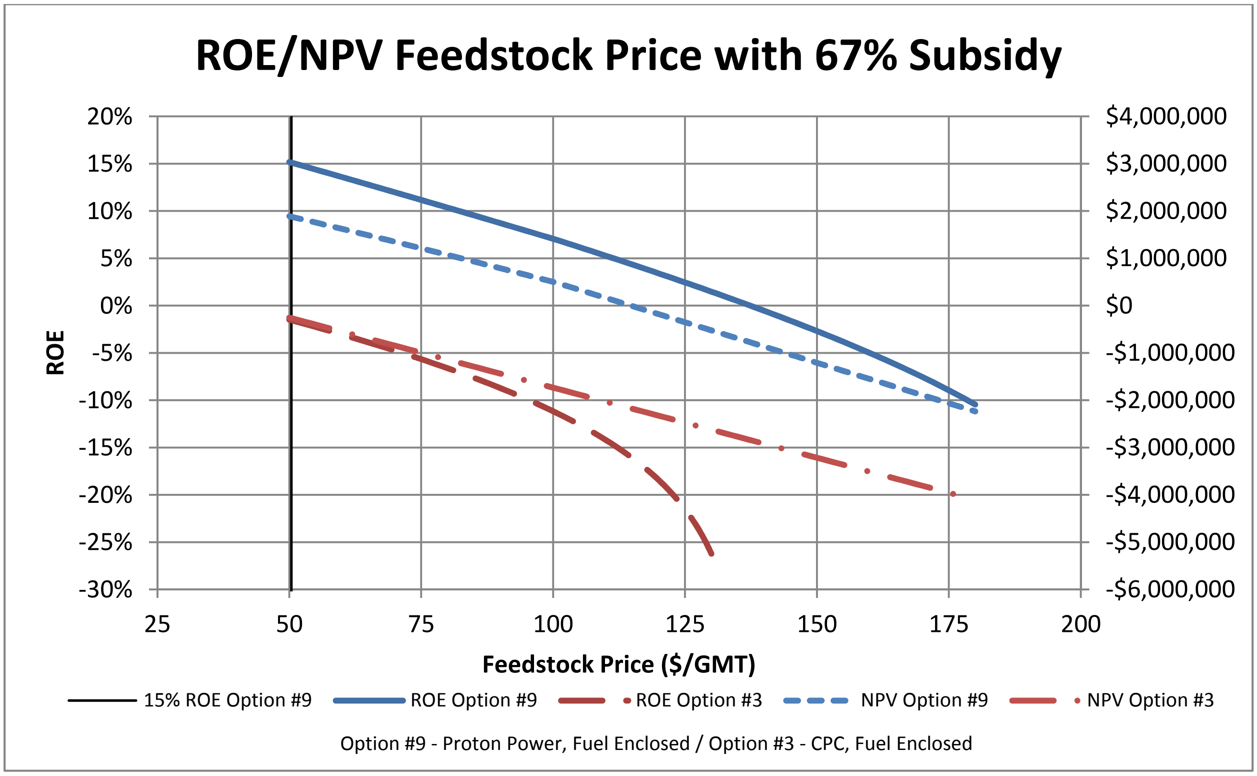


Figure 4.4 ROE/NPV Feedstock Price Sensitivity

4.3.1.2 Other Variables

For the two cases with fuel enclosures, Figure 4.5, 4.6, and 4.7 were prepared to highlight the ROI and NPV for plant O&M costs from $125,000 to $500,000 annually, district heating sales from 1,000 to 2,000 MWh annually, and district heating sale price from $110 to $250 / MWh. This variable are subject to change based on the facility/network design and vendor selected. The O&M costs in Figure 4.5 focuses on O&M specific to operating the biomass gasification system, O&M for the DH network and ORC are not considered.

Variations in O&M costs will affect the project's ROE by approximately 2.5% for every $50,000 annual. Similarly, an increase in DH sales by 500 MWh per year would increase the ROE by 2.5%. As the DH network is only projected to sell 1280 MWh/year, and the gasifier rejects over 5,000 MWh/year, the opportunity exists to expand the network in the future for increased sales.

The DH sale price in Figure 4.7 shows the impact of a variation in the sale price for 1,280 MWh per year. Currently valued based on the CTCG report at $185/MWh, this price will likely need to be indexed based on diesel fuel prices when the project is implemented. Current price offers a 2% savings over diesel.

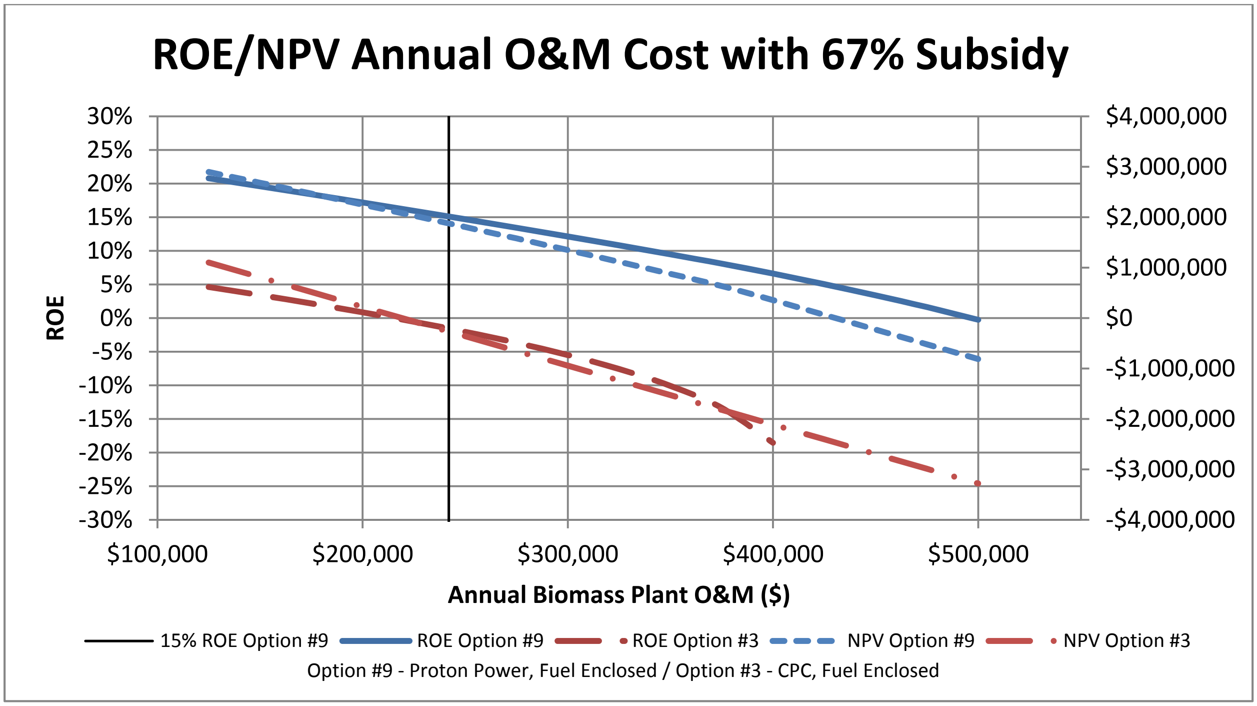


Figure 4.5 ROE/NPV Annual Plant O&M Price Sensitivity

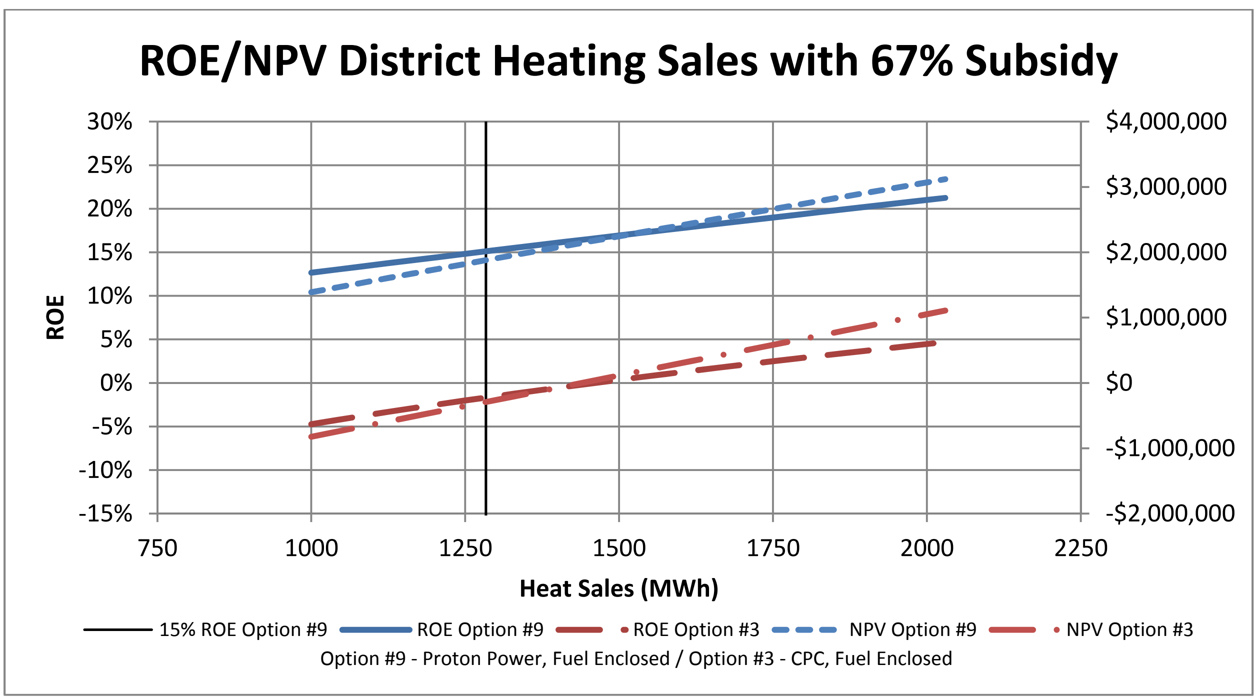


Figure 4.6 ROE/NPV District Heating Sales Sensitivity

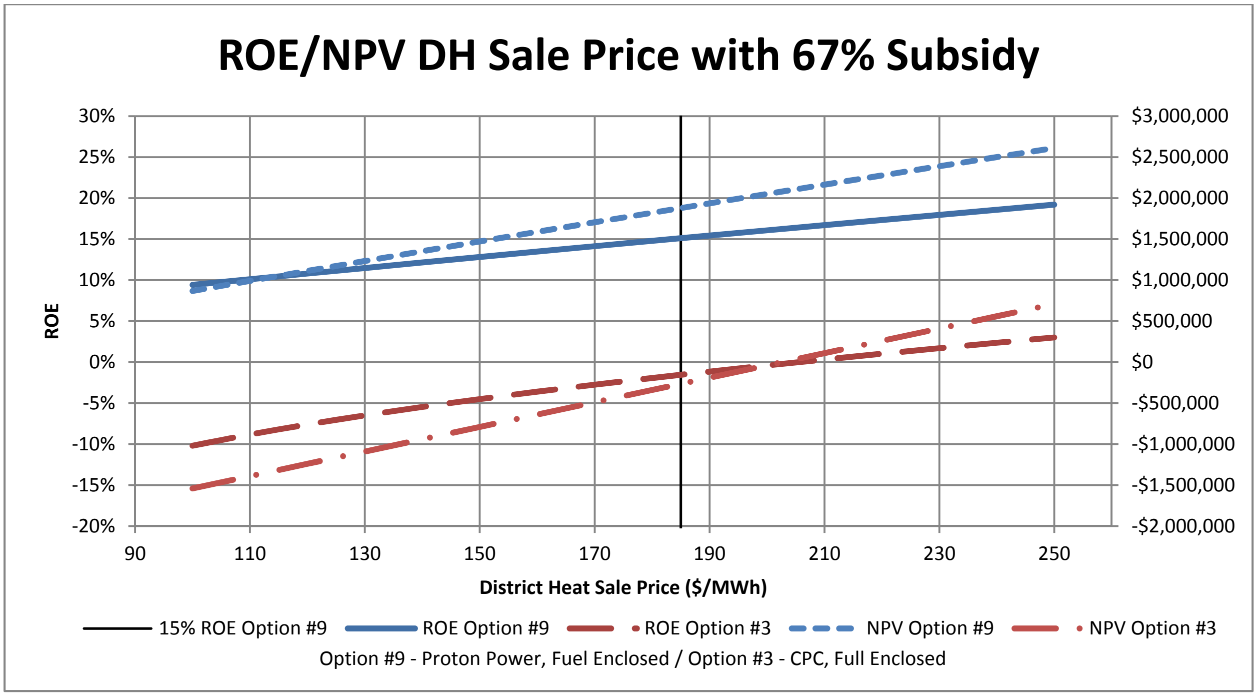


Figure 4.7 ROE/NPV District Heating Sale Price Sensitivity

4.3.1.3 Tornado Diagram

The figure on the following displays the impact of these key variables in a different manner. Figure 4.8 shows the results of independently adjusting the seven (7) key variables by ± 20% on the project ROE. The centerline of the graph represents the 15% ROE set point for Option #9 with 67% subsidy, while each bar is indicative of the positive or negative change in ROE resulting from a ± 20% change in a given variable. Table 4.17 shows the corresponding change in NPV for each variable as well as the specific ROE percentage. The variables are arranged from the most significant to the least significant based on the magnitude of their impact.

It is evident from Figure 4.8 that the most significant variable on the success of the project is the amount of capital subsidy provided, followed by electricity price potential, both discussed previously. Following these two factors, by decreasing influence, are project capital cost, plant O&M cost, district heat sale price, district heat annual sales and feedstock price.

The results of this analysis suggest that during the next level of study it will be vital to secure capital subsidies and or increases to the electricity sale price, as these are the greatest deciding factors in the outcome of the project. Further project definition through engineering can aid in acquiring a definitive value for capital and operating costs, as well as support firming up the DH system design and waste heat sale potential.

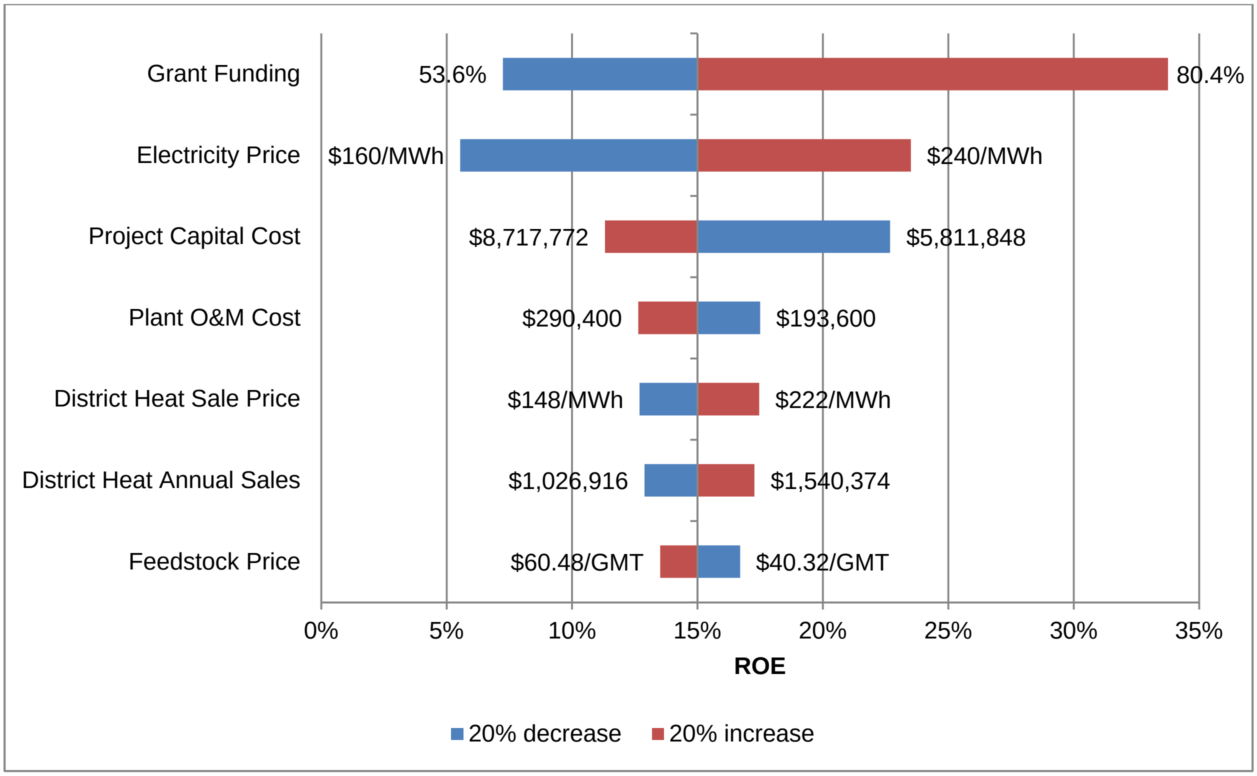


Figure 4.8 ROE/NPV District Heating Sale Price Sensitivity

Table 4.17 Tornado Diagram Results

	Variation	ROE	NPV
Grant Funding	+20%	33.76%	$2,804,710
	-20%	7.24%	$953,761
Electricity Price	+20%	23.51%	$3,233,005
	-20%	5.54%	$309,701
Project Capital Cost	+20%	11.31%	$1,548,366
	-20%	22.68%	$2,306,406
Plant O&M Cost	+20%	12.64%	$1,439,168
	-20%	17.50%	$2,306,886
District Heat Sale Price	+20%	17.46%	$2,298,968
	-20%	12.69%	$1,447,476
District Heat Annual Sales	+20%	17.27%	$2,312,515
	-20%	12.89%	$1,435,633

5.0 Next Steps

The FEED report outlines a series of challenges that exist for the project to be successful, whether it is feedstock security, technology risk or cost, or the need for financial support to bring the project to a reality. No project is without its challenges and, if financial support can be found, mitigation strategies could be developed to address requirements of regulators, enhanced policies (feedstock procurement) and the technical risks associated with the demonstration nature of the project.

Should the project partners decided to pursue the project to the next level of development to realize the potential for biomass gasification in the Yukon, the following sub-section outlines general tasks that would be required and a project implementation schedule.

5.1 NEXT LEVEL OF DEVELOPMENT

Looking beyond the conclusion of the FEED study, considered to be Phase 1 of the project, each area of the FEED will require additional work to bring greater definition and certainty to the project viability and requirements for support. With the completion of the FEED study, the project definition began to take shape but additional work and refinement needs to take place. To support bringing the project definition to the next level of study, work in each area of the project needs to be completed. The following statement of work includes, but is not limited to, phases of study to be completed ahead of detailed engineering and construction.

Phase 2 – Feedstock

Initial indications from the FEED show the potential to source feedstock from local sawmill and harvesting operations. The feedstock supply logistics and business models for this supply will have to be further refined in order to make the decision to proceed with detailed engineering.

- Procurement Logistics and Strategy.
    - Supplier Business Model.
    - Storage location options and retrieval*.
    - Chipping options and locations*.
    - Site Visits to Existing Operations.
    - Input to design.
    - Develop moisture content strategies*.
    - Alternative sources.

- Regulatory.
    - Security of supply w FMB*.
    - Confirm Strategy (who needs to be up to speed)*.
    - Regulatory approvals before EOI*.
- Procurement.
    - Expression of Interest (EOI) to Supply 500 kWe Plant*.
    - EOI Preparation*.
    - EOI Issued*.
    - Letters of Interest (LOI) Returned*.
    - LOIs Reviewed*.
    - Feedstock Assessment & Costing.
    - Procurement Plan.
    - Private Shortlisted Request for Proposal.
    - Formal Firm Proposals.
    - Procurement Contracting.

** Short-term items to support business case development (Phase 4)*

Phase 3 - Environmental Permitting

Based on the FEED study assessments completed, the current expectation is for a DO level assessment by YESAB. This needs to be confirmed and the proper impact assessment completed accordingly (including field studies, public consultation).

- Scoping Meeting with YESAB*.
- Field Surveys and Technical Analyses.
    - Wildlife and Wildlife Habitat (migratory birds, bats).
    - Wetlands and Vegetation.
    - Land Use/Traditional Use Consultation in Community (siting).
    - Archaeological and Heritage Resources.
- Impact Assessment Report.
    - Prepare Draft DO Proposal for Internal Review.
    - Client Review Period.
    - Preparation of Regulatory Draft DO Proposal.
    - Adequacy Review.
    - Respond to Information Requests from Adequacy Review.
    - DO Reviews Responses.

- Seeking Views and Information (public consultation).
- DO Reviews input from SVI.
- Potential further Information Requests.
- DO Prepares/Issues Recommendation or Referral.

- Permit Applications.

  - Community and Stakeholder Engagement*.
  - Prepare other Applications and Submit to Decision Bodies.
  - Decision Bodies Receive Recommendation from DO.
  - Review and Consideration by Decision Bodies.
  - Decision Bodies Issue Permits.

** Short-term items to support business case development (Phase 4)*

Phase 4 - Bridging Engineering & Business Case

The engineering and business case assessment completed as part of the FEED study provide direction on project approach and defined the project to the extent possible. With the knowledge gained, the next level of study can be completed ahead of detailed engineering to provide a Class 3 opinion of probable capital and operating costs as well as associated business case.

- Project Management & Local Support.

Bridging Engineering

- Engineering Design to support Waste Heat Integration.

  - Identification of buildings for the district heating network.
  - Contact building owners/operators to determine hook-up potential and assessment of current heat loads.
  - On-site assessment of buildings to determine building infrastructure requirements for energy transfer stations.
  - Heat load assessment to determine system sizing and which building to include in the network.
  - Prepare system design including but not limited to:
    - Main, distribution, and branch line sizing.
    - System control and metering infrastructure.
    - Energy transfer station sizing for each building.
  - Drawing and design package to support the development of a AACE Class 3 opinion of probable capital and operating cost for the system.

- Engineering Design to support Facility Design:
  - Gasification technology:
    - Develop and issue firm Request-for-Proposal for 500 kWe gasification technology.
    - Conduct bid comparison and select vendor for engineering design.
    - Plant design to support technology, grid interconnection, district heating interconnection, and fuel receiving.
  - Finalize site location:
    - Dependent on heating network design and feedstock storage requirements.
    - Conduct open house to solicit public input.
    - Select location, determine infrastructure requirements (grid interconnection, water/sewer), confirm land ownership and tax implications.
  - Materials Handling:
    - Confirm on-site/enclosed feedstock storage requirements.
    - Finalize fuel storage and reclaim method (loaders/bin, walking floor, other).
    - Support design, sizing and tie-in with selected technology vendor.
  - Plant Auxiliaries:
    - Confirm building/room sizing and infrastructure tie-in requirements.
    - Building services (lighting, HVAC).
  - Drawing and design package to support the development of an AACE Class 3 opinion of probable capital and operating cost for the system.
  - Project implementation schedule through to commercial handover.

Business Case

- Project support to develop business case, including:
  - Input into owner's applications for funding.
  - Determine model for heat sales and draft heat sale contract.
- Finalize business model and case as engineering is concluded, including:
  - Ownership model.
  - Sensitivity analyses.

Phase 5 - Detailed Engineering and Procurement

Phase 6 & 7 - Construction, Commissioning, Start-up, Commercial Handover

5.2 IMPLIMENTATION SCHEDULE

If the decision were made to proceed with the next level of development, three of the phases outlined above would need to start in 2013. Feedstock assessment will need to be further defined and support the requirements of the YESAB submission for the project. In future years, the feedstock procurement strategy and final supply contracts will be critical project components. Environmental permitting will also need to begin in 2013 with a consultation with YESAB to ensure the project can proceed with a D.O. level screening and establish requirements for field studies, modelling, and other areas deemed critical. The environmental team will also support the public and First Nations consultation process on an on-going basis. The main driver for project refinement in 2013 will be the bridging engineering and business case refinement. This work, outlined above, will provide greater clarity to the facility design (looking at firm vendor quotes and cost savings measures) to arrive at a Class 3 opinion of probable capital cost. On the business case side, it will be necessary to secure draft heat contracts and power purchase pricing to provide greater certainty to future revenue streams. Confirmation of the potential revenue, along with plant and feedstock costing will facilitate the development of a more sound business case.

A high-level implementation schedule is presented in Table 5.1 for consideration. A more detailed potential implementation schedule (Gantt Chart) is presented in Appendix K.

The schedule in Appendix K represents a fast track schedule to indicate the scope of each phase and its earliest possible completion. Table 5.1 relaxes the need to complete more detailed feedstock activities and environmental permitting tasks (field studies) until 2014 instead of 2013. This reduces upfront costs, and facilitates further refinement of the business model ahead of proceeding with detailed engineering and ordering of equipment.

Table 5.1 Implementation Schedule

Phase	Task Description	2013	2014	2015	2016
2	**Feedstock**				
3	**Environmental Permitting-DO Level**				
4	**Bridging Engineering & Business Case**				
5	**Detailed Engineering and Procurement**				
6	**Construction**				
7	**Start-up & Commissioning**				

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7.0 Appendices

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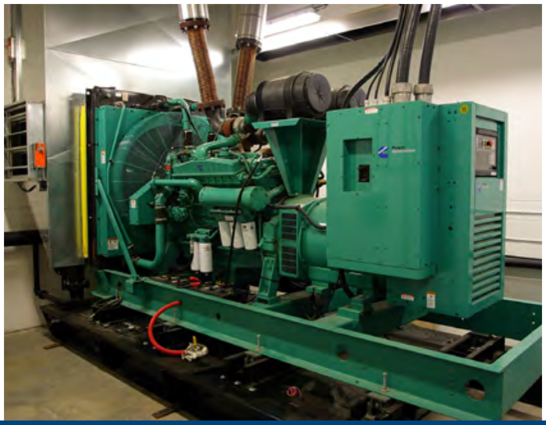
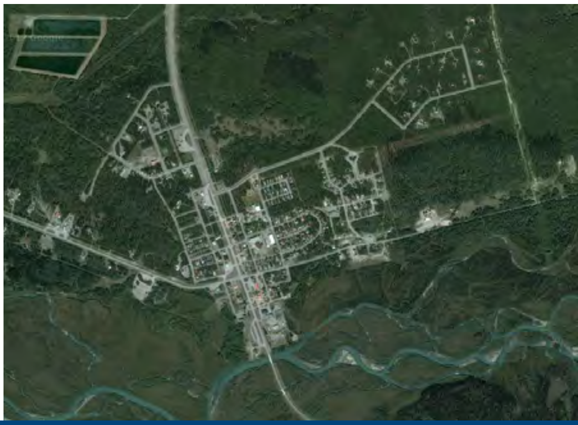
APPENDIX K	**IMPLEMENTATION SCHEDULE**



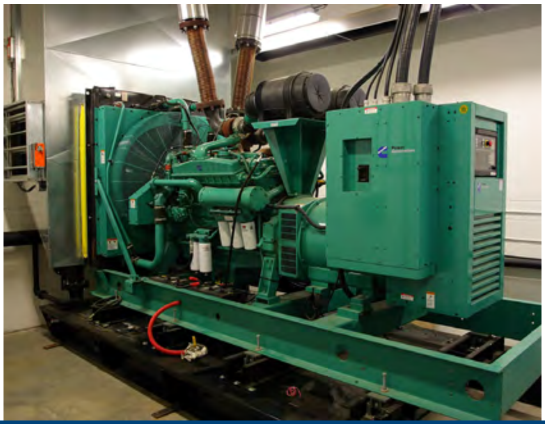


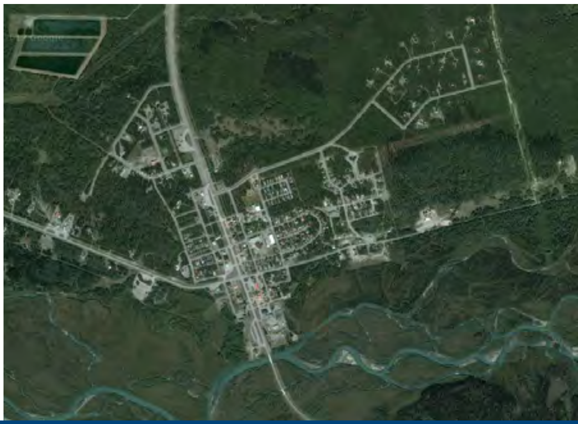
APPENDIX A

Interim Report #1

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7





REPORT

Interim Report #1 - Project Definition

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

October 18, 2012

Stantec

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Appendix A – Draft Plan Comments

1.0 Introduction / Study Progress

Stantec Consulting Ltd. (Stantec), in partnership with AFGOR Inc. (AFGOR), has been contracted to carry out Yukon Energy Corporation's (YEC) Front End Engineering Design (FEED) Study for the Yukon Bioenergy Demonstration Project in Haines Junction, Yukon. The objective of the study is a draft report to be delivered on January 15, 2013 covering the following project results:

- Evaluation and selection of a preferred technology for a small-scale bioenergy demonstration project in Yukon.
- Completion of a preliminary design for a preferred project location in Haines Junction, Yukon.
- Clearly defined business model.
- Identified additional funding sources.
- Business case analysis that will clarify the financial viability of the project.
- Technical, financial and regulatory risk management strategies.
- Drafted baseline conditions and impact assessment to form part of the project proposal submission to the Yukon Environmental and Socio-Economic Assessment Board related the bioenergy facility.
- Description of all environmental requirements associated with the project, as well as an outline of foreseeable potential project impacts, and mitigations that will be implemented to reduce project effects. The status and timelines for obtaining all required environmental approvals will also be outlined.
- Overview of engagement activities undertaken throughout 2012, and the results / outcomes of these activities (e.g. issues, challenges and opportunities identified), and a defined engagement and technology transfer strategy for the detailed design and subsequent phases of the project.

1.1 STUDY PROGRESS

This interim report is the first of two to be completed during the study, and represents project findings to date. Each chapter of this report represents progress in different areas of the project to meet the overall project objective. The three main areas of focus for the project are Engineering/Feedstock, Environmental/Engagement & Consultation, as well as Business

Planning. Progress to date in these three (3) areas is outlined below and forms the basis for this report.

- Engineering/Feedstock
  - Catalogue of Technologies (Task 6)
  - Technology Vendors
  - Technology Screening (Task 9)
  - Technology Costing (Task 7)
  - Technology Recommendation
  - Feedstock Characterization and Pre-processing (Task 10/11)
- Environmental / Engagement & Consultation
  - Engagement and Communications Plan (Task 16)
  - Regulatory Approvals Strategy (Task 36)
- Business Planning
  - Potential Funding Sources (Task 42)

2.0 Catalog of Technologies

The production of electricity through the conversion of biomass can be accomplished using a variety of different processes and a multitude of feedstocks. The production of bioenergy not only employs a previously underutilized fuel source, but also mitigates the effects of energy production on the environment. When selecting the appropriate technology, it is important to keep in mind the available feedstocks, required amount of generated electricity, environmental standards, capital cost, and process efficiency (McKendry, 2001). Accordingly, with timber being the sole feedstock at the present time, and the target energy production range being 2-4 MW, three different types of biomass conversion options will be investigated: gasification, pyrolysis and an externally fired gas turbine.

2.1 GASIFICATION

Gasification is a well-proven process that can be performed using either of two technologies – a simple system based on a fixed bed gasifier or fluidized bed technology of increased complexity. Within each of these types, further process options must be examined. Gasification involves the conversion of biomass to a gaseous fuel by heating in a gasification medium like air, oxygen or steam at temperatures greater than 800°C. Using this method, the chemical energy from carbon is converted into a combustible gas in two stages, unlike combustion where oxidation is complete in a single step. The quality of the product gas can be easily manipulated and allows for it to be more versatile in energy applications when compared to its biomass source.

The reactions associated with gasification are as follows:

Partial oxidation	$C + \frac{1}{2}O_2 \leftrightarrow CO$	$\Delta H = -268\ MJ/kgmole$
Complete oxidation	$C + O_2 \leftrightarrow CO_2$	$\Delta H = -406\ MJ/kgmole$
Water gas reaction	$C + H_2O \leftrightarrow CO + H_2$	$\Delta H = +118\ MJ/kgmole$

It can be seen above that the complete oxidation of carbon involves the greatest release of energy while partial oxidation accounts for 66% of the energy released during complete oxidation. The products from these reactions can then undergo further manipulation through the following reactions:

Water gas shift	$CO + H_2O \leftrightarrow CO_2 + H_2$	$\Delta H = -42\ MJ/kgmole$
Methane formation	$CO + 3H_2O \leftrightarrow CH_4 + H_2O$	$\Delta H = -88\ MJ/kgmole$

Because all of these reactions are reversible, altering the pressure, temperature and species concentrations allows for the tailoring of the product gas quality for the specific application. The resulting gas is therefore a mixture of carbon monoxide, carbon dioxide, methane, hydrogen and steam as well as unreacted nitrogen if air is used.

The source of oxygen in the reactions has a particular impact on the end result. While air is the most commonly used source, pure oxygen and steam can also be used. The calorific value (CV) of the gas is greatly affected by the oxygen source and typically will fall in the ranges seen below:

Low CV	4-6 MJ/Nm^3	Air and steam/air
Medium CV	12-18 MJ/Nm^3	Oxygen and oxygen/steam
High CV	40 MJ/Nm^3	Hydrogen and hydrogenation

For applications involving syngas combustion or use as engine fuel, low CV gas is most common while the higher CV gases are used as feedstock for further conversion into methane and methanol. Due to the cost of oxygen, air is normally utilized for processes up to 50MW. The overall efficiency of the gasification process is between 75% and 80%.

2.1.1 Fixed Bed Gasification

Fixed bed gasifiers are the customary method employed for gasification and operate at temperatures around 1000°C. Airflow direction distinguishes fixed bed gasifier types from one another. The two considered for this application are the updraft and downdraft configurations.

The updraft gasifier receives biomass feed through the top while the air is fed into the bottom of the unit through a grate. Above the grate, the residual solid remaining after the release of volatiles (or char) formed higher in the gasifier is combusted resulting in an internal temperature of approximately 1000°C. Ash falls through the grate at the bottom as hot gasses pass upwards into the reduction section. Further up in the devolatilization zone, the biomass is pyrolyzed. Here a fair amount of tar is formed and condenses partially on the biomass near the top of the gasifier and can leave in the product gas. In the top section the feed is dried and the gases are cooled to between 200°C and 300°C. The temperature is usually controlled by the addition of steam to the air or through humidification. The low temperature of the product means a high overall efficiency but also a high level of tar content in the product gas. A schematic of an updraft gasifier can be seen in Figure 1-1.

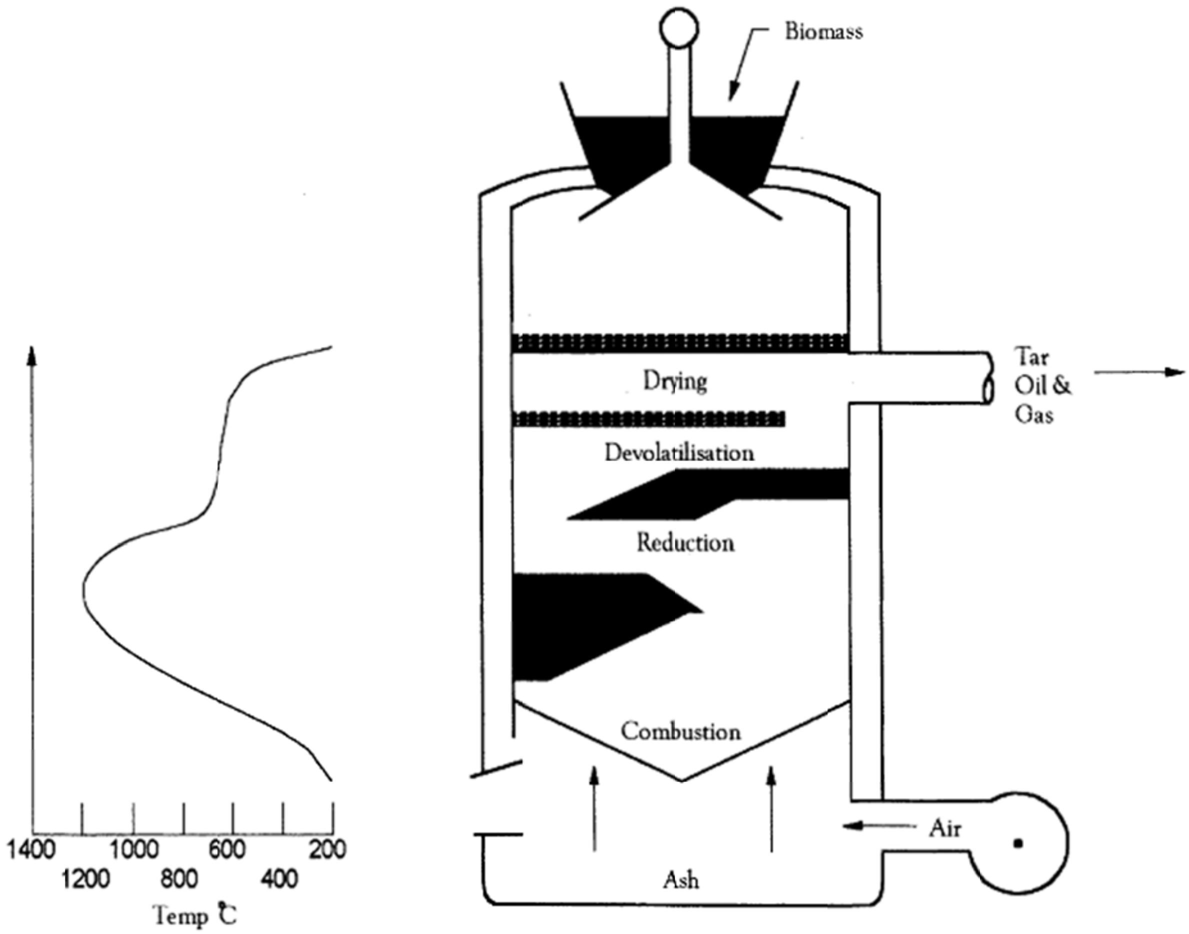

Figure 1-1: Schematic of Updraft Gasifier (McKendry, 2001)

The downdraft gasifier uses a co-current flow where the biomass feed and air move in the same direction. Since the gases leave the unit at a temperature between 900°C and 1000°C, the overall energy efficiency is low, resulting from the high heat content carried by the product gas. However, the heating of the gas allows for the partial cracking of tars formed during gasification and enables the production of gas with low tar content. While the tar content may be lower in a downdraft gasifier than the updraft design, the particulate content in the gas is much higher. A schematic of a down draft gasifier can be seen in Figure 1-2.

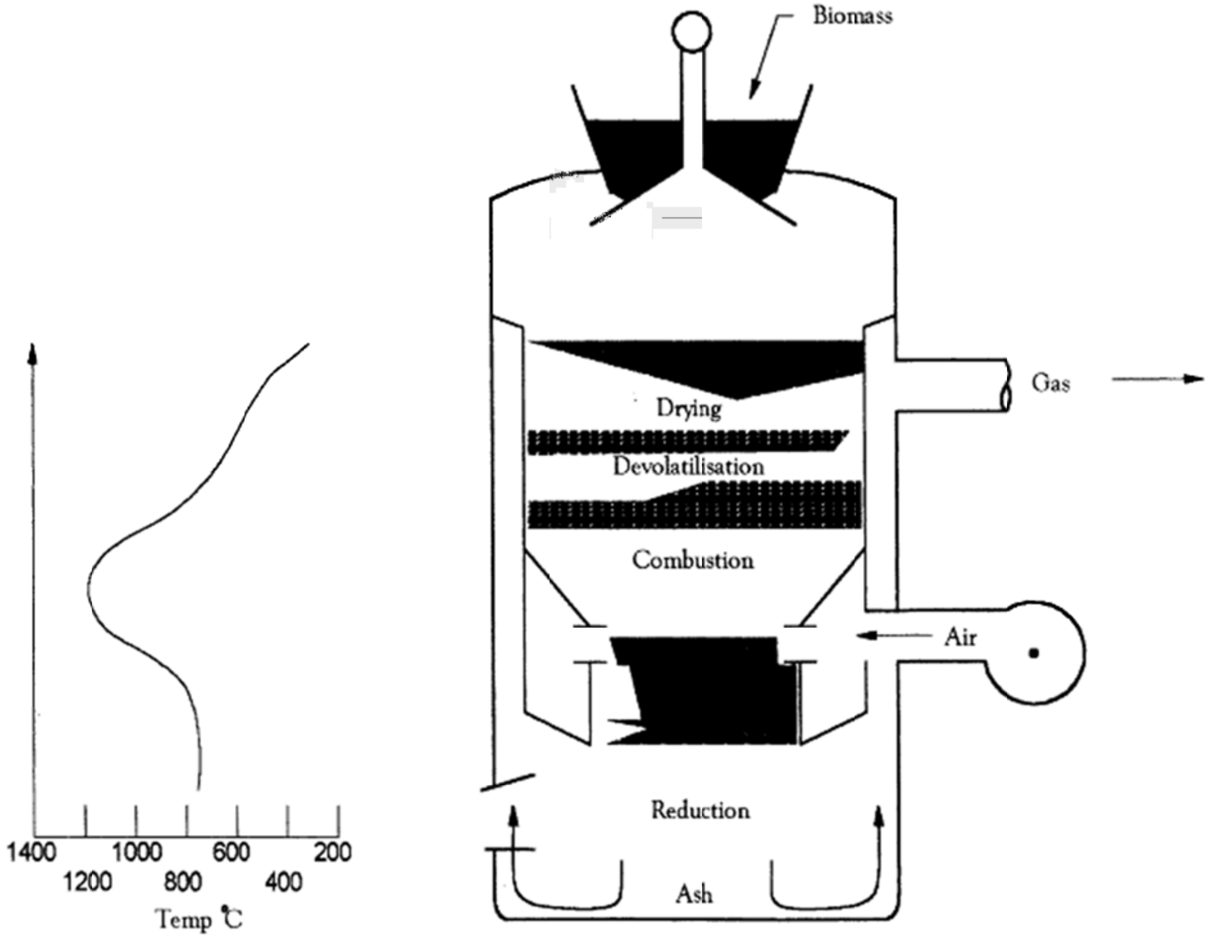

Figure 1-2: Schematic of Downdraft Gasifier (McKendry, 2001)

2.2 FLUIDIZED BED GASIFICATION

Fluidized bed gasification uses a bed of fine-grained material into which air is presented, thus fluidizing the bed material and guaranteeing close mixing of the bed material, combustion gas, and biomass feedstock. This mixing allows for a uniform temperature distribution in the gasification zone, which is the primary advantage over fixed bed gasifiers. The two foremost types of fluidized bed gasifiers are the circulating fluidized bed and bubbling bed types.

Circulating fluidized bed gasifiers are best suited for high capacity feed rates and are used in the paper industry for the gasification of bark and other forestry residues. The bed material circulates between the reaction vessel and a cyclone separator. (McKendry, 2001). The separator removes the ash while the bed material and char are returned to the reaction vessel, which helps to extend the solids residence time (Li, Grace, Lim, Watkinson, Chen, & Kim, 2004). A schematic of a circulating fluidized bed gasifier can be seen in Figure 1-3.

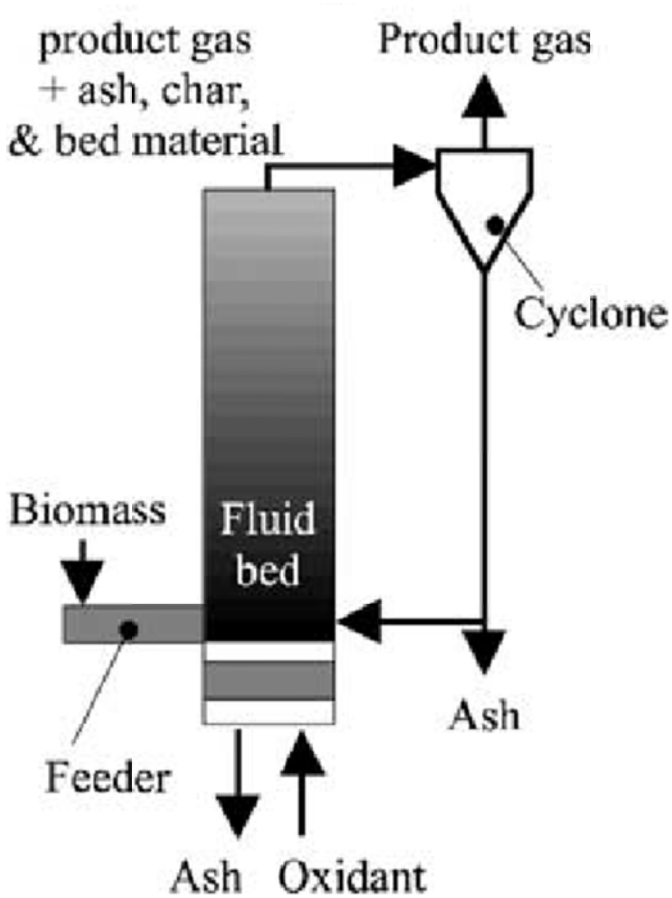

Figure 1-3: Circulating Fluidized Bed (Bridgwater, Toft, & Brammer, 2002)

Bubbling fluidized bed gasifiers are made up of a vessel with a grate located at the bottom for the introduction of air. The moving bed of fine-grained material is found just above the grate and is where the biomass feedstock is introduced. The bed temperature is maintained between 700°C and 900°C and is controlled by the air to biomass ratio. The biomass is then pyrolyzed in the hot bed forming a char with the gaseous compounds. Here the high molecular weight compounds are cracked via contact with the hot bed material resulting in a product gas with low tar content. A schematic of a bubbling fluidized bed gasifier can be seen in Figure 1-4.

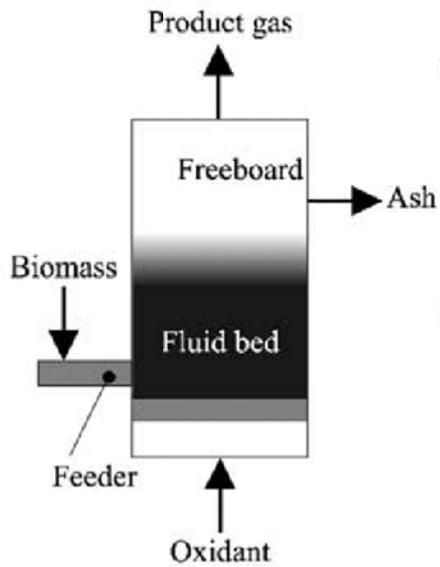

Figure 1-4: Bubbling Fluidized Bed (Bridgwater, Toft, & Brammer, 2002)

A major disadvantage to fluidized bed gasifiers is the potential for the slagging of the bed material. This is caused by the high ash content of the biomass. To avoid slagging, the bed temperature can be lowered, which results in an increased loss of char with the removal of ash. The amount of gas cleaning required is determined by the actual end-use of the gas. Fluidized bed gasifiers also produce a higher particulate load than fixed bed units. Some of these particles can be removed using cyclones. Depending on the amount of cleaning necessary, more sophisticated equipment may be needed. (McKendry, 2001). A summary of the advantages and disadvantages of different types of gasifiers can be seen in Table 1-1.

Table 1-1: Properties of Gasification Reactor Types (McKendry, 2001)

Reactor type	Advantages	Disadvantages
Fixed bed, updraft	Simple, inexpensive process Exit gas temperature about 250°C Operates satisfactorily under pressure High carbon conversion efficiency Low dust levels in gas High thermal efficiency	Large tar production Potential channeling Potential bridging Small feed size Potential clinkering
Fixed bed, down draft	Simple process Only traces of tar in product gas	Minimum feed size Limited ash content allowable Limits to scale up capacity Potential for bridging and clinkering
Fluidized bed, circulating	Flexible process Up to 850°C operating temperature	Corrosion and attrition problems Poor operational control using biomass
Fluidized Bed, bubbling	Flexible feed rate and composition High ash fuels acceptable Able to pressurize High CH_4 in product gas High volumetric capacity Easy temperature control	Operating temperature limited by ash clinkering High product gas temperature High tar and fines content in gas Possibility of high C content in fly ash

2.3 PYROLYSIS

Biomass can also be converted into a liquid fuel through a process called fast pyrolysis. (Brammer, Lauer, & Bridgwater, 2005). Pyrolysis is the thermal breakdown of biomass in the absence of oxidizing agents where the volatile components present in the biomass feed are vaporized in primary reactions by heating, leaving behind a char and ash residue. Pyrolysis always produces a gas, vapour that can be collected as a liquid and a solid char. Fast pyrolysis processes are designed and operated to maximize the liquid fraction at up to 75 wt% on a dry biomass feed basis. (Bridgwater, Toft, & Brammer, 2002). When compared to gas and solid, liquids have a high energy density and are easier to transport and store. The pyrolysis method has been used for commercial production of a variety of fuels, solvents, chemicals and other products from biomass feedstock. (Vamvuka, 2011). The liquid fuel or bio-oil possesses a lower heating value of approximately 16 MJ/kg and can be employed as a fuel in boilers, diesel engines or gas turbines for the production of heat, power or combined heat and power. (Brammer, Lauer, & Bridgwater, 2005). The bio-oil is a homogeneous mixture of organic compounds and water in a single phase. The fuel properties compared to diesel and heavy fuel oil can be found in Table 1-2 below.

Table 1-2: Comparison of Pyrolysis Liquid and Conventional Fuel Oil Characteristics (Bridgwater, Toft, & Brammer, 2002)

		Bio-oil	Diesel	Heavy Fuel Oil
Composition	%C	48.5	86.3	86.1
	%H	6.4	12.8	11.8
	%O	42.5	-	-
	%S	-	0.9	2.1
Density	kg/m^3 at 15°C	1220	854	963
Viscosity	cSt at 50°C	13	2.5	351
Flash point	°C	66	70	100
Ash	wt%	0.13	<0.01	0.03
Sulphur	wt%	0	0.15	2.5
Water	wt%	20.5	0.1	0.1
LHV	MJ/kg	17.5	42.9	40.7
Acidity	pH	3	-	-

A principal advantage of fast pyrolysis is the possibility of storing the bio-oil intermediate. This separation is referred to as de-coupling and is unique to fast pyrolysis since the energy is stored in liquid form. De-coupling allows for the pyrolysis conversion step and the diesel engine generation step to operate independently. Peak load or seasonal power requirements can benefit from this scenario since a small fast pyrolysis plant could operate continuously to produce bio-oil that would be stored for engine use when needed.

Fast pyrolysis involves rapid heating of the biomass feedstock to a temperature of approximately 500°C followed by rapid quenching of the vapours in order to reduce secondary reactions. (Bridgwater, Toft, & Brammer, 2002)**.** The structural components of biomass, including hemicelluloses, cellulose, lignin and extractives, pyrolyze at different rates and by different pathways and mechanisms. The rate and extent of component breakdown are dependent on the reactor type, temperature, pressure, particle size and heating rate. Dehydration, cracking, isomerization, dehydrogenation, aromatization, coking and condensation reactions all occur during pyrolysis to produce water, carbon oxides, other gases, charcoal, organic compounds, tars and polymers. This complex reaction pathway can be seen Figure 1-5.

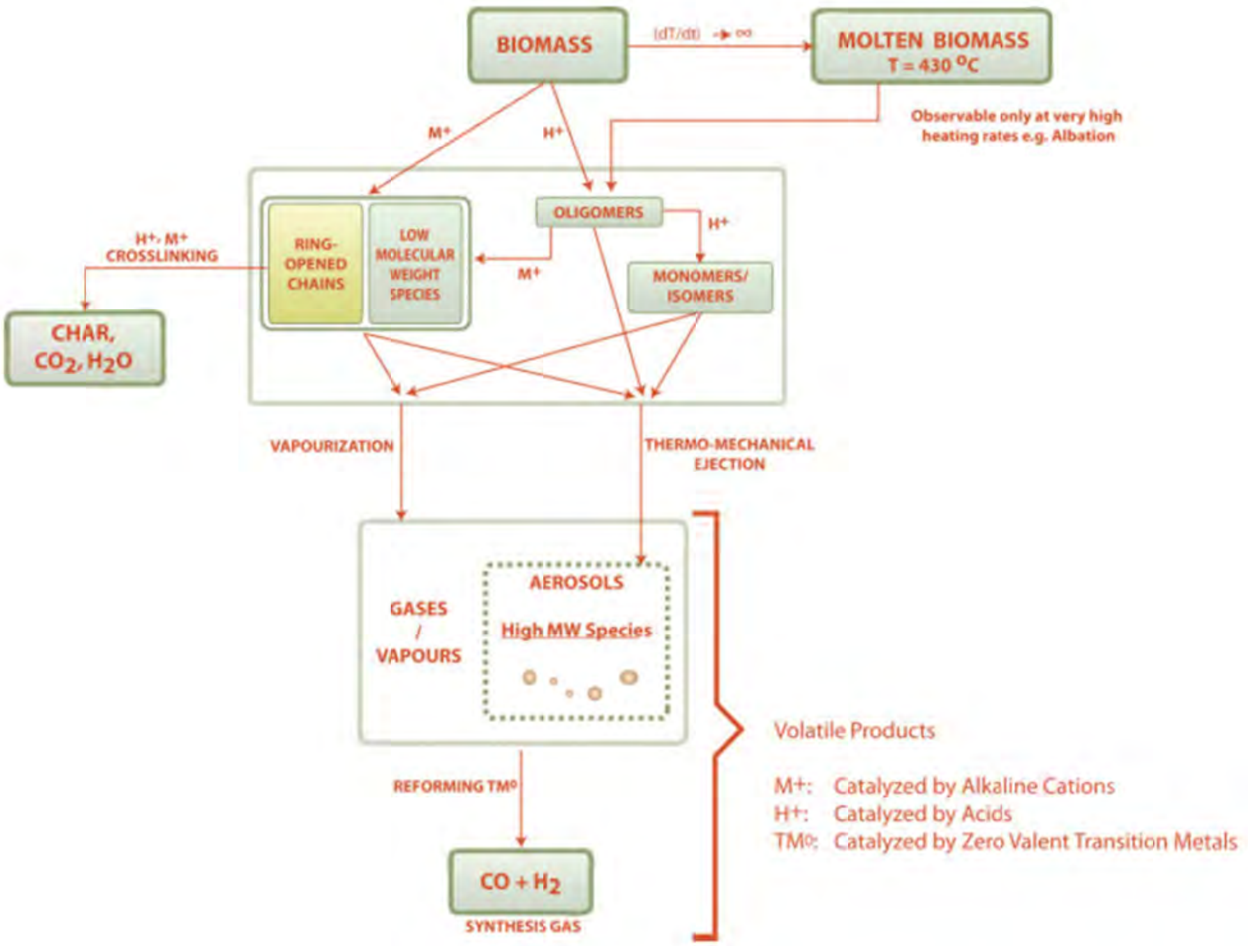

Figure 1-5: Mechanisms of Pyrolysis (Vamvuka, 2011)

Modern pyrolysis reactor configurations include fixed beds, moving beds, suspended beds, fluidized fixed beds, entrained flow reactors, stationary vertical shaft reactors, horizontal shaft kilns, inclined rotating kilns, single and multihearth reactors and a host of other designs. Fluidized beds are the most popular configurations, due to their ease and reliability of operation and ease of scaling to commercial plant sizes. They provide good temperature control and very efficient heat transfer to biomass particles. Liquid yields are typically 75 wt% on dry feed, with 10-15% char and gas making up the balance. Secondary reactions of the volatiles in the biomass matrix and additional heat supply from the in-bed heaters cause additional vapour cracking to char and non-condensable gases. The residence time of the reactants can be controlled by the flow of fluidizing gas, while special attention must be given to the system separating coke from the reaction products. (Vamvuka, 2011) Fluidized bed arrangements have been the most common reactors for fast pyrolysis, specifically the bubbling type. (Bridgwater, Toft, & Brammer, 2002). A comparison of reactor types can be seen in Table 1-3.

Table 1-3: Advantages and Disadvantages of Biomass Pyrolysis Systems (Vamvuka, 2011)

Reactor type	Advantages	Disadvantages
Fluid type	Good solids mixing High heat transfer rates Good temperature control Ease of scaling	Heat transfer to bed must be proven at large scale Max particle sizes up to 6 mm If circulating, increased complexity of system, char attrition and reactor wear
Entrained flow		Low heat transfer rates Limited gas/solid mixing Small particle sizes required
Rotating cone	Good solids mixing No carrier gas required Ease of scaling Small investment cost	Heat transfer to bed must be proven at large scale Small particle sizes required
Vacuum reactor	No carrier gas required Lower temperature required Can process larger particles	Low heat transfer rates Solids residence time high Liquid yield rather low
Ablative reactor	Heat transfer gas not required Lower temperature required Can process larger particles Compact design and intensive system	Reaction rates limited by heat transfer to the reactor Char abrasion Scaling is costly

Most fast pyrolysis processes demand a finely divided, substantially dry feed and some feed pretreatment is therefore typical before the reactor. Exceptions are ablative and vacuum pyrolysis, which both have the advantage of tolerating much larger feed sizes. In the majority of reactor setups particle size is constrained by a need to limit secondary reactions of the primary pyrolysis vapours with char formed at the particle surface. This is because the char catalyzes secondary reactions that reduce the liquids yield. The majority of feedstocks must also be dried before entering the reactor. Feed moisture content must be limited to improve liquid product yield and quality though some moisture enhances fuel properties such as viscosity. A maximum feed moisture content of 10% is usually specified while 7% moisture content is preferred (Bridgwater, Toft, & Brammer, 2002). A typical fast pyrolysis process is depicted in Figure 1-6 showing the necessary preparation steps, alternative reactors and product collection. (Bridgwater T. , 2006).

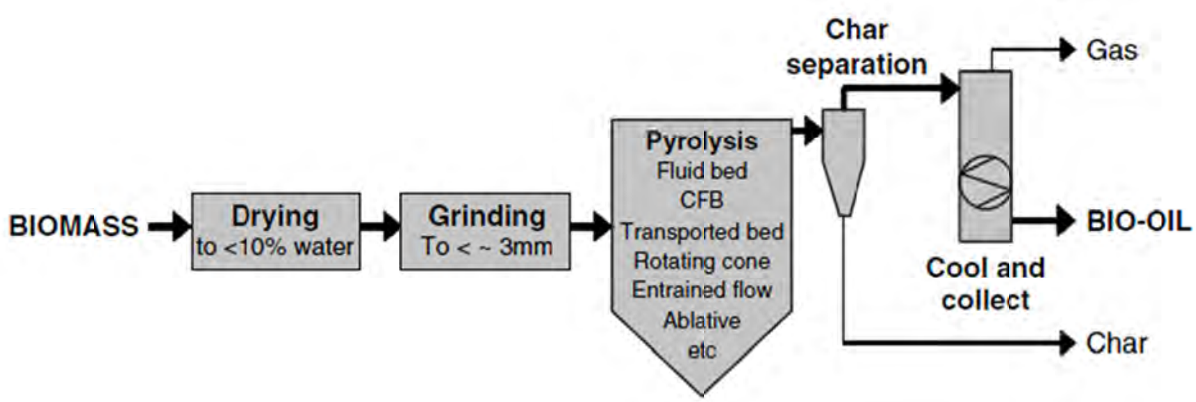

Figure 1-6: Conceptual fast pyrolysis process (Bridgwater T. , 2006)

Most development for electricity generation is focused on the use of raw pyrolysis liquids in gas turbine or diesel engine applications and has been successfully carried out. Pyrolysis liquids are very different from conventional diesel fuels but crude pyrolysis oil has been shown to burn well in engines. Ignition happens to be difficult but pilot-ignition has proven to solve this problem by using a small amount of an auxiliary fuel to ignite the main fuel. Less development has been done using gas turbines and fast pyrolysis. Earlier tests on a combustor rig designed to simulate a slurry-fed gas turbine revealed problems including entrained char in the bio-oil which blocked fuel injection systems; ash fouling downstream of the gas turbine; corrosion to turbine components; and increased smoke emissions. 1996 tests by Orenda in Canada have evaluated the firing of a 2.5 MW_e industrial gas turbine with better results. The turbine has been run successfully for several hours entirely on pyrolysis liquids while flame tunnel tests are examining the long-term resistance of turbine parts to corrosive attack from alkali metals in the ashes entrained in pyrolysis liquids. (Bridgwater, Toft, & Brammer, 2002).

2.4 EXTERNALLY FIRED GAS TURBINE

The burning of biomass in air, otherwise known as combustion, is used over a wide range of outputs to convert the chemical energy stored in biomass into heat, mechanical power, or electricity by employing a variety of process equipment such as stoves, furnaces, boilers, steam turbines, turbo-generators, etc. Combustion of biomass produces hot gases at temperatures of 800-1000°C. It is possible to burn any type of biomass but in practice combustion is only possible for biomass with a moisture content of <65%, unless the biomass is pre-dried.

The scale of combustion plants ranges from very small domestic heating applications to large scale industrial plants in the range of 100-300+ MW. Net bio-energy conversion efficiencies for biomass combustion power plants range from 20% to 40%. The higher efficiencies are obtained with systems over 100MW_e or when biomass is co-combusted in coal-fired power plants. (McKendry, 2001).

In the United States and around the world, direct combustion is the most common method of converting biomass resources into heat, power or combined heat and power. (Peterson & Hase, 2009) It contributes to over 97% of bioenergy production in the world. (Zhang, Xu, &

Champagne, 2010). A direct combustion system burns biomass to generate hot flue gas, which is either used directly to provide heat or fed into a boiler to generate steam. In a boiler system, the steam can be used to provide heat for industrial processes while a steam turbine can be used to generate electricity. (Peterson & Hase, 2009).

Fouling and corrosion of the combustor are typical issues associated with biomass combustion. These are considered to be detrimental because of the resulting reduction in heat transfer in the combustor. Fouling is commonly associated with the presence of alkali metals and some other elements (such as silicon, sulphur, chlorine, calcium and iron) in the biomass ash. With a series of complex reactions, these elements are deposited in the forms of chlorides, silicates or sulphates on the wall of the combustor or the surface of the heat transfer elements. (Zhang, Xu, & Champagne, 2010).

The two primary types of direct combustion boiler systems for biomass utilization are fixed-bed and fluidized-bed systems (Peterson & Hase, 2009), with increasing carrier gas velocity within the reactor. A higher gas velocity translates to an intensive mixing of the feedstock, which enhances the combustion efficiency and the heat exchange rate. (Zhang, Xu, & Champagne, 2010).

In a fixed-bed system, the biomass is fed onto a grate where it combusts as air passes through the fuel, releasing the hot flue gases into the heat exchanger section of the boiler to generate steam. (Peterson & Hase, 2009). The simplest fixed-bed system is comprised of one combustion room with a grate. As soon as the biomass feed is added to the furnace, it is pyrolyzed into volatile gases and chars. Primary and secondary air supplies are provided under and above the grate for the combustion of chars and volatile gases, respectively. The heat generated through the combustion of chars is responsible for providing enough heat for the pyrolysis of newly added biomass. Due to the high content of volatile matter in biomass fuels, a greater secondary air supply is required than the primary air supply. A fixed-bed biomass combustion system is typically operated at around 850-1400°C. Some common examples of fixed-bed systems include manual-fed, spreader-stoker, underscrew, through-screw, static grate, and inclined grate. (Zhang, Xu, & Champagne, 2010).

A fluidized-bed system, in contrast, feeds the biomass into a hot bed of suspended, incombustible particles, where the biomass combusts to release the hot flue gas. Manufacturers of fluidized-bed systems claim that this technology produces more complete combustion of the feedstock, resulting in reduced SO_2 and NO_2 emissions and improved system efficiency. Fluidized-bed boilers also can utilize a wide range of feedstocks. Fluidized-bed systems, however, have greater parasitic loads than stokers. (Peterson & Hase, 2009). The bed material is typically composed of silica sand, limestone, dolomite, or other non-combustible materials while the operating range is 700-1000°C. The bed materials act as the heat transfer media which are fluidized by the air flow coming from the bottom of the unit. The biomass which is amalgamated with the moving medium has high combustion efficiency. Fluidized-bed systems can be divided into bubbling fluidized bed and circulating fluidized bed, much like the aforementioned gasifiers. As a result of the high mixing intensity created by the upward-flowing air at a high velocity, circulating fluidized bed systems behave more efficiently than bubbling fluidized bed. In a circulating fluidized bed combustor, fuel particles and the bed materials are separated from the fast flowing gas stream in the cyclone and then re-enter the reactor. Circulating fluidized-bed systems display several advantages, including the adaptation to various fuels with different properties, sizes, shapes and moisture (up to 60%) and ash content reaching 50%. (Zhang, Xu, & Champagne, 2010).

Electricity production via steam turbine has a conversion efficiency of 15% to 35% depending upon the manufacturer. The efficiency of a direct combustion biomass system is influenced by such things as moisture content of the biomass, combustion air distribution and amounts, operating temperatures and pressures, fuel feed handling, gas cleaning, distribution and mixing, and furnace retention time. (Peterson & Hase, 2009).

To circumvent the issues involved in gas cleaning, the fuel can be burned in a separate combustor and the turbine gases can be heated indirectly in a high-temperature gas-gas heat exchanger (Bridgwater A. , 1995). Externally fired gas turbines not only allow for this possibility of burning “dirty” fuel, it also utilizes the waste heat from the turbine in a recuperative process. (Kautz & Hansen, 2007), see Figure 1-7. However, an important concern with this method is the loss of efficiency due to the indirect heating of the turbine working gases as well as the temperature limit enforced by the heat exchanger materials. Despite the fact that indirect heating can improve the turbine reliability, there are costs gained in flue gas treatment and the gas-gas heat exchanger. (Bridgwater A. , 1995). Unfortunately, the costs of future commercial indirectly-fired gas turbines are difficult to predict and it is challenging to say confidence which combustion technology would provide the lowest generating costs. Indirectly-fired gas turbines do however appear to be a competitive energy-conversion technology for biomass in the future. The power-spectrum range for such gas turbines is 30-2000kW, making it necessary to purchase multiple units to reach the desired electricity production (Kautz & Hansen, 2007).

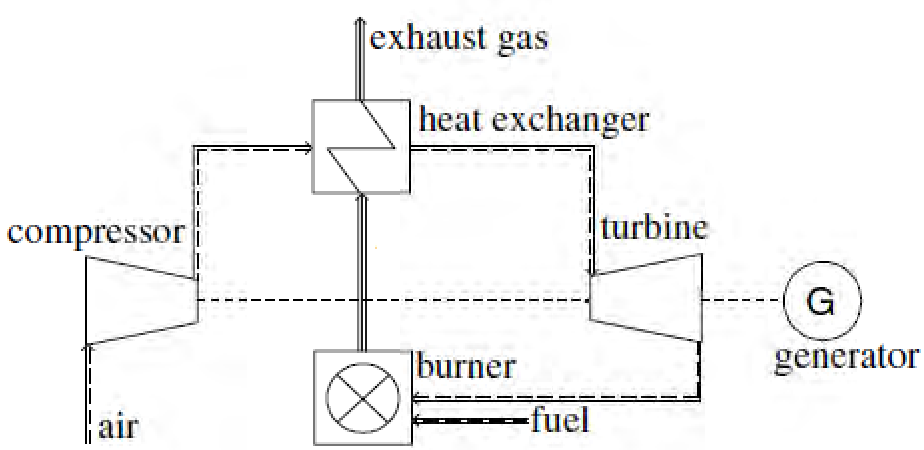

Figure 1-7: Externally Fired Gas Turbine (Kautz & Hansen, 2007)

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3.0 Technology Assessment and Recommendation

Throughout the world one can find biomass gasification taking place from a scale suitable to heat a home, to that to power a country. The focus of this study is to concentrate on a gasification technology capable of producing a syngas for clean-up that can then be introduced to a reciprocating engine in the capacity range of 2 – 4 MW. Although the technology should be innovative, it must be at or near commercialization to facilitate its installation in a northern community (i.e., not for research but practical/reliable use). Several technologies also require the use of steam which is not available nor considered for generation. Two other biomass technologies are showcased for comparison (external fired gas turbine and pyrolysis-oil/ethanol/bio-oil).

To facilitate screening of the technologies, a ranking or scoring system has been established to support the technology recommendation. The criterion used for the ranking system as well as the points awarded by criterion are outlined in Table 3-1. The ranking system does not include items impacting all the biomass systems, such as feedstock availability, socio-economic viability, job creation, or permitting requirements as these are common to all the systems at this level of evaluation.

Table 3-1: Screening Criterion

Level of Development	R&D / Pilot – 0 Pst.	Demonstration – 3 Pts.	Commercial – 5 Pts.
Capacity Range	Outside 2-4 MW_e – 0 Pts.		Within 2-4 MW_e* - 5 Pts.
Use of Engine for Power	No – 0 Pts.		Yes – 5 Pts.
Gasification Complexity**	Advanced – 0 Pts.	Standard – 3 Pts.	Direct Comb. – 5 Pts.
Installation Base	1 Installation – 0 Pts.	2 Installations – 3 Pts.	More than two – 5 Pts.
Steam Required	Yes – 0 Pts.		No – 5 Pts.
Achievable Score	**Minimum – 0 Pts.**		**Maximum – 30 Pts. (100%)**

* Includes modular units capable of entering range (i.e. if maximum size is 1 MW_e, two units could be installed to enter desired range). Units significantly larger than the range will be excluded due to uncertainties regarding scale-down.

** Complexity is based on system design. Advanced is representative of dual bed or pressurized gasifiers, BFBs, and CFBs; Standard represents draft gasifiers (low to medium Btu syngas) to clean-up and the engine; Direct Combustion is for the externally fired gas turbine.

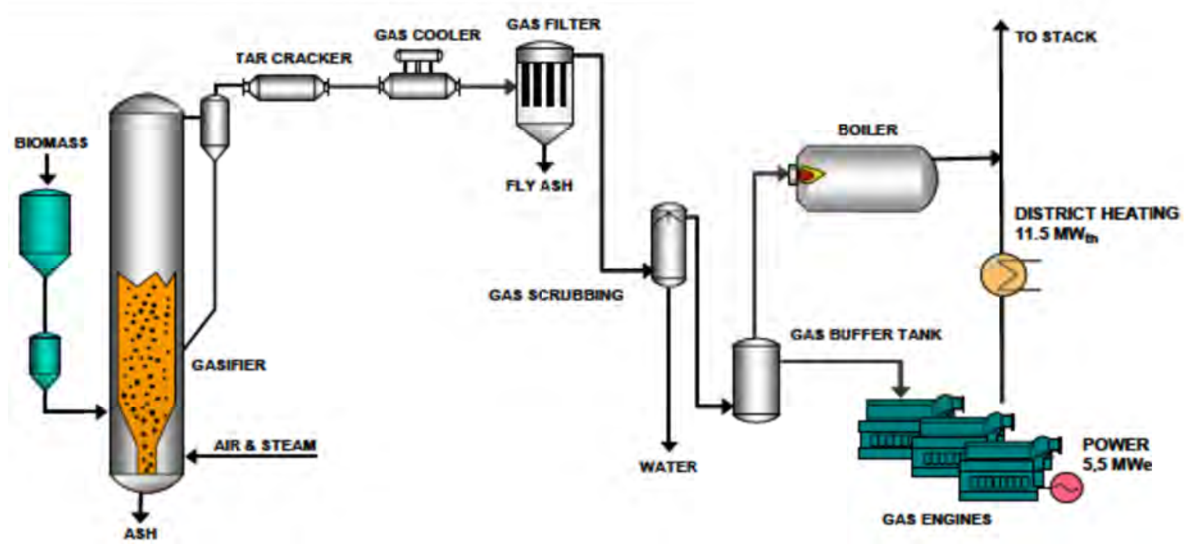
3.1 VENDOR TECHNOLOGIES

This sub-section presents the catalog of technologies considered and provides technology information as well as screening assessment.

Developer / Company:	Andritz-Carbona	**Location:**	Skive, Denmark
Owner:	I/S Skive Fjernvarme	**Status:**	Operational
Technology:	Bubbling Fluidized Bed	**Tech Status:**	Commercial
Capacity:	5.5 MW_e, 11 MW_{th}	**Application:**	CHP w/ District Heating

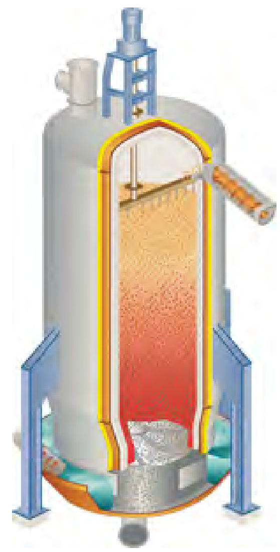
The Carbona plant was installed in 2005 as a demonstration unit for a new type of gasifier. Supported by the USDOE, the plant has achieved commercial operations and sells heat and power to the city of Skive. The installation is the only one by Andritz-Carbona, and in its current form supplies both boilers for steam generation and reciprocating engines. It is unclear if the unit can be scaled down, but is an advanced gasification system requiring steam.

Level of Development	Commercial – 5 Pts.
Capacity Range	Outside 2-4 MW_e – 0 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	1 Installation – 0 Pts.
Steam Required	Yes – 0 Pt.
Score	**10 Pts. (33%)**



Developer / Company:	Babcock & Wilcox Vølund	**Location:**	Harboøre, Denmark 3 x Japan
Owner:	Babcock & Wilcox Vølund	**Status:**	Operational
Technology:	Updraft Gasifier	**Tech Status:**	Commercial
Capacity:	Harboøre: 1 MW_e, 3.5 MW_{th} Kani-city: 2 MW_e, 8 MW_{th} Yamagata: 2 MW_e, 8 MW_{th}	**Application:**	CHP w/ District Heating ORC

B&W Vølund's updraft gasifier has an extensive installation base using biomass and waste feedstocks. Majority of systems are steam based, with three noted above using reciprocating engines as desired. Reports indicate this updraft gasifier is Advanced from a complexity standpoint (complicated clean-up system and requires water treatment plant) as well the gasifier requires steam.

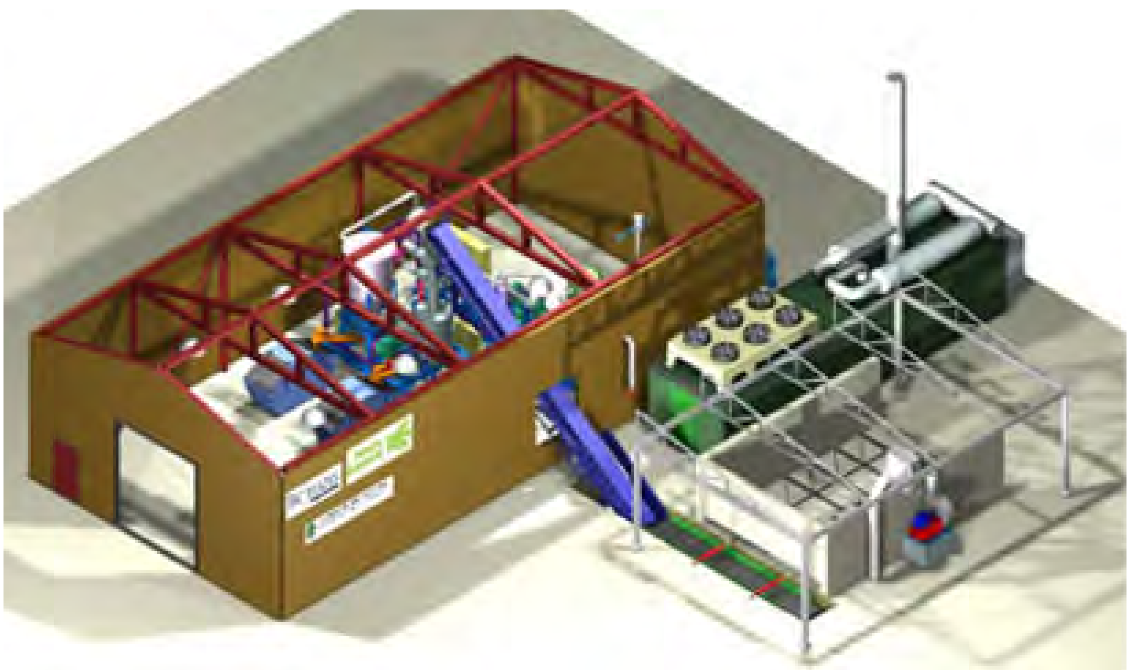


Level of Development	Commercial – 5 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	More than two – 5 Pts.
Steam Required	Yes – 0 Pt.
Score	**20 Pts. (67%)**

Developer / Company:	Biomass Engineering Ltd.	**Location:**	5 units in UK
Owner:	Various	**Status:**	Operational
Technology:	Downdraft Gasifier	**Tech Status:**	Commercial
Capacity:	Cumbria: 1 MW_e Mossborough: 0.25 MW_e,	**Application:**	CHP w/ District Heating

Biomass Engineering Ltd. has several installations of their downdraft gasifier operating In the UK. All units are equal or less than 1 MW_e in size. The two installations noted above are the only ones identified as having used a reciprocating engine, although testing has been conducted on a micro gas turbine as well. The downdraft gasifier does not require steam.

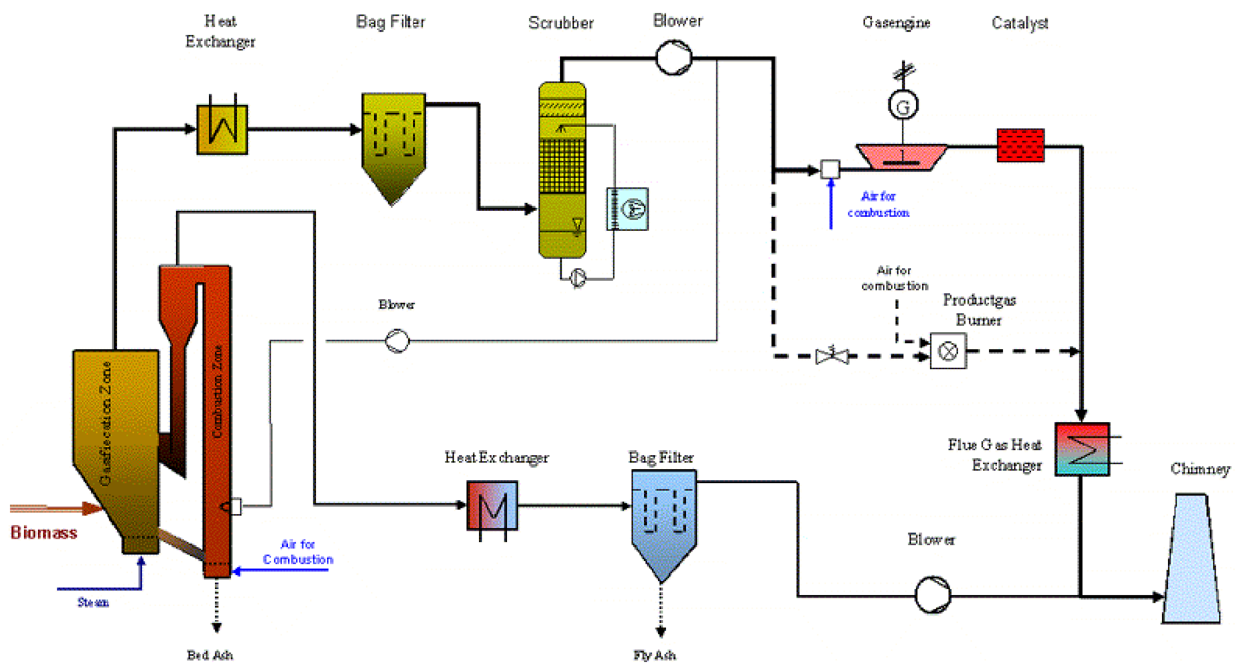
Level of Development	Commercial – 5 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Standard – 3 Pts.
Installation Base	2 Installations – 3 Pts.
Steam Required	No – 5 Pt.
Score	**26 Pts. (87%)**



Developer / Company:	FICFB (Vienna University and Repotec)	**Location:**	Güssing, Austria Oberwart, Austria
Owner:	Various	**Status:**	Operational
Technology:	Dual Bed (BFB & CFB)	**Tech Status:**	Demonstration
Capacity:	Güssing: 1 MW_e Oberwart: 2.7 MW_e,	**Application:**	CHP w/ District Heating ORC

Fast Internally Circulated Fluidized Bed (FICFB) was developed with dual fluidized beds (CFB combustor, BFB gasifier) to produce a high calorific value syngas. Although it has achieved this objective, the unit is advanced in complexity and is likely to enter the market in large-scale applications. The units have been run with reciprocating engines and organic Rankine cycle (ORC).

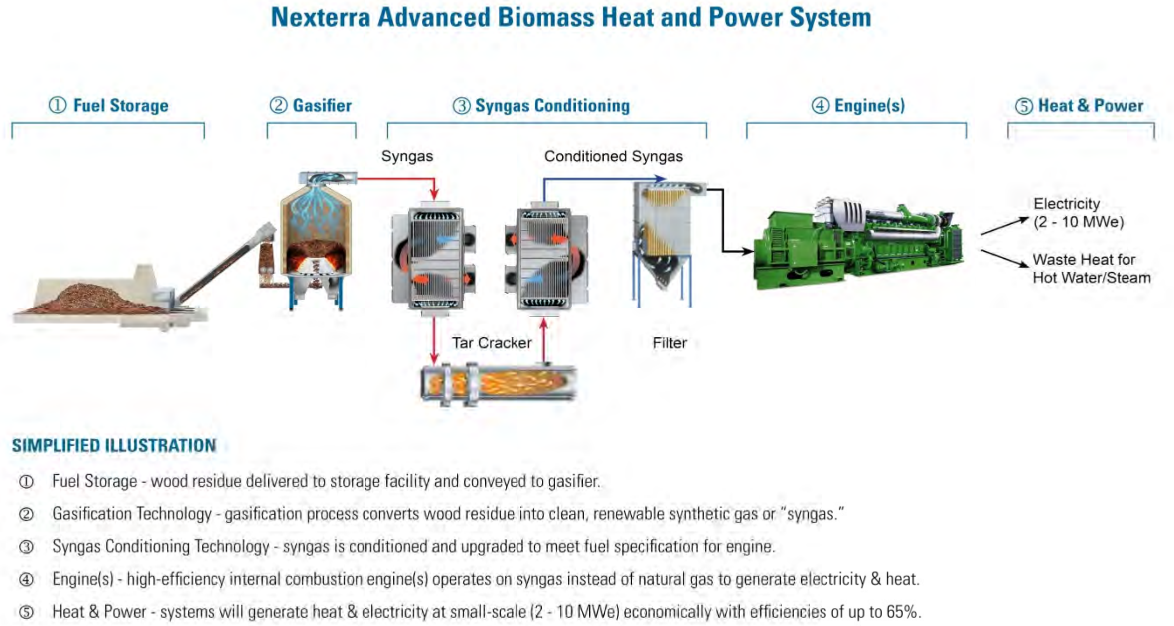
Level of Development	Demonstration – 3 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	2 Installations – 3 Pts.
Steam Required	Yes – 0 Pt.
Score	**16 Pts. (53%)**



Developer / Company:	Nexterra Systems Corp.	**Location:**	Multiple – Oak Ridge, Vancouver, Victoria, North Carolina, New Westminster, UBC
Owner:	Various	**Status:**	Operational
Technology:	Dual Bed (BFB & CFB)	**Tech Status:**	Demonstration CHP
Capacity:	UBC: 2 $MW_{e,}$ 3 MW_{th}	**Application:**	CHP w/ District Heating

Nexterra is the most recognizable Canadian gasification vendor. With installations of their gasifier throughout Canada and the USA, they have developed a solid platform for biomass gasification (low-medium calorific value syngas). Their most recent installation on the University of British Columbia campus is their first CHP using a reciprocating engine. The complexity of the system is Standard with an updraft gasifier and syngas clean-up. Nexterra's gasifier is well proven and does not require steam.

Level of Development	Demonstration – 3 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Standard – 3 Pts.
Installation Base	1 Installations – 0 Pts.
Steam Required	No – 5 Pt.
Score	**21 Pts. (70%)**



Developer / Company:	Pyroforce Energietechnologie AG	**Location:**	Nidwalden, Switzerland Güssing, Austria
Owner:	Pyroforce	**Status:**	Operational (Güssing not)
Technology:	2-zone downdraft	**Tech Status:**	Demonstration
Capacity:	Nidwalden: 1.2 MW_{el} Güssing: 0.35 MW_{el}	**Application:**	Syngas to engines

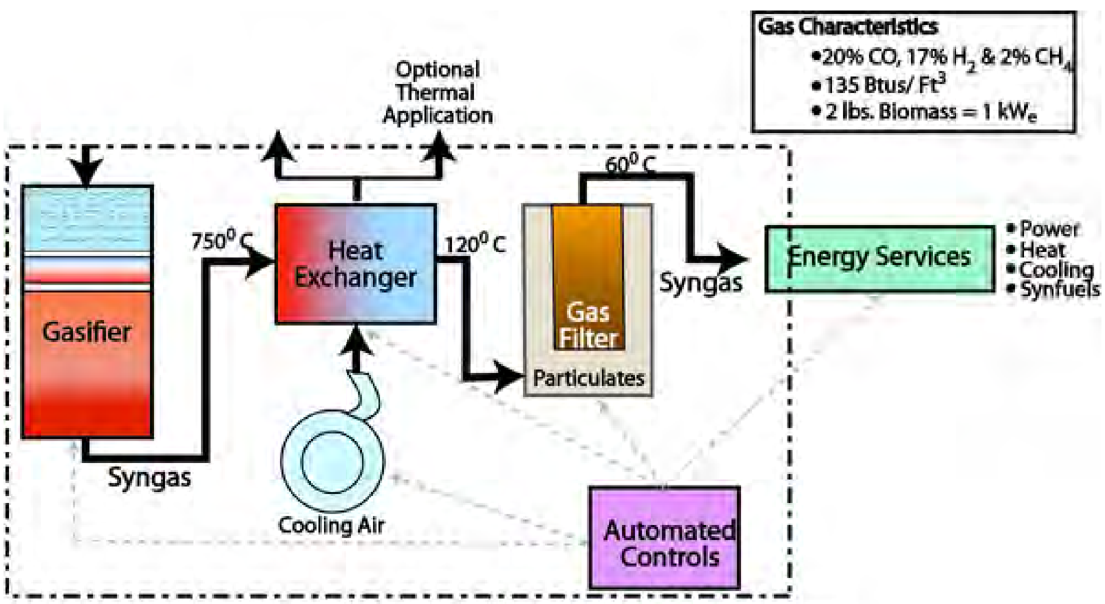
Pyroforce has a pilot/demonstration unit at an industrial site in addition to the two locations above. The Pyroforce system is based on a modular technology in a sense that each gasifier is only 150 kW_e and multiple units are used to achieve the required capacity. The gasifiers do not require steam.

Level of Development	Demonstration – 3 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Standard – 3 Pts.
Installation Base	2 Installations – 3 Pts.
Steam Required	No – 5 Pt.
Score	**24 Pts. (80%)**

Developer / Company:	Community Power Corporation (Afognak Native Corporation, Alaska)	**Location:**	33 locations in North America
Owner:	Various	**Status:**	Operational
Technology:	Downdraft Gasification	**Tech Status:**	Commercial
Capacity:	25 kW_e and 100 kW_e	**Application:**	Power, CHP

Community Power Corporation (CPC) develops modular gasification systems using a downdraft gasifier. They are available in 25 and 100 kW_e capacities, which can be combined to achieve any overall capacity (max. 3 MW_e). Complexity is low with a high degree of automation, and not steam or water wash requirements. CPC development was supported by the USDOE and NREL.

Level of Development	Commercial – 5 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Standard – 3 Pts.
Installation Base	More than two – 5 Pts.
Steam Required	No – 5 Pt.
Score	**28 Pts. (93%)**

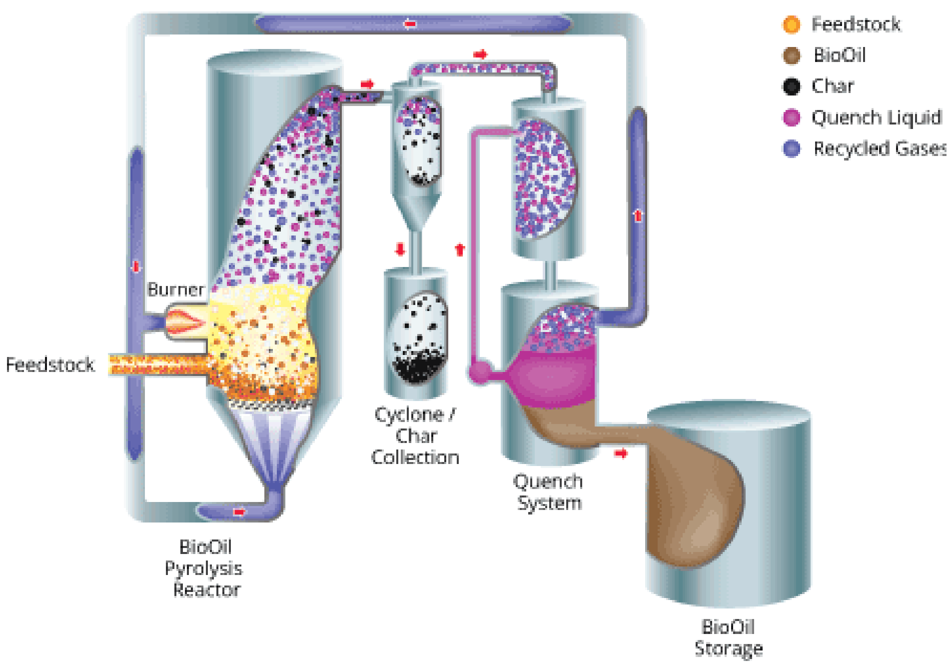


CPC BioMax® GASIFICATION MODULE SCHEMATIC

Developer / Company:	Dynamotive Energy Systems	**Location:**	West Lorne, Ontario Guelph, Ontario
Owner:	Dynamotive Energy Systems	**Status:**	Operational
Technology:	Fast Pyrolysis	**Tech Status:**	Commercial
Capacity:	2.5 MW_e (West Lorne) 5 MW_e (Guelph)	**Application:**	Electricity, Specialty Products

Dynamotive's patented fast pyrolysis involves the rapid heating of a biomass feedstock in the absence of oxygen. Prepared feedstock is heated to a lower temperature than other pyrolysis systems thus having the benefit of higher overall energy conversion efficiency. Gas turbines are used commercially to produce electricity but leftover BioOil often results and is typically further processed into other chemicals. (Dynamotive, 2012)

Level of Development	Commercial – 5 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Engine for Power	No – 0 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	2 Installations – 3 Pts.
Steam Required	No – 5 Pts.
Score	**18 Pts. (60%)**



Developer / Company:	Ensyn	**Location:**	Tuscany, Italy Sabah, Malaysia Renfrew, Ontario
Owner:	Ensyn	**Status:**	Under Development, Operational (Ontario)
Technology:	Fast Pyrolysis	**Tech Status:**	Commercial
Capacity:	11-13 MW_e (Italy) 28-34 MW_e (Malaysia)	**Application:**	Power, CHP

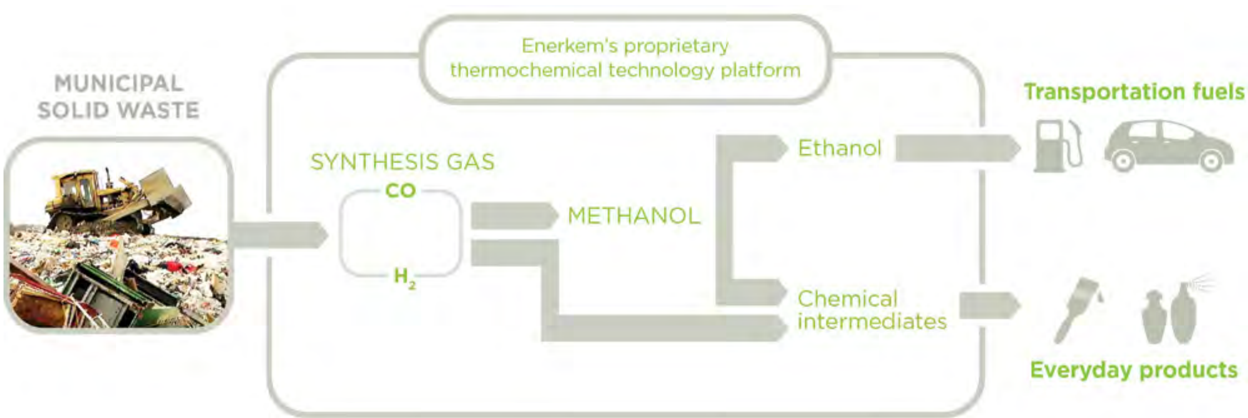
Ensyn's patented Rapid Thermal Processing (RTP) technology uses heat to thermally crack carbon-based feedstock into high yields of higher-value liquids. Ensyn operates a fuel production facility in Renfrew, Ontario which produces commercial quantities of RTP liquids for clients. The RTP Renewable Fuel Oil can be injected directly into a turbine or diesel engine in a variety of combinations depending on the required output (Envergent Technolgies, 2010).

Level of Development	Commercial – 5 Pts.
Capacity Range	Outside 2-4 MW_e – 0 Pts.
Use of Engine for Power	Yes – 5 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	1 Installation – 0 Pts.
Steam Required	No – 5 Pts.
Score	**15 Pts. (50%)**

Developer / Company:	Enerkem	**Location:**	Edmonton, Alberta Pontotoc, Mississippi Varennes, Québec
Owner:	Various	**Status:**	Under Development
Technology:	Bubbling Fluidized Bed	**Tech Status:**	Commercial
Capacity:	10 Million gallons/yr	**Application:**	Ethanol/Methanol Production

Enerkem currently operates two plants in addition to the three commercial scale plants that are under development – a demonstration facility in Westbury, Quebec and a pilot plant in Sherbrooke, Quebec. The three commercial scale plants will convert municipal solid waste into methanol and cellulosic ethanol. Enerkem's primary focus is the production of cellulosic ethanol of which methanol is an intermediate product (Enerkem, 2010).

Level of Development	Commercial – 5 Pts.
Capacity Range	Outside 2-4 MW_e – 0 Pts.
Use of Engine for Power	No – 0 Pts.
Gasification Complexity	Advanced – 0 Pts.
Installation Base	1 Installation – 0 Pts.
Steam Required	No – 5 Pts.
Score	**10 Pts. (33%)**

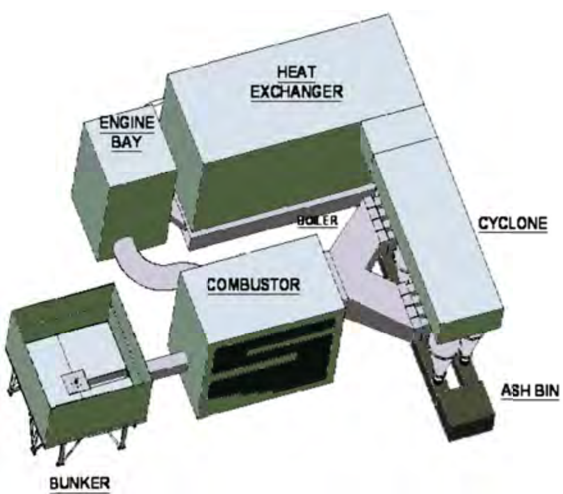


Developer / Company:	(1) Talbott's (2) Entropic	**Location:**	(1) Shropshire, England (2) University of Manitoba
Owner:	(1) Talbott's (2) Entropic	**Status:**	Operational
Technology:	Indirect Fired	**Tech Status:**	Demonstration
Capacity:	100 kW_e, 200kW_{th}	**Application:**	CHP

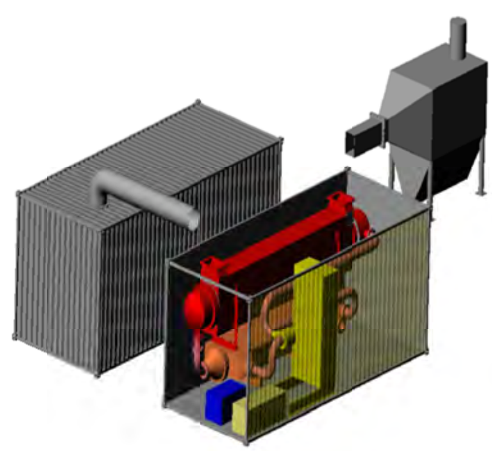
Tallbott's manufactures over 40 different systems at its UK factory with over 4000 installations worldwide. The BG100 generator was officially launched and installed at Harper Adams University College in Shropshire, England in 2006. The unit has been discontinued due to operations issues. They have since released a BG250 (250 kW_e, 600 kW_{th}), and have a BG25 and BG50, 25 kW_e and 50 kW_e respectively.

A similar product is available from Entropic in Port Coquitlam, BC, with their 100 kW_e version.

Level of Development	Demonstration – 3 Pts.
Capacity Range	Within 2-4 MW_e - 5 Pts.
Use of Micro Turbine for Power	Yes – 5 Pts.
Gasification Complexity	Direct Comb. – 5 Pts.
Installation Base	1 Installation – 0 Pts.
Steam Required	No – 5 Pts.
Score	**23 Pts. (77%)**



(1) Talbott's BG250



(2) Entropic HBC100

3.2 TECHNOLOGY SCREENING SUMMARY

A summary of the technology scorecards is presented in Table 3-2 on the following page. Reviewing each vendor's score, the top scores, greater than 20 pts, were ranked from one (1) to six (6). Given the criteria considered, the smaller, more modular systems in the smaller capacity ranges took the top two rankings: (1) Community Power Corp., and (2) Biomass Engineering Ltd. The other downdraft unit, Pyroforce ranked third (3) followed by the alternative external fired gas turbine unit (4) Talbott's/Entropic. The final two rankings represent the larger updraft systems: (5) Nexterra, and (6) B&W Vølund.

3.3 TECHNOLOGY COSTING

To provide an indication of installed costs for the unit, publically available information was compiled for the vendor installations. This information is not recommend for direct comparison purposes due to the lack of detail available, if any is available, as it is challenging to determine what equipment and installations costs are being included. Table 3-3 presents the findings for the installed costs summary for consideration.

Table 3-3: Vendor Published Costs per MW_e Installed ($ CAD 2012, 2.5%/yr inflation)

Vendor	Technology	Published Cost per MW_e
Andritz-Carbona	Bubbling Fluidized Bed	**$9.3M**
Babcock & Wilcox Vølund	Updraft Gasifier	**$7.0M**
Biomass Engineering Ltd.	Downdraft Gasifier	**$8.2M**
FICFB	Dual Bed	**$7.2M**
Nexterra	Updraft Gasifier	**$8.5M**
Pyroforce	2-Zone Downdraft	**$8.2M**
Community Power Corp.	Downdraft Gasifier	**$8.1M**
Dynamotive	Fast Pyrolysis	**$40M (21 x$10^6$ L/yr)**
Ensyn	Fast Pyrolysis	**$100M (87 x$10^6$ L/yr)**
Enerkem	Bubbling Fluidized Bed	**$80M (36 x$10^6$ L/yr)**
Talbott's	Indirect Fired	**$10.1M**

An average cost for the top six vendor's average out to approximately $8.4M/$MW_e$.
Using this as a baseline, and assuming some cost reduction for economies of scale, a 2 - 4 MW_e installation will have an approximate installed cost of $16M - $32M. This is primarily the cost of the biomass plant itself, and would exclude any waste heat recovery project.

Table 3-2: Summary of Vendor Scorecards

Technology	Developer/ Owner	Level of Development	Capacity Range	Engine for Power	Gasification Complexity	Installation Base	Steam Required	Score	Rank	Elec. Eff.*
Bubbling Fluidized Bed	Andritz-Carbona	5	0	5	0	0	0	10 (33%)		
Updraft Gasifier	Babcock & Wilcox Vølund	5	5	5	0	5	0	20 (67%)	6	
Downdraft Gasifier	Biomass Engineering Ltd.	5	5	5	3	3	5	26 (87%)	2	
Dual Bed	FICFB	3	5	5	0	3	0	16 (53%)		
Updraft Gasifier	Nexterra	3	5	5	3	0	5	21 (70%)	5	26%
2-Zone Downdraft	Pyroforce	3	5	5	3	3	5	24 (80%)	3	
Downdraft Gasifier	Community Power Corp.	5	5	5	3	5	5	28 (93%)	1	20%
Fast Pyrolysis	Dynamotive	5	5	0	0	3	5	18 (60%)		
Fast Pyrolysis	Ensyn	5	0	5	0	0	5	15 (50%)		
Bubbling Fluidized Bed	Enerkem	5	0	0	0	0	5	10 (33%)		
Indirect Fired	Talbott's	3	5	5	5	0	5	23 (77%)	4	13%

3.4 TECHNOLOGY RECOMMENDATION

The technology summary in the previous section ranked three (3) technologies as front runners based on their current installation base and applicability to general project requirements. In order to make a meaningful recommendation it is also important to assess as many known considerations as possible. Although this study is in its early stages (technology-wise), there are several other aspects for consideration to formalize a recommendation.

Feedstock supply: The supply of fuel is critical to the project and is being evaluated on an on-going basis. From the standpoint of technology, the supply requirements are directly related to the capacity of the unit. In this case, a 2 – 4 MW_e installation is currently under consideration and will require 30,000 – 50,000 GMT/yr of fuel (to be confirmed (TBC)). This is not a large amount of fuel, but is more than is currently available and will have to be secured.

Trained operators: There is currently no biomass thermal or gasification plant in Haines Junction or the Yukon, and it can be assumed that finding multiple skilled operators for the new plant will be a challenge. The larger and more complex the plant becomes, the greater the challenge to staff and maintain the plant for the long-term.

Plant Efficiency: Thermal power generation projects are not extremely efficient. Typical small/medium scale boiler/steam turbine units may reach approximately 20-25% gross plant efficiency, depending on unit size and equipment. A gasification unit in the same scale has the potential to achieve higher efficiencies (up to 40%) depending on the arrangement and unit performance. In either case, straight power generation will be discarding more than half of the heat input to the system as waste heat. This loss will have a large impact on the financial viability of the project, and is the principle driver for projects to consider cogeneration (waste heat recovery).

Waste heat recovery is already under consideration for this project, but is currently being sized as a result of the power generation capacity. Although this is a typical approach if the power requirement is fixed, in this case, it may not be the driving force due to the preliminary and unconfirmed sizing of the required electrical generating capacity. In most cogeneration applications, it is the waste heat usage that drives the size of the power generation unit to support its development. Furthermore, if there is variability to the heat load, than the peak heat load is not necessarily used to size the system (i.e., the existing system meets peak requirement and the new system deals with the baseload). Using Haines Junction district heating studies as an example, the peak load is 1.2 MW_{th} yet the average load is 300-500 kW_{th} (TBC). Assuming a gasification plant is 80% efficient, 40% to electricity and 40% to waste heat, the generation capacity of the unit should only be 300 - 500 kW_e as opposed to 2 – 4 MW_e.

Combining the vendor rankings and giving consideration to the aspects above, Stantec provides the following path forward for consideration. As the 2 – 4 MW_e plant capacity is the focus of the study, the project should base the plant on an updraft gasification design, and issue Requests for Quotation (RFQ) to B&W Volund and Nexterra.

If there is the opportunity to refine the desired size of the power plant and make it smaller, the RFQ should be extended to the other technology vendors. As a sensitively analysis to the main focus of the study, Stantec recommends this be undertaken. With respect to the aspects above: a smaller unit size would have a better opportunity to secure a feedstock supply (less volume), operation of the small units (CPC and Talbott's) are significantly less complicated than the other technologies considered (more automated/less hands-on); and the plant can be easily tailored to suit a viable use of the waste heat, maximizing the efficiency and sustainability of the unit. This approach is keeping with the results of the 2011 biomass workshop and at the conclusion of the FEED study, would give the project a fallback position if the 2 – 4 MW_e unit is determined to not be economically viable/accepted or the small units become more attractive.

4.0 Feedstock Characterization

Characterization of the feedstock is the first step to understanding the potential impacts to the biomass power plant. The feedstock can impact several areas of the plant's operations, including: pre-processing requirements, materials handling requirements/arrangements, and technology specific issues (gasification, syngas clean-up, emissions, waste streams). The preliminary data below represents a desktop analysis and preliminary results from AGFOR on-site assessment the week of October 8 – 12. These characterizations are based on publically available information and will be refined as the project progresses.

Based on preliminary assessments the majority, if not all, of the biomass feedstock will be White Spruce. Beyond the species, it is important to note that most of the available feedstock is dead. The chemistry provided in the tables below is for live wood (green) wood. Dead wood will have lost some of the volatiles and other chemicals, furthermore will have a very low moisture content (less than 25%, most likely 10 – 15%. Live / green wood can also be harvested, and maybe required to support moisture content requirements of the 2 – 4 MW biomass plant. The green wood does grow in low moisture conditions compared to other Canadian climates, and can be expected to have moisture content of approximately 35%. Blending of these two sources will be able to provide some level of moisture control. Biomass drying is not perceived to be a preprocessing requirement at this time based on these findings.

The following tables (5-1, 5-2, and 5-3) present the chemical properties of the available species that will be used and refined to support the development of the project.

Table 5-1: Proximate Analysis for White Spruce (Isenberg, 1980)

	Volatile Matter (wt%)	Fixed Carbon (wt%)	Ash (wt%)
White Spruce (Bark)	72.5	24.0	3.5

Table 5-2: Ultimate Analysis for Spruce, Popular, Pine (Francescato, 2008)

	% Dry Weight								Energy
	C	H	O	N	K	S	Cl	Ash	MJ/Kg
Spruce (with Bark)	49.8	6.3	43.2	0.13	0.13	0.015	0.005	0.6	18.8
Poplar	47.5	6.2	44.1	0.42	0.35	0.031	0.004	1.8	18.5
Pine	51.1	5.91	38.2	0.1				4.7	18.9

Table 5-3: Ultimate Analysis for Spruce, Popular, Pine (ECN Phyllis, 2008)

	mg/Kg Dry Weight								
	Al	**As**	**B**	**Ca**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**
Spruce*		0.3			0.6	0.9	4		
Poplar	10		6	4200	0.3		13	30	0
Pine*		0.3			0.6	0.9	4		
	Mg	**Mn**	**Na**	**Ni**	**P**	**Pb**	**Zn**		
Spruce*				3.9		9.8	303		
Poplar	490	17	17		320	1.4	36		
Pine*				3.9		9.8	303		

* these values were general ones given to conifers i.e. not specific to species

4.1 MOISTURE CONTENT

When compared to fossil fuels, biomass has a relatively low heating value. This is due to its distinct characteristics – high moisture and high oxygen content. For typical biomass fuels, high moisture content is one of the biggest disadvantages. Although the combustion reactions are exothermic, the evaporation of water is endothermic. The heating value of the fuel is negatively correlated with the relative amount of water even when the moisture content is within the maximum acceptable limit.

Figure 5-1 displays the negative linear relationship between the moisture content and the heating value. As the moisture content increases, both the higher heating value (HHV) and the lower heating value (LHV) decrease. HHV and LHV are used to describe the heat production of a unit quantity of fuel during its complete combustion. Another important characteristic of biomass fuel is its elevated oxygen content. Usually, the oxygen content of biomass is as high as 35 wt% on a dry basis.

4.2 WOOD QUALITY CHARACTERISTICS

Beetle-killed wood retains 40% moisture for the first few years until the tree "greys" and the moisture content drops to around 30%. Some of the documentation from BC suggests that the moisture content of beetle-killed pine in cool, dry environments may drop to 13% - 18% over the proposed 20-year shelf life (Lewis & Hartley, 2006)

The above are all subject to microclimate and the moisture fluctuations.

The Haines Junction area meets the cool, dry environment criteria which reinforces preliminary findings to October 2012. The principle difference lies in the species: Pine in BC and White Spruce in the Haines Junction area. Moisture content is more a function of effect of climate on wood than of two coniferous species.

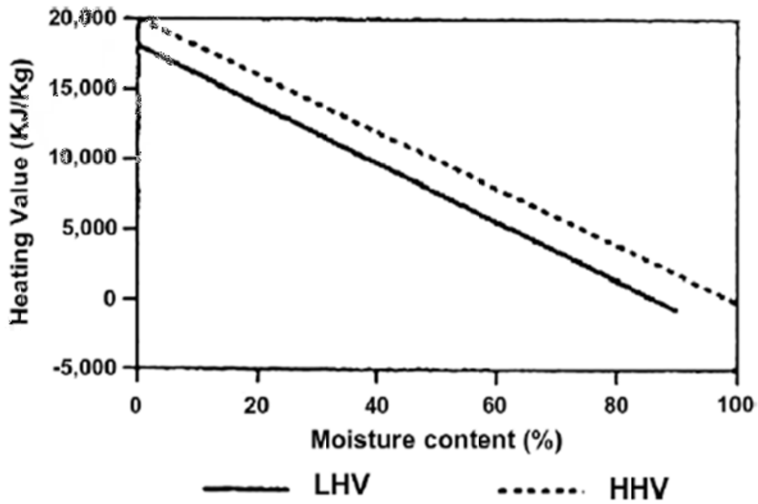


Figure 5-1: Relationship Between Heating Value and Moisture Content of Biomass Fuel (Zhang, Xu, & Champagne, 2010)

4.3 WORK CITED

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5.0 Engagement and Communication Plan

Stantec received a copy of the draft engagement and communications plan developed by the Steering Committee on 26 September 2012. The document was developed to provide a framework from which to build on as the project develops.

Elements of the plan were brought to action sooner than anticipated with the requirement for AGFOR to begin their assessment of the biomass feedstock. Gaston Damecour was in the Yukon to commence the assessment the week of October 8 – 12. During this time, Gaston had to engage several stakeholders as well as the Forestry Management Branch to understand the feedstock harvesting requirements.

In the coming weeks, Stantec will document and use Gaston's experience to refine the engagement and execution plan in consultation with the Steering Committee. A kick-off meeting with the Communications team (Janet, Tanis, & Amy) is currently scheduled for October 19, with the focus to identify a draft timeline for project activities. Identification of tentative dates and activates is requested by the Steering Committee for October 22.

General comments to the draft plan can be found in Appendix A.

6.0 Regulatory Approvals Strategy

6.1 OVERVIEW OF THE PROJECT EFFECTS ASSESSMENT AND REGULATORY REGIMES

Yukon government, First Nation government, and Federal government regulatory approvals and decisions are required before any construction activities may be undertaken for any project that may emerge from this and other related feasibility studies. These approvals and decisions, however, may only be made after the required screening assessment by the Executive Committee of the Yukon Environmental and Socio-economic Assessment Board (YESAB) of a Project Proposal submitted pursuant to the Yukon Environmental and Socio-economic Assessment Act (YESAA).

While such a project will have several activities which would make it assessable under YESAA, a screening level assessment by the YESAB Executive Committee would be required in accordance with Item 55 of Schedule 3 of the Assessable Activities, Exceptions and Executive Committee Projects Regulations as the Project will involve cutting 20,000 m^3 or more of standing or fallen trees or removing that amount of fallen or cut trees. The power plant (principle project) on its own would only trigger an assessment at the Designated Office level, but the principal project's interdependence1 with the accessory project, consisting of local feedstock procurement, raises the level of assessment.

Pending the issuance of a favorable YESAB Executive Committee screening (report and) recommendation, decision documents would be issued by any federal, first nation, and/or territorial government that will issue authorizations for the project to proceed (e.g., Air Emissions Permit, Timber Permit). Once the decision documents are issued permitting/licensing applications can be processed by the appropriate authority and authorizations subsequently issued to begin construction and commence operations.

6.2 YUKON LICENSING AND PERMITTING

The follow tables outline the Territorial, First Nations, and Federal government authorizations that may be required for the construction and operation of the proposed Biofuel Power Facility and the operation and maintenance of the associated feedstock. This list will be amended based as the technical aspects of the facility and harvesting become further defined as the Project progresses. The information below has been based on the Permit and Authorization Guide for Yukon Activities (2005) and information currently available for the Government of Yukon, Champagne and Aishihik First Nations, and Federal Government agencies online.

[1] **Interdependence** – if the principal project could not proceed without the undertaking of another project, the two may be considered to form a single project.

6.2.1 Power Facility

[redacted]				
Air Emissions greater than 5Mbtu-hr	YG Environment Act, Air Emissions Regulation	Air Emissions Permit	Environment Yukon	
Release of Air Pollutants	YG Environment Act, Air Emissions Regulation	Air Emissions Permit	Environment Yukon	
Ozone Depleting Substance Use	YG Environment Act, Air Emissions Regulation	Ozone Depleting Substances/halocarbons permit	Environment Yukon	Requirement to be determined based on design
Special Waste Management	YG Environment Act, Special Waste Regulations	Special Waste Facility, Disposal and Generator Permit	Environment Yukon	Requirement to be determined based on design
Solid Waste Disposal	YG Environment Act, Solid Waste Regulations	Facility Permit	Environment Yukon	
Storage Tank/Petroleum Tank Use	YG Environment Act, Storage Tank Regulations	Application for Operation, Closure, Abandonment or Renovation to Storage Tanks/Permit	Community Services, Protective Services	Requirement to be determined based on design
Water Use or Deposit of (Water) Waste	Waters Act	Water Use License	Yukon Water Board	Requirement to be determined based on water use quantities
Potable Water Supply	Public Health Act, Drinking Water Regulation	Drinking/Potable Water Permit	Health and Social Services, Public Health and Safety	

Land Acquisition, Title to Land	Land Titles Act	Issuance of Title	Justice	Requirement to be determined based on land parcel
Tenure for Land Lease or Agreement of Sale	Territorial Lands Act	Application for Land	Energy, Mines & Resources	Requirement to be determined based on land parcel
Tenure for Land Lease	CAFN Lands Act	CAFN Lands Disposition (Lease for commercial or industrial purposes)	CAFN heritage, Lands and Resources	Commercial lease of land requires CAFN Lands Committee review of application and Chief and Council approval
Temporarily Using or Occupying Commissioner's Land	Territorial Lands Act	Land Use Permit	Energy, Mines & Resources	Requirement to be determined based on land parcel
Temporarily Using or Occupying CAFN Settlement Land	CAFN Lands Act	CAFN Lands Disposition (easement, right of way)	CAFN heritage, Lands and Resources	
Facility Construction	YG Land Services	Building Permits	YG Community Services, Building Safety	
	Building Standards Act	Plumbing Permit	YG Community Services, Building Safety	

	Public Health & Safety Act, Sewage Disposal Systems Regulation	Sewage Disposal Permit	Health & Social Services, Environmental Health Services	Requirement to be determined based on design
	Electrical Protection Act	Electrical Permit	YG Community Services, Building Safety	
	Gas Burning Devices Act	Gas Installation Permit	YG Community Services, Building Safety	Requirement to be determined based on design
Clearing or Installing a Utility Right-of-Way	Territorial Lands Act	Land Use Permit, Disposition Approval	Energy, Mines & Resources	Requirement to be determined based on design
Construction of New Road Access	Territorial Lands Act	Land Use Permit	Energy, Mines & Resources	Requirement to be determined based on site location
Construct Road Access on Highway Right-of-Way	Highways Regulation	Access Permit	Highways & Public Works	Requirement to be determined based on site location
Temporary use of CAFN Settlement Land / use or alteration of resources on surface of land	CAFN Traditional Activities Protection Act	TAPA Permit	CAFN Heritage, Lands and Resources Dept.	Permits issued by Director
Activities in a Habitat Protection Area	Wildlife Act, Wildlife Regulation	Permission for Activity	YG Environment	Requirement to be determined based on site location
Activities in a Wildlife Area	Wildlife Area Regulation	Wildlife Permit	YG Environment	Requirement to be determined based on site location

Harmful Alteration, Disruption or Destruction of Fish Habitat	Fisheries Act	Fisheries Act Authorizations S.35.2	Fisheries and Oceans Canada (DFO)	Requirement to be determined based on site location and construction
Destruction of Fish by Means other than Fishing	Fisheries Act	Fisheries Act Authorizations S.32	Fisheries and Oceans Canada (DFO)	Requirement to be determined based on site location and construction
Obstruction of Fish Passage	Fisheries Act	Fisheries Act Authorization S.22	Fisheries and Oceans Canada	Requirement to be determined based on site location and construction
Bridge Crossing	Waters Act; Territorial Lands Act; Navigable Waters Act (as necessary)	Water License; Land Use Permit; Navigable Water Authorization	Yukon Water Board; Energy, Mines & Resources; Transport Canada	Requirements to be determined based on site location and construction
Navigable Water work	Navigable Water Protection Act; Territorial Lands Act	Application for an Approval of Proposed Works	Fisheries and Oceans Canada (DFO); Energy, Mines & Resources	Requirements to be determined based on site location and construction

***Also of note:** Yukon Forest Resources Act and regulations concerning the construction and operation of a wood processing facility.

6.2.2 Feedstock/Harvest

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Timber Harvesting	Timber Harvest Plan, Forest Resources Act	Timber Resource License	YG Forestry	
Timber cutting on CAFN Settlement Land for commercial purposes	CAFN Traditional Activities Protection Act	TAPA permit	CAFN (Heritage, Lands and Resources Department)	
Burn Wood Refuse	Forest Protection Act, Forest Protection Regulation	Burning Permit	Community Services, Protective Services	
Land Acquisition, Title to Land	Land Titles Act	Issuance of Title	Justice	Requirement to be determined based on land parcel
Tenure for Land Lease or Agreement of Sale	Territorial Lands Act	Application for Land	Energy, Mines & Resources	Requirement to be determined based on land parcel
Temporarily Using or Occupying Commissioner's Land	Territorial Lands Act	Land Use Permit	Energy, Mines & Resources	Requirement to be determined based on land parcel
Construction of New Road Access	Territorial Lands Act	Land Use Permit	Energy, Mines & Resources	Requirement to be determined based on site location

Construction of new road access – forest resource use	Yukon Forest Resources Act; Forest Resource Road Regulations	Forest Resource Road License/permit	Energy, Mines & Resources	Requirement to be determined based on site location
Construct Road Access on Highway Right-of-Way	Highways Regulation	Access Permit	Highways & Public Works	Requirement to be determined based on site location
Activities in a Habitat Protection Area	Wildlife Act, Wildlife Regulation	Permission for Activity	YG Environment	Requirement to be determined based on site location
Activities in a Wildlife Area	Wildlife Area Regulation	Wildlife Permit	YG Environment	Requirement to be determined based on site location
Transportation of Bulk Commodity	Bulk Commodity Haul Regulations	Bulk Commodity Haul Agreement	Highways & Public Works	Requirement to be determined based on transportation quantities
Oversize Trucking	Highways Act	Over Dimensional or Over Weight Vehicle Permits	Highways & Public Works	Requirement to be based on transportation methods

Assessment of historic resources as part of the timber harvest planning or road construction	Historic Resources Act	Archaeological permit	Department of Culture and Tourism	Required to conduct heritage assessments in the field
Other research projects	Examples: Scientists and Explorers Act (Yukon) Fisheries Act Migratory Birds Act CAFN TAPA based TK policy	Various authorizations	Canadian Wildlife Service; Dept Fisheries and Oceans; Yukon Culture and Tourism; Yukon Environment; CAFN	Quite likely necessary if project will include fish and wildlife monitoring

Note: The intent of this chapter is to provide a draft regulatory strategy from which to build on as the project develops and more definitive information becomes available. Stantec is committed to working with YEC and CAFN to define regulatory requirements on and on-going basis of the biomass plant and the feedstock supporting it.

6.3 YESAB

The scope of Stantec's work includes the delivery of a draft Project Proposal for the Biofuel Power Facility that meets the requirements as set out by the Yukon Environmental and Socio-economic Assessment Act (YESAA). Based on preliminary discussions with the Project Team, this submission will be designed for an Executive Committee level assessment. The Feedstock Harvest component of the Project will not be included in the Project Proposal at this time, but will be addressed in a separate technical and regulatory recommendation report aimed at informing a Yukon Environmental and Socio-economic Board (YESAB) submission at a future date. Assessment methods to be used are based on a structured approach that align with YESAB's direction which first assesses potential Project-specific effects and then potential cumulative effects. The following is Stantec's understanding of the assessment process based on YESAA and previous project and professional experience.

.1 **Scoping of Assessment**: identification of Valued Environmental and Socio-economic Components (VCs) relevant to the Project and the assessment including scoping the geographic and temporal boundaries for each VC.

.2 **Baseline Conditions**: baseline analysis including a reviewing current and potential future VC conditions. Examination of the possible interactions between the Project and VCs with a focus on identifying potential effects of concern to be carried forward for assessment.

.3 **Effects Assessment and Mitigation**: after baseline conditions without the Project and proposed mitigations are considered, assessment of the significance of the residual effects that remain. Qualitative and quantitative approach to positive and adverse effects on VCs.

a. **Cumulative Effects Assessment**: consideration of the potential cumulative effects arising from Project effect interactions with other projects, past, existing or future. To be considered a cumulative effect, the other past, existing and future projects being considered in the assessment must affect a VC that is also being affected by the principal project; in this way the projects act cumulatively upon a valued component.

b. **Residual Effects**: summaries of the type and extent of any residual environmental effects of the Project after implementation of the proposed mitigation, including characterization with rationale as to whether adverse residual environmental and socio-economic effects are significant or not significant, as defined in S. 58 of YESAA. Included as part of mitigation are any plans for responding to any known or predicted residual effects, and procedures for identifying and responding to effects that were not predicted or foreseen.

.4 **Monitoring and Adaptive Management**: development of recommendations for monitoring and adaptive management of residual Project-specific and cumulative effects.

6.4 SCOPING OF THE ASSESSMENT

This step includes:

- Identifying issues of concern related to the Project,
- Selecting VCs for further examination that include both Environmental and Socio-economic,
- Identifying potential sources and pathways of effects from the Project to each VC selected,
- Identifying spatial and temporal boundaries for assessing effects of the Project for each selected VC; and
- Identifying other actions and effects pathways that may act cumulatively with the Project to affect the same VCs.

As stated in Stantec's Project Proposal, a number of Valued Components have been anticipated for various phases or activities associated with the physical works of the proposed Project. From a preliminary perspective, these can be defined as follows:

Table 6.1: Potential Interactions of the Power Facility with the Environment

Phases, Activities or Physical Works Associated with the Power Facility	Atmospheric Environment*	Water Resources	Freshwater Environment	Terrestrial Environment	Health and Safety	Land Use and Infrastructure	Archaeological and Heritage Resources	Traditional and Aboriginal Resources	Transportation	Labour and Economy	Effects of Environment on Project
Construction	1	1	0	1	1	1	1	1	1	1	1
Operation	1	1	0	1	1	1	0	1	1	1	1
Decommissioning and Abandonment	1	1	0	0	1	1	0	0	0	1	1

KEY
0 = No interaction. The environmental effects are not significant and not considered further in the assessment.
1 = Interaction occurs; however, based on past experience and professional judgement the interaction would not result in significant environmental effect, even without mitigation; or interaction would not be significant due to application of codified environmental protection practices that are known to effectively mitigate the predicted environmental effects. The environmental effects are not significant and not considered further in the assessment.
2 = Interaction could result in environmental effect of concern even with mitigation; the potential environmental effects are considered further in this assessment.

*Stantec assessment methodology incorporates air quality, greenhouse gases and acoustic quality under the Atmospheric VC.

Table 6.2: Potential Interactions of the Feedstock Harvest with the Environment

Phases, Activities or Physical Works Associated with the Feedstock Harvest	Atmospheric Environment	Water Resources	Wildlife Resources*	Vegetative Resources*	Health and Safety	Land Use and Infrastructure*	Archaeological and Heritage Resources*	Traditional and Aboriginal Resources*	Transportation	Labour and Economy	Effects of Environment on Project
Construction	1	1	2	2	1	2	2	2	1	1	1
Operation	1	1	2	2	1	2	2	2	1	1	1
Decommissioning and Abandonment	0	0	1	1	0	0	0	0	0	0	1
KEY 0 = No interaction. The environmental effects are not significant and not considered further in the assessment. 1 = Interaction occurs; however, based on past experience and professional judgement the interaction would not result in significant environmental effect, even without mitigation; or interaction would not be significant due to application of codified environmental protection practices that are known to effectively mitigate the predicted environmental effects. The environmental effects are not significant and not considered further in the assessment. 2 = Interaction could result in environmental effect of concern even with mitigation; the potential environmental effects are considered further in this assessment.											

*Rankings subject to change as substantial unknowns exist regarding the site location. If feedstock harvesting represents a large footprint, higher rankings for wildlife, traditional pursuits, heritage/cultural uses, tourism (including viewscapes and related tourism land uses such as guiding, outfitting, etc.). There may be substantial unknowns regarding the possible mitigation measures.

The scope of this assessment will be focused on components that could be linked to the Project; as set out in the YESAB Guide to Assessment, both project-specific issues and regional issues that are relevant to the project need to be considered in the establishment of VCs. Therefore Valued Components have potential to be modified throughout the feasibility study, to be finalized upon its completion. Similarly, determination of VCs and environmental and socio-economic scoping requires input from local communities and interested parties; in this case, that may involve field studies and consultation that may not be completed by the end date of this Project phase. This should be noted and VCs revisited when a final Project Proposal for the Feedstock and Facility components is completed.

Other scoping considerations include the identification of spatial and temporal boundaries for the assessment of the Project effects on selected VCs. At this time, both of these boundaries have yet to be determined as the Project location, phases and schedule have not been set. However, YESAB Guides provide definitions which will be adhered to when they are chosen:

Construction Phase: This phase generally consists of the estimated time required to complete the construction of the Project, including commissioning of the facilities.

Construction Footprint Area: Construction Footprint Area is the geographic area needed for construction and operation of the physical infrastructure associated with Power facility (i.e. power access, access road, the plant, office, log storage yard, chipping plant, chip storage – conveyor, hopper, etc.).

Operation Phase: The time period following construction, through the life of the relevant components of the project, during which time the project will be used for its primary purpose of power generation.

Decommissioning Phase: The time period following operation when the Facility is no longer being utilized for its primary purpose; this may include transitioning the facility to another use or closure and abandonment.

Project Study Region: A Project Study Region for examining potential environmental and socio-economic effects has yet to be defined. Once defined, the extent of a baseline assessment for each VC required will be added.

6.5 BASELINE CONDITIONS

For use in assessing the Project's environmental and socioeconomic effects, the baseline conditions for the selected VCs will be considered through a desktop analysis. Baseline conditions will be characterized using published data and information generated in the Feasibility Study. Information may also be obtained through consultation with interested and informed parties and potential field surveys (to be conducted as required at a later date and not as part of the scope of Stantec's current assignment).

In summary, baseline conditions for each VC are proposed to be based on:

- **Atmospheric Environment:** (Air quality, greenhouse gases and sound quality)- for air: inferred from existing ambient data measured in Whitehorse as well as any available local qualitative or quantitative information (existing sources of emissions in the area); for greenhouse gases: existing provincial inventory of GHG emissions as reported to Environment Canada; for sound: inferred based on monitoring data for areas of similar land use based on Stantec's professional judgment;

- **Water Resources:** Summary of existing municipal water supply in the area of the Project and discussion of any nearby surface or groundwater resources based on readily available data.

- **Wildlife Resources:** Summary of existing wildlife in the Project area based on readily available previously conducted studies and local information.

- **Vegetative Resources:** Summary of existing vegetation on the Project site based on a qualitative assessment of the site and any readily available desktop information (recommendations for field assessment requirements to be provided).

- **Health and Safety:** Summary of existing Yukon Energy health and safety program, records.

- **Land Use and Infrastructure:** Summary of existing land use and infrastructure on the Project site and directly adjacent sites.

- **Archaeological and Heritage Resources:** Summary of readily available documentation on archaeological and heritage resource potential on the Project site.

- **Traditional and Aboriginal Resources:** Summary of readily available documentation and discussion of any information obtained through consultation on traditional and aboriginal use of the Project site.

- **Transportation:** Summary of readily available information on traffic volumes and road way level of service designations in Haines Junction.

- **Labour and Economy:** Summary of readily available information on existing employment stats, economic drivers in Haines Junction.

- **Effects of Environment on the Project:** Summary of readily available climatic data (wind speeds, precipitation levels, temperature normal).

6.6 EFFECTS & MITIGATION

Once baseline data is collected for each VC, the assessment will consider the effects of the Project, as well as other actions which may act cumulatively with the Project, on the selected VCs. Effects are examined for the construction, operation and decommissioning phases of the Project. Where required, mitigation to minimize environmental effects on each VC will be included in the assessment. Further details summarizing VC-specific effects will be incorporated as existing conditions are established through site determination process.

6.6.1 Cumulative Effects Assessment

The cumulative effects assessment (CEA) is integral to the assessment approach and examines the likely effects of the Project in combination with the likely effects of other past, existing and future projects and activities.

The assessment of potential cumulative effects will be conducted for all environmental and socio-economic VCs. Each assessment begins with a screening that involves determining whether or not all three of the following conditions are met:

- The Project results in a demonstrable or measureable residual environmental effect on the VC.
- The Project-specific residual environmental effect on the VC does or is likely to act in a cumulative fashion with the effects of past, existing or future projects and activities in the area (i.e. there is not spatial or temporal overall of effects).
- There is a reasonable expectation that the Project’s contribution to cumulative environmental effects will affect the viability or sustainability of the VC.

Cumulative effects assessment proceeds beyond a screening-level assessment for an effect only when all three of these conditions are met. Although YESAA does not require that a project proposal submission to the Executive Committee consider cumulative effects, it is standard practice in environmental assessment and will be included as part of the submission. The cumulative effects analysis conducted is designed to assist in determinations regarding whether there will be any significant adverse cumulative environmental or socio-economic effects.

The cumulative effects framework suggested by YESAB is similar to that of a federal assessment and includes:

- The identification of regional VCs.
- The compilation of cumulative effects VC baseline information.

- The determination of spatial boundaries for the assessment.
- Identification of other projects and activities and a determination regarding their residual effects.
- The determination of the temporal boundaries of the assessment.
- Identification of potential cumulative effects, the characterization of such effects and identification of mitigation measures.
- Determination of significance of identified cumulative effects.
- Consideration of other Projects including:
  - Other projects for which proposals have been submitted under Subsection 50(1) of YESAA;
  - Existing or proposed activities in or outside Yukon that are known to the Designated Office, Executive Committee or Panel of the Board from information provided to it or obtained by it under YESAA.
  - Those projects whose effects are likely to act in combination with the anticipated effects of the proposed Project.

Similar to other assessment frameworks, where adverse cumulative effects are considered likely, mitigation measures will be designed and determinations made regarding the significance of the residual adverse cumulative effects after the application of those mitigation measures.

6.7 RESIDUAL EFFECTS AND EVALUATION OF SIGNIFICANCE

Significance will be evaluated by comparing residual effects against VC thresholds such as standards or guidelines, targets, or acceptable limits of change. Land use objectives or trends may also be used, as per local regulatory guidance. YESAB Guides detail further acceptable criteria that can be used to evaluable the significance of adverse residual effects from the Project after recommended mitigation measures are considered.

6.8 DETERMINATION OF SIGNIFICANCE

Adverse and likely effects are critical in the determination of significance in the assessment process. In relation to YESAA, this determination must include the recognition of traditional and local knowledge including:

- The need to protect the rights of Yukon Indian persons under final agreements.

- The special relationship between Indian Yukon persons and the wilderness environment of Yukon.
- The cultures, traditions, health and lifestyles of Yukon Indian persons and other residents of Yukon.

Similar to federal assessment practice, YESAB Guides detail the following criteria to evaluate the significance of adverse residual environmental and socio-economic effects:

Direction or Nature of the Effect: Positive, neutral, or negative/adverse; in the case of socio-economic effects, effects may at times be considered to be both positive and negative.

Magnitude of the Effect (level of detectability of effect):

- Low (effect unlikely to be detectable or measurable, or below established thresholds of acceptable change; for some environmental assessments, less than 5% of the VC population or area is affected).
- Moderate (effect could be detectable within normal range of variation with a well-designed monitoring program,10 or below established thresholds of acceptable change; for some environmental assessments, from 5 to 10% of the VC population is affected).
- High (effect would be readily detectable without a monitoring program and outside normal range of variation, or exceeds established thresholds of acceptable change; for some environmental assessments, greater than 10% of the VC population or area is affected).

Geographic or Socio-Economic Extent of the Effect:

- Low (effect extends only within the Construction Footprint Area).
- Moderate (effect extends beyond footprint and is within the Project Study Region; for socio-economic effects, extends to include the community of Mayo).
- High (effect extends beyond Project Study Region and is within Yukon, or extends outside Yukon.

Duration of the Effect (how long the effect would last):

- Low (short-term effects lasting less than one year, or not materially beyond the duration of the construction phase of the Project).
- Moderate (medium-term effects lasting from 1 to 10 years, or no more than one-generation span of the species affected).
- High (long-term effect lasting more than 10 years or more than one generation of the species affected; effects lasting throughout a major portion of the operations phase of the Project).

Frequency of the Effect (how often the impact would occur):

- Low (never, once, seldom).
- Moderate (occasionally).
- High (continuously - on a regular basis or at regular intervals).

Reversibility of the Effect (is the effect reversible and if so can it be reversed in the short or long term):

- Complete Reversibility (immediate, or reversible over very short periods i.e., less than one year).
- High Reversibility (good probability of effect being reversible, periods 1 to 10 years or no more than one-generation span of the species affected).
- Low Reversibility (Irreversible, or reversible over the period of more than one generation of the species affected).

Ecological or Socio-Economic Context (sensitivity to environmental or socio-economic disturbance, capacity to adapt to change):

- Low (VC is resilient to imposed change).
- Moderate (VC has some capacity to adapt to imposed change).
- High (VC is fragile and has low resilience to imposed change).

The assessment of significance for environmental effects determines a clear overall direction of change (positive, neutral or negative/adverse) for the VC. In contrast, the assessment of significance for socio-economic effects must also consider the following:

- The relevance of perceptions in affecting how people view changes.
- Differing perspectives and values among different groups of people about their community and region, as well as their individual and family circumstances.
- The problems inherent in assessing separately effects on different aspects or components (i.e., different VCs) of people‘s lives that each contribute to an overall ―effect‖ on any group of people, i.e., effects may be either positive or negative, depending on the people affected, and may be both positive and negative when different groups are affected differently or when different VCs are considered for the same group.

Definitions for the likeliness of adverse residual effects will be distilled from the above and identified by the Project Team as the study progresses.

6.9 MITIGATION AND ADAPTIVE MANAGEMENT/MONITORING

The Executive Committee level screenings require suggested monitoring methods in order to manage effects. Monitoring effects is necessary in order to determine the success and suitable of mitigation measures, and to ensure predicted effects were accurate. Unanticipated effects will also be identified through monitoring and adaptive management designs.

7.0 Sources of Project Financing

As part of the Phase 5 – Project Financing task, Stantec has conducted preliminary research into potential sources for project funding. At the kick-off meeting in Whitehorse on September 19th, one potential source of funding discussed was Sustainable Development Technology Canada (SDTC). Stantec reviewed the workshop presentation for SDTC (attached) and provide the following comments.

7.1 SUSTAINABLE DEVELOPMENT TECHNOLOGY CANADA

SDTC operates two funds intended to stimulate investment in sustainable technologies. The first fund is the “SD Tech Fund™” which is ten years old and aimed at development of emerging clean technologies. The key here is the word “emerging”. To be eligible, the Yukon biomass would have to be considered “unproven”[2].

The second fund managed by SDTC is the “NextGen Biofuels Fund™”. This fund is aimed at “large demonstration-scale facilities for next-generation renewable fuels and co-products.

Both of these funds were discussed with Paul Austin (SDTC, Vancouver office), to determine potential eligibility for the Yukon project.

Unfortunately this project is likely to not qualify for either funding. The SD Tech Fund is strictly for new technologies or innovative use of clean technologies, and a proven biomass technology / waste heat application is not what SDTC is looking for in new applications. With regard to the NextGen Fund, it is for “first of a kind” type biofuel projects already in a continuous operation mode.

7.2 POTENTIAL FUNDING SOURCES

Research indicates that there are other funding programs that may be applicable to the project. These will require direct follow-up with the applicable government agencies to determine if it is worthwhile to apply. Furthermore, once (if) a waste heat option is finalized, this may also lead to other funding opportunities.

From Canadian Northern Economic Development Agency there are the following programs. Strategic Investments in Northern Economic Development (SINED)

SINED has been allocated $22 million funding per Territory for the years 2009-2014 as part of its Targeted Investment Program (TIP). The four areas of focus for TIP are building the knowledge base, enhancing the economic infrastructure base, capacity development, and

[2] SDTC states in the presentation materials under the heading “SOI Don’ts” – Proven Technology = no need for SDTC

economic diversification. It is possible that the Yukon project could qualify for funding as an economic diversification plan.

7.2.1 Community Economic Opportunities Program (CEOP) /

The CEOP and CEDP funding provides project-based support and core operational support for First Nation communities for projects that lead to more community employment, greater use of land and resources, enhanced community infrastructure etc..

7.2.2 Community Infrastructure Improvement Fund (CIIF)

The CIIF program provides up to $1 million in funding for projects that improve community infrastructure. Recipients of the program must be not-for-profit entities, local/territory governments or First Nations. Infrastructure must be directly accessible to the public (i.e. district heating) and must be materially completed by March 31, 2014. There is some question whether the Yukon project would qualify due to restrictions pertaining to commercial activities.

From Natural Resources Canada (NRCan), who is funding this Yukon feasibility study via its ecoEnergy Initiatives Program, may also have possible funding availability under grant programs as follows.

7.2.3 Aboriginal Economic Development in Forestry

The Canadian Forest Service (CFS) has been mandated by AFI to provide knowledge and facilitate coordination of federal support programs for Aboriginal economic forestry development, of which bioenergy is a priority focus. Limited multi-year funding may be available from AFI where it is determined that critical gaps exist in support from other programs that may pose a risk to project success. There is no formal application process involved. Instead, any funding will be subject to the CFS identifying the need and strategic value of the project as well as availability of the funding from AFI.

7.2.4 Biomass for Energy Program

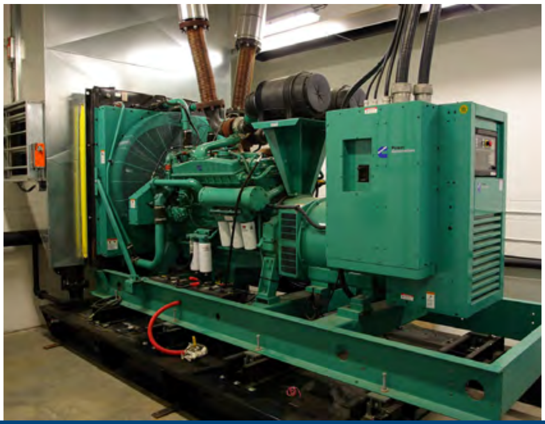
Established in 2000, the Biomass for Energy Program focuses on research and development related to technologies used in the growing, harvesting and transportation of biomass feedstock. The program is also funded through the Canadian Forest Service.

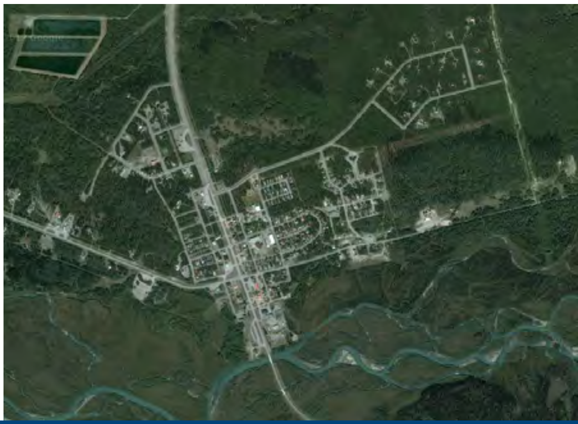
As part of the federal government Office of Energy Research and Development (OERD) is another potential research and development grant program focusing on biomass technologies.

7.2.5 Bio-based Energy Systems and Technologies (BEST) Program

This program supports the research and development of technologies used to improve the supply, conversion and utilization of both existing and new biomass feedstock supply.

Finally, for taxable entities, accelerated Capital Cost Allowance provisions are available for capital assets used in the production of energy using renewable fuel sources. The provisions allow for an increased depreciation of equipment at a rate of 30% annually.



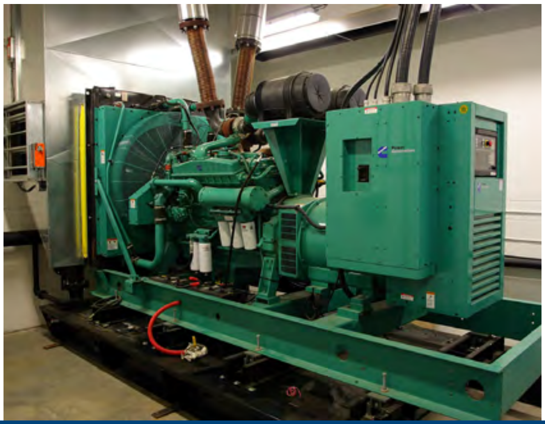


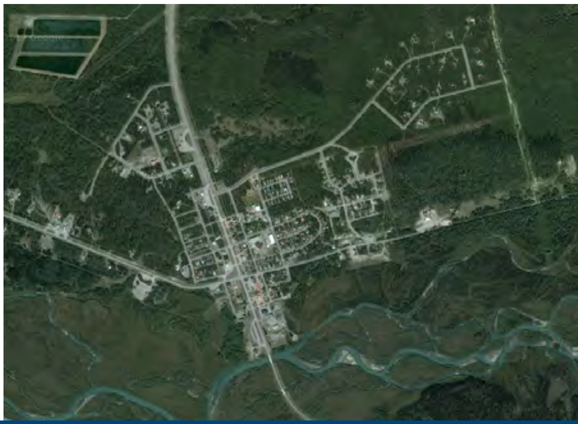
APPENDIX B

Interim Report #2

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7





REPORT

Interim Report #2 - Vendor Site Visits

Front End Engineering Design (FEED) Study

Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

December 3, 2012

Stantec

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6.0 PATH FORWARD 6.4

1.0 Introduction / Report Objective

Stantec Consulting Ltd. (Stantec), in partnership with AFGOR Inc. (AFGOR), has been contracted to carry out Yukon Energy Corporation's (YEC) Front End Engineering Design (FEED) Study for the Yukon Bioenergy Demonstration Project in Haines Junction, Yukon. The objective of the study is a draft report to be delivered on January 26, 2013 covering the following project results:

- Evaluation and selection of a preferred technology for a small-scale bioenergy demonstration project in Yukon.
- Completion of a preliminary design for a preferred project location in Haines Junction, Yukon.
- Clearly defined business model.
- Identified additional funding sources.
- Business case analysis that will clarify the financial viability of the project.
- Technical, financial and regulatory risk management strategies.
- Drafted baseline conditions and impact assessment to form part of the project proposal submission to the Yukon Environmental and Socio-Economic Assessment Board related the bioenergy facility.
- Description of all environmental requirements associated with the project, as well as an outline of foreseeable potential project impacts, and mitigations that will be implemented to reduce project effects. The status and timelines for obtaining all required environmental approvals will also be outlined.
- Overview of engagement activities undertaken throughout 2012, and the results / outcomes of these activities (e.g. issues, challenges and opportunities identified), and a defined engagement and technology transfer strategy for the detailed design and subsequent phases of the project.

1.1 REPORT OBJECTIVE

This interim report is the second of two to be completed during the study, and represents project findings with respect to vendor site visits completed in November. This report seeks to highlight findings from the vendor site visits, as well as provide a high level financial assessment of the vendor installations. The financial assessment is drawn from information provided by the vendors/owners, as well as publically available information.

The vendor site visits were completed on November 5 and 6, 2012. A site visit of Nexterra's installation at the University of British Columbia (UBC) was completed on November 5, while visits to Entropic at the University of Manitoba (U of M) and Community Power Corporation (CPC) at the Pineland Forest Nursery in Hadashville, Manitoba was completed on November 6, 2013.

A six (6) person team represented the project during the visits, three (3) from Stantec and three (3) from the Steering Committee. Stantec representatives included Chris van Driel (Project Manager), Rick Grey (Mechanical Lead), and Michael Wright (Electrical, Instrumentation, and Controls Lead). Steering Committee (SC) representatives included Shannon Mallory (Deputy Project Manager – Yukon Energy (YEC)), Ray Well (SC Co-Chair, Champagne and Aishihik First Nations (CAFN)), and Hector Campbell (SC member, YEC).

This report is broken into five chapters, one (1) for each site visit, one (1) for the financial assessments, and the final chapter to summarize the path forward.

2.0 Nexterra Visit – November 5, 2012

The site visit for Nexterra took place at 10:00 am on Monday, November 5, 2012 on the UBC campus. The visit was facilitated by Phil Beaty, Vice President, Strategic Relationships, for Nexterra, and Brent Sauder, Director, Strategic Initiatives for UBC. Initially the group met in a conference room on campus to discuss the university's experience during the project's development and execution. This was followed by a guided tour of the facility with the Nexterra representative and operating staff only. During the visit the plant was operational.

2.1 PROJECT OVERVIEW

This project was kick-started by John Grace of UBC based on his academic research into gasification and more specifically gas conditioning/clean-up. UBC and Nexterra wanted a demonstration sized plant to prove the concept and facilitate R&D at the university. Based on the UBC concept, GE came in as a partner and supported the development.

UBC is unique in that it is its own municipality with its own substation. The challenge in BC is the low power rates brought on by their hydro resources. That said; UBC still had the desire to demonstrate a BC technology in BC. On the waste heat side, they are also in the process of converting their existing steam district heating system over to hot water.

For UBC the social license was the first step, with five (5) sites initially under consideration. Faculty members were quick to get onboard for the research ability, and the community soon adopted a "yes, in my backyard" mentality. In the end the unit was located on the edge of the campus in order to reduce truck traffic for fuel deliveries. During full operation, UBC receives three (3) trucks a day, with enough storage for a three (3) day weekend.

On the permitting side UBC requested the strictest emission regulations be met. To that end, UBC requested that the system be designed and will be tested to meet Metro Vancouver requirements, as well as those in the USA jurisdictions of San Joaquin Valley and Massachusetts. The facility is further equipped with a local and external air shed monitoring system.

Building construction was initially completed using standard steel building formats. During the project's development UBC worked with FP Innovations and selected a new construction method – cross linked timber or CLT. The current facility uses CLT for the roof and walls of the building.

The Nexterra system does require trained operators to run the facility. Operators would require similar skills to that of boiler operators, and if a hot water system was installed, they would not require steam tickets. That said, a 4th to 3rd class ticket would be a starting point for skilled operator requirements. Although the system is fairly automated, skilled operators are required to react quickly in an upset condition. As a minimum, the system requires two (2) full-time staff on-site 24 hours a day / 7 days a week. Currently the UBC plant operates in eight (8) hours shifts, requiring a minimum of eight (8) trained operators to support the plant.

2.2 SITE TOUR

Following the sit-down discussions, the group toured the plant installation. The following photos follow the sequence of the tour with highlights as noted for information.

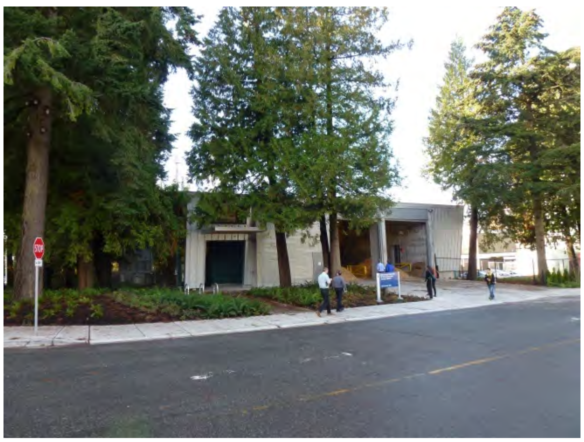


Figure N1: Building Exterior

Figure N2: Fuel Receiving

Located directly on campus, the facility's architectural design made it difficult to distinguish between other buildings on campus. Plant footprint is approximately 90' x 180'. Fuel is received and unloaded using walking-floor transport trucks.

Figure N3: Gasifier Fuel

Figure N4: Fuel Rejects

Figure N5: Fuel Reclaim System

Figure N6: Fuel Processing

The Nexterra unit currently runs on chips brought in through a third party. Fuel is reclaimed from the fuel bunker and processed with a disc screen (for size and contaminant control) and a magnet (to prevent metals from entering with the fuel).

Figure N7: Biomass Dryer

Figure N8: Fuel on Dryer Belt

After fuel processing, the biomass is fed to a single pass dryer. Fuel is wet when received (approximately 40%) and needs to be dried to 20% moisture content by weight, before entering the gasifier. Both bottom and fly ash from the unit is sent to landfill, spent activated carbon (from the filtration system) is disposed of by burning in the oxidizer.

Figure N9: Metering Bin Ahead of Gasifier

Figure N10: Single Nexterra Gasifier

Following the dryer, fuel is fed to the day bin for storage and then onto the metering bin prior to being fed into the gasifier. For UBC, Nexterra installed two parallel gas paths to facilitate the generation of electricity and heat using the engine, and a second path using an oxidizer to generate heat and steam to service the district energy network.

Figure N11: Thermal Oxidizer

Figure N12: Thermal Stack

Figure N13: Water Heater

Figure N14: Electrostatic Precipitator

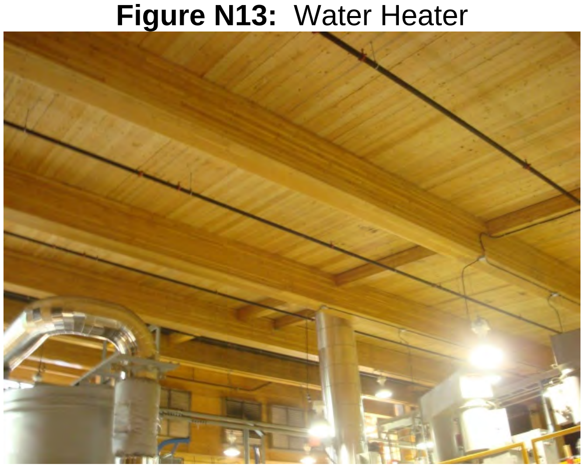


Figure N15: Cross Laminated Timbers

Figure N16: Auxiliary Equipment

Due to the proprietary nature of the installation, photos could not be taken of the syngas clean up equipment. Rather than entering the oxidizer and water heater as shown above, the syngas for the engine enters a series of vertical vessels used to cool the gas and reheat it, before and after the tar cracker. The tar cracker, as its name suggests, is used to 'crack' and breakdown tars that are present in the syngas (to prevent damage to the engine).

Figure N17: 2 MW_e Jenbacher Engine

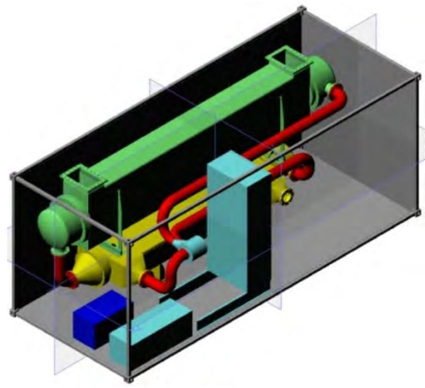
Figure N18: 2 MW_e Jenbacher Engine

After the tar cracker the gas is cleaned by injecting a sorbent and collecting the particulate in a filtration system (bag house). From the filtration system the gas is feed to the Jenbacher reciprocating engine. The UBC installation features a Jenbacher 620 GS, a 20-cylinder reciprocating engine capable of delivering approximately 3.3 MW_e of electricity on natural gas. As the biomass syngas has a lower calorific value then natural gas, the unit is derated and limited in the peak power it can generate. The 620 is guaranteed to generate the 2 MW_e based on syngas from Nexterra.

2.3 OVERALL IMPRESSION

General impression of the group following the visit was that the installation was very large and more complex than expected. The size of the facility, number of operators, and perceived complexity of operation did not seem appropriate for a unit to be located in Haines Junction. The capital cost, maintenance requirements, parts availability, and service technician/operator skill set were also of concern. Mr. Beaty re-iterated that the UBC unit was the first of its kind and Nexterra is not actively marketing it. It will be more than a year before annual performance numbers are available, and only then would Nexterra begin to entertain installing their second unit.

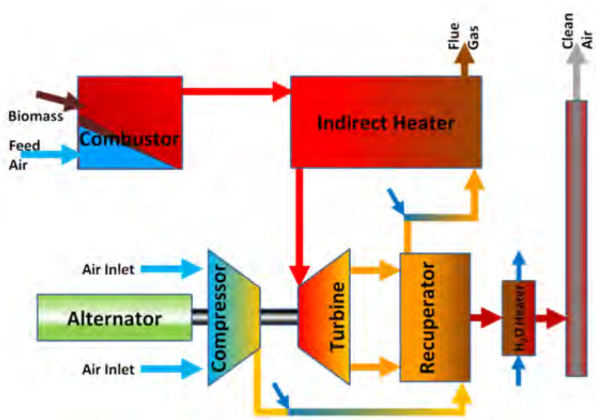
3.0 Entropic Visit – November 6, 2012



The site visit for Entropic took place at 9:00 am on Tuesday, November 6, 2012 on the University of Manitoba (U of M) campus. The visit was facilitated by Dr. Eric Bibeau, NSERC/Manitoba Hydro Industrial Research Chair in Alternative Energy and co-founder of Entropic. Initially the group met in Dr. Bibeau office on campus to discuss the Entropic's technology and product development. This was followed by a guided tour of the installation with Dr. Bibeau. During the visit the plant was not operational and it was unclear when it would achieve "demonstration" status.

3.1 PROJECT OVERVIEW

Entropic is in the R&D stages of their technology. The concept is to design a biomass system with a small footprint that can compete on a conventional technology's price point of \$4M/MW$_e$. Using the price point as a basis Dr. Bibeau and this team are trying to apply a hybrid Brayton Cycle to achieve high efficiency power generation in a modular package of 250 kW$_e$.



The Entropic design builds upon that of the indirect fired Brayton Cycle. The principle difference is in the thermodynamics in that they inject water at critical points in the process to increase unit efficiency. Although only currently theoretical in models, the team at U of M are trying to get their unit up and running. Should they be successful, the hybrid design touts the benefits of maximized energy transfer through increase mass through the turbine, decreased turbine inlet temperature (therefore reduced stress on the unit), maximize equipment capacities, and overall increase in efficiency – to double that of a standard externally fired unit.

3.2 SITE TOUR

Following the sit-down discussions, the group toured the plant installation. The following photos follow the sequence of the tour with highlights as noted for information.

Figure E1: Unit is Located Inside the Trailer

Figure E2: Unit Inside the Trailer

The Entropic unit is located inside a trailer/container in a private research area of the university campus. The unit occupies approximately a third of the container.

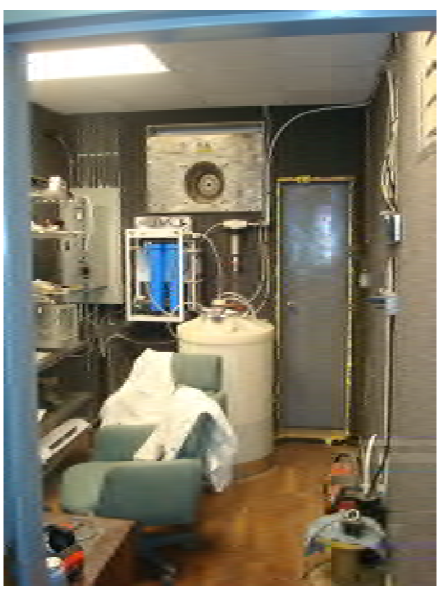


Figure E3: Control Room and Water Treatment Area

Figure E4: Unit from Rear of Trailer

The control room and water treatment area are located in the back quarter of the trailer. Water treatment requires the use of a reverse-osmosis (RO) unit to purify the water before use. Water is injected into the air/syngas and must be pure of contaminants.

Figure E5: 100 kW_e Micro-Turbine

Figure E6: Propane Combustion Chamber

In contrast to the Jenbacher which occupies and entire room, the micro-turbine used by Entropic was significantly smaller and more compact. The unit as shown contains the air compressor, turbine, and generator/alternator. As the unit is not yet operational, it is currently fired on propane instead of biomass for testing purposes. No biomass handling equipment was available for review.

3.3 OVERALL IMPRESSION

General impression of the group following the visit was that this technology/vendor was not appropriate for future consideration. The technology is not near a viable status for consideration on this project, though appears promising.

4.0 CPC Visit – November 6, 2012

The site visit for Community Power Corporation (CPC) took place at 1:00 pm on Tuesday, November 6, 2012 at Pineland Forest Nursery in Hadashville, Manitoba. The visit was facilitated by Carl Peterson, Field Engineer, for CPC. This unit is located on and integrated to Pineland's operations, but is owned by Manitoba Hydro. Jeremy Langner is the Project Manager for Manitoba Hydro (MH), but was unavailable at the time of the site visit. Mr. Langner did provide Stantec with some information on the project as a follow-up to the visit. The General Manager of Pineland, Trevor Stanley, was also unable to attend the site visit, but joined the group later in the evening to answer questions and discuss the project. The tour of the unit took place immediately upon arrival, with questions & answers carrying the group through until departure. During the visit the plant was operational.

4.1 PROJECT OVERVIEW

The following overview was developed from follow-up information provided by Mr. Langner.

The CPC system is manufactured in a series of five (5) 20 ft. shipping containers. Shipping the unit in this containerized form allows the majority of the work to be performed at the manufacturer's facility. The Pineland system was installed in June and July 2012, and Manitoba Hydro/CPC/Pineland have been testing it ever since. The unit has been run to peak capacity and has been able to generate a maximum of approximately 120 kW_e of electricity gross, with about 20 kW_e of parasitic loss. Pineland is also recovering heat off of the engine's cooling jackets and exhausts, and sending this to a thermal loop to heat greenhouses. The heat supplements Pineland's existing 2 MWth biomass boiler, located in an adjacent building.

The CPC system uses a stainless steel downdraft gasifier with air injection points throughout the fixed bed. There is a vibrating grate that can dump material if required. The temperature profile is precisely controlled throughout the bed to insure good gas quality. This allows the filtration system to be very simple – filter bags with backup carbon safety filters. This filters out a very fine carbon dust from the gas. The gas is then sent to two (2) 8.1 L V8 spark-ignition engines, each connected to a 65 kW_e alternator. Another feature of the system is the biomass dryer that uses heat from the gas cooling heat exchanger to dry the feedstock. This allows MH/Pineland to accept up to 45% moisture content, and dry down to approximately 15% moisture.

With regards to fuel rates and flows, MH currently pays in the range of $55 to $65 per tonne as delivered for their biomass supply. The wood chips come from several sources within 2 hours or less of the project site. The fuel consumption is stated by CPC as 90 kg of dry biomass per hour, however, MH have not been running consistently enough to determine a more accurate figure. The CPC system can accept ¼" x ¼" through 2" x 2" chips.

As far as maintenance costs are concerned, MH does not have enough data to provide concrete figures. It will highly depend on the number of oil changes per month. CPC has specified an oil change every 10 days. MH are also budgeting the equivalent of 1 hour per day of daily checks, and 2 to 3 man-days per month spent on gasifier maintenance. During this initial start-up phase, these numbers are expected to be higher.

Operating efficiency is also difficult to determine giving the limited operating hours. Assuming MH/Pineland are burning 90 kg/hr for 100 kW of output (net), and the biomass has a higher heating value of 20 MJ/kg (dry), MH would have a net electrical efficiency of approximately 20%. MH believes that the total efficiency will be at least double when they include the heat.

In a discussion with the Mr. Peterson, CPC typically provides four weeks of commissioning and start-up services. This includes two (2) weeks on-site for commission the unit and systems, one (1) week of full-time training for site personnel, and one (1) week of field supervision following the training. Beyond the four (4) weeks, Mr. Peterson indicated that CPC monitor the unit remotely for any system warnings or errors. As for the level of skill required to operate the units, Mr. Peterson indicated that the majority of operators are ex-electricians or ex-mechanics. Ex-electricians are preferred give the system electronics and potential advantage when troubleshooting problems, but both have been successful at operating the units.

4.2 SITE TOUR

Upon arriving the group toured the plant installation. The following photos follow the sequence of the tour with highlights as noted for information.

Figure C1: Plant Exterior

Figure C2: Fuel Receiving

The five (5) container system is located on a concrete pad next to the fuel storage/receiving building.

Figure C3: Fuel Storage Interior

Figure C4: Fuel Bin (3 Days Storage)

The existing fuel storage building was retrofitted with the new fuel bin for the CPC plant. The bin is loaded from the top, and can hold sufficient fuel for three (3) days of operation.

Figure C5: Auger Supplying Biomass

3

Figure C6: Biomass Dryer

An auger carries the biomass from the bin to the biomass dryer located in the first of the five (5) containers. The dryer is used to dry the incoming biomass fuel, and uses hot air from the syngas cooling process to dry the fuel. The desired moisture content is around 15% (16.5% during the visit).

Figure C7: Downdraft Gasifier

Figure C8: Gasifier Bottom Ash

Following the biomass dryer, fuel and air enter the gasifier. Ash is collected at the bottom of the gasifier and conveyed to a storage bin outside the container. Bins need to be checked regularly, and emptied approximately every two (2) days (48 hours).

Figure C9: Downdraft Gasifier

Figure C10: Gasifier Bottom Ash

Leaving the gasifier, the hot syngas is cooled using fresh/filtered air, which is in-turn, sent to the biomass dryer to dry the incoming biomass. The cooled syngas is sent to the container above to be filtered.

Figure C11: Carbon Filters

Figure C12: Fly Ash Collection

The filters are located in the container above the gasifier in a series of five (5) cabinets (four (4) online, one (1) offline for cleaning. Fly ash that is collected is sent to the barrels on the outside of the unit that need to be emptied every 100 hours.

Figure C13: Engine #1 (Front of Container)

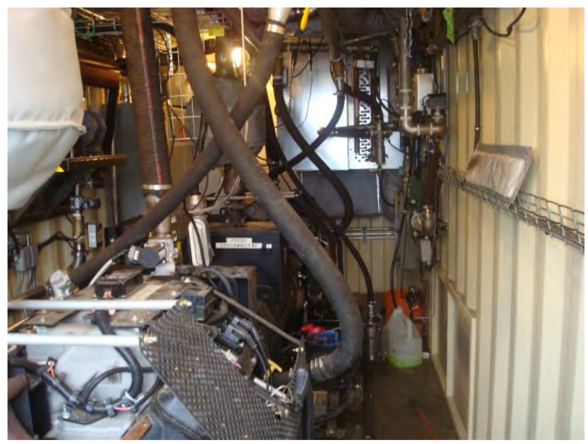


Figure C14: Engine #2 (Rear of Container)

Cleaned syngas from the filters in delivered to the two engines in the final process container. The two V8 spark ignition engines are located in the same container (with little room to spare).

Figure C15: Control Room/Container

Figure C16: Heat Recovery

The final container of the set houses the control room and all the units' electrical equipment. The control interface is a custom built interface to support unit operations. The CPC unit does integrate waste heat recovery in its operation by way of hot water being sent to the existing biomass boiler house hot water heater. The hot water displaces the need to use their biomass boiler. The hot water loop is currently running with 40°C - 60°C temperature difference, but will be looking to achieve 50°C - 70°C once running consistently.

4.3 OVERALL IMPRESSION

General impression of the group following the visit was that this technology/vendor was the most appropriate of the three for Haines Junction. Apart for the small capacity (100 kW_e) the plants simplicity, operations, level of operator skill required, and proven heat recovery potential make is a strong candidate for installation in the Yukon.

5.0 Financial Assessment

Before attending the site visit, Stantec envisioned being able to provide the Steering Committee (SC) with a detailed breakdown of the vendor's installation for review and comparison. Unfortunately, the vendor's/owner's of the systems were not interested in sharing these details with the project team. Some information has been received on general project parameters and Stantec has tried to pull together some online resources to fill in the blanks. The following subsections outline the finding for the Nexterra UBC installation and the CPC Pineland installation. Entropic data is not available and therefore not considered.

5.1 NEXTERRA

Data for Nexterra was achieve through two sources, the first being Phil Beaty of Nexterra[1] and the second publically available information from UBC during their Board of Governors approval process. During this process, Nexterra re-iterated that they "are not currently marketing the Nexterra/GE Jenbacher high efficiency CHP solution. Accordingly we are not offering typical price and delivery information."

From the UBC documentation[2]:

Equipment Procurement	$12,500,000
Field Installation	$3,800,000
Building Design & Construction	$6,400,000
Site Services	$1,200,000
Landscape and Office Relocation	$1,300,000
Contingency	$800,000
Total Project Capital Cost	**(2009) $26,000,000** **(2012 @ 2.0%/yr) $28,100,000**

Of this projected capital cost, 23% was to be provided by UBC and other private sources, while 29% was to be received through Provincial funding programs, and the remaining 48% through Federal government funding (mainly Clean Energy Fund, SDTC, and NRCan). Recent correspondence with Nexterra puts a new project capital cost at $18M - $20M but excludes the building, foundations, and balance of plant equipment (which is not detailed).

5.2 COMMUNITY POWER CORPORATION

Data for CPC was achieved through two sources, the first being Jeremy Langner with Manitoba Hydro[3] regarding the Pineland installation and the second, a publically available pre-feasibility

1 Personal correspondence, Phil Beaty to Chris van Driel, Nexterra Site Visit, 16 November 2012
2 The University of British Columbia, Request for Decision, 9 September 2009, Bioenergy Research and Demonstration Project.
3 Personal correspondence, Jeremy Langner to Chris van Driel, Pineland Forest Nursery Presentation, 27 November 2012

study[4] conducted by Manitoba Hydro using a BioMax 100 as an option for combined heat and power at another location.

From the Manitoba Hydro documentation:

Capital Cost	
Equipment Procurement[4]	$500,000
Biomass Storage and Handling[4]	$84,000
Heat Recovery[4]	$60,000
Foundation, Piping, Interconnection[3]	$130,000
Contingency	$80,000
Total Project Capital Cost	**(2010) $854,000** **(2012 @ 2.0%/yr) $889,000**

Operating Cost	
Average O&M ($20/MWh x 782.6 MWh)	$15,653
Fuel Cost ($60/tonnes x 596 tonnes)	$35,772
Contingency (5%)	$2,571
Total Project Operating Cost	**(2010) $54,000** **(2012 @ 2.0%/yr) $56,000**

Fuel cost of $60/tonnes is in line with the average values of $55 - $65/tonne provided for Pineland.

Revenue	
Electricity ($53/MWh x 782.6 MWh)	$41,500
Thermal ($45/MWh x 1171 MWh)	$52,700
Contingency (5%)	$5,000
Total Project Revenue	**(2010) $99,200** **(2012 @ 2.0%/yr) $103,200**

Simple Payback	
Project Revenue	$103,200
Operating Cost	$56,000
Total Project Revenue	**$47,200**
Project Capital Cost	$889,000
Simple Payback	**19 Years**

[4] Manitoba Hydro, Bioenergy CHP and District Heating, Pre-feasibility Study for Providence College, July 2010

Using the Manitoba Hydro data as a baseline, Stantec has altered the figures to provide a relative comparison to the figures expected if the site was to be in the Yukon. These figures are not firm, but used to highlight the potential outlook for the project. Stantec's options are limited to provide this information as little background data or details were provided on where the figures were drawn from in the initial study or the basis for their assumptions. The Yukon Construction Factor and Average O&M increases are assumed values as little basis is provided for a more thorough analysis. Fuel cost of $125/tonnes is in line with current expectations for fuel pricing (to be confirmed), and electricity and thermal heating pricing derived from previous biomass reports by Morrison Hershfield.

Capital Cost	
Equipment Procurement[4]	$500,000
Biomass Storage and Handling[4]	$84,000
Heat Recovery[4]	$60,000
Foundation, Piping, Interconnection[3]	$130,000
Contingency	$80,000
Total Project Capital Cost	(2012 @ 2.0%/yr) $889,000
Yukon Construction Factor	**(x1.75) $1,556,000**
Operating Cost	
Average O&M ($40/MWh x 783 MWh)	$31,000
Fuel Cost ($125/tonnes x 600 tonnes)	$75,000
Contingency (5%)	$5,000
Total Project Operating Cost	**$111,000**
Revenue	
Electricity ($200/MWh x 783 MWh)	$157,000
Thermal ($150/MWh x 1171 MWh)	$176,000
Contingency (5%)	$17,000
Total Project Revenue	**$350,000**
Simple Payback	
Project Revenue	$350,000
Operating Cost	$111,000
Total Project Revenue	**$239,000**
Project Capital Cost	$1,556,000
Simple Payback	**7 Years**

6.0 Path Forward

Based on the impressions of the project team during the site visits, it was clear that Entropic unit was not to be considered moving forward, and that the path forward regarding unit capacity should be re-considered. As such the Steering Committee was asked to confirm their desire to continue pursuing a 2 – 4 MW_e unit using Nexterra as one of the main technology providers. Following a Steering Committee meeting, the decision was made to revise the technologies under consideration and allow for a 500 kW_e to 2 MW_e unit to be considered. This would facilitate the smaller units, namely CPC and similar vendors, to offer a multiple of their current offering to achieve a capacity that could be considered.

Currently a Request for Quotation has been issued to a series of vendors, including Nexterra and CPC, to respond with budgetary quotes for the installation of a system in Haines Junction, Yukon.

ONE TEAM. INTEGRATED SOLUTIONS.

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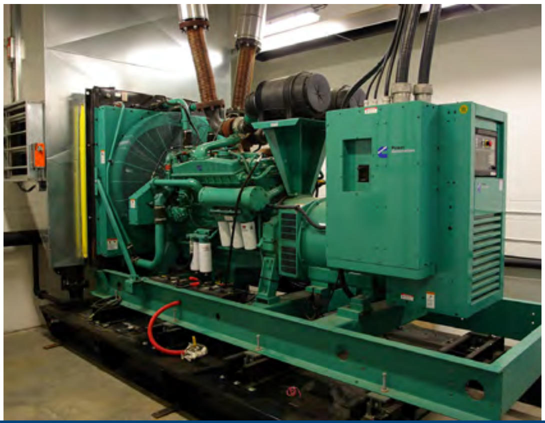
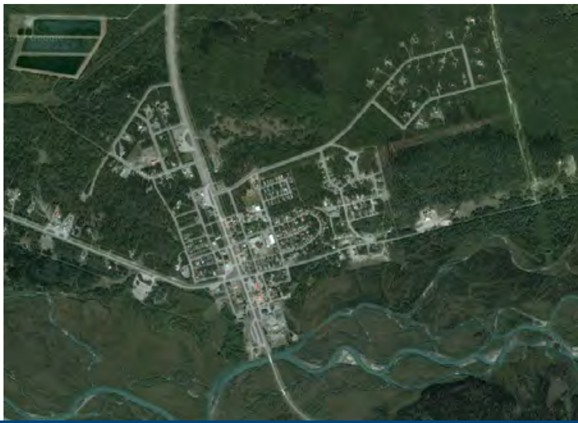




APPENDIX C

Vendor Packages

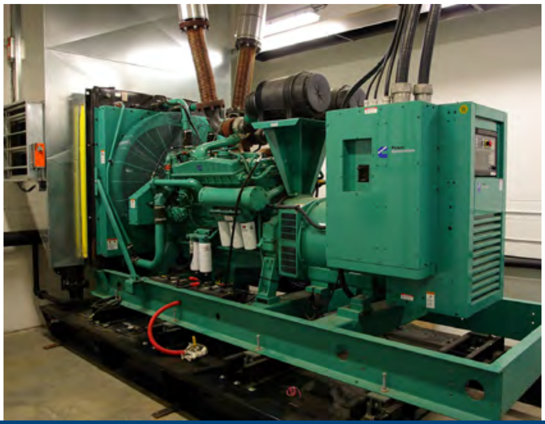
Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

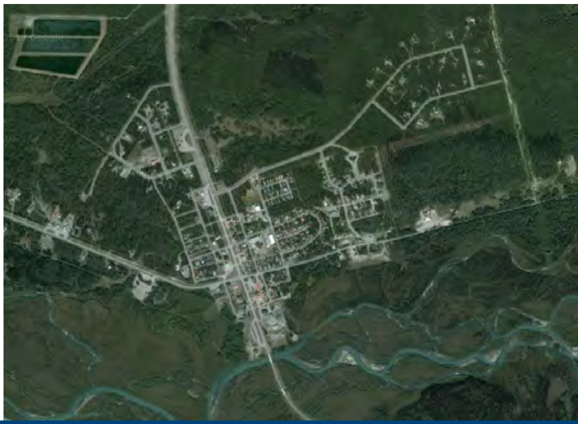
Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

Stantec

OMITTED

Confidential and Proprietary Information



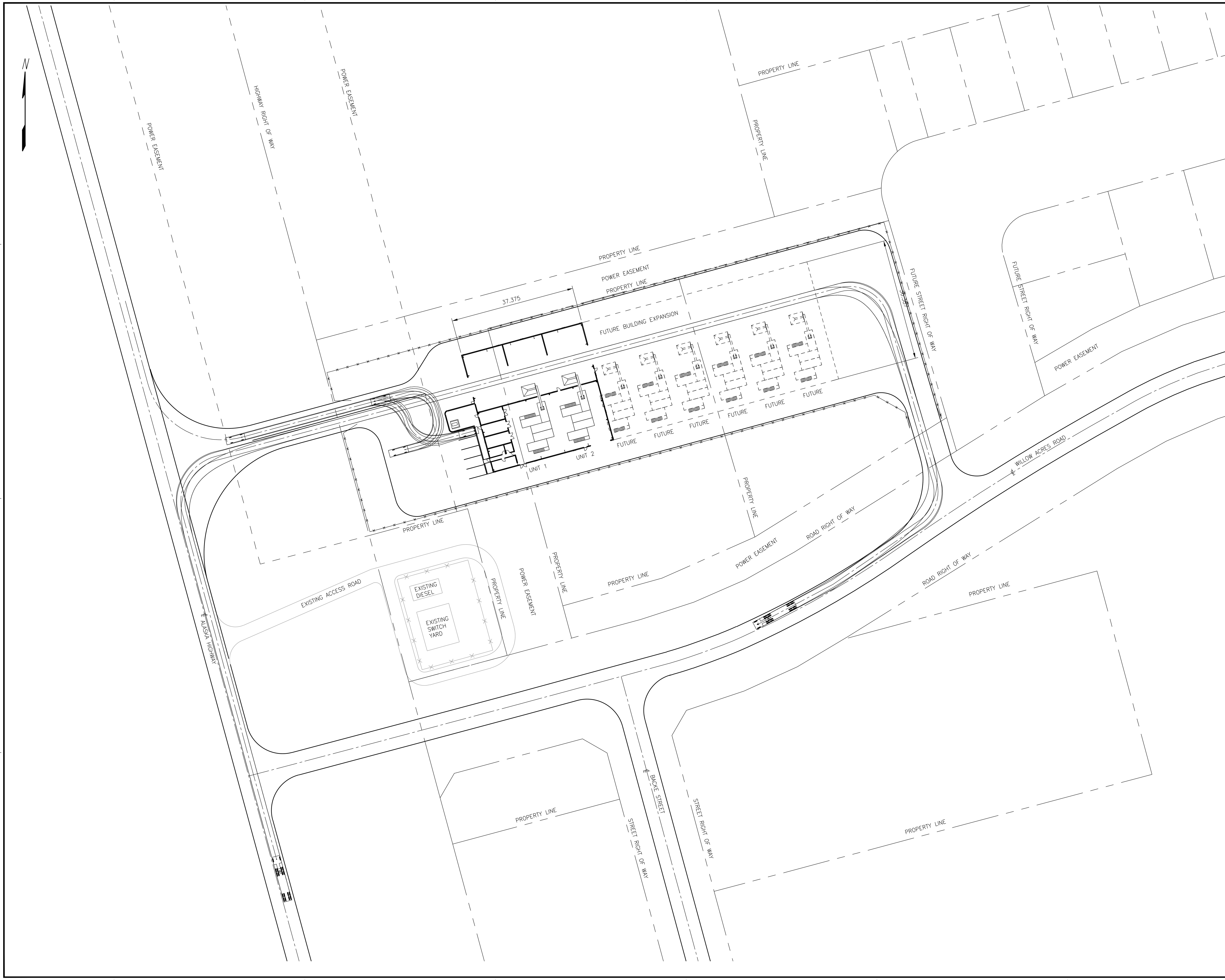


APPENDIX D

Basis of Estimate - Option #1

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7



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Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

SITE LAYOUT
PROPOSED BIOENERGY PROJECT

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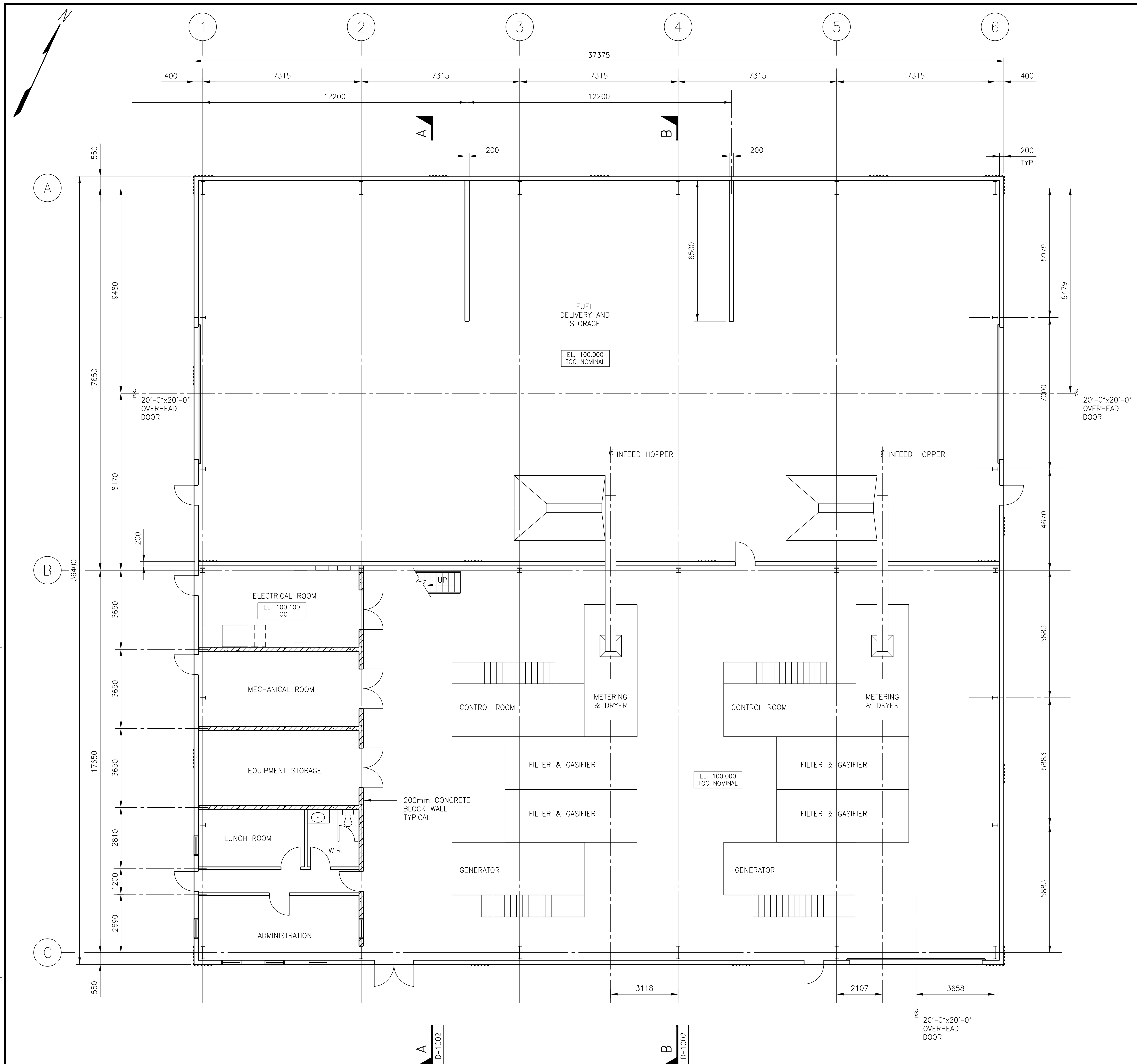

PLAN AT EL. 100.000 TOC (UNO)

SCALE: 1:100

REFERENCE DRAWINGS		
DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

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A	OCTOBER 18, 2013 CLIENT	FINAL REPORT

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No.	DATE	BY	REVISIONS	DES. DFTG.

DESIGNED KAA	DRAWN KRN
CHECKED DESIGN DFTG.	DATE OCT. 17, 2013
	SCALE 1:100
APPROVED	SPEC.
P.M. CGV	P.T. —

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

GENERAL ARRANGEMENT
PLAN
OPTION 1
UNITS IN BUILDING

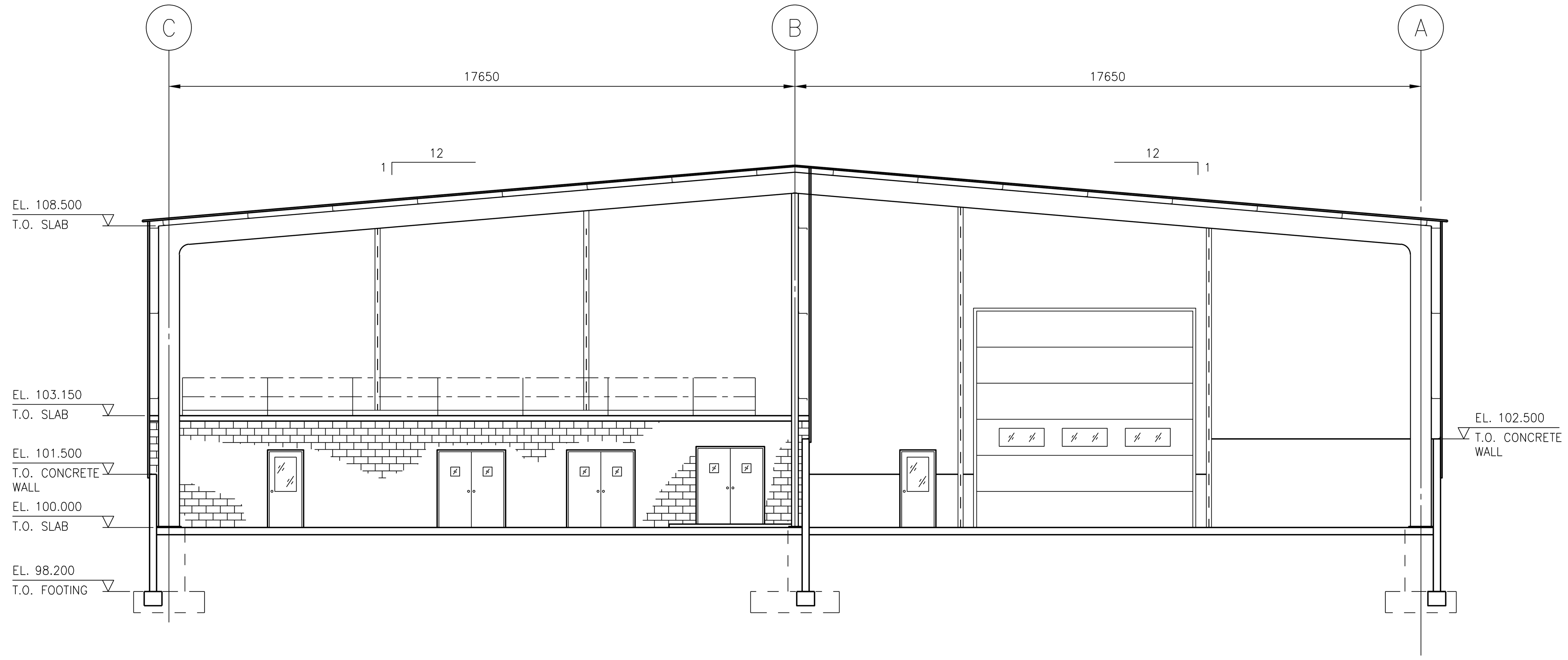
JOB No.	DWG. No.	REV.
133545658	D-1001	A

U:\133545658\2_civil\3_drawing\133545658D1001.dwg

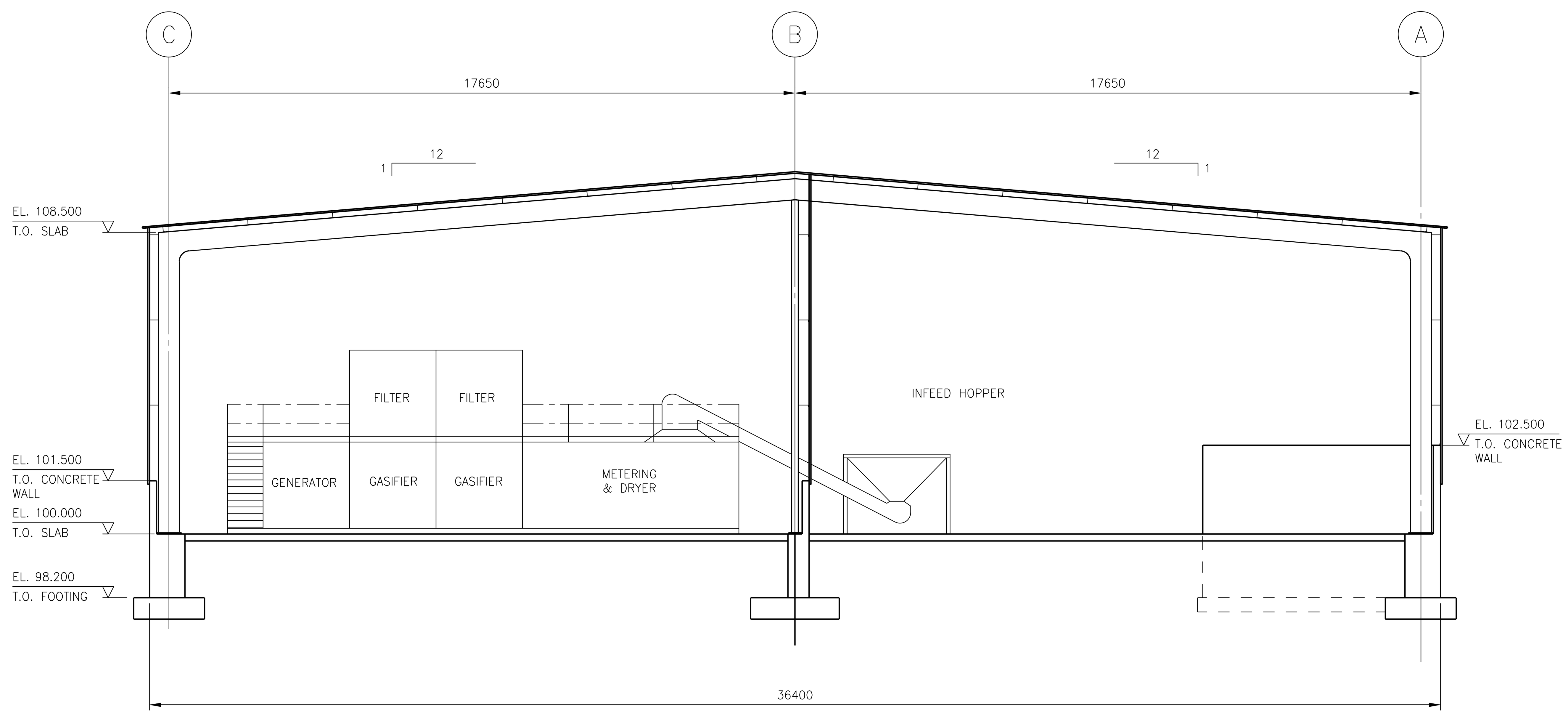
Oct 18, 2013 3:06pm dgillies

G | F | E | D | C | B | A

4 | 3 | 2 | 1



SECTION A
D-1002
SCALE: 1:100
REF. DWG.D-1001



SECTION B
D-1002
SCALE: 1:100
REF. DWG. D-1001

REFERENCE DRAWINGS

DWG. No.	TITLE	BY

PRELIMINARY
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REV.	ISSUED TO	ISSUED FOR
B	OCTOBER 18, 2013 CLIENT	FINAL REPORT
A	FEBRUARY 01, 2013 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES. DFTG.

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CHECKED DESIGN DFTG. | DATE OCT. 18, 2013
SCALE 1:100
APPROVED | SPEC.
P.M. CGV | P.T. __

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

GENERAL ARRANGEMENT
SECTIONS
OPTION 1
UNITS IN BUILDING

JOB No. 133545658 | DWG. No. D-1002 | REV. B

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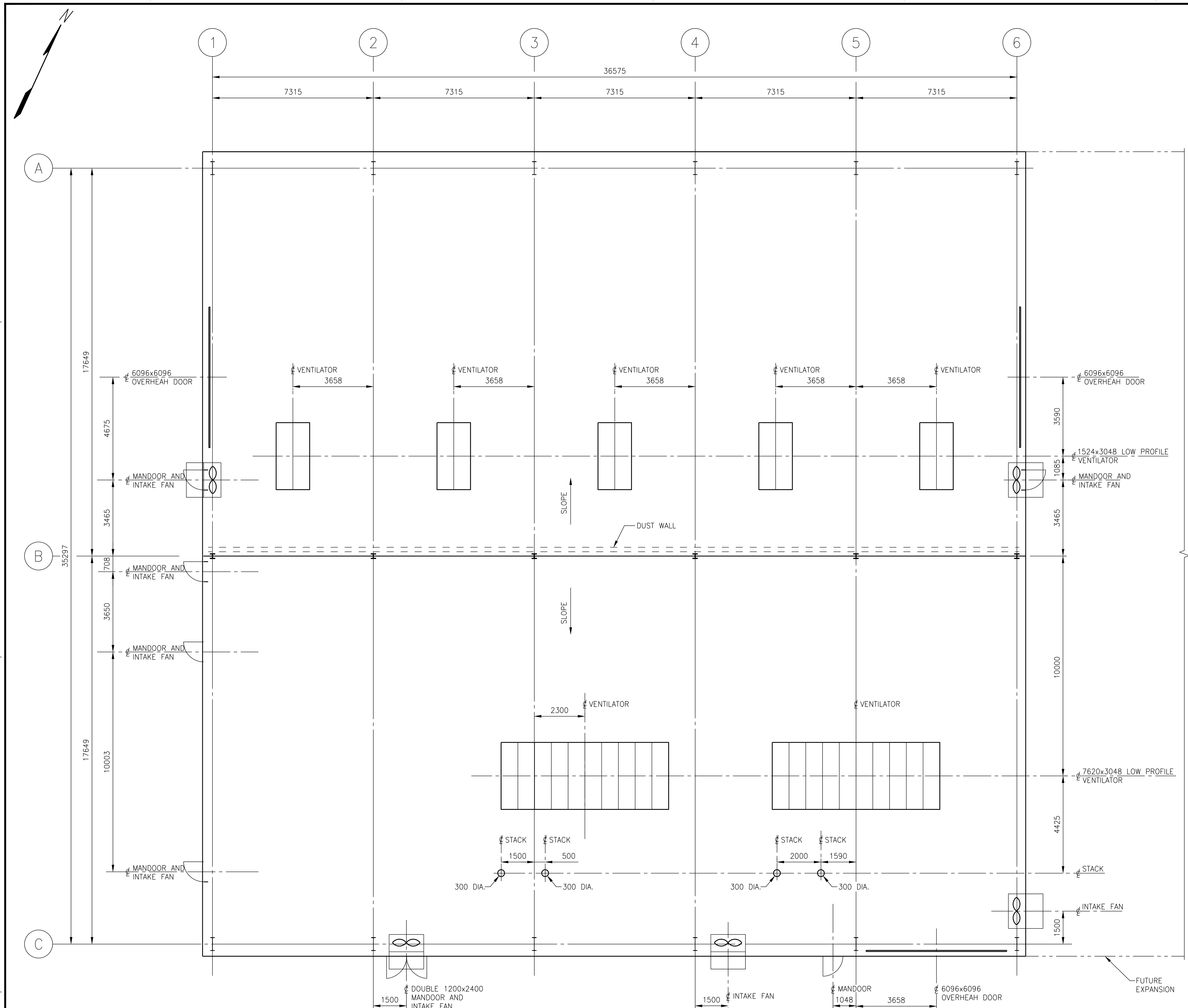
Oct 18, 2013 3:08pm dgillies



ROOF PLAN

SCALE: 1:100

NOTES:

1. FOR BUDGET PRICING, USE SUPPLIER'S STANDARD BUILDING PACKAGE SPECIFICATIONS.
2. BUILDING SUPPLY TO INCLUDE:
   A. ALL STRUCTURAL AND MISCELLANEOUS STEEL COLUMNS, ROOF BEAMS, PURLINS, GIRTS, SAG RODS, BRACING AND TIES, FRAMED OPENINGS AND EDGE ANGLES.
   B. COLUMN ANCHORAGE, ALTHOUGH THERE WILL BE A 1200 DADO WALL (BY OTHERS) COLUMNS WILL BE FOUNDED AT SLAB LEVEL (EL. 100).
   C. METAL ROOF, COMPLETE WITH INSULATION (R50) FLASHING AND TRIM.
   D. METAL WALL PANEL, COMPLETE WITH INSULATION (R30) FLASHING AND TRIM. UNINSULATED METAL DUST WALL (COMPLETE WITH GIRTS) WILL BE REQUIRED ADJACENT TO COL LINE B
   E. ALL DOORS (MANDOORS 900x2100 NOMINAL) EXCEPT WHERE NOTED).
   F. WEATHER HOODS AT FANS (1500 WIDE x 1000 PROJECTIONS). FANS WILL BE SUPPLIED BY MECHANICAL CONTRACTOR.
   G. ROOF-TOP VENTILATORS.
3. PROVIDE SEPARATE DELIVERY PRICE FOR HAINES JUNCTION, YUKON.
4. FRAME ON LINE 6 TO BE DESIGNED FOR FUTURE EXPANSION TO EAST (7315 BAY)

REFERENCE DRAWINGS

DWG. No.	TITLE	BY

PRELIMINARY
FOR INFORMATION ONLY

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A	OCTOBER 18, 2013 CLIENT	FINAL REPORT

No.	DATE	BY	REVISIONS	DES.	DFTG.

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CHECKED DESIGN DFTG.	DATE OCT. 17, 2013
	SCALE AS NOTED
APPROVED	SPEC.
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Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

BUILDING FINISHES
ROOF PLAN

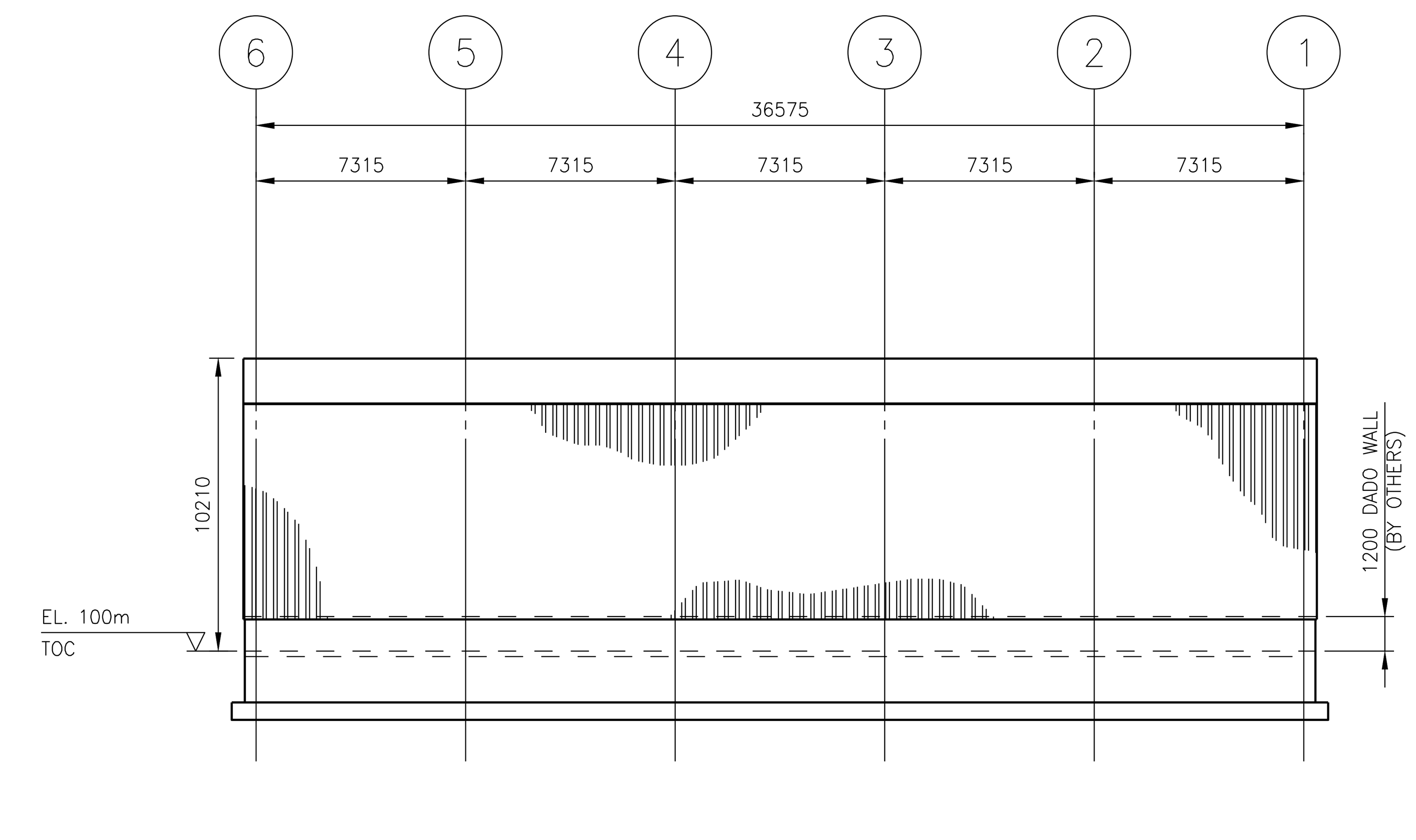
JOB No.	DWG. No.	REV
133545658	D-2001	A

U:\133545658\1_architectural\3_drawing\133545658D2001.dwg

Oct 18, 2013 3:18pm dgillies

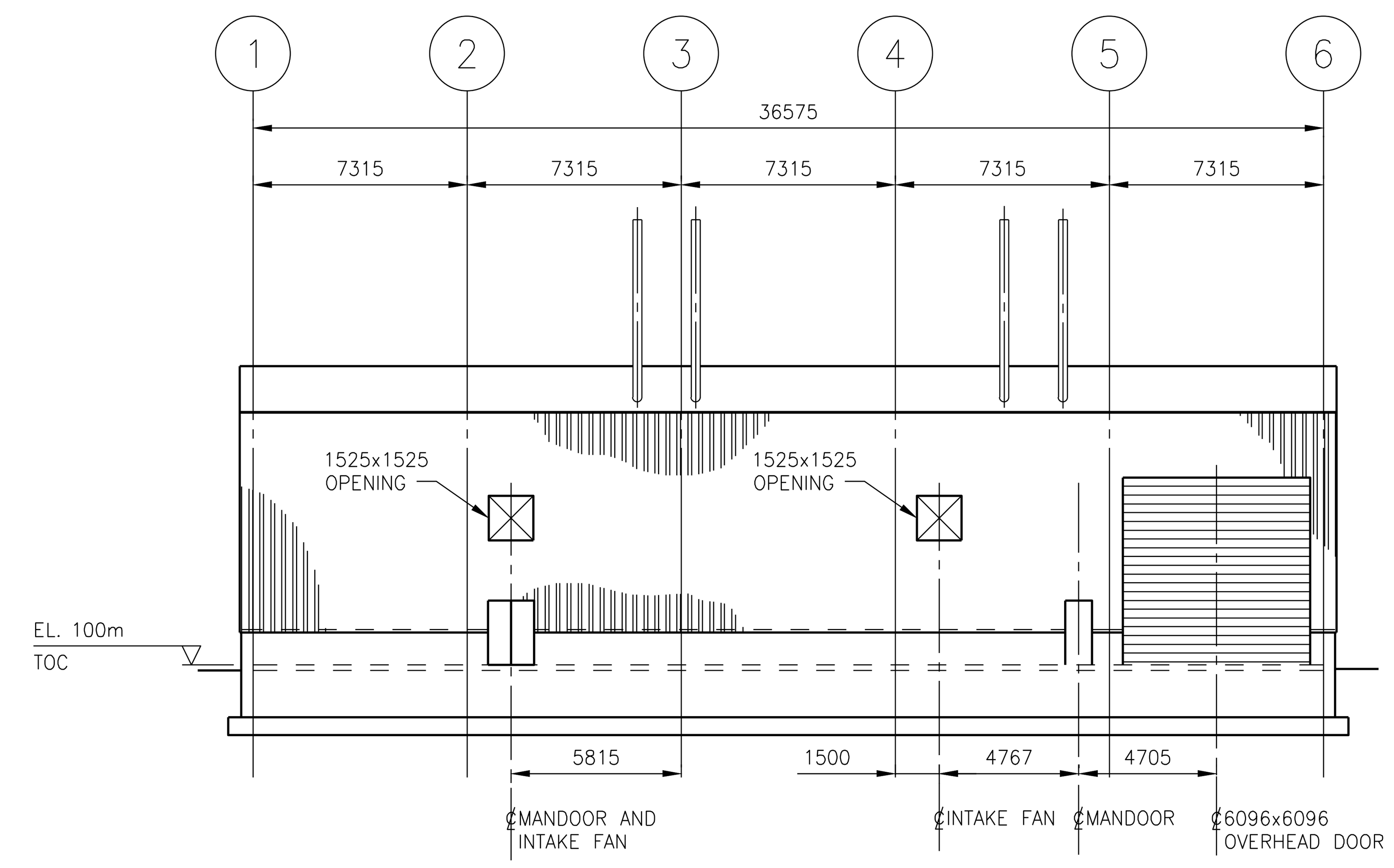
NOTES:

1. SEE DRAWING D-2001 FOR NOTES



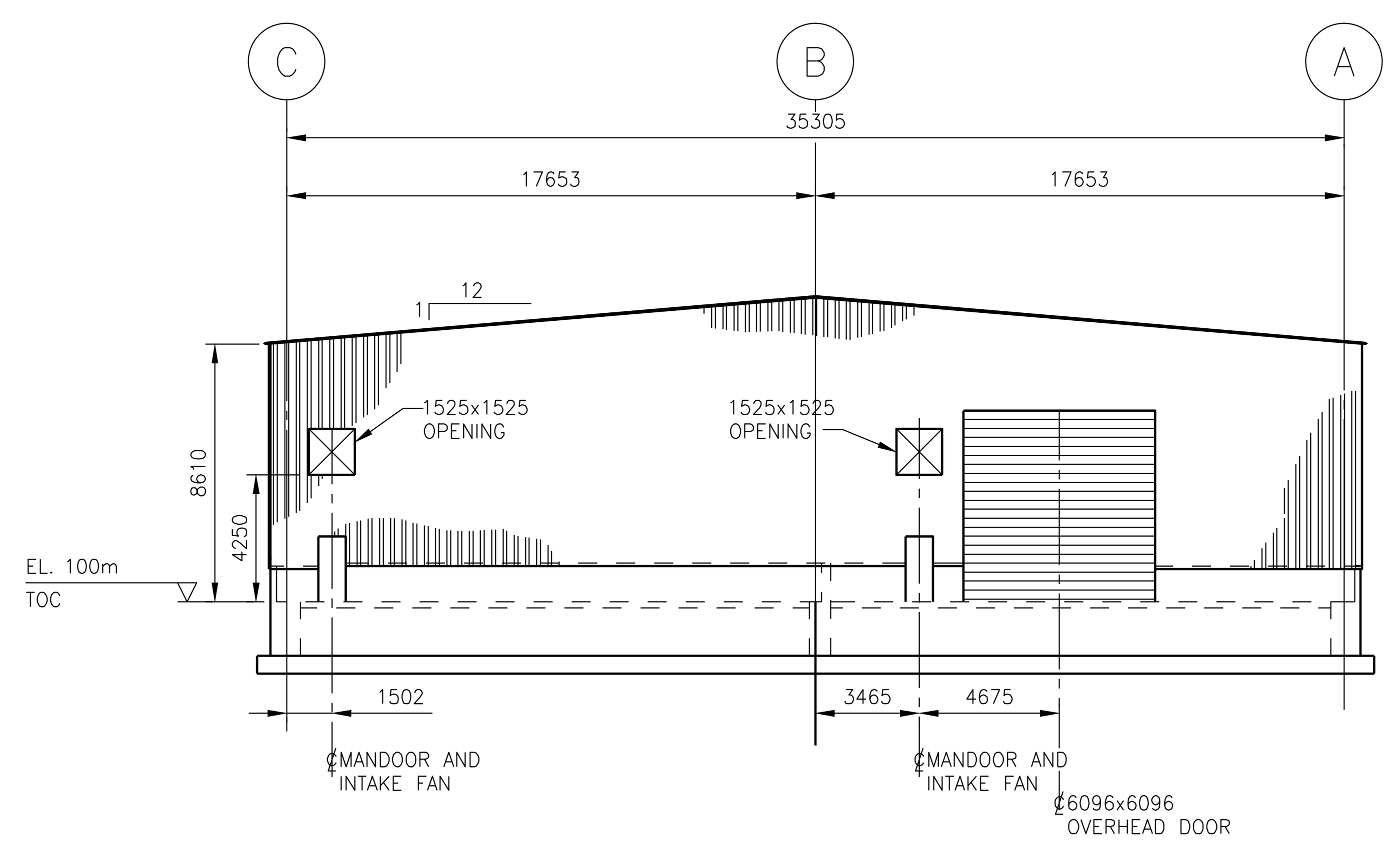
NORTH ELEVATION

SCALE: 1:200



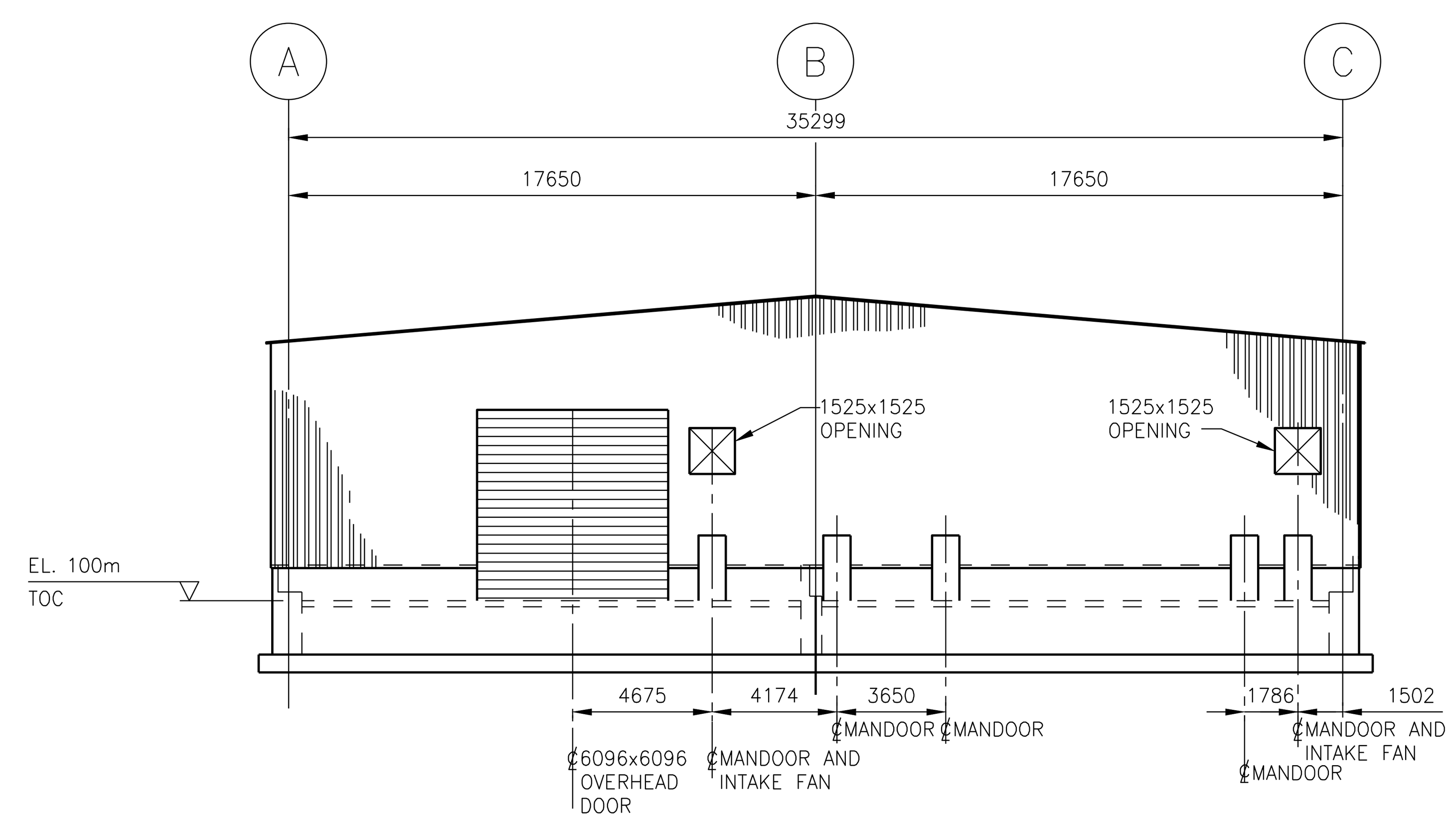
SOUTH ELEVATION

SCALE: 1:200



EAST ELEVATION

SCALE: 1:200



WEST ELEVATION

SCALE: 1:200

REFERENCE DRAWINGS

DWG. No.	TITLE	BY

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CHECKED DESIGN DFTG.	DATE OCT. 17, 2013
	SCALE AS NOTED
APPROVED	SPEC.
P.M. CGV	P.T. —

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

BUILDING FINISHES
BUILDING ELEVATIONS
—
—

JOB No.	DWG. No.	REV
133545658	D-2101	A

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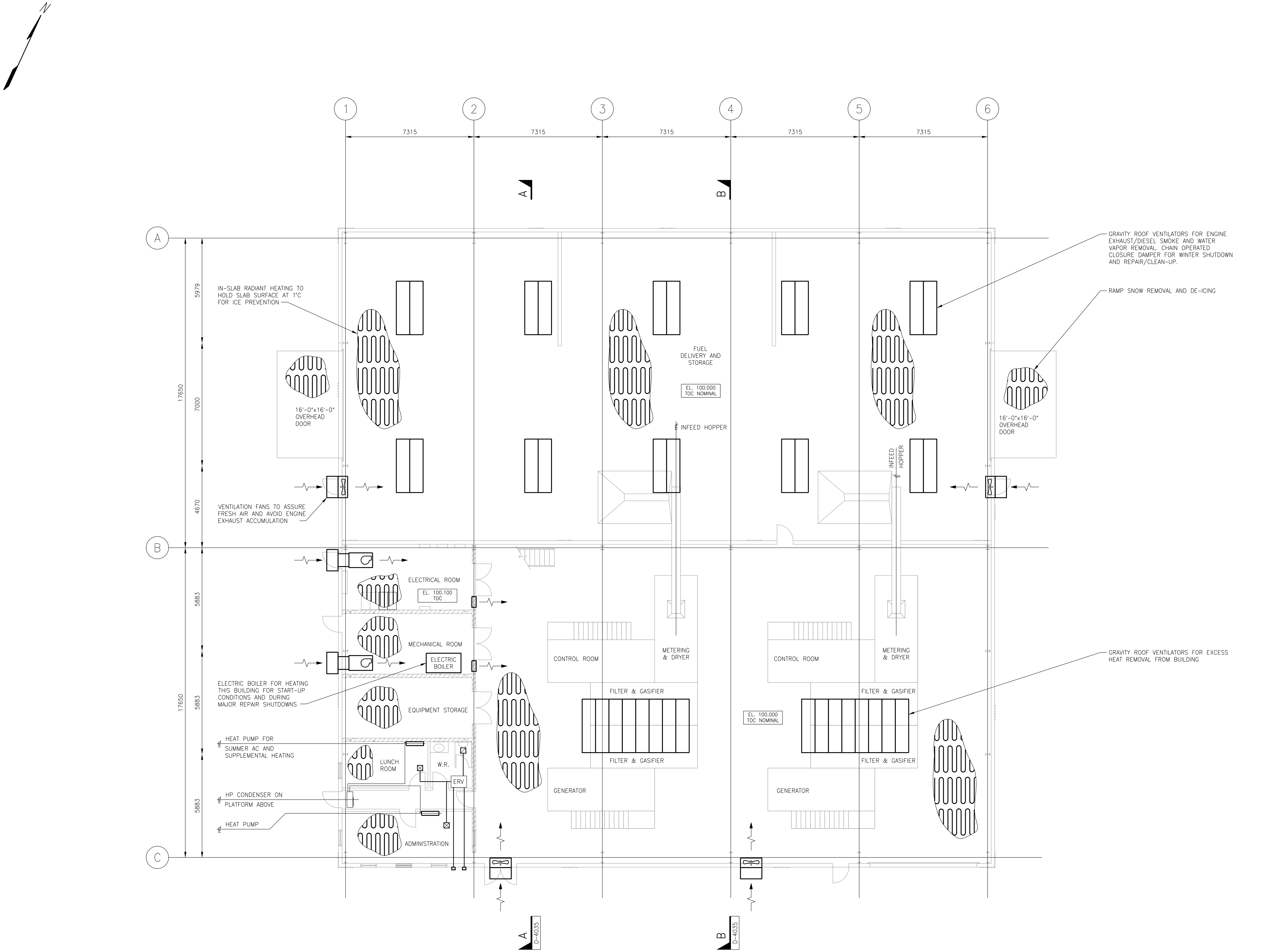
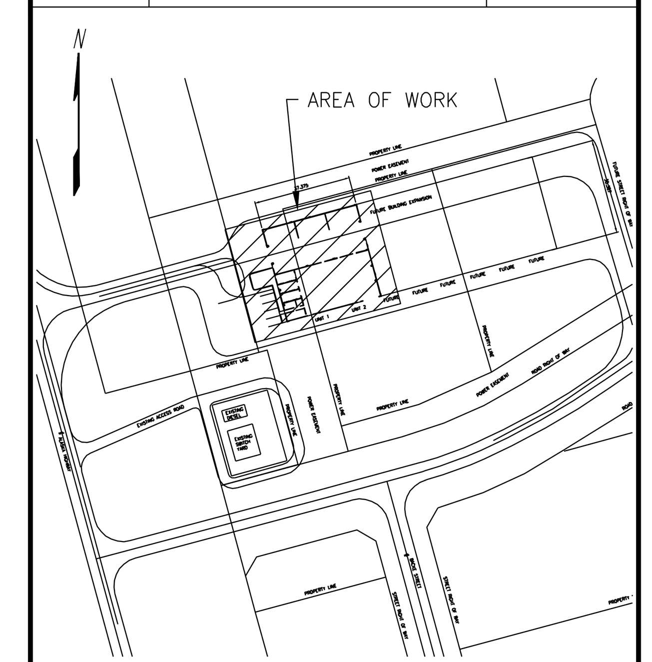


PLAN AT EL. 100.000 TOC (UNO)

SCALE: N.T.S.

REFERENCE DRAWINGS

DWG. No.	TITLE	BY
D-4035	HVAC CONCEPTUAL DIAGRAM SECTION	STANTEC



KEY PLAN

NOTES:

1. IN SLAB RADIANT HEAT SOURCE IS LOW GRADE DISTRICT HEATING RETURN WATER TO INCREASE RECOVERED HEAT EFFICIENCY.
2. HEAT REJECTION OF PLANT WHEN DISTRICT HEATING LOAD IS OFF TO BE DEVELOPED FURTHER DURING EQUIPMENT SELECTION. (RADIATOR DIRECTED VERTICALLY TO VENT THROUGH GRAVITY ROOF VENTS?)

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B	OCTOBER 18, 2013 CLIENT	FINAL REPORT
A	FEBRUARY 01, 2013 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES. DFTG.

DESIGNED KJC	DRAWN BCF
CHECKED DESIGN DFTG.	DATE OCT. 17, 2013
	SCALE N.T.S.
APPROVED	SPEC.
P.M. CGV	P.T. --

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

HVAC CONCEPTUAL DIAGRAM
PLAN
OPTION 1
UNITS IN BUILDING

JOB No.	DWG. No.	REV.
133545658	D-4031	B

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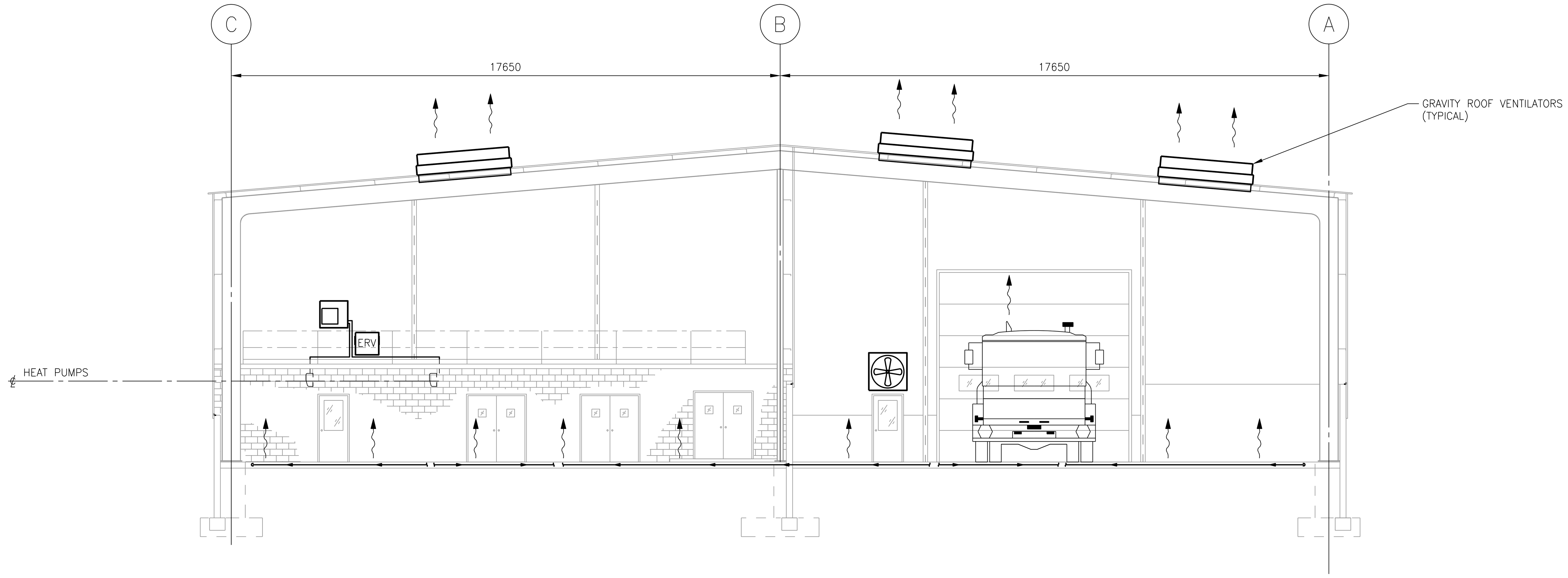
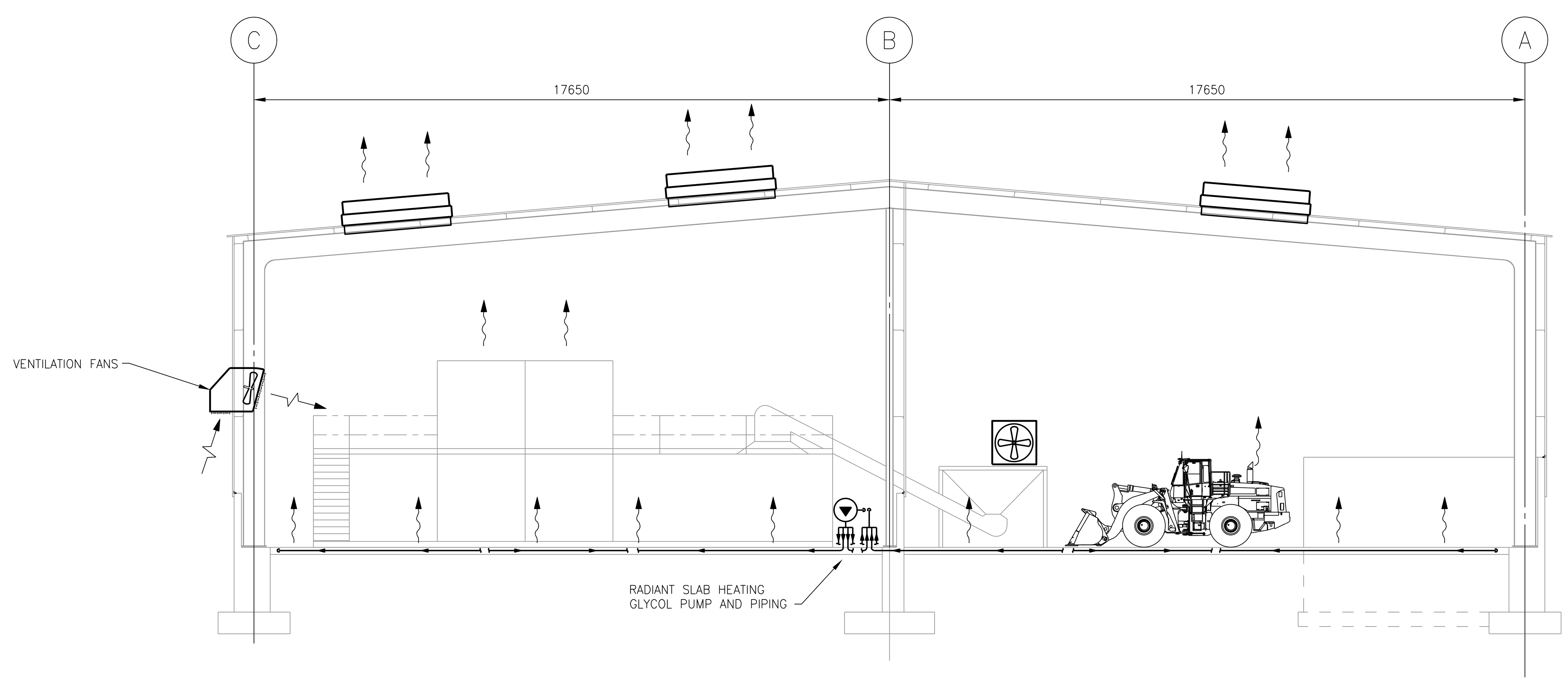
Oct 18, 2013 3:22pm dgillies



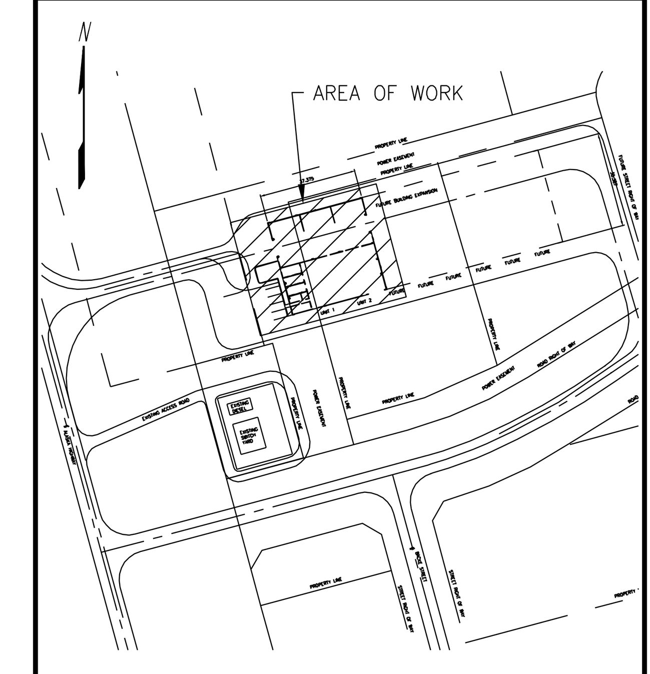
SECTION A
D-4035
SCALE: N.T.S.
REF. DWG.D-4031



SECTION B
D-4035
SCALE: N.T.S.
REF. DWG. D-4031

REFERENCE DRAWINGS

DWG. No.	TITLE	BY
D-4031	HVAC CONCEPTUAL DIAGRAM PLAN	STANTEC



KEY PLAN

PRELIMINARY
FOR INFORMATION ONLY

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B	OCTOBER 18, 2013 CLIENT	FINAL REPORT
A	FEBRUARY 01, 2013 CLIENT	INFORMATION

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DESIGNED KJC
DRAWN BCF
CHECKED DESIGN DFTG.
DATE OCT. 17, 2013
SCALE N.T.S.
APPROVED
SPEC.
P.M. CGV
P.T. —

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

HVAC CONCEPTUAL DIAGRAM
SECTION
OPTION 1
UNITS IN BUILDING

JOB No. 133545658
DWG. No. D-4035
REV. B

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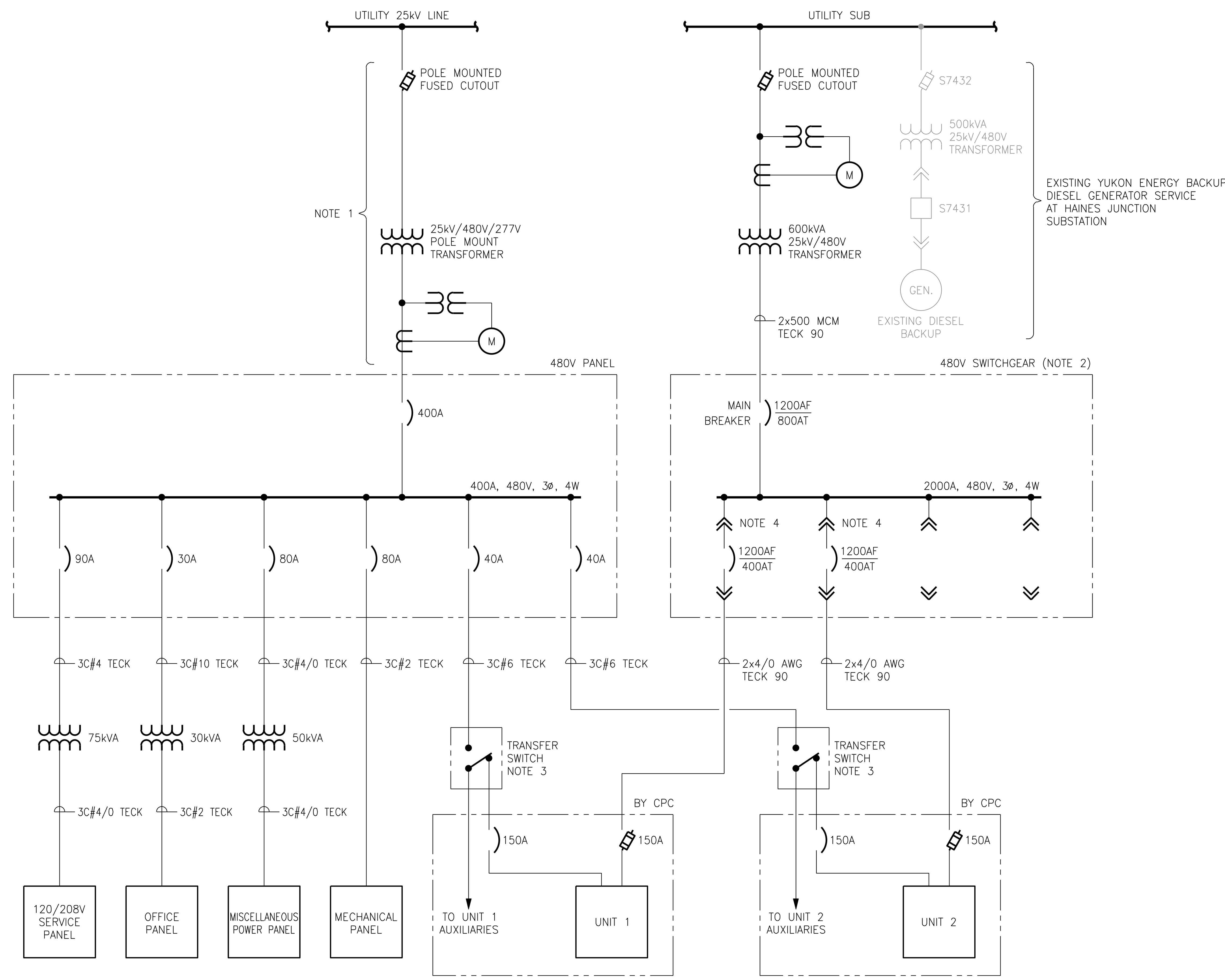
Oct 18, 2013 3:23pm dgillies

REFERENCE DRAWINGS

DWG. No.	TITLE	BY

NOTES:

1. UTILITY TO PROVIDE SERVICE ENTRANCE TO BUILDING COMPLETE WITH POLE MOUNTED TRANSFORMER, FUSED CUTOUTS AND METERING. THIS WILL PROVIDE INDEPENDENT POWER TO THE BUILDING AND PROVIDE BACKUP TO THE GENERATOR AUXILIARIES.
2. 480V SWITCHGEAR USED TO PARALLEL THE GENERATOR OUTPUTS SHALL HAVE A MAIN BREAKER, 2 UNIT BREAKERS AND 2 PREPARED SPACES.
3. MANUAL TRANSFER SWITCHES SHALL BE USED TO SWITCH BETWEEN SELF-GENERATED AUXILIARY POWER OR UTILITY SUPPLIED AUXILIARY POWER.
4. INTERLOCK CONTROL LOGIC SHALL BE IMPLEMENTED BETWEEN SWITCHGEAR BREAKERS AND THEIR CORRESPONDING UNIT GENERATOR TO PREVENT UNIT OPERATION ON AN OPEN BUS.



PRELIMINARY
FOR INFORMATION ONLY

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B	OCTOBER 18, 2013 CLIENT	FINAL REPORT
A	FEBRUARY 01, 2013 CLIENT	INFORMATION

No.	DATE	BY	REVISIONS	DES.	DFTG.

DESIGNED	DRAWN
CHECKED (DESIGN / DFTG.)	DATE OCT. 17, 2013
	SCALE NTS
APPROVED	SPEC.
P.M. CGV	P.T. ––

Stantec

YUKON BIOENERGY DEMONSTRATION PROJECT

YUKON ENERGY
SINGLE LINE

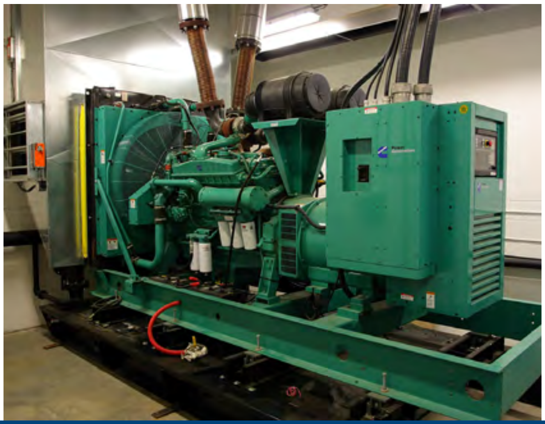
JOB No.	DWG. No.	REV
133545658	D-5700	B

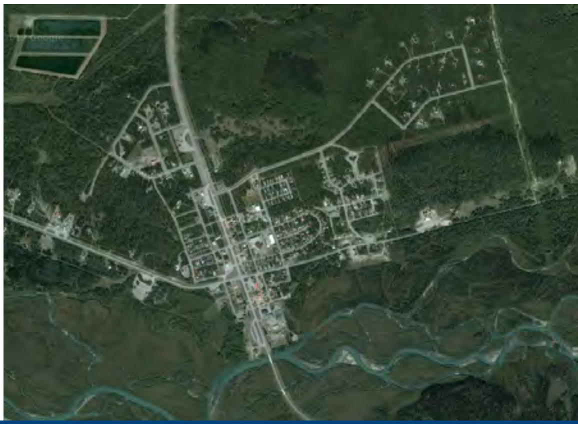
Client: **Yukon Energy**
Project: **Haines Junction BioEnergy Demonstration**
Project No: **133545658**
Currency: **CAD**

STANTEC CONSULTING
Opinion of Probable Construction Cost
Summary OPTION 1

Prepared by: **TEAM**
Date: **March 6, 2013**
Revision No.: **0**
Issue Date: **March 4, 2013**
Checked:

Area	Line	Description	**Labour** Hours	**Labour** Cost	**Mat'l/Commodity** Cost	**Equipment** Cost	**Sub-Contractor** Cost	**Total** Cost
-	1	**PROJECT TOTAL, BASE SCOPE**						**$12,727,154**
-	2	Civil - Structural	00 hrs	$562,428	$1,001,238	$195,250	$1,235,200	$3,528,066
-	3	Mechanical & HVAC	1,532 hrs	$168,520	$199,500	$5,205,000	$192,476	$5,765,496
-	4	Electrical	3,373 hrs	$371,089	$172,531	$238,465	$74,197	$856,282
-	5	**Sub Total**	**4,905 hrs**	**$1,102,037**	**$1,373,269**	**$5,638,715**	**$1,501,873**	**$10,149,844**
-	6	Preliminary Engineering @ 3% (Class III Estimate)						$152,647.33
-	7	Detail Engineering @ 10% Direct Construction Cost						$508,824.42
-	8	Construction Management @ 2.5% Direct Construction Cost						$127,206.11
-	9	Site Construction Support by Engineering @ 1% Direct Construction Cost						$50,882.44
-	10	Commissioning Costs @ 1.5%						$76,323.66
-	11	Escalation Allowance @ 5%						$254,412.21
-	12	Capital Spares - 5% of CPC equipment cost						$250,000
-	13	**Sub Total**						**$11,570,140**
-	14	Contingency @ 10%						$1,157,014.04





APPENDIX E

Architectual Upgrade - Option #2

Front End Engineering Design (FEED) Study

Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

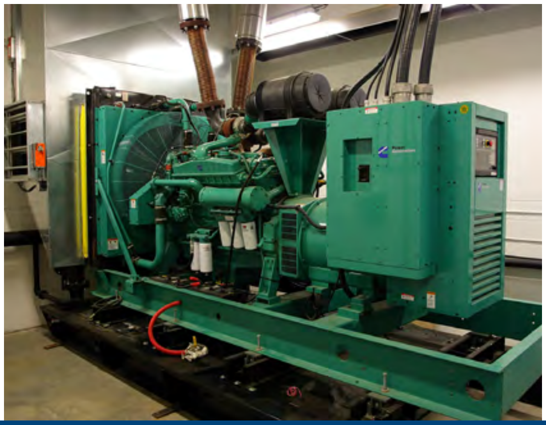
Stantec

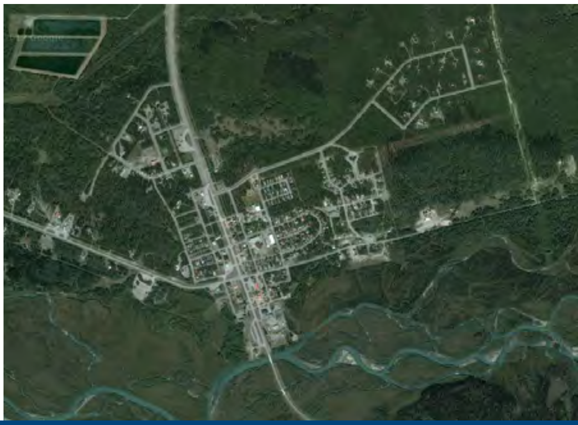
Client: **Yukon Energy**
Project: **Haines Junction BioEnergy Demonstration**
Project No: **133545658**
Currency: **CAD**

STANTEC CONSULTING
Opinion of Probable Construction Cost
Summary OPTION 2

Prepared by: **TEAM**
Date: **March 6, 2013**
Revision No.: **1**
Issue Date: **March 4, 2013**
Checked:

Area	Line	Description	Labour Hours	Labour Cost	Mat'l/Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
-	1	PROJECT TOTAL, BASE SCOPE						$13,494,160
-	2	Civil - Structural	00 hrs	$617,073	$1,094,838	$203,150	$1,631,800	$4,094,958
-	3	Mechanical & HVAC	1,532 hrs	$168,520	$199,500	$5,205,000	$192,476	$5,765,496
-	4	Electrical	3,373 hrs	$371,089	$172,531	$238,465	$74,197	$856,282
-	5	**Sub Total**	**4,905 hrs**	**$1,156,682**	**$1,466,869**	**$5,646,615**	**$1,898,473**	**$10,716,737**
-	6	Preliminary Engineering @ 3% (Class III Estimate)						$169,654.10
-	7	Detail Engineering @ 10% Direct Construction Cost						$565,513.66
-	8	Construction Management @ 2.5% Direct Construction Cost						$141,378.41
-	9	Site Construction Support by Engineering @ 1% Direct Construction Cost						$56,551.37
-	10	Commissioning Costs @ 1.5%						$84,827.05
-	11	Escalation Allowance @ 5%						$282,756.83
-	12	Capital Spares - 5% of CPC equipment cost						$250,000
-	13	**Sub Total**						**$12,267,418**
-	14	Contingency @ 10%						$1,226,741.80





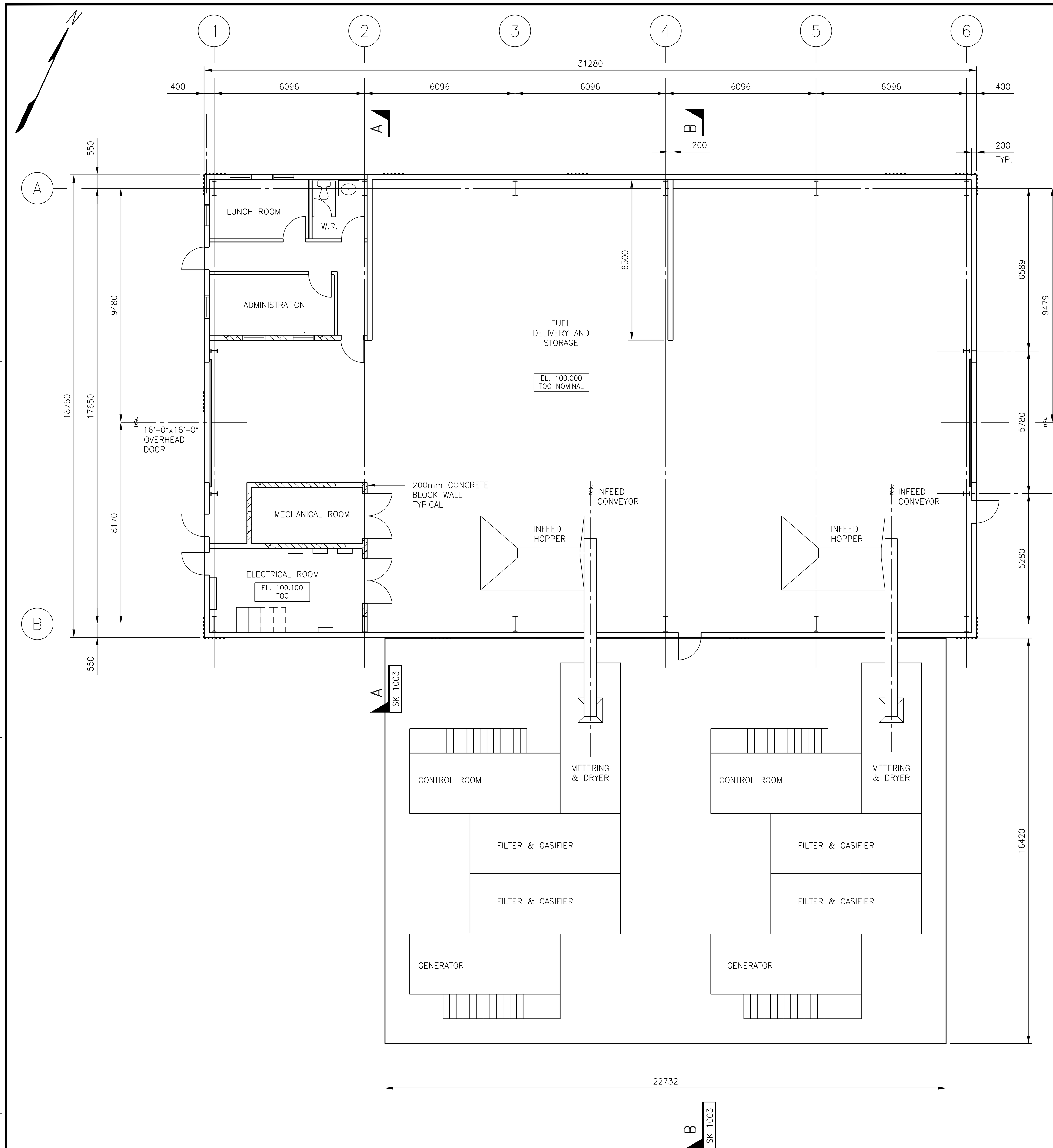
APPENDIX F

Basis of Estimate - Option #3

Front End Engineering Design (FEED) Study

Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7



PLAN AT EL. 100.000 TOC (UNO)

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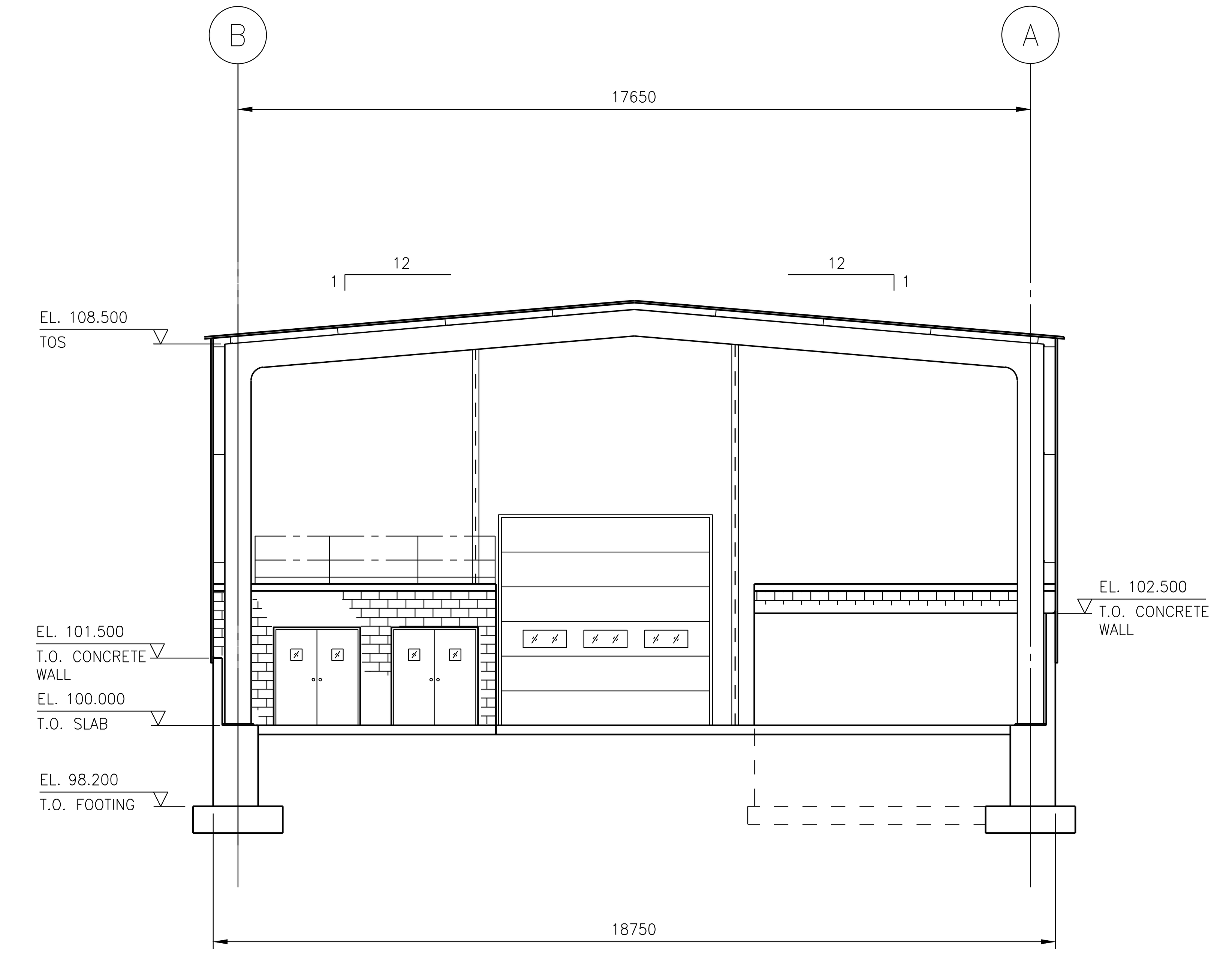
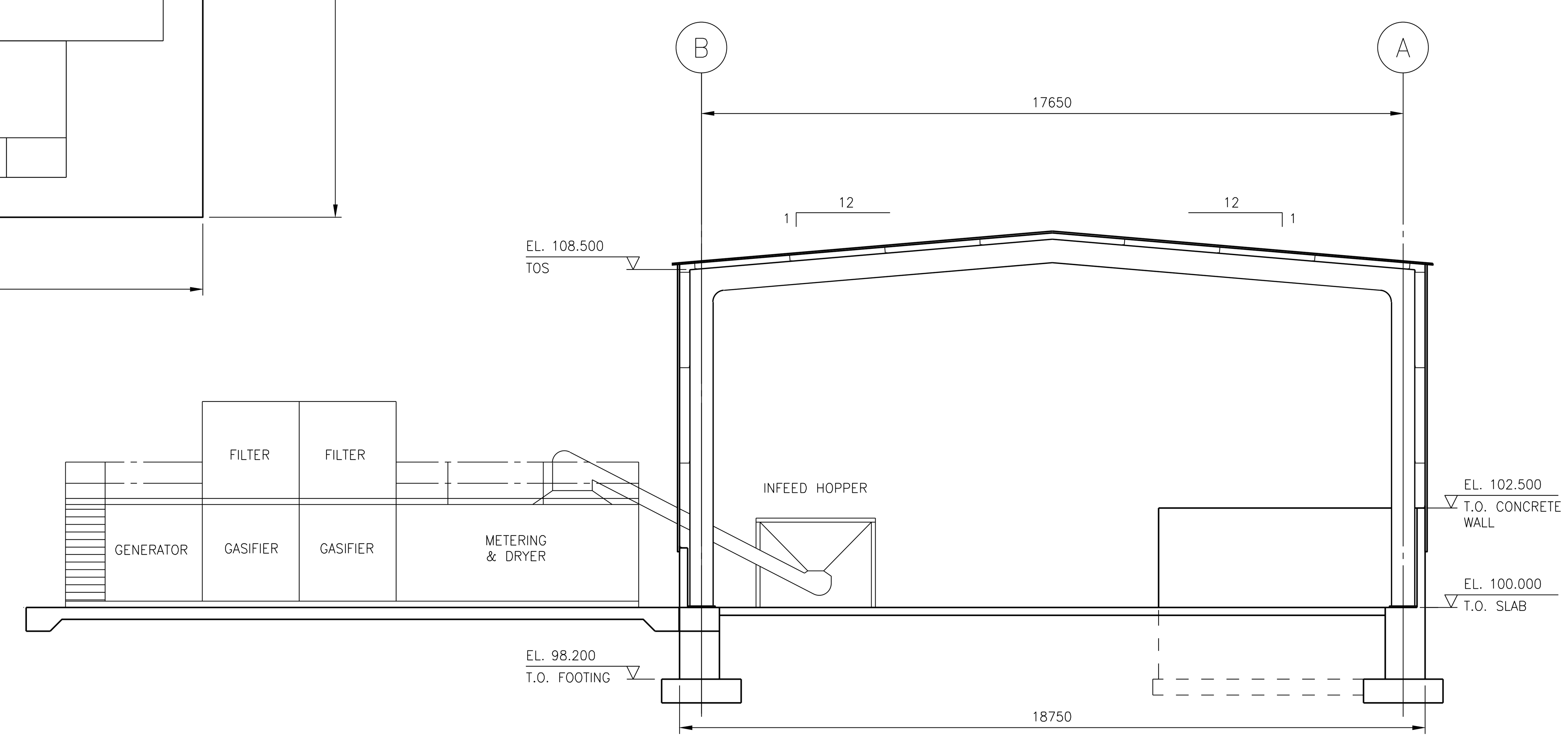


SECTION A SK-1003

SCALE: 1:100

REF. DWG. SK-1003



SECTION B SK-1003

SCALE: 1:100

REF. DWG. SK-1003

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DATE OCT. 17, 2013
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SPEC.
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P.T. —

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YUKON BIOENERGY DEMONSTRATION PROJECT

GENERAL ARRANGEMENT
PLAN AND SECTIONS
OPTION 2
UNITS OUTDOORS

JOB No. 133545658
DWG. No. D-1003
REV. A

Oct 18, 2013 3:16pm dgillies

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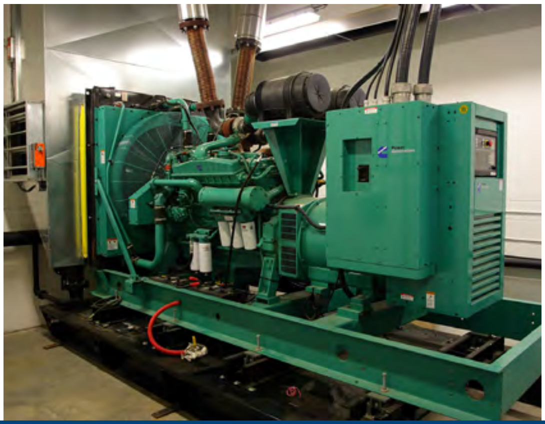
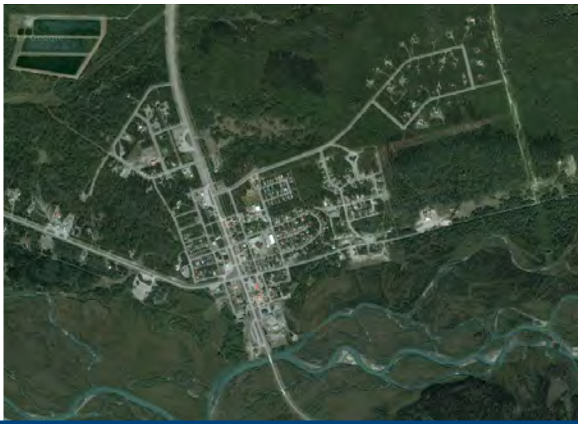
Client: **Yukon Energy**
Project: **Haines Junction BioEnergy Demonstration**
Project No: **133545658**
Currency: **CAD**

STANTEC CONSULTING
Opinion of Probable Construction Cost
Summary OPTION 3

Prepared by: **TEAM**
Date: **March 4, 2013**
Revision No.: **1**
Issue Date: **March 4, 2013**
Checked:

Area	Line	Description	Labour Hours	Labour Cost	Mat'l/Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
-	1	PROJECT TOTAL, BASE SCOPE						$11,402,782
-	2	Civil - Structural	00 hrs	$399,213	$714,346	$167,750	$846,626	$2,624,934
-	3	Mechanical & HVAC	1,869 hrs	$205,634	$117,600	$5,204,000	$84,301	$5,611,535
-	4	Electrical	4,229 hrs	$463,036	$151,271	$238,235	$85,447	$937,990
-	5	**Sub Total**	**6,099 hrs**	**$1,067,883**	**$983,217**	**$5,609,985**	**$1,016,374**	**$9,174,458**
-	8	Preliminary Engineering @ 3% (Class III Estimate)						$122,831.35
-	9	Detail Engineering @ 10% Direct Construction Cost						$409,437.84
-	10	Construction Management @ 2.5% Direct Construction Cost						$102,359.46
-	9	Site Construction Support by Engineering @ 1% Direct Construction Cost						$40,943.78
-	11	Commissioning Costs @1.5%						$61,415.68
-	13	Escalation Allowance @ 5%						$204,718.92
-	14	Capital Spares - 5% of CPC equipment cost						$250,000
-	15	**Sub Total**						**$10,366,165**
-	16	Contingency @ 10%						$1,036,616.54





APPENDIX G

500 kWe Expansion - Option #4

Front End Engineering Design (FEED) Study

Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

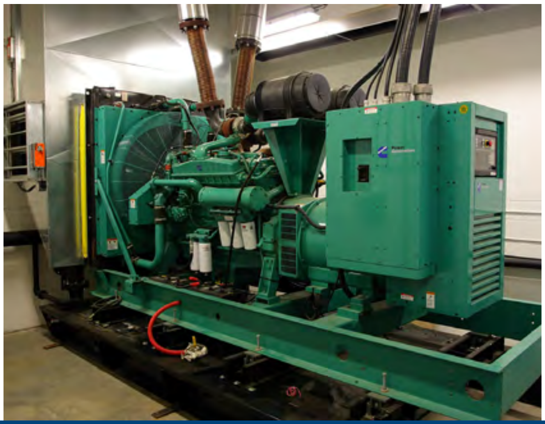
Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

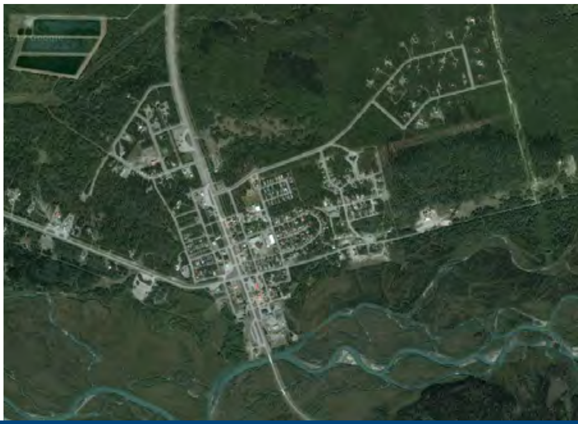
Stantec

Client:	**Yukon Energy**	Prepared by:	**TEAM**
Project:	**Haines Junction BioEnergy Demonstration**	Date:	**March 6, 2013**
Project No:	**133545658**	Revision No.:	**1**
Currency:	**CAD**	Issue Date:	**March 4, 2013**
		Checked:	

STANTEC CONSULTING
Opinion of Probable Construction Cost
Summary OPTION 4 Expa
4 X 250kW Units

Area	Line	Description	Labour Hours	Labour Cost	Mat'l/Commodity Cost	Equipment Cost	Sub-Contractor Cost	Total Cost
-	1	**PROJECT TOTAL, BASE SCOPE**						**$22,484,173**
-	2	Civil - Structural	00 hrs	$648,841	$1,226,438	$229,250	$1,390,000	$4,703,094
-	3	Mechanical & HVAC	3,715 hrs	$408,694	$376,500	$10,210,000	$302,428	$11,297,622
-	4	Electrical	5,983 hrs	$658,369	$283,829	$320,748	$101,033	$1,363,979
-	5	**Sub Total**	**9,699 hrs**	**$1,715,905**	**$1,886,767**	**$10,759,998**	**$1,793,461**	**$17,364,695**
-	6	Preliminary Engineering @ 3% (Class III Estimate)						$368,538.46
-	7	Detail Engineering @ 10% Direct Construction Cost						$1,228,461.54
-	8	Construction Management @ 2.5% Direct Construction Cost						$307,115.39
-	9	Site Construction Support by Engineering @ 1% Direct Construction Cost						$122,846.15
-	10	Commissioning Costs @ 1.5%						$184,269.23
-	11	Escalation Allowance @ 5%						$614,230.77
-	12	Capital Spares - 5% of CPC equipment cost						$250,000
-	13	**Sub Total**						**$20,440,157**
-	14	Contingency @ 10%						$2,044,016





APPENDIX H

Impact Assessment

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

Stantec

DRAFT FOR
NRCAN SUBMISSION

Environmental and Socioeconomic Impact Assessment (EIA): Haines Junction Biomass Energy Project

Prepared for:

Yukon Energy Corporation
2 Miles Canyon Road
Whitehorse, YT Y1A 6S7

Prepared by:

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Project No. 133545658
May 24, 2013

EXECUTIVE SUMMARY

Project Overview

The Project considered in this assessment is a 0.5 MW to 2 MW biomass energy plant located in Haines Junction, Yukon Territories. The plant would generate electrical power which would be supplied to the grid as well as thermal energy which would be used to heat local buildings. The plant would be primarily fueled by beetle killed wood to be harvested from areas within approximately 50 to 70 km. This assessment was drafted in consideration of preliminary information available based on the Front End Engineering Design Study which included a preliminary feedstock harvesting study. The objective of the draft assessment is to establish the scope of assessment for the Project and provide preliminary findings on potential environmental and socio-economic effects associated with the plant for use in the decision making process by the Project steering committee. Further development of this assessment will occur if a go decision is made on the Project with the final objective of providing a complete proposal to the Yukon Environmental and Socio-economic Assessment Board (YESAB). In particular, detailed assessment of forest harvesting has not been completed as details of these activities have not yet been fully defined.

Project Description and Schedule

The Proponents of the Project are Yukon Energy Corporation (YEC) and Champagne and Aishihik First Nations (CAFN). A number of other partners have been instrumental in the development of the Project.

Regulatory and Policy Context

The Project will require a *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) submission although the level of assessment may be different depending on the scale of project to be registered. This is discussed in the strategy section of the FEED Study for consideration by the steering committee.

First Nations and Community Consultation

A summary of the First Nations and Community Consultation Plan is provided in Chapter 2.0 of this assessment. To date, one open house has been held. Questions and feedback from this event indicate that there is support for the Project in the community and that the scope of studies planned should address community issues and concerns.

Effects Assessment

The assessment of potential effects has been completed based on expected effects from this Project, desktop literature review and in consideration of initial consultation with First Nations and the public on their interests and values. Valued Components (VCs) have been identified for environmental and socio-economic aspects and baseline conditions have been established based on desktop literature review and consultation. Preliminary findings for each VC have been developed in consideration of the plant operation and will require updates once the Project location and infrastructure are finalized. Updates will also include a more detailed assessment of feedstock harvesting activities.

The Atmospheric Environment has been identified as a VC and defined to include air quality, sound quality and greenhouse gas (GHG) emissions. In consideration of existing conditions and estimated Project emissions of air contaminants, ambient air quality is expected to remain well below regulatory objectives during operation of the plant. Annoyance from noise is not expected to be caused by the plant if it is located at least 500 m from residences (to avoid sleep disturbance). If the plant is located in a building this distance could be less. Further study is recommended to include confirmatory predictions using vendor information and a baseline sound pressure level survey in the area where the plant will be located. The chipping operation will likely need to be located 500 to 1,000 m from residences and sensitive receptors (such as the school or other areas of frequent land use) to avoid annoyance.

Minimal influence on water resources is expected as the plant will use little to no water (depending on vendor) and should be located at least 30 m away from surface water sources. Feedstock (in chip form) will be stored indoors to avoid siltation to surface water run-off.

Significant environmental effects on vegetation and wildlife are not expected based on the species documented in Haines Junction. Field work will be done as a confirmatory measure once the site is chosen.

Additional consultation is required in relation to traditional ecological knowledge and traditional activities and culture to confirm any constraints that should be considered.

Known and documented heritage resources have been confirmed and will be avoided in locating the plant. A field survey would be conducted prior to initiating any ground breaking activities.

Transportation infrastructure is not expected to be noticeably influenced as a result of the Project. Truck traffic is estimated at 3 to 15 trucks per week to supply feedstock during Operation. Similar or less traffic is expected during Construction.

The Project will require resources for construction and operation, therefore a positive effect on labour and economy is expected. Planning of forest harvesting will include consideration of existing land users to ensure that other land users such as existing harvesters, trappers, outfitters and wilderness tourism are not negatively affected.

Human health and well-being should not be affected by the Project. The plant would be operated within applicable regulations which have been developed to protect human health and well-being.

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1.0 INTRODUCTION

The Project considered in this assessment is a 0.5 MW to 2 MW biomass energy plant located in Haines Junction, Yukon Territories. The plant would generate electrical power which would be supplied to the grid as well as thermal energy which would be used to heat local buildings. The plant would be primarily fueled by beetle-killed wood to be harvested from areas within approximately 50 to 70 km.

1.1 PROJECT OVERVIEW

The Champagne and Aishihik First Nations (CAFN), the Dakwakada Development Corporation, Yukon Energy Corporation Cold Climate Innovation of the Yukon Research Centre, and the Village of Haines Junction are investigating the potential for a biomass fuelled energy plant in the community of Haines Junction, Yukon Territories (herein referred to as “the Project”). The plant would provide some much-needed renewable electricity for the territory as well as building heating for one or more buildings in Haines Junction via the waste heat from the power plant exhaust gases. Use of combined heat and power technology will maximize the efficiency of the process and use of the renewable resource. Currently the size of the facility is still under consideration with 0.5 MW to 2 MW electrical output being reviewed. There is potential to start with a small demonstration type project of 0.5 MW, gain operating experience and potentially proceed with expansion of the site up to 2 MW as local expertise is developed. The long term vision of the Project Team includes diverse options including further district heating which could include a greenhouse project utilizing waste heat that could supply regional need for vegetables and decrease local reliance on the Alaska Highway for food transport. The production of renewable energy plus the added benefits of increased forest resource use and possible agricultural use could create additional employment opportunities for the local community and help the region become more self-sufficient.

The Project described and assessed herein is based on preliminary information available at the Front End Engineering and Design (FEED) stage and includes the following primary components:

- construction and operation of a 0.5 MW to 2 MW bioenergy plant using gasification and reciprocating engine technology, located in Haines Junction; and
- fuel processing and handling equipment to be located at or nearby the bioenergy plant (sufficient to process approximately 10,000 to 40,000 m^3 biomass annually).

The power and waste heat transmission linear infrastructures are not assessed in detail as the final locations for this infrastructure are not available at the front end engineering design (FEED) stage. It is currently anticipated that waste heat from electrical generation would be used to heat the Haines Junction School and possibly other buildings, depending on the size of unit selected.

The activities associated with forest feedstock harvesting are presented at a high level in this report; however, site specific environmental assessment is beyond the scope of this assessment. Recommendations for further study and assessment are noted where identified by the environmental assessment team. Follow-up and monitoring are identified based on the information available during the FEED stage of the Project.

1.1.1 Project Purpose

The purpose of the Project is to install and operate a bioenergy plant to increase the use of local biomass as a fuel and to support energy security and the local forest industry. Local agriculture may also be developed in the form of greenhouses that are heated by using the waste heat from the biomass plant. Biomass is a locally available, renewable resource. It is considered an economical choice in the Yukon Territory by Yukon Energy, and is alignment with Yukon Government policies including the Yukon Energy Strategy and the Yukon Climate Change Action Plan. The forests surrounding Haines Junction incurred substantive levels of spruce beetle kill in the 1990's and those areas are the primary targeted feedstock for this Project. The shelf life of that wood is not currently well understood however it is currently considered by some to be a major forest fire threat and has been shown to be suitable fuel for the technology proposed for this Project.

Biomass or wood based fuels are considered greenhouse gas or carbon neutral (are not considered to contribute to increased GHGs in the atmosphere). This is because trees and other vegetation sequester carbon dioxide, a greenhouse gas as they live and grow, and store it until they die and decay, or are harvested and burned. Although burning wood and other biomass produces carbon dioxide, essentially no more is produced through burning than was consumed by the tree as it lived; therefore, as long as new trees are allowed to grow in place of those harvested over the long term, the carbon balance is maintained. The use of biomass along with other forms of renewable energy (such as wind, hydroelectric and solar) are considered key mitigating actions to reduce global GHG emissions.

According to the 2011-12 CAFN Annual Report (CAFN 2012a), the CAFN Council has identified special focus on three pillars: Wellness and Healing; Economic Development; and building vibrant Traditional Culture. This Project would support the pillar of economic development through the creation of facility and forest harvesting related employment opportunities. The CAFN is striving to develop the Project in consideration of traditional culture, wellness and healing as well. CAFN signed a Memorandum of Understanding with the Village of Haines Junction (VOHJ) and Dakwakada Development Corporation (DDC). The CAFN, VOHJ and DDC have a strategic interest in creating a business opportunity to generate electrical energy and provide low cost heating. This Project aligns with the objectives of the Memorandum of Understanding (MOU) which include:

- working together to develop a renewable energy development strategy for CAFN Traditional Territory that respects and reflects economic, environment and community interests;
- promoting an equal relationship that fosters dialogue to assess energy project potential and identification of priorities; and
- enhancing economic opportunities for CAFN in their Traditional Territory.

Members of the CAFN community and members of the public have also voiced a genuine concern for the increasing risk of forest fire in the area due to the large volume of trees killed by the Spruce Bark Beetle, in the area surrounding Haines Junction, as these trees are lower in moisture than green wood. In terms of CAFN's readiness to harvest the forest resources in a strategic fashion, the CAFN has completed a Strategic Forest Management Plan as well as an Integrated Landscape Plan for their Traditional Territories (CAFN 2005, EMR 2006). These documents include assessment of forest resources, management priorities and guidelines for timber harvest project planning. Therefore, the CAFN is ready from a planning perspective to proceed with responsible execution of additional forest harvesting as required. Through this type of project, the CAFN will have an additional viable use for forest biomass available on their Traditional Territories and will be able to put their planning tools into action. Harvesting priorities include spruce bark beetle-killed areas and areas most sensitive to forest fire or which pose a larger risk of loss in the event of fire (near communities).

1.1.2 Project Benefits

The Project benefits are summarized as follows:

- use of a renewable, Yukon based fuel resource;
- maximizing the energy outputs of the resource through combined heat and electricity generation;
- reducing the local reliance and consumption of fossil fuels (buildings to be heated by the Project currently burn diesel for heating);
- reduction in some emissions of air contaminants through an associated reduction in fossil fuel use for local building heat;
- economic opportunities in Haines Junction associated with plant and forest based jobs; and
- creation of an additional use for forest harvested biomass surrounding Haines Junction.

1.2 PROPONENT INFORMATION

1.2.1 Project Team

The Proponents of the Project include Yukon Energy Corporation (YEC) and Champagne and Aishihik First Nations (CAFN). The current plan for Project ownership is that CAFN would be the majority owner of the Project, likely in partnership with YEC. The ultimate structure of ownership and operational control of the Project is one of the primary tasks of the feasibility studies currently underway. The evaluation is considering the risks associated with various models for ownership and operation of both the plant and harvesting operations. In any event it is expected that CAFN members will be used to the greatest extent possible and trained for eventual assumption of full operations over a maximum 20 year period. Yukon Energy will hold a minority interest in the Project in relation to the plant, but are not interested in the operations of the logging business.

Consideration of outsourcing operations to an independent service provider is part of the overall risk assessment and feasibility study for the Project. In terms of the plant site, Yukon Energy has expertise and experience in ownership and operation of generating facilities, although this would be their first involvement with biomass. CAFN does not have previous generation experience, however they have expertise is forest harvesting and forest resource management as demonstrated through their leadership in the development of the Strategic Forest Management Plan (SFMP) and have a strong interest in providing jobs to CAFN community members as part of the Project. Thus the Proponents are considering the best ownership and operational scenario, to minimize risk to the Project and maximize community gains.

Established in 1987, Yukon Energy is a publicly owned electrical utility that operates as a business, at arms-length from the Yukon government. They are the main generator and transmitter of electrical energy in Yukon and work with their parent company Yukon Development Corporation to provide Yukoners with a sufficient supply of safe, reliable electricity and related energy services.

There are almost 15,000 electricity consumers in the territory. Yukon Energy directly serves about 1,700 of these customers, most of whom live in and around Dawson City, Mayo and Faro. Indirectly, they provide power to many other Yukon communities (including Whitehorse, Carcross, Carmacks, Haines Junction, Ross River and Teslin) through the Yukon Electrical Company Limited. Yukon Electric buys wholesale power from Yukon Energy and sells it to retail customers in the territory.

Yukon Energy has the capacity to generate approximately 132 megawatts of power. Ninety two megawatts of that are provided by our hydro facilities in Whitehorse, Mayo and Aishihik Lake (40 megawatts at Whitehorse, 37 megawatts at Aishihik and 15 megawatts at Mayo), 39 megawatts by diesel generators (which we currently only use as back-up) and 0.8 megawatts by two wind turbines located on Haeckel Hill near Whitehorse.

Yukon Energy is regulated by the *Business Corporations Act*, the *Public Utilities Act* and the *Yukon Water Act*. Our headquarters are located near the Whitehorse Rapids hydro plant in Whitehorse, with community offices in Mayo, Faro and Dawson City (Yukon Energy 2013).

CAFN established itself as a self-governing First Nation in 1993, after more than 20 years of negotiations. CAFN's rights to the Yukon portion of its traditional lands and resources were confirmed with the signing of the Champagne and Aishihik First Nations Final Agreement between CAFN, the Government of Canada and the Government of Yukon.

CAFN was one of the first four Yukon First Nations to conclude their final agreements. In addition, the self-government agreement provides CAFN with the power to enact laws on a wide range of matters affecting the rights of its citizens. On September 17, 1998 the Champagne and Aishihik First Nations made history by passing three acts: the *Income Tax Act*, *Fish and Wildlife Act*, and the *Traditional Pursuits Act*. These acts became effective on January 1, 1999.

A variety of municipal services, (housing, roads, water and sewer) as well as social services (health, nutrition, employment and training) are fully administered by the First Nations' government. The Department of Lands and Resources, which also includes Heritage and Economic Development, manages CAFN's traditional lands and integrates education and training of its citizens.

CAFN has undergone radical change in the last 100 years. Not long ago, the Southern Tutchone people of this region lived as part of the land. Today, they are working on the establishment of their own government and CAFN is becoming the steward of its homeland as it builds a sustainable economy.

1.2.2 Policies and Visions on Environmental and Sustainable Development

YEC and CAFN have converging values when it comes to environmental responsibility and sustainable development and both organizations have environmental stewardship ingrained in their policies, guiding principles and values. Further information on YEC's environmental policy can be found on their website at http://www.yukonenergy.ca/about/policies/environmental/.

CAFN has published a number of strategic plans in relation to sustainable development that will directly guide the implementation of this Project including their Vision Statement and Strategic Plan. CAFN's guiding documents can be accessed on their website at http://www.cafn.ca/.

CAFN's Land Claim Agreement provides for the ownership of some 2,427 square kilometers of land. It also continues to provide guaranteed access to fish and wildlife resources. Most importantly, the agreement establishes the CAFN government as co-managers of all natural and cultural resources in its traditional territory. CAFN is now a full partner on the Kluane National Park Management Board, the Alsek Renewable Resources Council and has representation on numerous other regional and territorial boards that make recommendations on heritage, educational, environmental and economic issues.

1.3 REQUIRED AUTHORIZATIONS AND REGULATORY APPROVALS

Yukon government, First Nation government, and federal government regulatory approvals and decisions are required before any activities (construction and operation) may be undertaken for any project that may emerge from this and other related feasibility studies. These approvals and decisions, however, may only be made after the required assessment by the Yukon Environmental and Socio-economic Assessment Board (YESAB) of a Project Proposal submitted pursuant to the Yukon *Environmental and Socio-economic Assessment Act* (*YESAA*).

1.3.1 *YESAA* Screening Requirements

While this type of project will have several activities which would make it assessable under *YESAA*, a screening level assessment by the YESAB Executive Committee would be required in accordance with Item 55 of Schedule 3 of the Assessable Activities, Exceptions and Executive Committee Projects Regulations as the Project will involve cutting 20,000 m^3 or more of standing or fallen trees or removing that amount of fallen or cut trees. The power plant (principal project) on its own would only trigger an assessment at the Designated Office level (Executive Committee assessment required for wood-fired electrical generating stations with a production capacity of 5 MW or more), but the principal project's interdependence with the accessory project, consisting of local feedstock procurement, raises the level of assessment to a screening.

The expected biomass consumption for the plant ranges from 10,000 m^3 to 40,000 m^3 annually (0.5 to 2 MW). Therefore the smaller plant may only require a Designated Office (DO) proposal submission. The requirements will be confirmed through consultation with YESAB prior to submission.

1.3.2 Applicable Legislation, Regulations, and Permits

Pending the issuance of a favorable YESAB Executive Committee screening or DO decision, the proponent is able to pursue any required federal, First Nation, and/or territorial government authorizations for the project to proceed (*e.g.*, Air Emissions Permit, Timber Permit). Once the decision documents are issued, the permitting/licensing applications can be processed by the applicable authority and authorizations subsequently issued to begin construction and commence operations.

The territorial, First Nations, and federal government authorizations that may be required for the construction and operation of the proposed Bioenergy Facility and associated feedstock harvesting are shown in the following tables (Tables 1.3.1 and 1.3.2). This list will be amended based as the technical aspects of the facility and harvesting become further defined as the Project progresses. The information below is based on the Permit and Authorization Guide for Yukon Activities (2013) and information currently available for the Government of Yukon (YG), Champagne and Aishihik First Nations and Federal Government agencies online.

The Strategic Forest Management Plan and Integrated Landscape Plan for the CAFN Traditional Territory (TT) are the overarching guiding documents for forest management and harvesting in CAFN TT as set out in the provisions under Chapter 17 of the CAFN Final Agreement. Timber harvesting activities and associated feedstock harvesting activities should be assumed to require consistency with their direction, otherwise the activities would not get authorized. Higher performance standards exist in this plan than exist under other forms of regulation.

Renewable Resource Councils (RRCs) are local management bodies in the Yukon established in areas where individual land claim agreements have been signed. RRCs are a voice for local community members in managing renewable resources, such as fish, wildlife, habitat and forestry matters, specific to their Traditional Territory. RRCs provide strong input into planning and regulation by the territorial, federal and First Nations governments. RRCs also play an important advisory role to the territorial management board for fish and wildlife by raising awareness of specific issues and providing local and traditional information.

The Alsek Renewable Resource Council (ARRC) is the applicable RRC for the Haines Junction community and surrounding CATT. The ARRC's jurisdiction is the Champagne and Aishihik Traditional Territory (CATT) which includes the Yukon communities of Haines Junction, Canyon Creek, Takhini, Mendenhall, Silver City, Kloo Lake, Aishihik and Klukshu (YFWMB 2013).

The ARRC began its work in 1995 after the signing of the Champagne and Aishihik First Nations (CAFN) Final Agreement. The Final Agreement created the ARRC as the "primary instrument for local renewable resources management."

Table 1.3.1 Bioenergy Facility Regulatory Requirements

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Air Emissions greater than 5 Mbtu-hr	• *Yukon Government Environment Act* • *Air Emissions Regulation*	• Air Emissions Permit	• Environment Yukon	
Release of Air Pollutants	• *Yukon Government Environment Act* • *Air Emissions Regulation*	• Air Emissions Permit	• Environment Yukon	
Ozone Depleting Substance Use	• *Yukon Government Environment Act* • *Air Emissions Regulation*	• Ozone Depleting Substances/ Halocarbons Permit	• Environment Yukon	Requirement to be determined based on design.
Special Waste Management	• *Yukon Government Environment Act* • *Special Waste Regulations*	• Special Waste Facility • Disposal and Generator Permit	• Environment Yukon	Requirement to be determined based on design.
Solid Waste Disposal	• *Yukon Government Environment Act* • *Solid Waste Regulations*	• Facility Permit	• Environment Yukon	Requirement to be determined based on design.
Storage Tank/Petroleum Tank Use	• *Yukon Government Environment Act* • *Storage Tank Regulations*	• Application for Operation, Closure • Abandonment or Renovation to Storage Tanks/Permit	• Community Services, Protective Services	Requirement to be determined based on design.
Water Use or Deposit of (Water) Waste	• *Waters Act*	• Water Use License	• Yukon Water Board	Requirement to be determined based on water use quantities.
Potable Water Supply	• *Public Health Act* • *Drinking Water Regulation*	• Drinking/Potable Water Permit	• Health and Social Services • Public Health and Safety	
Land Acquisition, Title to Land	• *Land Titles Act*	• Issuance of Title	• Justice	Requirement to be determined based on land parcel.
Tenure for Land Lease or Agreement of Sale	• *Territorial Lands Act*	• Application for Land	• Energy, Mines & Resources	Requirement to be determined based on land parcel.
Tenure for Land Lease	• *CAFN Lands Act*	• CAFN Lands Disposition (lease for commercial or industrial purposes)	• CAFN Heritage, Lands and Resources	Commercial lease of land requires CAFN Lands Committee review of application and Chief and Council approval.

Table 1.3.1 Bioenergy Facility Regulatory Requirements

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Temporarily Using or Occupying Commissioner's Land	• *Territorial Lands Act*	• Land Use Permit	• Energy, Mines & Resources	Requirement to be determined based on land parcel.
Temporarily Using or Occupying CAFN Settlement Land	• *CAFN Lands Act*	• CAFN Lands Disposition (easement, right-of-way)	• CAFN Heritage, Lands and Resources	
Facility Construction	• *Yukon Government* Land Services	• Building Permits	• YG Community Services • Building Safety	
	• *Yukon Government Forest Resources Act*	• Timber Resource Processing Permit	• Forest Management Branch	Requirement for construction, operation of any timber processing facility.
	• *Building Standards Act*	• Plumbing Permit	• YG Community Services, Building Safety	
	• *Public Health & Safety Act* • *Sewage Disposal Systems Regulation*	• Sewage Disposal Permit	• Health & Social Services • Environmental Health Services	Requirement to be determined based on design.
	• *Electrical Protection Act*	• Electrical Permit	• YG Community Services, Building Safety	
	• *Gas Burning Devices Act*	• Gas Installation Permit	• YG Community Services, Building Safety	Requirement to be determined based on design.
Clearing or Installing a Utility Right-of-Way	• *Territorial Lands Act*	• Land Use Permit, Disposition Approval	• Energy, Mines & Resources	Requirement to be determined based on design.
Construction of New Road Access	• *Territorial Lands Act*	• Land Use Permit	• Energy, Mines & Resources	Requirement to be determined based on site location.
Construct Road Access on Highway Right-of-Way	• *Highways Regulation*	• Access Permit	• Highways & Public Works	Requirement to be determined based on site location.
Temporary Use of CAFN Settlement Land / Use or Alteration of Resources on Surface of Land	• *CAFN Traditional Activities Protection Act*	• TAPA Permit	• CAFN Heritage, Lands and Resources	Permits issued by Director.
Activities in a Habitat Protection Area	• *Wildlife Act* • *Wildlife Regulation*	• Permission for Activity	• YG Environment	Requirement to be determined based on site location.
Activities in a Wildlife Area	• *Wildlife Area Regulation*	• Wildlife Permit	• YG Environment	Requirement to be determined based on site location.

Table 1.3.1 Bioenergy Facility Regulatory Requirements

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Harmful Alteration, Disruption or Destruction of Fish Habitat	• *Fisheries Act*	• Fisheries Act Authorizations S.35.2	• Fisheries and Oceans Canada	Requirement to be determined based on site location and construction.
Destruction of Fish by Means Other than Fishing	• *Fisheries Act*	• *Fisheries Act* Authorizations S.32	• Fisheries and Oceans Canada	Requirement to be determined based on site location and construction.
Obstruction of Fish Passage	• *Fisheries Act*	• *Fisheries Act* Authorization S.22	• Fisheries and Oceans Canada	Requirement to be determined based on site location and construction.

Table 1.3.2 Feedstock Harvesting Regulatory Requirements

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Timber Harvesting	• *Timber Harvest Plan, Forest Resources Act and Regulation*	• Timber Resource License	• Energy, Mines and Resources • Forest Management Branch	
Timber Cutting on CAFN Settlement Land for Commercial Purposes	• *CAFN Traditional Activities Protection Act*	• TAPA Permit	• CAFN Heritage, Lands and Resources	
Burn Wood Refuse	• *Forest Protection Act* • *Forest Protection Regulation*	• Burning Permit	• Community Services, Protective Services	
Land Acquisition, Title to Land	• *Land Titles Act*	• Issuance of Title	• Justice	Requirement to be determined based on land parcel.
Tenure for Land Lease or Agreement of Sale	• *Territorial Lands Act*	• Application for Land	• Energy, Mines & Resources	Requirement to be determined based on land parcel.
Temporarily Using or Occupying Commissioner's Land	• *Territorial Lands Act*	• Land Use Permit	• Energy, Mines & Resources	Requirement to be determined based on land parcel.
Construction of New Road Access	• *Territorial Lands Act (see below)*	• Land Use Permit	• Energy, Mines & Resources	Requirement to be determined based on site location.
Construction of New Road Access – Forest Resource Use	• *Forest Resources Act – Forest Resource Road Regulations*	• Forest Resource Road Licence/Permit	• Energy, Mines & Resources	Requirement to be determined based on site location.

Table 1.3.2 Feedstock Harvesting Regulatory Requirements

Facility or Activity	Act or Regulation	Approval/Permit Required	Lead Agency	Comments
Construct Road Access on Highway Right-of-Way	• *Highways Regulation*	• Access Permit	• Highways & Public Works	Requirement to be determined based on site location.
Activities in a Habitat Protection Area	• *Wildlife Act* • *Wildlife Regulation*	• Permission for Activity	• YG Environment	Requirement to be determined based on site location.
Activities in a Wildlife Area	• *Wildlife Area Regulation*	• Wildlife Permit	• YG Environment	Requirement to be determined based on site location.
Transportation of Bulk Commodity	• *Bulk Commodity Haul Regulations*	• Bulk Commodity Haul Agreement	• Highways & Public Works	Requirement to be determined based on transportation quantities.
Oversize Trucking	• *Highways Act*	• Over Dimensional or Over Weight Vehicle Permits	• Highways & Public Works	Requirement to be based on transportation methods.
Assessment of Historic Resources as Part of the Timber Harvest Planning or Road Construction	• *Historic Resources Act*	• Archaeological Permit	• Department of Culture and Tourism	Required to conduct heritage assessments in the field.
Other Research Projects	Examples: • *Scientists And Explorers Act* (Yukon) • *Fisheries Act* • *Migratory Birds Act* • CAFN TAPA Based Traditional Knowledge Policy	Various Authorizations	• Canadian Wildlife Service • Fisheries and Oceans Canada • Yukon Culture and Tourism • Yukon Environment • CAFN	Quite likely necessary if project will include fish and wildlife monitoring.

2.0 FIRST NATIONS, OTHER GOVERNMENT AND COMMUNITY CONSULTATIONS

2.1 CONSULTATION REQUIREMENTS

Section 50(3) of the *Yukon Environmental and Socio-Economic Assessment Act* (YESAA) lists the following First Nations and stakeholder consultation requirements:

> *"Before submitting a proposal to the Executive Committee, the proponent of a project shall consult any first nation in whose territory, or the residents of any community in which, the project will be located or might have significant environmental or social economic effects."*

Section 3 of YESAA states:

> *"Where, in relation to any matter, a reference is made in this Act to consultation, the duty to consult shall be exercised:*
>
> *(a) by providing, to the party to be consulted,*
>
> *(i) notice of the matter in sufficient form and detail to allow the party to prepare its views on the matter,*
>
> *(ii) a reasonable period for the party to prepare its views, and*
>
> *(iii) an opportunity to present its views to the party having the duty to consult; and*
>
> *(b) by considering, fully and fairly, any views so presented."*

2.2 CONSULTATION OVERVIEW AND APPROACH

The overarching aim of Project consultation efforts is to generate awareness, understanding and support within the local communities of Haines Junction and Champagne and Aishihik First Nations, and to reach an accurate and complete understanding of the concerns and interests that local communities and interested stakeholders may have with regard to the construction and operation of a biomass energy generation facility. The goals of Project consultation efforts are as follows:

- create and maintain awareness and understanding of the project among the general public, decision-makers, key stakeholders, and interested First Nations (particularly Haines Junction residents and Champagne and Aishihik First Nations citizens), including potential costs and benefits, and timelines and opportunities for engagement;
- identify stakeholders and potentially interested First Nations, build and maintain strong relationships with those groups, and ensure that engagement occurs at the right level, at the right time, in the right way;
- identify, document and monitor issues and concerns that arise during the engagement process

- identify planning, design and management measures that can be used to avoid, mitigate or resolve potential negative environmental and socio-economic impacts;
- encourage the sharing of traditional land use and traditional knowledge information by interested and potentially affected First Nations groups; and
- provide early notification of the project and ensure that there are adequate opportunities for First Nations, stakeholder and public input.

2.3 PUBLIC CONSULTATION PLAN

The project involves consultation and relationship-building over a number of different phases spanning several years. As the Project progresses from the initial feasibility assessment through the internal assessment of potential environmental and socio-economic effects and then into the external impact assessment process, the Project Team will consult with interested First Nations, stakeholders and the general public through a mix of targeted meetings, open house sessions and information updates on Project partner websites. The depth of consultation will depend on stakeholders as shown in Table 2.3.1 below.

Table 2.3.1 Consultation Levels

Consultation Level	STAKEHOLDER TYPE
Collaborate	Stakeholders that are responsible for driving the Project.
Involve	Stakeholders who have a high-level of engagement with the Project and are involved in the decision-making process.
Consult	Stakeholders who need to have a good understanding of the Project and will be invited to provide input at critical points (*e.g.*, Federal, Territorial, and FN Resource Management Agencies, FN citizens and local residents, industry, land users and owners, planning groups and committees, NGOs, ENGO).
Inform	Stakeholders who require a broad level of awareness of the project Stakeholders who may be influential or important.

To cultivate relationships with First Nations and key stakeholders that have an active interest in the Project, meetings will be held to provide updates on the Project, discuss planned work, listen to concerns and assess areas of interest. The Project Team may also choose, where appropriate, to engage with particular First Nations and stakeholder groups when planning and conducting specific Project tasks.

The project will be located within the traditional territory of the CAFN and they are the primary First Nation that will be engaged with regard to the Project. While it is highly unlikely that the Project will have an effect on the traditional territories of other First Nations, there is potential that the following First Nations and First Nations associations may express some interest in the Project and may request more information and dedicated meetings:

- Carcross/Tagish First Nation;
- Council of Yukon First Nations – Natural Resources and Environment;
- Kluane First Nation;

- Kwanlin Dun First Nation;
- Little Salmon Carmacks First Nation;
- Ta'an Kwäch'än Council; and
- White River First Nation.

As the Project progresses, the Project Team will communicate by letter with interested First Nations at key regulatory milestones to disseminate Project documentation and keep those groups up-to-date.

Following submission of the project proposal, YESAB will conduct their formal First Nation and public consultation review process. During that process, the Project Team may be asked to respond to queries or concerns. The Project Team will continue to meet with stakeholders and First Nation groups to resolve ongoing issues as appropriate and public meetings may be held to provide further opportunities for participation and input.

Under YESAA, the knowledge and views of Yukon First Nations and their citizens will be sought out by regulators. Notification will be sent to all First Nations whose territory the project may be located on or where the project might have significant environmental or socio-economic effects. First Nations will have the opportunity to participate and share their views and information during the comment period for the assessment.

In the YESAA, it is explicitly stated that traditional knowledge is a factor that must be considered and incorporated into an impact assessment. Specific meetings will be held with the CAFN to plan and carry out required traditional land use or traditional knowledge studies. These studies will provide essential Project-specific information for integration into the environmental and socio-economic impact assessment.

2.4 CONSULTATION TECHNIQUES

The following are techniques available for use by the Project Team to engage interested First Nations, stakeholders and the general public:

- letters and email correspondence;
- face to face meetings;
- workshops and open houses:
  - project information sheets and posters (distributed to local government offices, libraries, local recreational centers, community bulletin boards, schools, First Nation band offices);
- radio and television advertisements;
- targeted media interviews;
- website and social media; and

- advertisements in community newspapers.

All feedback from First Nations and stakeholders will be tracked in a shared information management system. Speeches and presentations will be documented in a similar manner; the identities of those who attended the event and the nature of feedback received will be documented. Information on communications activities will be available on demand to the Project team and the data will be regularly updated. Public consultation completed to date is summarized in Table 2.4.1. Some more informal meetings with individual stakeholders have also been completed to date.

Table 2.4.1 Consultation Events To-Date

Location	Description	Date	Venue
Haines Junction, Yukon	Open House geared engaging CAFN members and Haines Junction residents, building support, disseminating information and gathering preliminary issues and concerns.	January 23, 2013	Da Ku Cultural Centre 280 Alaska Highway Haines Junction, Yukon

2.5 KEY CONCERNS RAISED DURING CONSULTATION

The first open house for the Project was held in Haines Junction on Jan. 23, 2013. A detailed summary has been prepared by the Proponent and will be considered in the development of future public and First Nations communications as well as in shaping the Project in the next stages. The open house included presentations on the technologies being considered, the preliminary feedstock availability assessment, environmental issues being considered and the waste heat recovery component of the Project.

Approximately 75 to 80 members of the community attended including CAFN members and general public as well as representatives from the Village of Haines Junction and Forest Management Branch. Questions and comments received during the session are summarized as follows and have been considered in the development of this assessment:

- concern that the engines be the most efficient available were raised;
- use of generated heat during the summer;
- proximity of the biomass plant to the Village and noise levels;
- pros and cons of using a gasification system versus a conventional steam system;
- effect of cold climate of Haines Junction on functioning of biomass plant;
- whether live trees will be used as fuel in addition to beetle-killed trees;
- whether the technology will be available in all CAFN communities;
- what is the capacity of the ‘green zone’ to regenerate (related to the Forest Management Zones defined in the local Integrated Landscape Plan);

- maximum distances that a biomass plant can be located from inhabited areas and still be economic;
- potential impacts on wood supplies for wood cutting industry and whether price of firewood will increase;
- location of plant;
- need for heating and jobs in the local communities;
- forest fire concerns;
- ash disposal;
- plant size and capacity to utilize beetle-killed wood;
- whether similar plants could be located in Burwash and Destruction Bay;
- cost of heating infrastructure;
- responsibility for hiring and maintenance;
- which businesses (CAFN and non-businesses) may realize benefits; and
- whether excess heat could be stored during summer for the winter.

2.6 KEY CONCERNS ANALYSIS

No new issues were raised during the first consultation event beyond those aspects that are either currently being evaluated or are planned for subsequent stages of the Project. Overall, First Nations and public in attendance were supportive of the Project and concerns were focused around avoiding issues with current harvesting activities (competition for forest resources), maximizing local job development and addressing the growing risk of forest fire from dead standing trees in beetle kill zones.

3.0 PROJECT DESCRIPTION

This chapter provides an overview of the project location and study area characteristics, the Project technology and infrastructure and the schedule for permitting, construction, operation and eventual decommissioning.

3.1 PROJECT LOCATION

The geographic location of the Project is in the Village of Haines Junction in the Yukon Territory. The Project location is shown in Figure 3.1.1. The community of Haines Junction has its beginnings as a highway construction camp built in 1942 at the junction of the Alaska Highway and Haines Road.

3.1.1 Local Climate

The Climate in the Ruby Ranges Ecoregion, which includes the Haines Junction area and a large swath of the Champagne and Aishisik Traditional Territory (CATT – Figure 3.1.1), is characterized as the driest in the Yukon Territory. This ecoregion receives only 250-300 mm of precipitation annually, resulting from a rain shadow produced by the St. Elias Mountains to the west (Yukon Ecoregions Working Group, YEWG 2004). The Shakwak Valley, where Haines Junction is situated, experiences the coldest temperatures of the Ecoregion, ranging from -30° to -35° C in January (YEWG, 2004). Permafrost is present in most of the ecoregion, except in the southern portion in and around Haines Junction (YEWG 2004). Climate in the Yukon Southern Lakes Ecoregion is also relatively arid. Only 200 to 325 mm of precipitation occurs in the Yukon Southern Lakes, again due to the rain shadow from the St. Elias-Coast Mountains. Mean annual temperature ranges from -1° to -4°C throughout the ecoregion, and is colder in the northwest than in the southeast, with the lowest temperatures occurring in January ranging from -21° to -25°C (YEWG 2004). Permafrost underlies less than a quarter of the area within the ecoregion, in part due to the arid climate described above (YEWG 2004).

3.1.2 Study Area Boundaries

The preliminary study area is focused on the Village of Haines Junction as the specific plant site has not yet been chosen, nor have the areas for additional harvesting been finalized. The location of the plant site will likely be within 400 m of larger buildings in Haines Junction as this is the approximate limitation for use of waste heat from the plant. The village and key buildings being considered for waste heat use are shown in Figure 3.1.2. The potential location being used for FEED is also shown in Figure 3.1.2. This location is considered as the preliminary site location in this assessment and is a greenfield site (has not been recently developed). Excluding the harvesting area(s), the plant and construction activities will cover an area of approximately 2.8 hectares (ha).

3.1.3 Village Services

The following description of services has been gathered from Haines Junction’s Integrated Community Sustainability Plan and CAFN’s Integrated Community Sustainability Plan (Village of Haines Junction 2007, CAFN 2009a).

Figure 3.1.1 Project Location

Figure 3.1.2 Preliminary Range of Sites for Waste Heat Use

Recreational facilities in Haines Junction include an arena, curling rink, swimming pool, outdoor basketball court and a skateboard park. There is also a community library with public internet access, a youth centre, and a community hall. Haines Junction is served by a local community Health Centre, a volunteer ambulance service, a locally based social worker, and a locally based counselor. Recently, a Seniors' Centre has opened with limited hours.

The RCMP operates a detachment in Haines Junction and the local Haines Junction Community Justice Committee provides alternative justice systems.

There is a volunteer fire department, with staff trained in first aid and CPR. St. Elias Community School offers kindergarten to Grade 12 and the Haines Junction campus of Yukon College offers full-time academic upgrading programs and delivers a variety of continuing education courses. The campus's location near the St. Elias Mountains provides opportunities for such courses as avalanche training, wilderness guiding and wilderness survival. Youth employment training, early childhood courses and office administration are also offered.

The Yukon Electrical Co. Ltd. supplies hydroelectric power from Aishihik Lake, with diesel generator back-up. The village has a piped water supply that is also available to some properties owned by CAFN. Other areas use trucked-in, chlorinated well water or personal wells.

3.1.4 Traditional Territory

The CAFN's Land Claim Agreement provides for the ownership of some 2,427 square kilometers of land. It also continues to provide access to fish and wildlife resources. CAFN is a full partner on the Kluane National Park Management Board, the Alsek Renewable Resources Council and has representation on numerous other regional and territorial boards that make recommendations on heritage, educational, environmental and economic issues.

Haines Junction is not a traditional CAFN settlement but is located on well used travel routes. The original name for the area was Dakwakada, meaning high cache, which indicates that the area was an important hunting and fishing region. The community only gradually became a place where CAFN people permanently settled in the 1940s and 1950s after Haines Junction began to grow as a regional centre. The number of First Nation residents increased sharply beginning in the 1960s when the federal government relocated families from Champagne and Aishihik to the community.

3.1.5 Yukon Land Use Planning Region

In Yukon, the Umbrella Final Agreement introduced a new regional land use planning process. Currently there are eight planning regions in Yukon with borders generally following the traditional territories of Yukon First Nations. The Project is located in the Kluane planning region (Kluane and Champagne & Aishihik TT). The region does not yet have an approved regional land use plan. The objectives of regional planning in the Yukon (under the Final Agreements) are:

- Minimizes actual or potential land use conflicts. These conflicts will likely grow worse without planning;

- Recognizes and promotes the cultural values of Yukon First Nations people. Certain cultural activities are intrinsically linked to the land;
- Ensures Sustainable Development by developing social, cultural, economic and environmental policies that apply to the management, protection and use of land, water and resources in an integrated and coordinated manner;
- Spells out how and where land uses may or may not occur, and so increase the land use certainty. In some cases, land use plans may help avoid legal action between different land users (YLUPC 2011).

Both YESAA and Land Use Plans are concerned with how and where development occurs and YESAB is an important component in implementing land use plans. In reviewing proposed projects, YESAB must consult The Yukon Land Use Planning Council (YLUPC) as to whether the project conforms to the land use plan, and how the project can conform to the plan, if it doesn't already. Although conformity with the plan does not determine whether a project can proceed or not, it will be factored into the decision (YLUPC 2011).

3.1.6 Consistency with Other Plans

The Project would be executed in harmony with planning tools used by Champagne and Aishihik First Nations including the Integrated Community Sustainability Plan (ICSP) (CAFN 2009a) published in 2009 and the Strategic Forest Management Plan (SFMP) and the Integrated Landscape Plan (ILP) (EMR 2006). The ICSP included a number of focus areas that are consistent with this Project including energy efficiency upgrades, renewable energy generation and potential for incorporation of a community greenhouse. The Village of Haines Junction completed its Integrated Community Sustainability Plan in 2007 with similar priorities noted in comparison to the CAFN ICSP.

Details of requirements for the Project to proceed in conjunction with the SFMP and ILP are outlined in each VC section as applicable. As this plan relates to forest management, further specifics of how the Project would ensure consistency with the ILP will be confirmed in the next stage of study.

3.2 PROJECT INFRASTRUCTURE AND TECHNOLOGY

The technology for the Project is the use of a biomass gasification process to fuel a reciprocating engine. This technology has been selected as a gasifier is the only biomass technology that will allow for the use of a reciprocating engine which can be used to generate electricity without steam while also generating waste heat that can be used for building heating. Steam boiler and steam turbine combinations can also be used for these purposes but require more advanced training for operators and this expertise is not readily available in the Yukon, especially in small communities such as Haines Junction. Thus, the gasifier/reciprocating engine combination is considered the best choice for small Yukon communities wishing to use a combined heat and electrical power generating technology. The gasifier and engine technology is discussed further in the following section.

3.2.1 Gasifier and Engine Technology

Gasification is a process that converts a carbon-containing solid material into a gas (called synthetic gas or simply “syngas”) for use in applications such as electricity generation, heating, or chemical manufacturing. The chemical reactions to produce syngas take place in a vessel known as a gasifier. The temperature, pressure, and concentration of certain chemical species in the gasifier affect the chemical composition of the syngas. In general, syngas formed from biomass or woody material contains carbon monoxide, carbon dioxide, methane, hydrogen, steam, and unreacted nitrogen if air is used.

A simple block diagram of a gasification system is provided in Figure 3.2.1.

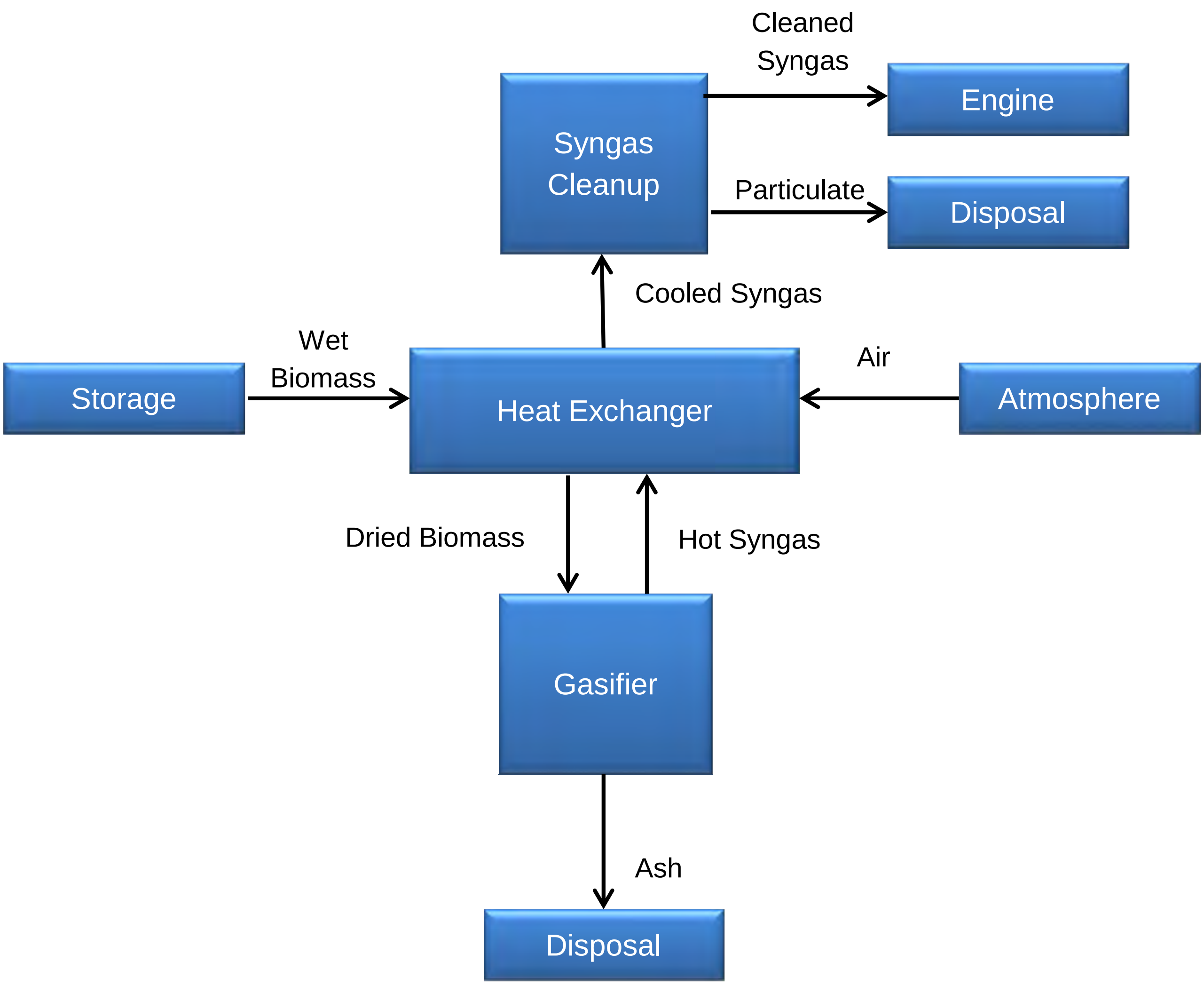


Figure 3.2.1 Simplified Block Diagram of a Gasification System

In a gasifier, the biomass feedstock is added in chip form (feedstock must be chipped using a mobile or stationary chipper) to the vessel along with air (a source of oxygen). In applications where the presence of nitrogen would be undesirable, pure oxygen or hydrogen is used instead. Temperatures in a gasifier can vary from 200°C to 1,000°C. Hot syngas from the gasifier is typically passed through a heat exchanger to dry the incoming feedstock and cool the gas. This cooled gas is then filtered to minimize the particulate concentration and tar in the gas. This clean-up stage is important to decrease the wear on downstream equipment, such as a reciprocating engine. As an added benefit, the syngas cleanup reduces the release of particulate matter to the atmosphere. Ash is also generated by the gasifier and is collected for disposal in a landfill that is capable of handling such waste. This ash (sometimes called biochar due to its natural origin) could also potentially be used for other applications such as soil application or as a component of asphalt.

The FEED study is currently considering a biomass gasification system to generate 0.5 MW_e to 2 MW_e (megawatt of electric energy) using a reciprocating gas engine. Further details are available in the FEED study.

3.2.1.1 Case Studies

As this technology is quite novel (use of a gasifier, reciprocating engine combination), the following case studies are briefly described to provide additional details of potential technologies and required infrastructure. As part of the FEED study, the Project team visited three organizations to study their gasification systems and evaluate the potential for these systems to meet the Haines Junction Project objectives.

The Community Power Corporation (CPC) operates a 100 kW_e system at Pineland Forest Nursery in Hadashville, Manitoba. The system is housed in five shipping containers (each 6 m in length) with a separate fuel storage building. In addition to electricity generation, heat is recovered and used to heat greenhouses on-site. The system includes a stainless steel downdraft gasifier, a heat exchanger to dry incoming biomass, carbon filters to clean the syngas, and two V8 spark ignition engines for electricity generation. The control interface and electrical equipment are housed in a control room. The biomass supply is wood chips.

The exterior of the plant is shown in Photo 1.

Photo 1: Exterior of CPC Gasifier Plant

On the other end of the capacity envelope being considered for this Project, Nexterra operates a gasification system on the Vancouver campus of the University of British Columbia (UBC) for the production of electricity (2 MW_e) and heat. The system, including wood chip storage, is housed in a building, approximately 27 m x 55 m (90 feet by 180 feet), on the campus. Following screening, woodchips are dried in a single pass dryer then stored in bins. An updraft gasifier converts the biomass to syngas and ash. Nexterra uses a proprietary syngas cleanup system that includes tar cracking (for the breakdown of tar) and a bag house filtration system. The cleaned syngas is fed either to a 20 cylinder reciprocating engine to generate with a capacity of 2 MW_e or to a thermal oxidizer to generate heat and steam for district energy network.

The engine used to generate electricity from Nexterra syngas is shown in Photo 2.

Photo 2: Engine Used by Nexterra System

The FEED study completed by Stantec is based on a combination of CPC 100 kW_e units to form a 0.5 MW_e facility. Three options for a 0.5 MW_e facility were considered in the FEED Study.

3.2.2 Waste Heat Uses

Cleantech Community Gateway (CTCG) completed a study to review options for waste heat use from several electrical production scenarios, entitled *Haines Junction Bioenergy Project – Evaluation of Waste Heat Potential* (CTCG 2012). These options are considered integral to the development of the Project in relation to the biomass energy plant sizing and siting. Three options for the use of recovered heat were evaluated by CTCG: District Energy System (DES), Organic Rankin Cycle (ORC), and Controlled Environment Agriculture (CEA, *i.e.*, greenhouses). Each option is summarized in the following paragraphs.

For a 0.5 MW_e system that produces hot water, CTCG recommended that the hot water be used to heat one building such as the Haines Junction School or another building of similar heat requirement. The school's peak heat demand is 360 kW, which is slightly less than the peak thermal output of a 0.5 MW_e system. According to the CTCG report, in order for the use of waste heat to be economical, the length of the heat supply pipe between the power plant and the school must be approximately 350 m or less. The FEED study preliminary site selected was based on this parameter and review of available parcels of land.

The feasible radius for heating several select local buildings is provided in Figure 3.1.2.

CTCG noted that a 3 MW_{th} (megawatt thermal energy) power plant would be required to meet the peak heating requirements of the seven buildings identified as potential DES customers:

- Haines Junction School;
- Fire Hall;
- Convention Centre;
- Arena Complex;
- Swimming Pool and Community Hall Complex;
- YK Government Administration Building; and
- CAFN Cultural Centre and Kluane National Park Visitor Information Centre.

When considering the economics of a Direct Energy System (DES), a smaller network including the school, convention centre, arena complex, and the swimming pool and community hall has a lower risk and better economics.

An Organic Rankine Cycle (ORC) generator can be used to generate additional power using the waste heat. Two ORC generators were considered in the CTCG study. With respect to technical risk, district energy systems are considered to have low technical risk when designed and installed correctly. Integration of an ORC generator would require more substantive innovation, development, and testing, the cost of which is not currently known. Hence there is a higher technical risk and capital cost with the ORC generator than the DES. The CTCG concluded that the ORC option is not recommended for this Project.

Controlled Environment Agriculture (CEA) seeks to control lighting, temperature, nutrients, hydroponics, and air control in a greenhouse. Such a system in Haines Junction could potentially create a local food supply. CTCG made assumptions based on a CEA system in Alaska (Chena Hot Springs) and used standardized inputs to model the potential viability of a CEA greenhouse for Haines Junction. The results of the assessment indicate that a greenhouse with dimensions of 10.7 m by 47.5 m (35 ft by 156 ft) could supply Haines Junctions with 100% of its demand for tomatoes, cucumbers, and lettuce.

The CTCG found that a greenhouse is not likely to be economically feasible in Haines Junction without some form of subsidy or strategy to decrease operating costs. However, with respect to the socioeconomic impacts, a greenhouse may be of value to the community, potentially resulting in an increase in health and overall community wellness that may be worth the investment.

3.2.3 Fuel Harvesting and Handling

Biomass would be harvested from green forest management zones (Figure 3.2.2) as defined in the CAFN Integrated Landscape Plan (ILP).The specific areas associated with this Project will be further defined in the next stage of the Project. Chipping of the harvested trees would be required to prepare the feedstock for gasification. The chipping could be done with a mobile chipper at the roadside, at the plant or at a dedicated secondary log storage and chipping site. The logistics of chipping have not been finalized. These would also be confirmed in the next stage, as suppliers/harvesters are confirmed. The chips would be stored inside at the plant, with capacity for approximately 7 days being kept onsite.

3.2.4 Auxiliary Infrastructure

Auxiliary infrastructure associated with the gasifier/reciprocating engine system include electrical equipment (*e.g.*, transformer, metering) and building space for offices and feedstock storage (and gasifier/engines if not in self-contained shipping containers).

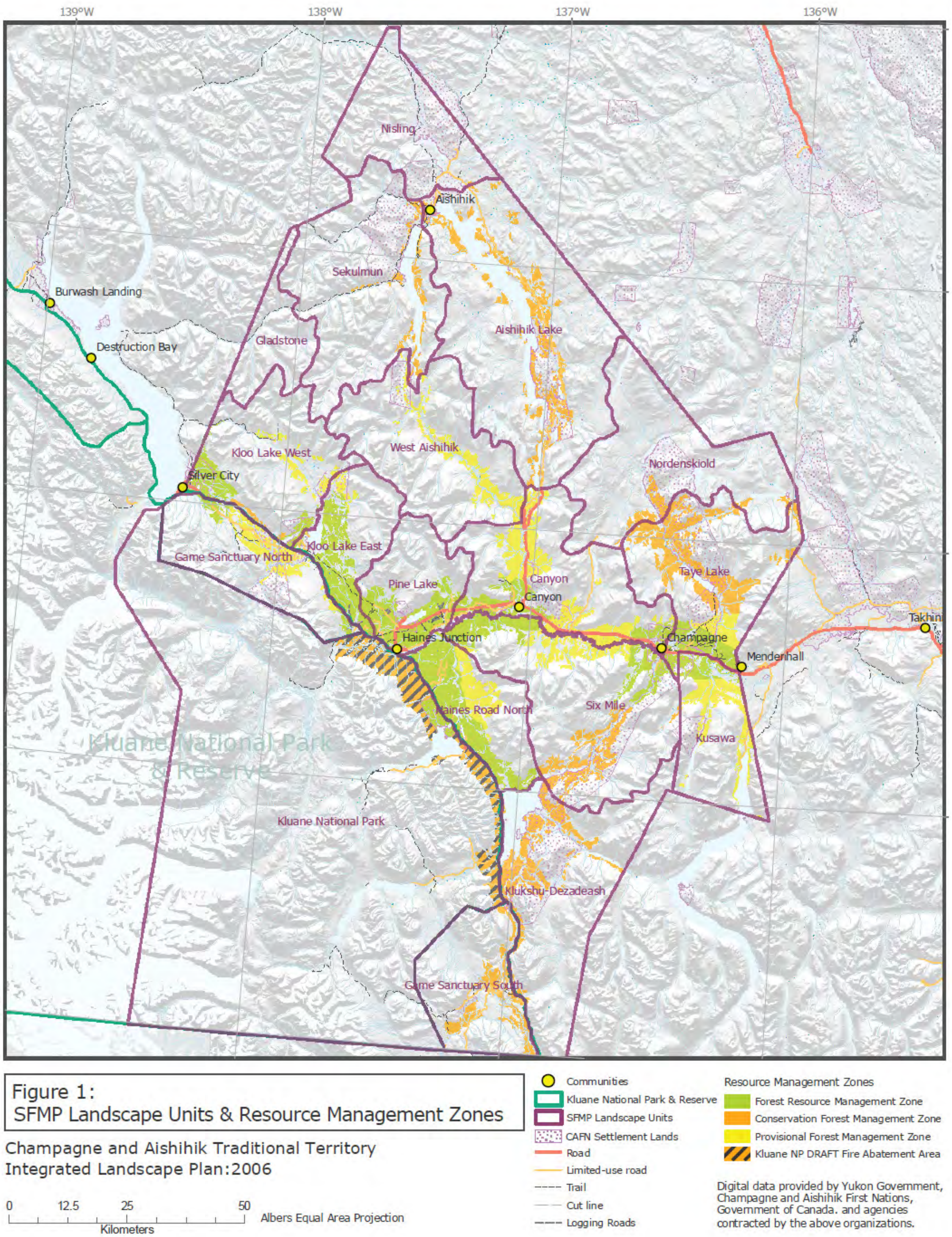


Figure 3.2.2 SFMP Landscape Units and Resource Management Zones

3.3 EMISSIONS AND WASTES

3.3.1 Air Contaminant and GHG Emissions

3.3.1.1 Construction

Since the Project involves modest construction requirements due to its relatively small scale, the releases of air contaminants and greenhouse gases to the atmosphere due to construction activities are expected to be small.

There will be nominal (essentially zero) emissions from the use of heavy construction equipment (*e.g.,* heavy-duty trucks) at the site, as well as some limited amounts of fugitive dust associated with ground preparation activities at the plant site. The transportation of construction materials and equipment to and from the Project site will also result in releases air contaminants and greenhouse gases to the atmosphere. Emissions from these sources, however, are not expected to be substantive and are expected to be generally confined to the Project site.

Forest harvesting construction activities may also result in moderate amounts of combustion gases and fugitive dust emissions from mobile equipment in the event that construction of new logging roads are required. Based on the preliminary feedstock harvesting assessment completed (as part of the FEED study), no new roads would be required to supply a 0.5 MW_e plant.

3.3.1.2 Operation

Operation of the Project will result in emissions of combustion gases and particulate matter to the atmosphere from the engine exhaust stacks. Two operational scenarios are considered for the Project, since the specific size of the operation is not yet confirmed. Based on the FEED study the size of the plant may range from 0.5 MW to 2 MW (electric energy). Therefore the emissions are estimated for the 0.5 MW and 2 MW cases to establish the range of emission rates for each air contaminant.

Where the Project is in the early design stages, multiple vendors are still being considered to supply the biomass gasifier and engine equipment. The air contaminant emissions estimates provided below are based on information provided by a specific vendor currently being considered for the Project (Community Power Corporation (CPC) 2012). The vendor emissions are for a 0.1 MW unit and have been scaled up for the scenarios below. Direct scaling is considered conservative as in practice 0.5 MW can be achieved using four (4) 0.1 MW units while emissions have been based on five units. The greenhouse gas (GHG) emissions are estimated by mass balance using the fuel consumption data from the vendor information. For assessment purposes, the units were assumed to operate continuously (*i.e.*, 24 hours per day, 365 days per year).

Estimated emissions for both Project operational scenarios considered are provided in Table 3.3.1.

Table 3.3.1 Estimated Emissions During Operation of the Project

Air Contaminant/GHG[1]	Scenario 1 0.5 MW Case (t/a)	Scenario 2 2 MW Case (t/a)
Nitrogen Oxides (NO_X)	2.8	11.2
Carbon Monoxide (CO)	1.2	4.6
Sulphur Dioxide (SO_2)	0.4	1.4
Total Suspended Particulate Matter (TSP)	0.012	0.048
Particulate Matter < 2.5 Microns ($PM_{2.5}$)	0.012	0.048
Carbon Dioxide (CO_2)[2]	6,700	26,780

Notes:
1. Estimates are based emissions information provided in vendor proposal for 0.1 MW, directly scaled up for larger units.
2. CO_2 emissions associated with biomass combustion are reported separately under the Environment Canada reporting program as these emissions are considered part of the global carbon cycle.

The operation of the Project which would supply heating to local buildings in addition to generation of electricity is expected to offset some air contaminant and greenhouse gas emissions currently resulting from diesel combustion for space heating of community buildings.

The releases of other GHGs (CH_4 and N_2O) from the operation of the Project are expected to be nominal, and are therefore not considered further in the assessment.

Releases of other air contaminants, specifically hazardous contaminants such as volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans from the Project could occur in small amounts and are expected to be similar to that of other modes of biomass combustion.

Emissions of the hazardous air contaminants with largest expected emissions, *i.e.*, the air contaminants with the highest US EPA AP-42 biomass combustion emission factor, were estimated (US EPA 2003). Based on the US EPA AP-42 Emission Factors, benzene (C_6H_6) and formaldehyde (HCHO) are the air contaminants that are likely to be released in the highest quantities during Operation of the Project. Benzene emissions are estimated to range from 0.11 t/a to 0.44 t/a and formaldehyde emissions are estimated to range from 0.12 t/a to 0.47 t/a, depending on the scale of the Project (0.5 MW and 2 MW scenarios considered in the estimates). The emissions were estimated using the AP-42 emission factors and the energy input from the biomass fuel from the CPC proposal (CPC 2012). Discussion of how these emissions compare to other forms of heat and energy is provided in the Atmospheric Environment Section 5.2.

The gasification process is operated with relatively dry biomass (15% moisture) at a high temperature and the syngas produced is cleaned and filtered prior to combustion, which helps to reduce the release particulate matter to the atmosphere. The combustion of syngas in an internal combustion engine also serves to reduce emissions of hydrocarbons as a result of higher operating pressures and temperatures than that of a boiler. In addition, the annual volume of biomass consumed during Operation is relatively small.

Further details on the emissions from the Project and are provided in Section 5.2 of this document.

3.3.2 Sound Emissions

During Construction, the potential exists for unwanted sound ("noise") to be generated that could be considered to be a nuisance to nearby residents and land users, primarily as a result of the operation of heavy equipment required to complete construction activities. Equipment deliveries and construction traffic accessing the site, although not expected to be substantive, may result in slightly increased traffic levels in the community and possibly increased sound pressure levels at nearby locations.

During Operation of the Project, the potential exists for noise to be generated from the plant as well as harvesting operations. The biomass energy plant components will be housed within buildings and/or containers to reduce the resulting sound emissions from the gasifier and engines. The wood chipper location is currently unknown, as is the technology to be used.

The estimated sound pressure level from the operation of a 0.5 MW gasification plant is 81 dB_A at 4.5 m (10 feet), based on the maximum sound pressure level provided by CPC (CPC 2012).

The estimated sound pressure level from the operation of a 2 MW gasification plant is 87 dB_A at 4.5 m (10 feet), based on the maximum sound pressure level provided by CPC (CPC 2012).

Wood chipping of whole trees is known to be a noisy activity. A UK study on sound emissions from mobile chippers found that at a distance of 8 m of the chipper, sound pressure levels (based on 11 chippers) ranged from 89 to 99 dB_A (Health and Safety Laboratory 2008).

These sound pressure levels are used to estimate sound pressure levels at various distances from the Project, in Section 5.2.

3.3.3 Construction and Operational Solid Wastes

Solid waste generated during the construction phase would be disposed of in an approved landfill.

Operational solid wastes may include particulate matter collected by the syngas cleaning system (if required based on the design), char removed from the gasifier, and wastes associated with maintenance activities (*e.g.*, oily rags, cleaners). All wastes generated would be disposed of in an approved landfill.

3.4 PROJECT PHASES AND SCHEDULING

The Project schedule depends on the size of biomass plant selected following the FEED Study review. Preliminary schedules for the potential envelope of Project sizes are provided in Figure 3.4.1.

Size of Plant	0.5 MW	2 MW
Phase 1: Biomass Technology Research and Feasibility Study	Now March 2013	
Phase 2: Feedstock Assessment	2013	2013-2014
Phase 3: Integrated Environmental and Socio-Economic Effects Assessment	2013	2014
Phase 4: External Effects Assessment and Licencing/Permitting	2013-2014	2014-2016
Phase 5: Detailed Design and Tendering	2013-2014	2016
Phase 6: Construction	2014	2016+
Phase 7: Operation	2014-2015	2016+
Phase 8: Decommissioning	To be determined.	

Figure 3.4.1 Project Phases and Schedule

3.5 ALTERNATIVES

Gasifier and reciprocating engine technology is the ideal choice for northern communities who wish to generate combined heat and power as steam is not required. Steam plants and systems require operators with power engineering certification and these professionals are not readily available in northern communities. Gasifer, reciprocating engine systems can be operated by trained mechanics or electricians which is more suited to the existing work force in the north. As the site has not been selected, an alternatives discussion will be delayed until siting is finalized. Alternatives for siting are being considered based on technically feasible locations (close enough for heat recovery), visually acceptable, appropriate land use and sufficient set-backs to limit noise complaints. Traditional and current activities and culture will also play an important role in Project siting, with areas of importance for these activities to be defined through the consultation process.

4.0 DESCRIPTION OF EXISTING ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

Existing conditions for environmental and socio-economic conditions in relation to the Project location and valued components are summarized in this Chapter. This information is provided for use in the assessment of potential environmental and socioeconomic effects from the Project.

4.1 ENVIRONMENTAL CONDITIONS

A summary of existing environmental conditions in the vicinity of the Project is provided in this chapter. The summary is based on existing literature and sources of information that are available in the area of the Project. Field reconnaissance has not been conducted at this time.

4.1.1 Study Area and Physiography

The Village of Haines Junction is located at kilometer (km) 1,632 of the Alaska Highway at the intersection of Haines Highway. Haines Junction is approximately 158 km west of Whitehorse, the capital city of Yukon Territory. The village is located between mountain ranges of the Kluane Ranges, the Dezadeash Range, and the Ruby Range. The Auriol Range (of the Kluane Ranges) is the closest range to the village and is situated approximately 5.5 km southwest of Haines Junction. The village situated within Shakwak Valley, which covers the area from Pine Lake southwest to the Auriol Range. Haines Junction is located north of the main branch of Dezadeash River. The village is the gateway to Kluane National Park and Reserve.

4.1.2 Surficial Geology, Terrain, and Soils

EBA Engineering Consultants Ltd. (2003) encountered alternately clayey tills and fine grained glaciolacustrine depositing consisting of silt and clay with occasional sand and gravel lenses during drilling of well No. 5 in Haines Junction. During the drilling program an artesian sand and gravel aquifer was encountered below the alternating layers at a depth of 329 m continuing to 369.2 metres below ground level.

Bedrock geology in the Ruby Ranges is characterized by three geological terranes and two faults, with highly metamorphosed sedimentary and granitic rocks covering most of the area (YEWG 2004). The surficial geology of the ecoregion is comprised of steep bedrock exposures, colluvium and talus slopes at high elevation, moraine and glaciofluvial gravelly sands at mid-elevation, and silt-clay deposits from the Lake Sekulmun-Aishihik glacial lake retreat at lower elevations (YEWG 2004). Bedrock geology in the Yukon Southern Lakes ecoregion is divided up into three zones; coarse-grained, crystalline metamorphic and granitic rocks in the east and west and mafic volcanic, limestone and clastic sediments in the central zone. Surficial geology in characterized by deposits laid down during the most recent glacial retreat period, the McConnell, and vary throughout the ecoregion (YEWG 2004:210).

4.1.3 Transportation

The Yukon Government (YG) Transportation and Planning Branch conducts annual traffic counts and publishes a summary report to inform interested parties (Government of Yukon 2011a). The following average summer daily traffic (ASDT), and average annual daily traffic (AADT) are considered relevant to the Project. The Alaska Highway South of Haines Junction has an ADT of 579 (based on 70 days of counts) while the Alaska Highway to the North was counted at 491 AADT and a ASDT count of 720, showing a notable increase due to summer tourism. Haines Road counts for 2011 were 227 AADT and 370 for ASDT. Traffic counts east of Haines Junction on the Alaska Highway show a slight decline from 1994 to 2011 (0.8% decrease).

4.1.4 Groundwater Resources

The location of the biomass plant will be within Haines Junction, although the exact location is not finalized. Based on technical constraints for the use of waste heat from the plant, the plant must be located within approximately 400 m of larger buildings within the village (*e.g*., the school and cultural centre).

The Village of Haines Junction has five developed municipal wells. As of 2012, well number 3 and well number 5 are the only wells currently being used as supply wells. In 2010 the total water consumption of the village was 140,088 cubic metres (m^3) (J. Gibson Environmental Consulting 2011). The municipal water system has recently undergone upgrades to increase production and storage capacity of water for the village. The upgrades factored in population growth and increased industry in the area. As part of the upgrades, well No. 4 was decommissioned.

There are ten private wells located in and around Haines Junction. These wells are associated with business (*e.g*., gas station, motel), a subdivision, the school, the experimental farm, and some private residences.

All the wells in Haines Junction have been installed in overburden materials; there are no known bedrock wells. According to a 2003 report by EBA Engineering Consultants Ltd. (EBA Engineering Consultants Ltd. 2003), the aquifers in the area have component of dips from south to north.

Groundwater samples were collected following a pump test on well number 5 (conducted by EBA Engineering Consultants Ltd. in July 2003). They reported that the analytical results were below the Canadian Council of Ministers of the Environment (CCME) Canadian Drinking Water Quality Guidelines for all parameters.

Areas to be harvested as sources of feedstock have not been identified at this time. Once selected, information regarding groundwater resources at these sites, if available/applicable, will be included in this report.

4.1.5 Traditional Ecological Knowledge

Minimal published information is available on traditional ecological knowledge. and formal consultation has not been conducted specifically to define relevant Traditional Ecological Knowledge (TEK). Details on TEK in the area will be provided as part of the next stage of the assessment based on consultation with CAFN and the Haines Junction community.

4.1.6 Additional Existing Conditions

The existing conditions for the VCs being considered in detail in this assessment are summarized in Chapter 5 as follows:

- Atmospheric Environment, including air quality, greenhouse gas emissions and sound quality are discussed in Section 5.2.2.
- Terrestrial Environment including vegetation, wildlife and wetland habitat are summarized in Section 5.3.2.
- Freshwater Resources are summarized in Section 5.4.2.
- Heritage Resources are summarized in Section 5.5.2; and
- Traditional Activities and Culture are summarized in Section 5.6.2.

4.2 SOCIO-ECONOMIC CONDITIONS

4.2.1 Champagne Aishihik First Nation

The Champagne and Aishihik First Nations (CAFN) is a self-governing First Nation with Traditional Territories in the Yukon Territory and Northern British Columbia. CAFN has a total population of approximately 1,238 (as of June 2012) with 712 people residing in the Yukon Territory.

The CAFN was named after two of its historic settlements: Champagne, located on the Dezadeash River; and Aishihik, situated at the headwaters of the Alsek River drainage. Formerly, the Southern Tutchone population was located throughout the region in other villages including Kloo Lake, Klukshu, Canyon, Shäwshe and Hutshi.

Their main administrative center is located in Haines Junction. The CAFN also maintains an office in Whitehorse.

Of the Yukon's fourteen First Nations, the CAFN is one of the largest in the Yukon. Its traditional territory covers 41,000 square kilometers, 29,000 of which are located in the Yukon and 12,000 in British Columbia. The easterly portion of CAFN's traditional territory lies in the Yukon River watershed where the Yukon River flows into the Bering Sea, while the larger, westerly portion lies in the Alsek River watershed where the Alsek River flows into the Gulf of Alaska. Much of Kluane National Park (Yukon) and all of Tatshenshini-Alsek Park (BC) lie within CAFN's traditional territory.

4.2.2 Labour and Economy

Occupations in Haines Junction are predominantly trades, sales and service, business, and management. Other occupations in the village include science, government, industry, processing and manufacturing, health, and arts, culture, and sports.

4.2.3 Public Health and Well-being

YEC has a comprehensive health and safety program that has been developed in accordance with the Yukon Occupational Health and Safety Act and regulations. Yukon Energy has entrenched health and safety training and procedures in every day operation and ensures that policies, practices, and procedures are clear to employees, and are consistently applied. Training on safe practices and procedures is a responsibility taken very seriously. Ongoing reviews, regular inspections and periodic audits are conducted to identify areas for improvement in health and safety practices with the goal of continuous improvement in mind.

4.2.4 Land Use and Infrastructure

The Village of Haines Junction does not have a land use plan (VOHJ 2007). The proponent will consider acceptable land use when planning for the Project and will consult with the Village in locating the Project.

5.0 ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT

The overall assessment approach is described in this section.

5.1 ASSESSMENT APPROACH

The approach to the effects assessment includes scoping, studying the potential Project-environment interactions, estimating releases to the environment, assessing the potential environmental effects, establishing significance of the effects, and providing consideration of follow-up and monitoring that may be required.

Scoping of the assessment includes:

- identifying issues of concern related to the Project,
- selecting Valued Components (VCs) for further examination that include both Environmental and Socio-economic aspects;
- identifying potential sources and pathways of effects from the Project to each VC selected;
- identifying spatial and temporal boundaries for assessing effects of the Project for each selected VC; and
- identifying other actions and effects pathways that may act cumulatively with the Project to affect the same VCs.

5.1.1 Valued Environmental and Socio-Economic Components

A number of Valued Components have been anticipated for various phases or activities associated with the physical works of the proposed Project. Based on currently available Project information, these are defined as in Table 5.1.1. Consideration has been given to the plant as well as the feedstock harvesting activities.

Table 5.1.1 Potential Interactions of the Project with the Environment

Phases, Activities or Physical Works Associated with the Power Facility	Atmospheric Environment	Groundwater Resources	Freshwater Environment	Vegetation Environment	Wildlife Resources	Human Health and Wellbeing	Land Use and Infrastructure	Heritage Resources	Traditional Activities and Culture	Transportation	Labour and Economy	Effects of Environment on Project
Plant Site												
Construction	1	1	0	1	1	1	1	2	1	1	1	1
Operation	2	1	0	1	1	1	1	0	1	1	1	1
Decommissioning and Abandonment	1	1	0	0	0	1	1	0	0	0	1	1
Forest Feedstock Harvesting												
Construction	1	0	2	1	1	1	1	2	1	1	1	1
Operation	1	0	2	2	2	1	1	2	2	1	1	2
Decommissioning and Abandonment	1	0	1	1	0	0	0	0	0	0	1	0

KEY
0 = No interaction. The environmental effects are not significant and not considered further in the assessment.
1 = Interaction occurs; however, based on past experience and professional judgement the interaction would not result in significant environmental effect, even without mitigation; or interaction would not be significant due to application of codified environmental protection practices that are known to effectively mitigate the predicted environmental effects. The environmental effects are not significant and not considered further in the assessment.
2 = Interaction could result in environmental effect of concern even with mitigation; the potential environmental effects are considered further in this assessment.

The current scope of impact assessment does not include detailed assessment of potential interactions of Feedstock Harvesting with the environment; however, Table 5.1 above has been drafted based on expected interactions with both the plant site and feedstock harvesting. There are unknowns regarding the possible mitigation measures required for harvesting activities. The higher rankings are focused on wildlife, traditional pursuits, trapping, and heritage/cultural values and other land use (guiding, recreational uses, outfitting, wilderness tourism).

Based on the rankings provided in Table 5.1.1 above, the Project will result in an interaction with the following VCs (*i.e.*, a ranking of 1), during one or more phases of the Project:

- Groundwater Resources;
- Human Health and Wellbeing
- Land Use and Infrastructure;
- Transportation; and
- Labour and Economy.

Further discussion is provided below.

Groundwater Resources

Groundwater is the water held beneath the earth's surface in the pores, fractures, crevasses, and seams of bedrock and surficial geology. Groundwater Resources refer specifically to the value and function of groundwater in maintaining stream flow for ecological habitat and in supplying fresh water for human use. Groundwater availability for ecological and human uses and its susceptibility to chemical degradation or physical depletion by human activities is determined by the natural chemical and physical properties of the surficial and bedrock geology in which it is found.

Interactions between the Project and Water Resources have been ranked as 1 in Table 5.1.1 because the Project will not substantively alter the water requirements during any phase, and the existing water supply will continue to be used throughout the Operation of the Project. The maximum conceivable water consumption of this Project is estimated at 3.2 m^3/day or less depending on the vendor selected.

Water resources in Yukon are regulated at the federal and territorial level under a number of Acts and regulations.

Relevant acts, policies and guidelines related to the protection of water quality include the following:

- Yukon *Environmental and Socio-economic Assessment Act*;
- Yukon *Waters Act* and *Regulations*; and
- water quality guidelines (Canadian Council of Ministers of the Environment).

Groundwater resources are included as a VC because they provide potable, commercial, and industrial water supply to the population of Haines Junction. The potential for the disruption or contamination of the groundwater drinking supply for nearby residents therefore requires assessment.

Possible effects to Groundwater Resources include a change in groundwater quantity and a change in groundwater quality. It is unlikely that there will be effects to the quantity of groundwater in Haines Junction resulting from the Project as the village's water treatment system was recently upgraded. In addition, due to mitigation included Section 6.0 (Accidents, Malfunctions, and Unplanned Events), a contingency plan will be in place during operation for accidental spills at the plant. At this time the location of feedstock harvesting is unknown, however, vibration from large machinery may affect the water quality of any drinking water wells in the vicinity of harvesting operations.

In the event that the feedstock harvesting site is located near drinking water wells the potential effects will be evaluated. Mitigation measures may include baseline sampling and monitoring of the well(s) during operation to confirm that the water quality is not affected.

Follow-up may include monitoring of any drinking water wells in the vicinity of feedstock harvest operations. Additionally, investigation of any residential well owner complaints may be conducted, with application of industry standard remedial measures to rectify an effect.

In consideration of the nature of the interactions and relation to existing legislation and environmental policy in respect of Groundwater Resources, significant adverse environmental effects of the Project on Water Resources during all phases of the Project are not anticipated. Groundwater Resources are not considered further in this document.

Human Health and Wellbeing

Interactions between the Project and Human Health and Wellbeing have been ranked as 1 because Project activities, if not carried out in a careful and safe manner, could result in risks to the public or workers. Occupational exposure of Project workers to an industrial site carries with it a number of health and safety concerns, which are subject to territorial occupational health and safety legislation.

Yukon Energy has, and will continue to have, many measures in place to protect safety, including worker health and safety policies, and limited access to the facility. The Project would comply with emissions limits, which are established to be protective of health.

The Project will necessarily comply with all requirements of the Yukon Occupational Health and Safety Act and Regulations; thus, the environmental effects of the Project on Health and Safety will not be significant from the perspective of worker safety and occupational exposure. There are no features of the Project that would result in a higher potential for Accidents, Malfunctions, or Unplanned Events to occur as compared to similar industrial projects. Prior to commissioning of the plant, an emergency response plan would be developed to handle potential accidents, malfunctions and unplanned events that may occur in a safe manner. Employees hired to work at the plant or in harvesting activities would be provided with all required health and safety training prior to beginning work.

Procedures would be developed for the safe operation of the plant to minimize the likelihood of a work place accident or unplanned event that could affect the public.

As the Project involves consumption of spruce bark beetle-killed wood that is very dry and is suspected to be creating increased potential of forest fires surrounding Haines Junction, there could be a reduced likelihood of health and safety issues associated with implementation of the Project.

Based on the above, no substantive interactions between the Project and Health and Safety are anticipated. Therefore, significant adverse environmental of the Project on Health and Safety during all phases of the Project are not anticipated, and are not considered further.

Land Use and Infrastructure

As the location of the Project is not currently known, the extent of potential effects on land Use and Infrastructure cannot be fully assessed at this time. Land use by First Nations communities is considered as part of the Traditional Activities and Culture section.

Transportation

Interactions between the Project and Transportation have been ranked as 1 in Table 5.1.1 because of Project-related traffic to and from the plant site and forest harvesting areas during Construction and Operation. Materials will be delivered to, and transported away from, the Project site by truck. During

Construction, Project components and other materials will be required. During Operation, biomass will be transported to the site and small shipments of ash will be transported away from the site.

Road Transportation is governed by the Yukon *Highways Act* and the Yukon *Motor Vehicle Act* and associated regulations. The Project will adhere to the restrictions and limitations included in these and applicable federal acts and regulations.

Traffic during Construction for materials and equipment deliveries is expected to be very low and is estimated at several trucks per week as well as several passenger vehicles. The estimated traffic is a total of 3 to 15 trucks per week during Operation depending on the size of plant installed. This increased traffic can easily be accommodated by existing truck routes.

There may be a requirement to dispose of some general construction wastes during Construction, which will be transported to existing recycling operations or to an approved sanitary landfill for disposal. However, the volumes of waste materials to be managed and transported from the site during Construction are expected to be very low, as most or all of the infrastructure would be fabricated offsite.

Ash generated during Operation will be trucked off-site to the landfill, composting facilities or other approved locations. Based on the quantities of ash generated at the site, it is expected that less than 1 shipment per week would be required.

During Operation of the Project, a reduction in the number of fuel oil trucks travelling to Haines Junction may occur as less diesel would be required in the buildings using the plant's waste heat.

Based on the above, no substantive interactions between the Project and Road Transportation are anticipated. The Project-related traffic is expected to be confined to existing truck routes and the addition of 15 trucks per day is not expected to result in a noticeable change in traffic volumes on these routes for the purposes of efficient and safe road transportation. Therefore, the potential environmental effects on Road Transportation during all phases of the Project are rated not significant, and are not considered further.

Labour and Economy

Interactions between the Project and Labour and Economy have been ranked as 1 in Table 5.1.1 because activities and physical works associated with all phases of the Project will result in job creation and business expenditure. Labour and Economy refers to the importance of employment opportunities and economic growth on a local and regional scale within the Yukon. The Proponent is committed to hiring CAFN citizens and other local and Yukon residents, where available.

During Construction, the Project is expected to create direct construction labour employment for construction contractors for site clearing and preparation as well as infrastructure work over the 8 month Construction period. The extent of job creation is dependent on whether the plant is located in a building and if so, what type of building is chosen. The total capital investment of the Project is estimated at approximately C$7 to $45 million dollars (depending on the option chosen).

The Project will generate additional employment during Operation; through employment at the plant site as well as in forest harvesting. The extent of employment is dependent on the plant technology and size chosen as well as the methods used for harvesting. Regardless of the methods employed, several new jobs will be created in Haines Junction in both technical trades and forest resource management.

Employment opportunities will also occur during Decommissioning and Abandonment of the Project, at the appropriate time, although not currently contemplated.

Employment in the Yukon is regulated at the territorial level under the Employment Standards Act and Regulations.

The potential effects on labour and economy could also extend beyond the Project to • outfitters and tourism, commercial trapping and fishing and other forestry and agriculture. To reduce land use conflicts and any potential negative effects on others in relation to proposed activities on-site or along the access route, the Proponent will continue to consult with other users and communicate its plans and the timing of proposed activities to other resource users (*e.g.*, trappers, outfitters, and known subsistence harvesters) who may be affected by the Project, as soon as practicable and prior to commencement of the activity.

Given the lifespan of the Project and the potential for other future development activity in the area, it is a challenge to predict with certainty the full range of socio-economic effects that will occur. However, as the Project will only require a small fraction of available feedstock for Operation and will be planned to proceed in harmony with existing land use, negative effects are expected to be very small if they do occur.

Key socio-economic indicators for the Project will be monitored by the Proponent (*e.g.*, number of local, Yukon, other employees and value of local, Yukon goods and services). This will provide for an understanding of the Project's socio-economic effects, identification of any emerging or unanticipated effects, and the opportunity for the Proponent or other parties to respond as appropriate.

The effects monitoring and adaptive management related to Terrestrial Environment (Section 5.4) and Freshwater Resources (Section 5.5) may also be relevant in terms of potential effects on other local or regional economic activities, such as outfitting, tourism, and trapping. More information on proposed mitigation and adaptive management measures can be found in the sections referenced.

Overall, the increased demand for labour and anticipated employment opportunities and related economic spin-offs of the Project are expected to result in positive environmental effects on Labour and Economy. As such, positive environmental effects on Labour and Economy as a result of the Project are anticipated and are not discussed further.

VCs Ranked as 2

Based on the rankings provided in Table 5.1.1 above, the Project may result in a significant interaction with Atmospheric Environment (ranking of 2 during Plant Operation), Freshwater Environment (ranking of 2 for Feedstock Harvesting), Vegetation Environment (ranking of 2 during Feedstock Harvesting, Wildlife Resources (ranking of 2 for Feedstock Harvesting), Heritage Resources (ranking of 2 during Plant Operation and Feedstock Harvesting), Traditional Activities and Culture (ranking of 2 during Feedstock Harvesting) and Effects of the Environment on the Project (ranking of 2 during Feedstock Harvesting). These VCs are thus assessed in greater detail in the detail VC sections of this chapter.

The scope of this assessment is focused on components that could be linked to the Project; as set out in the YESAB Guide to Assessment, both Project-specific issues and regional issues that are relevant to the Project need to be considered in the establishment of VCs. Therefore, VCs have potential to be modified throughout the next stage of assessment (revisions based on decisions made following the FEED Study review). Similarly, determination of VCs and environmental and socio-economic scoping requires input from local communities and interested parties; in this case, that may involve field studies and consultation that have not been completed in this Project phase. Therefore, VCs and rankings will be revisited during the completion of the final Project Proposal for the Feedstock and Facility components.

5.1.2 Project Interactions with the Bio-Physical and Human Environment

The Project activities that may interact with the bio-physical and human environments are identified and described for each VC.

5.1.3 Description of Effects Mechanisms

For each VC, one or more measurable parameters will be identified for the potential Project-related and cumulative environmental effects. The magnitude of the change in these measurable parameters will be used to characterize the Project environmental effects and to evaluate the significance of the potential environmental effects.

5.1.4 Temporal and Spatial Boundaries

The temporal boundaries for the assessment will be defined based on the timing and duration of Project activities and the nature of the interactions with each VC. The purpose of a temporal boundary is to identify when an environmental effect may occur in relation to specific Project phases and activities.

The spatial boundaries for the assessment will be defined based on the geographical extent of the environmental effects (*i.e.,* the zone of influence) for each VC. Generally, the spatial boundaries will be referred to as the Assessment Area.

At this time, both of these boundaries have yet to be determined. However, YESAB Guides provide definitions which will be adhered to when they are finalized. The preliminary phases and footprints and defined in Section 3 (Project Description) and provided here for ease of review.

Construction Phase: This phase generally consists of the estimated time required to complete the construction of the Project, including commissioning of the facilities.

Construction Footprint Area: Construction Footprint Area is the geographic area needed for construction and operation of the physical infrastructure associated with Power facility (*i.e.,* power access, access road, the plant, office, maintenance building, log storage yard, chipping plant, chip storage, conveyor, hopper, *etc*.)

Operation Phase: The time period following construction, through the life of the relevant components of the Project, during which time the Project will be used for its primary purpose of power generation.

Decommissioning Phase: The time period following operation when the Facility is no longer being used for its primary purpose; this may include transitioning the facility to another use or closure and abandonment.

Project Study Region: A broader Project Study Region for examining potential environmental and socio-economic effects has yet to be defined.

5.1.5 Mitigation of Project Effects

Standard mitigation measures that have been developed by the “Ex Comm” under Section 37 of the *YESAA* will be included in the design and operation of the Project. Further, any additional mitigation required to reduce potential environmental effects to acceptable levels (below the threshold of significance, see Section 5.1.7) will be proposed and included in the assessment.

5.1.6 Characterization of Residual Effects

Residual environmental effects are those that remain after mitigation has been applied. Each residual environmental effect will be described for each VC and each Project phase. Residual effects will be assessed for significance.

Environmental effects for each VC will be characterized for each applicable Project phase and presented in an environmental effects summary table. The following criteria will be used to characterize potential residual environmental effects:

- **Direction –** the ultimate long-term trend of the environmental effect (*i.e.,* positive or adverse);
- **Magnitude –** the amount of change in a measurable parameter or variable relative to existing (baseline) conditions;
- **Geographic Extent –** the area where an environmental effect of a defined magnitude occurs (*e.g.,* site-specific, local, regional);
- **Duration –** the period of time required until the VC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (*e.g.,* short-term, medium-term, long-term, or in some cases permanent);
- **Frequency –** the number of times during the Project or a specific Project phase or activity that an environmental effect might occur (*e.g.,* one time or multiple times) in a specified time period;
- **Reversibility –** the likelihood that a measurable parameter will recover from an environmental effect, including through active management techniques (*e.g.,* habitat restoration); and
- **Ecological or Socio-economic Context –** the general characteristics of an area in which the Project is located, as indicated by past and existing levels of human activity.

A key for each environmental effects summary table will provide summary criteria that will be modified as necessary for each VC based on the specific boundaries (temporal, spatial) and significance criteria selected for each VC.

5.1.7 Determination of Significance of Residual Effects

The criteria or standards for determining the significance of environmental effects will be identified for each measurable parameter in each VC, beyond which a residual environmental effect would be considered significant. These will be generally selected in consideration of provincial and federal regulatory requirements, standards, objectives, or guidelines that are applicable to the VC. In the absence of standards or criteria, significance criteria will be suggested by the Study Team for consideration by the decision making regulatory authorities.

5.1.8 Project Interactions with Other Projects (Cumulative Effects)

A cumulative environmental effects assessment will be conducted for those Project-related environmental effects that may overlap (spatially or temporally) with other projects and activities that have been or will be carried out.

The environmental effects of other past and existing projects are generally reflected in the existing baseline environment and will therefore be considered in the Project-related environmental effects assessment for each VC.

Other projects that may overlap spatially or temporally with the Project will be identified.

5.1.9 Cumulative Effects Assessment Methods

The assessment of each cumulative environmental effect will begin with a description of the environmental effect and the mechanisms whereby the Project environmental effects may interact with other projects and activities in the Assessment Area. Where possible, the cumulative environmental effects will be quantified in terms of the degree of change in the appropriate measurable parameter(s).

5.1.10 Mitigation of Cumulative Effects

Similar to Project-related environmental effects, mitigation measures that would reduce the cumulative environmental effects will be described.

5.1.11 Characterization of Residual Cumulative Effects

Residual cumulative environmental effects will be described and assessed, taking the proposed mitigation into account. The cumulative environmental effects will be characterized where applicable and appropriate in terms of the direction, magnitude, geographic extent, frequency, duration, reversibility, and ecological or social-economic context.

5.1.12 Effects Monitoring and Adaptive Management

Follow-up programs are used, where applicable, to verify environmental effects predictions and effectiveness of mitigation measures. Monitoring programs are compliance programs used to verify that mitigation has been applied. Appropriate follow-up and/or monitoring programs are proposed where a need has been identified or where the scientific certainty of the environmental effects predictions or the effectiveness of the mitigation warrants the need for such programs.

5.2 ATMOSPHERIC ENVIRONMENT

The Atmospheric Environment is considered a VC as the atmosphere is a pathway for transport of air contaminants to humans, wildlife and vegetation as well as the built environment. If not properly managed, releases of air contaminants to the atmosphere may cause adverse environmental effects on the air, the land and the waterways in the vicinity of the Project.

Greenhouse gas (GHG) emissions are considered a major factor in climate change and are thus also assessed in relation to changes in GHG emissions from the Project.

Changes to air quality during Construction are expected to be limited to potential fugitive dust during ground preparation. Changes to air quality during Operation of the Project are possible due to emissions from the combustion of gasified biomass and from trucks used to deliver feedstock and/or materials to the site and move feedstock onsite.

Changes to sound quality during Construction and Operation of the Project are possible due to sound emissions from mobile and stationary equipment.

Measurable parameters and significance criteria for air quality are defined based on regulatory ground-level concentration standards and objectives, while for GHG emissions these are based on current best practice guidance from the CEA Agency. For sound quality, measureable parameters and significance criteria are defined based on sound pressure level guidelines.

The assessment of the Atmospheric Environment was centered on a 10 km x 10 km area centred near the Project site.

Existing conditions are defined based on published data from Environment Canada and Yukon Environment. An air contaminant and GHG emissions inventory was developed for Operation of the Project, as this is likely to generate the highest emissions of air contaminants and GHGs emissions during the Project life. Dispersion modelling of specific contaminants, selected due to substantive emissions, was performed for Operation to predict the ground-level concentrations of those contaminants. The results of the modelling were compared to ambient air quality standards and objectives.

The dispersion modelling results showed that during Operation the ambient concentrations are likely to be well below the ambient standards and objectives for the operational scenarios considered.

The estimated GHG emissions from Operation are considered to be low (less than 50,000 tonnes of carbon dioxide equivalent (CO_2e)).

Sound pressure levels during Construction are anticipated to attenuate to 55 dB_A within 600 to 1,500 m of the site (depending on activity). Construction activities are transient and will not take place during nighttime to help reduce annoyance and avoid sleep disturbance. Therefore, although Construction within 600 to 1,500 metres will generate perceivable noise, annoyance will be limited in duration and extent and occur during daytime hours only.

Sound pressure levels during Operation of the plant (excluding the chipper) are anticipated to attenuate to a nighttime background level (assumed at approximately 40 dB_A) within 600 metres of the site, considering the 2 MW_e case and as a conservative estimate. However, wood chipping activities may be noticeably noisy and may cause widespread annoyance within 1,000 m. It is thus recommended that annoyance be mitigated by procuring the lowest noise generating chipper feasible, locating the chipper at least 1,000 m from the nearest permanent resident and/or installing noise mitigation such as a barrier between the chipper and the nearest residences to reduce noise transmission.

Thus, as will be demonstrated by the analyses that follow, with the proposed mitigation and environmental protection measures, the residual environmental effects on the Atmospheric Environment during all phases of the Project are rated not significant.

5.2.1 Scope of the Assessment

The scope of the environmental assessment of Atmospheric Environment is defined in consideration of the nature of the regulatory setting, the issues identified during public and First Nations engagement activities, potential Project-VEC interactions, and existing knowledge.

The Atmospheric Environment is considered a Valued Component (VC) for a number of reasons, as follows.

- The atmosphere and its constituents are needed to sustain life and maintain the health and well-being of humans, wildlife, vegetation and other biota.
- The atmosphere is a pathway for the transport of air contaminants to the freshwater, marine, terrestrial and human environments, presenting the contaminants in the form of varying atmospheric concentrations or in particle phase or gas phase deposition.
- If not properly managed, releases of air contaminants to the atmosphere from the Project may cause adverse environmental effects on the air, the land, and the waterways in the vicinity of the Project.
- GHG emissions accumulate in the atmosphere and are believed to be a major factor in producing the greenhouse effect which is believed to influence climate.
- If not properly managed, sound emissions in the form of noise (unwanted sound) from the Project may cause adverse environmental effects on the sound quality in the vicinity of the Project.

The Atmospheric Environment has therefore been selected as a VC due to the potential for Project-related activities to cause adverse environmental effects through processes that occur in the atmosphere.

In this assessment, the approach is to select the environmental effects, select the associated measurable parameters (concentrations, emissions rates of GHG or air contaminants) to be considered, establish boundaries for the assessment, characterize the environmental effects, establish the significance criteria, assess the residual environmental effects (with mitigation such as emission control equipment), determine significance, and prepare a follow-up or monitoring program as applicable.

5.2.1.1 Key Issues and Identification of Potential Effects

Potential interactions between the Project and the Atmospheric Environment are highlighted and those aspects of the Project that may cause environmental effects, either positive or adverse, are identified. The Project may interact with the Atmospheric Environment in the following ways:

- combustion of gasified biomass will generate air contaminant emissions in the form of particulate matter and combustion gases;
- construction and operation of the Project will result in sound emissions;
- equipment movement on-site, trucks used to deliver feedstock, equipment and/or materials to the site, and passenger vehicles will generate combustion gases and greenhouse gases as well as sound emissions during construction and operation;
- earthworks and on-site earth moving activities during construction will generate particulate matter in the form of fugitive dust; and
- removal of vegetation from forested areas to be used as fuel for the Project will result in combustion emissions from harvesting equipment, fugitive dust and a reduction in the availability of carbon dioxide sinks currently associated with the forested areas.

The potential environmental effects to be assessed are associated with Project-related releases of air contaminants and GHGs to the atmosphere during Construction, Operation, and Decommissioning of the Project.

5.2.1.2 Regulatory/Policy Setting

The regulatory requirements for assessing environmental effects on Atmospheric Environment in environmental assessments are prescribed by both the federal and territorial governments.

Air quality is regulated in the Yukon pursuant to the *Air Emissions Regulation* under the *Environment Act* (Government of Yukon 1998). The requirements for facilities that are sources of air contaminants are described in the Regulation and as part of the permitting process (Part V of the Air Emissions Regulation). Ambient air quality standards for Criteria Air Contaminants (CACs) are presented in the Yukon Ambient Air Quality Standards document. The releases of GHGs are not currently regulated in the Yukon.

Federally, the main instrument for managing air quality is via the *Canadian Environmental Protection Act* (*CEPA*) as well as from Canada-Wide Standards that have been developed under the CCME Canada-Wide Accord on Environmental Harmonization. The standards may include qualitative or quantitative standards, guidelines or objectives for protecting the environment and human health. A number of these exist to protect air quality, including those for benzene (not an ambient standard); dioxins and furans for specific industries, mercury for specific industries, and ambient air quality objectives for $PM_{2.5}$ and O_3.

The emissions of air contaminants from the Project and the predicted downwind ground-level concentrations (GLC) are compared to applicable Yukon Environment ambient air standards or emissions limits, as well as to Canada-Wide Standards (CWS), where they exist. The ambient standards are developed by the regulatory agencies, including Yukon Environment and Environment Canada, and others such as the British Columbia Ministry of Environment (BCMOE), to provide threshold values for assessing the extent of the potential environmental effects on air quality, human health and the environment.

The ambient air quality standards and objectives used in the assessment are presented in Table 5.2.1. These thresholds are a combination of the territorial, provincial and federal values from the Yukon, British Columbia and Environment Canada, respectively.

Table 5.2.1 Ambient Air Quality Standards and Objectives

Compound	Averaging Period	Yukon Ambient Air Quality Standards* (µg/m³)	Other Ambient Air Quality Standards or Criteria (µg/m³)
Total Suspended Particulate Matter (TSP)	24-hour Annual	120 60 (geometric mean)	-- --
Particulate Matter Less than 10 microns (PM_{10})	24-hour	--	50 [2]
Particulate Matter Less than 2.5 microns ($PM_{2.5}$)	24-hour	30	30 [1]
Sulphur Dioxide (SO_2)	1-hour 24-hour Annual	450 (172 ppbv) 150 (57 ppbv) 30 (11 ppbv)	-- -- --
Nitrogen Oxides (NO_X) as Nitrogen Dioxide (NO_2)	1-hour 24-hour Annual	400 (213 ppbv) 200 (106 ppbv) 60 (32 ppbv)	-- -- --
Carbon Monoxide (CO)	1-hour 8-hour	14,885 (13 ppmv) 5,725 (5 ppmv)	-- --

Notes:
* Yukon Environment Ambient Air Quality Standards.
1 CCME (2000), Canada-wide Standards for Particulate Matter (Based on 98th percentile of 3 year rolling average).
2 BCMOE (2009), British Columbia Ministry of Environment Ambient Air Quality Objective for PM_{10}.

For GHG emissions and climate, the federal government recently released the latest version of *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act* in May 2012 (Environment Canada 2012a). Canada officially withdrew its participation in the Kyoto Protocol in December 2011; however, the federal government is still committed to addressing climate change. In October 2010, the final *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* established fleet average GHG emission standards for new vehicles in model years 2011 through 2016. Standards for the 2017 to 2025 model years are in development. In August 2011, the federal government proposed regulations to apply a GHG performance standard to new coal-fired electricity generation plants for the purpose of encouraging a phase-out of traditional coal-fired electricity generation. Proposed regulations for the reduction of GHG emissions from new on-road heavy-duty vehicles were announced in April 2012.

With respect to federal guidance on assessing GHG emissions and climate change, the Canadian Environmental Assessment Agency ("CEA Agency") has not updated its 2003 guidance (CEA Agency 2003). This EIA Report includes an assessment of emissions from the Project and from the related industrial sector. Further, where Project emissions are medium or high, preparation of a GHG Management Plan is required.

In relation to sound quality, there are no overarching noise guideline levels, regulations, or standards currently established in the Yukon Territory for limiting acceptable noise levels from industrial facilities. The Yukon Government generally requires that sound emissions from any activity not disturb the peace and quiet of persons outside the premises or vehicle (Government of Yukon 2002a).

Under Health Canada's *Useful Information for Environmental Assessments* (Health Canada 2010), construction activities that last for less than 2 months may be considered temporary and do have any sound pressure level guidance. For construction phases less than one year in duration, Health Canada recommends using the US EPA method from their 1974 document on noise (US EPA 1974), where an equivalent day-night average ("L_{DN}") of 55 dB_A outdoors is considered the threshold for widespread complaints. For construction phases greater than one year in duration and during operation the Health Canada guidance is based on the change in percentage of highly annoyed due to the noise. L_{DN} is an energy-weighted average, similar to the equivalent sound pressure level, L_{eq}, for a full day, except that the night time hour (22:00 to 07:00) levels are artificially weighted by an additional 10 dB_A to reflect increased sensitivity of the community to sound levels during those hours. The percentage highly annoyed is estimated for the baseline condition and for the baseline plus the construction condition. The guideline indicates that the increase from the estimated percent highly annoyed of the baseline condition to the construction of a project should not be greater than 6.5%. The algorithm to calculate the percent highly annoyed is defined by ISO 1996-1:2003 (Canadian Standards Association 2003).

As the Haines Junction School is the nearest sensitive receptor to the preliminary Project site, guideline levels from the World Health Organization (WHO) for schools are also considered. The sound pressure level in an outdoor playground area should not exceed 55 dB_A or 35 dB_A indoors (WHO 1999).

With respect to perception of noise, a 3 dB change in sound pressure level is considered to be the threshold of which a change in sound pressure level is noticeable (Hoover & Keith Inc. 1981). A change of 10 dB_A gives a perception that the sound is twice as loud (Hoover & Keith Inc. 1981).

These regulatory requirements form the basis for the assessment of the potential environmental effects on Atmospheric Environment and are discussed in more detail in the following sections.

5.2.1.3 Selection of Measureable Parameters

The environmental assessment of the Atmospheric Environment is focused on the following aspects:

- Change in Air Quality;
- Change in GHG Emissions; and
- Change in Sound Quality.

The Atmospheric Environment has been divided into three key factors for consideration in the EIA, reflecting key Project-atmospheric interactions: Air Quality, Climate Change and Sound Quality.

- Air Quality is defined as a measure of the constituents of ambient air, and includes the presence and the quantity of these constituents including air contaminants in the atmosphere. The aspect of concern is defined as a Change in Air Quality, reflecting potential changes resulting from emissions from the Project.

- GHG Emissions and Climate, for the purpose of this assessment, are defined as the presence and quantity of GHGs in the atmosphere. The aspect related to climate change to be assessed is the net emissions of greenhouse gases (GHG) as a result of the Project.

- Sound Quality in the outdoor environment may be adversely affected by the Project. Noise is defined as unwanted sound and is usually present through a range of frequencies. The audible frequencies for humans are in the range of 20-20,000 Hertz (Hz). In this assessment, the environmental effects of sound emissions from the Project on Sound Quality in the area surrounding the Project are assessed.

The assessment of Changes in Air Quality, GHG Emissions and Sound Quality in the atmosphere requires knowledge of the constituents making up and present in the atmosphere, both in magnitudes and as trends. This knowledge is established by measuring concentrations of air contaminants and GHG as well as sound pressure levels in the atmosphere at strategic locations for extended or representative periods of time.

The measurable parameters used for the assessment of the environmental effect presented above and the rationale for their selection are provided in Table 5.2.2.

Table 5.2.2 Measurable Parameters for Atmospheric Environment

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Air Quality	Ambient ground-level concentrations of Criteria Air Contaminants	• Regulatory objectives, guidelines and/or standards exist provincially and federally for SO_2, NO_X, CO, TSP, PM_{10} and $PM_{2.5}$, as well as specific hydrocarbon compounds.
Change in GHG Emissions	GHG emissions - CO_2, CH_4 and N_2O (in units of CO_2 equivalents or CO_2e)	• Greenhouse gases have been identified as a major contributor to climate change worldwide, thus management of GHG emissions has become a concern for the general public, industry and government.
Change in Sound Quality	Sound Pressure Levels, A-weighted scale (dB_A)	• Ambient sound pressure levels are characterized using a logarithmic decibel (dB) scale, with the A-weighted (dB_A) scale being the most commonly used for environmental sound assessments. Measured parameters for environmental sound or noise (defined as unwanted sound) are often expressed as an “equivalent sound level” (L_{eq}) which represents an equivalent energy level over a specified period of time (*e.g.*, 1-hour or 24-hours).

The magnitude of GHG emissions is expressed in units of CO_2e. The term “greenhouse effect” is commonly used to describe the earth’s heat balance that maintains temperature, humidity and precipitation regimes and makes the earth habitable for humans and other forms of life. Increases in the ambient concentrations of CO_2 and other GHGs such as CH_4 and N_2O, over recent decades are believed by many to have changed the heat balance resulting in a warming of the planet. The ability to trap heat in the atmosphere varies with each GHG. This difference is expressed in terms of global warming potential (GWP). The GWP is established relative to CO_2 (*e.g.,* CH_4 has approximately 21 times the warming ability as CO_2). The relative contribution to the greenhouse effect, and both the emissions and concentrations of each GHG in the atmosphere, are commonly expressed in terms of its carbon dioxide equivalent, or CO_2e, by accounting for the GWP of each GHG.

5.2.1.4 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the Atmospheric Environment are defined below.

Project Development Area (PDA): The PDA is the most basic and immediate area of the Project. The PDA is limited to the area of physical ground disturbance associated with the Project, and consists of an area that includes the area of physical disturbance associated with the biomass plant. It will be revised following final site selection and detailed design and ultimately include the plant site and the area associated with biomass feedstock harvesting (including forest roads). The PDA is the area represented by the physical Project footprint as defined in Chapter 3.1.2 above.

Local Assessment Area (LAA): The LAA includes a 10 km x 10 km area centred on the plant site. The LAA is the maximum area within which Project-related environmental effects are likely to occur. The LAA includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur.

Regional Assessment Area (RAA): The RAA is limited to and includes the Yukon Territory for air quality, and extends nationally and globally for greenhouse gas emissions. For sound quality, the RAA is considered to extend 2 km from the PDA as no measurable cumulative effects related to sound quality would occur beyond this area. The RAA is the area within which the Project's environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The extent to which cumulative environmental effects for Atmospheric Environment may occur depend on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable future projects or activities that have been or will be carried out, as defined within the RAA.

5.2.1.5 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the Atmospheric Environment include the phases of Construction, Operation, and Decommissioning.

5.2.1.6 Residual Effects Significance Criteria

For a Change in Air Quality, a significant adverse residual environmental effect is one that degrades the quality of the ambient air such that the maximum Project-related ground-level concentration plus the conservative background level of the air contaminant being assessed frequently exceeds the respective ambient air quality objective, guideline or standard. "Frequently" is defined as once per week for 1 hour objectives, once per month for 24 hour objectives or any exceedance of annual average objectives.

For a Change in GHG Emissions (related to climate change), following guidance from the CEA Agency, "the environmental assessment process cannot consider the bulk of GHG emitted from already existing developments. Furthermore, unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured" (CEA Agency 2003). It is, therefore, recognized that it is not possible to assess significance related to a measured environmental effect on climate change on a project-specific basis. At the same time, it is recognized that a scientific consensus is emerging in respect of global emissions of GHG and consequent changes to global climate as generally representing a significant cumulative environmental effect. Project emissions of GHG will contribute to these cumulative environmental effects, but the contribution, although measurable and potentially important in comparison to local and territorial levels, will be very small in a global context. Policies and regulations are being developed by the Government of Canada for regulating GHG emissions for specific sources or industry sectors.

Thus, instead of setting a specific significance criterion for environmental effects on GHG emissions or climate change and determining whether and how it can be met, the assessment involves estimating Project-related GHG emissions and considering the magnitude, intensity, and duration of Project emissions as directed by the CEA Agency guidance (CEA Agency 2003). Three categories are described in the CEA Agency guidance: low, medium and high. In this EIA, these are attributed quantitatively based on evaluation of GHG emissions from other industrial facilities and regulatory thresholds (such as reporting thresholds for GHG emissions to provincial and federal programs). For the purpose of assessment of magnitude of the Project GHG emissions, (on a tonnes CO_2e per annum basis), the following criteria have been developed.

- Less than 50,000 tonnes is considered low (as below this reporting to the federal program is not required).
- Between 50,000 and 500,000 tonnes is considered medium.
- Greater than 1 million tonnes is considered high.

Where the GHG emissions are considered to be either medium or high, a GHG Management Plan must be prepared.

For a Change in Sound Quality with respect to sound pressure levels, a significant adverse residual environmental effect on the Acoustic Environment is one where Project-related sound emissions during Construction cause the sound pressure levels at the nearest noise sensitive area or receptor (NSA) to frequently exceed the US EPA guidance of 55 dB_A (L_{DN}) and during Operation cause the percent of highly annoyed receptors to increase by 6.5%. “Frequently” is defined as twice (*i.e.*, two days) per week.

5.2.2 VC Existing Conditions

5.2.2.1 Air Quality

As noted earlier, the Project is located in an area that is primarily rural, in the community of Haines Junction. There are no other substantive sources located nearby. Existing emissions of air contaminants are limited to household and institutional (school, other smaller community buildings) heating appliances burning wood or oil and motor vehicle fuel combustion.

There are no ambient air quality monitoring stations in the area of the Project. The nearest air quality monitoring station is located in Whitehorse, approximately 130 km to the east of the Project site. In the absence of any other ambient air quality monitoring information near the Project site, existing conditions in the Project area are based on the most recent monitoring data from the Whitehorse station. Ambient concentrations of particulate matter < 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide

(CO), and ozone (O_3) are measured at the station. The most recently available monitoring data were obtained from Yukon Environment and Environment Canada. Ambient air quality data is collected at Whitehorse by Environment Canada as part of the National Air Pollution Surveillance Program (NAPS) (Environment Canada 2012b).

Based on the information provided by Environment Canada, there have been equipment operational issues over the last few years; therefore, there are some gaps in the data. Thus, data from 2008-2010 were used to establish the existing conditions with respect to ambient air quality in the area.

The publication from Yukon Environment, entitled *Yukon State of the Environment Interim Report – An Update from Environmental Indicators 2012* provides an additional description of existing and historical ambient air quality conditions in the Whitehorse Area (Yukon Environment 2012a).

Based on the information provided in the environment report, there were 15 days with exceedances of the $PM_{2.5}$ ambient standard in 2009. As noted above, there are some gaps in the data; in 2009 the months of January and February are missing due to equipment operational issues. The average concentration of $PM_{2.5}$ in 2009 is also higher than in recent years. This is likely attributed to a substantive increase in wildfires in the summer of 2009. There were no measured concentrations exceeding the 24-hour $PM_{2.5}$ Yukon Standard in 2008 or in 2010.

For NO_2 and CO, no exceedances of the Yukon ambient air quality standards were measured in 2008, 2009 or 2010 at the Whitehorse station. Further, based on the monthly average data from Environment Canada the NO_2 and CO concentrations are relatively low, most of the time.

For O_3, there were no exceedances of the 8-hour average Canada-wide Standard for the period of 2008 to 2010.

The 2010 annual average NO_2, CO, and O_3 concentrations measured at the Whitehorse station are 5.5 $\mu g/m^3$, 0.4 $\mu g/m^3$, and 32 $\mu g/m^3$, respectively. The 2010 annual average $PM_{2.5}$ concentration measured at Whitehorse is 1.9 $\mu g/m^3$. The 2010 annual average concentrations are based on data from the beginning of January to the end of May, as data from June to December were unavailable for 2010 due to station operational issues, as noted above.

The measured air contaminant concentrations at Whitehorse are likely to be higher than ambient concentrations in Haines Junction, given Haines Junction is a smaller, more rural community and Whitehorse is a larger centre with more sources of emissions, specifically vehicle traffic and increased stationary combustion related to heating. However, due to the regional nature of ambient ozone concentrations, the concentrations measured at Whitehorse would likely be similar to what would be observed in Haines Junction.

In summary, as there are no substantive sources of emissions in the in the vicinity of the Project or in region, the air quality in the Project area is considered to be good, as the rate of compliance with the ambient standards is greater than 95% for the period of 2008 to 2010. Occasionally during winter under certain meteorological conditions (calm winds, atmospheric temperature inversion), smoke from home heating has been observed at ground level.

5.2.2.2 Air Contaminant and GHG Emissions

The existing air contaminant and GHG emissions sources in the Haines Junction area consist mainly of combustion emissions associated with space heating of public buildings and houses located in the community, power generation in small diesel generators (very infrequent) and vehicle emissions. Emissions also result from natural events/releases such as forest fires (during the summer months).

Air contaminant and GHG emissions from institutional sources related to space heating requirements in the Haines Junction area are provided in Table 5.2.3. The emission rates are estimated using US EPA emission factors for diesel combustion (US EPA 2010) and the estimated diesel fuel offset volumes from the *Haines Junction Bioenergy Project – Evaluation of Waste Heat Potential Final Report* dated December 10, 2012, prepared by Clean Technology Community Gateway (CTCG 2012).

Table 5.2.3 Estimated Existing Space Heating Emissions – Haines Junction

Building	Emission Rate (t/a)						
	NO_X	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$	CO_2
School	0.082	0.021	0.88	8.2E-03	4.5E-03	3.4E-03	91.9
Convention Centre	0.019	4.8E-03	0.20	1.9E-03	1.0E-03	8.0E-04	21.4
Arena & Pool Complex	0.13	0.033	1.4	0.013	7.1E-03	5.5E-03	147
Fire Hall and Yukon Government Building	0.085	0.021	0.91	8.5E-03	4.6E-03	3.5E-03	95.2
Total	**0.32**	**0.080**	**3.4**	**0.032**	**0.017**	**0.013**	**356**

Greenhouse gases (GHG) of primary concern include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), among others. Territorial GHG emissions in 2010, including industrial facilities, vehicles and natural sources, were 340 kilotonnes of carbon dioxide equivalent (CO_2e) (Environment Canada 2012c). No facilities in the Yukon Territory reported GHG emissions to Environment Canada in 2010, indicating none are over 50,000 t CO_2e (Environment Canada 2011).

Canada's GHG emissions in 2010 were 692,000 kilotonnes CO_2e (Environment Canada 2012c). Yukon's contribution to national GHG emissions is <1%. GHG emissions due to stationary combustion account for 324 kilotonnes CO_2e in 2010 (Environment Canada 2012c), which represents approximately 0.05% of Canada's 2010 emissions.

Carbon dioxide emissions globally are estimated to be 34 Gt per year (Climate Analysis Indicator Tool (CAIT 2012). Canada's contribution to global GHG emissions is approximately 2%.

5.2.2.3 Sound Quality

Sound Quality in the outdoor environment can be influenced by a variety of natural and anthropogenic sources. These may include unwanted sounds (noise) from stationary and mobile sources, noise from industrial equipment, vehicle traffic, and the operation of heavy equipment such as bulldozers, trucks, or diesel generators. It is also well known that sound propagation and the potential environmental effects of noise on nearby receptors is heavily influenced by weather conditions such as temperature, humidity, wind direction and wind speed. Local topographical features such as hills or wooded areas may serve to attenuate sound levels. Also, large reflective surfaces such as water bodies may serve to reflect sound to more distant locations than would occur in their absence. There may also be sound reflections if the atmospheric mixing height is low (a few hundred metres), or if solid structures are located close to sources of noise emissions.

Existing sound levels in the immediate vicinity of the proposed Project have not been documented in this or any previous work. Local traffic is expected to be the main contributor. However, given the nature of the area within the community of Haines Junction, existing sound levels are expected to be typical of a small rural community with higher sound pressure levels near the main throughways. According to the ERCB (2007), a typical sound level on a quiet street during daytime hours is 50 dB_A. Based on the experience of the Study Team, sound pressure levels at night in a quiet rural community may be between 30 and 40 dB_A.

5.2.3 Potential Project VC Interactions

5.2.3.1 Project Effects Mechanisms

Each Project activity and physical work for the Project is listed in Table 5.2.4. The activities are ranked as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Atmospheric Environment.

Table 5.2.4 Potential Project Environmental Effects to the Atmospheric Environment

Project Activities and Physical Works	Potential Environmental Effects		
	Change in Air Quality	Change in GHG Emissions	Change in Sound Quality
Construction			
Site preparation	1	1	2
Physical construction of the facility structures and installation of equipment	1	1	2
Commissioning	1	1	1
Construction of infrastructure for feedstock harvesting	1	1	1
Operation			
Operation and Maintenance of Plant Site	2	2	2
Feedstock Harvesting	1	1	1
Decommissioning, Reclamation and Closure			
Plant Site	1	1	1
Harvested Areas	1	1	1

Project-Related Environmental Effects
Notes:
Project-Related Environmental Effects were ranked as follows:
0 = No interaction. The environmental effects are rated not significant and are not considered further in this report.
1 = Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices and/or permit conditions.. The environmental effects are rated not significant and are not considered further in this report.
2 = Interaction may, even with codified mitigation and/or permit conditions, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EA.

The Project activities during Construction, Operation and Decommissioning may result in emissions of sound, air contaminants and GHGs to the atmosphere. These emissions may cause adverse environmental effects on the Atmospheric Environment, specifically a Change in Air Quality, Change in GHG Emissions and Change in Sound Quality during Operation.

During Construction, air contaminant and GHG emissions and noise are likely to occur; however, given the relatively small scale of the Project, emissions of air contaminants, GHGs and noise are not likely to be substantive. Fugitive dust is expected to be the largest potential concern during Construction and can be mitigated using water application if needed (during windy, dry periods). Effort to re-vegetate the surrounding area as soon as possible during Construction will also limit the potential for dust generation. Based on the small site footprint and scope of Construction required, these activities are not evaluated in detail and are considered a 1.

During Operation, feedstock harvesting activities may result in air contaminant, GHG and sound emissions to the atmosphere. However, these emissions are expected to be in remote locations, periodic and are not likely to be substantive, given that a large portion or all of the feedstock required for the Project can be sourced from existing forestry operations in the area, depending on the scale of the Project. These activities are therefore not evaluated in detail and are ranked as 1. Once the Project scale has been confirmed, the assessment of feedstock harvesting activities may need to be re-visited, as required.

Project activities during Decommissioning are expected to result in sound emissions and releases of air contaminants and GHGs in magnitude that are similar to or less than those associated with Construction and Operation activities; thus these are not evaluated in detail and are considered a 1.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 5.5, including cumulative environmental effects, on the Atmospheric Environment during any phase of the Project are rated not significant, and are not considered further in the assessment.

5.2.3.2 Assessment of Environmental Effects

A summary of the environmental effects assessment and prediction of residual environmental effects resulting from interaction ranked as 2 on the Atmospheric Environment (Operation of plant site for air quality and Construction and Operation for Sound Quality) is provided in Table 5.2.5.

Table 5.2.5 Summary of Residual Project-Related Environmental Effects on the Atmospheric Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics: Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context	Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
Change in Air Quality • Combustion gases. • Particulate matter (dust).	Operation	• Implement idling reduction program. • Implement equipment maintenance program. • Continuous emissions monitors (specifically O_2) in exhaust stack to optimize combustion. • Process closely monitored and controlled for optimum operation. • Syngas cleaned and filtered prior to combustion in engines. • Biomass stored inside to minimize potential dust emissions and help control moisture content to maximize gasification and combustion efficiency.	A	L	L	LT/ C	R	D	N	M	L	Y	One source emissions testing campaign is recommended to confirm vendor emission guarantees.
	Residual Environmental Effects for all Phases								N	M	L	Y	

Table 5.2.5 Summary of Residual Project-Related Environmental Effects on the Atmospheric Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					
Change in GHG Emissions • Fuel combustion. • Feedstock harvesting.	Operation	• Implement equipment maintenance program. • Implement idling reduction program.	A	L	L	LT/C	R	D	N	M	L	Y	Estimate direct GHG emissions for comparison with reporting threshold.
	Residual Environmental Effects for all Phases								N	M	L	Y	
Change in Sound Quality • Equipment operation.	Construction	• Construction and trucking of material during daytime hours only. • Use of mufflers. • Maintenance for equipment.	A	L	L	MT/R	R	D	N	H	L	Y	If noise complaints are received, sound monitoring may be conducted and activities modified to reduce noise.
	Operation	• Maintenance of equipment. • Gasifier and engines in enclosed in containers/buildings. • Trucking and chipper operation during daytime hours only. • Locate chipper 500 to 1,000 m from nearest resident or other mitigation (depending on sound power level of chosen technology.	A	L	L	LT/C	R	D	N	H	L	Y	If noise complaints are received, sound monitoring may be conducted and activities modified to reduce noise.
	Residual Environmental Effects for all Phases								N	H	L	Y	

Table 5.2.5 Summary of Residual Project-Related Environmental Effects on the Atmospheric Environment

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					

KEY

Direction
- P Positive.
- A Adverse.

Magnitude
- L Low: (Air Quality is not affected or slightly affected but is well below objectives, guidelines, or standards; GHG Emissions < 10,000 t CO_2e/a; sound pressure levels at or below background)
- M Medium: (Air Quality is affected to values that are near but largely below the objectives, guidelines, or standards; GHG Emissions < 50,000 and > 10,000 t CO_2e/a; sound pressure levels above background and below limits)
- H High: (Air Quality is degraded to values that may substantially exceed objectives, guidelines, or standards; GHG Emissions > 50,000 t CO_2e/a; sound pressure levels exceed limits)

Geographic Extent
- S Site-specific: Within the PDA.
- L Local: Within the LAA.
- R Regional: Within the RAA.

Duration
- ST Short term: Occurs and lasts for short periods (*e.g.,* days/weeks).
- MT Medium term: Occurs and lasts for extended periods of time (*e.g.,* years).
- LT Long term: Occurs during Construction and/or Operation and lasts for the life of Project.
- P Permanent: Occurs during Construction and Operation and beyond.

Frequency
- O Occurs once.
- S Occurs sporadically at irregular intervals.
- R Occurs on a regular basis and at regular intervals.
- C Continuous.

Reversibility
- R Reversible.
- I Irreversible.

Ecological/Socio-economic Context
- U Undisturbed: Area relatively or not adversely affected by human activity.
- D Developed: Area has been substantially previously disturbed by human development or human development is still present.
- N/A Not Applicable.

Significance
- S Significant.
- N Not Significant.

Prediction Confidence
Confidence in the significance prediction, based on scientific information and statistical analysis, professional judgment and known effectiveness of mitigation:
- L Low level of confidence.
- M Moderate level of confidence.
- H High level of confidence.

Likelihood
Likelihood of a significant environmental effect occurring, based on professional judgment:
- L Low probability of occurrence.
- M Medium probability of occurrence.
- H High probability of occurrence.

Cumulative Environmental Effects?
- Y Potential for environmental effect to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.
- N Environmental effect will not or is not likely to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.

5.2.3.3 Mitigation Measures

The following mitigation measures, through careful design and planning, will be employed to avoid or reduce the environmental effects of the Project on the Atmospheric Environment potentially resulting from the environmental effects mechanisms described above.

- Continuous emissions monitors (specifically O_2) of exhaust gases to control combustion and minimize emissions;
- Gasification and combustion processes closely monitored and controlled for optimum operation to reduce air contaminant emissions;
- Filtration of syngas prior to combustion to remove any tar formation from the gasification process;
- Biomass stored inside to minimize potential dust emissions and help control moisture content to maximize gasification and combustion efficiency;
- Construction and Decommissioning activities and trucking to and from the site (feedstock transport) limited to daytime hours only to minimize sound pressure levels at night;
- Use of mufflers on heavy equipment and vehicles to reduce sound emissions;
- Equipment enclosed in buildings where feasible or located to minimize sound pressure levels at off-site sensitive receptors; and
- Location of the chipper at least 1,000 m from nearest permanent residence or further review of noise generation of specific chipper required for a low noise model or incorporation of mitigation such as a barrier to attenuate noise.

5.2.3.4 Characterization of Residual Effects

As described in the text below, the results of the dispersion modelling indicate that for the three Project configuration scenarios considered for Operation, exceedances of the applicable ambient air quality standards, objectives and criteria are unlikely to occur. In most cases the predicted ground-level concentrations were well below the ambient standards and objectives.

During Operation, with respect to air contaminant emissions, it is expected that emissions of NO_2 and CO are likely to increase slightly over the existing conditions following implementation of the Project, due to the combustion of gasified biomass. However, a decrease in SO_2 emissions over the existing condition is also expected, as biomass contains less sulphur than fossil fuels. The reduction in SO_2 emissions is expected due to a reduction in fossil fuel consumption for space heating requirements of public buildings in the community. The magnitude of the increases and reductions in air contaminant emissions are dependent on the size selected for the Project as well as the final stack design, as this will dictate how many individual heating systems in community buildings are decommissioned and how emissions from the Project are dispersed.

GHG emissions are likely to range from 6,700 to 26,780 t/a of CO_2 due to biomass combustion, depending on the ultimate scale of the Project. Emissions of CO_2 account for the majority of the total GHG emissions. However, CO_2 emissions from biomass combustion are reported separately under the Environment Canada reporting system, since carbon dioxide emissions from biomass are considered carbon neutral as the emissions are part of the global carbon cycle. Emissions of other GHGs including CH_4 and N_2O are expected to be nominal, given the relatively low volumes of fuel consumed during Operation. Therefore, given the Project is to replace existing fossil fuel fired heating systems in the community; a small offset of GHG emissions is expected following implementation of the Project, ranging from 90 to 350 t/a CO_2.

To estimate sound pressure levels at distances from sources, the Study Team used the inverse square law which indicates that sound energy dissipates approximately 6 dB for a doubling of distance (ERCB 2007). This calculation does not account for attenuation from atmospheric or ground absorption (terrain effects) and hence is considered conservative.

The Study Team estimated the sound pressure levels of heavy equipment used for tree clearing, site preparation, and facility installation using typical equipment types and engine horsepower. The Construction phase is anticipated to take less than one year. Tree cutting can be a noisy activity and may cause sound pressure levels to exceed 55 dB_A within 1,500 metres. Noise from earth moving activities may exceed 55 dB_A on occasion within approximately 600 m from the activity. These are conservative estimates as the effects of terrain, treed areas, and buildings were not taken into account. Construction activities are transient and will not take place during nighttime to help reduce annoyance and avoid sleep disturbance. Therefore, although Construction within 600 to 1,500 metres will generate perceivable noise, annoyance will be limited in duration and extent and occur during daytime hours only. The L_{DN} criterion of 55 dB_A will likely be exceeded within 1,500 m of tree cutting, and may be exceeded on occasion within 600 m of earth moving activities. As the Project site is relatively small, Construction is expected to cause a short term disturbance. A 8-month period is anticipated for Construction.

The estimated sound pressure level from Operation of a 2 MW_e gasification plant is 87 dB_A at 4.5 m (10 feet), based on the maximum sound pressure level provided by CPC (CPC 2012). The sound from the facility would attenuate from 87 dB_A to 55 dB_A approximately 120 m from the site, as a conservative estimate. Based on the expected baseline noise levels in the village, it is estimated that the 2 MW_e facility would not be highly audible during daytime beyond 120 m. At night, the plant may be audible up to 325 m from the site; however at that level would not be highly audible and would not be expected to cause sleep disturbance (may be perceived as a dull hum on very quiet evenings outdoors).

The nearest sensitive receptor (the school building) is approximately 160 m from the proposed site in the FEED study. WHO indicates that the sound pressure level in an outdoor playground area should not exceed 55 dB_A and also indicate an indoor level of 35 dB_A for schools (WHO 1998). Since building walls are capable of decreasing sound levels by 10-20 dB_A (no windows open) (WHO 1998), meeting the outdoor limit of 55 dB_A results in meeting the indoor limit of 35 dB_A. Therefore as long as the plant is located greater than 120 m away from the school, noise from Operation of the facility is not expected to exceed WHO guidelines.

The percentage highly annoyed (% HA) by noise in the existing case was estimated to be approximately 2.2%, based on an assumed daytime sound pressure level of 50 dB_A and a nighttime sound pressure level of 40 dB_A. A 10 dB_A penalty was added to the nighttime sound pressure level, as per guidance from US EPA and Health Canada. For Project Operation, the % HA at a location 120 m away (where the Project contribution to sound pressure level is 55 dB_A during day and night), in addition to the existing case, was estimated to be 4.8%. Therefore the change in % HA is 2.6%, which is below the 6.5% significance criterion. The significance criterion would be exceeded if the Project contribution to sound pressure levels exceeds 60 dB_A (approximately 75 m or closer for the 2 MW_e case) at a sensitive receptor.

The location of the wood chipping operation is not currently known. Based on the reference wood chipping sound pressure level information (Health and Safety Laboratory 2008), noise from the chipper would be noticeable over background within approximately 500 to 1,000 m from the wood chipper (depending on technology of wood chipper used). At closer than 200 to 400 m, the noise would be highly audible (perceived as a doubling of background noise). As stated above, these are conservative estimates as screening effects were not taken into account. Therefore the noise from the wood chipping operations during daytime hours is not expected to be noticeable beyond 1,000 m. Wood chipping is only expected to be required for several hours per day and not every day. Wood chipping would be scheduled to avoid evening, nighttime and early morning hours as well as weekends. If the chipper is to be located within 1 km of permanent residents, the school or other areas considered noise sensitive, further assessment would be completed to establish background sound pressure levels at the location as well as the actual sound levels for the required chipper. Effort would be made in selection of the chipping equipment as well as through noise mitigation (such as barriers) as required to reduce the noise at the nearest sensitive receptor to 3 dB or less above background levels (where the noise would be just perceivable).

Dispersion Modelling

Dispersion modelling of air contaminant emissions resulting from Operation of the Project was conducted to predict resulting ground-level concentrations downwind. This technical evaluation was used to inform the assessment of environmental effects on Air Quality. Emissions during construction activities were not modelled as the releases will be short-term in duration (during the construction period) and the air contaminant emissions are likely to be less than those during Operation.

As noted above, since the Project is in the early design stages, the scale and configuration of the Project operation is not yet confirmed. Therefore, three scenarios currently being considered for the Project were modelled as follows:

- **Scenario 1:** 0.5 MW biomass gasifier and engines with two 8 metre exhaust stacks;
- **Scenario 2:** 2 MW biomass gasifier and engines with eight 8 metre exhaust stacks; and
- **Scenario 3:** 2 MW biomass gasifier and engines with one 20 metre exhaust stack.

These scenarios are expected to conservatively evaluate the range of potential technology configurations that could be chosen. The maximum short term and long term (annual) average ground-level concentrations are predicted with the most recent version of the AERMOD dispersion model.

The inputs required for the dispersion modelling consist of three components: meteorological data; receptor grid and terrain data; and point source characteristics and emissions data.

Hourly meteorological data (*e.g.*, wind speed and direction, temperature) from the beginning of January 2006 to the end of December 2011 were obtained from the National Climatic Data Centre (NCDC 2012) for the Whitehorse Airport, the nearest representative surface station to the Project site. Twice daily, upper air sounding data were also obtained for the Whitehorse weather station, the nearest representative upper air station to the Project site (NOAA 2012). The raw data for the area were used to calculate stability parameters and mixing layer depths (mixing heights) with AERMET, the AERMOD meteorological pre-processor.

A receptor grid covering the LAA was established for the dispersion modelling, consisting of a 10 km x 10 km Cartesian receptor grid with the Project site near the center of the grid. The receptor grid spacing was 100 m apart for the 6 km by 6 km grid centered near the Project and 500 m apart for the remainder of the 10 km x 10 km domain. Terrain elevation data used in the development of the receptor grid were obtained from the Yukon Environment GIS Data (Yukon Environment 2012b).

The source data required to run the AERMOD model includes the following:

- Physical location of the point sources;
- Emission rate of the selected air contaminant;
- Physical height of the emission source (stack height);
- Diameter of the stack at its exit (stack exit diameter);
- Average stack exhaust gas exit velocity; and
- Average stack exhaust gas temperature.

The source parameters and emission rates required for the dispersion modelling were obtained from emissions data provided by equipment vendors (CPC 2012).

The model input parameters and emission rates included in the modelling for Operation of the Project are provided in Tables 5.2.6 and 5.2.7, below.

Table 5.2.6 Model Inputs – Source Parameters

Source	Location (m)		Stack Height (m)	Stack Diameter (m)	Average Stack Gas Exit Temperature (K)	Average Stack Gas Exit Velocity (m/s)
	UTM X	UTM Y				
Scenario 1						
Engine Stack 1	363,155	6,738,485	7.6	0.2	647	10.0
Engine Stack 2	363,162	6,738,479	7.6	0.2	647	10.0
Scenario 2						
Engine Stack 1	363,125	6,738,503	7.6	0.2	647	10.0
Engine Stack 2	363,139	6,738,503	7.6	0.2	647	10.0
Engine Stack 3	363,174	6,738,489	7.6	0.2	647	10.0

Table 5.2.6 Model Inputs – Source Parameters

Source	Location (m)		Stack Height (m)	Stack Diameter (m)	Average Stack Gas Exit Temperature (K)	Average Stack Gas Exit Velocity (m/s)
	UTM X	UTM Y				
Engine Stack 4	363,160	6,738,489	7.6	0.2	647	10.0
Engine Stack 5	363,173	6,738,503	7.6	0.2	647	10.0
Engine Stack 6	363,158	6,738,503	7.6	0.2	647	10.0
Engine Stack 7	363,139	6,738,488	7.6	0.2	647	10.0
Engine Stack 8	363,124	6,738,488	7.6	0.2	647	10.0
Scenario 3						
Engine Stack	363,125	6,738,503	20.0	0.3	647	10.0

Table 5.2.7 Model Inputs – Air Contaminant Emission Rates

Source	Emission Rate (g/s)					
	NO_X	CO	SO_2	TSP	PM_{10}	$PM_{2.5}$
Scenario 1						
Engine Stack 1	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 2	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Scenario 2						
Engine Stack 1	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 2	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 3	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 4	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 5	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 6	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 7	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Engine Stack 8	0.045	0.018	5.7E-03	1.9E-04	1.9E-04	1.9E-04
Scenario 3						
Engine Stack	0.36	0.15	0.045	1.5E-03	1.5E-03	1.5E-03

Additional details on the source parameters and emissions rates used in the modelling are provided in the Emission and Wastes section in the Project Description (Section 3.3).

The effects of downwash due to wind flow over and around the surrounding buildings are considered in the modeling. Since building wake effects may influence the predictions, building heights and widths were included in the input file using the US EPA Building Profile Input Program (BPIP-PRIME) so those effects would be considered in the analysis (US EPA 1997).

After running AERMOD, output files were generated for the maximum 1-hour, 8-hour and 24-hour predicted concentrations and annual average concentrations at each receptor for the complete 6-year time period spanned by the meteorological input file.

Measured ambient air quality data were used to characterize the baseline and establish background concentrations used in the modelling. The incremental changes related to Project activities during Operation were considered in the context of these baseline values by adding maximum model-predicted values to measured ambient (*i.e.*, background) values.

To conservatively estimate baseline ambient air concentrations for relevant averaging periods in the Study Area, monitoring data from the nearest ambient station to the Project site were considered. The nearest ambient air quality monitoring station to the Project site is located in Whitehorse, approximately 130 km to the east. For averaging periods of 24 h or less, the maximum of the monthly hourly averages from 2008-2010 were used in conjunction with the OMOE relation for determination of alternate averaging periods. For annual averaging periods, the average of the monthly concentrations was used.

The background concentrations of the Criteria Air Contaminants (CAC) used in the modelling analysis are presented in Table 5.2.8. Ambient baseline values were estimated wherever data were available for all relevant averaging periods. For certain air contaminants, limited or no ambient data were available. For the cases where no data are available, the background concentrations are assumed to be negligible. Where limited data are available, details of the specific data treatment are specified in the table below.

Table 5.2.8 Ambient Background CAC Concentrations Used for Modelling

Criteria Air Contaminant	Averaging Period	Background Concentration Used ($\mu g/m^3$)	Additional Notes
SO^2	1-hour	--	No data available, SO_2 not monitored at Whitehorse station.
	24-hour	--	
	Annual	--	
NO_2	1-hour	19.9	Estimated using maximum of monthly hourly average concentrations measured at the Whitehorse station in 2008. 24-hour average background concentration estimated using OMOE relation. Annual background concentration based on the average of the 2008 monthly average values.
	24-hour [1]	8.2	
	Annual	7.1	
CO	1-hour	1.1	Estimated using maximum of the monthly hourly average concentrations measured at the Whitehorse station from 2008-2010 and OMOE relation.
	8-hour [1]	0.61	
TSP	24-hour[1]	4.3	No data available, TSP not monitored at Whitehorse station. In absence of ambient data for TSP, $PM_{2.5}$ background concentration used for 24-hour averaging period. For annual average, the average of the monthly $PM_{2.5}$ concentrations from 2008-2010 was used.
	Annual	2.5	
PM_{10}	24-hour[1]	4.3	No data available, PM_{10} not monitored at Whitehorse station. In absence of ambient data for PM_{10}, $PM_{2.5}$ background concentration was used.
$PM_{2.5}$	24-hour[1]	4.3	Estimated using maximum of the monthly hourly average concentrations measured at the Whitehorse station from 2008-2010 and OMOE relation.

Notes:
1 Ambient background concentrations (24 h or weekly) were converted to an alternate averaging period using the following equation described in Table 7-1 in the OMOE's document "Procedure for Preparing an Emission Summary and Dispersion Modelling Report", dated July 2009: $C_0 = C_1 \times (t_1/t_0)^n$ where C_0 = the concentration at the averaging period t_0, C_1 = the concentration at the averaging period t_1, and n = 0.28.

Although no SO_2 data are available for the Yukon, as the Project will result in decreased SO_2 emissions in Haines Junction, this is not considered a technical limitation.

Dispersion Modelling Results

The maximum predicted ground-level air contaminant concentrations (including background) for each operational scenario modelled are provided in Table 5.2.9, 5.2.10 and 5.2.11.

Table 5.2.9 Maximum Predicted Ground-level Concentrations – Scenario 1

CAC	Averaging Period	Background (µg/m³)	Location		Maximum Predicted Concentration (µg/m³)	Maximum Predicted Concentration Plus Background (µg/m³)	Objective/ Guideline or Standard (µg/m³)	Percentage of Objective/ Guideline or Standard
			UTM X (m)	UTM Y (m)				
SO_2	1-hour	-	363,200	6,738,600	7.78	7.78	450	2%
	24-hour	-	363,200	6,738,400	2.80	2.80	150	2%
	Annual	-	363,100	6,738,600	0.52	0.52	30	2%
NO_2	1-hour	20	363,200	6,738,600	42.8	62.8	400	16%
	24-hour	8.2	363,200	6,738,400	15.4	23.6	200	12%
	Annual	7.1	363,100	6,738,600	3.82	10.9	60	18%
CO	1-hour	1.1	363,200	6,738,600	23.0	24	14,885	<1%
	8-hour	0.61	363,200	6,738,400	13.1	13.8	5,725	<1%
TSP	24-hour	4.3	363,200	6,738,400	0.09	4.39	120	4%
	Annual	2.5	363,100	6,738,600	0.02	2.52	60	4%
PM_{10}	24-hour	4.3	363,200	6,738,400	0.09	4.39	50	9%
$PM_{2.5}$	24-hour	4.3	363,200	6,738,400	0.09	4.39	30	15%
C_6H_6	24-hour	-	363,200	6,738,400	0.65	0.65	2.3	28%
HCHO	24-hour	-	363,200	6,738,400	0.68	0.68	65	1%

Table 5.2.10 Maximum Predicted Ground-level Concentrations – Scenario 2

CAC	Averaging Period	Background (µg/m³)	Location		Maximum Predicted Concentration (µg/m³)	Maximum Predicted Concentration Plus Background (µg/m³)	Objective/ Guideline or Standard (µg/m³)	Percentage of Objective/ Guideline or Standard
			UTM X (m)	UTM Y (m)				
SO_2	1-hour	-	363,300	6,738,500	24.1	24.1	450	5%
	24-hour	-	363,200	6,738,400	9.55	9.55	150	6%
	Annual	-	363,100	6,738,600	2.25	2.25	30	8%
NO_2	1-hour	20	363,300	6,738,500	133	153	400	38%
	24-hour	8.2	363,200	6,738,400	52.5	60.7	200	30%
	Annual	7.1	363,100	6,738,600	12.4	19.5	60	32%
CO	1-hour	1.1	363,300	6,738,500	72.4	73.5	14,885	<1%
	8-hour	0.61	363,200	6,738,400	42.2	42.8	5,725	<1%
TSP	24-hour	4.3	363,200	6,738,400	0.32	4.62	120	4%
	Annual	2.5	363,100	6,738,600	0.08	2.58	60	4%
PM_{10}	24-hour	4.3	363,200	6,738,400	0.32	4.62	50	9%
$PM_{2.5}$	24-hour	4.3	363,200	6,738,400	0.32	4.62	30	15%
C_6H_6	24-hour	-	363,200	6,738,400	2.21	2.21	2.3	96%
HCHO	24-hour	-	363,200	6,738,400	2.31	2.31	65	4%

Table 5.2.11 Maximum Predicted Ground-level Concentrations – Scenario 3

CAC	Averaging Period	Background ($\mu g/m^3$)	Location UTM X (m)	Location UTM Y (m)	Maximum Predicted Concentration ($\mu g/m^3$)	Maximum Predicted Concentration Plus Background ($\mu g/m^3$)	Objective/ Guideline or Standard ($\mu g/m^3$)	Percentage of Objective/ Guideline or Standard
SO_2	1-hour	-	363,200	6,738,600	6.73	6.73	450	1%
	24-hour	-	363,200	6,738,400	2.34	2.34	150	2%
	Annual	-	363,100	6,738,600	0.68	0.68	30	2%
NO_2	1-hour	20	363,200	6,738,600	39.5	59.5	400	15%
	24-hour	8.2	363,200	6,738,400	13.7	21.9	200	11%
	Annual	7.1	363,100	6,738,600	3.99	11.1	60	18%
CO	1-hour	1.1	363,200	6,738,600	21.8	22.9	14,885	<1%
	8-hour	0.61	363,200	6,738,600	15.2	15.8	5,725	<1%
TSP	24-hour	4.3	363,200	6,738,400	0.10	4.40	120	4%
	Annual	2.5	363,100	6,738,600	0.03	2.53	60	4%
PM_{10}	24-hour	4.3	363,200	6,738,400	0.10	4.40	50	9%
$PM_{2.5}$	24-hour	4.3	363,200	6,738,400	0.10	4.40	30	15%
C_6H_6	24-hour	-	363,200	6,738,400	0.58	0.58	2.3	25%
HCHO	24-hour	-	363,200	6,738,400	0.60	0.60	65	1%

The maximum predicted concentrations of the modelled air contaminants, including background, were well below the ambient air quality standards and objectives for the three scenarios modelled. The operational configuration for Scenario 3 results in the lowest downwind concentrations; this is due to better dispersion of the stack exhaust plume which results from having a higher stack (20 m in height). Although the emission rates are lower for Scenario 1, the shorter stack (approximately 8 m in height) results in less dispersion downwind which in turn causes higher ground-level concentrations.

Concentration contour plots of the 1-hour maximum predicted ground-level NO_2 concentrations are provided below in Figures 5.2.1, 5.2.2 and 5.2.3, for each scenario. The highest predicted concentrations generally occur in the immediate vicinity of the Project site.

Ground-level concentrations of selected hazardous air contaminants were also modelled for each scenario. The estimated 24-hour ground-level concentrations were predicted for the air contaminants expected to be released in the largest quantities (benzene and formaldehyde), as noted above in Section 3.3. The estimated 24-hour benzene and formaldehyde concentrations were compared with Ontario Ministry of the Environment Ambient Air Quality Criteria (OMOE 2012). The estimated 24-hour benzene and formaldehyde ground-level concentrations were below the OMOE ambient criteria of 2.3 $\mu g/m^3$ and 65 $\mu g/m^3$, respectively, for each modelled scenario.

Figure 5.2.1 Maximum Predicted 1-hour Nitrogen Dioxide Ground-level Concentrations – Scenario 1

Figure 5.2.2 Maximum Predicted 1-hour Nitrogen Dioxide Ground-level Concentrations – Scenario 2

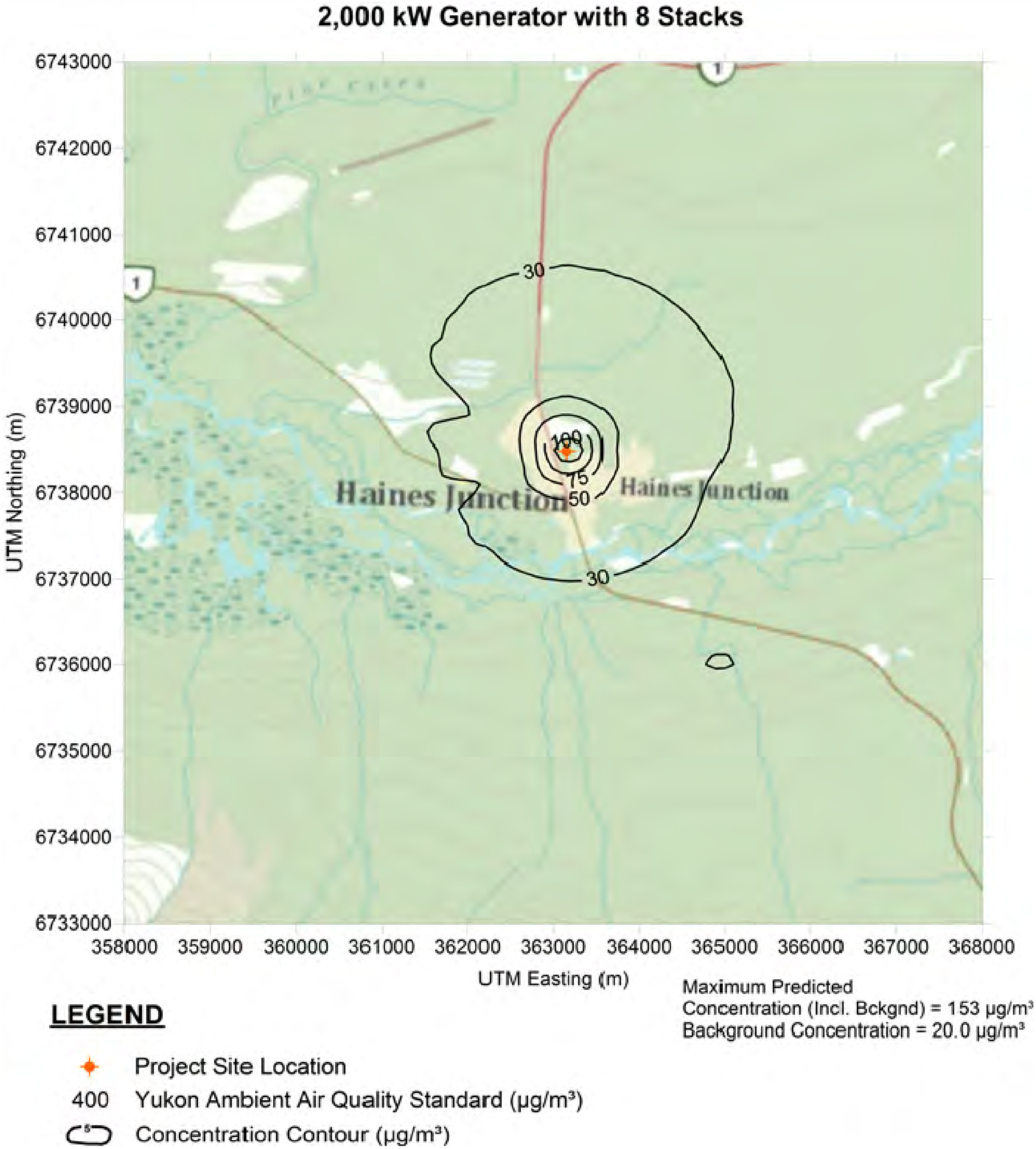
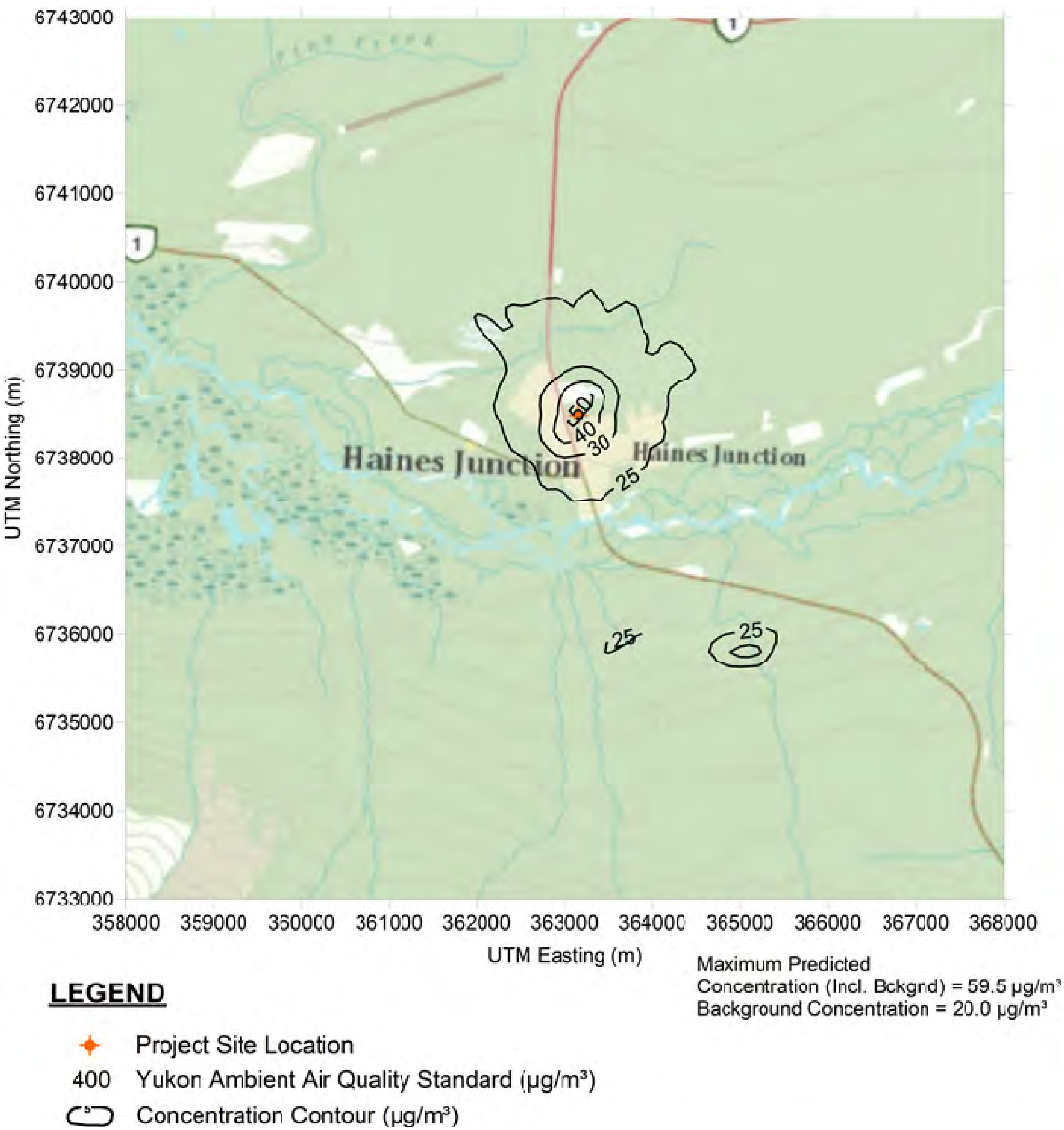


Figure 5.2.3 Maximum Predicted 1-hour Nitrogen Dioxide Ground-level Concentrations – Scenario 3



5.2.4 Assessment of Cumulative Effects

In addition to the Project environmental effects discussed above, an assessment of the potential cumulative environmental effects was conducted for other projects and activities that have potential to cause environmental effects that overlap with those of the Project, as identified in Table 5.2.5. The potential cumulative environmental effects to the Atmospheric Environment are presented in Table 5.2.12. In the table each interaction with other projects is ranked as 0, 1, or 2 with respect to the nature and degree to which important Project-related environmental effects overlap with those of other projects and activities.

Table 5.2.12 Potential Cumulative Environmental Effects to the Atmospheric Environment

Other Projects and Activities With Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects		
	Change in Air Quality	Change in GHG Emissions	Change in Sound Quality
Industrial Land Use (Past or Present)	1	1	1
Forestry and Agricultural Land Use (Past or Present)	1	1	1
Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (Past or Present)	1	1	1
Recreational Land Use (Past or Present)	1	1	1
Residential Land Use (Past or Present)	1	1	1
Industrial Land Use (Future)	1	1	1
Forestry and Agricultural Land Use (Future)	1	1	1
Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons (Future)	1	1	1
Recreational Land Use (Future)	1	1	1
Planned Residential Development (Future)	1	1	1

Cumulative Environmental Effects

Notes:

Cumulative environmental effects were ranked as follows:

0 = Project environmental effects do not act cumulatively with those of other Projects and Activities.

1 = Project environmental effects act cumulatively with those of other Project and Activities, but are unlikely to result in significant cumulative environmental effects OR Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects but will not measurably change the state of the VC.

2 = Project environmental effects act cumulatively with those of other project and activities, and may result in significant cumulative environmental effects OR Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects and may measurably change the state of the VC.

With respect to Forestry and Land Use, logging equipment and trucks release combustion gases, GHGs, and sound emissions and may cause fugitive road dust emissions during Operation in the areas harvested for Project feedstock. These emissions are transient as the logging operations move from site to site, and are limited to emissions from the operation of heavy equipment. As such, cumulative environmental effects from the Project and Forestry and Land Use are not expected to be substantive most of the time.

Existing Industrial Land Use near the Project includes the Yukon Electrical Company Diesel Plant in Haines Junction. The operation of the diesel plant is infrequent, typically during periods of electrical grid outages. Given there are no substantive industrial sources with frequent emissions in the area of the Project, the interactions between the other sources and the Project with respect to a Change in the Air Quality, a Change in GHG Emissions, and a Change in Sound Quality are likely to be minimal.

At this time, no future Industrial Land Use projects are known. The interaction between any future projects and the Project would be addressed by the EA for a future project.

With respect to Residential Land Use, air contaminant and GHG emissions from space heating requirements could combine with Project emissions at the ground-level on occasion, specifically during times with poor dispersion. However, given the small magnitude of the emissions due to residential space heating, cumulative environmental effects from the Project and Residential Land Use are not expected to be substantive most of the time.

It is not expected that Current Use of Land and Resources for Traditional Purposes by Aboriginal Persons will be substantively affected by the Operation of the Project as air contaminant emissions released from the Project will disperse from the site and ground-level concentrations will return to background levels.

The Project has the potential to interact with the recreational areas near the Project with respect to a Change in Air Quality and a Change in GHG Emissions during Operation. However, given the emissions from the Project are relatively low, negligible cumulative effects are expected with respect to Recreational Land Use.

Sound emissions from Current Use of Land and Resources by Aboriginal Persons for Traditional Purposes, Recreational Land Use and Residential Land Use are generally minimal and close to background sound levels. As such, substantive interactions between their environmental effects and those of the Project are not anticipated.

At this time, there are no known planned or future residential developments considered near the Project. The interaction between any future projects and the Project would be addressed by the EA for a future project.

5.2.4.1 Mitigation of Cumulative Environmental Effects

Mitigation measures for the Project Case were discussed previously for Project-related environmental effects (Section 5.2.3.3). The mitigation measures proposed for the Project-related environmental effects are also anticipated to be effective in mitigating any cumulative environmental effects, as would the mitigation associated with other past and future projects and activities.

5.2.5 Determination of Significance

5.2.5.1 Residual Project Environmental Effects

With the proposed mitigation and environmental protection measures, the residual environmental effect of a Change in Air Quality during all phases of the Project is rated not significant. This conclusion has been determined with a high level of confidence based on the conservative assumptions and emission factors used to estimate air contaminant emissions.

With the proposed mitigation and environmental protection measures, the residual environmental effect of a Change in GHG Emissions during all phases of the Project is rated not significant. This conclusion has been determined with a high level of confidence based on the conservative assumptions and emission factors used to estimate GHG emissions.

With the proposed mitigation and environmental protection measures, the residual environmental effect of a Change in Sound Quality during all phases of the Project is rated not significant. This conclusion has been determined with a high level of confidence based on the conservative assumptions used to estimate sound pressure levels.

5.2.5.2 Residual Cumulative Environmental Effects

The characterization of the potential cumulative environmental effects and associated mechanisms, combined with the proposed mitigation measures proposed in Section 5.2.4.2 demonstrate that the residual cumulative environmental effect of a Change in Air Quality is rated not significant. This determination has been made with a moderate level of confidence due to the preliminary nature of data available for the Project activities and the site location.

The characterization of the potential cumulative environmental effects and associated mechanisms, combined with the proposed mitigation measures proposed in Section 5.2.4.2 demonstrate that the residual cumulative environmental effect of a Change in GHG Emissions is rated not significant. This determination has been made with a moderate level of confidence due to the preliminary nature of data available for the Project activities.

The characterization of the potential cumulative environmental effects and associated mechanisms, combined with the proposed mitigation measures proposed in Section 5.2.4.2 demonstrate that the residual cumulative environmental effect of a Change in Sound Quality is rated not significant. This determination has been made with a moderate level of confidence due to the preliminary nature of data available for the Project activities, including Project location.

The proposed mitigation measures demonstrate that the Project contribution to the cumulative environmental effects on a Change in Air Quality, a Change in GHG Emissions, and a Change in Sound Quality is rated not significant. This determination has been made with a moderate level of confidence.

5.2.6 Summary Consultation Influence on the Assessment

At the time of writing, consultations in the community are on-going. A summary of the consultations as they apply to Atmospheric Environment will be provided following the completion of the consultations for the Project.

5.2.7 Effects Monitoring and Adaptive Management

During Operation, it is recommended that one stack testing campaign be conducted following commissioning of the Project to confirm vendor emissions guarantees. Given the current uncertainty of the scale and operational configuration of the Project, some parts of the assessment of Atmospheric Environment may need to be updated, specifically with respect to feedstock harvesting.

Ambient air quality monitoring is not warranted, given relatively small scale of the Project with relatively low emissions and the absence of substantive existing emission sources. There are no other warranted follow-up programs for air quality.

If sound complaints are received during Construction and/or Operation, monitoring may be implemented to confirm that sound pressure levels are within acceptable levels.

5.3 TERRESTRIAL ENVIRONMENT

5.3.1 Scope of the Assessment

This section defines the scope of the environmental assessment of the Terrestrial Environment in consideration of the nature of the regulatory setting, issues identified during public and First Nations engagement activities, potential Project-VC interactions, and existing knowledge.

5.3.1.1 Key Issues and Identification of Potential Effects

5.3.1.2 Regulatory/Policy Setting

The assessment of the Terrestrial Environment for the Project has been completed in accordance with the requirements of the *Yukon Environmental and Socio-Economic Assessment Act* (*YESAA*). The *YESAA* is not specific with respect to which aspects of vegetation and wildlife are to be assessed. However, the Yukon Environmental and Socio-economic Assessment Board (YESAB) does provide guidance in the Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions (YESAB 2005).

The Project has the potential to interact with the Terrestrial Environment by changing terrestrial habitats, including wetlands, and/or populations of vascular plants and/or wildlife species that are important in a socio-economic or environmental context, including species at risk (SAR), as defined federally by the *Species at Risk Act* (*SARA*), or species of conservation concern (SOCC), defined here as species ranked S1, S2, or S3 by the Yukon Conservation Data Centre (YCDC), with a general status rank of May Be At Risk, or Sensitive as determined by the Canadian Endangered Species Conservation Council (CESCC), and/or that have undergone an assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but not yet included on Schedule 1 of *SARA*. Additional species considered in this assessment as SOCC include species that will be assessed by COSEWIC. SOCC are species that, unlike SAR, are not afforded direct protection by legislation. SOCC are placed on lists as a precautionary measure that reflects an observed trend in their provincial population status.

Additional guidance for the feedstock component of the Project can be found in the “Strategic Forest Management Plan (SFMP)”, the “Integrated Landscape Plan (ILP) for the Champagne and Aishihik Traditional Territory”, and the YESAB “Proponent’s Guide: Completing a Forestry Project Proposal”. The SFMP was developed to provide direction for sustainable forest management in the CATT. The ILP was developed to provide guidance for projects involving forestry harvest and site planning. The SFMP directs the ILP to identify areas where forest harvesting should or should not take place. At a broad scale the ILP has identified these areas based on a number of factors, including:

- cultural;
- traditional;

- tourism;
- viewscapes;
- wilderness;
- wildlife;
- biological diversity;
- connectivity;
- community safety from wildfire risk;
- timber; and
- economy.

The Forestry Project Proposal Guide is a document designed to accompany the Project Proposal Form for Forestry. The completed form contains information that the YESAB requires to conduct an environmental and socio-economic assessment.

5.3.1.3 Selection of Measureable Parameters

The environmental assessment of the Terrestrial Environment is focused on the following environmental effects:

- Change in Terrestrial Populations; and
- Change in Wetlands.

The Project has the potential to affect the Terrestrial Environment through changes in abundance of wildlife and wildlife habitat, and degradation in habitat quality, all of which influence terrestrial populations of wildlife and plants. These potential changes could possibly influence the loss, or sustained presence of terrestrial populations and the maintenance of biodiversity in the region. In light of the value placed on terrestrial populations and wetlands by regulatory agencies, stakeholders, and the public, the environmental assessment of the Terrestrial Environment is focused on these environmental consequences which encompass the critical aspects of the VC.

The measurable parameters used for the assessment of the environmental effect presented above and the rationale for their selection is provided in Table 5.3.1.

Table 5.3.1 Measurable Parameters for Terrestrial Environment

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Terrestrial Populations	Loss of Vascular Plant SAR or SOCC (number of individuals)	• Addresses loss of known locations of rare vascular plants within the territory that are disturbed as a result of the Project.
	Loss of Wildlife SAR or SOCC (number of individuals)	• Loss of Wildlife SAR or SOCC (number of individuals)
	Changes to community structure or composition	• Addresses changes to the community structure and/or composition at a temporal scale.
	Loss of Migratory Birds (number of individuals)	• Addresses the concern of loss of individuals of migratory birds, including their nests, eggs, and young.
	Direct Habitat Loss (ha)	• This includes habitats for many wildlife and vascular plant species (such as old growth forests) and will also include an evaluation of the rarity of habitats affected.
	Loss of Old Growth Forest	• Old growth forests are important to biodiversity as well as regulators, First Nations, and other residents of Yukon Territory.
Change in Wetlands	Loss of wetland area (ha)	• Wetlands provide habitat for many wildlife and vascular plant species and will also include an evaluation of the rarity and proportion of wetlands affected.
	Loss of wetland function	• Wetlands can provide a number of functions, including hydrological, socio-economic, and ecological.

The measurable parameters in Table 5.4.1 were based on the professional judgment of the Study Team. Measurable parameters have clear units of measurement and are indicative of change in the Terrestrial Environment.

5.3.1.4 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the Terrestrial Environment are defined below.

Project Development Area (PDA): The PDA is the most basic and immediate area of the Project. The PDA is limited to the area of physical ground disturbance associated with the Project, and consists of an area that includes the area of physical disturbance associated with the biomass plant and associated facilities as well as the area associated with biomass feedstock harvesting (including forest roads, to be defined in detail upon further study). The PDA is the area represented by the physical Project footprint as defined in Chapter 3.1.2 above.

Local Assessment Area (LAA): The LAA includes a 10 x 10 km centred on the PDA. At present, the feesdstock harvesting area has not been identified; however a qualitative assessment of the harvesting area has been undertaken. The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. The LAA will be redefined to include areas of forest harvesting activities once the forest harvesting activities associated with the Project have been defined.

Regional Assessment Area (RAA): The RAA is limited to and includes the Yukon Territory. The RAA is the area within which the Project's environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The extent to which cumulative environmental effects for Vegetation and Wetland Resources may occur depend on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable future projects or activities that have been or will be carried out, as defined within the RAA.

5.3.1.5 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on the Terrestrial Environment include the phases of Construction, Operation, and Decommissioning. The preliminary Project schedule is provided in Section 3.4.

5.3.1.6 Administrative and Technical Boundaries

The assessment of the potential environmental effects of this Project on the Terrestrial Environment includes a consideration of populations of species that are listed under various federal and territorial acts and regulations. Existing habitat information used for the EA includes YCDC occurrences for species of special status in the vicinity of the Project, and information on Environmentally Significant Areas (ESAs). Information used for the assessment of potential environmental effects on the Terrestrial Environment was obtained from the *SARA*, the *MBCA*, 1994, the *Federal Policy on Wetland Conservation*, the *YESAA*, YCDC, the *Yukon Forest Protection Act*, the *Yukon Forest Resources Act*, the *Territorial Lands Act* (Yukon), and Yukon *Wildlife Act*, and the *Yukon Act* . Additional knowledge of vegetation and wetlands potentially affected by the Project is based on other information provided by the above sources, and the professional judgment of the Study Team.

Canada's indigenous species, subspecies, and distinct populations that are considered "At Risk" are protected under the *SARA*. The *SARA* provides legal protection to species and the conservation of their biological diversity. The purposes of the Act are to prevent species from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and encourage the management of other species to prevent them from becoming at risk. Designation under the Act follows recommendation and advice provided by COSEWIC to the Government of Canada. The COSEWIC is responsible under the *SARA* for assessing the biological status of each rare species in Canada. Under the *SARA*, the Governor in Council may accept the assessment and add the species to Schedule 1 of the *SARA*, decide not to add the species to Schedule 1, or may refer the assessment back to COSEWIC for further information or consideration.

Subsection 79(1) of the *SARA* stipulates that every person who is required by or under an Act of Parliament to ensure that an assessment of the environmental effects of a project is conducted must, without delay, notify the competent minister or ministers in writing of the project if it is likely to affect a listed wildlife species or its critical habitat. Additionally, *SARA* Subsection 79(2) states that where a federal environmental assessment is being carried out in relation to a project that may affect a listed wildlife species or its critical habitat, the person responsible for ensuring the assessment is conducted must:

- identify potential adverse effects on the listed wildlife species and its critical habitat;

- if the project is carried out:
  - ensure that measures are taken to avoid or lessen those adverse effects and to monitor them; and
  - ensure that such measures are consistent with any applicable recovery strategy and action plans.

Under the *SARA*, there are three schedules; species officially protected are listed under Schedule 1 of the *SARA* and designated as “Extinct, Extirpated, Endangered, Threatened, and Special Concern” by COSEWIC are protected by that Act. Species listed as “Special concern” are not protected by the prohibitions of Sections 32-36 of the *SARA*; however, they do not require that provincial or regional management plans are development to protect the species. Species of special concern are considered species at risk as Section 79 requirements of the Act apply to these species. “Listed Species” refer to species listed in Schedule 1 of the *SARA* and includes species designated as extirpated, endangered, threatened, or of special concern. Listed species are identified on the Species at Risk Public Registry.

Schedule 1 of the *SARA* is the official list of wildlife species at risk. Once a species is “listed”, the measures to protect and recover a listed wildlife species are implemented. Species that were designated at risk by the COSEWIC prior to the existence of the *SARA* require reassessment before being placed on Schedule 1. These species are listed on Schedule 2 if they were previously assessed by COSEWIC as endangered or threatened, and on Schedule 3 if they were previously assessed by COSEWIC as special concern. Both Schedules 2 and 3 are not provided with legal protection under the *SARA*.

Migratory birds are protected federally under the *Migratory Birds Convention Act* (*MBCA*) (1994), which states that “...no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter, or duck box of a migratory bird…” without a permit. The Act includes prohibition of “incidental take” of migratory birds or their nests as a result of activities such as those required for the Project.

Wildlife species are protected in the territory under the Yukon *Wildlife Act*. The Act reserves the right to place prohibitions, restrictions, or measures to be observed or implemented for the protection or survival of a population or species designated as “specially protected”. Section 5 of the regulations lists several specially protected species, including:

- Cougar (*Puma concolor*);
- Gyrfalcon (*Falco rusticolus*);
- Peregrine Falcon (*Falco peregrinus*);
- Trumpeter Swan (*Cygnus buccinators*); and
- Chisana Caribou Herd.

The *Yukon Act* also offers protection from being hunted to wildlife species declared by order of the Governor in Council to be in danger of becoming extinct.

Forests are protected in the territory under the *Forest Protection Act*, the *Forest Resources Act*, and the *Territorial Lands Act*. These acts regulate the harvesting of forestry resources (through a permitting process), construction of forestry roads, and activities surround fires in forested areas, as well as many other activities.

Wetlands are protected federally under the *Federal Policy on Wetland Conservation.* The objective of this policy is to *"…promote the conservation of Canada's wetlands to sustain their ecological and socio-economic function now, and in the future*…" Coordination of implementation of the policy is the responsibility of Environment Canada, specifically the Canadian Wildlife Service and the Environmental Conservation Branch. Although there is no specific federal legislation regarding wetlands, they may be protected federally under the *SARA*, if they contain critical species habitat for Species At Risk, the *MBCA*, 1994, if they contain nests of migratory birds, and/or the *Fisheries Act*, if the wetland contributes to existing or potential fish habitat.

5.3.1.7 Residual Effects Significance Criteria

Residual environmental effects rating criteria for the potential environmental effects of the Project on the Terrestrial Environment are applied to the evaluation of a loss of plant populations, SAR, or SOCC.

A *significant residual adverse environmental effect* on the Terrestrial Environment is defined as a Project-related environmental effect that results in any of the following:

- On secure species, one that affects terrestrial populations or habitat in such a way as to cause a decline in abundance or change in distribution of common and secure population(s) such that populations will not be sustainable within the RAA.

- On any Endangered or Threatened Species at Risk, one that results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA*. Sections 32-36 stipulate that it is an offence to capture, take, possess, collect, and sell endangered or threatened species. It is also illegal to damage or destroy the residence, for example the nest or den, of an endangered or threatened species.

- On any species of special status (SAR or SOCC), one that alters the terrestrial habitat within the spatial boundaries physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a viable plant or wildlife population that is dependent upon that habitat such that the likelihood of the long-term survival of these populations within the RAA is substantially reduced as a result.

- On any species of special status (SAR or SOCC), one that results in the direct mortality of individuals or communities such that the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) within the RAA is substantially reduced as a result.

- For wetland environments, one that results in a non-compensated net loss of wetland area and function.

5.3.2 VC Existing Conditions

The Terrestrial Environment includes vascular plant and wildlife (including birds) species and communities, and their habitats, including both upland and wetland habitats. The assessment focuses on important habitats and vascular plant and wildlife species at risk (SAR), as defined by the federal *Species at Risk Act* (*SARA*), or species of conservation concern (SOCC), defined here as species ranked S1, S2, or S3 by the YCDC, and with a status rank of At Risk, May Be At Risk, or Sensitive as determined by the CESCC. Additional species considered in this assessment as SOCC at the request of Environment Canada include species that will be assessed by COSEWIC in the coming year. Other species, communities, and habitats in the Yukon are secure, and although they may be affected by the Project, are not of particular sensitivity to the potential environmental effects.

5.3.2.1 Vegetation

Haines Junction is located in the Ruby Ranges ecoregion of the Boreal Cordillera ecozone. Vegetation in the lower boreal forest areas of the ecoregion include white spruce (*Picea glauca*), black spruce (*Picea mariana*), dwarf willow (*Salix herbacea*), birch (*Betula* sp.), ericaceous shrubs, and to a lesser extent, lodgepole pine (*Pinus contorta*). In poorly draining areas black spruce, scrub willow, birch, and various mosses can be found. Subalpine areas include alpine fir (*Abies lasiocarpa*) and lodgepole pine, while the highest elevated alpine areas of the ecoregion have plant communities that consist of mountain avens (*Dryas octopetala*), dwarf willow, birch, ericaceous shrubs, graminoid species, and mosses (The Ecological Framework of Canada n.d.).

Haines Junction has three species of trees; white spruce, trembling aspen (*Populous temuloides*), and balsam poplar (*Populous balsamifera*). The Project site is classified as a white spruce forest. A search of the YCDC did not indicate that there are any plant SAR or SOCC that have been identified in the vicinity of the site (B. Bennett pers. comm. 2012). There is currently only one plant listed by the *SARA* in the Yukon. The Baikal sedge (*Carex sabulosa*) is listed on Schedule 1 as Threatened, S2 by the YCDC, and as At Risk in the territory by the CESCC). The Baikal sedge can be found in sand dune habitats; the habitat at the Project site is not suitable for the sedge (B. Bennett, pers. comm. 2012). There are three additional plant SOCC found in the Yukon; the Yukon draba (*Draba yukonensis*, listed as endangered by COSEWIC, S1 by YCDC, and May be at Risk by CESCC), spiked saxifrage (*Saxifraga spicata*, awaiting review by COSEWIC in 2013, listed at May be at Risk by CESCC, and S1S2 by YCDC), and Yukon podistera (*Podistera yukonensis*, awaiting review by COSEWIC in 2013, listed at May be at Risk by CESCC, and S2 by YCDC). No suitable habitat is found at the Project site for these plants SOCC (B. Bennett pers. comm. 2013).

There are 170 recorded invasive plant species in the Yukon, each with its own invasiveness rank and general abundance with Yukon Environment. The spread of invasive species threatens biodiversity and is of concern to native species and habitats. Nineteen of these species are considered highly invasive and are listed below in Table 4.1.1.

Table 5.3.2 Highly Invasive Plant Species in Yukon Territory

Common Name	Scientific Name	Invasiveness Rank	Abundance	Persistence
Crested Wheat Grass	*Agropyron cristatum*	1	C	1
Smooth Brome	*Bromus inermis*	1	C	1
Spotted Knapweed	*Centaurea maculosa*	1	X	3
Creeping (Canada) Thistle	*Cirsium arvense*	1	R	2
Narrow-leaved Hawksbeard	*Crepis tectorum*	1	C	1
Leafy Spurge	*Euphorbia esula*	1	R	2
Field Hawkweed	*Hieracium caespitosum*	1	R	2
Oxeye Daisy	*Leucanthemum vulgare*	1	R	1
Narrow-leaved (Altai) Lyme Grass	*Leymus angustus*	1	R	2
Dalmatian Toadflax	*Linaria dalmatica*	1	X	3
Butter-and-eggs	*Linaria vulgaris*	1	C	1
Lucerne	*Medicago falcata*	1	C	1
White Sweetclover	*Melilotus alba*	1	C	1
Yellow Sweetclover	*Melilotus officinalis*	1	C	1
Reed Canary Grass	*Phalaris arundinacea*	1	?	1
Field Snow-thistle	*Sonchus arvensis ssp. uliginosus*	1	C	1
Common Tansy	*Tanacetum vulgare*	1	U	2
Scentless Chamomile	*Tripleurospermum inodoratum*	1	R	1
Tufted Vetch	*Vicia cracca*	1	C	2

Notes:
Invasiveness Rank
1 - Highly invasive - may displace or replace native ecosystems.

General Abundance
C = Common – widespread, established.
R = Rare, known from only one or two localities.
U = Unknown.
X = Possibly not persistent.
? = Possibly native.

Persistence
1 = Widespread.
2 = Local.
3 = Not persistent.

Source: Government of Yukon 2012a, Yukon Introduced Plants, January 2012 accessed at: http://www.env.gov.yk.ca/animals-habitat/invasiveplants.php.

Spruce bark beetle (*Dendroctonus rufipennis*) infestation in the region has had an impact on the age class and stand height of forests in the region (CAFN 2005). Large stands of dead wood are now found in many areas throughout the CAFN region. The beetle attacks semi-mature and mature white spruce, boring into the tree to create a cavity for eggs. Once hatched, larvae bore into the phloem. The beetles are carriers of a fungus that affects the phloem tubes of the trees and helps the beetles weaken the trees. Stands of dead trees are wildfire hazards and are of concern, especially near residential areas.

The closest wetlands to Haines Junction are located adjacent to the southern municipal boundaries of the village and are associated with Dezadeash River (see Figure 5.3.1).

Figure 5.3.1 Terrestrial Environment

The location of the source feedstock has not been identified at the time of writing. Once selected, information regarding vegetation (including invasive species) and wetlands at the sites will be included in this report.

5.3.2.2 Wildlife

Wildlife typically encountered in the Ruby Ranges ecoregion include caribou (*Rangifer tarandus*), grizzly bears (*Ursus arctos horribilis*), black bears (*Ursus americanus*), Dall sheep (*Ovis dalli*), moose (*Alces alces*), foxes (*Vulpes* sp.), wolves (*Canis* sp.), hares (*Lepus* sp.), ravens (*Corvus corax*), rock ptarmigan (*Lagopus muta*), willow ptarmigan (*Lagopus lagopus*), and golden eagles (*Aquila chrysaetos*) (The Ecological Framework of Canada n.d.).

A search of the YCDC did not indicate that there are any wildlife SAR or SOCC that have been identified in the vicinity of Haines Junction (B. Bennett, pers. comm. 2012). While no SAR or SOCC have been identified, it is always possible to encounter Barn Swallows (*Hirundo rustica*, designated as Threatened by COSEWIC and Sensitive by CESCC) nesting in old buildings. It has also been suggested that there is potential nesting habitat for Olive-sided Flycatcher (*Contopus cooperi*, listed in Schedule 1 of the *SARA* as Threatened and ranked At Risk by CESCC) and Common Nighthawk (*Chordeiles minor*, listed in Schedule 1 of the *SARA* as Threatened and ranked At Risk by CESCC) in the village (B. Bennett pers. comm. 2012). The possibility of encountering grizzly bears (designated as Special Concern by COSEWIC and Sensitive by CESCC) also exists (B. Bennett pers. comm. 2012). Additional SAR and SOCC in the Yukon are listed in Table 4.2, below.

Table 5.3.3 Additional Wildlife Species at Risk and Species of Conservation Concern in Yukon Territory

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2010)	YCDC S-Rank
Northern Long-eared Bat	*Myotis septentrionalis*	No schedule, no status	Endangered	Sensitive	S3
Little Brown Bat	*Myotis lucifugus*	No schedule, no status	Endangered	Secure	S1S3
Canada Warbler	*Wilsonia canadensis*	Schedule 1, Threatened	Threatened	At Risk	S1B
Red Knot	*Calidris canutus roselaari*	Schedule 1, Threatened	Threatened	-	-
Wood Bison	*Bison bison athabascae*	Schedule 1, Threatened	Threatened	At Risk	S2S3
Woodland Caribou (boreal population)	*Rangifer tarandus caribou*	Schedule 1, Threatened	Threatened	-	S1
Western Toad	*Anaxyrus boreas*	No schedule, no status	Special Concern	Sensitive	S3
Horned Grebe	*Podiceps auritus*	No schedule, no status	Special Concern	Sensitive	S3B
Peregrine Falcon	*Falco peregrinus anatum/tundrius*	Schedule 1, Special Concern	Special Concern	Sensitive	S3B
Rusty Blackbird	*Euphagus carolinus*	Schedule 1, Special Concern	Special Concern	Sensitive	S3B
Short-eared Owl	*Asio flammeus*	Schedule 1, Special Concern	Special Concern	Sensitive	S3B
Buff-breasted Sandpiper	*Tryngites subruficollis*	No schedule, no status	Special Concern	May be at Risk	S1B

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2010)	YCDC S-Rank
Collared Pika	*Ochotona collaris*	No schedule, no status	Special Concern	Sensitive	S3
Polar Bear	*Ursus maritimus*	Schedule 1, Special Concern	Special Concern	May be at Risk	S1
Wolverine (western population)	*Gulo gulo*	No schedule, no status	Special Concern	Sensitive	S3
Woodland Caribou (northern mountain population)	*Rangifer tarandus caribou*	Schedule 1, Special Concern	Special Concern	-	S3
Bank Swallow	*Riparia riparia*	No schedule, no status	Upcoming assessment in 2013	Secure	S5B
Red-necked Phalarope	*Phalaropus lobatus*	No schedule, no status	Upcoming assessment in 2014	Sensitive	S3B
Evening Grosbeak	*Coccothraustes vespertinus*	No schedule, no status	To be determined	Sensitive	S3B

Notes:

S1 = Critically Imperiled—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 = Imperiled—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.

S3 = Vulnerable—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 = Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 = Secure—Common, widespread, and abundant in the jurisdiction.

S#S# = Range Rank — A numeric range rank (*e.g*., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (*e.g*., SU is used rather than S1S4).

B = Breeding—Conservation status refers to the breeding population of the species in the nation or state/province.

Wild Species: The General Status of Wild Species in Canada

At Risk: Species for which a formal, detailed risk assessment (COSEWIC status assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (*i.e*. Endangered or Threatened). A COSEWIC designation of Endangered or Threatened automatically results in a Canada General Status Rank (Canada rank) of At Risk. Where a provincial or territorial formal risk assessment finds a species to be Endangered or Threatened in that particular region, then, under the general status program, the species automatically receives a provincial or territorial general status rank of At Risk.

May Be At Risk: Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC, or provincial or territorial equivalents.

Sensitive: Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.

Secure: Species that are not believed to belong in the categories Extinct, Extirpated, At Risk, May Be At Risk, Sensitive, Accidental or Exotic. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant.

Source Wild Species: The General Status of Wild Species in Canada' website Available at: http://www.wildspecies.ca/ranks.cfm?lang=e (CESCC 2012).

The Fish and Wildlife Branch of Yukon Environment maintains data on key areas where wildlife are found during important stages of their life cycle. Key Wildlife Areas (see Figure 5.3.1) located within the Village of Haines Junction municipal boundary include those for Sharp-tailed Grouse (*Tympanuchus phasianellus*) at the northern boundary and moose at the southeastern boundary. Just outside the municipal boundary there are key areas for grizzly bear (east of the village) and an additional area for moose (southwest of the village). An additional search using the Yukon Energy, Mines, and Resources lands viewer mapping application also displayed a spring staging area for geese east of the village.

The location of the biomass plant and the areas for feedstock harvesting have not been identified at this time. Once selected, targeted field surveys will be conducted at the sites and will be included in this report.

5.3.3 Potential Project VC Interactions

Table 5.4.2 below lists each Project activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Terrestrial Environment.

Table 5.3.4 Potential Project Environmental Effects to the Terrestrial Environment

Project Activities and Physical Works	Potential Environmental Effects	
	Change in Terrestrial Populations	Change in Wetlands
Construction		
Site Preparation	2	0
Physical Construction of the Facility Structures And Installation of Equipment	2	0
Commissioning of the plant	1	0
Construction of Infrastructure for Feedstock Harvesting	2	1
Operation		
Operation and Maintenance of Plant site	1	0
Feedstock Harvesting	2	1
Decommissioning, reclamation, and closure		
Plant Site	1	0
Harvested Areas	1	1

Notes:
Project-Related Environmental Effects were ranked as follows:
0 No interaction. The environmental effects are rated not significant and are not considered further in this report.
1 Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices and/or permit conditions. The environmental effects are rated not significant and are not considered further in this report.
2 Interaction may, even with codified mitigation and/or permit conditions, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EA.

Construction

<u>VCs With No Interaction With the Project (Ranking of 0)</u>

During Construction, site preparation, construction of the facility structures and installation of equipment, and commissioning of the plant have been ranked as 0 for potential change in wetlands. There are no wetlands in the vicinity of the proposed biomass plant site (based on FEED site selection), and as such, no potential for the Project to directly impact wetland habitat. Therefore, a change in wetlands resulting from these Project activities is rated not significant.

<u>VCs With Interactions That Would Not Result in Significant Environmental Effects (Ranking of 1)</u>

During Construction, commissioning of the plant has been ranked as 1 for potential change in terrestrial populations. Once site preparation and construction of the building are complete, there are no further disturbances expected on the site. If present, the locations any sensitive habitats, SAR, or SOCC within the PDA will have been identified during field surveys and as such, all commissioning activities will be conducted away from these areas.

Construction of infrastructure for feedstock harvesting has been ranked as 1 for potential changes in wetlands. At this time, information surrounding the harvesting of feedstock is not known. Table 5.4.2 will be revised once the forest harvesting activities associated with the Project have been defined and field surveys have been conducted.

Operation

VCs With No Interaction With the Project (Ranking of 0)

During Operation, operation and maintenance of the plant site has been ranked as 0 for potential change in wetlands. There are no wetlands present at the proposed plant site and therefore, there is no potential for operation and maintenance activities at the site to directly impact wetland habitat. As a result, a change in wetlands resulting from these Project activities is rated not significant.

VCs With Interactions That Would Not Result in Significant Environmental Effects (Ranking of 1)

During Operation, operation and maintenance of the plant site has been ranked 1 for potential change in terrestrial populations. In the event sensitive habitats, SAR, or SOCC are discovered on the site during field surveys, it would be ensured that operation and maintenance activities would be conducted away from these areas. Indirect environmental effects could also be associated with Accidents, Malfunctions, and Unplanned Events; however, contingency plans will be put in place during Operation to address such events.

Feedstock harvesting has been ranked as 1 for potential change in wetlands. At this time the source of feedstock is unknown. If feedstock is to be collected in the vicinity of wetland habitat, there could be potential for erosion and sedimentation, as well as changes in hydrology in wetlands due to the removal of the trees. Implementation of established and effective erosion and sedimentation controls will be used during all harvesting activities, limiting the magnitude of any potential interactions. Any hydrological changes in wetlands will be compensated for, and thus are rated not significant. The assessment of feedstock harvesting in relation to wetlands will be revised once the forest harvesting activities associated with the Project have been defined and field surveys have been conducted.

Decommissioning, Reclamation, and Closure

VCs With No Interaction With the Project (Ranking of 0)

During decommissioning, reclamation, and closure of the Project activities at the plant site have been ranked as 0 for potential change in wetlands. There are no wetlands present at the proposed plant site and therefore, there is no potential for decommissioning activities at the site to directly impact wetland habitat. As a result, a change in wetlands resulting from these activities is rated not significant.

VCs With Interactions That Would Not Result in Significant Environmental Effects (Ranking of 1)

Decommissioning, reclamation, and closure activities at the plant have been ranked as 1 for potential change in terrestrial populations. Decommissioning activities would be governed by regulations current at the time of the activities and reclamation plan would be developed at that time. The site would likely be redeveloped for other purposes or left to re-vegetate naturally.

The decommissioning, reclamation, and closure of harvested areas has been ranked as 1 for both potential environmental effects. While the activities and location of feedstock harvesting have yet to be determined, it is likely that these activities would include the removal of access roads. If access roads were being removed in areas in the vicinity of wetlands erosion and sedimentation controls would be in place prior to work being conducted. Reclamation efforts would likely involve re-forestation efforts in the previously harvested areas.

Thus, in consideration of the nature of the interactions and the planned implementation of mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 5.4.2, including cumulative environmental effects, on the Terrestrial Environment during any phase of the Project are rated not significant, and are not considered further in the assessment.

5.3.3.1 Assessment of Project-Related Environmental Effects

A summary of the environmental effects assessment and prediction of residual environmental effects resulting from interactions ranked as 2 on the Terrestrial Environment is provided in Table 5.4.3.

Table 5.3.5 Summary of Residual Project-Related Environmental Effects on the Vegetation and Wetland Resources

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					
Change in Terrestrial Populations	Construction: • Site preparation; • Physical construction of the facility structures and installation of equipment; and • Construction of infrastructure for feedstock harvesting	• Avoid known locations of plant and wildlife SAR and SOCC, where feasible. • Include any SAR or SOCC found within or adjacent to the PDA in post-construction monitoring and follow-up plans. • Conduct clearing activities at the plant location in fall and/or winter, outside the breeding season of migratory birds and calving season. • If active nests are discovered during tree clearing at the plant site, a vegetated buffer zone around the nest will be established and activities will be minimized in the immediate area until nesting is complete and chicks have fledged and left the area. • Flag any vascular plant SAR or SOCC found within 30 m of the PDA, and minimize Construction adjacent to the plants whenever feasible. • Keep litter and garbage contained to limit wildlife encounters. • Use designated roadways and access roads.	A	L	S	ST/O	R	U/D	N	M	L	N	Follow-up to include field study of the selected plant site and potentially feedstock harvesting infrastructure areas (if not previously evaluated).

Table 5.3.5 Summary of Residual Project-Related Environmental Effects on the Vegetation and Wetland Resources

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					
		• Flag off environmentally sensitive areas prior to site clearing and construction. • Limit Project-related activity outside of the PDA. • Clean construction machinery prior to entering and leaving areas known to contain invasive species to reduce their spread. • Native species will be used, where possible, for re-vegetation efforts. Where not possible, species used will be non-invasive.											
	Operation: • Feedstock harvesting	• Clean construction machinery prior to entering and leaving areas known to contain invasive species to reduce their spread. • Conduct tree clearing activities at the plant location in fall and/or winter, outside the breeding season of migratory birds and calving season. • Avoid known locations of plant SAR and SOCC, where feasible. • Use designated roadways and access roads. • Limit Project-related activity outside of the PDA. • Keep litter and garbage	x	x	x	x/x	x	x	x	x	x	x	Follow-up to include field surveys once location of feedstock harvesting is determined.

Table 5.3.5 Summary of Residual Project-Related Environmental Effects on the Vegetation and Wetland Resources

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics: Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context	Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
		contained to limit wildlife encounters. • Field engineering, design, and construction of new roads will follow the Timber Harvest Planning and Operating Guidebook.											

KEY

Direction:
P Positive.
A Adverse.

Magnitude:
L Low: Change of plant populations that do not affect the sustainability or biodiversity of populations within the RAA; no change in wetland function.
M Moderate: Change in populations that affect the sustainability of populations or biodiversity within the RAA; change in wetland function after the application of mitigation and compensation.
H High: Change in populations that affect the sustainability of populations or biodiversity within the region; non-compensated loss of wetland function.

Geographic Extent:
S Site-specific: Within the PDA.
L Local: Within the region.

Duration:
ST Short term: Occurs and lasts for short periods (*e.g.,* days/weeks/months).
MT Medium term: Occurs and lasts for extended periods of time (*e.g.*, years).
LT Long term: Occurs during Construction and/or Operation and lasts for the life of Project.
P Permanent: Occurs during Construction and Operation and beyond.

Frequency:
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility:
R Reversible.
I Irreversible.

Ecological/Socio-economic Context:
U Undisturbed: Area relatively or not adversely affected by human activity.
D Developed: Area has been substantially previously disturbed by human development or human development is still present.
N/A Not Applicable.

Significance:
S Significant.
N Not Significant.

Prediction Confidence:
Based on scientific information, statistical analysis, professional judgment, and/or effectiveness of mitigation.
L Low level of confidence.
M Moderate level of confidence.
H High level of confidence.

Likelihood:
Based on professional judgment:
L Low probability of occurrence.
M Medium probability of occurrence.
H High probability of occurrence.

5.3.3.2 Potential Project Environmental Effect Mechanisms

The following Project activities and physical works associated with Construction and Operation that were ranked as 2 will interact with the Terrestrial Environment and have potential to result in significant adverse residual environmental effects, and will thus be considered in more detail in this EA:

- site preparation (change in terrestrial populations only);
- physical construction of the facility structures and installation of equipment (change in terrestrial populations only);
- construction of infrastructure for feedstock harvesting (change in terrestrial populations only); and
- feedstock harvesting (change in terrestrial populations only).

The interactions between these Project activities and the Terrestrial Environment are discussed in the context of the measurable parameters for the potential environmental effects.

The activities associated with Construction (*i.e.*, site preparation and installation of structures) have potential to result in a change in terrestrial populations through habitat loss and degradation, loss of individuals of plant and wildlife SAR and SOCC, and mortality to migratory birds. Field studies will be conducted once the plant site is selected to determine the potential for changes in terrestrial populations.

Construction activities within the PDA will result in the permanent loss of habitat for some plant and wildlife species, and the creation of edge habitat along the PDA, through vegetation removal and grubbing of the site. Clearing of the PDA will result in the direct habitat loss of forest. At this time the amount of clearing required for the plant site has not been determined. Only three species of trees grown in the village of Haines Junction, including, white spruce, trembling aspen, and balsam poplar. These species are typically found in previously disturbed sites such as roadsides and forest edges, and are commonly found in the Yukon.

Further discussion will be included regarding the feedstock harvesting site once details are available. When available the following details will be included, where applicable:

- habitat types within the LAA;
- discussion of old growth forest;
- loss and degradation of habitat;
- habitat fragmentation;
- discussion of plant SAR and/or SOCC;
- migration routes;

- trapping activities in the vicinity of the PDA;
- identification of forest resource management zones (*i.e.*, high wildlife value areas and fuel abatement areas) in the vicinity of the PDA;
- identification of traditional use plants;
- loss of wetland area and the resultant loss of wetland function (including hydrological function).

5.3.3.3 Mitigation Measures

The mitigation measures that will be implemented during the Project are listed in Table 5.4.3. The key mitigation measures to reduce environmental effects of the Project on the Terrestrial Environment are listed below. These mitigation measures will be implemented wherever technically and economically feasible to minimize potential environmental effects of the Project on the Terrestrial Environment:

- avoid known locations of plant and wildlife SAR and SOCC, and established nest sites of migratory birds;
- limit Project-related activity outside of the PDA;
- clean construction machinery prior to entering and leaving the worksite to reduce the spread of potential invasive species from one area to another;
- flag off environmentally sensitive areas prior to Construction;
- conduct clearing activities in fall and/or winter, outside the breeding season of migratory birds (May 1 to August 31). If any clearing during migratory bird breeding season is required, surveys will be conducted to determine if migratory bird nesting activity is taking place. If nesting activity is taking place that clearing will be delayed until bird young of the year have fledged and left the nest;
- conduct clearing activities in fall and/or winter, outside of calving season;
- establish buffers and protect active migratory bird nests until fledging, upon their discovery in work areas;
- keep litter and garbage contained to reduce wildlife encounters;
- use designated roadways and access roads;
- follow conditions of any Project environmental permits; and
- field engineering, design, and construction of new roads will follow the Timber Harvest Planning and Operating Guidebook.

Due to the unknown location of feedstock harvesting, additional mitigation may be required, including but not limited to:

- Employ standard erosion and sediment control measures, including:
    - erosion control fencing;
    - check dams;
    - sedimentation control ponds where appropriate;
    - construction sequencing to minimize soil exposure;
    - retaining existing vegetation as long as possible;
    - re-vegetating and mulching of denuded areas;
    - diverting run-off away from denuded areas;
    - optimizing length and steepness of slope;
    - keeping surface water run-off velocities low;
    - proper sizing and protecting of drainage ways and outlets;
    - intercepting of sediments on site; and
    - inspecting and maintaining the above-mentioned control measures.
- Minimize channeling near wetlands.
- Clean construction machinery prior to entering and leaving wetlands to reduce the spread of potential invasive species from one wetland to another.

The mitigation sequence of avoidance, minimization, and compensation, as applied to the Project, are presented here in the form of mitigation to avoid wetlands where possible, minimize the loss and potential environmental effects, and ultimately compensate for any residual losses.

5.3.3.4 Characterization of Residual Effects

If not carefully carried out or suitably mitigated, the Project could affect the Terrestrial Environment due to a change in terrestrial populations. The loss of individuals of SAR or SOCC would constitute a residual environmental effect. At the plant site there are no anticipated occurrences of SAR or SOCC, however, if they were present it is anticipated that the individuals of each species outside of the PDA will ensure that the local populations persist. Effective Project planning, design, avoidance, and the application of known and proven mitigation measures will reduce the environmental effects of the Project on changes to Terrestrial Populations so that they are not significant. The application of the same standard mitigation to avoid or reduce potential environmental effects on migratory birds will be implemented. This includes clearing outside the breeding season when nests and/or nestlings are not present.

Residual effects related to feedstock harvesting will be evaluated once the harvesting area has been selected. If the selected areas are in the vicinity of a wetland, effective Project planning, design, avoidance, and the application of known and proven mitigation measures will reduce the environmental effects of the Project on changes to wetlands so that they are not significant. Where avoidance is not possible, mitigation measures that will be established for work with regard to wetlands will include implementation of well-established and proven erosion and sedimentation control measures. With mitigation, potentially including compensation, the Project will result in no net loss of wetland function and area.

With the proposed mitigation (*e.g.*, no loss of protected or rare species, mitigation for protection of migratory birds) the residual environmental effects of a change in terrestrial populations during all phases of the Project are rated not significant. This conclusion has been determined with a moderate level of confidence in consideration of the planned implementation of proposed proven mitigation measures described above and current lack of site specific data.

5.3.4 Assessment of Cumulative Effects

In addition to the Project environmental effects discussed above, an assessment of the potential cumulative environmental effects was conducted for other projects and activities that have potential to cause environmental effects that overlap with those of the Project, as identified in Table 1.2.3. Table 5.4.4 below presents the potential cumulative environmental effects to the Terrestrial Environment, and ranks each interaction with other projects as 0, 1, or 2 with respect to the nature and degree to which important Project-related environmental effects overlap with those of other projects and activities.

Table 5.3.6 Potential Cumulative Environmental Effects to the Terrestrial Environment

Other Projects and Activities With Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects	
	Change in Terrestrial Populations	Change in Wetlands
Upgrades to Municipal Water Treatment System	0	0
Land Use	1	1

Notes:
Cumulative environmental effects were ranked as follows:
0 = Project environmental effects do not act cumulatively with those of other Projects and Activities.
1 = Project environmental effects act cumulatively with those of other Project and Activities, but are unlikely to result in significant cumulative environmental effects OR Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects but will not measurably change the state of the VEC.
2 = Project environmental effects act cumulatively with those of other project and activities, and may result in significant cumulative environmental effects OR Project environmental effects act cumulatively with existing significant levels of cumulative environmental effects and may measurably change the state of the VEC.

Interactions between the Project and upgrades to the municipal water treatment system in Haines Junction have ranked as a 0 in Table 5.23. The upgrades are currently complete and increased the villages capacity for municipal water use, including that for industry. Any additional future upgrades to the water treatment system would only serve to further improve water quality and quantity in Haines Junction and would not result in adverse cumulative environmental effects.

Potential Project-related effects on terrestrial populations and wetlands could overlap with current land use within the RAA and therefore result in a cumulative change in terrestrial populations and change in wetlands. Historical and current use of land for recreational purposes includes recreational hunting, fishing, trail development, and use of land for hiking, all-terrain vehicles, or snowmobiling as well as industrial and forest resource harvesting activities. Past and present terrestrial population effects and change in wetlands associated with land use in the RAA have potential to interact cumulatively with the Project to adversely affect terrestrial populations and wetlands.

Existing recreational land use in the RAA has potential to encroach on lands and waters that support terrestrial populations, and result in changes in wetland area and function. These potential effects could be amplified due to overlap with similar effects associated with Project-related activities and infrastructure. Trails intended for recreational land use support ATV and other traffic that can also disturb wetlands, and other wildlife habitat important to terrestrial populations and can overlap cumulatively with other projects affecting these habitats.

Resource land use in the RAA, including forestry and mining activities, has potential to interact cumulatively with the Project to affect terrestrial populations and wetlands through removal, destruction, or disturbance of SOCC individuals and habitats, including wetlands. Potential forestry-related cumulative effects on SOCC will be mitigated by the compliance with territorial forestry guidelines, where applicable and by the natural regeneration of forestry resources.

The contribution of the Project to cumulative environmental effects is not expected to be substantive in the LAA, and likely not in the RAA.

Cumulative effects will be re-evaluated once the location of feedstock harvesting is determined and final plant siting has been completed.

5.3.5 Determination of Significance

5.3.5.1 Residual Cumulative Environmental Effects

The potential environmental effects of the Project on a Change in Terrestrial Populations and Change in Wetlands are not significant, but will overlap with the environmental effects of other projects and activities that have been or will be carried out. The principal activities of concern are forest resource harvesting, mining, and recreational land use resulting in the loss of terrestrial habitat, including wetlands. The residual cumulative environmental effects of a Change in Terrestrial Populations and Change in Wetlands, as a result of past, present, and reasonably foreseeable projects or activities that have been or will be carried out, in combination with the environmental effects of the Project, during all phases are rated not significant. This determination has been made with a moderate level of confidence as the specific areas are currently undefined.

5.3.6 Summary Consultation Influence on the Assessment

At the time of writing, consultations in the community are on-going. A summary of the consultations as they apply to Terrestrial Environment will be provided following the completion of the consultations for the Project.

5.3.7 Effects Monitoring and Adaptive Management

Baseline terrestrial field studies of the PDA will be completed prior to Construction. Studies typically include breeding bird surveys and rare plant surveys, with incidental occurrences of other wildlife species being recorded in conjunction with these activities. Studies are developed in consultation with regulatory authorities (*e.g.*, Yukon Environment, Environment Canada, *etc*.)

In the event that the feedstock harvesting areas are located in the vicinity of a wetland, wetland monitoring is recommended for any wetlands (mapped or unmapped) within the PDA or a 15 m buffer, in order to assess potential change in function. A wetland monitoring plan will be developed prior to construction. Monitoring (as per Section 79 of the *SARA*) may be warranted if SAR are likely to be affected by the Project (to be determined by targeted field studies). No other follow-up or monitoring is required to verify the predictions of the environmental effects assessment on the Terrestrial Environment, or to verify the effectiveness of mitigation.

5.4 FRESHWATER RESOURCES

Freshwater Resources consists of watercourses (rivers and streams) that provide habitat for fish and other freshwater aquatic species. The Freshwater Resources VC includes fish and fish habitat and surface water quality as indicators of the overall health of the ecosystem. Fish habitat includes physical (*e.g*., substrate, temperature, flow velocity and volumes, water depth), chemical (*e.g*., dissolved oxygen, pH, nutrients), and biological (*e.g*., fish, benthic invertebrates, aquatic plants) attributes of the environment that are required by fish to carry out life cycles processes (*e.g*., spawning, rearing, feeding, overwintering, migration). Biomass plant activities are not anticipated to have significant environmental effects on the Freshwater Environment as the plant is not located in the immediate vicinity of any freshwater source. Once the locations of feedstock harvesting have been selected, further information will be included with respect to the selected areas and the VC scope of assessment would be revised as required.

5.4.1 Scope of the Assessment

This section defines the scope of the environmental assessment of Freshwater Resources in consideration of the nature of the regulatory setting, issues identified during public and First Nations engagement activities, potential Project-VEC interactions, and existing knowledge.

5.4.2 Existing Conditions

The Yukon Territory is drained by three major river systems. The Yukon drainage basin, the Alsek/Tatshenshini drainage basin, and the Peel and Liard sub-basins of MacKenzie River (Fisheries and Oceans Canada 2011). These rivers and streams have 38 recorded species of freshwater fishes. A list of these species and their status ranks can be found in Table 4.1.3. Please note that the last CESCC assessment that included an assessment for fish was in 2005 report; no current fish ranking data is available in the 2010 report.

Table 5.4.1 Freshwater Fish Species in Yukon Territory

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2005)	YCDC S-Rank
Artic Lamprey	*Lethenteron*	No schedule,	No status	Undetermined	S2S4B

Table 5.4.1 Freshwater Fish Species in Yukon Territory

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2005)	YCDC S-Rank
	camtschaticum	no status			
Lake Chub	*Couesius plumbeus*	No schedule, no status	No status	Secure	S5
Northern Pearl Dace	*Semotilus margarita*	No schedule, no status	No status	-	-
Flathead Chub	*Platygobio gracilis*	No schedule, no status	No status	Undetermined	SU
Longnose Dace	*Rhinichthys cataractae*	No schedule, no status	No status	Undetermined	SNA
Northern Redbelly Dace	*Chrosomus eos*	No schedule, no status	No status	-	-
Finescale Dace	*Phoxinus neogaeus*	No schedule, no status	No status	-	-
Goldfish	*Carassius auratus auratus*	No schedule, no status	No status	Exotic	Exotic/SNA
Longnose Sucker	*Catostomus catostomus*	No schedule, no status	No status	Secure	S5
White Sucker	*Catostomus commersonii*	No schedule, no status	No status	Secure	S2S3
Northern Pike	*Esox lucius*	No schedule, no status	No status	Secure	S5
Pond Smelt	*Hypomesus olidus*	No schedule, no status	No status	-	-
(Arctic) Rainbow Smelt	*Osmerus mordax*	No schedule, no status	No status	Undetermined	SU
Rainbow Trout/Steelhead	*Oncorhynchus mykiss*	No schedule, no status	No status	Secure	S3
Lake Trout	*Salvelinus namaycush*	No schedule, no status	No status	Secure	S3S4
Dolly Varden	*Salvelinus malma malma*	No schedule, no status	Special Concern	Secure	S3S4
Bull Trout	*Salvelinus confluentus*	No schedule, no status	Special Concern	Sensitive	S3
Arctic Char	*Salvelinus alpinus*	No schedule, no status	No status	Undetermined	S1
Chum Salmon	*Oncorhynchus keta*	No schedule, no status	No status	Secure	S4
Kokanee/Sockeye Salmon	*Oncorhynchus nerka*	No schedule, no status	Upcoming assessment in 2014	Sensitive	S3
Chinook Salmon	*Oncorhynchus tshawytscha*	No schedule, no status	No status	Secure	S2S3B
Coho Salmon	*Oncorhynchus kisutch*	No schedule, no status	No status	Secure	S3
Least Cisco	*Coregonus sardinella*	No schedule, no status	No status	Secure	S4
Bering Cisco	*Coregonus laurettae*	No schedule, no status	Special Concern	Undetermined	S3
Arctic Cisco	*Coregonus autumnalis*	No schedule, no status	No status	Undetermined	S2S3
Lake Whitefish	*Coregonus clupeaformis*	No schedule, no status	No status	Secure	S4

Table 5.4.1 Freshwater Fish Species in Yukon Territory

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2005)	YCDC S-Rank
Squanga Whitefish	*Coregonus sp.*	Schedule 3, Special Concern	Special Concern	-	S3
Broad Whitefish	*Coregonus nasus*	No schedule, no status	No status	Secure	S4
Pygmy Whitefish	*Prosopium coulterii*	No schedule, no status	No status	Sensitive	S4
Round Whitefish	*Prosopium cylindraceum*	No schedule, no status	No status	Secure	S5
Mountain Whitefish	*Prosopium williamsoni*	No schedule, no status	No status	Undetermined	SU
Inconnu	*Stenodus leucichthys*	No schedule, no status	No status	Secure	S4
Arctic Grayling	*Thymallus arcticus*	No schedule, no status	No status	Secure	S5
Trout-perch	*Percopsis omiscomaycus*	No schedule, no status	No status	Undetermined	SU
Burbot	*Lota lota*	No schedule, no status	No status	Secure	S5
Threespine Stickleback	*Gasterosteus aculeatus*	No schedule, no status	No status	Exotic	SNA
Ninespine Stickleback	*Pungitius pungitius*	No schedule, no status	No status	Undetermined	S2S3
Slimy Sculpin	*Cottus cognatus*	No schedule, no status	No status	Secure	S5
Spoonhead Sculpin	*Cottus ricei*	No schedule, no status	Not at Risk	Undetermined	SU

Notes:
S1 = Critically Imperiled—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
S2 = Imperiled—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.
S3 = Vulnerable—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
S4 = Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5 = Secure—Common, widespread, and abundant in the jurisdiction.
S#S# = Range Rank — A numeric range rank (*e.g*., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (*e.g*., SU is used rather than S1S4).
B = Breeding—Conservation status refers to the breeding population of the species in the nation or state/province.
SU = Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA = Not Applicable —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.

Wild Species: The General Status of Wild Species in Canada

At Risk: Species for which a formal, detailed risk assessment (COSEWIC status assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (*i.e*. Endangered or Threatened). A COSEWIC designation of Endangered or Threatened automatically results in a Canada General Status Rank (Canada rank) of At Risk. Where a provincial or territorial formal risk assessment finds a species to be Endangered or Threatened in that particular region, then, under the general status program, the species automatically receives a provincial or territorial general status rank of At Risk.
May Be At Risk: Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC, or provincial or territorial equivalents.
Sensitive: Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk
Secure: Species that are not believed to belong in the categories Extinct, Extirpated, At Risk, May Be At Risk, Sensitive, Accidental or Exotic. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant.
Exotic: Species that have been moved beyond their natural range as a result of human activity. In this report, Exotic species have been purposefully excluded from all other categories.

Table 5.4.1 Freshwater Fish Species in Yukon Territory

Common Name	Scientific Name	*SARA* Schedule and Status	COSEWIC Rank	CESCC Rank (2005)	YCDC S-Rank
Source Wild Species: The General Status of Wild Species in Canada' website Available at: http://www.wildspecies.ca/ranks.cfm?lang=e (CESCC 2006)					

The closest river to the anticipated Project site is an unnamed tributary of the Dezadeash River. The tributary flows west and is located approximately 800 m to the north of the village, within the municipal boundary. The main branch of Dezadeash River flows west and is located adjacent to the south of the village. Dezadeash River empties into Alsek River and is located within the boundaries of the Alsek River watershed. Fish species found within the Alsek River basin are listed in Table 4.1.5 below.

Table 5.4.2 Fish Species Found within the Alsek River Basin, Yukon Territory

Common Name	Scientific Name
Sockeye Salmon	*Oncorhynchus nerka*
Rainbow Trout	*Oncorhynchus mykiss*
Dolly Varden	*Salvelinus malma malma*
Lake Trout	*Salvelinus namaycush*
Humpback (Lake) Whitefish	*Coregonus clupeaformis*
Pygmy Whitefish	*Prosopium coulterii*
Round Whitefish	*Prosopium cylindraceum*
Arctic Grayling	*Thymallus arcticus*
Northern Pike	*Esox lucius*
Longnose Sucker	*Catostomus catostomus*
Burbot	*Lota lota*
Slimy Sculpin	*Cottus cognatus*
Source: Fisheries and Oceans Canada 2011	

The location of feedstock harvesting has not yet been determined. Once the location is selected information on freshwater resources in these areas will be included in this report.

5.4.3 Regulatory/Policy Setting

For the purposes of this report, the current interpretation of the federal *Fisheries Act* has been applied. Changes to the Act will come into effect in 2013. Planned mitigation with respect to Freshwater Resources will not be affected by any changes to the Act. The federal *Fisheries Act* defines "fish" to mean all fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans, or marine animals, and the eggs, sperm, spawn, larvae, spat, and juvenile stages of fish, shellfish, crustaceans, and marine animals. The federal *Fisheries Act* defines "fish habitat" as spawning grounds and any other areas including, nursery, rearing, food supply, and migration areas on which fish directly or indirectly depend on. Fish habitat includes physical (*e.g.*, substrate, temperature, flow velocity and volumes, water depth), chemical (*e.g.*, dissolved oxygen, pH, nutrients), and biological (*e.g.*, fish, benthic invertebrates, plankton, aquatic plants) attributes of the environment that are required by fish to carry out life cycles processes (*e.g.*, spawning, rearing, feeding, overwintering, migration).

Fish and fish habitat are protected through federal and provincial legislation. Currently, fish habitat is protected under the *Fisheries Act*, as per the DFO's Policy for the Management of Fish Habitat (DFO 1986). This policy applies to all projects and activities in or near water. The guiding principle of this policy is to achieve no-net-loss of the productive capacity of fish habitats. Fish and fish habitat are regulated by Sections 20, 21, 22, 30, 32, 35, 36, 37, 40, and 43 of the *Fisheries Act* which is administered by DFO, as follows.

- Sections 20, 21, and 22 relate to the obstruction of fish passage, and state that where fish passage is obstructed, a fish pass or passage must be provided, and sufficient water must flow to allow for fish migration and movement past the obstruction.
- Section 30 requires that if deemed necessary by the Minister of Fisheries, screens will be placed on artificially created ditches to prevent fish from entering.
- Section 32 prohibits the killing of fish from means other than fishing.
- Section 35 prohibits the harmful alteration, disruption or destruction (HADD) of fish habitat by any persons unless authorized by the Minister of Fisheries.
- Section 36 prohibits the release of deleterious substances into any river or harbour or in any water where fishing is carried on.
- Section 37 states that anyone undertaking work that may cause HADD must submit their works for review by the Minister. The Minister can then refuse the works, grant permission for the works providing changes are made, or grant permission for the works to take place.
- Section 40 outlines the consequences of contravening section 35 of the *Fisheries Act*.
- Section 43 outlines the regulations for carrying out the purposes and provisions of the *Fisheries Act*.

A number of Boards and Councils have been established under the Umbrella Final Agreement (UFA) and Yukon First Nation Final Agreements which have advisory and management responsibilities related to fish and fish habitat Yukon-wide, and within specific First Nation Traditional Territories. These include the Yukon Fish and Wildlife Management Board which make recommendations to the Yukon and First Nation governments on issues related to fisheries management, legislation, research, policies and programs; and the Mayo District Renewable Resource Council (MDRRC), which is responsible for making recommendations on fish and wildlife management; policies and proposed development activities in the Na-cho Nyäk Dun Traditional Territory. The Salmon Sub-Committee, also established under the UFA, is mandated with providing advice and recommendations to governments specific to the management of salmon and salmon habitat in the territory.

Surface water quality is managed through federal guidelines. The CCME maintains guidelines for the protection of aquatic life for many water quality parameters. These guidelines are generally accepted as best practice in environmental assessment to mitigate Project activities such that the CCME guidelines are not exceeded, where it is considered technically and economically feasible to do so.

Aquatic SAR are protected federally under *SARA*. While there are no current publicly available provincial ranks for fish species of special concern, fish are included in the 2005 CESCC ranking list and they have a YCDC rank within the province.

5.4.4 Key Issues and Identification of Effects

Freshwater Resources has been selected as a VC due to its importance in supporting aquatic life. Freshwater Resources are valued as biological and natural resources by the public and by federal and territorial regulatory authorities.

There have been no interactions identified between Freshwater Resources and the proposed plant site (FEED site location) or throughout the majority of Haines Junction (with the exception of the southern part of the village). At this time the location of feedstock harvesting is unknown and could potentially be in the vicinity of a river, lake, pond, or stream.

Potential effects to Freshwater Resources resulting from harvesting activities could include effects to freshwater resulting in changes to fish populations, disruption, destruction or alteration to fish habitat, and/or impacts to water quality.

5.4.5 Mitigation Measures

The application of known and proven mitigation measures will be implemented as part of the Project to avoid or minimize the environmental effects on Freshwater Resources, in the event any part of the Project will be conducted in the vicinity of a freshwater source. The following mitigation measures will be employed along with other mitigation, as appropriate.

- implementation of well-established and proven erosion and sedimentation control measures, including silt fences, mulching, and hydroseeding;
- all barren soil will be stabilized for over-wintering;
- proper storage and use of hazardous materials;
- The Proponent will consult with DFO to ensure that Project activities (if determined to interact with freshwater resources) will be conducted, where possible, outside of biologically sensitive life stages of resident fish species. If activities are required in waters during these periods, DFO may require additional mitigation;
- visual monitoring in the vicinity of the Project to ensure that turbidity in waterways is limited;
- removal of any construction debris or other material that enters the freshwater environment; and
- compensation for HADD in accordance with the DFO Policy for the Management of Fish Habitat, if required.

5.4.6 Summary Consultation Influence on the Assessment

This section will be completed following planned consultations.

5.4.7 Effects Monitoring and Adaptive Management

Depending on the harvesting areas, baseline field surveys may be required, and would include fish and fish habitat studies.

Continued monitoring of sediment controls is suggested during all Project activities that have potential to affect freshwater resources. Water quality monitoring may be conducted if determined necessary during Project planning. The Canadian Water Quality Guidelines for Protection of Aquatic Life (for TSS) should be consulted for guidance in this event. If required, monitoring of the HADD compensation project will be conducted after the Project is implemented.

5.5 HERITAGE RESOURCES

The proposed biomass gasification power plant (the Project) by the Champagne and Aishihik First Nations (CAFN) and the Yukon Energy Corporation (YEC) will be located within the village of Haines Junction, Yukon, on Settlement Lands belonging to the CAFN. The Project is comprised of two parts:

- the biomass energy plant (the Plant); and
- biomass feedstock timber harvesting (Feedstock).

The Plant will operate as a power and heat source for buildings within Haines Junction and the Feedstock will be the fuel source for the Plant. At the time of the writing of this document, the areas to be harvested for Feedstock are unknown; however, future development of Feedstock is anticipated to take place on Settlement and non-Settlement Lands within the Champagne and Aishihik Traditional Territory (CATT).

5.5.1 Scope of the Assessment

This section defines the scope of the environmental assessment for Heritage Resources valued component in consideration of the nature of the regulatory setting, issues identified during public and First Nations engagement activities, potential Project-VC interactions, and existing knowledge.

At the time of the writing of this document, public and First Nations engagement activities have not all taken place. An introductory open house was held in Haines Junction and input from that engagement is included in Section 2.0 (Consultation). This assessment will be updated prior to submission to YESAA to incorporate engagement issues as warranted.

5.5.1.1 Key Issues and Identification of Potential Effects

Potential interactions between the Project and Heritage Resources are presented below and those aspects of the Project that may cause environmental effects, either positive or adverse, are identified. The Project may interact with Heritage Resources in the following ways:

- the Construction and Operation phases of the Plant will result in ground disturbing operations, potentially impacting unidentified subsurface heritage resources; and

- the Construction and Operation phases of the Feedstock will result in site-alteration (removal of vegetation from forested areas), potentially affecting built or subsurface heritage resources.

The potential environmental effects to be assessed are associated with Project-related ground disturbing or site-altering activities that may have an effect on Heritage Resources.

5.5.1.2 Regulatory/Policy Setting

Heritage Resources in the Yukon Territory are protected and managed under multiple sets of legislation; the *Historic Resources Act*, the *Umbrella Final Agreement,* the Champagne and *Aishihik First Nations Final* Agreement, and the Yukon *Environmental and Socio-Economic Assessment Act* (*YESAA*).

5.5.1.2.1 Definition of Heritage Resources

Heritage Resources, as defined in the *Historic Resources Act* include *"…(a) a historic site, (b) a historic object, and (c) any work or assembly of works of nature or of human endeavour that is of value for its archaeological, palaeontological, pre-historic, historic, scientific, or aesthetic features*…" (Government of Yukon 2002b:5).

Heritage Resources, as defined in the *Umbrella Final Agreement* (Government of Canada 1993a:4–5), include:

- **Moveable Heritage Resources:** Moveable non-documentary works or assemblies of works of people or of nature that are of scientific or cultural value for their archaeological, palaeontological, ethnological, prehistoric, historic or aesthetic features, including moveable structures and objects;

- **Heritage Sites:** An area of land which contains Moveable Heritage Resources, or which is of value for aesthetic or cultural reasons;

- **Documentary Heritage Resources**: Public Records or Non- Public Records, regardless of physical form or characteristics, that are of heritage significance, including correspondence, memoranda, books, plans, maps, drawings, diagrams, pictorial or graphic works, photographs, films, microforms, sound recordings, videotapes, machine-readable records, and any copy thereof.

The definition of a Heritage Resource under *YESAA* mirrors the definition outlined in the *Umbrella Final Agreement*, but also includes "…*an area of land that contains a work or assembly of works…or an area that is of aesthetic or cultural value, including a human burial site outside a recognized cemetery…*" (YESAB 2011).

Any object, whether archaeological, historic, ethnographic or palaeontological in nature, abandoned, and more than 45 years old can be deemed a historic object by the Government of Yukon's Minister of Tourism and Culture (the Minister). The Minister may, with appropriate criteria, designate a site as a historic site, whether or not historic objects are associated with it. The only exception is when the site in question is located on Yukon First Nation settlement land. In this case, the Minister may designate a site with consent from the Yukon First Nation which governs the settlement land, in this case, CAFN (Government of Yukon 2002b).

Historic sites are generally classified as being associated with the historic period, and are typically associated with built heritage structures (Gotthardt and Thomas 2007). It should be noted that while the historic period is, by convention, associated with appearance of documentary written records, within CATT the historic period commences in the early-mid 19th century, and coincides with the arrival of the Hudson's Bay Company in the Yukon Territory (Thomas 2006:13). Archaeological sites are generally associated with human evidence pre-dating European contact, or, the prehistoric period and are usually associated with sub-surface deposits or remains (Gotthardt and Thomas 2007).

5.5.1.2.2 Legislation

The *Historic Resources Act* (Government of Yukon 2002b), is administered by representatives in the Historic Sites Unit and Heritage Resources Unit (HRU) (Archaeology, Palaeontology, and Geographic Place Names Programs), Cultural Services Branch, in the Yukon Department of Tourism and Culture.

- The Historic Sites Unit "provides for the research, preservation, management, development and interpretation of Yukon's historic sites and routes" (Government of Yukon 2012b). This includes the administration of the *Historic Resources Act* and meeting the Government of Yukon heritage obligations under the *Umbrella Final Agreement* and individual First Nation final agreements.

- The Heritage Resources Unit "is responsible for the management, conservation, research and interpretation of land-based heritage resources" (Government of Yukon 2012c). This includes licencing for scientific research under the *Scientists and Explorers Act* (Government of Yukon 2002c) and permitting for archaeological research under a Yukon Archaeological Sites Regulation Permit.

The *Umbrella Final Agreement* (Government of Canada 1993a) signed between the Government of the Yukon, The Government of Canada, and The Council for Yukon Indians, allows for self-governance and management of all aspects of heritage pertaining to individual Yukon First Nations traditional territories and Settlement Lands, in this case the CAFN. CAFN has developed a framework for Heritage Resources, outlined in *Chapter 13 – Heritage of the Champagne and Aishihik First Nations Final Agreement* (Government of Canada 1993b).

YESAA guidelines state that socio-economic effects include that any effects on Heritage Resources must be taken into consideration by all parties involved in a proposed development.

5.5.1.2.3 Heritage Resources Assessments

The implementation of a Heritage Resource Assessment (HRA) in the Yukon Territory is dependent on two factors:

- the level of impact a development may have; and,

- the type of lands on which the proposed development is taking place (*i.e.,* Settlement vs. non-Settlement lands).

As a result of the need for disposition of lands for the Project, an HRA, mandated under *Operational Policy 2011-01 – Heritage Resources Information Requirements for Land Application Proposals Policy* (YESAB 2011) of *YESAA* is required. HRAs are comprised of two stages. The first stage, the "overview assessment", includes a description of known heritage resources in the Project area, an evaluation of potential to encounter unknown heritage resources, the effects the Project may have on existing or unidentified/potential heritage resources, and, if necessary, appropriate mitigation measures. The overview assessment takes place at a desktop level, and provides baseline information. Following the "overview assessment", if it is determined that further investigation of potential effects of the Project on existing or unidentified/potential Heritage Resources is warranted, then the second stage, a "site assessment" must take place within the Project Development Area (PDA).

Known heritage resources may be identified prior to design and construction of a project. Archaeologists use these known resources, along with generalisations about the movement of past humans across the landscape and environmental factors (*e.g.,* distance to water, slope of terrain) to suggest the potential for encountering previously unrecorded heritage resources. This is not an exact process, and the factors that archaeologists consider when determining the "heritage resource potential" of an area can vary significantly depending on the region or sub-region. Furthermore, the criteria employed by archaeologists for assessing heritage resource potential often do not include consideration for intangible heritage resources. The cultural, ethnographic, or spiritual connection and the special relationship between First Nations and their environments is not an easily quantified value. Documentary and ethnographic accounts, oral histories, community consultation, and traditional use studies are all essential elements for understanding this relationship.

As this Project will have the potential to interact with Heritage Resources due to ground disturbing activities, both for the Plant and Feedstock elements, an HRA is required.

On non-Settlement lands, or lands administered by the Government of Yukon, an HRA follows policies and guidelines established by the Cultural Services Branch. The *Position Statement – Historic Resources Impact Assessment and Mitigation Requirements Related to Land Altering Developments* (the Position Statement) (Government of Yukon 2003) and processes outlined in the *British Columbia Archaeological Impact Assessment Guidelines* (the Guidelines) (Government of British Columbia 1998) provide guidance and methodology for conducting an HRA.

Particularly relevant for the Feedstock component of the Project is the implementation plan for forestry-related HRAs conducted within CATT (Section 3.8 of the *Integrated Landscape Plan for the Champagne and Aishihik Traditional Territory* (the ILP)) (EMR 2006). The ILP was developed by CAFN and the Yukon Department of Energy, Mines and Resources as a means to address concerns about management of Heritage Resources with the development of a forestry industry in the Yukon. Furthermore, Energy, Mines and Resources has developed *Forest Resources Regulation – Historic and Archaeological Resources Standards and Guidelines* (EMR 2011) to assist with the protection and management of Heritage Resources.

As outlined in *Chapter 13 – Heritage* of the *Champagne and Aishihik First Nations Final Agreement*, CAFN will develop independent heritage management policies for Settlement Lands. *CAFN Heritage Resources specialists are currently developing an assessment process to ensure the protection of Heritage Resources. In consultation with Stantec, CAFN have indicated they envisage this process as operating independent of, but parallel to, territorial impact assessments.*

5.5.1.3 Selection of Measureable Parameters

The environmental assessment of Heritage Resources is focused on the following environmental effect:

- Change in Heritage Resources within the PDA.

The environmental effect has been selected as a result of the need for disposition of lands for the Project and the requirement to conduct an HRA. The requirement to protect any known or unknown/undocumented heritage resources is also outlined under the *Historic Resources Act* and Chapter 13 of the *Champagne and Aishihik First Nations Final Agreement*. The manner in which these effects are mitigated is described in the Guidelines and appropriate mitigation to be developed in consultation with CAFN.

The measurable parameters used for the assessment of potential environmental effects presented above and the rationale for their selection is provided in Table 5.7.1.

Table 5.5.1 Measurable Parameters for Heritage Resources, Traditional Activities and Culture

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Heritage Resources	Presence/absence of a heritage resource	• The Position Statement (Government of Yukon 2003) and the Guidelines (Government of British Columbia 1998) establish the process for determining presence/absence of heritage resources (*e.g.,* overview assessment (documentary research, direct consultation and preliminary field reconnaissance), and archaeological impact assessment (survey, evaluative testing, assessment, impact management)) on non-Settlement Lands. Presence confirms an environmental effect; absence indicates that any discovery (unplanned) of a Heritage Resource would be an Accident. • *CAFN Heritage Resources specialists are currently developing an assessment process to ensure the protection of Heritage Resources. In consultation with Stantec, CAFN have indicated they envisage this process as operating independent of, but parallel to, territorial impact assessments.* • The *Historic Resources Act* and *Chapter 13 – Champagne and Aishihik First Nations Final Agreement* protect all Heritage Resources, including built heritage, prehistoric and historic sites and objects, archaeological, palaeontological, ethnological, or aesthetic features, moveable structures and objects, documentary resources and human burial sites.

5.5.1.4 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of the Heritage Resources, Traditional Activities and Culture are defined below.

Project Development Area (PDA): The PDA is the most basic and immediate area of the Project. The PDA is limited to the area of physical ground disturbance associated with the Project, and consists of an area that includes the area of physical disturbance associated with the biomass plant and associated facilities as well as the area associated with biomass feedstock harvesting (including forest roads). The PDA is the area represented by the physical Project footprint as defined in Chapter 3.1.2 above.

Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA, Haines Junction, and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. Since the potential environmental effects on Heritage Resources are limited to the area where ground disturbing or site-altering activities will take place, for this VC, the LAA is essentially the same as the PDA. At this time, there are no anticipated environmental effects that will occur outside of the PDA for Heritage Resources.

Regional Assessment Area (RAA): The RAA is limited to and includes the Yukon Territory. The RAA is the area within which the Project's environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The extent to which cumulative environmental effects for Heritage Resources may occur depend on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable future projects or activities that have been or will be carried out, as defined within the RAA. For Heritage Resources, the RAA may be considered lands within the Champagne and Aishihik Traditional Territory (CATT), and the southwest region of the Yukon Territory.

5.5.1.5 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on Heritage Resources include the phases of Construction, Operation, and Decommissioning.

5.5.1.6 Residual Effects Significance Criteria

A *significant adverse residual environmental effect* on Heritage Resources is defined as one that results in a permanent Project-related disturbance to, or destruction of, all or part of a Heritage Resource (including Historic sites and objects, and all moveable and documentary Heritage Resources) considered by CAFN and the Government of Yukon to be of major importance due to factors such as rarity, undisturbed condition, spiritual or cultural importance, or research importance, and that cannot be mitigated or remedied by way of compensation.

5.5.2 VC Existing Conditions

The Project PDA will be located within the limits of the village of Haines Junction, in southwest Yukon. The preliminary PDA of the proposed biomass plant is located just east of the intersection between Willow Acres Road and the Alaska Highway (to be confirmed prior to detailed design). As the site location has not been finalized, the greater area of the village of Haines Junction was included in the evaluation of existing information.

At the time of the writing of this report, specific Feedstock areas are undefined. It is anticipated that feedstock timber harvesting will take place within the CATT, which encompasses an estimated 1,959,000 HA of southwest Yukon, according to the ILP (EMR 2006) (Figure 5.5.1). However, planning and development for the forest industry will occur only in the Forest Resource Management Zone (93,700 HA in the ILP) (EMR 2006). The areas that would potentially be harvested for Feedstock are likely to be predominantly located within 50-70 km of Haines Junction over the life of the Project, delimited by the boundaries of the Forest Resource Management Zone (Damecour, pers. comm. 2012).

Typically, there are two methods for determining the existing conditions of Heritage Resources within the PDA. These include:

- **evaluation of existing information,** gathering data of known heritage resources provided by documented archaeological and historic sites, territorial and museum records, First Nations (*i.e*., CAFN), local historical societies, community historians; and

- **field investigation,** consists of a field assessment for those resources that might exist within the PDA but of which we currently do not have knowledge.

5.5.2.1 Evaluation of Existing Information – Heritage Resources

Representatives from CAFN and the Cultural Services Branch, Government of Yukon, provided information on known or recorded heritage resources for Haines Junction. Various documentary resources were consulted for background information and history of the PDA and the general Project area. The results are presented below.

Haines Junction is a small village located along the Alaska Highway, and named after the point where the Alaska and Haines Highways meet. The village was established in the 1940s during construction of the Alaska Highway, but has been home to the Southern Tutchone people and their ancestors for over 5,000 years. Prior to its 1940’s naming, Haines Junction was known as “Dakwakada”, or “high cache” for the type of food caches used in that area throughout the year (VOHJ 2012). The region surrounding Haines Junction is well known for its dynamic landscape; located in the foothills of the St. Elias Mountains, close to glaciers, and immediately east of the boundary of Kluane National Park and Reserve. Kluane Park, along with adjoining parks in British Columbia and Alaska are designated as a UNESCO World Heritage Site (Figure 5.5.1).

Human History and Prehistory

The known period of human occupation in the southwest Yukon extends back over 12,000 years since the receding of the Cordilleran Glaciers and has been well documented relative to other regions even within the Yukon (Clark 1991; Thomas 2006). The prehistory of this region is generally divided up chronologically into five periods based on technological changes visible in the archaeological record and known assemblages (Thomas 2006). This sequence begins with the Palaeo-Indian period (ca. 12,000–8000 BP) and the Northern Cordilleran tradition (ca. 8000–7000 BP) (Clark 1991), followed by the Little Arm Phase (ca. 7000-5000 BP), Taye Lake Phase (ca. 5000-1250 BP) and culminates in the Aishihik Phase (ca. 1250-200 BP) (Workman 1978; Thomas 2006).

Stratigraphic dating of late prehistoric sites (associated with the Aishihik Phase) in the southwest of Yukon and eastern Alaska is made easier by the presence of the White River Ash layer, or White River tephra. This pale-coloured ash layer is the result of a volcanic eruption originating at Mount Bona, Alaska just over 1200 years ago in AD 803 (Clague et al. 1995). Although its thickness and coverage depends on distance from the original eruption, the tephra can be 20 cm thick almost 300 km from the source (Clark 1991), and covers an area of approximately 540,000 km^2 (Robinson 2001). It is speculated that while this eruption certainly caused immediate disruption and displacement of the Southern Tutchone people living there at the time, they returned to the area shortly after the eruption event (Clark 1991).

Figure 5.5.1 Champagne and Aishihik First Nations Traditional Territory

The Southern Tutchone are a group of peoples linked by a common language family, Athabaskan (McClellan 1975), or Athapaskan (Clark 1991; Workman 1978). The six regional groups that constitute the Southern Tutchone occupy an area including most of the southwest Yukon Territory and into northern British Columbia and parts of Alaska (McClellan 1975; Thomas 2006). Four of these groups occupy the Alsek River drainage system, and comprise the modern-day Champagne and Aishihik First Nations (CAFN 2012b; Thomas 2006). These groups are:

- the Champagne Band, formerly centred at the village of Champagne (approximately 65 km east of Haines Junction) and originally lived near *Shäwshe*-Dalton Post;
- the Hutshi Band, previously located east of Hutshi Lake (northeast of Haines Junction) and exploited territory in the headwaters of the Nordenskiold River;
- the Aishihik Band and village were in the past situated at the head of Aishihik Lake (north-northeast of Haines Junction); they shared common territory with Champagne and exploited territory as far east as Kluane Lake; and
- the Kloo Lake Band resided near a trading post located on Kloo Lake, northwest of Haines Junction (McClellan 1975; Thomas 2006:11).

Up until the early 1900s the most recent ancestors of modern-day Champagne and Aishihik First Nations were subsistence hunter-fisher-gatherers, exploiting the land and resources surrounding them. Summers were usually spent gathering berries and fishing salmon, including Sockeye, coho and chinook on the Tatshenshini River although fish resources in the lakes and rivers within traditionally exploited territories were year-round food sources (CAFN 2013; Thomas 2006). Late summer hunting of moose, caribou, Dall's sheep, mountain goat, gophers and other small mammals was essential both for food and for trade with other groups in the region, particularly the Pacific Coast Tlingit groups (CAFN 2013; McClellan 1975; Thomas 2006). During the winter, the Southern Tutchone would use caches of dried fish and meat for subsistence (McClellan 1975; Thomas 2006). Winter was also the period of time when trapping was most prevalent, a practice that took place primarily in and around the lakes where much of the population lived (McClellan 1975; Thomas 2006).

Trapping and trade of furs was always an essential part of the CAFN economy, and after the arrival of the Europeans this practice intensified and increased in importance (Thomas 2006). The Chilkat people, a sub-group of the Pacific Coast Tlingit and neighbours of the Southern Tutchone, moved inland to southwest Yukon during the early European Contact period (Thomas 2006). This migration lead to an increase in trapping and trade with Europeans, but also allowed for greater trade, exchange and sharing of culture between the Chilkat and Southern Tutchone peoples (CAFN 2013; McClellan 1975). Trapping continues to be actively pursued in modern times by members of CAFN on both a full- and part-time basis (CAFN 2013).

Prior to the arrival of European goods and technology (*e.g.*, steel implements, outboard motors for boats), the Southern Tutchone employed resources readily available to them from the land for crafting tools. Implements made of bone, antler and stone were used for cutting down trees, preparing hides, and processing meat (McClellan 1975). Native copper was a resource available to the Southern Tutchone due to its availability in nugget form. It is speculated that prior to European contact, native copper have been sourced at the upper White River/Klutlan glacier area approximately 185 km west-northwest of Haines Junction (Workman 1978).

The first Europeans explored southwest Yukon in the late 1800s, entering over the Chilkat Pass, a boundary between the Coast and St. Elias mountain ranges southwest of Haines Junction, following the Chilkat (now Dalton) Trail (Thomas 2006; VHJ 2012). European-led expeditions to the area occurred from 1882-1896; however, it was the Klondike gold rush that brought the Canadian Government to the region. The Northwest Mounted Police established Dalton Post in 1898, and legal surveys demarcating the national and territorial boundaries along the Tatshenshini-Alsek drainage were established the same year (Thomas 2006). The discovery of gold in the creeks east of Kluane Lake in 1903 created an influx of over a thousand miners to the area, a rush that continued sporadically in the region until the late 1920s (Thomas 2006; VHJ 2012). The completion of the Haines Road/Alaska Highway in 1942 saw the establishment of Village of Haines Junction at this crossroads, Historic Mile 1016 on the Alaska Highway (Government of Yukon 2012d).

Environment

The Champagne and Aishihik Traditional Territory (CATT) encompasses six ecoregions including the Klondike Plateau, Ruby Ranges, Saint Elias Mountains, Yukon Plateau-Central, Yukon Southern Lakes and the Yukon-Stikine Highlands (EMR 2006). The only two ecoregions within the CATT that may be affected by the Project are the Ruby Ranges Ecoregion and a small portion of the Yukon Southern Lakes Ecoregion (EMR 2006; Smith et al. 2007). However, of equal importance is the Yukon Stikine Highlands Ecoregion, due to the presence of the Tatshenshini River which lies within its boundaries. The Tatshenshini River is a traditionally significant river for CAFN peoples, as described in *Chapter 13 – Schedule B* of the CAFNFA and a designated Canadian Heritage River (CHRS 2013; Government of Canada 1993b).

Major waterbodies and watercourses in the Ruby Ranges are located in the Aishihik Basin east of the St. Elias Mountains where Haines Junction and the CATT are situated. These include the Dezadeash, Aishihik, Kathleen, Donjek and Kluane Rivers. The Alsek and Kaskawulsh Rivers form the south boundary of the Ruby Ranges Ecoregion, and Nisling River the north (YEWG 2004). The largest lake entirely within the Yukon, Kluane Lake, is also located in the Ruby Ranges (YEWG 2004). Significant watercourses in the Yukon Southern Lakes include the Teslin, upper Yukon, and Takhini Rivers, and smaller rivers including Nisutlin, Wolf and M'Clintock Rivers. Major waterbodies include Teslin, Wolf, Marsh and Laberge Lakes, and the Nisultin River Delta wetland complex (YEWG 2004).

The glacial history of the valley where Haines Junction is located, created by the Shakwak Trench, is fairly complex. Margins of three Pleistocene glaciers, all originating in the St. Elias Mountains to the west, are visible in various places in the Ruby Ranges ecoregion (YEWG 2004). Approximately 90% of this ecoregion was glaciated during the pre-Reid glaciation (2.9 million years ago to ca. 400,000 years ago), 60% during the Reid glaciation (ca. 300,000 to 230,000 years ago) and 50% during the McConnell glaciation (ca. 28,000 to 15,000 years ago) (YEWG 2004). The Yukon Southern Lakes ecoregion was covered in glacial ice between ca. 26,000 and 9000 years ago (YEWG 2004).

The close proximity of existing glaciers to the Haines Junction area, and the advance and retreat of various ice-sheets has resulted in an area that has been flooded repeatedly over the last 12,000 years. Glacial- and Neoglacial Lake Alsek formed as a result of the built-up of water from glacial ice blocking the Alsek River drainage, southwest of Haines Junction (Duk-Rodkin 2004; YEWG 2004). Most recently, the Shakwak valley was submerged under Neoglacial Lake Alsek from 1725–1850, caused by the advance of the Lowell Glacier (YGS 2012). While the period between 1725–1850 is the most recent, Neoglacial Lake Alsek had formed three times in the period known as the “Little Ice Age”, a global cooling period extending for approximately 500 years between the years 1350–1850 (YGS 2012).

Champagne and Aishihik Heritage Routes

The Champagne and Aishihik Heritage Routes were identified in the *Champagne and Aishihik First Nations Final Agreement* as having a particular cultural and heritage significance to CAFN and consist of:

- The Shakat Trail that follows from Aishihik Village to Nisling River, Onion Creek, Tincup Lake, Talbot Creek, Albert Creek and back to Aishihik Village;
- The Isaac Creek Trail that follows from Aishihik Village to Tetchal Mun (Sekulmun Lake), Isaac Creek, Gladstone Creek, Kluane Lake, Talbot Arm (Kluane Lake), Talbot Creek, and then meets with the Shakat Trail;
- The Hutshi Trail that follows from Hutshi to Giltana Lake, Tetchal Mun (Sekulmun Lake), Aishihik Village, Nisling River and Carmacks;
- The Kloo Lake to Aishihik Village Trail that follows from Kloo Lake to Dry Pass, Bear Lakes, Tetchal Mun (Sekulmun Lake) and Aishihik Village; and
- The Selkirk Trail that follows from Kusawa Lake (west side) to Takhini River, Klusha Creek, Nordenskiold River, Yukon River and Fort Selkirk, with a branch west from Kusawa Lake to Klukshu.

These routes are outlined in *Chapter 13 – Schedule A* and depicted in *Appendix B – Maps* in the *Champagne and Aishihik First Nations Final Agreement*.

The PDA of the Plant will not impact any of the recorded Champagne and Aishihik Heritage Routes. At the time that this report was written, Feedstock areas were undefined. It is recommended that prior to development of Feedstock areas, Champagne and Aishihik Heritage Routes be taken into consideration as areas of avoidance and special concern to ensure the protection of these heritage resources.

Recorded Archaeological Sites in the Yukon Archaeological Sites Data Base

<u>Pre-Contact Resources</u>

Biomass Energy Plant

A review of the general Project boundaries for the preliminary Plant PDA, which included all CAFN Settlement Lands and all non-Settlement Lands located within the community of Haines Junction, was conducted by HRU, Cultural Services Branch of the Government of Yukon. This review found that no documented archaeological sites are located inside the preliminary PDA of the Plant or within the limits of the village of Haines Junction (Gotthardt, pers. comm. 2012).

Feedstock Harvesting

At the time that this report was written, feedstock areas were undefined and no formal review was conducted. Upon receiving Feedstock PDAs, the HRU and Heritage Resources specialists with CAFN will be contacted and consulted prior to any ground disturbing or site-altering activities to determine presence/absence of recorded Pre-Contact archaeological sites in the Yukon Archaeological Sites Data Base.

Historic Resources

<u>Biomass Plant</u>

Upon reviewing the Yukon Register of Historic Places and the Canadian Register of Historic Places, there were no identified Historic Places located in the preliminary Plant PDA, or within the limits of the village of Haines Junction (CRHP 2012; YRHP 2012). The Yukon Sites Inventory Program provided information on six documented Historic Sites/Structures within the LAA for the Plant (*i.e.,* Haines Junction). Exact locations were provided for all six structures (Figure 5.5.2) and after reviewing, no Historic Sites/Structures will be impacted by the Plant component of the Project.

<u>Feedstock Harvesting</u>

At the time that this report was written, Feedstock areas were undefined and no formal review was conducted. Upon receiving Feedstock PDAs, the Government of Yukon Historic Sites Registrar, the Yukon Register of Historic Places and the Canadian Register of Historic Places will be contacted and consulted prior to any ground disturbing or site-altering activities to determine presence/absence of known Historic Resources.

Palaeontological Resources

<u>Biomass Energy Plant</u>

Representatives from HRU, Palaeontology Program, were contacted regarding the potential to encounter palaeontological resources within the Plant PDA. The area in and around Haines Junction was completely glaciated during the late Wisconsinan period (13,000–14,000 years before present), thus the preservation of Pleistocene-aged fossils is unlikely (Hare pers. comm. 2012; Smith et al. 2007). Holocene-aged fossils have been recovered from the mountainous areas surrounding Haines Junction; however, none within the Plant PDA or LAA (Farnell et al. 2004; Hare pers. comm. 2012).

The closest recorded palaeontological resource was found at Pine Lake, approximately 10 km northeast of Haines Junction (Figure 5.5.1), and was a Pleistocene elk (*Cervus elaphus*) mandible collected from glacial outwash deposits located near the lake. The discovery of this fossil suggests that other late Pleistocene vertebrate remains may be located in glacial sediments (glaciofluvial outwash) in the areas surrounding Haines Junction (Zazula pers. comm. 2013).

Figure 5.5.2 Historic Sites and Structures

Feedstock Harvesting

At the time that this report was written, Feedstock areas were undefined and no formal review was conducted. Upon receiving Feedstock PDAs, the HRU, Palaeontology Program will be contacted prior to any ground disturbing or site-altering activities to determine the potential for encountering palaeontological resources. However, due to the level of ground-disturbance involved in forest harvesting, the likelihood for interaction with palaeontological resources is not high.

5.5.2.2 Field Investigation

Field investigation was not completed at the time of the writing of this report. This section will be updated upon completion of a Heritage Resource Assessment for the Project.

5.5.3 Potential Project VC Interactions

5.5.3.1 Project Effects Mechanisms

Table 5.7.2 below lists each activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Heritage Resources.

Table 5.5.2 Potential Project Environmental Effects to the Heritage Resources

Project Activities and Physical Works	Potential Environmental Effects
	Change in Heritage Resources
Construction	
Site preparation	2
Physical construction of the Facility Structures	2
Installation of Equipment	0
Commissioning	0
Construction of Infrastructure for Feedstock Harvesting	2
Operation	
Operation and Maintenance of Plant Site	0
Feedstock Harvesting	2
Decommissioning, Reclamation and Closure	
Plant Site	0
Harvested Areas	1

Project-Related Environmental Effects
Notes:
Project-Related Environmental Effects were ranked as follows:
0 = No interaction. The environmental effects are rated not significant and are not considered further in this report.
1 = Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices and/or permit conditions. The environmental effects are rated not significant and are not considered further in this report.
2 = Interaction may, even with codified mitigation and/or permit conditions, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EA.

5.5.3.2 Construction

Activities ranked as 0 for the Construction Phase in Table 5.7.2 include: Installation of Equipment and Commissioning. Installation of the Equipment and Commissioning does not involve ground disturbance and therefore there will be no interaction with these activities and Heritage Resources. As a result, the potential environmental effects of Installation of the Equipment and Commissioning activities on a change in Heritage Resources are ranked as 0.

There are no Construction activities ranked as 1 in Table 5.7.2.

5.5.3.3 Operation

Activities ranked as 0 for the Operation Phase in Table 5.7.2 include: Operation and Maintenance of Plant Site. Operation and Maintenance of the Plant Site does not involve ground disturbance and therefore there will be no interaction with these activities and Heritage Resources. As a result, the potential environmental effects of Operation and Maintenance of Plant Site on a change in Heritage Resources are ranked as 0.

There are no activities ranked as 1 in Table 5.7.2.

5.5.3.4 Decommissioning, Reclamation and Closure

Activities ranked as 0 for the Decommissioning, Reclamation and Closure Phase in Table 5.7.2 include: Plant Site. No ground disturbance beyond that already completed during the Construction is anticipated for this phase of the Project. As a result, the potential environmental effects of Plant Site activities on a change in Heritage Resources are ranked as 0.

Activities ranked as 1 in Table 5.7.2 include: Harvested Areas. Ground disturbance is not expected to take place at this stage, in which case the result will be no further environmental effects to Heritage Resources during the Decommissioning, Reclamation and Closure – Harvested Areas activity. However, in the event that post-harvest scarification or mechanical ground preparation activities take place during the Decommissioning, Reclamation and Closure – Harvested Areas activity, the implementation of a Heritage Resource Assessment (HRA) (described below in Section 5.5.3.6), protection of sites, and establishment of buffer zones prior to the Construction and Operation phases will prevent any significant environmental effect to Heritage Resources.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 5.7.2 on Heritage Resources during any phase of the Project are rated not significant, and are not considered further in the assessment.

5.5.3.5 Assessment of Environmental Effects

A summary of the environmental effects assessment and prediction of residual environmental effects resulting from interactions ranked as 2 on Heritage Resources is provided in Table 5.7.3.

Table 5.5.3 Summary of Residual Project-Related Environmental Effects on the Heritage Resources, Traditional Activities and Culture

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					
Change in Heritage Resources • Unauthorized disturbance or destruction of Heritage Resources of significance.	Construction (includes: Site Preparation, Physical Construction of the Facility Structure, and Construction of Infrastructure for Feedstock Harvesting)	• Complete a confirmatory Heritage Resource Assessment within the PDA. • Report results of HRA to the Government of Yukon Heritage Resources Unit and CAFN. • If approved, implement mitigation for any heritage resources encountered during field investigation. • Development of an archaeological response protocol should there be any accidental discovery of heritage resources during Project activities.	A	L	S	P/O	I	U/D	N	H	L	N	To be determined following completion of Heritage Resource Assessment.
	Operation (Feedstock Harvesting)	• Development of a strategic plan for the assessment, inventory, mitigation and/or protection of heritage resources in Feedstock areas. • Complete a confirmatory Heritage Resource Assessment within the PDA(s) for Feedstock. • Report results of HRA to the Government of Yukon Heritage Resources Unit and CAFN. • If approved, implement mitigation for any heritage resources encountered during field investigation.	A	L	S	P/O	I	U/D	N	H	L	N	To be determined following determination of potential Feedstock harvesting areas and completion of subsequent Heritage Resource Assessment.

Table 5.5.3 Summary of Residual Project-Related Environmental Effects on the Heritage Resources, Traditional Activities and Culture

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics						Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring
			Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context					
		• Minimize the impact area or propose buffering zones, flagging and/or fencing. • Winter logging on snow-covered ground. • Post-harvest Heritage Resource Assessments may be recommended											
	Residual Environmental Effects for all Phases								N	H	L	N	

Table 5.5.3 Summary of Residual Project-Related Environmental Effects on the Heritage Resources, Traditional Activities and Culture

Potential Residual Project-Related Environmental Effects	Project Phases, Activities, and Physical Works	Proposed Mitigation / Compensation Measures	Residual Environmental Effects Characteristics: Direction	Magnitude	Geographic Extent	Duration and Frequency	Reversibility	Ecological/Socio-economic Context	Significance	Prediction Confidence	Likelihood	Cumulative Environmental Effects?	Recommended Follow-up or Monitoring

KEY

Direction
P Positive.
A Adverse.

Magnitude
L Low: Minor impairments to heritage resources or recent built feature (*e.g.*, loss of individual artifact, movement of hunting blind, trap line)
M Medium: Loss of heritage resources in a previously disturbed context (*e.g.*, some artifacts disturbed/lost, features remain intact), or in a deteriorated state (*e.g.*, wooden structures such as an abandoned cabin, brush camp or cache)
H High: Destruction or loss of a significant portion of intact heritage resources, including sites, structures, and subsurface heritage resources in a stable and undisturbed condition.

Geographic Extent
S Site-specific: Within the PDA.
L Local: Within the LAA.
R Regional: Within the RAA.

Duration
ST Short term: Occurs and lasts for short periods (*e.g.,* days/weeks).
MT Medium term: Occurs and lasts for extended periods of time (*e.g.,* years).
LT Long term: Occurs during Construction and/or Operation and lasts for the life of Project.
P Permanent: Occurs during Construction and Operation and beyond.

Frequency
O Occurs once.
S Occurs sporadically at irregular intervals.
R Occurs on a regular basis and at regular intervals.
C Continuous.

Reversibility
R Reversible.
I Irreversible.

Ecological/Socio-economic Context
U Undisturbed: Area relatively or not adversely affected by human activity.
D Developed: Area has been substantially previously disturbed by human development or human development is still present.
N/A Not Applicable.

Significance
S Significant.
N Not Significant.

Prediction Confidence
Confidence in the significance prediction, based on scientific information and statistical analysis, professional judgment and known effectiveness of mitigation:
L Low level of confidence.
M Moderate level of confidence.
H High level of confidence.

Likelihood
Likelihood of a significant environmental effect occurring, based on professional judgment:
L Low probability of occurrence.
M Medium probability of occurrence.
H High probability of occurrence.

Cumulative Environmental Effects?
Y Potential for environmental effect to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.
N Environmental effect will not or is not likely to interact with the environmental effects of other past, present or foreseeable projects or activities in RAA.

5.5.3.6 Mitigation Measures

The following mitigation measures, through careful design and planning, will be employed to avoid or reduce the environmental effects of the Project on Heritage Resources potentially resulting from the environmental effects mechanisms described above:

Construction Phase

The HRA will include a visual assessment of the PDA for the Plant and infrastructure for Feedstock where ground disturbing activities are planned. This HRA will seek to confirm presence/absence of heritage resources within those PDAs. The methodology for the HRA will be developed as part of a strategic Heritage Resources management plan in consultation with the Government of Yukon Heritage Resources Unit and Forest Management Branch and representatives from CAFN.

Results of the HRA will be reported to Government of Yukon Heritage Resources Unit and CAFN. Following consultation with HRU and CAFN, additional investigation and/or mitigation of any identified heritage resources discovered in the PDAs may be necessary.

In the event that heritage resources not identified during the HRA are encountered, an archaeological response protocol will be developed. This will include, at a minimum, the immediate cessation of all ground-disturbing activities and require contacting representatives with CAFN or the HRU.

Operation Phase (in relation to Feedstock only)

The following mitigating measures have been defined to avoid significant effects on Heritage Resources, in general consideration of the Feedstock activities and will be refined as the extent of the activities become known.

A strategic plan for the assessment, inventory, mitigation and/or protection of Heritage Resources will be developed in consultation with CAFN and the Government of Yukon Heritage Resources Unit and Forest Management Branch. This plan will be implemented prior to any ground disturbance and/or site-altering activities where appropriate.

The HRA will include a visual assessment of the PDAs for Feedstock harvesting where ground disturbing and/or site-altering activities are planned. This HRA will seek to confirm presence/absence of heritage resources within the PDA(s). The methodology for the HRA will be developed as part of a strategic Heritage Resources management plan in consultation with the Government of Yukon Heritage Resources Unit and Forest Management Branch and representatives from CAFN. Areas will be assessed on a case by case basis as Feedstock areas are developed.

Results of the HRA will be reported to Government of Yukon Heritage Resources Unit and CAFN. Following consultation with HRU and CAFN, additional investigation and/or mitigation of any identified heritage resources discovered in the PDAs may be necessary.

In the event that heritage resources not identified during the HRA are encountered, an archaeological response protocol will be developed. This will include, at a minimum, the immediate cessation of all ground-disturbing activities and require contacting representatives with CAFN or the HRU.

Should heritage resources, including places of cultural or spiritual importance to CAFN citizens, be identified in Feedstock areas, buffer zones using flagging and/or fencing will be established to minimize the potentially affected area. Forest Resource Regulations, for example, stipulate that 100 m “no disturbance” buffer zones may be established in areas with known heritage resources. Furthermore, if following the HRA it is determined that heritage resources are solely subsurface deposits, winter logging on snow-covered ground is recommended. Forest harvesting on snow covered grounds can minimize ground disturbance and any potential effects to Heritage Resources.

Post-harvest HRAs may be recommended as a research and monitoring requirement, as outlined in Section 3.8 of the ILP.

Field investigations have not been completed at the time of the writing of this report. Information pertaining to the results of the HRA, including the identification of heritage resources and any required mitigation, will be discussed in detail here when complete.

5.5.3.7 Characterization of Residual Effects

At this time, no field investigation or HRA has been conducted for the Plant or Feedstock. It is recommended that the Characterization of Residual Effects be revised following the completion of the field investigation and HRA.

The potential for an adverse environmental effect on Heritage Resources present in the PDA has the highest probability of occurring during Construction (Site Preparation, Physical Construction of the Facility Structures) of the Plant component and Construction and Operation of the Feedstock component of the Project when ground breaking activities will take place. The majority of ground disturbing, earth moving, and site-altering (*e.g.*, tree-felling) activities will take place during these phases. With appropriate mitigation measures in place, the potential destruction or alteration of all or part of a Heritage Resource, including those Heritage Resources identified by CAFN as pertaining to a special relationship their people have with the natural environment, should be avoidable.

The Plant component is located within Haines Junction village limits, is a small footprint, and while it will most likely be located in an undeveloped block (preliminary PDA is undeveloped), the area surrounding the Plant PDA has witnessed development extending back to the original development of the Alaska Highway. Background research and consultation with the Government of Yukon HRU and Palaeontology Program (Gotthardt pers. comm. 2013; Hare pers. comm. 2012; Zazula pers. comm. 2013) and representatives with CAFN (Brown pers. comm. 2013) indicate that the potential for encountering heritage resources in the immediate preliminary Plant PDA or within the village of Haines Junction is considered low.

Many of the proposed Feedstock harvesting areas within the CATT are undeveloped and located in areas where past overland travel routes, past and present hunting, trapping and fishing, and short-term habitation may have taken place. Some of the most sensitive areas, *Conservation Forest Management Zones,* have been previously accounted for and protected from future timber harvesting under the ILP (EMR 2006). The potential for encountering heritage resources within Feedstock harvesting areas could range from low to high, depending on the locations. However, the implementation of mitigation measures, including Heritage Resource Assessments, “no disturbance” buffer zones, and winter logging where warranted will reduce the likelihood of a significant adverse effect on Heritage Resources.

Consultation with regulatory bodies (*i.e.*, the Government of Yukon HRU and CAFN) will take place following the determination of Feedstock harvesting areas. No ground disturbing or site-altering activities will proceed prior to this consultation and/or the implementation of an HRA for the Feedstock PDAs.

Potential adverse environmental effects are anticipated to be low in magnitude for all phases of the Plant component as the likelihood of encountering heritage resources is low within the village of Haines Junction. Potential for adverse environmental effects are anticipated to be low in magnitude for all phases of the Feedstock as the assessment and mitigation measures in place will allow for the protection and/or avoidance and/or excavation of heritage resources identified in the PDAs. The geographic extent of the environmental effect is limited to the specific area within the PDA where potential heritage resources are located and thus mitigation measures are achievable. The duration of any potential adverse environmental effects on Heritage Resources for the Project would be permanent and irreversible. Heritage Resources are non-renewable, and cannot be reclaimed or reconstituted. Disturbance of an intact Heritage Resource occurs only once, either through mitigation or accident, and is permanently altered thereafter. Mitigation would be conducted in a controlled, professional, and sensitive manner with the input and participation of CAFN, regulatory bodies and all Project stakeholders. Due to these measures, the potential adverse environmental effects to Heritage Resources are not anticipated. The ecological context of the preliminary Plant PDA is relatively undisturbed, but the LAA (the village of Haines Junction) is a developed area. Potential Feedstock PDAs will be located in an area within the CATT that is both undeveloped and undisturbed apart from low-level forest operations.

An HRA will be conducted, including a visual assessment of areas within the Plant PDA. At the time that this report was written, Feedstock areas were undefined; however, it is anticipated that an HRA will be conducted on a case by case basis as areas are defined. Implementation of mitigation measures established in consultation between CAFN, the Government of Yukon HRU and Forest Management Branch and any party involved in conducting the HRA will also take place at this time. Procedures and protocols outlined in the Position Statement and the Guidelines will be followed. CAFN is currently developing a process to ensure the protection of Heritage Resources. This process will act as an independent and parallel assessment to those outlined in the Position Statement and Guidelines.

A significant adverse environmental effect on Heritage Resources during the Construction and Operation of the Plant and Feedstock components of the Project is not anticipated. A significant adverse environmental effect may be avoided through the implementation of mitigation where by all areas with known heritage resources, or the potential to encounter heritage resources, including areas of cultural or spiritual importance, are investigated prior to any ground disturbing or site-altering activities.

5.5.4 Assessment of Cumulative Effects

At the time of the writing of this report, there is insufficient information to conduct an assessment of Cumulative Effects or Statement of Significance for Heritage Resources. This will be revised upon the determination of final Plant and Feedstock PDA locations.

5.6 TRADITIONAL ACTIVITIES AND CULTURE

The proposed biomass gasification power plant (the Project) by the Champagne and Aishihik First Nations (CAFN) and the Yukon Energy Corporation (YEC) will be located within the village of Haines Junction, Yukon on Settlement Lands belonging to the CAFN. The Project is comprised of two parts:

- the biomass plant (the Plant); and
- biomass feedstock timber harvesting (Feedstock).

The Plant will operate as a power and heat source for buildings within Haines Junction and the Feedstock will be the fuel source for the Plant. At the time of the writing of this document, the PDA(s) of the Feedstock are unknown; however, future development of Feedstock is anticipated to take place on non-Settlement Lands within the Champagne and Aishihik Traditional Territory (CATT).

Traditional Activities and Culture is recognized as a VC for this EIA due to the potential impacts with those activities identified in consultation with CAFN as being of traditional or cultural importance to the community and citizens at large. These activities may include hunting, fishing, or trapping but may also include social and community gatherings, cultural or spiritual ceremonies. This assessment of Traditional Activities and Culture is preliminary and will be further refined through consultation with the CAFN community members as details of feedstock harvesting are defined.

5.6.1 Scope of the Assessment

This section defines the scope of the environmental assessment of Traditional Activities and Culture in consideration of the nature of the regulatory setting, issues identified during public and First Nations engagement activities, potential Project-VEC interactions, and existing knowledge.

At the time of the writing of this document, public and First Nations engagement activities have not all taken place. An introductory open house was held in Haines Junction and input from that engagement is included in Section 2.0 (Consultation). This assessment will be updated prior to submission to YESAA to incorporate engagement issues as warranted.

5.6.1.1 Key Issues and Identification of Potential Effects

Potential interactions between the Project and Traditional Activities and Culture are highlighted and those aspects of the Project that may cause environmental effects, either positive or adverse, are identified. The Project may interact with Traditional Activities and Culture in the following ways:

- Construction and Operation of the Plant will result in ground disturbing and site-altering activities (alternative use of the land during Operation), potentially impacting the ability to conduct Traditional or Cultural Activities within the Plant PDA and on adjacent lands; and
- Construction and Operation of the Feedstock will result in site-alteration (removal of vegetation from forested areas), potentially impacting the ability to conduct Traditional or Cultural Activities taking place within the greater CATT.

5.6.1.2 Regulatory/Policy Setting

The *Traditional Activities and Protection Act* (the Act) (CAFN 1998) was established:

> *"(a) to ensure the wise management of Settlement Land and resources of Champagne and Aishihik people on behalf of present and future generations; (b) to ensure comprehensive and integrated decision making respecting the use and management of Settlement Land and resources, including the full consideration of environmental, cultural, historic and socio-economic factors in that decision making; and (c) to protect the culture, traditions, health and lifestyle of Champagne and Aishihik people and to ensure that information pertaining to these things is used respectfully and wisely in decisions made by the Champagne and Aishihik First Nations."* (CAFN 1998:3)

Any development project taking place on CAFN Settlement Lands is required to obtain a permit for, and is responsible for protection of, those Settlement Lands under the Act. The Act and permits issued under it are enforced by the administrator of the act (the Director) and officers appointed by the CAFN Council.

The protection of Traditional Activities and Culture on non-Settlement Lands in the CATT is afforded through *Section 3.8 – Heritage and Culture Guidelines* of the *Integrated Landscape Plan for the Champagne and Aishihik Traditional Territory* (the ILP) (EMR 2006). Section 3.8 of the ILP outlines a process by which qualified representatives on behalf of CAFN and the Government of Yukon Heritage Resources will assess the cultural and heritage values of each proposed forest development on a site by site basis.

5.6.1.3 Selection of Measureable Parameters

The environmental assessment of Traditional Activities and Culture is focused on the following environmental effect:

- Change in Traditional Activities and Culture within the PDA

This environmental effect has been selected as a result of the need for disposition of lands for the Project and protection afforded to Traditional Activities and Culture under *YESAA* and the Act.

The measurable parameters used for the assessment of the environmental effect presented above and the rationale for their selection is provided in Table 5.8.1.

Table 5.6.1 Measurable Parameters for Traditional Activities and Culture

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Traditional Activities and Culture	Ability to conduct Traditional or Cultural Activities within the PDA	• Traditional Activities and Culture are afforded protection under CAFN legislation, the *Traditional Activities Protection Act.* • Land- and Site-altering (*e.g.*, tree-felling) activities, and noise and dust during construction, within the PDA has the potential to impact traditional and/ or cultural activities that may take place within the PDA (*e.g.*, subsistence harvesting, cultural or spiritual ceremonies, social gatherings)

5.6.1.4 Spatial Boundaries

The spatial boundaries for the environmental effects assessment of Traditional Activities and Culture are defined below.

Project Development Area (PDA): The PDA is the most basic and immediate area of the Project. The PDA is limited to the area of physical ground disturbance associated with the Project, and consists of an area that includes the area of physical disturbance associated with the biomass plant and associated facilities as well as the area associated with biomass feedstock harvesting (including forest roads). The PDA is the area represented by the physical Project footprint as defined in Chapter 3.1.2 above.

Local Assessment Area (LAA): The LAA is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA includes the PDA, Haines Junction, and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. Since the potential environmental effects on Traditional Activities and Culture may extend beyond the PDA (*e.g.*, the disruption of key migration routes for hunting, trap-line concessions), the LAA must include

Regional Assessment Area (RAA): The RAA is limited to and includes the Yukon Territory. The RAA is the area within which the Project's environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. The extent to which cumulative environmental effects for Traditional Activities and Culture may occur depend on physical and biological conditions and the type and location of other past, present, and reasonably foreseeable future projects or activities that have been or will be carried out, as defined within the RAA. For Traditional Activities and Culture, the RAA may be considered lands within the CATT, and the southwest region of the Yukon Territory.

5.6.1.5 Temporal Boundaries

The temporal boundaries for the assessment of the potential environmental effects of the Project on Traditional Activities and Culture include the phases of Construction, Operation, and Decommissioning.

5.6.1.6 Residual Effects Significance Criteria

A *significant adverse residual environmental effect* on Traditional Activities and Culture is defined as one that results in a permanent Project-related change in ability to conduct a Traditional or Cultural Activity including, but not limited to, those activities conducted by CAFN citizens and outlined as "traditional activities" in the Act *"…for food, subsistence or ceremonial purposes to strengthen and enhance social, spiritual and cultural relationships and values…*" (CAFN 1998:2) and that cannot be mitigated or compensated for.

5.6.2 VC Existing Conditions

The Project PDA will be located within the limits of the village of Haines Junction, in southwest Yukon. The preliminary PDA of the biomass energy plant is located just east of the intersection between Willow Acres Road and the Alaska Highway. This assessment will be updated as required following final siting.

At the time of the writing of this report, specific Feedstock areas are undefined. It is anticipated that feedstock timber harvesting will take place within the CATT, which encompasses an estimated 1,959,000 HA of southwest Yukon, according to the ILP (EMR 2006) (Figure 5.5.1). However, planning and development for the forest industry will occur only in the Forest Resource Management Zone (93,700 HA in the ILP) (EMR 2006). The areas that would potentially be harvested for Feedstock are likely to be predominantly located within 50-70 km of Haines Junction over the life of the project, delimited by the boundaries of the Forest Resource Management Zone (Damecour, pers. comm. 2012).

Methods for determining the existing conditions of Traditional Activities and Culture within the Project PDA rely on communication with the population who currently occupy that land, or have knowledge of recent use and activities conducted therein. At the time of the writing of this report, documentary sources remain the primary resource for Traditional Activities and Culture. Consultation with CAFN citizens, non-aboriginal Yukon citizens living in the area, and traditional use studies for the Project, including the Plant and Feedstock PDAs will be conducted and/or consulted prior to any Project-related ground disturbance or site-altering activities.

5.6.2.1 Evaluation of Existing Information

Information contained in the Heritage Resources VC (Section 5.5) describes the general human setting of the recent past with a particular focus on the Southern Tutchone people, direct ancestors to the modern-day Champagne and Aishihik First Nations. Section 5.5 discusses traditional hunting-fishing-gathering practices and a brief overview of the Southern Tutchone seasonal round based on information available in documentary sources. Further descriptions of more recent (*i.e.*, present-day) use of the land and resources, community, spiritual, and cultural activities practiced by CAFN and non-aboriginal Yukon citizens in the Project area will be gathered through consultation during the detailed Feedstock assessment.

5.6.3 Potential Project VC Interactions

5.6.3.1 Project Effects Mechanisms

Table 5.8.2 below lists each Project activity and physical work for the Project, and ranks each interaction as 0, 1, or 2 based on the level of interaction each activity or physical work will have with the Traditional Activities and Culture.

Table 5.6.2 Potential Project Environmental Effects to Traditional Activities and Culture

Project Activities and Physical Works	Potential Environmental Effects
	Change in Traditional Activities and Culture
Construction	
Site preparation	1
Physical construction of the Facility Structures	1
Installation of Equipment	0
Commissioning	0
Construction of infrastructure for Feedstock Harvesting	2
Operation	
Operation and Maintenance of Plant Site	0
Feedstock Harvesting	2
Decommissioning, Reclamation and Closure	

Table 5.6.2 Potential Project Environmental Effects to Traditional Activities and Culture

Project Activities and Physical Works	Potential Environmental Effects
	Change in Traditional Activities and Culture
Plant Site	0
Harvested Areas	0

Project-Related Environmental Effects
Notes:
Project-Related Environmental Effects were ranked as follows:
0 = No interaction. The environmental effects are rated not significant and are not considered further in this report.
1 = Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices and/or permit conditions. The environmental effects are rated not significant and are not considered further in this report.
2 = Interaction may, even with codified mitigation and/or permit conditions, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EA.

5.6.3.2 Construction

Activities ranked as 0 for the Construction Phase in Table 5.8.2 include: Installation of Equipment and Commissioning. Final Plant site selection will take into account key areas for Traditional Activities and Culture, and Installation of the Equipment and Commissioning does not involve land- or site-altering activities, therefore will not interact with any Traditional or Cultural Activities. As a result, the potential environmental effects of Installation of the Equipment and Commissioning activities on a change in Traditional Activities and Culture are ranked as 0.

Activities ranked as 1 for the Construction Phase in Table 5.8.2 include: Site Preparation and Physical Construction of the Facility Structures. While both activities ranked as 1 in the table will result in land- or site-altering activities, site selection of the Plant will take into consideration, and be located to minimize, interaction with Traditional Activities and Culture. As a result, it is anticipated that no significant environmental effect, due to the application of codified practices and permit conditions, would occur to Traditional Activities and Culture.

Operation

Activities ranked as 0 for the Operation Phase in Table 5.8.2 include: Operation and Maintenance of Plant Site. The biomass energy Plant will be located to avoid key areas for Traditional Activities and Culture, and the Operation and Maintenance of Plant Site activity does not involve land- or site-altering activities, therefore will not interact with any Traditional or Cultural Activities. As a result, the potential environmental effects of Operation and Maintenance of Plant Site activities on a change in Traditional Activities and Culture are ranked as 0.

There are no activities ranked as 1 during the Operation phase in Table 5.8.2.

5.6.3.3 Decommissioning, Reclamation and Closure

Activities ranked as 0 for the Decommissioning, Reclamation and Closure Phase in Table 5.8.2 include: Plant Site and Harvested Areas. No land- or site-alteration beyond that already completed during the Construction and Operation Phases are anticipated for this phase of the Project. As a result, the potential environmental effects of Plant Site and Harvested Areas activities on a change in Traditional Activities and Culture are ranked as 0. The ranking of 0 for Plant Site and Harvested Areas activities assumes that the Plant PDA will remain unchanged and that the Feedstock PDA(s) will be re-forested and returned to natural growth.

There are no activities ranked as 2 for Traditional Activities and Culture in the Decommissioning, Reclamation and Closure phase.

Thus, in consideration of the nature of the interactions and the planned implementation of known and proven mitigation, the potential environmental effects of all Project activities and physical works that were ranked as 0 or 1 in Table 5.8.2, including cumulative environmental effects, on Traditional Activities and Culture during any phase of the Project are rated not significant, and are not considered further in the assessment.

5.6.3.4 Assessment of Environmental Effects

The only interactions ranked as a 2 and thus requiring further assessment are related to Feedstock harvesting which is not being assessed in detail in this draft assessment. At the time of the writing of this report, there is insufficient information to conduct a further assessment of Environmental Effects on Traditional Activities and Culture. Mitigation measures, Residual and/or Cumulative effects will be revised upon the determination of final Plant and Feedstock PDA locations. No land- or site-altering activities or disruption of Traditional or Cultural Activities (*e.g.*, subsistence hunting, trapping, spiritual or cultural ceremonies, social and community gatherings) will take place for the Project prior to consultation with CAFN citizens and non-aboriginal Yukon citizens living on and/or using lands that may potentially be impacted by the Project.

6.0 ASSESSMENT OF EFFECTS OF ACCIDENTS AND MALFUNCTIONS

Accidents and malfunctions are unplanned, adverse events affecting the Project during Construction and Operation. Three potential sources of accidents and malfunctions are considered in this assessment: process upsets, fires, and vehicle collisions.

Process upsets will be minimized to the extent possible by conducting the appropriate preventative and routine maintenance of mechanical components of the Project, as well as the control of the process operation by an installed system. In the event of a process upset, operators would respond to the event by manually adjusting the relevant process parameters to resolve the issue as quickly as possible. For mechanical breakdowns, operators would be dispatched as soon as possible to conduct the required maintenance or repairs of the affected equipment. In the case of major process upsets, if the issue cannot be resolved internally in a timely fashion, the process would be shut down in a controlled manner to conduct the required repairs.

Fires at the Project site could result from an accident, from spontaneous combustion of biomass, or from potential fires within the equipment (*e.g.*, gas cleaning). The immediate concern for a fire would be for human health and safety. Local air quality conditions may be influenced by emissions from a fire and other adjacent infrastructure could be at risk of damage or loss as well.

The emissions from a fire would likely consist mainly of smoke (particulate matter) and CO_2 but could also include CO, NO_X, SO_2, VOCs, and other products of incomplete combustion. A large fire could create particulate matter levels greater than the ambient air quality standard over distances of several kilometres, but such situations would be of short duration and are not expected to occur.

The facility will be equipped with several fire hydrants, and personnel will be adequately trained in fire-fighting procedures, to respond to any fire that may result from spontaneous combustion of biomass or other means. However, since limited quantities of biomass will be stored on-site, and since their storage will be for a relatively short period of time, the risk of spontaneous combustion is low.

The potential for vehicle accidents exists for all phases of the Project. In addition to the employee-related traffic to and from the site, the operation of heavy equipment on-site during Construction as well as the operation of heavy trucks for equipment and biomass deliveries has the potential to result in vehicle accidents during Operation.

The Project is anticipated to be located near the Alaska Highway, which is a main roadway. The Project will result in an increase of 3 to 15 trucks per week in during Operation. This increased truck traffic associated with Operation of the Project equates to a small increase in overall traffic volumes in the area. Further to this, the Project-related traffic is expected to be confined to existing truck routes. Therefore, the increase in traffic is not expected to result in a substantive increase in the potential for vehicles accidents.

7.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The effects of the environment on the Project are associated with risks of natural hazards and influences of nature on the Project, during all phases. These environmental effects are defined in Section 2(1) of the *Canadian Environmental Assessment Act* as *"…any change to the project that may be caused by the environment…whether any such change or effect occurs within or outside Canada*." Typically, potential effects of the environment on any project are a function of project or infrastructure design and how these may be affected by nature. These effects may arise from physical conditions, land forms, and site characteristics which may act on the Project such that the Project components, schedule and/or costs could be substantively and adversely changed.

Good engineering design involves the consideration of environmental effects and loadings or stresses (from the environment) on the Project. The planning and engineering design for this Project are no exception. Equipment and materials will be used that are able to withstand severe weather, and other influences. Environmental stressors, such as those that could arise as a result of climate change, severe weather, and other factors, would be addressed by engineering design, materials selection, and best practices.

Mitigation strategies for minimizing the likelihood of a significant effect of the environment on the Project are inherent in the planning process, the engineering design codes and standards, and the construction practices. As such, and in consideration of the best management practices that will be applied throughout the design, Construction and Operation of the Project, as demonstrated in the following sections, the effects of the environment on the Project during all phases of the Project will be managed through responsible design and thus have been rated not significant.

7.1.1 Influence of Consultation on the Assessment

At the time of writing, consultations in the community are on-going. A summary of the consultations as they apply to effects of the environment on the Project will be provided following the completion of the consultations.

7.1.2 Potential Effects on the Project

The environmental attributes that were considered to have a potential effect on the Project were based on a review of the known past and existing conditions, and knowledge gained through projections of potential future conditions (*e.g.*, potential effects of climate change). Based on the issues and concerns identified, the environmental attributes selected for consideration include:

Severe weather, including:

- wind;
- precipitation; and
- electrical storms.

Climate change, including:

- changes in mean temperature; and
- changes in precipitation amounts, frequency, and type (rain).

As a result of climate change, the Haines Junction area may be subject to melting permafrost and increased risk of forest fires resulting from causes other than the Project.

Climate conditions and climate change are presently the focus of much concern globally. "*With global attention now focused on climate change, government agencies, non-profit organizations, the private sector, and individual citizens are gearing up to face climate-related challenges*" (NOAA 2010). The people of the Yukon have already begun addressing climate change by holding two conferences, titled *Climate Change in Our Backyard*, in 2006 and 2009. The conferences brought together local experts in the Champagne and Aishihik First Nations Traditional Territory (CATT) and researchers to discuss the observed changes in the CATT, what changes might be expected, and what adaptive strategies may be employed.

7.1.3 Extreme Weather Events

Extreme weather events may be characterized as events of heavy precipitation or strong winds.

There are climate normals data available from the Whitehorse meteorological station (Environment Canada 2012d) . The most extreme daily rainfall event in Whitehorse was recorded on June 27, 1985 to be 44.9 mm, and the most extreme daily snowfall event was recorded on March 8, 1967 to be 27.2 cm. The maximum hourly wind speed was recorded on January 9, 1962 to be 72 km/hour, and a maximum gust speed of 106 km/hour was recorded on February 19, 1964.

With respect to effects on the Project, extreme weather events may affect the harvesting and transportation of wood through temporarily reduced access to wood and transportation infrastructure. In addition, the storage of wood chips on site may be compromised if the biomass storage building fails. These effects may be mitigated by considering extreme weather events in the design and operation of the Project activities and infrastructure.

7.1.4 Forest Fire

Between 1950 and 2006, a total of 6,294 fires have occurred in the Yukon. Forest fires may be caused by lightning strikes or human activities. The average annual area burned is 1,495 km^2 (149,515 hectares) (Government of Yukon 2011b). Haines Junction has a volunteer fire department.

In the event that Haines Junction is evacuated due to a forest fire, the Project can be safely and quickly shut down. The immediate area surrounding the site will be cleared of vegetation. No other effects on the Project due to forest fires are anticipated.

7.1.5 Climate Change

"Climate" is defined as the statistical average (mean and variability) of weather conditions over a substantial period of time (typically 30 years), accounting for the variability of weather during that period (Catto 2006). The relevant parameters used to characterize climate are most often surface variables such as temperature, precipitation, and wind, among others.

"Climate change" is an acknowledged change in climate that has been documented over two or more periods, each with a minimum of 30 years (Catto 2006). The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified (*e.g.*, by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC 2007). The United Nations Framework Convention on Climate Change (UNFCCC) makes a distinction between climate change attributed to human activities and climate variability attributable to natural causes, by defining climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (IPCC 2007).

The definition of climate change dictates the context in which the effects of those changes are discussed. While it is appropriate to examine the effects of projected climate change on Operation over the next 50 to 100 years, it is not fitting to consider the effects of climate change projections on Construction which will take place over a relatively short period of time (6 to 8 years) in the near future. Construction will occur over the first year of the Project, and as such it is more appropriate to consider the effects of recent climatological conditions, especially the potential adverse effects of weather variability and weather extremes (*e.g.*, change in precipitation) on Construction.

To assess the environmental effects of climate on the Project, current climate and climate change must both be considered. Current climate conditions are established by compiling relevant historical data and establishing a climatological background for the Haines Junction area. Climate change effects projected over the life of the Project (approximately 20 years) are determined through a review of the two Climate Change in Our Backyard conference reports (CAFN 2006; CAFN 2009b). The 2009 report indicates that the annual mean temperature of southern Yukon is projected to be 2.6°C warmer and that precipitation is projected to increase by 10 to 45% in the next 50 years. As a result, changes to water resources, biodiversity, transportation infrastructure, health, and local economies are anticipated. Nevertheless, given the lifetime of the Project (approximately 20 years), the effects of Climate Change are not likely to cause adverse effects on the Operation of the Project.

8.0 SUMMARY OF SIGNIFICANCE

The assessment of potential effects provided in the sections above has been completed based on desktop literature and information review and in consideration of initial consultation with First Nations and the public on their interests and values. Preliminary findings for each VC have been developed in consideration of the Project activities as understood from the FEED study and may require updates once the Project location and infrastructure are finalized. Updates may also include a more detailed assessment of feedstock harvesting activities.

In consideration of existing ambient air quality conditions and estimated Project emissions of air contaminants, ambient air quality is expected to remain well below regulatory objectives during operation of the plant. Annoyance from noise is not expected to be caused by the plant if it is located at least 500 m from residences (to avoid sleep disturbance). If the plant is located in a building this distance could be less. The chipping operation will likely need to be located 500 to 1,000 m from residences and sensitive receptors (such as the school or other areas of frequent land use) to avoid annoyance.

Minimal influence on water resources is expected as the plant will use little to no water (depending on vendor) and should be located at least 30 m away from surface water sources. Feedstock (in chip form) will be stored indoors to avoid siltation to surface water run-off.

Significant environmental effects on vegetation and wildlife are not expected based on the species documented in Haines Junction.

Additional consultation is required in relation to traditional ecological knowledge and traditional activities and culture to confirm any constraints that should be considered. Based on the consultation conducted to date, no concerns have been raised that are expected to hinder development of the Project in a way that will not significantly effect these values.

Known and documented heritage resources have been confirmed and will be avoided in locating the plant.

Transportation infrastructure is not expected to be noticeably influenced as a result of the Project. Truck traffic is estimated at 3 to 15 trucks per week to supply feedstock during Operation. Similar or less traffic is expected during Construction.

The Project will require resources for construction and operation, therefore a positive effect on labour and economy is expected. Planning of forest harvesting will include consideration of existing land users to ensure that other land users such as existing harvesters, trappers, outfitters and wilderness tourism are not negatively affected.

Human health and well-being should not be affected by the Project. The plant would be operated within applicable regulations which have been developed to protect human health and well-being.

The risk of accidents related to the Project will be minimized through the design and procedures during Operation.

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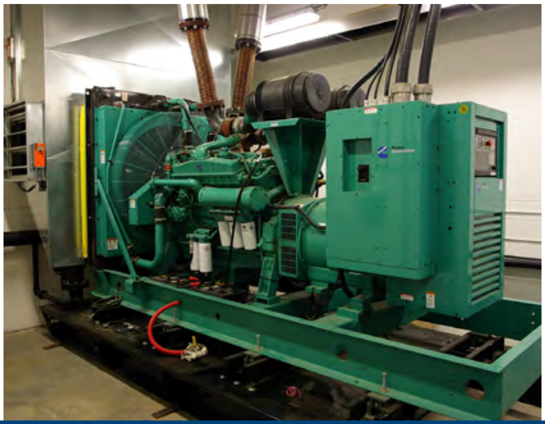

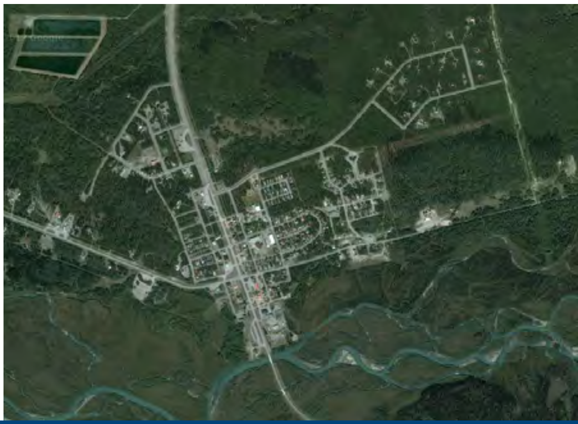

APPENDIX I

Engagement Plan

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

DRAFT YUKON BIOMASS FEED STUDY - PUBLIC AND FIRST NATIONS ENGAGEMENT PLAN

Prepared for:

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Stantec

Stantec

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1 BACKGROUND

1.1 Introduction

The primary objective of this Front End Engineering Design (FEED) Study is to confirm the viability of electricity generation in Yukon using small-scale gasification technology fuelled from local forest biomass feedstock. The project will require either a Yukon Environmental and Socio-economic Assessment Board (YESAB) District Office or Executive Office level effects assessment for the biomass facility. Baseline work on feedstock harvesting is outside the scope of this project.

Also outside of the scope of this project is the waste heat study that will be led by Champagne and Aishihik First Nations' Renewable Energy Committee. The waste heat study will identify possible uses of the waste heat from the biomass plant, will be carried out at the same time as the FEED study, and will be completed by Clean Technology Community Gateway (CTCG).

This engagement plan sets out how the project team will meaningfully engage with First Nations, stakeholders, regulators, decision-makers and the general public. It provides a working list of stakeholders and potentially interested First Nations, a description of communication timelines, and describes how engagement will be carried out. It is based, in part, on information provided in the draft communications plan provided to Stantec by the project team.

For the purposes of this document, the Project Partners/Project Sponsors are the following:

- Yukon Energy (YEC)
- Champagne Aishihik First Nations (CAFN)
- Dakwakada Development Corporation (DDC)
- Cold Climate Innovation (CCI)
- Village of Haines Junction (VHJ)

The Project Steering Committee is made up of the following individuals:

- Michael Brandt, YEC – Co-Chair
- Ray Wells, YEC – Co-Chair
- Roger Brown, CAFN
- Hector Campbell, YEC
- Stephen Mooney, CCI

The Project Management Team and Project Contributors are those individuals shown in Figure 2.1.

1.2 Communications Approach

Strong stakeholder engagement is required to build community support for the use of biomass energy generation in Haines Junction. As several organizations are sponsoring the project, the project team will ensure the views of each Project Partner are contained in engagement and communication materials, as appropriate. The outputs from project engagement will be shared with the Project Partners and Steering Committee members at key decision points and at the end of the project.

1.3 Public Engagement Principles

The project will involve stakeholder and relationship-building over a number of different phases and possibly over a number of years. The following principles will guide this engagement:

Communication

- Communicate regularly on the project's progress
- Wherever practical, maximise opportunities for stakeholders to provide feedback
- Clearly communicate feedback mechanisms to foster two-way communication

Transparency

- Clearly explain the decision-making process and define the intended outcomes of any engagement activities
- Where and as appropriate, communicate to stakeholders what they can and cannot influence in the consultation process
- Inform stakeholders about how their input will be used
- Where appropriate, document decisions or outcomes of meetings with stakeholders

Inclusiveness

- Identify stakeholders and, wherever possible, involve them in any consultation at an early stage
- Seek to understand stakeholder issues or concerns
- Facilitate stakeholder engagement as appropriate

1.4 Communications Aim

The overarching communications aim for the project is to generate stakeholder awareness, understanding and support and to communicate the following to project audiences:

- CAFN, DDC, YEC, CCIC, and VHJ are working together to investigate the possibility of locating a biomass electricity generation plant in the Haines Junction area

- If the project proceeds, it could mean additional renewable energy and, potentially, a source of district heat, creation of local jobs, and economic opportunities/growth for local businesses and corporations
- The project may serve as a demonstration project for biomass power generation in other similar northern and rural communities in Canada

1.5 Key Messages

The steering committee and project team have worked to develop the following key messages. These key messages will be used when communicating with stakeholders, regulators and the general public. These messages may be amended and added to as the project progresses.

Table 1.1: Key Messages

Question	Detailed Key Messages
Who are the Project Partners?	▪ The Champagne and Aishihik First Nations, the Dakwakada Development Corporation, Yukon Energy, Cold Climate Innovation at the Yukon Research Centre, and the Village of Haines Junction
What's the project all about?	▪ The partners are exploring a potential opportunity to produce renewable energy in the Haines Junction area using biomass gasification technology ▪ The plant concept envisions the building of a small scale gasification plant that will generate between 0.5 and 2 megawatts of renewable electricity, helping to develop a sustainable and secure energy future for the Haines Junction community and the Yukon. ▪ The partners are looking at producing electricity using a power plant fueled by beetle-killed trees, sawmill waste, and other sources of renewable wood fiber harvested from the Haines Junction area. The partners are also exploring whether heat energy produced by the power plant could potentially be provided to local facilities.
What stage is the project at?	▪ We are in the early stages of exploring this opportunity and we are investigating different technologies and project scales. ▪ Our initial work includes informing and discussing the concept with First Nations, stakeholders and the public while conducting a detailed feasibility study to see if operating a biomass gasification power plant in Haines Junction is technologically, environmentally and financially a good choice. ▪ Based on preliminary work that demonstrated the possible viability of a biomass gasification facility in Haines Junction, Stantec has been engaged to conduct a detailed feasibility study funded by each of the project partners and Natural Resources Canada, Canadian Northern Economic Development Agency and the Government of Yukon. The results of that technology study are expected in 2013. ▪ Once the results of Stantec's feasibility study are known, the project partners will share that information and seek feedback. They will then decide whether to continue with further studies and how best to move forward. Future work will involve exploring in greater detail the source and sustainable supply of wood fiber fuel for the proposed biomass facility. If the overall concept is feasible, the biomass project will then undergo community, environmental, socio-economic, and regulatory reviews before a decision is finally made to proceed with construction and operations.
Why is the project unique?	▪ This is the first time that the project partners have combined forces to collaborate on a potential renewable energy project. The technology is innovative and has been successfully used in other parts of Canada, in the United States, and in Europe and

Question	Detailed Key Messages
	Asia. If built, the power plant would be the first biomass electricity production facility in the Yukon and has the potential to act as a demonstration project for other small rural and northern communities.
What are the potential benefits of the project?	▪ A biomass power plant could generate at least 0.5 megawatts of much-needed renewable electricity, contributing to a sustainable and secure energy future for the Haines Junction community and the Yukon. ▪ The project could create local jobs and offer long-term economic opportunities for local businesses to grow. ▪ Waste heat from the facility could potentially be used to heat existing or new facilities (such as a community greenhouse).
What are the potential challenges?	▪ Cost ▪ Wood fiber availability ▪ Ensuring sustainable wood fiber harvesting and sustainable operation of the power plant ▪ Potential noise and other effects from increased traffic, construction, and industrial activity ▪ Possible air emissions
What are key questions that the Project Partners still need to answer?	▪ Given existing technology and potential fuel sources, is a biomass power project in the Haines Junction area technically and economically feasible? ▪ Is there an acceptable location for the biomass power plant? ▪ Can a biomass power plant be developed and operated in an environmentally and socially responsible way? ▪ Is there enough renewable wood fiber available to fuel the proposed power plant for the long-term? ▪ Where would the wood fiber be harvested and can it be sustainably harvested? ▪ What are the likely positive and negative effects on the environment and on local residents? ▪ Would there be any significant negative effects? ▪ Could any significant negative effects be satisfactorily avoided or mitigated?

1.6 Communications Goals and Objectives

- Create and maintain awareness and understanding of the project among the general public, decision-makers, key stakeholders, and interested First Nations, including its potential costs and benefits, and proposed engagement processes
- Identify stakeholders and potentially interested First Nations, build and maintain strong relationships, ensure that engagement occurs at the right level, at the right time, in the right way
- Identify, document and monitor issues and concerns that arise during the engagement process
- Identify needed planning, design and management measures to avoid, mitigate or resolve issues

- Encourage the sharing of traditional land use and traditional knowledge information by interested and potentially affected First Nations
- Provide early notification of the project and adequate opportunities for public input
- Ensure the steering committee, project partners and the project team communicate with ‘one voice’ to the public, stakeholders and regulators
- Identify and manage communications issues to minimize their potential adverse impact on the project

2 PROJECT TEAM

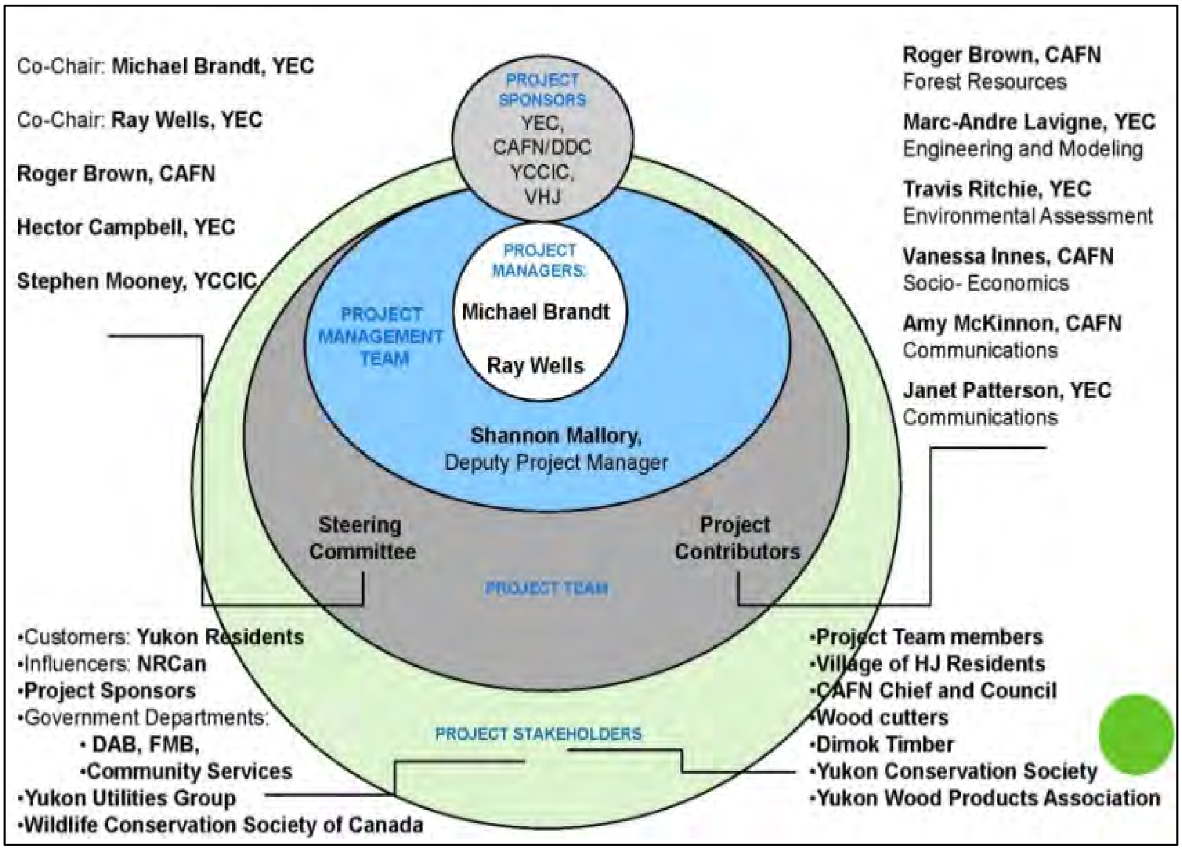
2.1 Structure

The project team is shown in Figure 1.1 below. The project team is comprised of technical staff from YEC, DDC and CAFN. Team members will be given tasks that are relevant to their knowledge area by the steering committee, co-project managers or deputy project manager.

To support the project management team and project consultants, the Steering Committee has been established that has technical representation from at least two of the Project Partners. A number of sub-committees may be formed to deal with specific issues throughout the project. The Steering Committee will:

- Have overall guidance and direction of the Project
- Direct actions to the deputy project manager and the co-project managers as well as the project team

Figure 2.1: Project Team



2.2 Roles and Responsibilties

To ensure that project communications are clear, consistent and coordinated, the roles and responsibilities of the Project Partners, Steering Committee, project management team, and Project Contributors must be clearly described. The following roles and responsibilities have been recommended by the Steering Committee:

Table 2.1: Communications Roles and Responsibilities

Partner	Role/Responsibility
Project Sponsors/Project Partners	The Project Sponsors will: • Defer all public/media communications regarding the project to their Communications representatives
Project Steering Committee	The Steering Committee will: ▪ Have overall guidance and direction of the Project ▪ Direct actions to the deputy project manager and the co-project managers as well as to the project team ▪ Act as project points of contact and decision makers for their organizations as members of the Project Steering Committee ▪ Approve the communications and stakeholder engagement strategy ▪ Approve all media releases and media interviews ▪ Approve all engagements and communications with assessment, resource management and regulatory agencies (e.g., YG Forest Management Branch, YESAB), beyond sharing information that is already in the public domain ▪ The Project Steering Committee with the Project Sponsors, Project Management Team and Project Contributors will be involved in the the development of the key messages to ensure consistency and content accuracy of communication
Project Management Team	The Project Management Team will: ▪ Defer all public communications regarding the project to communications representatives ▪ Act as a key contact point for stakeholders in cooperation with the deputy project manager ▪ Have overarching responsibility for preparation of communications and engagement materials and events ▪ Have overarching responsibility for assessment and regulatory agency communications and engagement ▪ Identify and manage issues ▪ Approve all communications as authority may be designated to it in writing by the steering committee
Deputy Project Manager / Designate (e.g. Project Consultants)	The Deputy Project Manager/Designate will: ▪ develop draft materials for Project Sponsor, Project Steering Committee, Project Management Team and Project Contributor review ▪ provide information to Communications Representatives for website materials ▪ maintain the contact database ▪ prepare papers and advice to the Project Management Team, the Steering Committee, and Project Contributors ▪ communicate with Stantec regarding Steering Committee direction on engagement and communications activities
Project Contributors	The Project Contributors will play a supporting role in communications and stakeholder engagement for the project. Working with the Steering Committee, the Project Contributors may assist with: • managing communications and engagement activities

Partner	Role/Responsibility
	• identifying and managing issues • assisting with media activities as required • monitoring media coverage and the external environment for impacts on the project • providing strategic communications advice to the Project Management Team and Steering Committee as needed
Communications Representatives	Will draft the following: • summaries of media coverage and external opinion/discussions relating to the Project • communication responses to manage reactive media activities • information for newsletters The Communications Representatives will update the engagement plan as needed

3 COMMUNICATION PROTOCOLS

3.1 Confidentiality

Project-related documents are considered confidential and are only to be shared with the internal project team unless specific approval is given for their release by the steering committee.

3.2 Communications With Regulators

Any communications and engagement regarding the project with assessment and regulatory agencies/personnel requires prior notification and approval by the steering committee. Improptu conversations may occur, but shall not go beyond sharing information currently available to the public and hearing what the other party may want to share.

3.3 Media Relations

The following rules should govern all project-related communications with the media:

- Media releases are to be signed off by the Steering Committee before being sent out
- All planned contact with media will be coordinated through the project management team
- All media releases and media engagements (e.g., interviews) will be pre-approved by the Steering Committee
- <u>*** NRCan requires three weeks notice of any news releases</u>

- Before doing media interviews, the spokesperson should notify all project parties by email. Following the interview, the spokesperson should send another email to the Project parties providing a summary of the conversation
- Communications representatives will be the initial point of contact for all reactive media enquiries (see table below for details)

Table 3.1: Project Media Contacts

Project Partner	Communications Representatives
Yukon Energy	David Morrison / Janet Patterson
CAFN	Chief James Allen
DDC	Murray Arsenault
Village of Haines Junction	Mayor George Nassiopoulos
Cold Climate Innovation Research Centre	Tanis Davey

3.4 Communications with Steering Committee

Project communications with the Steering Committee will be governed by the following rules:

- Steering Committee meetings will be sent out with an outlook meeting request with a link and phone number for GoTo Meeting
- Project status reports will be sent to the Steering Committee by email as they are received from the consultant

3.5 Monitoring

The project management team will continuously identify emerging issues by monitoring the following:

- Media coverage
- Blogs and other social media (Facebook/Twitter/Google +)
- Policy environment
- Stakeholder feedback (formal and informal)

4 ENGAGEMENT WITH STAKEHOLDERS

4.1 Project Stakeholders

Potential project stakeholders are listed below (this list will be added to and amended over time):

Table 4.1: Stakeholder List

Industry and Industry Associations Arctic Inland Building Products Dimok Timber Ltd. Tourism Industry Association Yukon Wilderness Tourism Association Yukon Outfitters Association Yukon Wood Products Association	**Project Team, Sponsors and Contributors** CAFN Dakwakada Development Corporation Yukon Energy Centre Cold Climate Innovation Village of Haines Junction
Research and Academic Yukon College, Northern Research Institute	**Regulators and Decisionmakers** YESAB YUB Yukon Executive Council Office
Local Government and Local Government Associations Village of Haines Junction (Mayor and Council) Association of Yukon Communities	**Potentially affected land users and representative organizations** Trappers Guide Outfitters Hunters Recreational/Commercial Fishermen
Nongovernmental Organizations Wildlife Conservation Society of Canada Council of Canadians Yukon Conservation Society Canadian Parks and Wilderness Society	**Yukon Government** Environment Yukon Yukon Highways and Public Works Yukon Economic Development Yukon Energy, Mines and Resources Yukon Government Climate Change Secretariat Yukon Health and Social Services Yukon Land Use Planning Council
Government of Canada Environment Canada Canadian Northern Economic Development Agency (CanNor) Natural Resources Canada	**Other Interested or Influential Groups** Local Residents of Village of Haines Junction and surrounding area Alsek Renewable Resource Council General Public Media MLAs MPs

4.2 YESAA Stakeholder Consultation Requirements and Processes

Section 50(3) of the *Yukon Environmental and Socio-Economic Assessment Act* (“YESAA”) states the following with respect to both First Nations and stakeholder consultation requirements:

> Before submitting a proposal to the Executive Committee, the proponent of a project shall consult any first nation in whose territory, or the residents of any community in which, the project will be located or might have significant environmental or social economic effects.

Section 3 of YESAA states:

> Where, in relation to any matter, a reference is made in this Act to consultation, the duty to consult shall be exercised
>
> (a) by providing, to the party to be consulted,
>
> > (i) notice of the matter in sufficient form and detail to allow the party to prepare its views on the matter,
> >
> > (ii) a reasonable period for the party to prepare its views, and
> >
> > (iii) an opportunity to present its views to the party having the duty to consult; and
>
> (b) by considering, fully and fairly, any views so presented.

Under YESAA, the amount of public participation and engagement required varies significantly depending on the type of assessment. Public participation is significantly greater in an Executive Committee screening scenario when compared to the level of participation required for a Designated Office evaluation. Scale of the project, the environmental sensitivity to the type of development, and level of public concerns also may dictate the degree of public participation required.

When reviewing the project proposal, the Yukon Environmental and Socio-economic Assessment Board (YESAB), will be most concerned that :

- Adequate consultation was conducted with all stakeholders
- The project team listened, fully and fairly considered, and responded to the issues raised during the consultation
- The project team made adjustments to the planning process or the project proposal as a result of the consultation where appropriate

Following submission of the Project Proposal, YESAB will conduct their formal First Nation and public consultation review process. During that process, the project team may be asked to respond to queries or concerns. The project team will continue meetings with all stakeholders and First Nation groups on ongoing issues as appropriate and public meetings may be held to provide further opportunities for participation.

5 ENGAGEMENT WITH FIRST NATIONS

The project will be located entirely within the traditional territory of the CAFN and they are the primary First Nations that will be engaged with regard to the Project. As they are a project partner it is likely that engagement with the CAFN community and leadership will take place in an ongoing fashion, with regular meetings and information updates to assess ongoing CAFN community support and to deepen the understanding of potential CAFN concerns. Dedicated presentations for CAFN members only (possibly in the various CAFN communities outside of Haines Junction) may also be held to encourage feedback and to ensure support.

While it is unlikely that the project will have an effect on the traditional territories of other First Nations, there is potential that the following First Nations and First Nations associations may express some interest in the Project and may request information:

- Carcross/Tagish First Nation
- Council of Yukon First Nations – Natural Resources and Environment
- Kluane First Nation
- Kwanlin Dun First Nation
- Little Salmon Carmacks First Nation
- Ta'an Kwäch'än Council
- White River First Nation

Letters introducing the project and project partners may be sent to those First Nations that express interest (or are likely to have an interest) in the Project. Meetings and/or follow-up phone calls may be necessary. A record of all communications and communication attempts will be maintained. The majority of communication with interested First Nations groups should be by letter or, alternatively, the details of verbal communications should be confirmed by letter to maintain an accurate record.

5.1 YESAA First Nations Consultation Requirements

YESAA, Section 50(3) states the following with respect to First Nations consultation:

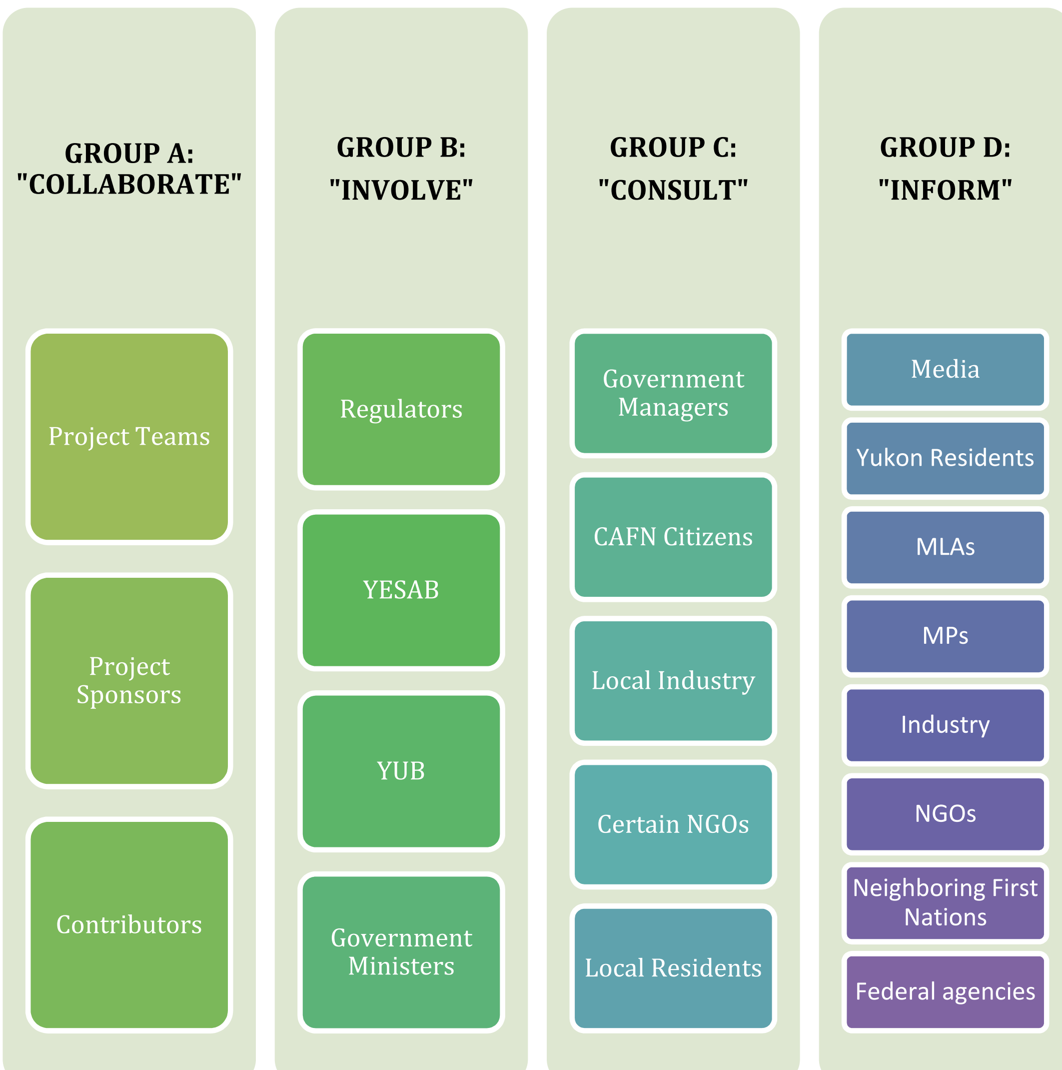
> Before submitting a proposal to the Executive Committee, the proponent of a project shall consult any first nation in whose territory, or the residents of any community in which, the project will be located or might have significant environmental or social economic effects.

Under YESAA the knowledge and views of Yukon First Nations and their citizens will be sought out by regulators. Notification will be sent to all First Nations whose territory the project may be located on or where the project might have significant environmental or socio-economic effects. Renewable Resource Councils, Yukon Fish and Wildife Management Board and Salmon Sub-Committee will be notified if the Project may have environmental or socio-economic effects on areas or wildlife within their mandate. First Nations will have the opportunity to participate and share their views and information during the comment period for the assessment. YESAA also provides opportunities for incorporation of traditional knowledge into the assessment of the Project and that traditional knowledge is a factor that must be considered and incorporated into the assessment.

6 LEVEL OF ENGAGEMENT AND PARTICIPATION

The level of engagement and participation in the Project by First Nations communities and stakeholders can be grouped as follows:

Figure 6.1: Engagement and Participation Levels



The following table describes the different stakeholder audiences, their projected engagement level, potential methods of engagement (this table will be updated and amended as needed)

Table 6.1: Audiences and Engagement Levels

Group	Engagement Level	Description	Audiences
A	COLLABORATE	Stakeholders that are responsible for driving the Project (e.g. Project Sponsors, Project Management, Deputy Project Manager, Project Steering Committee, Project Contributors)	CAFN Dakwakada Development Corporation Yukon Energy Yukon Research Centre Cold Climate Innovation Village of Haines Junction
B	INVOLVE	Stakeholders who have a high-level of engagement with the Project and are involved in the decision-making process	YESAB YUB Yukon Executive Council Office First Nation regulatory agencies(?) Government Ministers? Natural Resources Canada
C	CONSULT	Stakeholders who need to have a good understanding of the Project and will be invited to provide input at critical points (e.g. Federal, Territorial, and FN Resource Management Agencies, FN citizens and local residents, industry, land users and owners, planning groups and committees, NGOs, ENGO)	CAFN citizens CAFN Resource Management Agencies Local Residents of Village of Haines Junction and surrounding area <u>Potentially affected local land users and representative organizations</u> Trappers Guide Outfitters Hunters (?) <u>Nongovernmental Organizations</u> Yukon Conservation Society <u>Territorial Government Resource Management Agencies</u> Environment Yukon Yukon Highways and Public Works Yukon Energy, Mines and Resources <u>Government of Canada Resource Management Agencies</u> Canadian Northern Economic Development Agency (CanNor) Alsek Renewable Resource Council
D	INFORM	Stakeholders who require a broad level of awareness of the project Stakeholders who may be influential or important	Yukon Residents Media MLAs MPs <u>Research and Academic</u> Yukon College, Northern Research Institute <u>Industry and Industry Associations</u> Arctic Inland Building Products Dimok Timber Ltd. Tourism Industry Association Yukon Wilderness Tourism Association Yukon Outfitters Association Yukon Wood Products Association Whitehorse Chamber of Commerce Yukon Chamber of Commerce Oil and Gas interests Mining interests – Yukon Chamber of Mines Other Logging interests <u>First Nations (FN citizens, resource management agencies and leadership)</u> Carcross/Tagish First Nation Council of Yukon First Nations – Natural Resources and Environment Kluane First Nation Kwanlin Dun First Nation Little Salmon Carmacks First Nation Ta'an Kwäch'än Council White River First Nation <u>Nongovernmental Organizations</u> Wildlife Conservation Society of Canada Council of Canadians Yukon Conservation Society Canadian Parks and Wilderness Society <u>Local Government and Local Government Associations</u> City of Whitehorse (Mayor and Council) Village of Carmacks (Mayor and Council) Association of Yukon Communities <u>Territorial Government Resource Management Agencies</u> Yukon Government Climate Change Secretariat Yukon Health and Social Services Yukon Housing Corporation Yukon Land Use Planning Council Yukon Water Board Yukon Surface Rights Board Yukon Fish and Wildlife Management Board Porcupine Caribou Management Board Yukon Community Services Yukon Economic Development <u>Government of Canada Resource Management Agencies</u> Environment Canada <u>Nongovernmental Organizations</u> Wildlife Conservation Society of Canada Council of Canadians Canadian Parks and Wilderness Society

7 ENGAGEMENT PROCESSES AND TIMELINES

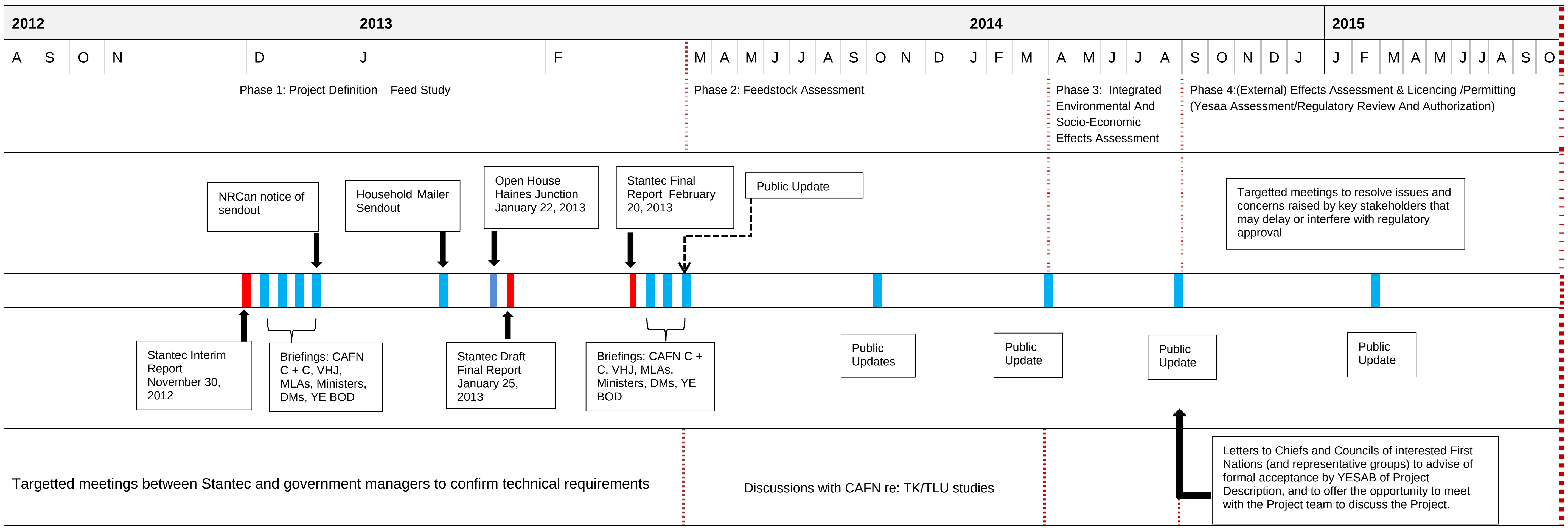
The following table provides a list of key dates, events, techniques and audiences:

Table 7.1: Key Dates, Events and Audiences

Phase	Date	Event and Techniques	Key Audiences
PHASE 1	**AUGUST 2012 – MARCH 2013**	**BIOMASS TECHNOLOGY RESEARCH AND FEASIBILITY STUDY**	
	November 30, 2012	**Stantec - Final Interim Report**	
	Late November – December 2012	Briefings on Project Progress • Face to face meetings and targetted correspondence • Targetted meetings between government managers and Stantec to confirm technical requirements such as code requirements	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors Government managers
	November 30, 2012	• Newsletter Complete	All
	December 13, 2012	• Final proofs to Aasman for design and printing	n/a
	Mid-January 2013	• Newsletter mailout sent to Haines Junction area residents. Information also posted on various websites. Key Messages: • Project is in early stages – here's what is happening • Build awareness of Project and progress • Project Team is looking for input on how stakeholders want to be consulted moving forward and their issues and concerns	CAFN citizens, Haines Junction area residents, Stakeholders, General public
	January 25, 2013 Stantec Submits Draft of Final Report		
	January 22, 2013 5:30 p.m Da Ku Cultural Centre Haines Junction	Open House in Haines Junction • Build awareness and support for Project • Confirm/add to list of those interested in participating in engagement opportunities and receiving information • Confirm location preferences among stakeholders and community	CAFN citizens, Haines Junction area residents, Interested stakeholders, General public Key regulatory agencies should also be notified of the open houses via email, and invited to attend.
	February 20, 2013 ***** Stantec Submits Final Report *******		
	Late February 2013	Briefings on Project Progress and Final Report results • Face to face meetings and targetted correspondence	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors
**** DECISION POINT ****			
	Spring 2013	Communication update to key stakeholders and the public • Email/targeted correspondence Provide updated information on Project progress (on website etc.) • Methods of communication and messages can be determined based on final report (i.e. is this project a go or no go at this point).	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
PHASE 2	**2013/2014**	**FEEDSTOCK ASSESSMENT**	
	Fall 2013	Communication update to key stakeholders and the public • Email/targeted correspondence Provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public

** DECISION POINT **			
PHASE 3	2014 INTEGRATED ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT		
	Spring 2014	Communication with CAFN regarding traditional knowledge and traditional land use studies + capacity support. Communication update to key stakeholders and the public (email/targeted correspondence, provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
** DECISION POINT **			
PHASE 4	2014 – 2016 (EXTERNAL) EFFECTS ASSESSMENT & LICENCING /PERMITTING (YESAA ASSESSMENT/REGULATORY REVIEW AND AUTHORIZATION)		
	Fall 2014	Communication update to key stakeholders and the public. • email/targeted correspondence and provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
	Spring 2015	Communication update to key stakeholders and the public • email/targeted correspondence and provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
	Fall 2015	• Communication update to key stakeholders and the public • Email/targeted correspondence • Face to face meetings or written correspondence to address specific issues and respond to queries and concerns that resut from the formal review process • Public meetings as required • Updated information on Project progress on website etc.	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
PHASE 5	2016 DETAILED DESIGN AND TENDERING		
	Spring 2016	Communication update to key stakeholders and the public • Email/targeted correspondence • Provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
** DECISION POINT **			
PHASE 6	2016+ CONSTRUCTION		
	Fall 2016	Communication update to key stakeholders and public • email/targeted correspondence, provide updated information on Project progress	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
	Spring 2017	Communication update to key stakeholders and public • email/targeted correspondence and provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
PHASE 7	2016 + OPERATIONS		
	Fall 2017	Communication update to key stakeholders and public • email/targeted correspondence and provide updated information on Project progress (on website etc.)	CAFN Chief and Council, Village of Haines Junction Mayor and Council, Kluane MLA, Ministers and DMs of Energy, Mines & Resources and Economic Development, Yukon Energy Board of Directors, CAFN citizens, Haines Junction area residents, General public
PHASE 8	DECOMMISSIONING		

Figure 7.1: Engagement Timelines



8 ENGAGEMENT METHODS

The following are techniques that may be used by the Project team to engage First Nations, stakeholders and the general public:

- Letters and email correspondence
- Face to face meetings
- Workshops and open houses
- Project information sheets and posters (distribute to local government offices, libraries, local recreational centres, community bulletin boards, schools, First Nation band offices
- Radio and television advertisements
- Media interviews
- Website and social media
- Advertisements in community newspapers

To cultivate relationships with First Nations and key stakeholders that have an active interest in the Project, meetings will be held to provide updates on the Project, discuss planned work, listen to concerns and assess areas of interest. The Project Team may also choose, where appropriate, to engage with particular First Nations and stakeholder groups in planning and conducting specific Project tasks.

8.1 Recording Communications

All feedback from First Nations and stakeholders will be tracked in a shared information management system (“Smartsheet”). Where follow-up communication is required, the responsibility for that communication will be clearly assigned to an individual and the name of the person who followed up will be recorded, along with when the communication happened, how it happened (e.g. email, telephone), and a brief description of the content of conversation/communication. Speeches and presentations will be documented in a similar manner; the identities of those who attended the event and the nature of feedback received will be documented. Where follow-up communication is required after the presentation or speech then the details of that communication will be documented and tracked.

Information on communications activities will be available on demand and the data will be regularly updated. Stantec recommendeds that a communications log modelled on the template found in Appendix B be used when documenting communications with First Nations, key stakeholders and the general public. The communications log should be accessible either by all members of the Project team so they are able to add their own data as they carry out engagement activities, or alternatively, by selected team members with responsibility for adding the information. Note that regular backing up and protection of engagement log contents from accidental deletion is essential. Stantec has agreed that it will be responsible for maintaining the log until January 30, 2013.

A "Record of Contact" form may also be used by team members to standardize recording of communications. A template for that form is attached as Appendix B.

8.2 Documenting Issues and Concerns

Issues may be recorded using a table similar to the following (new columns can be added where appropriate):

Table 8.1: Example Issue Log

Primary Issue	Potential Responses/Mitigations

8.3 Scheduled Meetings

Scheduled/completed meetings for the project are as follows (to be completed as dates are known):

Table 8.2: Meetings

Location	Date	Venue	Address

8.4 Open Houses

8.4.1 Timing

An introductory open house will be held in Haines Junction on January30, 2013 to introduce the Project, generate interest and inform First Nations citizens (particularly CAFN citizens), stakeholders and the general public. The following table will be revised as venues and dates are confirmed:

Table 8.3: Open Houses

Location	Date	Venue	Address
Haines Junction	January 22, 2013 (date moved to January 23, 2012 due to death of CAFN elder)	Da Ku Cultural Centre	280 Alaska Highway Haines Junction

8.4.2 Format and Materials

Project open houses will be staffed by members of the Project team, and potentially by representatives of the Project partners and Project consultants. Project representatives will be on hand to speak with attendees, present information, and answer questions from attendees.

Team members staffing the open house should discretely record comments, questions, and concerns from those in attendance on simple notepads when it is convenient. That information can then be transcribed into a more standardized record of contact form (see Appendix B for a record of contact form template) at a later date. We recommend that Team members not fill out forms while actually speaking to attendees.

Poster boards laid out within the venue can provide key information on aspects of the Project and Project Partners, preferred locations, preliminary designs, regulatory processes, potential interactions with the environment, key studies to be carried out and next steps.

The structure of the open houses should allow members of the public in attendance to speak with project representatives with expertise in particular subject areas of interest. Attending project team members should represent a wide range of technical expertise so that detailed and/or technical questions can be answered in person, wherever possible. This will reduce the need for follow-up communications and increase the likelihood that the open house will lead to greater understanding of the Project and spread of reliable and correct information throughout the community by attendees.

Materials required will include:

- Project information sheets
- Sign-up sheets
- Comments cards

Stantec recommends the use of draw prizes or other incentives at open houses. Prizes can enhance interest, boost attendance, encourage attendees to provide contact information, and increase the likelihood that attendees will stay longer and provide more comments and questions.

8.4.3 Recording Attendance

A "welcome" table will be placed inside the entrance of each open house and will be staffed by Project team members who are responsible for tracking attendance. Attendees will be asked to sign in and provide email addresses or other contact information (so that they can be added to Project newsletter, information mailing list etc.). Signing in should not be required, however. Project team members should also maintain an overall head count of all attendees and keep a record of total attendance.

9 ENGAGEMENT PERFORMANCE MEASURES

The Project's engagement processes should be evaluated using both objective and subjective measures. Relevant measures include the following:

- Number of specific meetings, open houses and other engagement sessions with interested First Nations, key stakeholders and representative local organizations (e.g. non-profit organizations, advocacy groups)
- Website traffic statistics (e.g. number of visits, frequency, duration, etc.)
- Quantity and quality of dialogue generated (letters, comments, discussion on project website and external discussions)
- Number of public events held and attendance level at those events, presentations or workshops provided, inquiries received concerning the Project, brochures/flyers distributed, subscribers to website and/or newsletter, articles or columns in local newspapers, radio/tv spots, and radio/tv interviews

These statistics should be tabulated and included in the Project reporting, along with other indicators as part of the summary of engagement necessary for any future project proposal for assessment pursuant to YESAA

APPENDIX A

Communication Log Template

Communication Number	Confidential (Yes/No)	Communication Date	Communication Location	Project Team Member Contact	Communication Method	Individual Contact Name/Contact Information	Aboriginal Group or Stakeholder Group Name	Group Type	Project Phase	Issues	Communication Summary	Outcomes (e.g. information exchange, engagement discussions,	Documents Distributed	Follow Up Action? (Action/Lead/Deadline/ Completed?)	Add to Mailing List?

APPENDIX B

Record of Contact Form (Example)

YUKON BIOMASS FEED STUDY PROJECT

Record of Contact Form (Confidential? ☐ Yes ☐ No)

Date: Pick from Calendar **Location:** Enter Location of contact

PROJECT TEAM CONTACT

Name: **Organization:** Enter Project Team Organization

COMMUNICATION METHOD

☐ Telephone – incoming	☐ Telephone – outgoing	☐ Group Meeting/Event[1]
☐ E-Mail Received	☐ E-mail Sent	☐ In-Person Conversation
☐ Letter/Fax Received	☐ Letter/Fax Sent	

☐ Other (specify): Specify contact method

EXTERNAL CONTACT INFORMATION

First Name: Enter First Name Last Name: Enter Last Name

Role/Position: Enter Role/Position if applicable Organization: Enter Organization if applicable

Address:
Enter Address Here

City / Town: Enter City / Town	Province: Pick from List	Postal Code: Enter Postal Code
Business No: Enter Business Phone No.	Cell No: Enter Cellphone No.	Home No Enter Home Phone No.:

Fax: Enter Fax Number E-mail: Enter E-mail Address

Add to Project Mailing List:
☐ Yes ☐ No

Contact information for other external contacts: *(list any other participants & information here)*
Enter other external contacts information

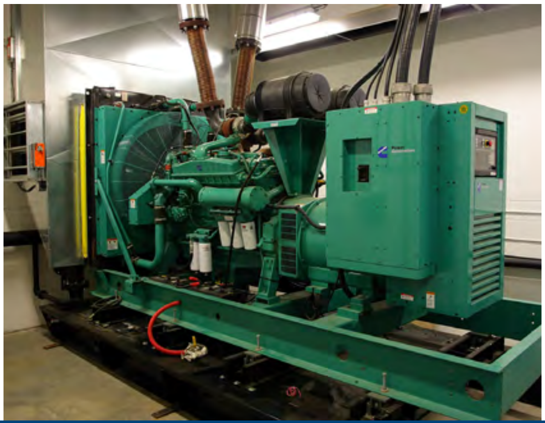
[1] A separate meeting note / event record template can be created for documenting events other than individual communications. Copies of completed forms should be retained in the files of the responsible organization.

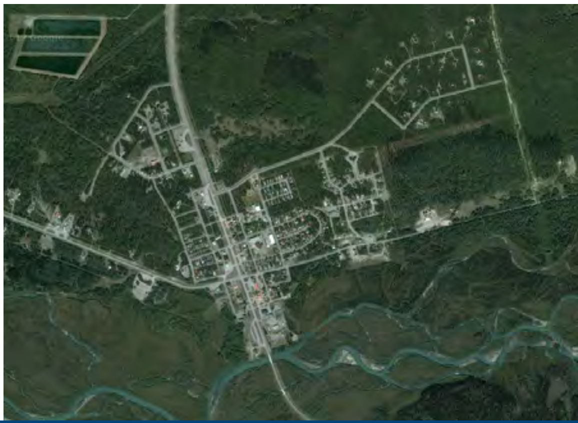
Group Type (*Please check all that apply):*		
☐ First Nation ☐ Federal Government/Agency ☐ Territorial Government/Agency ☐ Local Government/Agency ☐ Local Authority	☐ Business ☐ Industry Association ☐ Citizen/Resident Association ☐ Non-Government Organization ☐ Environmental NGO ☐ Special Interest	☐ Research and Academic ☐ Media ☐ General Public ☐ Other (specify): Specify other group type
PROJECT COMPONENT / PHASE		
Project Phase or Component:		
☐ Pre-Application ☐ Application Review ☐ Regulatory Approvals (if applicable)		
ISSUES (*IMPORTANT: Please check all that apply)*		
Issues Categories		

☐ Aboriginal Engagement	☐ Human Health/Risk Management
☐ Public/Stakeholder Engagement	☐ Land Use
☐ Water Resources	☐ Traditional Land Use
☐ Forestry	☐ Traditional Knowledge
☐ Vegetation	☐ Environmental Assessment Methodology
☐ Terrestrial Wildlife	☐ Environmental Assessment Process/Products
☐ Surface Geology, Soils and Terrain	☐ Documentation
☐ Reclamation	☐ Regulatory
☐ Air Quality	☐ Project Components
☐ Meteorology and Climate	☐ Project Phases/Schedule
☐ Noise and Vibration	☐ Legacy Issues
☐ Archaeological Resources	☐ Project Benefits
☐ Heritage Resources	☐ Negotiated Agreements/Commitments
☐ Socio-Cultural	
☐ Employment and Economic Opportunities	

Stantec

Contact Notes / Staff Response *Summary of the discussion/specific issues* Enter Contact Notes / Staff Response				
Documents Distributed *List the documents (title, date, author)* Enter Documents Distributed				
Follow-up Action Required	Follow-up action required? ☐ Yes ☐ No			
	Action	**Lead**	**Deadline**	**Complete?**
IMPORTANT: Please list date of action to be completed and party responsible for follow-up action				
Form Completed by*:* May be same as "Project Team Contact"			Date Form Completed: Pick from Calendar	
Distribution / Copies To: Enter text here		Input to Communications Log: ☐ Yes ☐ No		
		Date Entered to Communications Log: Pick from Calendar		





APPENDIX J

Financials

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

Stantec

ASSUMPTIONS - OPTION 1 (0.5 MW)

INPUT IN SHADED CELLS ONLY — yellow cells indicate awaiting final numbers from engineering

CAPITAL:

District heating, installed cost		*not included*
Biomass plant, installed cost	$6,307,949	
Total plant etc.	$6,307,949	*see 'Capital Costs' worksheet*
ORC	$194,235	
Feedstock yard		
Land	$0	*see 'Capital Costs' worksheet*
Buildings	$2,983,204	*see 'Capital Costs' worksheet*
Equipment	$2,278,988	*see 'Capital Costs' worksheet*
Total capital requirement	$11,764,376	
Capital renewal - annual rate		
Plant	4.0%	*% of original capex, starting in year 4 - assume 25 year life*
Buildings	2.0%	*% of original capex, starting in year 4 - assume 50 year life*
Equipment	6.0%	*% of original capex, starting in year 4 - assume 15 year life*

OPERATING:

Revenues

Total annual sales - kWh	3,504,000	*500kWe, 80% availability*
Electricity selling price - $/kWh	$0.200	per CAFN (Ray)
ORC Electricity sales - kWh	258361	*@ 8% of remaining heat*
District heat annual sales - kWh	1,283,645	*Revised DE Network*
Heat selling price - $/kWh	$0.185	*per CTCG*
Government subsidies - $/kWh	$0.00	

Expenses

O&M expenses - plant - $ / kWh		
O&M expenses - yard - $ / kWh		
O&M expenses - district heat - $	$37,000	*per CTCG*
O&M ORC	$5,938	*per CTCG*
O&M Plant	$242,000	*per FEED report*
Feedstock - $/tonne	$50.40	*per FEED report*

Production factor - tonnes/kWh	0.00086		*1 kg (.001 tonne) per hour = 1 kWh*
Fuel cost per kWh	$0.04		
Amortization (CCA) - annual rate			
Plant	50.0%		*Accelerated CCA class 43.2, see below*
Buildings	4.0%		*CCA class 1*
Equipment	30.0%		*CCA class 43*
Income tax - combined rate	35.0%		
FINANCIAL:			
Grant money	67%	$7,882,132	
Capitalization			
Debt %	70%	$2,717,571	per CAFN (Ray)
Equity %	30%	$1,164,673	per CAFN (Ray)
Total capital funding		$11,764,376	ok
Ownership			
CAFN	60%	$698,804	per CAFN (Ray)
Yukon Energy	30%	$349,402	per CAFN (Ray)
Village of Haines Junction	10%	$116,467	per CAFN (Ray)
	100%	$1,164,673	
Long term debt			
Interest rate	5.0%		
Debt term, in years	20		
ROI requirements - after tax			
CAFN	15%	per CAFN (Ray)	
Yukon Energy	15%		per CAFN (Ray)
Village of Haines Junction	15%		per CAFN (Ray)
WACC - after tax	8.00%		
Annual inflation rate	3.0%		*assumes same rate for both operating and capital expenditures*
Terminal (perpetuity) value multiple	20.0		*Terminal Value = FCF (yr 20)/(WACC – growth rate) : assumes growth rate = inflation rate*
Feedstock inflation rate	1%		

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Yukon

Corporate income tax rates (for December 31, 2012 year ends)

General (non M&P)	M&P	CCPC: Active business income to $500,000 — Non-M&P	CCPC: Active business income to $500,000 — M&P	CCPC: Investment income
15 **30**	2.5 **17.5**	4 **15**	2.5 **13.5**	15 **49.67**

Figures in **bold** are combined federal/territorial rates.

Other 2012 rates

Capital tax	None
Payroll tax	None
Sales tax	None

Additional highlights

No additional significant corporate tax changes were announced.

http://www.budget.gc.ca/2010/plan/anx5-eng.html#a27

Accelerated CCA for Clean Energy Generation

Class 43.2 was introduced in 2005 and is currently available for assets acquired on or after February 23, 2005 and before 2020. For assets acquired before February 23, 2005, accelerated CCA is provided under Class 43.1 (30 per cent). The eligibility criteria for these two classes are generally the same, except that cogeneration systems that use fossil fuels must meet a higher efficiency standard for Class 43.2 than for Class 43.1. Systems that only meet the lower efficiency standard are eligible for Class 43.1.

Class 43.2 includes a variety of stationary clean energy generation or conservation equipment that is used to produce electricity or thermal energy, or used to produce certain fuels from waste that are in turn used to produce electricity or thermal energy. Subject to detailed rules in the regulations, eligible equipment includes:

ELECTRICITY

- High efficiency cogeneration equipment;
- Wind turbines;
- Small hydroelectric facilities;
- Fuel cells;
- Photovoltaic equipment;
- Wave and tidal power equipment;
- Equipment that generates electricity using geothermal energy; and
- Equipment that generates electricity using an eligible waste fuel.

THERMAL ENERGY

- Active solar equipment;
- Ground source heat pump equipment;
- District energy equipment that distributes thermal energy from cogeneration;
- Equipment that generates heat for an industrial process or a greenhouse using an eligible waste fuel; and
- Heat recovery equipment used in electricity generation and industrial processes.

FUELS FROM WASTE

- Equipment that recovers landfill gas or digester gas;
- Equipment used to convert biomass into bio-oil; and
- Equipment used to produce biogas through anaerobic digestion.

If the majority of tangible property in a project is eligible for inclusion in Class 43.2, then certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian Renewable and Conservation Expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares.

Budget 2010 proposes to expand Class 43.2 to include: (a) heat recovery equipment used i a broader range of applications; and (b) distribution equipment used in district energy systems that rely primarily on ground source heat pumps, active solar systems or heat recovery equipment.

NEWCO CASH FLOW PROJECTION
OPTION 1 - 0.5 MW PLANT
(NEWCO OWNED / ISP OPERATED)

	TOTAL NPV	CONSTRUCTION Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
REVENUE																							
Electricity sales	$8,187,383		$721,824	$743,479	$765,783	$788,757	$812,419	$836,792	$861,896	$887,752	$914,385	$941,817	$970,071	$999,173	$1,029,148	$1,060,023	$1,091,824	$1,124,578	$1,158,316	$1,193,065	$1,228,857	$1,265,723	
ORC Electricity	$651,975		$53,222	$54,819	$56,464	$58,157	$59,902	$61,699	$63,550	$65,457	$67,420	$69,443	$71,526	$73,672	$75,882	$78,159	$80,503	$82,919	$85,406	$87,968	$90,607	$93,326	
District heat sales	$2,774,391		$244,599	$251,937	$259,495	$267,279	$275,298	$283,557	$292,063	$300,825	$309,850	$319,146	$328,720	$338,582	$348,739	$359,201	$369,977	$381,077	$392,509	$404,284	$416,413	$428,905	
Total revenue	**$11,613,749**	**$0**	**$1,019,645**	**$1,050,234**	**$1,081,741**	**$1,114,193**	**$1,147,619**	**$1,182,048**	**$1,217,509**	**$1,254,035**	**$1,291,656**	**$1,330,405**	**$1,370,317**	**$1,411,427**	**$1,453,770**	**$1,497,383**	**$1,542,304**	**$1,588,573**	**$1,636,231**	**$1,685,318**	**$1,735,877**	**$1,787,953**	
EXPENSE																							
Operations & maintenance - biomass	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operations & maintenance - district heat	($432,268)		($38,110)	($39,253)	($40,431)	($41,644)	($42,893)	($44,180)	($45,505)	($46,870)	($48,277)	($49,725)	($51,217)	($52,753)	($54,336)	($55,966)	($57,645)	($59,374)	($61,155)	($62,990)	($64,880)	($66,826)	
Operations & maintenance - ORC	($74,919)		($6,116)	($6,299)	($6,488)	($6,683)	($6,883)	($7,090)	($7,303)	($7,522)	($7,747)	($7,980)	($8,219)	($8,466)	($8,720)	($8,981)	($9,251)	($9,528)	($9,814)	($10,109)	($10,412)	($10,724)	
Administration expense	($2,827,264)		($249,260)	($256,738)	($264,440)	($272,373)	($280,544)	($288,961)	($297,629)	($306,558)	($315,755)	($325,228)	($334,985)	($345,034)	($355,385)	($366,047)	($377,028)	($388,339)	($399,989)	($411,989)	($424,348)	($437,079)	
Fuel (feedstock)	($1,492,889)		($152,887)	($154,415)	($155,960)	($157,519)	($159,094)	($160,685)	($162,292)	($163,915)	($165,554)	($167,210)	($168,882)	($170,571)	($172,276)	($173,999)	($175,739)	($177,497)	($179,271)	($181,064)	($182,875)	($184,704)	
Amortization	($10,433,788)		($1,978,500)	($3,063,564)	($1,701,804)	($1,174,753)	($900,949)	($758,839)	($686,212)	($650,955)	($636,312)	($633,415)	($637,489)	($645,911)	($657,206)	($670,522)	($685,358)	($701,412)	($718,499)	($736,507)	($755,365)	($775,034)	
Total expense	**($15,261,129)**		**($2,424,872)**	**($3,520,270)**	**($2,169,122)**	**($1,652,972)**	**($1,390,364)**	**($1,259,755)**	**($1,198,941)**	**($1,175,821)**	**($1,173,645)**	**($1,183,557)**	**($1,200,792)**	**($1,222,735)**	**($1,247,923)**	**($1,275,515)**	**($1,305,021)**	**($1,336,150)**	**($1,368,730)**	**($1,402,658)**	**($1,437,880)**	**($1,474,367)**	
EARNINGS BEFORE INTEREST & TAXES	**($3,647,379)**		**($1,405,227)**	**($2,470,036)**	**($1,087,381)**	**($538,778)**	**($242,745)**	**($77,707)**	**$18,568**	**$78,214**	**$118,010**	**$146,848**	**$169,526**	**$188,692**	**$205,847**	**$221,868**	**$237,284**	**$252,424**	**$267,501**	**$282,659**	**$297,997**	**$313,586**	
Less: Income taxes	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Add: Amortization	$10,433,788		$1,978,500	$3,063,564	$1,701,804	$1,174,753	$900,949	$758,839	$686,212	$650,955	$636,312	$633,415	$637,489	$645,911	$657,206	$670,522	$685,358	$701,412	$718,499	$736,507	$755,365	$775,034	
Add: Government (NRCan) capital funding	$7,298,271	**$7,882,132**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Capital expenditures	($10,892,941)	**($11,764,376)**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Annual capital renewal	($4,107,814)		$0	$0	$0	($505,040)	($520,191)	($535,797)	($551,871)	($568,427)	($585,480)	($603,044)	($621,135)	($639,769)	($658,962)	($678,731)	($699,093)	($720,066)	($741,668)	($763,918)	($786,836)	($810,441)	
Add: Terminal value of free cash flow at year 20	$1,023,371		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,563,599
Add: PV of unused tax losses at year 20	$515,281		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,801,345
FREE CASH FLOW	**($916,075)**	**($3,882,244)**	**$573,272**	**$593,528**	**$614,423**	**$130,935**	**$138,013**	**$145,335**	**$152,909**	**$160,742**	**$168,843**	**$177,219**	**$185,880**	**$194,834**	**$204,090**	**$213,659**	**$223,548**	**$233,770**	**$244,333**	**$255,248**	**$266,527**	**$278,180**	
CUMULATIVE FREE CASH FLOW		**($3,882,244)**	**($3,308,972)**	**($2,715,443)**	**($2,101,021)**	**($1,970,086)**	**($1,832,073)**	**($1,686,738)**	**($1,533,829)**	**($1,373,087)**	**($1,204,244)**	**($1,027,025)**	**($841,145)**	**($646,311)**	**($442,221)**	**($228,562)**	**($5,014)**	**$228,756**	**$473,088**	**$728,336**	**$994,863**	**$1,273,043**	

	IRR	ROI
	3.4%	**-4.6%**
Simple Payback	**1600.0%**	**Years**

Income tax calculations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Earnings before interest and taxes	($1,405,227)	($2,470,036)	($1,087,381)	($538,778)	($242,745)	($77,707)	$18,568	$78,214	$118,010	$146,848	$169,526	$188,692	$205,847	$221,868	$237,284	$252,424	$267,501	$282,659	$297,997	$313,586
Deduct: Interest expense on LTD	($411,753)	($399,301)	($386,226)	($372,497)	($358,081)	($342,945)	($327,052)	($310,365)	($292,843)	($274,445)	($255,127)	($234,843)	($213,545)	($191,183)	($167,702)	($143,047)	($117,159)	($89,976)	($61,435)	($31,467)
Net taxable income (loss)	($1,816,980)	($2,869,337)	($1,473,607)	($911,275)	($600,826)	($420,653)	($308,485)	($232,151)	($174,833)	($127,597)	($85,601)	($46,152)	($7,698)	$30,686	$69,582	$109,377	$150,342	$192,683	$236,562	$282,119
Income taxes payable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,740	$24,354	$38,282	$52,620	$67,439	$82,797	$98,742
Less: Prior year tax losses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($10,740)	($24,354)	($38,282)	($52,620)	($67,439)	($82,797)	($98,742)
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Unused tax losses, opening balance	$0	$635,943	$1,640,211	$2,155,973	$2,474,920	$2,685,209	$2,832,437	$2,940,407	$3,021,660	$3,082,851	$3,127,510	$3,157,470	$3,173,624	$3,176,318	$3,165,578	$3,141,224	$3,102,942	$3,050,323	$2,982,884	$2,900,087
Income tax losses - current year	$635,943	$1,004,268	$515,762	$318,946	$210,289	$147,228	$107,970	$81,253	$61,191	$44,659	$29,960	$16,153	$2,694	$0	$0	$0	$0	$0	$0	$0
Tax losses applied during the year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($10,740)	($24,354)	($38,282)	($52,620)	($67,439)	($82,797)	($98,742)
Unused tax losses - cumulative	**$635,943**	**$1,640,211**	**$2,155,973**	**$2,474,920**	**$2,685,209**	**$2,832,437**	**$2,940,407**	**$3,021,660**	**$3,082,851**	**$3,127,510**	**$3,157,470**	**$3,173,624**	**$3,176,318**	**$3,165,578**	**$3,141,224**	**$3,102,942**	**$3,050,323**	**$2,982,884**	**$2,900,087**	**$2,801,345**

ASSUMPTIONS - OPTION 2 (0.5 MW)

INPUT IN SHADED CELLS ONLY — yellow cells indicate awaiting final numbers from engineering

CAPITAL:

District heating, installed cost		*not included*
Biomass plant, installed cost	$6,324,410	
Total plant etc.	$6,324,410	*see 'Capital Costs' worksheet*
ORC	$194,235	
Feedstock yard		
Land	$0	*see 'Capital Costs' worksheet*
Buildings	$3,658,073	*see 'Capital Costs' worksheet*
Equipment	$2,284,935	*see 'Capital Costs' worksheet*
Total capital requirement	$12,461,654	
Capital renewal - annual rate		
Plant	4.0%	*% of original capex, starting in year 4 - assume 25 year life*
Buildings	2.0%	*% of original capex, starting in year 4 - assume 50 year life*
Equipment	6.0%	*% of original capex, starting in year 4 - assume 15 year life*

OPERATING:

Revenues

Total annual sales - kWh	3,504,000	*500kWe, 80% availability*
Electricity selling price - $/kWh	$0.200	per CAFN (Ray)
ORC Electricity sales - kWH	258361	*@ 8% of remaining heat*
District heat annual sales - kWh	1,283,645	*Revised DE Network*
Heat selling price - $/kWh	$0.185	*per CTCG*
Government subsidies - $/kWh	$0.00	

Expenses

O&M expenses - plant - $ / kWh		
O&M expenses - yard - $ / kWh		
O&M expenses - district heat - $	$37,000	*per CTCG*
O&M ORC	$5,938	*per CTCG*
O&M Plant	$242,000	*per FEED report*
Feedstock - $/tonne	$50.40	*per FEED report*

Production factor - tonnes/kWh	0.00086		*1 kg (.001 tonne) per hour = 1 kWh*
Fuel cost per kWh	$0.04		
Amortization (CCA) - annual rate			
Plant	50.0%		*Accelerated CCA class 43.2, see below*
Buildings	4.0%		*CCA class 1*
Equipment	30.0%		*CCA class 43*
Income tax - combined rate	35.0%		

FINANCIAL:

Grant money	67%	$8,349,308	
Capitalization			
Debt %	70%	$2,878,642	per CAFN (Ray)
Equity %	30%	$1,233,704	per CAFN (Ray)
Total capital funding		$12,461,654	ok
Ownership			
CAFN	60%	$740,222	per CAFN (Ray)
Yukon Energy	30%	$370,111	per CAFN (Ray)
Village of Haines Junction	10%	$123,370	per CAFN (Ray)
	100%	$1,233,704	
Long term debt			
Interest rate	5.0%		
Debt term, in years	20		
ROI requirements - after tax			
CAFN	15%	per CAFN (Ray)	
Yukon Energy	15%	per CAFN (Ray)	
Village of Haines Junction	15%	per CAFN (Ray)	
WACC - after tax	8.00%		
Annual inflation rate	3.0%	*assumes same rate for both operating and capital expenditures*	
Terminal (perpetuity) value multiple	20.0	*Terminal Value = FCF (yr 20)/(WACC – growth rate) : assumes growth rate = inflation rate*	
Feedstock inflation rate	1%		

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33 (37 of 52) 200% Find

Yukon

Corporate income tax rates (for December 31, 2012 year ends)

General (non M&P)	M&P	CCPC Active business income to $500,000 Non-M&P	CCPC Active business income to $500,000 M&P	CCPC Investment income
15	2.5	4	2.5	15
30	**17.5**	**15**	**13.5**	**49.67**

Figures in **bold** are combined federal/territorial rates.

Other 2012 rates

Capital tax	None
Payroll tax	None
Sales tax	None

Additional highlights

No additional significant corporate tax changes were announced.

http://www.budget.gc.ca/2010/plan/anx5-eng.html#a27

Accelerated CCA for Clean Energy Generation

Class 43.2 was introduced in 2005 and is currently available for assets acquired on or after February 23, 2005 and before 2020. For assets acquired before February 23, 2005, accelerated CCA is provided under Class 43.1 (30 per cent). The eligibility criteria for these two classes are generally the same, except that cogeneration systems that use fossil fuels must meet a higher efficiency standard for Class 43.2 than for Class 43.1. Systems that only meet the lower efficiency standard are eligible for Class 43.1.

Class 43.2 includes a variety of stationary clean energy generation or conservation equipment that is used to produce electricity or thermal energy, or used to produce certain fuels from waste that are in turn used to produce electricity or thermal energy. Subject to detailed rules in the regulations, eligible equipment includes:

ELECTRICITY

- High efficiency cogeneration equipment;
- Wind turbines;
- Small hydroelectric facilities;
- Fuel cells;
- Photovoltaic equipment;
- Wave and tidal power equipment;
- Equipment that generates electricity using geothermal energy; and
- Equipment that generates electricity using an eligible waste fuel.

THERMAL ENERGY

- Active solar equipment;
- Ground source heat pump equipment;
- District energy equipment that distributes thermal energy from cogeneration;
- Equipment that generates heat for an industrial process or a greenhouse using an eligible waste fuel; and
- Heat recovery equipment used in electricity generation and industrial processes.

FUELS FROM WASTE

- Equipment that recovers landfill gas or digester gas;
- Equipment used to convert biomass into bio-oil; and
- Equipment used to produce biogas through anaerobic digestion.

If the majority of tangible property in a project is eligible for inclusion in Class 43.2, then certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian Renewable and Conservation Expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares.

Budget 2010 proposes to expand Class 43.2 to include: (a) heat recovery equipment used i a broader range of applications; and (b) distribution equipment used in district energy systems that rely primarily on ground source heat pumps, active solar systems or heat recovery equipment.

NEWCO CASH FLOW PROJECTION
OPTION 2 - 0.5 MW PLANT
(NEWCO OWNED / ISP OPERATED)

	TOTAL NPV	CONSTRUCTION Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
REVENUE																							
Electricity sales	$8,187,383		$721,824	$743,479	$765,783	$788,757	$812,419	$836,792	$861,896	$887,752	$914,385	$941,817	$970,071	$999,173	$1,029,148	$1,060,023	$1,091,824	$1,124,578	$1,158,316	$1,193,065	$1,228,857	$1,265,723	
ORC Electricity	$651,975		$53,222	$54,819	$56,464	$58,157	$59,902	$61,699	$63,550	$65,457	$67,420	$69,443	$71,526	$73,672	$75,882	$78,159	$80,503	$82,919	$85,406	$87,968	$90,607	$93,326	
District heat sales	$2,774,391		$244,599	$251,937	$259,495	$267,279	$275,298	$283,557	$292,063	$300,825	$309,850	$319,146	$328,720	$338,582	$348,739	$359,201	$369,977	$381,077	$392,509	$404,284	$416,413	$428,905	
Total revenue	**$11,613,749**	**$0**	**$1,019,645**	**$1,050,234**	**$1,081,741**	**$1,114,193**	**$1,147,619**	**$1,182,048**	**$1,217,509**	**$1,254,035**	**$1,291,656**	**$1,330,405**	**$1,370,317**	**$1,411,427**	**$1,453,770**	**$1,497,383**	**$1,542,304**	**$1,588,573**	**$1,636,231**	**$1,685,318**	**$1,735,877**	**$1,787,953**	
EXPENSE																							
Operations & maintenance - biomass	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operations & maintenance - district heat	($432,268)		($38,110)	($39,253)	($40,431)	($41,644)	($42,893)	($44,180)	($45,505)	($46,870)	($48,277)	($49,725)	($51,217)	($52,753)	($54,336)	($55,966)	($57,645)	($59,374)	($61,155)	($62,990)	($64,880)	($66,826)	
Operations & maintenance - ORC	($74,919)		($6,116)	($6,299)	($6,488)	($6,683)	($6,883)	($7,090)	($7,303)	($7,522)	($7,747)	($7,980)	($8,219)	($8,466)	($8,720)	($8,981)	($9,251)	($9,528)	($9,814)	($10,109)	($10,412)	($10,724)	
Administration expense	($2,827,264)		($249,260)	($256,738)	($264,440)	($272,373)	($280,544)	($288,961)	($297,629)	($306,558)	($315,755)	($325,228)	($334,985)	($345,034)	($355,385)	($366,047)	($377,028)	($388,339)	($399,989)	($411,989)	($424,348)	($437,079)	
Fuel (feedstock)	($1,492,889)		($152,887)	($154,415)	($155,960)	($157,519)	($159,094)	($160,685)	($162,292)	($163,915)	($165,554)	($167,210)	($168,882)	($170,571)	($172,276)	($173,999)	($175,739)	($177,497)	($179,271)	($181,064)	($182,875)	($184,704)	
Amortization	($10,667,591)		($1,997,004)	($3,097,709)	($1,731,348)	($1,202,519)	($927,631)	($784,815)	($711,694)	($676,073)	($661,152)	($658,037)	($661,942)	($670,236)	($681,437)	($694,695)	($709,504)	($725,562)	($742,684)	($760,754)	($779,704)	($799,494)	
Total expense	**($15,494,932)**		**($2,443,377)**	**($3,554,415)**	**($2,198,667)**	**($1,680,738)**	**($1,417,046)**	**($1,285,730)**	**($1,224,424)**	**($1,200,939)**	**($1,198,485)**	**($1,208,179)**	**($1,225,244)**	**($1,247,059)**	**($1,272,154)**	**($1,299,688)**	**($1,329,167)**	**($1,360,300)**	**($1,392,914)**	**($1,426,906)**	**($1,462,219)**	**($1,498,827)**	
EARNINGS BEFORE INTEREST & TAXES	**($3,881,182)**		**($1,423,732)**	**($2,504,180)**	**($1,116,926)**	**($566,544)**	**($269,427)**	**($103,683)**	**($6,914)**	**$53,095**	**$93,171**	**$122,226**	**$145,073**	**$164,368**	**$181,615**	**$197,695**	**$213,137**	**$228,273**	**$243,317**	**$258,412**	**$273,658**	**$289,127**	
Less: Income taxes	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Add: Amortization	$10,667,591		$1,997,004	$3,097,709	$1,731,348	$1,202,519	$927,631	$784,815	$711,694	$676,073	$661,152	$658,037	$661,942	$670,236	$681,437	$694,695	$709,504	$725,562	$742,684	$760,754	$779,704	$799,494	
Add: Government (NRCan) capital funding	$7,730,841	**$8,349,308**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Capital expenditures	($11,538,568)	**($12,461,654)**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Annual capital renewal	($4,240,670)		$0	$0	$0	($521,374)	($537,015)	($553,126)	($569,719)	($586,811)	($604,415)	($622,548)	($641,224)	($660,461)	($680,275)	($700,683)	($721,703)	($743,355)	($765,655)	($788,625)	($812,284)	($836,652)	
Add: Terminal value of free cash flow at yea	$926,944		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,039,370
Add: PV of unused tax losses at year 20	$566,824		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,081,560
FREE CASH FLOW	**($1,261,988)**	**($4,112,346)**	**$573,272**	**$593,528**	**$614,423**	**$114,600**	**$121,189**	**$128,006**	**$135,060**	**$142,358**	**$149,907**	**$157,715**	**$165,791**	**$174,142**	**$182,778**	**$191,707**	**$200,938**	**$210,481**	**$220,345**	**$230,541**	**$241,079**	**$251,969**	
CUMULATIVE FREE CASH FLOW		**($4,112,346)**	**($3,539,073)**	**($2,945,545)**	**($2,331,122)**	**($2,216,522)**	**($2,095,333)**	**($1,967,327)**	**($1,832,266)**	**($1,689,908)**	**($1,540,001)**	**($1,382,286)**	**($1,216,495)**	**($1,042,353)**	**($859,575)**	**($667,868)**	**($466,930)**	**($256,449)**	**($36,103)**	**$194,438**	**$435,516**	**$687,485**	

	IRR	ROI
	1.8%	-6.2%
Simple Payback	18	Years

Income tax calculations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Earnings before interest and taxes	($1,423,732)	($2,504,180)	($1,116,926)	($566,544)	($269,427)	($103,683)	($6,914)	$53,095	$93,171	$122,226	$145,073	$164,368	$181,615	$197,695	$213,137	$228,273	$243,317	$258,412	$273,658	$289,127
Deduct: Interest expense on LTD	($436,158)	($422,967)	($409,117)	($394,575)	($379,305)	($363,272)	($346,437)	($328,760)	($310,200)	($290,712)	($270,249)	($248,763)	($226,202)	($202,514)	($177,641)	($151,525)	($124,103)	($95,309)	($65,076)	($33,332)
Net taxable income (loss)	($1,859,890)	($2,927,148)	($1,526,043)	($961,119)	($648,732)	($466,954)	($353,351)	($275,665)	($217,029)	($168,486)	($125,176)	($84,395)	($44,587)	($4,819)	$35,496	$76,748	$119,214	$163,102	$208,581	$255,795
Income taxes payable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,424	$26,862	$41,725	$57,086	$73,003	$89,528
Less: Prior year tax losses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($12,424)	($26,862)	($41,725)	($57,086)	($73,003)	($89,528)
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Unused tax losses, opening balance	$0	$650,961	$1,675,463	$2,209,578	$2,545,970	$2,773,026	$2,936,460	$3,060,133	$3,156,616	$3,232,576	$3,291,546	$3,335,357	$3,364,895	$3,380,501	$3,382,188	$3,369,764	$3,342,902	$3,301,177	$3,244,091	$3,171,088
Income tax losses - current year	$650,961	$1,024,502	$534,115	$336,392	$227,056	$163,434	$123,673	$96,483	$75,960	$58,970	$43,811	$29,538	$15,605	$1,687	$0	$0	$0	$0	$0	$0
Tax losses applied during the year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($12,424)	($26,862)	($41,725)	($57,086)	($73,003)	($89,528)
Unused tax losses - cumulative	**$650,961**	**$1,675,463**	**$2,209,578**	**$2,545,970**	**$2,773,026**	**$2,936,460**	**$3,060,133**	**$3,156,616**	**$3,232,576**	**$3,291,546**	**$3,335,357**	**$3,364,895**	**$3,380,501**	**$3,382,188**	**$3,369,764**	**$3,342,902**	**$3,301,177**	**$3,244,091**	**$3,171,088**	**$3,081,560**

ASSUMPTIONS - OPTION 3 (0.5 MW)

INPUT IN SHADED CELLS ONLY — yellow cells indicate awaiting final numbers from engineering

CAPITAL:

District heating, installed cost		*not included*
Biomass plant, installed cost	$6,271,314	
Total plant etc.	$6,271,314	*see 'Capital Costs' worksheet*
ORC	$194,235	
Feedstock yard		
Land	$0	*see 'Capital Costs' worksheet*
Buildings	$1,968,265	*see 'Capital Costs' worksheet*
Equipment	$2,126,588	*see 'Capital Costs' worksheet*
Total capital requirement	$10,560,401	
Capital renewal - annual rate		
Plant	4.0%	*% of original capex, starting in year 4 - assume 25 year life*
Buildings	2.0%	*% of original capex, starting in year 4 - assume 50 year life*
Equipment	6.0%	*% of original capex, starting in year 4 - assume 15 year life*

OPERATING:

Revenues

Total annual sales - kWh	3,504,000	*500kWe, 80% availability*
Electricity selling price - $/kWh	$0.200	per CAFN (Ray)
ORC Electricity sales-kWh	258361	*@ 8% of remaining heat*
District heat annual sales - kWh	1,283,645	*Revised DE Network*
Heat selling price - $/kWh	$0.185	*per CTCG*
Government subsidies - $/kWh	$0.00	

Expenses

O&M expenses - plant - $ / kWh		
O&M expenses - yard - $ / kWh		
O&M expenses - district heat - $	$37,000	*per CTCG*
O&M ORC	$5,938	*per CTCG*
O&M Plant	$242,000	*per FEED report*
Feedstock - $/tonne	$50.40	*per FEED report*

Production factor - tonnes/kWh	0.00086		*1 kg (.001 tonne) per hour = 1 kWh*
Fuel cost per kWh	$0.04		
Amortization (CCA) - annual rate			
Plant	50.0%		*Accelerated CCA class 43.2, see below*
Buildings	4.0%		*CCA class 1*
Equipment	30.0%		*CCA class 43*
Income tax - combined rate	35.0%		

FINANCIAL:

Grant money	67%	$7,075,469	
Capitalization			
Debt %	70%	$2,439,453	per CAFN (Ray)
Equity %	30%	$1,045,480	per CAFN (Ray)
Total capital funding		$10,560,401	ok
Ownership			
CAFN	60%	$627,288	per CAFN (Ray)
Yukon Energy	30%	$313,644	per CAFN (Ray)
Village of Haines Junction	10%	$104,548	per CAFN (Ray)
	100%	$1,045,480	
Long term debt			
Interest rate	5.0%		
Debt term, in years	20		
ROI requirements - after tax			
CAFN	15%	per CAFN (Ray)	
Yukon Energy	15%	per CAFN (Ray)	
Village of Haines Junction	15%	per CAFN (Ray)	
WACC - after tax	8.00%		
Annual inflation rate	3.0%		*assumes same rate for both operating and capital expenditures*
Terminal (perpetuity) value multiple	20.0		*Terminal Value = FCF (yr 20)/(WACC – growth rate) : assumes growth rate = inflation rate*
Feedstock inflation rate	1%		

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Yukon

Corporate income tax rates (for December 31, 2012 year ends)

General (non M&P)	M&P	CCPC: Active business income to $500,000 — Non-M&P	CCPC: Active business income to $500,000 — M&P	CCPC: Investment income
15 **30**	2.5 **17.5**	4 **15**	2.5 **13.5**	15 **49.67**

Figures in **bold** are combined federal/territorial rates.

Other 2012 rates

Capital tax	None
Payroll tax	None
Sales tax	None

Additional highlights

No additional significant corporate tax changes were announced.

http://www.budget.gc.ca/2010/plan/anx5-eng.html#a27

Accelerated CCA for Clean Energy Generation

Class 43.2 was introduced in 2005 and is currently available for assets acquired on or after February 23, 2005 and before 2020. For assets acquired before February 23, 2005, accelerated CCA is provided under Class 43.1 (30 per cent). The eligibility criteria for these two classes are generally the same, except that cogeneration systems that use fossil fuels must meet a higher efficiency standard for Class 43.2 than for Class 43.1. Systems that only meet the lower efficiency standard are eligible for Class 43.1.

Class 43.2 includes a variety of stationary clean energy generation or conservation equipment that is used to produce electricity or thermal energy, or used to produce certain fuels from waste that are in turn used to produce electricity or thermal energy. Subject to detailed rules in the regulations, eligible equipment includes:

ELECTRICITY

- High efficiency cogeneration equipment;
- Wind turbines;
- Small hydroelectric facilities;
- Fuel cells;
- Photovoltaic equipment;
- Wave and tidal power equipment;
- Equipment that generates electricity using geothermal energy; and
- Equipment that generates electricity using an eligible waste fuel.

THERMAL ENERGY

- Active solar equipment;
- Ground source heat pump equipment;
- District energy equipment that distributes thermal energy from cogeneration;
- Equipment that generates heat for an industrial process or a greenhouse using an eligible waste fuel; and
- Heat recovery equipment used in electricity generation and industrial processes.

FUELS FROM WASTE

- Equipment that recovers landfill gas or digester gas;
- Equipment used to convert biomass into bio-oil; and
- Equipment used to produce biogas through anaerobic digestion.

If the majority of tangible property in a project is eligible for inclusion in Class 43.2, then certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian Renewable and Conservation Expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares.

Budget 2010 proposes to expand Class 43.2 to include: (a) heat recovery equipment used i a broader range of applications; and (b) distribution equipment used in district energy systems that rely primarily on ground source heat pumps, active solar systems or heat recovery equipment.

NEWCO CASH FLOW PROJECTION
OPTION 3 - 0.5 MW PLANT
(NEWCO OWNED / ISP OPERATED)

	TOTAL NPV	CONSTRUCTION Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
REVENUE																							
Electricity sales	$8,187,383		$721,824	$743,479	$765,783	$788,757	$812,419	$836,792	$861,896	$887,752	$914,385	$941,817	$970,071	$999,173	$1,029,148	$1,060,023	$1,091,824	$1,124,578	$1,158,316	$1,193,065	$1,228,857	$1,265,723	
ORC Electricity	$651,975		$53,222	$54,819	$56,464	$58,157	$59,902	$61,699	$63,550	$65,457	$67,420	$69,443	$71,526	$73,672	$75,882	$78,159	$80,503	$82,919	$85,406	$87,968	$90,607	$93,326	
District heat sales	$2,774,391		$244,599	$251,937	$259,495	$267,279	$275,298	$283,557	$292,063	$300,825	$309,850	$319,146	$328,720	$338,582	$348,739	$359,201	$369,977	$381,077	$392,509	$404,284	$416,413	$428,905	
Total revenue	**$11,613,749**	**$0**	**$1,019,645**	**$1,050,234**	**$1,081,741**	**$1,114,193**	**$1,147,619**	**$1,182,048**	**$1,217,509**	**$1,254,035**	**$1,291,656**	**$1,330,405**	**$1,370,317**	**$1,411,427**	**$1,453,770**	**$1,497,383**	**$1,542,304**	**$1,588,573**	**$1,636,231**	**$1,685,318**	**$1,735,877**	**$1,787,953**	
EXPENSE																							
Operations & maintenance - biomass	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operations & maintenance - district heat	($432,268)		($38,110)	($39,253)	($40,431)	($41,644)	($42,893)	($44,180)	($45,505)	($46,870)	($48,277)	($49,725)	($51,217)	($52,753)	($54,336)	($55,966)	($57,645)	($59,374)	($61,155)	($62,990)	($64,880)	($66,826)	
Operations & maintenance - ORC	($74,919)		($6,116)	($6,299)	($6,488)	($6,683)	($6,883)	($7,090)	($7,303)	($7,522)	($7,747)	($7,980)	($8,219)	($8,466)	($8,720)	($8,981)	($9,251)	($9,528)	($9,814)	($10,109)	($10,412)	($10,724)	
Administration expense	($2,827,264)		($249,260)	($256,738)	($264,440)	($272,373)	($280,544)	($288,961)	($297,629)	($306,558)	($315,755)	($325,228)	($334,985)	($345,034)	($355,385)	($366,047)	($377,028)	($388,339)	($399,989)	($411,989)	($424,348)	($437,079)	
Fuel (feedstock)	($1,492,889)		($152,887)	($154,415)	($155,960)	($157,519)	($159,094)	($160,685)	($162,292)	($163,915)	($165,554)	($167,210)	($168,882)	($170,571)	($172,276)	($173,999)	($175,739)	($177,497)	($179,271)	($181,064)	($182,875)	($184,704)	
Amortization	($9,906,307)		($1,926,182)	($2,971,179)	($1,629,537)	($1,110,783)	($842,280)	($703,623)	($633,268)	($599,507)	($585,833)	($583,536)	($587,944)	($596,499)	($607,773)	($620,945)	($635,535)	($651,255)	($667,930)	($685,454)	($703,763)	($722,820)	
Total expense	**($14,733,648)**		**($2,372,554)**	**($3,427,884)**	**($2,096,856)**	**($1,589,002)**	**($1,331,695)**	**($1,204,538)**	**($1,145,997)**	**($1,124,373)**	**($1,123,166)**	**($1,133,678)**	**($1,151,246)**	**($1,173,323)**	**($1,198,490)**	**($1,225,938)**	**($1,255,198)**	**($1,285,993)**	**($1,318,160)**	**($1,351,606)**	**($1,386,278)**	**($1,422,152)**	
EARNINGS BEFORE INTEREST & TAXES	**($3,119,898)**		**($1,352,909)**	**($2,377,650)**	**($1,015,114)**	**($474,809)**	**($184,076)**	**($22,491)**	**$71,512**	**$129,662**	**$168,489**	**$196,727**	**$219,071**	**$238,104**	**$255,280**	**$271,445**	**$287,106**	**$302,581**	**$318,070**	**$333,712**	**$349,599**	**$365,801**	
Less: Income taxes	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Add: Amortization	$9,906,307		$1,926,182	$2,971,179	$1,629,537	$1,110,783	$842,280	$703,623	$633,268	$599,507	$585,833	$583,536	$587,944	$596,499	$607,773	$620,945	$635,535	$651,255	$667,930	$685,454	$703,763	$722,820	
Add: Government (NRCan) capital funding	$6,551,360	**$7,075,469**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Capital expenditures	($9,778,149)	**($10,560,401)**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Annual capital renewal	($3,824,865)		$0	$0	$0	($470,252)	($484,360)	($498,891)	($513,857)	($529,273)	($545,151)	($561,506)	($578,351)	($595,702)	($613,573)	($631,980)	($650,939)	($670,467)	($690,581)	($711,299)	($732,638)	($754,617)	
Add: Terminal value of free cash flow at yea	$1,228,736		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$6,680,073
Add: PV of unused tax losses at year 20	$411,455		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,236,894
FREE CASH FLOW	**($265,245)**	**($3,484,932)**	**$573,272**	**$593,528**	**$614,423**	**$165,722**	**$173,844**	**$182,241**	**$190,922**	**$199,896**	**$209,171**	**$218,757**	**$228,664**	**$238,902**	**$249,480**	**$260,410**	**$271,702**	**$283,368**	**$295,419**	**$307,867**	**$320,724**	**$334,004**	
CUMULATIVE FREE CASH FLOW		**($3,484,932)**	**($2,911,660)**	**($2,318,132)**	**($1,703,709)**	**($1,537,987)**	**($1,364,143)**	**($1,181,902)**	**($990,979)**	**($791,083)**	**($581,912)**	**($363,155)**	**($134,491)**	**$104,410**	**$353,890**	**$614,301**	**$886,003**	**$1,169,371**	**$1,464,790**	**$1,772,657**	**$2,093,382**	**$2,427,385**	

	IRR	ROI
	6.5%	**-1.5%**
Simple Payback	**12**	**Years**

Income tax calculations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Earnings before interest and taxes	($1,352,909)	($2,377,650)	($1,015,114)	($474,809)	($184,076)	($22,491)	$71,512	$129,662	$168,489	$196,727	$219,071	$238,104	$255,280	$271,445	$287,106	$302,581	$318,070	$333,712	$349,599	$365,801
Deduct: Interest expense on LTD	($369,614)	($358,436)	($346,699)	($334,375)	($321,435)	($307,848)	($293,582)	($278,602)	($262,873)	($246,358)	($229,017)	($210,809)	($191,691)	($171,617)	($150,539)	($128,407)	($105,169)	($80,768)	($55,148)	($28,246)
Net taxable income (loss)	($1,722,523)	($2,736,086)	($1,361,813)	($809,184)	($505,511)	($330,339)	($222,070)	($148,940)	($94,384)	($49,631)	($9,946)	$27,294	$63,589	$99,828	$136,568	$174,174	$212,902	$252,943	$294,451	$337,555
Income taxes payable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,553	$22,256	$34,940	$47,799	$60,961	$74,516	$88,530	$103,058	$118,144
Less: Prior year tax losses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($9,553)	($22,256)	($34,940)	($47,799)	($60,961)	($74,516)	($88,530)	($103,058)	($118,144)
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Unused tax losses, opening balance	$0	$602,883	$1,560,513	$2,037,148	$2,320,362	$2,497,291	$2,612,910	$2,690,634	$2,742,763	$2,775,798	$2,793,169	$2,796,650	$2,787,097	$2,764,841	$2,729,901	$2,682,102	$2,621,142	$2,546,626	$2,458,096	$2,355,038
Income tax losses - current year	$602,883	$957,630	$476,635	$283,214	$176,929	$115,619	$77,724	$52,129	$33,034	$17,371	$3,481	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tax losses applied during the year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($9,553)	($22,256)	($34,940)	($47,799)	($60,961)	($74,516)	($88,530)	($103,058)	($118,144)
Unused tax losses - cumulative	**$602,883**	**$1,560,513**	**$2,037,148**	**$2,320,362**	**$2,497,291**	**$2,612,910**	**$2,690,634**	**$2,742,763**	**$2,775,798**	**$2,793,169**	**$2,796,650**	**$2,787,097**	**$2,764,841**	**$2,729,901**	**$2,682,102**	**$2,621,142**	**$2,546,626**	**$2,458,096**	**$2,355,038**	**$2,236,894**

ASSUMPTIONS - OPTION 4 (EXPANSION) (1.0 MW)

INPUT IN SHADED CELLS ONLY — yellow cells indicate awaiting final numbers from engineering

CAPITAL:

District heating, installed cost		*not included*
Biomass plant, installed cost	$12,115,684	
Total plant etc.	$12,115,684	*see 'Capital Costs' worksheet*
ORC	$388,470	
Feedstock yard		
Land	$0	*see 'Capital Costs' worksheet*
Buildings	$3,909,184	*see 'Capital Costs' worksheet*
Equipment	$3,496,871	*see 'Capital Costs' worksheet*
Total capital requirement	$19,910,209	
Capital renewal - annual rate		
Plant	4.0%	*% of original capex, starting in year 4 - assume 25 year life*
Buildings	2.0%	*% of original capex, starting in year 4 - assume 50 year life*
Equipment	6.0%	*% of original capex, starting in year 4 - assume 15 year life*

OPERATING:

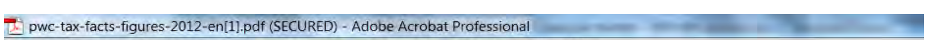
Revenues

Total annual sales - kWh	7,008,000	*500kWe, 80% availability*
Electricity selling price - $/kWh	$0.200	per CAFN (Ray)
ORC Electricity sales - kWh	516721	*@ 8% of remaining heat*
District heat annual sales - kWh	1,283,645	*Revised DE Network*
Heat selling price - $/kWh	$0.185	*per CTCG*
Government subsidies - $/kWh	$0.00	

Expenses

O&M expenses - plant - $ / kWh		
O&M expenses - yard - $ / kWh		
O&M expenses - district heat - $	$37,000	*per CTCG*
O&M ORC	$11,875	*per CTCG*
O&M Plant	$351,125	*per FEED report*
Feedstock - $/tonne	$50.40	*per FEED report*

Production factor - tonnes/kWh	0.00086		*1 kg (.001 tonne) per hour = 1 kWh*
Fuel cost per kWh	$0.04		
Amortization (CCA) - annual rate			
Plant	50.0%		*Accelerated CCA class 43.2, see below*
Buildings	4.0%		*CCA class 1*
Equipment	30.0%		*CCA class 43*
Income tax - combined rate	35.0%		
FINANCIAL:			
Grant money	67%	$ 13,339,840	
Capitalization			
Debt %	70%	$4,599,258	per CAFN (Ray)
Equity %	30%	$1,971,111	per CAFN (Ray)
Total capital funding		$19,910,209	ok
Ownership			
CAFN	60%	$1,182,666	per CAFN (Ray)
Yukon Energy	30%	$591,333	per CAFN (Ray)
Village of Haines Junction	10%	$197,111	per CAFN (Ray)
	100%	$1,971,111	
Interest rate	5.0%		
Debt term, in years	20		
ROI requirements - after tax			
CAFN	15%		per CAFN (Ray)
Yukon Energy	15%		per CAFN (Ray)
Village of Haines Junction	15%		per CAFN (Ray)
WACC - after tax	8.00%		
Annual inflation rate	3.0%		*assumes same rate for both operating and capital expenditures*
Terminal (perpetuity) value multiple	20.0		*Terminal Value = FCF (yr 20)/(WACC – growth rate) : assumes growth rate = inflation rate*
Feedstock inflation rate	1%		



http://www.budget.gc.ca/2010/plan/anx5-eng.html#a27

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33 (37 of 52) 200% Find

Yukon

Corporate income tax rates (for December 31, 2012 year ends)

General (non M&P)	M&P	CCPC: Active business income to $500,000 — Non-M&P	CCPC: Active business income to $500,000 — M&P	CCPC: Investment income
15	2.5	4	2.5	15
30	**17.5**	**15**	**13.5**	**49.67**

Figures in **bold** are combined federal/territorial rates.

Other 2012 rates

Capital tax	None
Payroll tax	None
Sales tax	None

Additional highlights

No additional significant corporate tax changes were announced.

Accelerated CCA for Clean Energy Generation

Class 43.2 was introduced in 2005 and is currently available for assets acquired on or after February 23, 2005 and before 2020. For assets acquired before February 23, 2005, accelerated CCA is provided under Class 43.1 (30 per cent). The eligibility criteria for these two classes are generally the same, except that cogeneration systems that use fossil fuels must meet a higher efficiency standard for Class 43.2 than for Class 43.1. Systems that only meet the lower efficiency standard are eligible for Class 43.1.

Class 43.2 includes a variety of stationary clean energy generation or conservation equipment that is used to produce electricity or thermal energy, or used to produce certain fuels from waste that are in turn used to produce electricity or thermal energy. Subject to detailed rules in the regulations, eligible equipment includes:

ELECTRICITY

- High efficiency cogeneration equipment;
- Wind turbines;
- Small hydroelectric facilities;
- Fuel cells;
- Photovoltaic equipment;
- Wave and tidal power equipment;
- Equipment that generates electricity using geothermal energy; and
- Equipment that generates electricity using an eligible waste fuel.

THERMAL ENERGY

- Active solar equipment;
- Ground source heat pump equipment;
- District energy equipment that distributes thermal energy from cogeneration;
- Equipment that generates heat for an industrial process or a greenhouse using an eligible waste fuel; and
- Heat recovery equipment used in electricity generation and industrial processes.

FUELS FROM WASTE

- Equipment that recovers landfill gas or digester gas;
- Equipment used to convert biomass into bio-oil; and
- Equipment used to produce biogas through anaerobic digestion.

If the majority of tangible property in a project is eligible for inclusion in Class 43.2, then certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian Renewable and Conservation Expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares.

Budget 2010 proposes to expand Class 43.2 to include: (a) heat recovery equipment used i a broader range of applications; and (b) distribution equipment used in district energy systems that rely primarily on ground source heat pumps, active solar systems or heat recovery equipment.

NEWCO CASH FLOW PROJECTION
OPTION 4 (EXPANSION) - 1.0 MW PLANT
(NEWCO OWNED / ISP OPERATED)

	TOTAL NPV	CONSTRUCTION Year 0	1	2	3	4	5	6	7	8	9	10
REVENUE												
Electricity sales	$16,374,767		$1,443,648	$1,486,957	$1,531,566	$1,577,513	$1,624,839	$1,673,584	$1,723,791	$1,775,505	$1,828,770	$1,883,633
ORC Electricity	$1,303,950		$106,445	$109,638	$112,927	$116,315	$119,804	$123,398	$127,100	$130,913	$134,841	$138,886
District heat sales	$2,774,391		$244,599	$251,937	$259,495	$267,279	$275,298	$283,557	$292,063	$300,825	$309,850	$319,146
Total revenue	**$20,453,108**	**$0**	**$1,794,691**	**$1,848,532**	**$1,903,988**	**$1,961,107**	**$2,019,941**	**$2,080,539**	**$2,142,955**	**$2,207,244**	**$2,273,461**	**$2,341,665**
EXPENSE												
Operations & maintenance - biomass	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operations & maintenance - district heat	($432,268)		($38,110)	($39,253)	($40,431)	($41,644)	($42,893)	($44,180)	($45,505)	($46,870)	($48,277)	($49,725)
Operations & maintenance - ORC	($149,838)		($12,232)	($12,599)	($12,977)	($13,366)	($13,767)	($14,180)	($14,605)	($15,043)	($15,495)	($15,960)
Administration expense	($4,102,162)		($361,659)	($372,509)	($383,684)	($395,194)	($407,050)	($419,262)	($431,839)	($444,795)	($458,138)	($471,883)
Fuel (feedstock)	($2,985,778)		($305,773)	($308,831)	($311,919)	($315,038)	($318,189)	($321,371)	($324,584)	($327,830)	($331,108)	($334,419)
Amortization	($18,477,139)		($3,631,635)	($5,588,324)	($3,042,993)	($2,061,095)	($1,556,189)	($1,297,592)	($1,167,761)	($1,106,386)	($1,082,236)	($1,078,948)
Total expense	**($26,147,186)**		**($4,349,409)**	**($6,321,515)**	**($3,792,003)**	**($2,826,337)**	**($2,338,087)**	**($2,096,584)**	**($1,984,296)**	**($1,940,925)**	**($1,935,254)**	**($1,950,934)**
EARNINGS BEFORE INTEREST & TAXES	**($5,694,078)**		**($2,554,718)**	**($4,472,983)**	**($1,888,015)**	**($865,230)**	**($318,147)**	**($16,045)**	**$158,659**	**$266,319**	**$338,207**	**$390,731**
Less: Income taxes	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Add: Amortization	$18,477,139		$3,631,635	$5,588,324	$3,042,993	$2,061,095	$1,556,189	$1,297,592	$1,167,761	$1,106,386	$1,082,236	$1,078,948
Add: Government (NRCan) capital funding	$12,351,704	**$13,339,840**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Less: Capital expenditures	($18,435,379)	**($19,910,209)**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Less: Annual capital renewal	($7,072,970)		$0	$0	$0	($869,594)	($895,682)	($922,553)	($950,229)	($978,736)	($1,008,098)	($1,038,341)
Add: Terminal value of free cash flow at yea	$2,426,932		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Add: PV of unused tax losses at year 20	$747,988		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FREE CASH FLOW	**($373,584)**	**($6,570,369)**	**$1,076,918**	**$1,115,341**	**$1,154,977**	**$326,271**	**$342,360**	**$358,994**	**$376,192**	**$393,969**	**$412,345**	**$431,337**
CUMULATIVE FREE CASH FLOW		**($6,570,369)**	**($5,493,451)**	**($4,378,111)**	**($3,223,133)**	**($2,896,863)**	**($2,554,503)**	**($2,195,509)**	**($1,819,317)**	**($1,425,348)**	**($1,013,003)**	**($581,666)**

	11	12	13	14	15	16	17	18	19	20	
REVENUE											
Electricity sales	$1,940,142	$1,998,346	$2,058,297	$2,120,046	$2,183,647	$2,249,157	$2,316,631	$2,386,130	$2,457,714	$2,531,446	
ORC Electricity	$143,053	$147,344	$151,764	$156,317	$161,007	$165,837	$170,812	$175,937	$181,215	$186,651	
District heat sales	$328,720	$338,582	$348,739	$359,201	$369,977	$381,077	$392,509	$404,284	$416,413	$428,905	
Total revenue	**$2,411,915**	**$2,484,272**	**$2,558,800**	**$2,635,564**	**$2,714,631**	**$2,796,070**	**$2,879,952**	**$2,966,351**	**$3,055,341**	**$3,147,002**	
EXPENSE											
Operations & maintenance - biomass	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operations & maintenance - district heat	($51,217)	($52,753)	($54,336)	($55,966)	($57,645)	($59,374)	($61,155)	($62,990)	($64,880)	($66,826)	
Operations & maintenance - ORC	($16,438)	($16,931)	($17,439)	($17,963)	($18,501)	($19,057)	($19,628)	($20,217)	($20,824)	($21,448)	
Administration expense	($486,039)	($500,620)	($515,639)	($531,108)	($547,041)	($563,453)	($580,356)	($597,767)	($615,700)	($634,171)	
Fuel (feedstock)	($337,764)	($341,141)	($344,553)	($347,998)	($351,478)	($354,993)	($358,543)	($362,128)	($365,750)	($369,407)	
Amortization	($1,087,818)	($1,104,135)	($1,125,293)	($1,149,819)	($1,176,860)	($1,205,915)	($1,236,683)	($1,268,983)	($1,302,708)	($1,337,799)	
Total expense	**($1,979,276)**	**($2,015,581)**	**($2,057,260)**	**($2,102,853)**	**($2,151,526)**	**($2,202,792)**	**($2,256,366)**	**($2,312,085)**	**($2,369,861)**	**($2,429,651)**	
EARNINGS BEFORE INTEREST & TAXES	**$432,639**	**$468,691**	**$501,541**	**$532,711**	**$563,105**	**$593,279**	**$623,587**	**$654,266**	**$685,481**	**$717,350**	
Less: Income taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Add: Amortization	$1,087,818	$1,104,135	$1,125,293	$1,149,819	$1,176,860	$1,205,915	$1,236,683	$1,268,983	$1,302,708	$1,337,799	
Add: Government (NRCan) capital funding	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Capital expenditures	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Annual capital renewal	($1,069,491)	($1,101,576)	($1,134,623)	($1,168,662)	($1,203,722)	($1,239,834)	($1,277,029)	($1,315,339)	($1,354,800)	($1,395,444)	
Add: Terminal value of free cash flow at yea	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$13,194,114
Add: PV of unused tax losses at year 20	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,066,468
FREE CASH FLOW	**$450,966**	**$471,250**	**$492,210**	**$513,868**	**$536,244**	**$559,360**	**$583,241**	**$607,909**	**$633,389**	**$659,706**	
CUMULATIVE FREE CASH FLOW	**($130,701)**	**$340,549**	**$832,759**	**$1,346,627**	**$1,882,870**	**$2,442,231**	**$3,025,472**	**$3,633,381**	**$4,266,770**	**$4,926,476**	

	IRR	ROI
	6.8%	**-1.2%**
Simple Payback	**12**	**Years**

Income tax calculations:	1	2	3	4	5	6	7	8	9	10
Earnings before interest and taxes	($2,554,718)	($4,472,983)	($1,888,015)	($865,230)	($318,147)	($16,045)	$158,659	$266,319	$338,207	$390,731
Deduct: Interest expense on LTD	($696,857)	($675,783)	($653,654)	($630,419)	($606,022)	($580,406)	($553,509)	($525,266)	($495,612)	($464,475)
Net taxable income (loss)	($3,251,575)	($5,148,766)	($2,541,669)	($1,495,649)	($924,169)	($596,451)	($394,849)	($258,948)	($157,405)	($73,744)
Income taxes payable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Less: Prior year tax losses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Unused tax losses, opening balance	$0	$1,138,051	$2,940,119	$3,829,703	$4,353,181	$4,676,640	$4,885,398	$5,023,595	$5,114,227	$5,169,318
Income tax losses - current year	$1,138,051	$1,802,068	$889,584	$523,477	$323,459	$208,758	$138,197	$90,632	$55,092	$25,811
Tax losses applied during the year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Unused tax losses - cumulative	**$1,138,051**	**$2,940,119**	**$3,829,703**	**$4,353,181**	**$4,676,640**	**$4,885,398**	**$5,023,595**	**$5,114,227**	**$5,169,318**	**$5,195,129**

Income tax calculations:	11	12	13	14	15	16	17	18	19	20
Earnings before interest and taxes	$432,639	$468,691	$501,541	$532,711	$563,105	$593,279	$623,587	$654,266	$685,481	$717,350
Deduct: Interest expense on LTD	($431,781)	($397,453)	($361,408)	($323,560)	($283,821)	($242,094)	($198,281)	($152,278)	($103,974)	($53,255)
Net taxable income (loss)	$858	$71,239	$140,133	$209,151	$279,284	$351,185	$425,305	$501,988	$581,507	$664,096
Income taxes payable	$300	$24,934	$49,047	$73,203	$97,750	$122,915	$148,857	$175,696	$203,527	$232,433
Less: Prior year tax losses	($300)	($24,934)	($49,047)	($73,203)	($97,750)	($122,915)	($148,857)	($175,696)	($203,527)	($232,433)
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Unused tax losses, opening balance	$5,195,129	$5,194,829	$5,169,895	$5,120,849	$5,047,646	$4,949,896	$4,826,982	$4,678,125	$4,502,429	$4,298,902
Income tax losses - current year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tax losses applied during the year	($300)	($24,934)	($49,047)	($73,203)	($97,750)	($122,915)	($148,857)	($175,696)	($203,527)	($232,433)
Unused tax losses - cumulative	**$5,194,829**	**$5,169,895**	**$5,120,849**	**$5,047,646**	**$4,949,896**	**$4,826,982**	**$4,678,125**	**$4,502,429**	**$4,298,902**	**$4,066,468**

ASSUMPTIONS - OPTION 9 (0.5 MW)

INPUT IN SHADED CELLS ONLY yellow cells indicate awaiting final numbers from engineering

CAPITAL:

District heating, installed cost		*not included*
Biomass plant, installed cost	$2,836,094	
Total plant etc.	$2,836,094	*see 'Capital Costs' worksheet*
ORC	$194,235	
Feedstock yard		
Land	$0	*see 'Capital Costs' worksheet*
Buildings	$2,128,742	*see 'Capital Costs' worksheet*
Equipment	$2,299,974	*see 'Capital Costs' worksheet*
Total capital requirement	$7,459,045	
Capital renewal - annual rate		
Plant	4.0%	*% of original capex, starting in year 4 - assume 25 year life*
Buildings	2.0%	*% of original capex, starting in year 4 - assume 50 year life*
Equipment	6.0%	*% of original capex, starting in year 4 - assume 15 year life*

OPERATING:

Revenues

Total annual sales - kWh	4,051,500	*500kWe, 92.5% availability*
Electricity selling price - $/kWh	$0.200	*per CAFN (Ray)*
ORC Electricity sales - kWh	329036	*@ 8% of remaining heat*
District heat annual sales - kWh	1,283,645	*Revised DE Network*
Heat selling price - $/kWh	$0.185	*per CTCG*
Government subsidies - $/kWh	$0.00	

Expenses

O&M expenses - plant - $ / kWh		
O&M expenses - yard - $ / kWh		
O&M expenses - district heat - $	$37,000	*per CTCG*
O&M ORC	$6,468	*per CTCG*
O&M plant	$242,000	*per FEED report*
Feedstock - $/tonne	$50.40	*per FEED report*

Production factor - tonnes/kWh	0.00086	*1 kg (.001 tonne) per hour = 1 kWh*
Fuel cost per kWh	$0.04	
Amortization (CCA) - annual rate		
Plant	50.0%	*Accelerated CCA class 43.2, see below*
Buildings	4.0%	*CCA class 1*
Equipment	30.0%	*CCA class 43*
Income tax - combined rate	35.0%	

FINANCIAL:

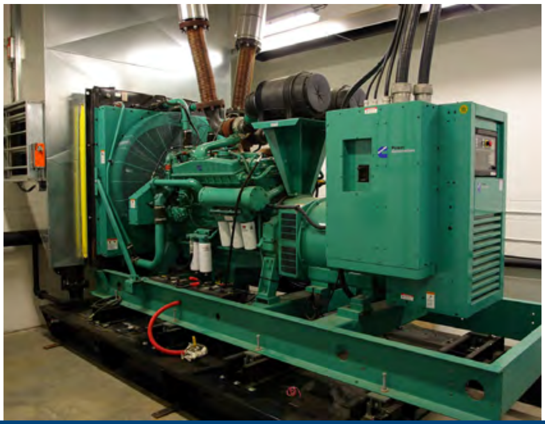
Grant money	67%	$4,997,560	
Capitalization			
Debt %	70%	$1,723,039	per CAFN (Ray)
Equity %	30%	$738,445	per CAFN (Ray)
Total capital funding		$7,459,045	ok
Ownership			
CAFN	60%	$443,067	per CAFN (Ray)
Yukon Energy	30%	$221,534	per CAFN (Ray)
Village of Haines Junction	10%	$73,845	per CAFN (Ray)
	100%	$738,445	
Long term debt			
Interest rate	5.0%		
Debt term, in years	20		
ROI requirements - after tax			
CAFN	15%	per CAFN (Ray)	
Yukon Energy	15%	per CAFN (Ray)	
Village of Haines Junction	15%	per CAFN (Ray)	
WACC - after tax	8.00%		
Annual inflation rate	3.0%	*assumes same rate for both operating and capital expenditures*	
Terminal (perpetuity) value multiple	20.0	*Terminal Value = FCF (yr 20)/(WACC – growth rate) : assumes growth rate = inflation rate*	
Feedstock inflation rate	1%		

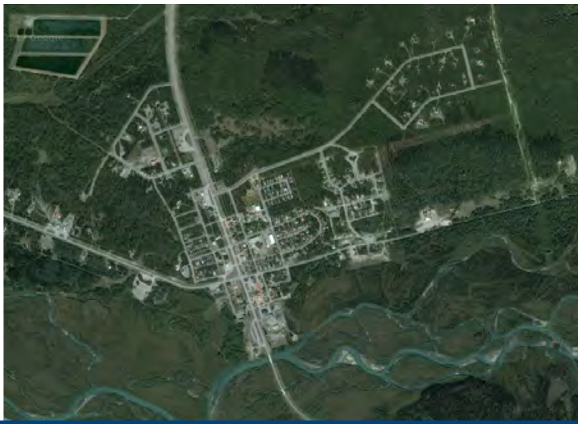
NEWCO CASH FLOW PROJECTION
OPTION 3 - 0.5 MW PLANT
(NEWCO OWNED / ISP OPERATED)

	TOTAL NPV	CONSTRUCTION Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
REVENUE																							
Electricity sales	$9,466,662		$834,609	$859,647	$885,437	$912,000	$939,360	$967,541	$996,567	$1,026,464	$1,057,258	$1,088,975	$1,121,645	$1,155,294	$1,189,953	$1,225,651	$1,262,421	$1,300,294	$1,339,302	$1,379,482	$1,420,866	$1,463,492	
ORC Electricity			$67,781	$69,815	$71,909	$74,067	$76,289	$78,577	$80,935	$83,363	$85,864	$88,439	$91,093	$93,825	$96,640	$99,539	$102,526	$105,601	$108,769	$112,032	$115,393	$118,855	
District heat sales	$2,774,391		$244,599	$251,937	$259,495	$267,279	$275,298	$283,557	$292,063	$300,825	$309,850	$319,146	$328,720	$338,582	$348,739	$359,201	$369,977	$381,077	$392,509	$404,284	$416,413	$428,905	
Total revenue	**$12,241,053**	**$0**	**$1,146,989**	**$1,181,399**	**$1,216,841**	**$1,253,346**	**$1,290,946**	**$1,329,675**	**$1,369,565**	**$1,410,652**	**$1,452,971**	**$1,496,561**	**$1,541,457**	**$1,587,701**	**$1,635,332**	**$1,684,392**	**$1,734,924**	**$1,786,972**	**$1,840,581**	**$1,895,798**	**$1,952,672**	**$2,011,252**	
EXPENSE																							
Operations & maintenance - biomass	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Operations & maintenance - district heat	($432,268)		($38,110)	($39,253)	($40,431)	($41,644)	($42,893)	($44,180)	($45,505)	($46,870)	($48,277)	($49,725)	($51,217)	($52,753)	($54,336)	($55,966)	($57,645)	($59,374)	($61,155)	($62,990)	($64,880)	($66,826)	
Operations & maintenance - ORC	($81,607)		($6,662)	($6,862)	($7,068)	($7,280)	($7,498)	($7,723)	($7,955)	($8,193)	($8,439)	($8,692)	($8,953)	($9,221)	($9,498)	($9,783)	($10,077)	($10,379)	($10,690)	($11,011)	($11,341)	($11,682)	
Administration expense	($2,827,264)		($249,260)	($256,738)	($264,440)	($272,373)	($280,544)	($288,961)	($297,629)	($306,558)	($315,755)	($325,228)	($334,985)	($345,034)	($355,385)	($366,047)	($377,028)	($388,339)	($399,989)	($411,989)	($424,348)	($437,079)	
Fuel (feedstock)	($1,726,153)		($176,775)	($178,543)	($180,328)	($182,132)	($183,953)	($185,792)	($187,650)	($189,527)	($191,422)	($193,336)	($195,270)	($197,222)	($199,195)	($201,186)	($203,198)	($205,230)	($207,283)	($209,355)	($211,449)	($213,564)	
Amortization	($6,382,465)		($1,096,594)	($1,733,475)	($1,022,422)	($742,523)	($590,039)	($506,286)	($460,472)	($436,186)	($424,511)	($420,494)	($421,312)	($425,313)	($431,504)	($439,271)	($448,230)	($458,132)	($468,817)	($480,181)	($492,157)	($504,702)	
Total expense	**($11,449,757)**		**($1,567,401)**	**($2,214,871)**	**($1,514,688)**	**($1,245,951)**	**($1,104,927)**	**($1,032,942)**	**($999,212)**	**($987,334)**	**($988,403)**	**($997,475)**	**($1,011,736)**	**($1,029,544)**	**($1,049,917)**	**($1,072,253)**	**($1,096,178)**	**($1,121,454)**	**($1,147,934)**	**($1,175,526)**	**($1,204,176)**	**($1,233,853)**	
EARNINGS BEFORE INTEREST & TAXES	**$791,296**		**($420,412)**	**($1,033,472)**	**($297,848)**	**$7,395**	**$186,019**	**$296,733**	**$370,353**	**$423,317**	**$464,568**	**$499,086**	**$529,722**	**$558,157**	**$585,415**	**$612,139**	**$638,746**	**$665,517**	**$692,646**	**$720,272**	**$748,496**	**$777,400**	
Less: Income taxes	($323,797)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	($3,605)	($186,346)	($201,187)	($216,427)	($232,128)	($248,340)	($265,107)	
Add: Amortization	$6,382,465		$1,096,594	$1,733,475	$1,022,422	$742,523	$590,039	$506,286	$460,472	$436,186	$424,511	$420,494	$421,312	$425,313	$431,504	$439,271	$448,230	$458,132	$468,817	$480,181	$492,157	$504,702	
Add: Government (NRCan) capital funding	$4,627,370	**$4,997,560**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Capital expenditures	($6,906,523)	**($7,459,045)**	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Less: Annual capital renewal	($2,691,575)		$0	$0	$0	($330,919)	($340,846)	($351,072)	($361,604)	($372,452)	($383,626)	($395,134)	($406,988)	($419,198)	($431,774)	($444,727)	($458,069)	($471,811)	($485,965)	($500,544)	($515,561)	($531,027)	
Add: Terminal value of free cash flow at yea	$1,787,783		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,719,354
Add: PV of unused tax losses at year 20	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
FREE CASH FLOW	**$1,879,236**	**($2,461,485)**	**$676,182**	**$700,003**	**$724,574**	**$418,999**	**$435,212**	**$451,947**	**$469,221**	**$487,051**	**$505,453**	**$524,445**	**$544,045**	**$564,272**	**$585,145**	**$603,078**	**$442,561**	**$450,651**	**$459,071**	**$467,780**	**$476,752**	**$485,968**	
CUMULATIVE FREE CASH FLOW		**($2,461,485)**	**($1,785,303)**	**($1,085,300)**	**($360,725)**	**$58,274**	**$493,485**	**$945,433**	**$1,414,654**	**$1,901,705**	**$2,407,158**	**$2,931,603**	**$3,475,649**	**$4,039,920**	**$4,625,065**	**$5,228,143**	**$5,670,704**	**$6,121,355**	**$6,580,426**	**$7,048,206**	**$7,524,958**	**$8,010,926**	

	IRR	ROI
	23.1%	**15.1%**
Simple Payback	**4**	**Years**

Income tax calculations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Earnings before interest and taxes	($420,412)	($1,033,472)	($297,848)	$7,395	$186,019	$296,733	$370,353	$423,317	$464,568	$499,086	$529,722	$558,157	$585,415	$612,139	$638,746	$665,517	$692,646	$720,272	$748,496	$777,400
Deduct: Interest expense on LTD	($261,067)	($253,171)	($244,881)	($236,177)	($227,037)	($217,440)	($207,363)	($196,783)	($185,673)	($174,008)	($161,760)	($148,899)	($135,396)	($121,217)	($106,329)	($90,697)	($74,283)	($57,048)	($38,952)	($19,951)
Net taxable income (loss)	($681,479)	($1,286,643)	($542,729)	($228,782)	($41,017)	$79,293	$162,990	$226,535	$278,895	$325,078	$367,962	$409,258	$450,019	$490,922	$532,417	$574,821	$618,363	$663,223	$709,544	$757,449
Income taxes payable	$0	$0	$0	$0	$0	$27,753	$57,046	$79,287	$97,613	$113,777	$128,787	$143,240	$157,507	$171,823	$186,346	$201,187	$216,427	$232,128	$248,340	$265,107
Less: Prior year tax losses	$0	$0	$0	$0	$0	($27,753)	($57,046)	($79,287)	($97,613)	($113,777)	($128,787)	($143,240)	($157,507)	($168,218)	$0	$0	$0	$0	$0	$0
Net tax payable	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$3,605**	**$186,346**	**$201,187**	**$216,427**	**$232,128**	**$248,340**	**$265,107**
Unused tax losses, opening balance	$0	$238,518	$688,843	$878,798	$958,871	$973,228	$945,475	$888,429	$809,141	$711,528	$597,751	$468,964	$325,724	$168,218	$0	$0	$0	$0	$0	$0
Income tax losses - current year	$238,518	$450,325	$189,955	$80,074	$14,356	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tax losses applied during the year	$0	$0	$0	$0	$0	($27,753)	($57,046)	($79,287)	($97,613)	($113,777)	($128,787)	($143,240)	($157,507)	($168,218)	$0	$0	$0	$0	$0	$0
Unused tax losses - cumulative	**$238,518**	**$688,843**	**$878,798**	**$958,871**	**$973,228**	**$945,475**	**$888,429**	**$809,141**	**$711,528**	**$597,751**	**$468,964**	**$325,724**	**$168,218**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**





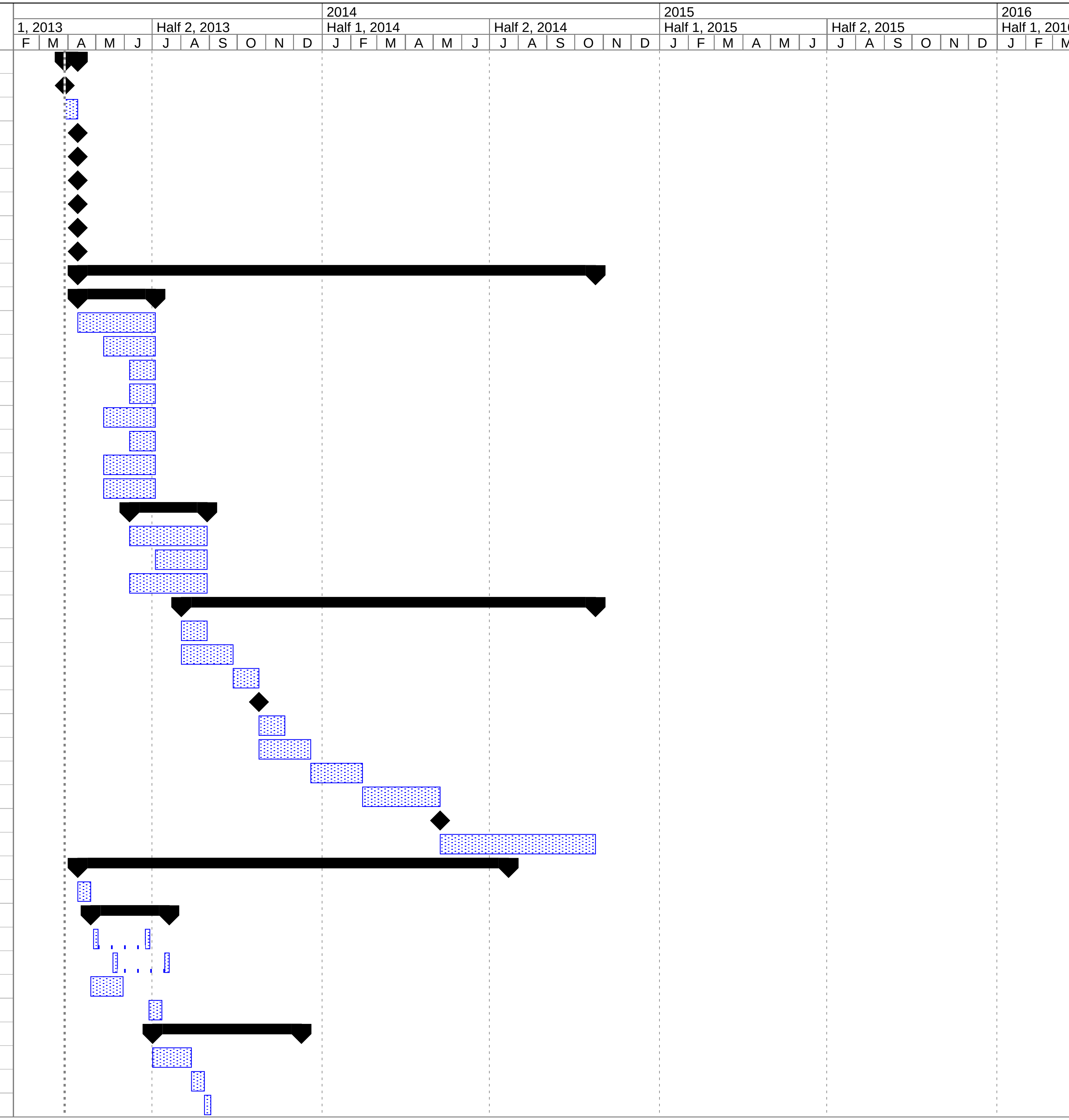
APPENDIX K

Implimentation Schedule

Front End Engineering Design (FEED) Study
Yukon Bioenergy Demonstration Project
in Haines Junction, Yukon

Yukon Energy Corporation
2 Miles Canyon Road, Whitehorse, YT Y1A 6S7

ID		Task Name	Duration	Start	Finish	Predecessors
1		**Phase 1 - FEED**	**10 days**	**Fri 03/29/13**	**Thu 04/11/13**	
2		Final Report Submission	0 days	Fri 03/29/13	Fri 03/29/13	
3		Final Report Review	10 days	Fri 03/29/13	Thu 04/11/13	2
4		**Approvals to Proceed**	**0 days**	**Thu 04/11/13**	**Thu 04/11/13**	**3**
5		CAFN (REC) Approval to Proceed	0 days	Thu 04/11/13	Thu 04/11/13	
6		YEC Board Approval to Proceed	0 days	Thu 04/11/13	Thu 04/11/13	
7		DDC Board Approval to Proceed	0 days	Thu 04/11/13	Thu 04/11/13	
8		VHJ Approval to Proceed	0 days	Thu 04/11/13	Thu 04/11/13	
9		YCCIC Approval to Proceed	0 days	Thu 04/11/13	Thu 04/11/13	
10		**Phase 2 - Feedstock**	**400 days**	**Fri 04/12/13**	**Thu 10/23/14**	**4**
11		**Procurement Logistics and Strategy (front end of**	**60 days**	**Fri 04/12/13**	**Thu 07/04/13**	
12		Procurement and Logistics Strategy	60 days	Fri 04/12/13	Thu 07/04/13	4
13		Supplier Business Model	40 days	Fri 05/10/13	Thu 07/04/13	12SS+20 days
14		Storage location options and retrieval*	20 days	Fri 06/07/13	Thu 07/04/13	13SS+20 days
15		Chipping options and locations*	20 days	Fri 06/07/13	Thu 07/04/13	14SS
16		Site Visits to Existing Operations	40 days	Fri 05/10/13	Thu 07/04/13	13SS
17		Input to design	20 days	Fri 06/07/13	Thu 07/04/13	14SS
18		Appreciate moisture content strategies	40 days	Fri 05/10/13	Thu 07/04/13	13SS
19		Alternative sources*	40 days	Fri 05/10/13	Thu 07/04/13	13SS
20		**Regulatory**	**60 days**	**Fri 06/07/13**	**Thu 08/29/13**	
21		Security of supply w FMB	60 days	Fri 06/07/13	Thu 08/29/13	14SS
22		Confirm Strategy (who needs to be up to speed)	40 days	Fri 07/05/13	Thu 08/29/13	21SS+20 days
23		Regulatory approvals before EOI	60 days	Fri 06/07/13	Thu 08/29/13	21SS
24		**Procurement**	**320 days**	**Fri 08/02/13**	**Thu 10/23/14**	
25		Expression of Interest (EOI) to Supply 500 kWe	20 days	Fri 08/02/13	Thu 08/29/13	22SS+20 days
26		EOI Preperation	40 days	Fri 08/02/13	Thu 09/26/13	25SS
27		EOI Issued	20 days	Fri 09/27/13	Thu 10/24/13	26
28		Letters of Interest (LOI) Returned	0 days	Thu 10/24/13	Thu 10/24/13	27
29		LOIs Reviewed	20 days	Fri 10/25/13	Thu 11/21/13	28
30		Feedstock Assessment & Costing	40 days	Fri 10/25/13	Thu 12/19/13	28
31		Procurement Plan	40 days	Fri 12/20/13	Thu 02/13/14	30
32		Private Shortlisted Request for Proposal	60 days	Fri 02/14/14	Thu 05/08/14	31
33		Formal Firm Proposals	0 days	Thu 05/08/14	Thu 05/08/14	32
34		Procurement Contracting	120 days	Fri 05/09/14	Thu 10/23/14	33
35		**Phase 3 - Environmental Permitting-DO Level Evaluati**	**332 days**	**Fri 04/12/13**	**Mon 07/21/14**	**4**
36		Scoping Meeting with YESAB	10 days	Fri 04/12/13	Thu 04/25/13	4
37		**Field Surveys and Technical Analyses**	**61 days**	**Fri 04/26/13**	**Fri 07/19/13**	
38		Wildlife and Wildlife Habitat (migratory birds, bat	10 days	Mon 04/29/13	Fri 06/28/13	36
39		Wetlands and Vegetation	10 days	Mon 05/20/13	Fri 07/19/13	36
40		Land Use/Traditional Use Consultation in Comm	25 days	Fri 04/26/13	Thu 05/30/13	36
41		Archaeological and Heritage Resources	10 days	Fri 06/28/13	Thu 07/11/13	40FS+20 days
42		**Impact Assessment Report**	**115 days**	**Tue 07/02/13**	**Mon 12/09/13**	
43		Prepare Draft DO Proposal for Internal Review	30 days	Tue 07/02/13	Mon 08/12/13	36FS+47 days
44		Client Review Period	10 days	Tue 08/13/13	Mon 08/26/13	43
45		Preparation of Regulatory Draft DO Proposal	5 days	Tue 08/27/13	Mon 09/02/13	44



Project: sch_cgv_20130301_project_ii
Date: Thu 03/28/13

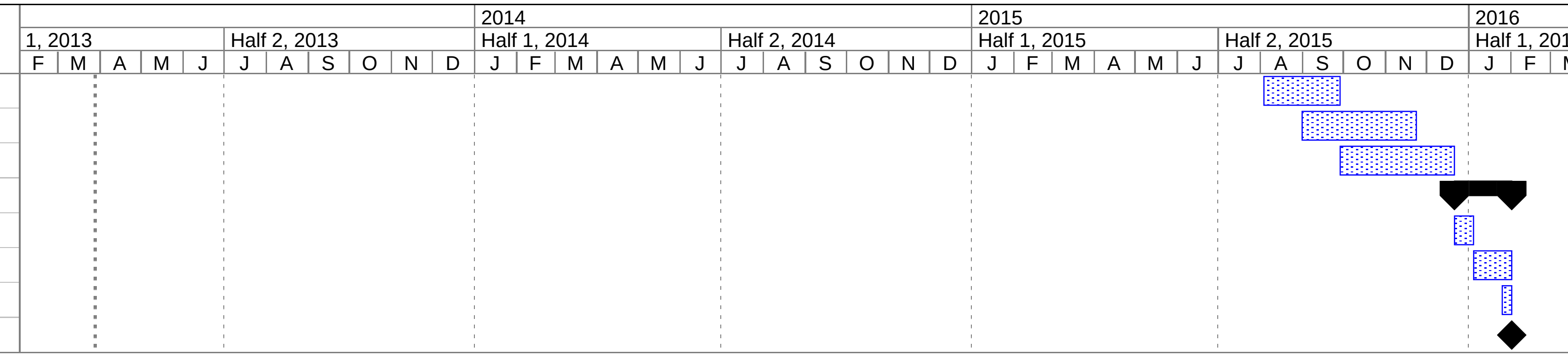
Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	Deadline

ID		Task Name	Duration	Start	Finish	Predecessors
46		Adequacy Review	10 days	Tue 09/03/13	Mon 09/16/13	45
47		Respond to Information Requests from Adequac	20 days	Tue 09/17/13	Mon 10/14/13	46
48		DO Reviews Responses	5 days	Tue 10/15/13	Mon 10/21/13	47
49		Seeking Views and Information (public consultat	15 days	Tue 10/22/13	Mon 11/11/13	48
50		DO Reviews input from SVI	5 days	Tue 11/12/13	Mon 11/18/13	49
51		Potential further Information Requests	15 days	Tue 11/19/13	Mon 12/09/13	50
52		DO Prepares/Issues Recommendation or Referr	0 days	Mon 12/09/13	Mon 12/09/13	51
53		**Permit Applications**	**314 days**	**Wed 05/08/13**	**Mon 07/21/14**	
54		Community and Stakeholder Engagement	6 days	Wed 05/08/13	Mon 07/21/14	36FS+8 days
55		Prepare other Applications and Submit to Decisi	20 days	Tue 08/13/13	Mon 09/09/13	43
56		Decision Bodies Receive Recommendation fron	0 days	Mon 12/09/13	Mon 12/09/13	52
57		Review and Consideration by Decision Bodies	10 days	Tue 12/10/13	Mon 12/23/13	56
58		Decision Bodies Issue Permits	0 days	Mon 12/23/13	Mon 12/23/13	57
59		**Phase 4 - Bridging Engineering & Business Case**	**100 days**	**Fri 04/12/13**	**Thu 08/29/13**	
60		**AFE Study**	**80 days**	**Fri 04/12/13**	**Thu 08/01/13**	
61		Engineering	80 days	Fri 04/12/13	Thu 08/01/13	4
62		Firm Vendor Quotes	40 days	Fri 05/10/13	Thu 07/04/13	61SS+20 days
63		Class 3 Capital and Operating Cost	20 days	Fri 07/05/13	Thu 08/01/13	61FF
64		**Business Case**	**100 days**	**Fri 04/12/13**	**Thu 08/29/13**	
65		Funding Support	20 days	Fri 04/12/13	Thu 05/09/13	4
66		Heat and Electricity Sale Contact Support	60 days	Fri 05/10/13	Thu 08/01/13	65
67		Revised Business Case	20 days	Fri 08/02/13	Thu 08/29/13	66
68		AFE Report for Notice to Proceed	0 days	Thu 08/29/13	Thu 08/29/13	67
69		**Phase 5 - Detailed Engineering and Procurement**	**440 days**	**Mon 12/23/13**	**Tue 09/01/15**	
70		Engineering Notice to Proceed	0 days	Mon 12/23/13	Mon 12/23/13	68,58
71		Detailed Engineering	240 days	Tue 12/24/13	Mon 11/24/14	70
72		Finalize Performance, Agreements, T&Cs with Vend	40 days	Tue 12/24/13	Mon 02/17/14	70
73		Award Gasification System	0 days	Mon 02/17/14	Mon 02/17/14	72
74		Spec/Bid Building	40 days	Tue 04/15/14	Tue 06/10/14	75SF
75		Award Building	0 days	Tue 06/10/14	Tue 06/10/14	81SF-180 days
76		Spec/Bid District Heating Network	40 days	Tue 02/18/14	Tue 04/15/14	77SF
77		Award District Heating Network	0 days	Tue 04/15/14	Tue 04/15/14	82SF-180 days
78		Spec/Bid BOP Equipment	60 days	Tue 06/10/14	Tue 09/02/14	79SF
79		Award BOP Equipment	0 days	Tue 09/02/14	Tue 09/02/14	83SF-180 days
80		Fabricate/Deliver Gasificaiton System	380 days	Tue 02/18/14	Mon 08/03/15	73
81		Fabricate/Deliver Building	80 days	Tue 02/17/15	Tue 06/09/15	90SF
82		Fabricate/Deliver District Heating Network	100 days	Tue 12/23/14	Tue 05/12/15	88SF
83		Fabricate/Deliver BOP Equipment	80 days	Tue 05/12/15	Tue 09/01/15	92SF
84		**Phase 6 - Construction**	**220 days**	**Tue 02/17/15**	**Mon 12/21/15**	
85		Construction Mobilization	0 days	Tue 02/17/15	Tue 02/17/15	86SS
86		Site Preparations	40 days	Tue 02/17/15	Mon 04/13/15	89SS-40 days
87		Heating Network Preparations	60 days	Tue 02/17/15	Mon 05/11/15	85
88		Install District Heating Network	80 days	Tue 05/12/15	Mon 08/31/15	87
89		Install Foundations	60 days	Tue 04/14/15	Mon 07/06/15	90SS-40 days
90		Install Building	60 days	Tue 06/09/15	Mon 08/31/15	91SS-40 days

Project: sch_cgv_20130301_project_ii
Date: Thu 03/28/13

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

ID		Task Name	Duration	Start	Finish	Predecessors
91		Install Gasificaiton System	40 days	Tue 08/04/15	Mon 09/28/15	80
92		Install BOP Equipment	60 days	Tue 09/01/15	Mon 11/23/15	91FS-20 days
93		Install Mechanical / Piping / E,I&C	60 days	Tue 09/29/15	Mon 12/21/15	91
94		**Phase 7 - Start-up & Commissioning**	**30 days**	**Tue 12/22/15**	**Mon 02/01/16**	
95		System Turnover	10 days	Tue 12/22/15	Mon 01/04/16	93
96		Commissioning	20 days	Tue 01/05/16	Mon 02/01/16	95
97		Performance Testing	5 days	Tue 01/26/16	Mon 02/01/16	96FF
98		Commercial Operation	0 days	Mon 02/01/16	Mon 02/01/16	97



Project: sch_cgv_20130301_project_ir
Date: Thu 03/28/13

Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	Deadline

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