Feasibility Assessment for Biomass Heating Systems
Aniak & Kalskag High Schools

FINAL REPORT – 7/28/2017

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Abbreviations

ACF	Accumulated Cash Flow
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AEA	Alaska Energy Authority
AFUE	Annual Fuel Utilization Efficiency
B/C	Benefit / Cost Ratio
BTU	British Thermal Unit
BTUH	BTU per hour
CCF	One Hundred Cubic Feet
CEI	Coffman Engineers, Inc.
CFM	Cubic Feet per Minute
Eff	Efficiency
F	Fahrenheit
ft	Feet
GPM	Gallons Per Minute
HP	Horsepower
HVAC	Heating, Ventilating, and Air-Conditioning
in	Inch(es)
kWh	Kilowatt-Hour
lb(s)	Pound(s)
MBH	Thousand BTUs per Hour
O&M	Operations and Maintenance
MMBTU	One Million BTUs
PC	Project Cost
R	R-Value
SF	Square Feet, Supply Fan
TEMP	Temperature
V	Volts
W	Watts

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I. Executive Summary

Coffman performed a preliminary biomass feasibility assessment for the Kuspuk School District to determine the technical and economic viability of biomass heating systems at Aniak High School in Aniak, Alaska and the George Morgan Sr. High School in Kalskag, Alaska. The study evaluated Garn style cordwood boiler systems that would supply the majority of heat to the schools.

The proposed wood boilers would be located in detached modules and heating pipes would connect to a new heat exchanger in the school's mechanical room. The existing heating oil boiler would still supplement heat in the schools during colder days during the heating season.

Due to the low price of heating oil at $2.60/gal, the benefit to cost ratios for each high school is less than 1.0 and therefore the cordwood boiler systems at the schools are not economically justified at this time.

However, the price of heating oil has varied greatly over the past couple of years and as heating oil prices rise the projects can become economically viable. When heating oil reaches $3.25/gal the cordwood boiler projects at both high schools become economically justified.

The summary of the results of the economic evaluation are shown in the table below.

Table 1 – Executive Summary

Item	Aniak High School	Kalskag High School
Project Capital Cost	($459,000)	($457,000)
Present Value of Project Benefits (20-year life)	$762,233	$731,744
Present Value of Operating Costs (20-year life)	($411,735)	($417,549)
Benefit / Cost Ratio of Project (20-year life)	0.76	0.69
Net Present Value (20-year life)	($108,502)	($142,806)
Year Cash Flow is Net Positive	First Year	First Year
Payback Period (Year Accumulated Cash Flow > Project Capital Cost)	> 20 years	>20 years

The energy prices in Aniak and Kalskag are shown in the following table. Wood pellets are less expensive than heating oil and electricity on an energy basis.

Table 2 – Energy Comparison

Community	Fuel Type	Units	Gross BTU/unit	System Efficiency	$/unit	Delivered $/MMBTU
Aniak	Cordwood	cord	17,000,000	80%	$250	$18.38
	Heating Oil	gal	134,000	65%	$2.60	$29.85
	Electricity	kWh	3,413	99%	$0.55	$162.78
Kalskag	Cordwood	cord	17,000,000	80%	$250	$18.38
	Heating Oil	gal	134,000	70%	$2.60	$27.72
	Electricity	kWh	3,413	99%	$0.55	$162.78

II. Introduction

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems for the Aniak High School in Aniak, Alaska and the George Morgan Sr. High School in Kalskag, Alaska. For this study, the George Morgan Sr. High School is referred to as the Kalskag High School.

Figure 1 – Aniak High School

Figure 2 – Kalskag High School

III. Preliminary Site Investigation

Coffman completed site visits to Aniak and Kalskag on May 16th and 17th, 2017.

Community Meeting

Coffman attended community meetings in both Aniak and Kalskag to discuss biomass heating systems with community members. Coffman presented the different types of biomass heating systems and talked about what opportunities are present in the communities.

Building Descriptions

Aniak

Aniak High School is a 21,400 square foot building built in the 1980's. The school is used during the typical school schedule and has a gym that is used by the community. Approximately 60 students attend the school from grades 7 to 12. There have been no energy audits of the school. Most of the school has been upgraded to T-8 lighting for energy efficiency upgrades.

Kalskag

The George Morgan Sr High School is located between the communities of Upper Kalskag and Lower Kalskag, near the south side of the airport. The school is 19,500 square feet and was built in 2011, because the old school burned down in 2009. The school is used during the typical school schedule and has a gym that is used by the community. There are 55 students that attend the school in grades 7 through 12. The school is new with a modern design. There has been no energy audit of the building.

Existing Heating System

Aniak

Aniak High School is heated by a Burnham oil fired boiler (620 MBH gross output, Model PF-504) that serves perimeter baseboard via a glycol loop in the all the school, except the gym. A Flexaire oil fired furnace (500 MBH gross output, Model SDF-50) provides heat for the gym. The furnace appears to be original and the age of the boiler is unknown. Both are in adequate condition and no major maintenance issues were reported.

Thermostats in the perimeter rooms and the gym control the heating units. There is no centralized control system.

The boiler, furnace and central pumps are located in the boiler room, which is located on a mezzanine room near the gym. The boiler runs in a primary arrangement, with the main pumps pumping glycol through the baseboards and boiler. The combustion efficiency of the boiler and furnace is unknown, as there were no combustion tests available. Due to the age and condition of the oil boiler and oil furnace it is estimated that the Annual Fuel Utilization Efficiency is 65% to account for typical oil unit inefficiencies, including short cycling.

A 1,000-gallon aboveground fuel tank is provided at the facility and provides oil for the emergency generator as well. The fuel tank is filled by three 8,000 gal tanks located by the Voc Ed Building.

Kalskag

Kalskag High School is heated by two Burnham oil-fired boilers (1281 MBH gross output, Model V1107). The boilers are located in the main mechanical room located in a detached building. The shop classroom is also in this detached building. The boilers are piped in a primary/secondary configuration and deliver glycol to baseboard, cabinet unit heaters and air handler heating coils. The boilers were manufactured in 2010 and they are operating in adequate condition. The combustion efficiency of the oil boilers is unknown, as there were no combustion tests available. For this study, the Annual Fuel Utilization Efficiency is estimated at 70% to account for typical oil boiler inefficiencies, including short cycling.

A central DDC system and Heat Timer Boiler Controller control the boilers, pumps and air handling systems. During the site visit the DDC computer could not be logged into. There were Heat Timer Boiler Controller setpoints found that could be updated for more efficient operation. It appears that the mechanical systems were never fully commissioned since the school was built in 2011. It is recommended that the school be commissioned in order to ensure efficient operations.

The following items were found during the site visit that could be changed during commissioning of the system:

1. The Heat Timer boiler controller is still in Winter Mode during the May site visit. Turning to summer mode will reduce heating oil consumption.
2. There is currently no Outdoor Air Temp Reset on the boilers. The boilers are currently running at 185F supply water temp even when the outside air temperature is 63F. Enabling an Outdoor Air Temp Reset will reduce heating oil consumption.
3. Consider reducing outdoor temp cutoff for the boiler (it is currently set at 70F).
4. UH-4 zone valve is broken.
5. CP-1A and 1B are constantly running in Hand mode.
6. CP-2B is constantly running in Hand mode. CP-2A is out of service for maintenance.
7. AHU-2 zone valve is disconnected, allowing hot glycol to run wild through the heating coil.
8. AHU-1 and AHU-2 are not used. It was reported that they may have never been programmed properly.

There is one 4,000 gal and two 12,000 gal aboveground fuel tanks that provide fuel to the boilers, bus, school trucks and teacher housing (located at a different location).

Domestic Hot Water

Aniak

Domestic hot water is provided by a Bock oil fired water heater (50 gal capacity). Hot water is used for lavatories, kitchen, showers, and laundry. The water heater is also located in the mezzanine by the gym with the boiler and furnace.

Kalskag

Domestic hot water is provided by a Boilermate, indirect hot water heater (119 gal) that is heated by a loop from the boiler. The water heater is located in the same mechanical room as the boilers.

Air Handling System

Aniak

Aniak High School does not have a building wide air handling system. Fresh air is supplied by operable windows. The furnace has an outdoor air supply duct for supplying fresh air to the gym.

Kalskag

Two air handling units supply are located in a second floor mechanical near the gym. AHU-1 serves the gym and AHU-2 serves the rest of the building. It was reported that the air handling units are typically not used, except for during basketball games in the gym.

Building Envelope

Aniak

As-Built drawings of the school were not available and so the actual construction details of the school are not known. The school has wood frame walls and a built-up roof. Insulation thicknesses could not be verified during the site visit. The school has double pane windows and an artic entry at the main entry.

Kalskag

Kalskag High School is a new building that is built with a modern energy efficient building envelope. As-built drawings of the school were not provided and so the wall and roof construction and insulation values could not be verified. The school is on a pile foundation and the building envelope appears to be in good condition. Windows are double pane. There are arctic entries at multiple entrances.

Available Space, Street Access, Fuel Storage and Site Constraints

Aniak

There is no available space inside the school for a new biomass boiler system. A new detached wood boiler module is proposed. There are many site constraints around the school that limit the available space for a new module. The south side of the school is the main entry and fields. To the east of the school is the Voc Ed building, which was used as an old military satellite site that has environmental contamination of the soils. There is currently an effort to remediate PCB contamination at the Voc Ed building site that is beginning summer of 2017. The west side of the school is heavily wooded with no road access.

The only available area left for a wood boiler module is on the back, north side of the school. There already exists a gravel access way on the northeast side of the school that is used to access the fuel tank at the bank of the school. A new gravel pad is required to make space for a wood boiler module and a wood storage shed.

It was reported that the Aniak airport will be expanded in the next three to four years, which will demolish the Voc Ed Building.

A site layout of Aniak High School is shown in the following figure.

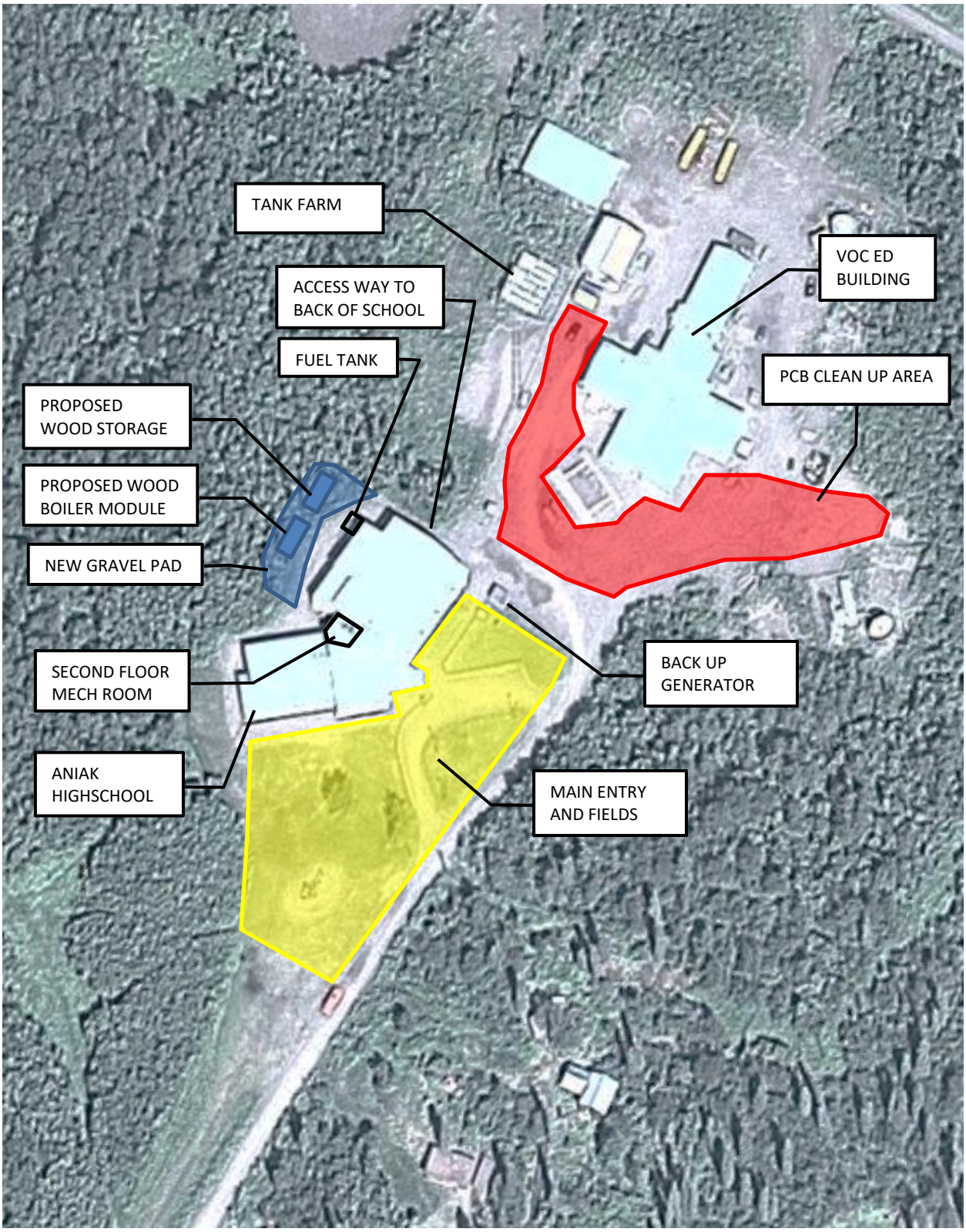

Figure 3 – Aniak High School Site Layout

Kalskag

There is no available space in Kalskag High School for a new wood boiler system. A detached wood boiler module is proposed. The most practical location for the proposed wood boiler module and wood storage shed is on a new gravel pad to the north of the school's mechanical room. This will allow easy access from the existing gravel road and have a short piping run from the module to the school's existing boilers.

There is limited space elsewhere around the school for the module. The west side of the school has the septic system and poor road access. The east side of the school is the main entry and parking lot. The south side of the school is an empty lot that may be used as a playground in the future. The north west of the school has fuel tanks, storage and the backup generator.

There is a bus barn building located to the west of the school. Heating records were not provided and the heating system could not be accessed during the site visit. It has a below ground fuel tank and above ground fuel tank. From the outside appears to be a typical metal warehouse type building. The bus barn could be connected to the proposed wood boiler module with buried insulated pipe. However, the economics of doing so are unknown at this time.

A site layout of Kalskag High School is shown in the following figure.

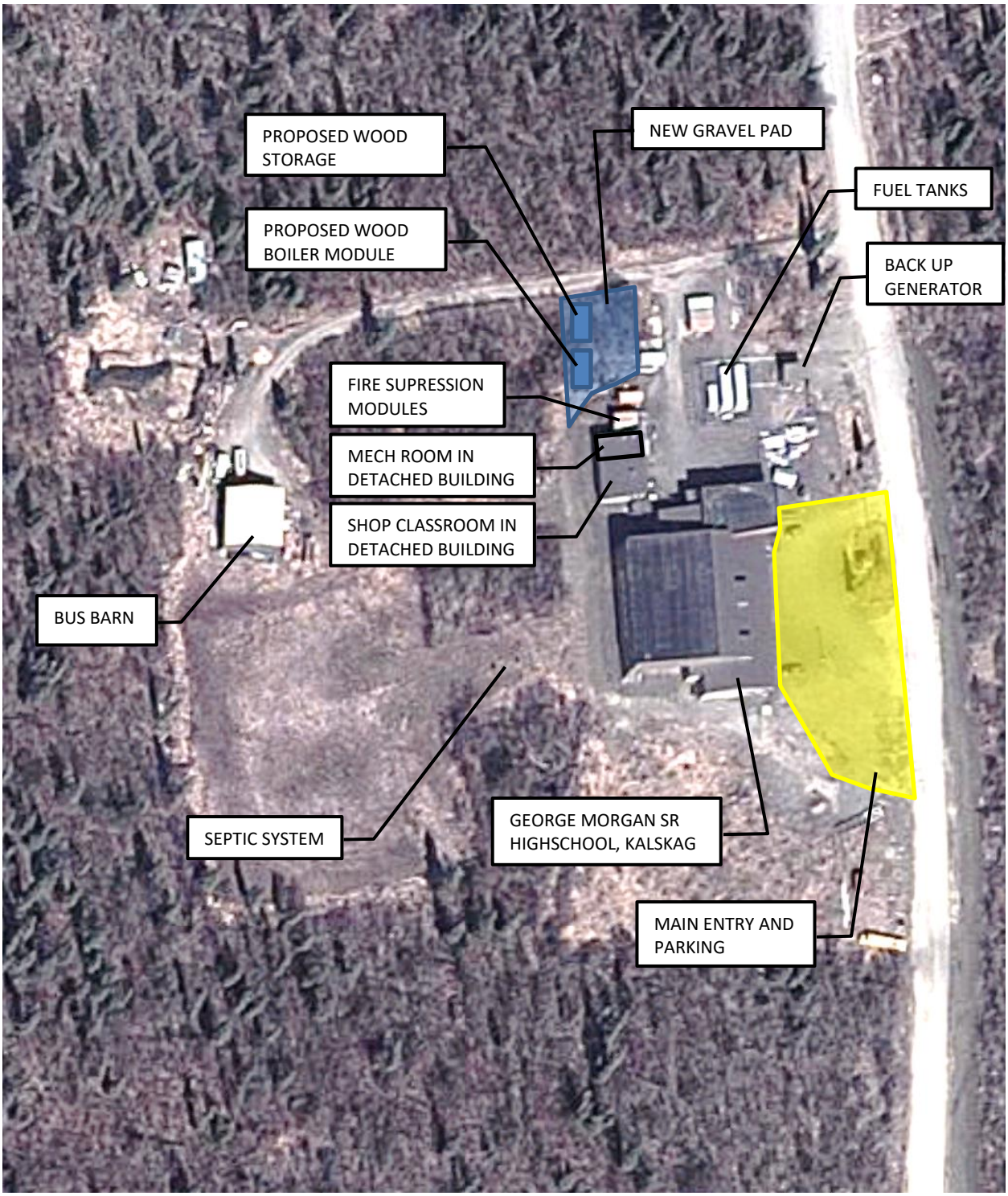

Figure 4 – Kalskag High School Site Layout

Biomass System Options

Cordwood is the only biomass heating fuel that is readily available in both Aniak and Kalskag and so a cordwood boiler system was selected as the preferred option for both schools. A Garn WHS-3200 wood boiler selected as the basis of design.

Figure 5 – Garn WHS-3200 Wood Boiler

The Garn WHS-3200 wood boiler has a 3,200-gallon water tank and is 7'4" wide x 7'8" high x 12' long. The Garn boiler would be housed in an 8' wide x 20' long insulated module that can be fabricated offsite and shipped to the schools for installation. The module would contain the Garn boiler, circulation pumps, heat exchanger, piping, electrical wiring, instrumentation and control panel. The manufacture stated combustion efficiency of the Garn boiler is 85%. For this study, the Annual Fuel Utilization Efficiency for the Garn boiler is estimated at 80%, to account for heat loss in the system.

The Garn boiler would deliver heat to a heat exchanger inside the module, which would transfer heat to a buried insulated piping loop system with 50% propylene glycol. This loop would deliver heat through a direct buried, insulated arctic pipe to a new heat exchanger in the school.

Biomass System Integration

Integration for both Aniak and Kalskag High Schools will be very similar. The new heat exchanger in the school will receive heat from the wood boiler module and connect to the return side of the existing oil boiler heating glycol return loop. By tying into the oil boiler return line, the wood boiler will be able minimize the firing of the oil boilers. In the event that the wood boiler cannot meet the heat demand of the building, the existing oil boilers will fire to provide the supplemental heat required. It is recommended that an aggressive outside temperature reset schedule on the oil boilers is used in order to maximize the utilization of the wood boiler.

IV. Energy Consumption and Costs

Energy Costs

The table below shows the energy comparison of different fuel types at the schools. 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, cordwood is cheaper than fuel oil on a $/MMBTU basis in both Aniak and Kalskag.

Table 3 – Energy Comparison

Community	Fuel Type	Units	Gross BTU/unit	System Efficiency	$/unit	Delivered $/MMBTU
Aniak	Cordwood	cord	17,000,000	80%	$250	$18.38
	Heating Oil	gal	134,000	65%	$2.60	$29.85
	Electricity	kWh	3,413	99%	$0.55	$162.78
Kalskag	Cordwood	cord	17,000,000	80%	$250	$18.38
	Heating Oil	gal	134,000	70%	$2.60	$27.72
	Electricity	kWh	3,413	99%	$0.55	$162.78

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.

In Aniak and Kalskag, spruce is the primary wood species according to the local harvester. For this study, cordwood was estimated to have 17.0 MMBTU/cord, which is a conservative estimate because the moisture content of the wood may vary.

Cordwood

The primary source of cordwood is the Native Village of Napaimute, which has a timber harvest located 3 miles downriver from Lower Kalskag. It is a 400 acre, 10-year lease from the Kuskokwim Corporation and there are approximately 7,000 to 8,000 cords on the lease. According to the timber harvest manager, most of the wood harvested is white spruce with some minor birch when it can be found. A mechanized harvester and firewood processer are used to harvest the wood and the operation employees people from Kalskag and the surrounding communities. The cordwood can be either barged on the river or shipped on the winter ice road to either Aniak or Kalskag. According to the timber

harvest manager, Napaimute could sell cordwood to Aniak and Kalskag High School for between $250 to $300 per cord. For this study $250/cord delivered to the schools was used.

Wood Pellets and Chips

There is no local wood pellet manufacturer or distributor in region, which means that wood pellets would have to be barged into the community. Therefore, wood pellet costs would be high and not a viable biomass source. There is also no wood chip manufacturer in the region. However, the Napaimute timber harvest operation is considering making chips in the future. But they do not have the machinery to make chips at this time. Due to these factors, wood pellets and wood chips were not selected as viable biomass fuel sources.

Heating Oil

The high price of fuel oil is the main economic driver for the use of lower cost biomass heating. Fuel oil is purchased in bulk by the school district and shipped into Aniak and Kalskag by barge. The current cost of bulk fuel oil is $2.60/gal. For this study, the energy content of fuel oil is based on 134,000 BTU/gal, according to “Heating Values of Fuels” by the UAF Cooperative Extension, 2009.

Electricity

Electricity for Aniak and Kalskag is provided by the Alaska Village Electric Cooperative (AVEC). According to the utility data provided by the school district, both schools have an electricity rate of $0.55/kWh. Heating with electricity is the most expensive energy source on a BTU basis.

Existing Fuel Oil Consumption

An estimate of the schools' heating oil consumption was made based on annual heating oil data provided by the school district from 2016. Actual heating oil bills were not provided for the study.

Table 4 – Existing Fuel Oil Consumption				
Building	**Fuel Type**	**Annual Consumption**	**Net MMBTU/yr**	**Avg. Annual Cost**
Aniak High School	Heating Oil #1	12,500 gal	1,088.8	$32,500
Kalskag High School	Heating Oil #1	12,000 gal	1,125.6	$31,200

Biomass System Consumption

It is estimated that the proposed biomass systems will offset approximately 90% of the heating energy for both Aniak High School and Kalskag High School. The remaining 10% of the heating energy at will be provided by the school's existing oil boilers. This result is based on an analysis of the school's annual heating oil consumption, the heat output of the Garn boiler and BIN weather data for the area. It is assumed that the Garn WHS-3200 is loaded every 9 to 12 hours, which will produce 150,000 BTU/hr to 200,000 BTU/hr with a 125F minimum supply water temperature, per manufacturer documentation. More frequent loading is possible, which will increase BTU output and allow additional heating oil offset during colder times of the year. The annual energy consumption and energy savings of the projects are shown in the following table.

Table 5 – Proposed Biomass System Fuel Consumption							
Building	**Fuel Type**	**% Heating Source**	**Net MMBTU/yr**	**Annual Consumption**	**Energy Cost**	**Total Energy Cost**	**Annual Energy Savings**
Aniak High School	Cordwood	90%	979.9	72 cords	$18,012	$21,400	**$11,100**
	Fuel Oil	10%	108.9	1,250 gal	$3,250		
	Additional Electricity	N/A	N/A	250 kWh	$138		
Kalskag High School	Cordwood	90%	1013.0	74 cords	$18,622	$21,880	**$9,320**
	Fuel Oil	10%	112.6	1,200 gal	$3,120		
	Additional Electricity	N/A	N/A	250 kWh	$138		

Note – Based on wood pellets at $250/ton, heating oil at $2.60/gal and electricity at $0.55/kWh.

V. Preliminary Cost Estimating

An estimate of probable costs was completed for installing the Garn boiler system at each school. The cost estimate is based equipment quotes and from previous projects in Alaska. A 15% remote factor was used to account for increased shipping and installation costs to the communities. Project and Construction Management was estimated at 5%. Engineering design and permitting was estimated at 15% and a 20% contingency was used.

Table 6 – Estimate of Probable Cost

		Aniak	Kalskag
Category	**Description**	**Cost**	**Cost**
Site Work	Site Grading for Module	$4,500	$4,000
	Gravel Fill	$4,000	$3,500
	Foundation (Timbers and Anchors)	$5,000	$5,000
	Buried Utilities	$4,500	$4,500
	Subtotal	**$18,000**	**$17,000**
Electrical Utilities	Service Entrance	$4,000	$4,000
	Conduit and Wiring	$4,000	$4,000
	Subtotal	**$8,000**	**$8,000**
Wood Boiler Module	Insulated Module 8 ft x 20 ft	$15,000	$15,000
	Garn Boiler WHS 3200	$45,000	$45,000
	Heat Exchanger	$7,000	$7,000
	Installation, Piping & Materials	$70,000	$70,000
	Fire Allowance	$10,000	$10,000
	Controls Allowance	$10,000	$10,000
	Electrical Allowance	$10,000	$10,000
	Shipping	$10,000	$10,000
	Installing Module Onsite	$10,000	$10,000
	Subtotal	**$187,000**	**$187,000**
Wood Storage Building	3-Sided Storage Shed Allowance	**$30,000**	**$30,000**
School Connection	Heat Exchanger	$7,000	$7,000
	Insulated Piping from Module	$10,000	$10,000
	Boiler Room Modifications	$15,000	$15,000
	Subtotal	**$32,000**	**$32,000**
Subtotal Material and Installation Cost		**$275,000**	**$274,000**
Remote Factor	15%	$41,250	$41,100
	Subtotal	**$316,250**	**$315,100**
Project and Construction Management	5%	$15,813	$15,755
	Subtotal	**$332,063**	**$330,855**
Design Fees and Permitting	15%	$49,809	$49,628
	Subtotal	**$381,872**	**$380,483**
Contingency	20%	$76,374	$76,097
Total Project Cost		$458,246	$456,580
Total Budgetary Cost		**$459,000**	**$457,000**

VI. Economic Analysis

The following assumptions were used to complete the economic analysis for this study.

Table 7 – Discount and Escalation rates	
Real Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	2%
Fossil Fuel Escalation Rate	5%
Electricity Escalation Rate	3%
O&M Escalation Rate	2%

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 previous Alaska Energy Authority funded biomass pre-feasibility studies. The wood fuel escalation rate was set at 2% because it is estimated that wood prices will rise slower than electricity prices.

A net present value analysis was completed using real dollars (constant dollars) and the real discount rate, as required per the Alaska Department of Education and Early Development Life Cycle Cost Analysis Handbook.

O&M Costs

Non-fuel related operations and maintenance costs (O&M) were estimated at $700 per year. The estimate is based on annual maintenance time for the Garn boiler. For only the first two years of service, the maintenance cost is doubled to account for maintenance staff getting used to operating the new system. Labor costs for daily stoking of the boiler are not included, as this is typically completed by a maintenance person who is already hired by the organization that utilizes the boiler and stoking the boiler would become part of their daily duties.

Definitions

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

Table 8 – Economic Definitions	
Economic Term	**Description**
Project Capital Cost	This is the opinion of probable cost for designing and constructing the project.
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.
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 and the heating oil required by the existing equipment to supply the remaining amount 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 than 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.
Payback Period (Year Accumulated Cash Flow > Project Capital Cost)	The Payback Period 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 quantity includes 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.

Results

An economic analysis was completed in order to determine the simple payback, benefit to cost ratio, and net present value of the proposed Garn cordwood boiler systems at the high schools. At each school, a Garn boiler would be located in a detached module and heating pipes would connect to a new heat exchanger in the school's mechanical room. The cordwood boiler would supplement heat for the existing oil boiler system. The cost of a cordwood storage shed at the schools was included in this analysis.

Due to the low price of heating oil, the benefit to cost ratios for each high school is less than 1.0. Any project with a benefit to cost ratio less than 1.0 is not considered economically justified, and therefore the cordwood boiler systems at the schools in not economically justified at this time.

However, historically the price of heating oil has varied greatly over time and as heating oil prices rise the projects can become economically viable. When heating oil reaches $3.25/gal the cordwood boiler projects at both Aniak and Kalskag High Schools become economically justified. This can be seen in the sensitivity analysis on the following page. Three years ago, heating oil prices in the communities were much higher than $3.25/gal.

A benefit of the cordwood projects is that it creates a local economy of wood use. Instead of money from heating oil sales leaving the community, the money is used to buy cordwood that is harvested by local labor. This creates local jobs and keeps money in the community.

The Alaska Energy Authority is now using a 25-year life span for the Garn Boiler for the Renewable Energy Fund applications. This means that the Garn will have five years of additional benefits after the 20-year study period.

The results are shown in the table below. Refer to Appendix B for the economic analysis spreadsheets for greater detail. (Note: Values shown in red and parenthesis are negative numbers)

Table 9 – Economic Analysis Results

Item	Aniak High School	Kalskag High School
Project Capital Cost	($459,000)	($457,000)
Present Value of Project Benefits (20-year life)	$762,233	$731,744
Present Value of Operating Costs (20-year life)	($411,735)	($417,549)
Benefit / Cost Ratio of Project (20-year life)	0.76	0.69
Net Present Value (20-year life)	($108,502)	($142,806)
Year Cash Flow is Net Positive	First Year	First Year
Payback Period (Year Accumulated Cash Flow > Project Capital Cost)	> 20 years	>20 years

Sensitivity Analysis

A sensitivity analysis was completed to show how changing heating oil costs and wood costs affect the benefit to cost (B/C) ratios of the project. As heating oil costs increase and wood costs decrease, the project becomes more economically viable. The B/C ratios greater than 1.0 are economically justified and are highlighted in green. B/C ratios less than 1.0 are not economically justified and are highlighted in orange.

For example, at a heating oil price of $3.25/gal and the current cordwood price of $250/cord, the cordwood boiler project at both Aniak and Kalskag High Schools are economically justified.

Table 10 – Sensitivity Analysis – Aniak High School

B/C Ratios		Cordwood Cost					
		$200/cord	$225/cord	$250/cord	$275/cord	$300/cord	$325/cord
Heating Oil Cost	$2.50/gal	0.85	0.78	0.71	0.64	0.57	0.50
	$2.75/gal	0.99	0.92	0.85	0.78	0.71	0.64
	$3.00/gal	1.13	1.06	0.99	0.92	0.85	0.78
	$3.25/gal	1.28	1.21	1.14	1.07	1.00	0.93
	$3.50/gal	1.42	1.35	1.28	1.21	1.14	1.07
	$3.75/gal	1.56	1.49	1.42	1.36	1.29	1.22
	$4.00/gal	1.71	1.64	1.57	1.50	1.43	1.36
	$4.25/gal	1.85	1.78	1.71	1.64	1.57	1.50
	$4.50/gal	1.99	1.93	1.86	1.79	1.72	1.65
	$4.75/gal	2.14	2.07	2.00	1.93	1.86	1.79
	$5.00/gal	2.28	2.21	2.14	2.07	2.00	1.93
	$5.25/gal	2.43	2.36	2.29	2.22	2.15	2.08

Table 11 – Sensitivity Analysis – Kalskag High School

B/C Ratios		Cordwood Cost					
		$200/cord	$225/cord	$250/cord	$275/cord	$300/cord	$325/cord
Heating Oil Cost	$2.50/gal	0.78	0.70	0.63	0.56	0.49	0.42
	$2.75/gal	0.91	0.84	0.77	0.70	0.63	0.56
	$3.00/gal	1.05	0.98	0.91	0.84	0.77	0.69
	$3.25/gal	1.19	1.12	1.05	0.98	0.90	0.83
	$3.50/gal	1.33	1.26	1.19	1.11	1.04	0.97
	$3.75/gal	1.47	1.40	1.32	1.25	1.18	1.11
	$4.00/gal	1.61	1.54	1.46	1.39	1.32	1.25
	$4.25/gal	1.75	1.67	1.60	1.53	1.46	1.39
	$4.50/gal	1.88	1.81	1.74	1.67	1.60	1.53
	$4.75/gal	2.02	1.95	1.88	1.81	1.74	1.66
	$5.00/gal	2.16	2.09	2.02	1.95	1.87	1.80
	$5.25/gal	2.30	2.23	2.16	2.08	2.01	1.94

VII. Forest Resource and Fuel Availability Assessments

Fuel Availability

For this study, the primary source of cordwood is the Napaimute timber harvest operation, described in the Cordwood section of the report. According to the operations manager, there is a large burn area across from Aniak that would be another source of cordwood. The Kuskokwim Corporation is the main land owner in the area and all wood harvesting on their land will require permits. There is also state land in the area, but there is limited access to it. No other Forest Resource assessments were located during this study.

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). Recent similarly sized Garn wood fired boiler systems installed in Alaska have not required 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 communities 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.

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. Wood pellets can also be used, but typically require a larger scale pellet manufacturer to make them. 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.

High Efficiency Wood Pellet Boilers

High efficiency pellet boilers are designed to burn wood pellets cleanly and efficiently. These boilers utilize pellet storage bins or silos that hold a large percentage of the building's annual pellet supply. Augers or vacuums transfer pellets from the silos to a pellet hopper adjacent to the pellet boiler, where pellets can be fed into the boiler for burning. Pellets are automatically loaded into the pellet boiler and do not require manual loading such as in a Garn cordwood boiler. The pellet boilers typically have a 3 to 1 turn down ratio, which allows the firing rate to modulate from 100% down to 33% fire. This allows the boiler to properly match building heat demand, increasing boiler efficiency. The efficiencies of these boilers can range from 85% to 92% efficiency depending on firing rate.

High Efficiency Cordwood 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. Two HELE cordwood boiler suppliers include Garn (www.garn.com) and TarmUSA (www.woodboilers.com). Both of these suppliers have units operating in Alaska. TarmUSA has a number of residential units operating in Alaska and has 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, in-floor 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 Cordwood 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. 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 25% percent and produce more than nine times the emission rate of standard industrial boilers. In comparison, HELEs 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 a 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.

Grants

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

The U.S. Department of Agriculture Rural Development has over fifty financial assistance programs for a variety of rural applications. This includes energy efficiency and renewable energy programs.

http://www.rd.usda.gov/programs-services

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

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/Programs/RenewableEnergyFund

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 washateria system.

http://www.akenergyauthority.org/Programs/AEEE/Biomass

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/Programs/EETF1

Appendix A
Site Photos

Aniak High School

1. South Elevation of Building

2. South West Elevation of Building

3. North Elevation of Building

4. Proposed area for cordwood boiler module on North side of building. Fuel tank in the background.

5. East Elevation

6. Voc Ed Building

7. Water Heater

8. Boiler

9. Hydronic Pumps

10. Well Water Tanks

11. Furnace

12. Boiler and Water Heater in Mech Room

13. Diesel Day Tank

14. Electrical Panels

Kalskag High School

15. East Elevation

16. East Elevation of School and Detached Shop and Mechanical Building

17. West Elevation

18. South Elevation

19. North Elevation

20. Bus Barn North Elevation

21. Fuel Tanks

22. Detached Shop and Mechanical Room Building

23. Fuel Transfer Pump Control Panel

24. Shop Service Disconnect

25. Boiler B-1

26. Boiler Circ Pump

27. Expansion Tank

28. Well Tanks and Hot Water Heater

29. Main Hydronic Circ Pumps

30. Electrical Panels

31. Air Handling Units

32. Gym

34. Building Layout

35. Classroom Thermostat

Appendix B
Economic Analysis Spreadsheets

Aniak High School
Aniak, Alaska

Economic Analysis Results	
Project Capital Cost	($459,000)
Present Value of Project Benefits (20-year life)	$762,233
Present Value of Operating Costs (20-year life)	($411,735)
Benefit / Cost Ratio of Project (20-year life)	0.76
Net Present Value (20-year life)	($108,502)
Year Accumulated Cash Flow is Net Positive	First Year
Payback Period (Year Accumulated Cash Flow > Project Capital Cost)	> 20 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	2%
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	$2.60		12,500	gal	**$32,500**	**$34,125**	**$35,831**	**$37,623**	**$39,504**	**$41,479**	**$43,553**	**$45,731**	**$48,017**	**$50,418**	**$52,939**	**$55,586**	**$58,365**	**$61,284**	**$64,348**	**$67,565**	**$70,943**	**$74,491**	**$78,215**	**$82,126**
Biomass System Operating Costs																								
Cord Wood (Delivered to site)	$250.00	90%	72.0	cords	($18,000)	($18,360)	($18,727)	($19,102)	($19,484)	($19,873)	($20,271)	($20,676)	($21,090)	($21,512)	($21,942)	($22,381)	($22,828)	($23,285)	($23,751)	($24,226)	($24,710)	($25,204)	($25,708)	($26,223)
Fossil Fuel	$2.60	10%	1,250	gal	($3,250)	($3,413)	($3,583)	($3,762)	($3,950)	($4,148)	($4,355)	($4,573)	($4,802)	($5,042)	($5,294)	($5,559)	($5,837)	($6,128)	($6,435)	($6,757)	($7,094)	($7,449)	($7,822)	($8,213)
Additional Electricity	$0.55		250	kWh	($138)	($142)	($146)	($150)	($155)	($159)	($164)	($169)	($174)	($179)	($185)	($190)	($196)	($202)	($208)	($214)	($221)	($227)	($234)	($241)
Operation and Maintenance Costs					($700)	($714)	($728)	($743)	($758)	($773)	($788)	($804)	($820)	($837)	($853)	($870)	($888)	($906)	($924)	($942)	($961)	($980)	($1,000)	($1,020)
Additional Operation and Maintenance Costs for first 2 years					($700)	($714)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($22,788)**	**($23,342)**	**($23,184)**	**($23,757)**	**($24,347)**	**($24,954)**	**($25,579)**	**($26,223)**	**($26,886)**	**($27,569)**	**($28,274)**	**($29,000)**	**($29,749)**	**($30,521)**	**($31,317)**	**($32,138)**	**($32,986)**	**($33,861)**	**($34,764)**	**($35,696)**
Annual Operating Cost Savings					$9,713	$10,783	$12,647	$13,866	$15,157	$16,526	$17,974	$19,508	$21,131	$22,849	$24,665	$26,586	$28,617	$30,763	$33,031	$35,427	$37,957	$40,630	$43,451	$46,430
Accumulated Cash Flow					$9,713	$20,495	$33,142	$47,008	$62,165	$78,691	$96,665	$116,173	$137,305	$160,153	$184,818	$211,404	$240,021	$270,784	$303,815	$339,241	$377,199	$417,829	$461,280	$507,710
Net Present Value					**($449,570)**	**($439,406)**	**($427,833)**	**($415,513)**	**($402,439)**	**($388,599)**	**($373,984)**	**($358,584)**	**($342,389)**	**($325,387)**	**($307,568)**	**($288,921)**	**($269,435)**	**($249,097)**	**($227,896)**	**($205,819)**	**($182,854)**	**($158,989)**	**($134,209)**	**($108,502)**

George Morgan Sr High School
Kalskag, Alaska

Economic Analysis Results	
Project Capital Cost	($457,000)
Present Value of Project Benefits (20-year life)	$731,744
Present Value of Operating Costs (20-year life)	($417,549)
Benefit / Cost Ratio of Project (20-year life)	0.69
Net Present Value (20-year life)	($142,806)
Year Accumulated Cash Flow is Net Positive	First Year
Payback Period (Year Accumulated Cash Flow > Project Capital Cost)	>20 years

Inflation Rates	
Discount Rate for Net Present Value Analysis	3%
Wood Fuel Escalation Rate	2%
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	$2.60		12,000	gal	**$31,200**	**$32,760**	**$34,398**	**$36,118**	**$37,924**	**$39,820**	**$41,811**	**$43,902**	**$46,097**	**$48,401**	**$50,822**	**$53,363**	**$56,031**	**$58,832**	**$61,774**	**$64,863**	**$68,106**	**$71,511**	**$75,087**	**$78,841**
Biomass System Operating Costs																								
Cord Wood (Delivered to site)	$250.00	90%	74.0	cords	($18,500)	($18,870)	($19,247)	($19,632)	($20,025)	($20,425)	($20,834)	($21,251)	($21,676)	($22,109)	($22,551)	($23,002)	($23,462)	($23,932)	($24,410)	($24,899)	($25,397)	($25,904)	($26,423)	($26,951)
Fossil Fuel	$2.60	10%	1,200	gal	($3,120)	($3,276)	($3,440)	($3,612)	($3,792)	($3,982)	($4,181)	($4,390)	($4,610)	($4,840)	($5,082)	($5,336)	($5,603)	($5,883)	($6,177)	($6,486)	($6,811)	($7,151)	($7,509)	($7,884)
Additional Electricity	$0.55		250	kWh	($138)	($142)	($146)	($150)	($155)	($159)	($164)	($169)	($174)	($179)	($185)	($190)	($196)	($202)	($208)	($214)	($221)	($227)	($234)	($241)
Operation and Maintenance Costs					($700)	($714)	($728)	($743)	($758)	($773)	($788)	($804)	($820)	($837)	($853)	($870)	($888)	($906)	($924)	($942)	($961)	($980)	($1,000)	($1,020)
Additional Operation and Maintenance Costs for first 2 years					($700)	($714)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Costs					**($23,158)**	**($23,716)**	**($23,561)**	**($24,137)**	**($24,730)**	**($25,340)**	**($25,968)**	**($26,614)**	**($27,280)**	**($27,965)**	**($28,672)**	**($29,399)**	**($30,149)**	**($30,922)**	**($31,719)**	**($32,541)**	**($33,389)**	**($34,263)**	**($35,165)**	**($36,096)**
Annual Operating Cost Savings					$8,043	$9,044	$10,837	$11,981	$13,194	$14,480	$15,843	$17,288	$18,817	$20,436	$22,150	$23,963	$25,881	$27,910	$30,055	$32,321	$34,717	$37,248	$39,921	$42,745
Accumulated Cash Flow					$8,043	$17,087	$27,924	$39,904	$53,098	$67,578	$83,422	$100,709	$119,526	$139,962	$162,112	$186,075	$211,957	$239,867	$269,921	$302,243	$336,960	$374,207	$414,129	$456,874
Net Present Value					**($449,191.75)**	**($440,666.56)**	**($430,749.49)**	**($420,104.82)**	**($408,723.60)**	**($396,596.63)**	**($383,715)**	**($370,068)**	**($355,646)**	**($340,440)**	**($324,438)**	**($307,631)**	**($290,007)**	**($271,555)**	**($252,264)**	**($232,123)**	**($211,118)**	**($189,239)**	**($166,472)**	**($142,806)**

Appendix C
AWEDTG Field Data Sheets

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

5/16/17

APPLICANT:	Aniak High School, Aniak
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:	Severin Gardner
Mailing Address:	PO Box 30
City:	Kalskag
State:	AK **Zip Code:** 99607
Office phone:	(907) 471-2288 **Cell phone:** ( )
Fax:	(907)
Email:	sgardner@kuspuk.org

Facility Identification/Name:	Aniak High School, Aniak	
Facility Contact Person:	Lee Morgan / Jeromy Hoeldt / Todd Boynton	
Facility Contact Telephone:	(907) 675-4721	(907) 675-4330
Facility Contact Email:	tboynton@kuspuk.org (Principal)	

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

SCHOOL FACILITY (Name: Aniak High School **)**

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [X] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):

Size of facility (sq. ft. heated):	21,400 SF	Year built/age:	30+	
Number of floors:	1	Year(s) renovated:	None	
Number of bldgs.:	1	Next renovation:	None	
# of Students:	60 (Grades 7-12)	Has en energy audit been conducted?:	No	If Yes, when? * —

OTHER FACILITY (Name: _____ **)**

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [ ] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [ ] Other (list):

Size of Facility (sq. ft. heated)		Year built/age:	
Number of floors:		Year(s) renovated:	
Number of bldgs.:		Next renovation:	
Frequency of Usage:		# of Occupants	
Has an energy audit been conducted?		If Yes, when? *	

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

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply) Boiler Rm is in Mezzanine Area.

- ☒ Heat plant in one location: ☐ on ground level ☐ below ground level ☒ mezzanine ☐ roof ☒ at least 1 exterior wall
- ☐ Different heating plants in different locations: How many? _____ What level(s)? _____
- ☐ Individual room-by-room heating systems (space heaters)
- ☐ Is boiler room accessible to delivery trucks? ☐ Yes ☒ No In second story mezzanine.

HEAT DELIVERY (check all that apply) GLYCOL

- ☒ Hot water: ☒ baseboard ☐ radiant heat floor ☐ cabinet heaters ☐ air handlers ☐ radiators ☐ other: _____
- ☐ Steam: _____
- ☒ Forced/ducted air
- ☐ Electric heat: ☐ resistance ☐ boiler ☐ heat pump(s)
- ☐ Space heaters

HEAT GENERATION (check all that apply)

							Gross Output Heating capacity (Btuh / kWh)	Annual Fuel Consumption	Cost
☒ Hot water boiler:	☐ natural gas	☐ propane	☐ electric	☒ #1 fuel oil	☐ #2 fuel oil		620 MBH	12,400 gal	$2.60/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		500 MBH		
☐ 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)

- ☒ Thermostats on individual devices/appliances; no central control system (T-STATS in classrooms control baseboard zone valves)
- ☐ Pneumatic control system Manufacturer: _____ Approx. Age: _____
- ☐ Direct digital control system Manufacturer: _____ Approx. Age: _____

Record Name Plate data for boilers (use separate sheet if necessary):
Burnham Oil Boiler, Model PF-504, 620 MBH Gross output
Flexaire Furnace, Model SDF-50, #025H-MB-LH, 625 MBH Input
500 MBH output

Describe locations of different parts of the heating system and what building areas are served:
Furnace only for Gym.
Boiler for perimeter baseboard for rest of school.

Describe age and general condition of existing equipment:
Furnace original. Boiler unknown. OK working condition.

Who performs boiler maintenance? Kuspuk School District Maintenance. Describe any current maintenance issues: Nothing major. working OK.

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):
In crawlspace under building

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
1,000 gal tank located behind Gym. Tank is filled by 3 x 8,000 gal Tank farm by VOC Ed building. All tanks have containment.

If this fuel is also used for other purposes, please describe:
None.

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 50gal, Bock, Oil-Fired.
- ☐ 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): In boiler room mezzanine

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

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): Wood frame Insulation Value: Unknown
Roof type: Hot Roof Insulation Value: unknown
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 No dwgs available
Outside Air/Air Exchange: ☐ HRV ☐ CO_2 Sensor

ELECTRICAL

Utility company that serves the building or community: Aniak Light & Power
Type of grid: ☐ building stand-alone ☒ village/community power ☐ railbelt grid
Energy source: ☐ hydropower ☒ diesel generator(s) ☐ Other: _____
Electricity rate per kWh: $0.55 Demand charge: no
Electrical energy phase(s) available: ☒ single phase ☐ 3-phase
Back-up generator on site: ☒ Yes ☐ No If Yes, provide output capacity: 50 kW
Are there spare circuits in MDP and/or electrical panel?: ☒ Yes ☐ No

Record MDP and electrical panel name plate information: SEE PHOTOS

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $ none /ton Viable fuel source? Yes (No)
- Wood chip cost delivered to facility $ none /ton Viable fuel source? Yes (No)
- Cord wood cost delivered to facility $ 300-400/cord Viable fuel source? (Yes) No
- Distance to nearest wood pellet and wood chip suppliers? None in local region
- Can logs or wood fuel be stockpiled on site or at a nearby facility? Yes, in VOC'ed area. But there are contaminated soils.

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other:

The Kuskokwim Corporation (TKC). State of Alaska. Napaimute has a wood lot that reportedly has 7,000 - 8,000 cords of wood. Mike Leary runs the lot and sells wood at N$300/cord

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Yes, gravel access roads.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? Nearby Voc Ed building was old military White Alice site and has contaminated soils (PCB).

What are local soil conditions? Permafrost issues? Permafrost. Gravel pad typical

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?
Yes, VoC Ed bldg is ~300 ft away. But there are contaminated soils in between

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?
New Module would be best. Module located on north side of building. New gravel pad is required.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?
From School.

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room?
New piping could enter gym and route inside to 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? Primary System.
For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? (2" mains) Fins unknown.
Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? Not for oil.
Any systems that could be added to the boiler system? no
Are heating fuel records available? Yes, Jeremy Hoeldt has them.

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
- ✓ 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)

ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)

PRE-FEASIBILITY ASSESSMENT **FIELD DATA SHEET**

5/16/17

APPLICANT:	George Morgan Sr. High School, Kalskag
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:	Severin Gardner
Mailing Address:	PO Box 30
City:	Kalskag
State: AK	**Zip Code:** 99607
Office phone: (907) 471-2288	**Cell phone:** ( )
Fax: (907)	
Email:	sgardner@kuspuk.org

Facility Identification/Name:	George Morgan Sr. High School, Kalskag	
Facility Contact Person:	Severin Gardner	
Facility Contact Telephone:	(907) 471-2288	( )
Facility Contact Email:	sgardner@kuspuk.org	

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

SCHOOL FACILITY (Name: George Morgan Sr. High School, Kalskag)

School Type: (check all that apply)	[ ] Pre-School [ ] Elementary [ ] Middle School	[ ] Junior High [X] High School [ ] Campus	[ ] Student Housing [ ] Pool [ ] Gymnasium	[ ] Other (describe):

Size of facility (sq. ft. heated):	19,500 SF	Year built/age:	2011	
Number of floors:	1	Year(s) renovated:	None	
Number of bldgs.:	2	Next renovation:	No	
# of Students:	55 (Grade 7-12)	Has en energy audit been conducted?:	NO	If Yes, when? *

OTHER FACILITY (Name: _____)

Type:	[ ] Health Clinic [ ] Public Safety Bldg. [ ] Community Center	[ ] Water Plant [ ] Washeteria [ ] Public Housing	[ ] Multi-Purpose Bldg [ ] District Energy System [ ] Other (list):

Size of Facility (sq. ft. heated)		Year built/age:	
Number of floors:		Year(s) renovated:	
Number of bldgs.:		Next renovation:	
Frequency of Usage:		# of Occupants	
Has an energy audit been conducted?		If Yes, when? *	

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

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply) seperate building contains boiler room & Shop.

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

HEAT DELIVERY (check all that apply) GLYCOL

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

HEAT GENERATION (check all that apply)

							Heating capacity (Btuh / kWh) GROSS OUTPUT	Annual Fuel Consumption	Annual Fuel Cost
[x] Hot water boiler:	☐ natural gas	☐ propane	☐ electric	[x] #1 fuel oil	☐ #2 fuel oil		2 x 1281 MBH	12,000 gal	$2.60/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)

- ☐ Thermostats on individual devices/appliances; no central control system
- ☐ Pneumatic control system Manufacturer: _____ Approx. Age: _____
- [x] Direct digital control system Manufacturer: Unknown Approx. Age: 2011

→ Heat Timer Boiler Controller, DDC system, Does not appear to be properly set-up.

Record Name Plate data for boilers (use separate sheet if necessary):

2 Boilers each: Burnham, oil Boiler, Model V1107, Made 2010, 11 GPH INPUT, 1281 MBH GROSS OUTPUT
Piped in primary/secondary.

Describe locations of different parts of the heating system and what building areas are served:

Boiler Plant and shop are in detached Bldg. Boiler heats Buildings with baseboard and unit heaters and AHU.

Describe age and general condition of existing equipment:

Built in 2011. Good condition. Mech equip needs commissioning.

Who performs boiler maintenance? Kuspuk School District in Aniak. Describe any current maintenance issues:

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):

In Ceiling.

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

2 x 12,000 gal tanks + 1 x 4,000 gal tank. W/ containment.

If this fuel is also used for other purposes, please describe:

Teacher housing, bus, school trucks and other schools

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

- ☒ Lavatories
- ☒ Kitchen
- ☒ Showers Occasional for Basketball
- ☒ Laundry Little bit
- ☐ 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): In boiler room.

Describe on-site fuel storage: number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
119 gal Boiler Mate. Indirect. No oil burner.

BUILDING ENVELOPE

Brand new building in 2011. Modern design.

Wall type (stick frame, masonry, SIP, etc.): Steel & wood Insulation Value: unknown

Roof type: Built-up Insulation Value: unknown

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 Fire Alarm drawings available. No other drawings found.

Outside Air/Air Exchange: ☐ HRV ☐ CO_2 Sensor

ELECTRICAL

Utility company that serves the building or community: AVEC

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

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

Electricity rate per kWh: $0.55 Demand charge: none

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

Back-up generator on site: ☒ Yes ☐ No If Yes, provide output capacity: 75 kW

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

Record MDP and electrical panel name plate information: SEE Photos

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $ None /ton Viable fuel source? Yes (No)
- Wood chip cost delivered to facility $ none /ton Viable fuel source? Yes (No)
- Cord wood cost delivered to facility $ 300-350 /cord Viable fuel source? (Yes) No
- Distance to nearest wood pellet and wood chip suppliers? None in local region.
- Can logs or wood fuel be stockpiled on site or at a nearby facility? yes.

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other:

TKC owns majority. Surrounding State Land
Cord wood could be purchased from Napaimute wood lot down river. Mike Leary runs lot.

FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Yes, To North of boiler room.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)?
No significant constraints.

What are local soil conditions? Permafrost issues? Permafrost.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?
The bus barn is about 300 yrds away. (Old building)

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?
A new biomass boiler bldg is necessary. Locate on new gravel pad to the north west of boiler building.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?
From the school.

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

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? Primary/secondary boiler system.
For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? Unaccessible
Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source? No.
Any systems that could be added to the boiler system? System should be commissioned. Many set points are making operation inefficient.
Are heating fuel records available?
Yes.

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
- ✓ 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)