Feasibility Assessment for Biomass Heating Systems
Iliamna Village Office Building, Iliamna, Alaska

FINAL REPORT – 7/26/2013

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Contents

I. Executive Summary 1
II. Introduction 2
III. Preliminary Site Investigation 3
Building Description 3
Existing Heating System 3
Domestic Hot Water 3
Building Envelope 3
Available Space 3
Street Access and Fuel Storage 4
Building or Site constraints 4
Biomass System Integration 4
Biomass System Options 4
IV. Energy Consumption and Costs 5
Wood Energy 5
Energy Costs 5
Existing Fuel Oil Consumption 6
Biomass System Consumption 6
V. Preliminary Cost Estimating 8
VI. Economic Analysis 10
O&M Costs 10
Definitions 10
Results 12
Sensitivity Analysis 13
VII. Forest Resource and Fuel Availability Assessments 14
Forest Resource Assessments 14
Air Quality Permitting 14
VIII. General Biomass Technology Information 15
Heating with Wood Fuel 15
Types of Wood Fuel 15
High Efficiency Cord Wood Boilers 16
Low Efficiency Cord Wood Boilers 16
High Efficiency Wood Stoves 17
Bulk Fuel Boilers 17
Grants 17

Appendices

Appendix A – Site Photos
Appendix B – Economic Analysis Spreadsheet
Appendix C – Site Plan
Appendix D – AWEDTG Field Data Sheet

Abbreviations

ACF	Accumulated Cash Flow
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
AEA	Alaska Energy Authority
AFUE	Annual Fuel Utilization Efficiency
AHU	Air Handling Unit
ARCH	Architectural
B/C	Benefit / Cost Ratio
BAS	Building Automation System
BTU	British Thermal Unit
BTUH	BTU per hour
CCF	One Hundred Cubic Feet
CEI	Coffman Engineers, Inc.
CFM	Cubic Feet per Minute
CIRC	Circulation
CMU	Concrete Masonry Unit
CRAC	Computer Room Air Conditioning
CWCO	Cold Weather Cut Out
DDC	Direct Digital Control
ΔT	Delta T (Temperature Differential)
ECI	Energy Cost Index
ECM	Energy Conservation Measure
EF	Exhaust Fan
Eff	Efficiency
ELEC	Electrical
EPDM	Ethylene Propylene Diene Monomer
EUI	Energy Utilization Index
F	Fahrenheit
ft	Feet
GPM	Gallons Per Minute
HP	Horsepower
HPS	High Pressure Sodium
HVAC	Heating, Ventilating, and Air-Conditioning
IESNA	Illuminating Engineering Society of North America
in	Inch(es)
IPLC	Integrated Power and Load Circuit
IRC	Internal Revenue Code
kBTU	One Thousand BTUs
kWh	Kilowatt-Hour
LED	Light-Emitting Diode
MBH	Thousand BTUs per Hour
MECH	Mechanical
MH	Metal Halide
O&M	Operations and Maintenance
MMBTU	One Million BTUs
P	Pump
PC	Project Cost
PF	Power Factor

R	R-Value
PH	Phase
SC	Shading Coefficient
SAT	Supply Air Temperature
SF	Square Feet, Supply Fan
TEMP	Temperature
U	U-Value
V	Volts
VFD	Variable Frequency Drive
W	Watts

List of Figures

Fig. 1 – Iliamna, Alaska – Google Maps 2
Fig. 2 – Iliamna Village Council Office Building – Google Maps 2

List of Tables

Table 1 – Economic Evaluation Summary 1
Table 2 – Energy Comparison 5
Table 3 – Existing Fuel Oil Consumption 6
Table 4 – Proposed Biomass System Fuel Consumption 7
Table 5 – Option A - Estimate of Probable Cost 8
Table 6 – Option B - Estimate of Probable Cost 9
Table 7 – Inflation rates 10
Table 8 – Economic Definitions 11
Table 9 – Option A - Economic Analysis Results 12
Table 10 – Option B - Economic Analysis Results 13
Table 11 – Option A Sensitivity Analysis 13
Table 12 – Option B Sensitivity Analysis 13

I. Executive Summary

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems at the Iliamna Village Office Building in Iliamna, Alaska. In the study two options were evaluated. Both options utilize one GarnPak cord wood boiler system to offset heating oil consumption. In Option A, the GarnPak serves only the Village Office Building. In Option B, the GarnPak serves the Village Office Building and the adjacent shop building.

The results of the economic evaluation for both options are shown below. Both options are not economically justified at this time, due to the fact that the benefit to cost ratio of each option is less than 1.0. However, since the benefit to cost ratio of Option B is very close to 1.0 it may be prudent to further study this option. Further investigation is needed to determine the actual heating oil consumption of the shop building and to develop a more detailed cost estimate.

Economic Analysis Results	Option A	Option B
Project Capital Cost	($332,298)	($395,488)
Simple Payback	42.3 years	30.7 years
Present Value of Project Benefits (20 year life)	$544,586	$818,146
Present Value of Operating Costs (20 year life)	($302,773)	($438,717)
Benefit / Cost Ratio of Project (20 year life)	0.73	0.96
Net Present Value (20 year life)	($90,484)	($16,059)
Year Accumulated Cash Flow is Net Positive	First Year	First Year
Year Accumulated Cash Flow > Project Capital Cost	25 years	21 years

Table 1 – Economic Evaluation Summary

II. Introduction

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems for the Iliamna Village Council Office building in Iliamna, AK. The location of the building is shown in Figures 1 and 2.

Fig. 1 – Iliamna, Alaska – Google Maps

Fig. 2 – Iliamna Village Council Office Building – Google Maps

III. Preliminary Site Investigation

Building Description

The Iliamna Village Office Building is a 3,200 SF two story building that was built in 1988. It has two floors of office space and a large garage bay for storing the fire engine. There are no scheduled or planned renovations for the building. It is used by five to ten office staff during the work week from 8am to 5pm and occasionally during the weekend. It is typically used approximately 60 hours per week. No energy audit has been conducted at the building.

Existing Heating System

The building is heated by two identical Burnham Boilers (MN: LE2-GBI2S, 1.25 GPH Firing Rate, 143 MBH Output) that were installed in 2010. The boilers are located in the second floor boiler room. The boilers serve three heating zones and an indirect hot water heater. One heating zone is for two unit heaters located in the garage. The remaining zones heat the two floors of office space with baseboard radiators. New pumps, piping and boiler controller in the boiler room appear to have been installed during the 2010 boiler replacement. The boilers appear to be sized to be fully redundant, so that one boiler can carry the entire building heat load. This was confirmed by a heat load calculation. The combustion efficiency of the existing fuel oil boilers is approximately 80%.

There is no routine maintenance of the boilers. The boilers appear to be in poor shape considering the age of the boilers. The installation of the control wiring for the boilers and zone valves does not appear to be finished. Also, the boilers were short cycling during the site visit and the Tekmar boiler control module was reading an error message.

One 2,000 gal heating oil tank serves the boilers and is located to the north side of the building. No spill containment is present around the tank. Fuel in the tanks is used for heating only.

Domestic Hot Water

Domestic hot water is used for hand washing and also for laundry. There are three commercial washing machines in the building. Hot water is provided by a 50 gal Superstore indirect hot water heater, which uses a loop from the boiler for heat.

Building Envelope

The building is a typical pre-fabricated steel frame metal warehouse building. The office space was framed inside the originally open metal building. It is estimated that the walls have R-19 fiberglass batt insulation and the metal hot roof has R-25 fiberglass batt insulation. The windows are double pane and there is one arctic entry for the rear entrance.

Available Space

There is no allowable space inside the building for a wood heating system. The Village Council does not wish to sacrifice space inside the building for a wood boiler system. The office building sits on a large gravel pad and a second 60’x40’ shop building is approximately 80 ft to the north of the office building.

There is ample room on the gravel pad for a detached wood boiler building. The Village Council has selected a location for the wood boiler building approximately 80ft to the west of the office building.

This location can be easily accessed by a truck or forklift. This will require a buried arctic pipe between the wood boiler building and the office building.

Street Access and Fuel Storage

The building site is situated along a paved road and a truck can easily access all sides of the building. There is adequate space to the west side of the gravel pad for a wood boiler building and wood storage shed.

Building or Site constraints

The site is flat with no significant site constraints. There were no wetlands or signs of historical structures observed.

Biomass System Integration

A wood boiler system would easily be able to tie into the return line of the existing hydronic system of the building. The existing hydronic system, baseboards and unit heaters would be used to distribute heat around the building.

Biomass System Options

The most viable option for biomass resource is cord wood, as it is available locally in the Iliamna area. Wood chips and wood pellets were considered, but were considered not to be viable due to the expensive cost of shipping to Iliamna since there is no local supplier of either type of wood fuel. Chips and pellets can only be shipped to Iliamna in two ways: 1) flown in by plane or 2) shipped by barge from Homer to Williamsport, then trucked to Pile Bay, and finally barged across Lake Iliamna to Iliamna. Due to these expensive shipping issues, it was determined that a cord wood boiler system would be the most viable option for wood heating at the building.

Option A: For this study, a GarnPak cord wood boiler system is used. A GarnPak, or Garn-in-the-box, is a pre-constructed conex that contains one Garn cord wood boiler. The GarnPak would be located in the available space on the gravel pad 80' west of the building and would deliver heat to the building via buried and pre-insulated hydronic piping. The Garn boiler would deliver heat to a heat exchanger inside the GarnPak conex, which would transfer heat to a buried 50% propylene glycol loop. This loop would deliver heat via buried arctic pipe to a heat exchanger in the boiler room. This second heat exchanger would transfer heat to the office building's existing hydronic system. For this building, one Garn WHS 2000 is recommended. This size Garn will produce a similar heat output to one of the existing heating oil boilers at 148,000 BTU/hr with a 6 hr firing frequency.

Option B: Option B includes everything in Option A and a connection to the adjacent shop building. This option will supply heat with one Garn WHS 2000 boiler to both the Village Office Building and the shop building. Additional buried piping will be required, as well as another heat exchanger and piping to connect to the shop's existing hydronic system. The shop is currently heated by a Weil-McLain Gold Oil Boiler P-WGO-3, with 115,000 BTU/hr output. The boiler serves two radiant floor slab zones in the building. An EnergyLogic EL-200H waste oil furnace (160,000 BTU/hr) also supplies heat when waste oil is available.

IV. Energy Consumption and Costs

Wood Energy

The gross energy content of a cord of wood varies depending on tree species and moisture content. Black spruce, white spruce and birch at 20% moisture content have respective gross energy contents of 15.9 MMBTU/Cord, 18.1 MMBTU/cord and 23.6 MMBTU/cord, according to the UAF Cooperative Extension. Wet or greenwood has higher moisture contents and require additional heat to evaporate moisture before the wood can burn. Thus, wood with higher moisture contents will have lower energy contents. Seasoned or dry wood will typically have 20% moisture content. For this study, cord wood was estimated to have 16.0 MMBTU/cord. This is a conservative estimate based on the fact that the community has access to both spruce and birch. To determine the delivered $/MMBTU of the biomass system, a 75% efficiency for the Garn boiler system was assumed. This is based on manufacturer documentation and typical operational issues which do not allow firing 100% of the time.

Energy Costs

The high price of fuel oil is the main economic driver for the use of lower cost biomass heating. Fuel oil is shipped into Iliamna by plane and currently costs $6.75/gal. For this study, the energy content of fuel oil is based on 134,000 BTU/gal, according to the UAF Cooperative Extension.

Cord wood is sold in Iliamna not by the cord but by the truckload. A typical truck with a 6' bed can deliver cord wood to a site at $200 per truckload. A truck load of wood is approximately 0.61 cords. This is estimated to be equivalent to $330 per cord, which is used for this study.

The table below shows the energy comparison of different fuel types. The system efficiency is used to calculate the delivered MMBTU's of energy to the building. The delivered cost of energy to the building, in $/MMBTU, is the most accurate way to compare costs of different energy types. As shown below, cord wood is less than half the cost of fuel oil based on the $/MMBTU delivered to the building heat load.

Fuel Type	Units	Gross BTU/unit	System Efficiency	$/unit	Delivered $/MMBTU
Cord Wood	cords	16,000,000	75%	$330	$27.50
Fuel Oil	gal	134,000	80%	$6.75	$62.97
Electricity	kWh	3,413	99%	$0.69	$204.21

Table 2 – Energy Comparison

Existing Fuel Oil Consumption

The Iliamna Village Office Building uses approximately 3,440 gal of fuel oil annually for space heating and domestic hot water. This quantity is based on available heating oil records from 2012. The annual fuel cost, based on the current price of heating oil, is $23,220.

The heating oil consumption of the adjacent shop building is unknown. It is estimated that the shop building consumes about 0.9 gal/SF of heating oil and waste heat oil annually. It is estimated that 80% of the building heat is provided by heating oil, while the remaining 20% is provided by waste oil. Based on these assumptions, it is estimated that the shop building consumes approximately 1,728 gallons of heating oil annually. The combined annual heating oil cost of the Village Office Building and shop building is $38,884.

Building Name	Fuel Type	Avg. Annual Consumption	Net MMBTU/yr	Annual Fuel Cost
Iliamna Village Office Building	Fuel Oil	3,440 gal	368.8	$23,220
Shop Building	Fuel Oil	1,728 gal	185.2	$11,664
Total	Fuel Oil	5,168 gal	554.0	$34,884

Table 3 – Existing Fuel Oil Consumption

Biomass System Consumption

For both options it is estimated that the proposed biomass system will offset 85% of heating oil consumption for the building, or buildings. The remaining 15% of the heat for the building will come from the existing heating oil-fired boilers.

For Option A, the proposed biomass system would have a total annual energy cost of $14,370, to serve the Village Office Building. This annual energy cost includes wood and fuel oil costs, as well as the cost of the additional electricity required to operate the biomass heating system. It is estimated that 3,285 kWh annually will be required to operate the system pumps required by the Garn system.

For Option B, the proposed biomass system would have a total annual energy cost of $21,016, to serve both the Village Office Building and shop building. It is estimated that 4,106 kWh per year of electricity will be needed for this option.

Option	Fuel Type	% Heating Source	Net MMBTU/yr	Annual Consumption	Energy Cost	Total Energy Cost
Option A: Iliamna Village Office Building	Cord Wood	85%	313.5	26.1 cords	$8,620	$14,370
	Fuel Oil	15%	55.3	516 gal	$3,483	
	Electricity	N/A	N/A	3,285 kWh	$2,267	

Option	Fuel Type	% Heating Source	Net MMBTU/yr	Annual Consumption	Energy Cost	Total Energy Cost
Option B: Iliamna Village Office Building + Shop Building	Cord Wood	85%	470.9	39.2 cords	$12,950	$21,016
	Fuel Oil	15%	83.1	775 gal	$5,233	
	Electricity	N/A	N/A	4,106 kWh	$2,833	

Table 4 – Proposed Biomass System Fuel Consumption

V. Preliminary Cost Estimating

An estimate of probable costs was completed for Option A and Option B. The cost estimate is based on a similar GarnPak system, installed in 2012, which Coffman designed for Thorne Bay, Alaska. The estimate includes general conditions and overhead and profit for the general contractor. A 10% remote factor was used to account for increased shipping and installation costs in Iliamna. Engineering design and permitting was estimated at 15% and a 10% contingency was used.

Option A – GarnPak for Village Office Building				
Category	**Description**		**Cost**	
Site Work	NFS Fill		$	3,380
	Site Grading		$	1,500
	Traffic Protection		$	350
		Subtotal	**$**	**5,230**
Mechanical Utilities	Trench & Backfill		$	4,530
	Buried Piping		$	10,000
	Piping Allowance		$	8,000
		Subtotal	**$**	**22,530**
Electrical Utilities	Service Entrance		$	7,000
	Conduit and Wiring		$	6,900
	Fire Allowance		$	3,000
	Electrical Allowance		$	12,700
		Subtotal	**$**	**29,600**
Wood Boiler and Boiler Bldg	GarnPak Unit		$	120,000
	Installation		$	5,000
			$	**125,000**
Interior Mechanical & Electrical	HX, Piping & Materials		$	15,000
		Subtotal	**$**	**15,000**
Subtotal Material and Installation Cost			**$**	**197,360**
General Conditions	10%		$	19,736
		Subtotal	**$**	**217,096**
Overhead and Profit	10%		$	21,710
		Subtotal	**$**	**238,806**
Remote Factor	10%		$	23,881
		Subtotal	**$**	**262,686**
Design Fees and Permitting	15%		$	39,403
		Subtotal	**$**	**302,089**
Contingency	10%		$	30,209
Total Project Cost			**$**	**332,298**

Table 5 – Option A - Estimate of Probable Cost

Option B – GarnPak for Village Office Building and Shop Building			
Category	**Description**		**Cost**
Site Work	NFS Fill	$	3,380
	Site Grading	$	1,500
	Traffic Protection	$	350
	Subtotal	**$**	**5,230**
Mechanical Utilities	Trench & Backfill	$	9,060
	Buried Piping	$	20,000
	Piping Allowance	$	16,000
	Subtotal	**$**	**45,060**
Electrical Utilities	Service Entrance	$	7,000
	Conduit and Wiring	$	6,900
	Fire Allowance	$	3,000
	Electrical Allowance	$	12,700
	Subtotal	**$**	**29,600**
Wood Boiler and Boiler Bldg	GarnPak Unit	$	120,000
	Installation	$	5,000
		$	**125,000**
Interior Mechanical & Electrical	HX, Piping & Materials	$	30,000
	Subtotal	**$**	**30,000**
Subtotal Material and Installation Cost		**$**	**234,890**
General Conditions	10%	$	23,489
	Subtotal	**$**	**258,379**
Overhead and Profit	10%	$	25,838
	Subtotal	**$**	**284,217**
Remote Factor	10%	$	28,422
	Subtotal	**$**	**312,639**
Design Fees and Permitting	15%	$	46,896
	Subtotal	**$**	**359,534**
Contingency	10%	$	35,953
Total Project Cost		**$**	**395,488**

Table 6 – Option B - Estimate of Probable Cost

VI. Economic Analysis

The following assumptions were used to complete the economic analysis for the proposed biomass system at the Iliamna Village Office Building.

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Table 7 – Inflation rates

The real discount rate, or minimum attractive rate of return, is 3.0% and is the current rate used for all Life Cycle Cost Analysis by the Alaska Department of Education and Early Development. This is a typical rate used for completing economic analysis for public entities in Alaska. The escalation rates used for the wood, heating oil, electricity and O&M rates are based on rates used in the Alaska Energy Authority funded 2012 biomass pre-feasibility studies. These are typical rates used for this level of evaluation and were used so that results are consistent and comparable to the 2012 studies.

O&M Costs

Non-fuel related operations and maintenance costs (O&M) were estimated at $500 per year. This estimate is consistent with AEA's O&M estimates used for projects utilizing Garn cord wood boilers. For only the first two years of service, an additional $500 per year was added to account for maintenance staff getting used to operating the new system. O&M costs were estimated to be the same for both Option A and Option B.

Definitions

There are many different economic terms used in this study. A listing of all of the terms with their definition is provided below for reference.

Economic Term	**Description**
Project Capital Cost	This is the opinion of probable cost for designing and constructing the project.
Simple Payback	The Simple Payback is the Project Capital Cost divided by the first year annual energy savings. The Simple Payback does not take into account escalated energy prices. $$Simple\ Payback = \frac{Installed\ Cost\ of\ ECM}{First\ Year\ Energy\ Savings\ of\ ECM}$$
Present Value of Project Benefits (20 year life)	The present value of all of the heating oil that would have been consumed by the existing heating oil-fired heating system, over a 20 year period.

Economic Term	Description
Present Value of Operating Costs (20 year life)	The present value of all of the proposed biomass systems operating costs over a 20 year period. This includes wood fuel, additional electricity, and O&M costs for the proposed biomass system to provide 85% of the building's heat. It also includes the heating oil required for the existing oil-fired boilers to provide the remaining 15% of heat to the building.
Benefit / Cost Ratio of Project (20 year life)	This is the benefit to cost ratio over the 20 year period. A project that has a benefit to cost ratio greater 1.0 is economically justified. It is defined as follows: $$Benefit\ /\ Cost\ Ratio = \frac{PV(Project\ Benefits) - PV(Operating\ Costs)}{Project\ Capital\ Cost}$$ Where: PV = The present value over the 20 year period. Reference Sullivan, Wicks and Koelling, "Engineering Economy", 14th ed., 2009, pg. 440, Modified B-C Ratio.
Net Present Value (20 year life)	This is the net present value of the project over a 20 year period. If the project has a net present value greater than zero, the project is economically justified. This quantity accounts for the project capital cost, project benefits and operating costs.
Year Accumulated Cash Flow > Project Capital Cost	This is the number of years it takes for the accumulated cash flow of the project to be greater than or equal to the project capital cost. This is similar to the project's simple payback, except that it incorporates the inflation rates. This quantity is the payback of the project including escalating energy prices and O&M rates. This quantity is calculated as follows: $$Installed\ Cost \leq \sum_{k=0}^{J} R_k$$ Where: J = Year that the accumulated cash flow is greater than or equal to the Project Capital Cost. R_k = Project Cash flow for the kth year.

Table 8 – Economic Definitions

Results

The economic analysis for Option A and Option B was completed in order to determine the simple payback, benefit to cost ratio, and net present value of each. The results of the proposed GarnPak cord wood boiler system are shown below. For both options, the GarnPak would be located in the available space on the gravel pad 80 ft west of the Iliamna Village Office Building and would deliver heat to the building via buried hydronic piping.

Option A - Due to the high cost of the GarnPak system compared to the heating oil offset, the Option A has a low benefit to cost ratio of 0.73 over the 20 year study period. Any project with a benefit to cost ratio below 1.0 is typically considered not economically justified, but there may be other project benefits that make these projects still worth pursuing. From a standpoint of looking at this project individually and from a purely economic standpoint, this project is does not appear justified based on this pre-feasibility study.

In order for Option A to have a benefit to cost ratio of 1.0 over the 20 year study period, the project capital cost would need to be reduced to $241,000. However, reducing the capital cost to this level does not appear to be possible. The GarnPak itself costs $120,000, which leaves $121,000 remaining for site work, mechanical and electrical work, buried utilities, general conditions, overhead and profit, design and permitting fees, and a contingency. Moving the GarnPak building closer to the Tribal Office Building would reduce buried piping costs, however, this cost reduction may not be sufficient to make the project cost effective.

Option A - Economic Analysis Results	
Project Capital Cost	($332,298)
Simple Payback	42.3 years
Present Value of Project Benefits (20 year life)	$544,586
Present Value of Operating Costs (20 year life)	($302,773)
Benefit / Cost Ratio of Project (20 year life)	0.73
Net Present Value (20 year life)	($90,484)
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	25 years

Table 9 – Option A - Economic Analysis Results

Option B – Option B increases heating oil offset by the GarnPak system by connecting both the Village Office Building and the shop building. However, there will be the additional expense of at least 80 ft of buried piping to connect the GarnPak to the shop building as well as an additional heat exchanger and piping. Overall, Option B has a benefit to cost ratio of 0.96, making it not typically considered economically justified based on the cost estimate and available heating oil offsets. Since the project has a benefit to cost ratio close to 1.0 and the actual heating oil consumption of the shop building is not accurately known, this option may require more study to determine cost effectiveness.

Option B - Economic Analysis Results	
Project Capital Cost	($395,488)
Simple Payback	30.7 years
Present Value of Project Benefits (20 year life)	$818,146
Present Value of Operating Costs (20 year life)	($438,717)
Benefit / Cost Ratio of Project (20 year life)	0.96
Net Present Value (20 year life)	($16,059)
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	21 years

Table 10 – Option B - Economic Analysis Results

Sensitivity Analysis

A sensitivity analysis was completed for both options to show how changing heating oil costs and wood costs affect the B/C ratios of the projects. As heating oil costs increase and wood costs decrease, the project becomes more economically viable.

Option A – B/C Ratios		Wood Cost ($/cord)		
		$264/cord	$330/cord	$396/cord
Heating Oil Cost ($/gal)	$5.40/gal	0.55	0.45	0.35
	$6.75/gal	0.83	0.73	0.63
	$8.10/gal	1.11	1.01	0.91

Table 11 – Option A Sensitivity Analysis

Option B – B/C Ratios		Wood Cost ($/cord)		
		$264/cord	$330/cord	$396/cord
Heating Oil Cost ($/gal)	$5.40/gal	0.73	0.61	0.48
	$6.75/gal	1.09	0.96	0.83
	$8.10/gal	1.44	1.31	1.18

Table 12 – Option B Sensitivity Analysis

VII. Forest Resource and Fuel Availability Assessments

Forest Resource Assessments

Fuel availability assessments were not available for the Iliamna area. During the site visit it was found that the land around Iliamna village is sparsely forested, with a low density of small spruce trees. The tree density increases as one travels north to Six Mile Lake near Nondalton. Many of the Iliamna community harvest wood in this area, and haul wood back to Iliamna.

Per Coffman's discussions with Mr. Will Putman with the State Forestry Service, most of the permits for wood harvesting are owned and controlled by village corporations within the state. If harvesting is to take place in these areas, permission will need to be obtained from the village corporation prior to harvesting. If more than 40 acres per year or 50 cords of wood are collected per year, the harvesting is classified as a commercial operation. For a commercial harvest, the practices outlined in the Forest Resources and Practices Act will need to be followed. The Forest Resource and Practices Act protects the water and habitat within the harvesting site and applies to state, federal, and native corporation land. If less than 40 cords of wood are used per year, the use is considered as a personal use and a commercial permit is not required.

Air Quality Permitting

Currently, air quality permitting is regulated according to the Alaska Department of Environmental Conservation Section 18 AAC 50 Air Quality Control regulations. Per these regulations, a minor air quality permit is required if a new wood boiler or wood stove produces one of the following conditions per Section 18 AAC 50.502 (C)(1): 40 tons per year (TPY) of carbon dioxide (CO2), 15 TPY of particulate matter greater than 10 microns (PM-10), 40 TPY of sulfur dioxide, 0.6 TPY of lead, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. These regulations assume that the device will operate 24 hours per day, 365 days per year and that no fuel burning equipment is used. If a new wood boiler or wood stove is installed in addition to a fuel burning heating device, the increase in air pollutants cannot exceed the following per AAC 50.502 (C)(3): 10 TPY of PM-10, 10 TPY of sulfur dioxide, 10 TPY of nitrogen oxides, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. Per the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075), a person may not operate a wood-fired heating device in a manner that causes black smoke or visible emissions that exceed 50 percent opacity for more than 15 minutes in any hour in an area where an air quality advisory is in effect.

From Coffman's discussions with Patrick Dunn at the Alaska Department of Environmental Conservation, these regulations are focused on permitting industrial applications of wood burning equipment. In his opinion, it would be unlikely that an individual wood boiler would require an air quality permit unless several boilers were to be installed and operated at the same site. If several boilers were installed and operated together, the emissions produced could be greater than 40 tons of CO2 per year. This would require permitting per AAC 50.502 (C)(1) or (C)(3). Permitting would not be required on the residential wood fired stoves unless they violated the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075). The recent Garn boiler systems installed in Alaska have not needed or obtained air quality permits.

VIII. General Biomass Technology Information

Heating with Wood Fuel

Wood fuels are among the most cost-effective and reliable sources of heating fuel for communities adjacent to forestland when the wood fuels are processed, handled, and combusted appropriately. Compared to other heating energy fuels, such as oil and propane, wood fuels typically have lower energy density and higher associated transportation and handling costs. Due to this low bulk density, wood fuels have a shorter viable haul distance when compared to fossil fuels. This short haul distance also creates an advantage for local communities to utilize locally-sourced wood fuels, while simultaneously retaining local energy dollars.

Most villages in rural Alaska are particularly vulnerable to high energy prices due to the large number of heating degree days and expensive shipping costs. For many communities, wood-fueled heating can lower fuel costs. For example, cordwood sourced at $250 per cord is just 25% of the cost per MMBTU as #1 fuel oil sourced at $7 per gallon. In addition to the financial savings, the local communities also benefit from the multiplier effect of circulating energy dollars within the community longer, more stable energy prices, job creation, and more active forest management.

In all of the Lake and Peninsula Communities studied, the community's wood supply and demand are isolated from outside markets. The local cordwood market is influenced by land ownership, existing forest management and ecological conditions, local demand and supply, and the State of Alaska Energy Assistance program.

Types of Wood Fuel

Wood fuels are specified by energy density, moisture content, ash content, and granulometry. Each of these characteristics affects the wood fuel's handling characteristics, storage requirements, and combustion process. Higher quality fuels have lower moisture, ash, dirt, and rock contents, consistent granulometry, and higher energy density. Different types of fuel quality can be used in wood heating projects as long as the infrastructure specifications match the fuel content characteristics. Typically, lower quality fuel will be the lowest cost fuel, but it will require more expensive storage, handling, and combustion infrastructure, as well as additional maintenance.

Projects in rural Alaska must be designed around the availability of wood fuels. Some fuels can be harvested and manufactured on site, such as cordwood, woodchips, and briquettes. The economic feasibility of manufacturing on site is determined by a financial assessment of the project. Typically, larger projects offer more flexibility in terms of owning and operating the wood harvesting and manufacturing equipment, such as a wood chipper, splitter, or equipment to haul wood out of forest, than smaller projects.

Due to the limited wood fuel demand, large financial obligations and operating complexities, it is unlikely that the Lake and Peninsula communities in this study will be able to manufacture pellets. However, some communities may be able to manufacture bricks or fire logs made from pressed wood material. These products can substitute for cordwood in woodstoves and boilers, while reducing supply pressure on larger diameter trees that are generally preferred for cordwood.

High Efficiency Cord Wood Boilers

High Efficiency Low Emission (HELE) cordwood boilers are designed to burn cordwood fuel cleanly and efficiently. The boilers use cordwood that is typically seasoned to 25% moisture content (MC) or less and meet the dimensions required for loading and firing. The amount of cordwood burned by the boiler will depend on the heat load profile of the building and the utilization of the fuel oil system as back up. Three HELE cordwood boiler suppliers include Garn (www.garn.com), Greenwood (www.greenwoodusa.com) and TarmUSA (www.woodboilers.com). All three of these suppliers have units operating in Alaska. Greenwood and TarmUSA have a number of residential units operating in Alaska and have models that range between 100,000 to 300,000 BTU/hr. Garn boilers, manufactured by Dectra Corporation, are used in Tanana, Kasilof, Dot Lake, Thorne Bay, Coffman Cove and other locations to heat homes, washaterias, schools, and community buildings.

The Garn boiler has a unique construction, which is basically a wood boiler housed in a large water tank. Garn boilers come in several sizes and are appropriate for facilities using 100,000 to 1,000,000 BTUs per hour. The jacket of water surrounding the fire box absorbs heat and is piped into buildings via a heat exchanger, and then transferred to an existing building heating system, infloor radiant tubing, unit heaters, or baseboard heaters. In installations where the Garn boiler is in a detached building, there are additional heat exchangers, pumps and a glycol circulation loop that are necessary to transfer heat to the building while allowing for freeze protection. Radiant floor heating is the most efficient heating method when using wood boilers such as Garns, because they can operate using lower supply water temperatures compared to baseboards.

Garn boilers are approximately 87% efficient and store a large quantity of water. For example, the Garn WHS-2000 holds approximately 1,825 gallons of heated water. Garns also produce virtually no smoke when at full burn, because of a primary and secondary gasification (2,000 ^{o}F) burning process. Garns are manually stocked with cordwood and can be loaded multiple times a day during periods of high heating demand. Garns are simple to operate with only three moving parts: a handle, door and blower. Garns produce very little ash and require minimal maintenance. Removing ash and inspecting fans are typical maintenance requirements. Fans are used to produce a draft that increases combustion temperatures and boiler efficiency. In cold climates, Garns can be equipped with exterior insulated storage tanks for extra hot water circulating capacity. Most facilities using cordwood boilers keep existing oil-fired systems operational to provide heating backup during biomass boiler downtimes and to provide additional heat for peak heating demand periods.

Low Efficiency Cord Wood Boilers

Outdoor boilers are categorized as low-efficiency, high emission (LEHE) systems. These boiler systems are not recommended as they produce significant emission issues and do not combust wood fuels efficiently or completely, resulting in significant energy waste and pollution. These systems require significantly more wood to be purchased, handled and combusted to heat a facility as compared to a HELE system. The Alaska Department of Environmental Conservation has issued nuisance abatement orders for air pollution for outdoor wood boilers in Fairbanks. Fairbanks is ranked number four on Time Magazine's list of most air polluted cities in America. Additionally, several states have placed a moratorium on installing LEHE boilers because of air quality issues (Washington). These LEHE systems can have combustion efficiencies as low as twenty five (25%) percent and produce more than nine times the emission rate of standard industrial boilers. In comparison, Garns can operate around 87% efficiency.

High Efficiency Wood Stoves

Newer high efficiency wood stoves are available on the market that produce minimal smoke, minimal ash and require less firewood. New EPA-certified wood stoves produce significantly less smoke than older uncertified wood stoves. High efficiency wood stoves are easy to operate with minimal maintenance compared to other biomass systems. The Blaze King Classic high efficiency wood stove (www.blazeking.com) is a recommended model, due to its built-in thermostats that monitor the heat output of the stove. This stove automatically adjusts the air required for combustion. This unique technology, combined with the efficiencies of a catalytic combustor with a built-in thermostat, provides the longest burn times of any wood stove. The Blaze King stove allows for optimal combustion and less frequent loading and firing times.

Bulk Fuel Boilers

Bulk fuel boilers usually burn wood chips, sawdust, bark or pellets and are designed around the wood resources that are available from the local forests or local industry. Several large facilities in Tok, Craig, and Delta Junction (Delta Greely High School) are using bulk fuel biomass systems. Tok uses a commercial grinder to process woodchips. The chips are then dumped into a bin and are carried by a conveyor belt to the boiler. The wood fuel comes from timber scraps, local sawmills and forest thinning projects. The Delta Greely High School has a woodchip bulk fuel boiler that heats the 77,000 square foot facility. The Delta Greely system, designed by Coffman engineers, includes a completely separate boiler building which includes chip storage bunker and space for storage of tractor trailers full of chips (so handling of frozen chips could be avoided). Woodchips are stored in the concrete bunker and augers move the material on a conveyor belt to the boilers. The automated fuel handling requirements for bulk fuel systems are not cost-effective for small and medium sized structures due to higher maintenance costs and complexities. Due to these reasons, a bulk fuel boiler system is not recommended for small rural communities in Alaska with limited financial and human resources.

Grants

There are many grant opportunities for biomass work state, federal, and local for feasibility studies, design and construction. If a project if determined to be pursued, a thorough search of websites and discussions with the AEA Biomass group would be recommended to make sure no possible funding opportunities are missed. Below are some funding opportunities and existing past grants that have been awarded.

Currently, there is a funding opportunity for tribal communities that develop clean and renewable energy resources through the U.S. Department of Energy. On April 30, 2013, the Department of Energy announced up to $7 million was available to deploy clean energy projects in tribal communities to reduce reliance on fossil fuel and promote economic development on tribal lands. The Energy Department's Tribal Energy Program, in cooperation with the Office of Indian Energy, will help Native American communities, tribal energy resource development organizations, and tribal consortia to install community or facility scale clean energy projects.

http://apps1.eere.energy.gov/tribalenergy/

The Department of Energy (DOE), Alaska Native programs, focus on energy efficiency and add ocean energy into the mix. In addition the communities are eligible for up to $250,000 in energy-efficiency aid. The Native village of Kongiganak will get help strengthening its wind-energy infrastructure, increasing energy efficiency and developing "smart grid technology". Koyukuk will get help upgrading its energy infrastructure, improving energy efficiency and exploring biomass options. The village of Minto will explore all the above options as well as look for solar-energy ideas. Shishmaref, an Alaska Native village faced climate-change-induced relocation, will receive help with increasing energy sustainability and building capacity as it relocates. And the Yakutat T'lingit Tribe will also study efficiency, biomass and ocean energy. This DOE program would be a viable avenue for biomass funding.

http://energy.gov/articles/alaska-native-communities-receive-technical-assistance-local-clean-energy-development

The city of Nulato was awarded a $40,420 grant for engineering services for a wood energy project by the United States Department of Agriculture (USDA) and the United States Forest Service. Links regarding the award of the Woody Biomass Utilization Project recipients are shown below:

http://www.fs.fed.us/news/2012/releases/07/renewablewoods.shtml

http://www.usda.gov/wps/portal/usda/usdahome?contentid=2009/08/0403.xml

Delta Junction was awarded a grant for engineering from the Alaska Energy Authority from the Renewable Energy Fund for $831,203. This fund provides assistance to utilities, independent power producers, local governments, and tribal governments for feasibility studies, reconnaissance studies, energy resource monitoring, and work related to the design and construction of eligible facilities.

http://www.akenergyauthority.org/re-fund-6/4_Program_Update/FinalREFStatusAppendix2013.pdf

http://www.akenergyauthority.org/PDF%20files/PFS-BiomassProgramFactSheet.pdf

http://www.akenergyauthority.org/RenewableEnergyFund/RFA_Project_Locations_20Oct08.pdf

The Alaska Wood Energy Development Task Group (AWEDTG) consists of a coalition of federal and state agencies and not-for-profit organizations that have signed a Memorandum of Understanding (MOU) to explore opportunities to increase the utilization of wood for energy and biofuels production in Alaska. A pre-feasibility study for Aleknagik was conducted in 2012 for the AWEDTG. The preliminary costs for the biomass system(s) are $346,257 for the city hall and health center system and $439,096 for the city hall, health center, and future washeteria system.

http://www.akenergyauthority.org/biomasswoodenergygrants.html

http://www.akenergyauthority.org/BiomassWoodEnergy/Aleknagik%20Final%20Report.pdf

The Emerging Energy Technology Fund grand program provides funds to eligible applicants for demonstrations projects of technologies that have a reasonable expectation to be commercially viable within five years and that are designed to: test emerging energy technologies or methods of conserving energy, improve an existing energy technology, or deploy an existing technology that has not previously been demonstrated in Alaska.

http://www.akenergyauthority.org/EETFundGrantProgram.html

Appendix A
Site Photos

1. South elevation of office building.

2. West elevation of office building.

3. North elevation of office building.

4. East elevation of office building.

5. Site entrance. Office building on left (south) and shop building on right (north).

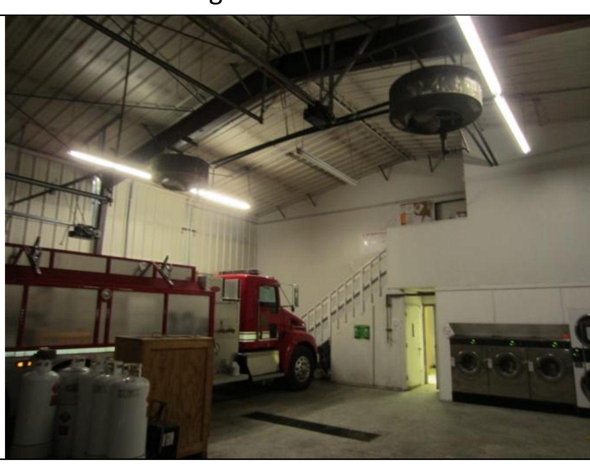
6. Location of GarnPak detached building, approximately 80 ft to the right (west) of the office building.

7. Fuel tank and red conex for fire department equipment.

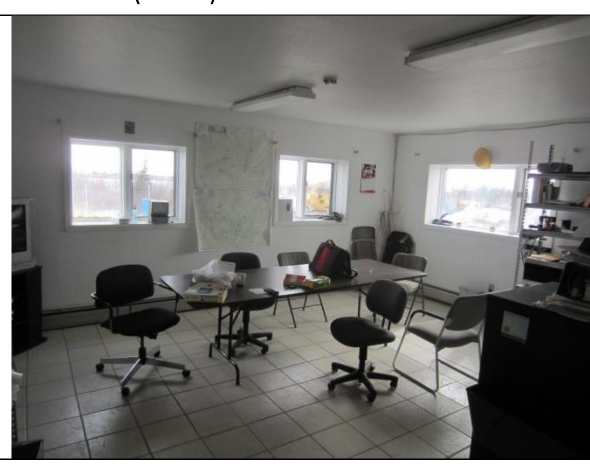
8. Office building boiler room.

9. Office building boiler room.

10. Boiler (1 of 2)



11. Garage area of the office building.



12. First floor conference room in the office building.

Appendix B
Economic Analysis Spreadsheet

Option A: Iliamna Tribal Office Building
Iliamna, Alaska

Economic Analysis Results	
Project Capital Cost	($332,298)
Simple Payback = Total Project Cost / First Year Cost Savings	42.3 years
Present Value of Project Benefits (20 year life)	$544,586
Present Value of Operating Costs (20 year life)	($302,773)
Benefit / Cost Ratio of Project (20 year life)	0.73
Net Present Value (20 year life)	($90,484)
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	25 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Description	Unit Cost	Heating Source Proportion	Annual Energy Units	Energy Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Existing Heating System Operating Costs														
Existing Heating Oil Consumption	$6.75		3,440	gal	**$23,220**	**$24,381**	**$25,600**	**$26,880**	**$28,224**	**$29,635**	**$31,117**	**$32,673**	**$34,307**	**$36,022**
Biomass System Operating Costs														
Wood Fuel (Delivered to site)	$330.00	85%	26.1	cord	($8,613)	($8,871)	($9,138)	($9,412)	($9,694)	($9,985)	($10,284)	($10,593)	($10,911)	($11,238)
Fossil Fuel	$6.75	15%	516	gal	($3,483)	($3,657)	($3,840)	($4,032)	($4,234)	($4,445)	($4,668)	($4,901)	($5,146)	($5,403)
Electricity	$0.69		3,285	kWh	($2,267)	($2,335)	($2,405)	($2,477)	($2,551)	($2,628)	($2,706)	($2,788)	($2,871)	($2,957)
Operation and Maintenance Costs					($500)	($510)	($520)	($531)	($541)	($552)	($563)	($574)	($586)	($598)
Additional Operation and Maintenance Costs for first 2 years					($500)	($510)	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($15,363)**	**($15,883)**	**($15,902)**	**($16,451)**	**($17,020)**	**($17,610)**	**($18,222)**	**($18,856)**	**($19,514)**	**($20,196)**
Annual Operating Cost Savings					$7,857	$8,498	$9,698	$10,429	$11,204	$12,025	$12,896	$13,817	$14,793	$15,826
Accumulated Cash Flow					$7,857	$16,355	$26,053	$36,482	$47,686	$59,711	$72,607	$86,424	$101,216	$117,042
Net Present Value					**($324,670)**	**($316,660)**	**($307,785)**	**($298,519)**	**($288,854)**	**($278,783)**	**($268,298)**	**($257,390)**	**($246,053)**	**($234,277)**

Description	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Existing Heating System Operating Costs										
Existing Heating Oil Consumption	**$37,823**	**$39,714**	**$41,700**	**$43,785**	**$45,974**	**$48,273**	**$50,686**	**$53,221**	**$55,882**	**$58,676**
Biomass System Operating Costs										
Wood Fuel (Delivered to site)	($11,575)	($11,922)	($12,280)	($12,648)	($13,028)	($13,419)	($13,821)	($14,236)	($14,663)	($15,103)
Fossil Fuel	($5,673)	($5,957)	($6,255)	($6,568)	($6,896)	($7,241)	($7,603)	($7,983)	($8,382)	($8,801)
Electricity	($3,046)	($3,138)	($3,232)	($3,329)	($3,429)	($3,531)	($3,637)	($3,746)	($3,859)	($3,975)
Operation and Maintenance Costs	($609)	($622)	($634)	($647)	($660)	($673)	($686)	($700)	($714)	($728)
Additional Operation and Maintenance Costs for first 2 years	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs	**($20,904)**	**($21,639)**	**($22,401)**	**($23,192)**	**($24,012)**	**($24,864)**	**($25,748)**	**($26,666)**	**($27,618)**	**($28,607)**
Annual Operating Cost Savings	$16,919	$18,075	$19,299	$20,593	$21,962	$23,409	$24,938	$26,555	$28,263	$30,068
Accumulated Cash Flow	$133,961	$152,036	$171,335	$191,928	$213,890	$237,298	$262,237	$288,792	$317,055	$347,124
Net Present Value	**($222,055)**	**($209,377)**	**($196,236)**	**($182,621)**	**($168,525)**	**($153,937)**	**($138,849)**	**($123,251)**	**($107,133)**	**($90,484)**

Option B: Iliamna Tribal Office Building and Shop Building
Iliamna, Alaska

Economic Analysis Results	
Project Capital Cost	($395,488)
Simple Payback = Total Project Cost / First Year Cost Savings	30.7 years
Present Value of Project Benefits (20 year life)	$818,146
Present Value of Operating Costs (20 year life)	($438,717)
Benefit / Cost Ratio of Project (20 year life)	0.96
Net Present Value (20 year life)	($16,059)
Year Accumulated Cash Flow is Net Positive	First Year
Year Accumulated Cash Flow > Project Capital Cost	21 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	3%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

Description	Unit Cost	Heating Source Proportion	Annual Energy Units	Energy Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Existing Heating System Operating Costs																								
Existing Heating Oil Consumption	$6.75		5,168	gal	**$34,884**	**$36,628**	**$38,460**	**$40,383**	**$42,402**	**$44,522**	**$46,748**	**$49,085**	**$51,540**	**$54,117**	**$56,822**	**$59,663**	**$62,647**	**$65,779**	**$69,068**	**$72,521**	**$76,147**	**$79,955**	**$83,953**	**$88,150**
Biomass System Operating Costs																								
Wood Fuel (Delivered to site)	$330.00	85%	39.2	cord	($12,936)	($13,324)	($13,724)	($14,136)	($14,560)	($14,996)	($15,446)	($15,910)	($16,387)	($16,879)	($17,385)	($17,906)	($18,444)	($18,997)	($19,567)	($20,154)	($20,758)	($21,381)	($22,023)	($22,683)
Fossil Fuel	$6.75	15%	775	gal	($5,231)	($5,493)	($5,767)	($6,056)	($6,359)	($6,677)	($7,010)	($7,361)	($7,729)	($8,115)	($8,521)	($8,947)	($9,395)	($9,864)	($10,358)	($10,875)	($11,419)	($11,990)	($12,590)	($13,219)
Electricity	$0.69		4,106	kWh	($2,833)	($2,918)	($3,006)	($3,096)	($3,189)	($3,284)	($3,383)	($3,484)	($3,589)	($3,697)	($3,808)	($3,922)	($4,039)	($4,161)	($4,285)	($4,414)	($4,546)	($4,683)	($4,823)	($4,968)
Operation and Maintenance Costs					($500)	($510)	($520)	($531)	($541)	($552)	($563)	($574)	($586)	($598)	($609)	($622)	($634)	($647)	($660)	($673)	($686)	($700)	($714)	($728)
Additional Operation and Maintenance Costs for first 2 years					($500)	($510)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($22,000)**	**($22,755)**	**($23,017)**	**($23,818)**	**($24,648)**	**($25,509)**	**($26,403)**	**($27,329)**	**($28,291)**	**($29,288)**	**($30,323)**	**($31,397)**	**($32,512)**	**($33,669)**	**($34,869)**	**($36,116)**	**($37,410)**	**($38,754)**	**($40,150)**	**($41,599)**
Annual Operating Cost Savings					$12,884	$13,873	$15,442	$16,565	$17,754	$19,012	$20,345	$21,756	$23,249	$24,828	$26,499	$28,266	$30,135	$32,110	$34,198	$36,405	$38,737	$41,201	$43,803	$46,551
Accumulated Cash Flow					$12,884	$26,757	$42,199	$58,764	$76,518	$95,530	$115,875	$137,631	$160,880	$185,709	$212,208	$240,474	$270,609	$302,720	$336,918	$373,323	$412,060	$453,261	$497,064	$543,615
Net Present Value					**($382,980)**	**($369,903)**	**($355,771)**	**($341,053)**	**($325,739)**	**($309,816)**	**($293,274)**	**($276,099)**	**($258,281)**	**($239,806)**	**($220,662)**	**($200,837)**	**($180,317)**	**($159,088)**	**($137,137)**	**($114,451)**	**($91,014)**	**($66,813)**	**($41,833)**	**($16,059)**

Appendix C
Site Plan

Site Plan of Iliamna Village Office Building

Appendix D
AWEDTG Field Data Sheet

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

APPLICANT:	Iliamna Village Council		
Eligibility: (check one)	☐ Local government ☐ State agency ☐ Federal agency ☐ School/School District ☒ Federally Recognized Tribe ☐ Regional ANCSA Corp. ☐ Village ANCSA Corp. ☐ Not-for-profit organization ☐ Private Entity that can demonstrate a Public Benefit ☐ Other (describe):		
Contact Name:	Dolly Ann Trevon		
Mailing Address:	P.O. Box 286		
City:	Iliamna, AK		
State:	AK	**Zip Code:**	99606
Office phone:	(907) 571-1246	**Cell phone:**	(907) 360-5406
Fax:	(907) 571-1256		
Email:	dolly.trefon@iliamnavc.org		

Facility Identification/Name:	Iliamna Village Council Office	
Facility Contact Person:	Tim Anelon	
Facility Contact Telephone:	(907) 571-7120	( )
Facility Contact Email:	tim.anelon@iliamnacorp.com	

SCHOOL/FACILITY INFORMATION (complete separate Field Data Sheet for each building)

SCHOOL FACILITY (Name: N/A **)**

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [ ] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):
Size of facility (sq. ft. heated):		Year built/age:		
Number of floors:		Year(s) renovated:		
Number of bldgs.:		Next renovation:		
# of Students:		Has en energy audit been conducted?:		If Yes, when? *

OTHER FACILITY (Name: Iliamna Village Council Office **)**

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [ ] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [X] Other (list): Office + Fire Hall
Size of Facility (sq. ft. heated)	60'x40'	Year built/age:	1988
Number of floors:	2	Year(s) renovated:	None
Number of bldgs.:	1	Next renovation:	None
Frequency of Usage:	60 hrs/week	# of Occupants	10 Average, 25 max
Has an energy audit been conducted?	NO	If Yes, when? *	N/A

10 hrs/day weekday + 5hrs/day weekend

*** If an Energy Audit has been conducted, please provide a copy.**

First flr = 60'x 40' ⟶ 3,200 SF Total
2nd Flr = 20'x 40'

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)

- [x] Heat plant in one location: ☐ on ground level ☐ below ground level [x] mezzanine ☐ roof ☐ at least 1 exterior wall
- ~~☐ Different heating plants in different locations: How many?~~ N/A What level(s)? N/A
- ~~☐ Individual room-by-room heating systems (space heaters)~~
- ☐ Is boiler room accessible to delivery trucks? ☐ Yes [x] No On second flr.

HEAT DELIVERY (check all that apply)

- [x] Hot water: [x] baseboard ☐ radiant heat floor ☐ cabinet heaters ☐ air handlers ☐ radiators [x] other: 2x Unit heaters for gara
- ~~☐ Steam:~~
- ~~☐ Forced/ducted air~~
- ~~☐ Electric heat: ☐ resistance ☐ boiler ☐ heat pump(s)~~
- ~~☐ Space heaters~~

HEAT GENERATION (check all that apply)

		Heating capacity (Btuh / kWh)	Annual Fuel Consumption	Cost
[x] Hot water boiler:	☐ natural gas ☐ propane ☐ electric [x] #1 fuel oil ☐ #2 fuel oil	286,000 Btu/hr	3,440 gal	$6.75/gal
~~☐ Steam boiler:~~	~~☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil~~			
~~☐ Warm air furnace:~~	~~☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil~~			
~~☐ Electric resistance:~~	~~☐ baseboard ☐ duct coils~~			
~~☐ Heat pumps:~~	~~☐ air source ☐ ground source ☐ sea water~~			
~~☐ Space heaters:~~	~~☐ woodstove ☐ Toyo/Monitor ☐ other:~~			

TEMPERATURE CONTROLS (type of system; check all that apply)

- [x] Thermostats on individual devices/appliances; no central control system
- ~~☐ Pneumatic control system~~ ~~Manufacturer:~~ ~~Approx. Age:~~
- ~~☐ Direct digital control system~~ ~~Manufacturer:~~ ~~Approx. Age:~~

Record Name Plate data for boilers (use separate sheet if necessary): 2 identical Burnham Boilers.
New Boilers installed in 2010. MN: LE2-GBI2S
1.25 GPH Firing Rate. 143 MBH DOE output

Describe locations of different parts of the heating system and what building areas are served:
Boilers serve 3 heating zones + indirect Hot water heater. Garage zone is heated by 2 unit heaters. Upstairs office zone + downstairs office zone have baseboard.

Describe age and general condition of existing equipment:
Boilers installed 2010. New pumps + copper piping in boiler room appear to be installed when boilers were in 2010. Wiring to boiler control modules appears unfinished.

Who performs boiler maintenance? Charlie (Mechanic) Describe any current maintenance issues:
There is no regular boiler maintenance.

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):
Piping is routed in walls and ceiling plenums and garage ceiling space.

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
2000 gal tank (6' Diameter x 9' length), One tank adjacent to bldg near boiler Rm. No containment area. On old concrete pad. Okay condition.

If this fuel is also used for other purposes, please describe:
No. Only for heating bldg.

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

- ☒ Lavatories
- ~~☐ Kitchen~~
- ~~☐ Showers~~
- ☒ Laundry
- ~~☐ Water treatment~~
- ~~☐ Other:~~ ______

TYPE OF SYSTEM
Check all that apply:

- ~~☐ Direct fired, single tank~~
- ~~☐ Direct fired, multiple tanks~~
- ☒ Indirect , using heating boiler with separate storage tank
- ~~☐ Hot water generator with separate storage tank~~
- ~~☐ Other:~~ ______

What fuels are used to generate hot water? (Check all that apply): ☐ natural gas ☐ propane ☐ electric ☒ #1 fuel oil ☐ #2 fuel oil

Describe location of water heater(s): Indirect hotwater heater located in boiler Rm
50 gal superstore heater.

Describe on-site fuel storage: number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
Same as boiler system

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): Typical Metal Building with 6" Fiberglass Insulation. Insulation Value: 19

Roof type: Metal Hot roof. Estimated 8" Fiberglass Insulation Insulation Value: 25

Windows: ☐ single pane ☒ double pane ☐ other: ______

Arctic entry(s): ☐ none ☒ at main entrance only ☐ at multiple entrances ☐ at all entrances

Drawings available: ~~☐ architectural ☐ mechanical ☐ electrical~~ None

Outside Air/Air Exchange: ~~☐ HRV ☐ CO_2 Sensor~~ None

ELECTRICAL

Utility company that serves the building or community: INNEC (Iliamna Newhalen Nondalton Elec. Coop)

Type of grid: ☐ building stand-alone ☒ village/community power ☐ railbelt grid

Energy source: ☒ hydropower ☒ diesel generator(s) ☐ Other: Tizimna Hydro

Electricity rate per kWh: $0.69 Demand charge: None

Electrical energy phase(s) available: ☒ single phase ☐ 3-phase

Back-up generator on site: ☒ Yes ☐ No If Yes, provide output capacity: 12 KW

Are there spare circuits in MDP and/or electrical panel?: ☒ Yes ☐ No

Record MDP and electrical panel name plate information: Single Phase, 240/120V.

Toyota Tacoma Truck load = $200/Load

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $ unknown /ton Viable fuel source? ~~Yes No~~ Research in Progress
- Wood chip cost delivered to facility $ unknown /ton Viable fuel source? ~~Yes No~~ Research in Progress
- Cord wood cost delivered to facility $ 330 /cord Viable fuel source? (Yes) No
- Distance to nearest wood pellet and wood chip suppliers? Barged in from distributer, FAIRBANKS/JUNEAU
- Can logs or wood fuel be stockpiled on site or at a nearby facility? Yes, to the west of existing bldg.

Who manages local forests? (Village Native Corp) Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other: ALSO SEE REPORT, SECTION VII

Iliamna Natives Limited

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Good access on large gravel pad.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? None. Lots of space available.

What are local soil conditions? Permafrost issues?
Clay & sand. Some permafrost. Office & Shop are on large gravel pad.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?
The shop Bldg. Approx. 80' to the north.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?
Separate Bldg is best for Village. No space allowable in bldg.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?
Power would come from transformer. Water from bldg.

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room?
Piping could be buried. Piping could enter by boiler room.

OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

- Is heat distribution system looping or branching? There are 3 heating zone loops.
- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? 3/4", 2.5"x2", 48 fins per ft.
- Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? Propane Driers (x4)
- Any systems that could be added to the boiler system? Tekmar boiler controller should be reinstalled.
- Are heating fuel records available? Yes. But are not well organized.

It was estimated based on 2012 bills that the bldg consumed $22,000 of heating oil. At an average price of $6.40/gal in 2012 that is approx. 3,440 gal.

PICTURE / VIDEO CHECKLIST

Exterior

- ✓ Main entry
- ✓ Building elevations
- ✓ Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building
- ✓ Access road to building and to boiler room
- ✓ Power poles serving building → No poles. underground. Transformers.
- ✓ Electrical service entry
- ✓ Emergency generator

Interior

- ✓ Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building.
- ✓ Boiler room piping at boiler and around boiler room
- ✓ Piping around domestic water heater
- ✓ MDP and/or electrical panels in or around boiler room
- ✓ Pictures of available circuits in MDP or electrical panel (open door).
- ✓ Picture of circuit card of electrical panel
- ✓ Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
- ✓ Pictures of any other major mechanical equipment
- ✓ Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.)
- ✓ Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan)

Wood

How much local wood availability is there? Lots of wood available according to Tim. However, it is unclear what quantity of wood can be sustainably harvested in the area.

Will additional wood demand cause issues? No demand issues appear to be a problem according to Tim Anelon.

Where would wood storage and wood drying occur: In location to west of bldg.

Typical Wind Direction at Storage Area: East wind & Northwind. Mostly East.

Local Wood Species (Birch, Spruce): Birch, Spruce

Moisture Content of Wood (Wet, dry, MC%): [dry circled]

Domestic Hot Water

Avg DHW Usage (ASHRAE Daily Avg for Office Bldg is 1.0 gal/day): 10 gal/day.

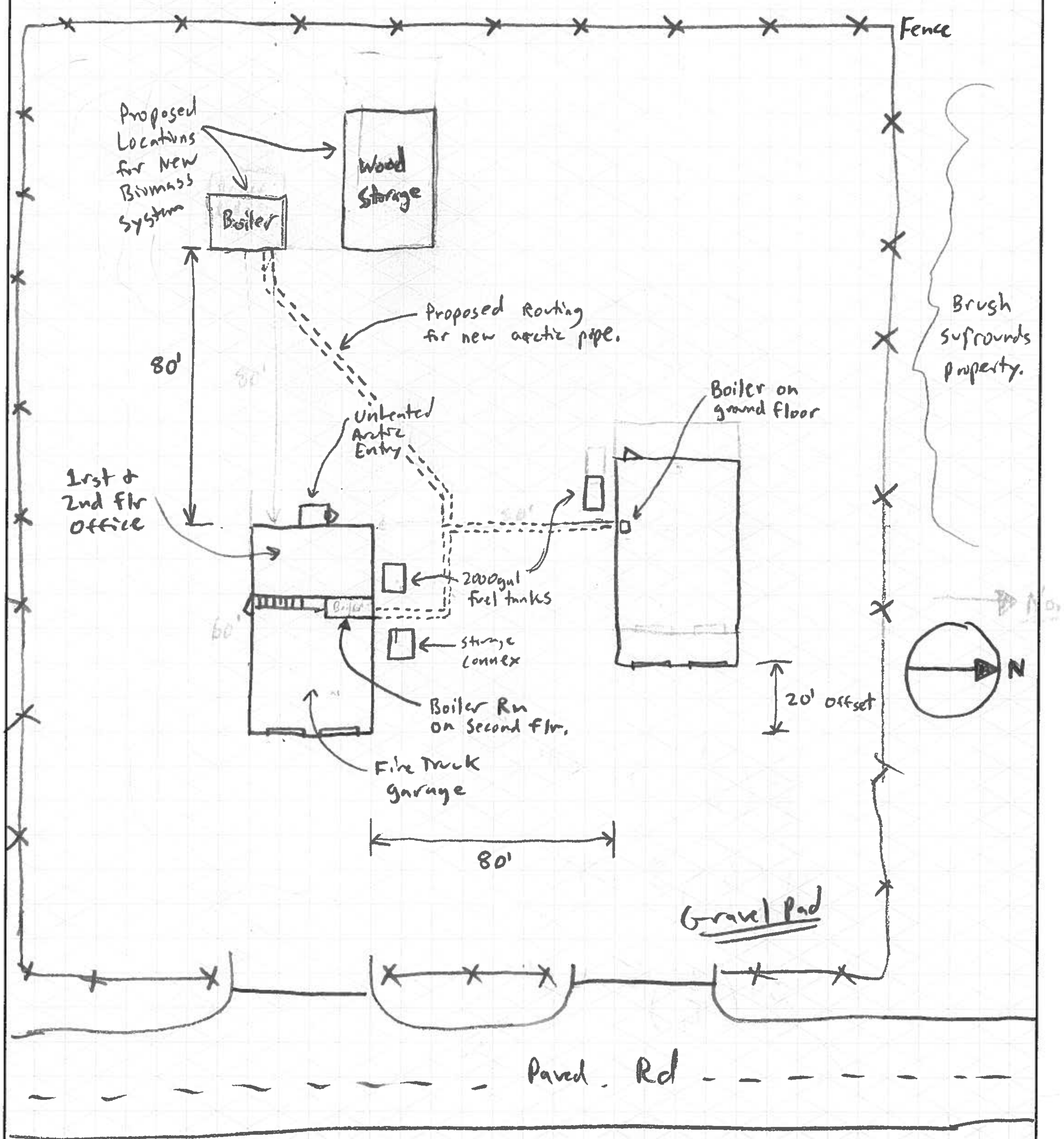
Logistics

How are construction materials shipped to Village (barge company): Iliamna Development Corp. Barge. (June 15 - October)

Is there local gravel or fill? How far away?

Local gravel pit located 1 mile away.

Site Plan - office = 60'x40', shop = 60'x40



Transformers

COFFMAN ENGINEERS

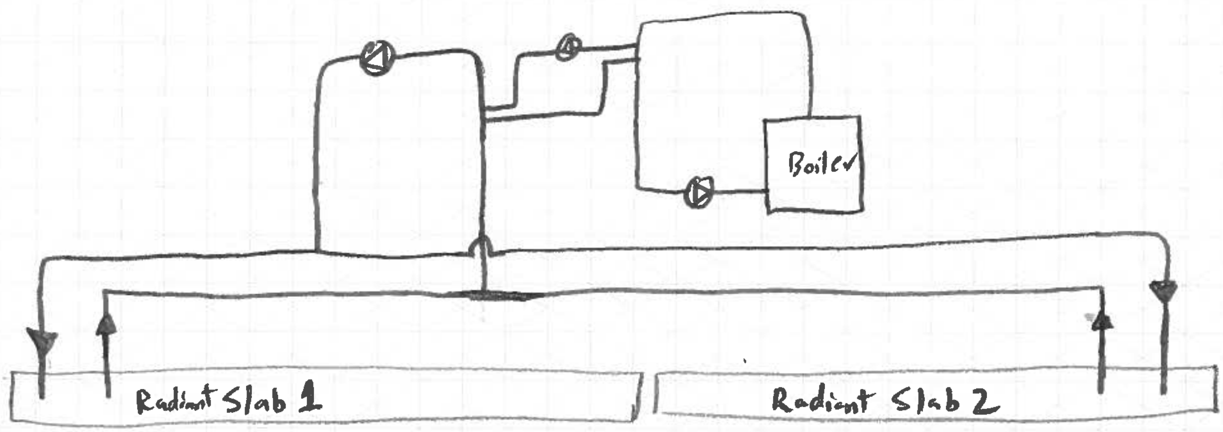
project: Iliamna Biomass	by: LJB	sheet no.	
location: Iliamna, AK	date: 4/24/13		
client: FEDC	checked	Job no. 13239	
	date		

Shop Building

- 60' x 40' w/ 2 large overhead doors.
- Wood frame structure
- Fiberglass batt insulation in Bad shape (R-10 maybe)
- Weil-McLain Gold Oil Boiler (P-WGO-3) Model Number)
  - 0.95 gph
  - 115,000 Btu/hr heating output
  - Boiler circ pump
  - Injection pump
  - Radiant slab circ pump.
  - Serves Radiant floor slab in whole shop floor.
  - Boiler controls all pumps it appears.
- EnergyLogic EL-200H Waste oil burner.
  - Model 200
  - 160,000 Btu/hr
  - 1.4 GPH

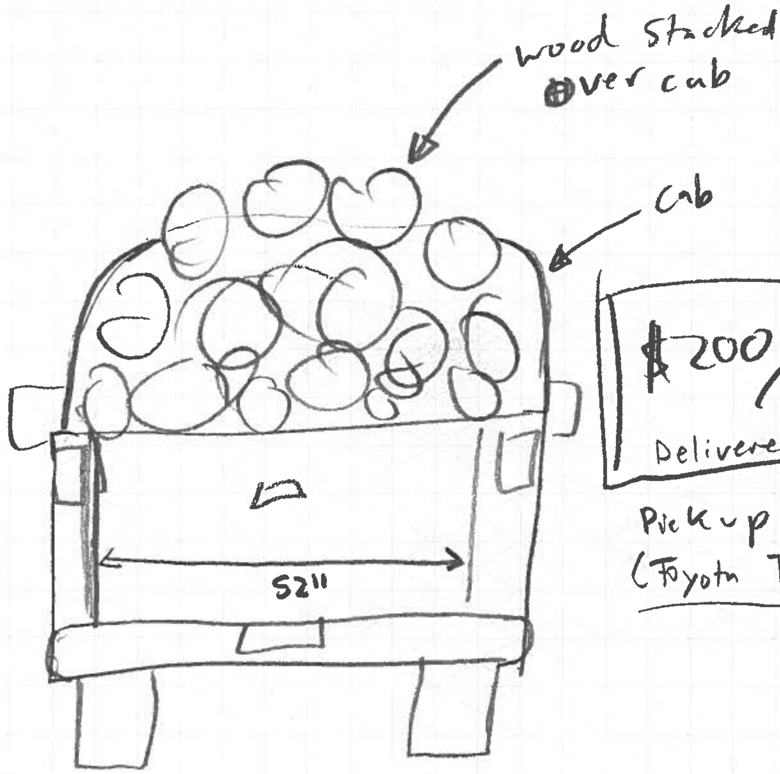
- This would be a good bldg to connect to with a new boiler system due to proximity and radiant floor.

- No restroom / sinks.



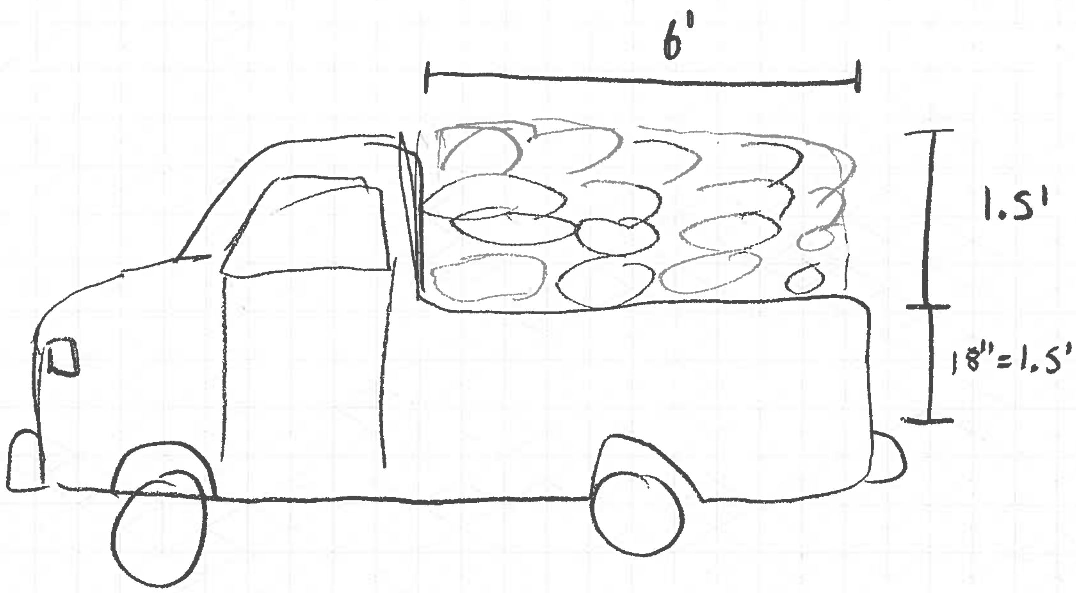
- IDC pays for oil. Sue Anelon 571-7130, 571-5805.

COFFMAN ENGINEERS	project: Iliamna Biomass	by: LJB	sheet no.
	location: Iliamna, AK	date: 4/24/13	
	client: FEDC	checked	Job no. 13239
		date	



$200/Load
Delivered.

Pickup truck load.
(Toyota Tacoma)



$$6'(1.5'+1.5')\left(\frac{52''}{12''/ft}\right)\left(\frac{1\ \text{cord}}{128\ ft^3}\right) = 0.61\ \text{cords} \Rightarrow \frac{\$200}{0.61\ \text{cord}} = \$330/\text{cord}$$

COFFMAN ENGINEERS

project: Iliamna Biomass	by: LJB	sheet no.	
location: Iliamna	date: 4/24/13		
client: FEDC	checked	Job no. 13239	
	date		

5:46 PM

04/24/13

Iliamna Village Council
Vendor QuickReport
January through December 2012

Type	Date	Num	Memo	Account	Clr	Split	Amount
Iliamna Development Corporation							
Check	1/27/2012	12047		1st National bank of...	X	-SPLIT-	-9,716.37
Check	1/30/2012	12058		1st National bank of...	X	Equipment fuel	-254.00
Check	1/30/2012	12062		1st National bank of...	X	Heating Fuel	-315.45
Check	2/1/2012	12063		1st National bank of...	X	-SPLIT-	-390.75
Check	2/15/2012	12083		1st National bank of...	X	-SPLIT-	-630.05
Check	3/6/2012	12120		1st National bank of...	X	-SPLIT-	-5,879.28
Check	3/23/2012	12150	INV: 12-274/...	1st National bank of...	X	-SPLIT-	-419.14
Check	4/2/2012	12163	INV: 12-295	1st National bank of...	X	Contractual	-37,318.75
Check	4/6/2012	12166	Ticket #6328	1st National bank of...	X	Equipment fuel	-95.12
Check	4/20/2012	12175	Sales Receip...	1st National bank of...	X	-SPLIT-	-696.99
Bill	4/24/2012	Ticket...	Ticket #6337	Accounts Payable		Equipment fuel	-107.58
Bill	4/26/2012	Ticket...	Ticket #6340	Accounts Payable		-SPLIT-	-65.60
Bill Pmt -Check	5/4/2012	12200		1st National bank of...	X	Accounts Pay...	-173.18
Bill	6/8/2012	SR13...	Sales Receip...	Accounts Payable		Office Supplie...	-123.36
Bill Pmt -Check	6/8/2012	12235	Sales Receip...	1st National bank of...	X	Accounts Pay...	-123.36
Bill	6/19/2012	INV: ...	INV: 12-837	Accounts Payable		-SPLIT-	-10,080.03
Bill Pmt -Check	6/19/2012	12240	INV: 12-837	1st National bank of...	X	Accounts Pay...	-10,080.03
Bill	6/28/2012	INV:1...	INV: 12-849 ...	Accounts Payable		-SPLIT-	-8,588.94
Bill Pmt -Check	6/28/2012	12244	INV: 12-849 ...	1st National bank of...	X	Accounts Pay...	-8,588.94
Bill	7/9/2012	12-954	INV: 12-954	Accounts Payable		Contractual	-23,607.97
Bill Pmt -Check	7/9/2012	12252	INV: 12-954	1st National bank of...	X	Accounts Pay...	-23,607.97
Bill	8/13/2012	SR 1...	Sales Receip...	Accounts Payable		Office Supplie...	-16.79
Bill Pmt -Check	8/14/2012	12269	Sales Receip...	1st National bank of...	X	Accounts Pay...	-16.79
Bill	8/17/2012	Invoic...	IRR Mainten...	Accounts Payable		Contractual	-37,318.75
Bill Pmt -Check	8/17/2012	12284		1st National bank of...	X	Accounts Pay...	-37,318.75
Bill	8/23/2012	SR#1...	4-100# propa...	Accounts Payable		Supplies (non-...	-600.00
Bill Pmt -Check	8/23/2012	12290	4-100# propa...	1st National bank of...	X	Accounts Pay...	-600.00
Bill	8/29/2012	Inv 12...	IRR Mainten...	Accounts Payable		Contractual	-37,318.75
Bill	8/29/2012	Inv 12...	IRR Mainten...	Accounts Payable		Contractual	-37,318.75
Bill Pmt -Check	8/29/2012	12298		1st National bank of...	X	Accounts Pay...	-74,637.50
Bill	8/30/2012		inv 12-1102	Accounts Payable		Contractual	-14,246.05
Bill Pmt -Check	8/30/2012	12300	inv 12-1102	1st National bank of...	X	Accounts Pay...	-14,246.05
Bill	8/31/2012	Office...	Office Supplies	Accounts Payable		Office Supplie...	-194.21
Bill Pmt -Check	8/31/2012	12315	Office Supplies	1st National bank of...	X	Accounts Pay...	-194.21
Bill	9/24/2012	Ticket...	Ticket # 7273...	Accounts Payable		Supplies (non-...	-600.00
Bill Pmt -Check	9/24/2012	12337	Ticket # 7273...	1st National bank of...	X	Accounts Pay...	-600.00
Bill	10/5/2012	Ticket...	Ticket #6689 ...	Accounts Payable		Heating Fuel	-625.00
Bill	10/5/2012	SR: 1...	Sales Receip...	Accounts Payable		-SPLIT-	-150.82
Bill Pmt -Check	10/5/2012	12341		1st National bank of...	X	Accounts Pay...	-775.82
Bill	10/19/2012		Invoice 12-12...	Accounts Payable		Heating Fuel	-625.00
Bill Pmt -Check	10/19/2012	12355	Invoice 12-12...	1st National bank of...	X	Accounts Pay...	-625.00
Bill	10/25/2012		Supplies for ...	Accounts Payable		Office Supplie...	-156.40
Bill Pmt -Check	10/25/2012	12361	Supplies for ...	1st National bank of...	X	Accounts Pay...	-156.40
Bill	11/13/2012		Ticket 6937	Accounts Payable		Heating Fuel	-3,810.00
Bill Pmt -Check	11/13/2012	12384	Ticket 6937	1st National bank of...	X	Accounts Pay...	-3,810.00
Bill	12/6/2012		Sludge truck ...	Accounts Payable		Equipment fuel	-226.38
Bill Pmt -Check	12/6/2012	12418	Sludge truck ...	1st National bank of...	X	Accounts Pay...	-226.38

3810
4903
4970
8224

$21907 for 2012 @ $6.40/gal = 3,440 gal/yr