Feasibility Assessment for Biomass Heating Systems at Pearl Creek, Weller, Two Rivers and Salcha Elementary Schools

FINAL REPORT – 7/28/2017

800 F Street, Anchorage, AK 99501
p (907) 276-6664 f (907) 276-5042

Lee Bolling, PE
## Contents

1. Executive Summary ............................................................................................................. 1
2. Introduction .......................................................................................................................... 2
3. Preliminary Site Investigation ............................................................................................... 4
    - Building Descriptions ........................................................................................................ 4
    - Existing Heating System .................................................................................................. 4
    - Available Space, Street Access, Fuel Storage and Site Constraints ................................ 5
4. Biomass System ..................................................................................................................... 12
    - Biomass System Options .................................................................................................. 12
    - Biomass System Integration ......................................................................................... 13
5. Energy Consumption and Costs ............................................................................................ 14
    - Energy Costs .................................................................................................................. 14
    - Cord Wood .................................................................................................................... 14
    - Wood Pellets .................................................................................................................. 14
    - Heating Oil ...................................................................................................................... 14
    - Electricity ....................................................................................................................... 15
    - Existing Fuel Oil Consumption ..................................................................................... 16
    - Biomass System Consumption ...................................................................................... 16
6. Preliminary Cost Estimating ................................................................................................. 18
7. Economic Analysis ................................................................................................................ 20
    - O&M Costs ...................................................................................................................... 20
    - Definitions....................................................................................................................... 20
    - Results ............................................................................................................................. 22
    - Sensitivity Analysis ........................................................................................................ 24
8. Forest Resource and Fuel Availability Assessments ........................................................... 26
    - Fuel Availability .............................................................................................................. 26
    - Air Quality Permitting .................................................................................................... 26
9. General Biomass Technology Information ........................................................................ 27
    - Heating with Wood Fuel ............................................................................................... 27
    - Types of Wood Fuel ....................................................................................................... 27
    - High Efficiency Wood Pellet Boilers ............................................................................. 28
    - High Efficiency Cordwood Boilers ................................................................................ 28
    - Low Efficiency Cordwood Boilers .................................................................................. 28
    - High Efficiency Wood Stoves ....................................................................................... 29
    - Bulk Fuel Boilers ............................................................................................................ 29
    - Grants ............................................................................................................................... 29
Appendices

Appendix A – Site Photos
Appendix B – Economic Analysis Spreadsheets
Appendix C – AWEDTG Field Data Sheets
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACF</td>
<td>Accumulated Cash Flow</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating, and Air-Conditioning Engineers</td>
</tr>
<tr>
<td>AEA</td>
<td>Alaska Energy Authority</td>
</tr>
<tr>
<td>AFUE</td>
<td>Annual Fuel Utilization Efficiency</td>
</tr>
<tr>
<td>B/C</td>
<td>Benefit / Cost Ratio</td>
</tr>
<tr>
<td>BTU</td>
<td>British Thermal Unit</td>
</tr>
<tr>
<td>BTUH</td>
<td>BTU per hour</td>
</tr>
<tr>
<td>CFM</td>
<td>Cubic Feet per Minute</td>
</tr>
<tr>
<td>Eff</td>
<td>Efficiency</td>
</tr>
<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>ft</td>
<td>Feet</td>
</tr>
<tr>
<td>FNSB</td>
<td>Fairbanks North Star Borough</td>
</tr>
<tr>
<td>FNSBSD</td>
<td>Fairbanks North Star Borough School District</td>
</tr>
<tr>
<td>GPM</td>
<td>Gallons Per Minute</td>
</tr>
<tr>
<td>HP</td>
<td>Horsepower</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilating, and Air-Conditioning</td>
</tr>
<tr>
<td>in</td>
<td>Inch(es)</td>
</tr>
<tr>
<td>kW</td>
<td>Kilowatt(s)</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilowatt-Hour</td>
</tr>
<tr>
<td>lb(s)</td>
<td>Pound(s)</td>
</tr>
<tr>
<td>MBH</td>
<td>Thousand BTUs per Hour</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operations and Maintenance</td>
</tr>
<tr>
<td>MMBTU</td>
<td>One Million BTUs</td>
</tr>
<tr>
<td>PC</td>
<td>Project Cost</td>
</tr>
<tr>
<td>R</td>
<td>R-Value</td>
</tr>
<tr>
<td>SF</td>
<td>Square Feet, Supply Fan</td>
</tr>
<tr>
<td>TEMP</td>
<td>Temperature</td>
</tr>
<tr>
<td>TPY</td>
<td>Tons per Year</td>
</tr>
<tr>
<td>V</td>
<td>Volts</td>
</tr>
<tr>
<td>W</td>
<td>Watts</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1 – Pearl Creek Elementary ........................................................................................................ 2
Figure 2 – Weller Elementary ................................................................................................................... 2
Figure 3 – Two Rivers Elementary .......................................................................................................... 3
Figure 4 – Salcha Elementary .................................................................................................................. 3
Figure 5 – Pearl Creek Site Layout ........................................................................................................ 6
Figure 6 – Weller Site Layout .................................................................................................................. 8
Figure 7 – Two Rivers Site Layout ......................................................................................................... 9
Figure 8 – Salcha Site Layout .................................................................................................................. 11
Figure 9 – Viessmann RF-300 Wood Pellet Boiler .................................................................................. 12

List of Tables

Table 1 – Executive Summary ................................................................................................................. 1
Table 2 – Energy Comparison ................................................................................................................ 1
Table 3 – Building Properties ................................................................................................................ 4
Table 4 – Building Properties ................................................................................................................ 4
Table 5 – Energy Comparison ................................................................................................................ 14
Table 6 – Existing Fuel Oil Consumption ............................................................................................... 16
Table 7 – Proposed Biomass System Fuel Consumption ........................................................................ 17
Table 8 – Estimate of Probable Cost ........................................................................................................ 19
Table 9 – Discount and Escalation rates ................................................................................................. 20
Table 10 – Economic Definitions ............................................................................................................ 21
Table 11 – Economic Analysis Results .................................................................................................. 22
Table 12 – Sensitivity Analysis – Pearl Creek ........................................................................................ 24
Table 13 – Sensitivity Analysis – Weller .................................................................................................. 24
Table 14 – Sensitivity Analysis – Two Rivers ......................................................................................... 25
Table 15 – Sensitivity Analysis – Salcha .................................................................................................. 25
1. Executive Summary

Coffman performed a preliminary biomass feasibility assessment for the Fairbanks North Star Borough to determine the technical and economic viability of biomass heating systems at four elementary schools in the Fairbanks area of Alaska: Pearl Creek, Weller, Two Rivers and Salcha. The proposed biomass heating systems are wood pellet boilers located in detached modules with heating pipes to the schools. A local wood pellet supplier would deliver pellets to an adjacent wood pellet silo.

Due to the current low price of heating oil at $2.90/gal, the benefit to cost ratios for each school is less than 1.0 and therefore the wood pellet systems at the schools are not economically justified at this time.

However, the price of heating oil can vary greatly over time and as heating oil prices rise these projects can become economically viable. For example, when heating oil reaches $3.50/gal the wood pellet boiler projects at Pearl Creek and Weller become economically justified.

The pellet boiler projects at Pearl Creek and Weller are more economic than at Two Rivers and Salcha. The reason for this is the greater amount of heating oil that can be offset in the larger schools of Pearl Creek and Weller, compared to the cost of the new pellet boiler system. Two Rivers and Salcha are less economic due to the relatively small heating oil offset and high project costs.

A summary of each project’s economic analysis is shown in the following table.

<table>
<thead>
<tr>
<th>Item</th>
<th>Pearl Creek</th>
<th>Weller</th>
<th>Two Rivers</th>
<th>Salcha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>($673,000)</td>
<td>($505,000)</td>
<td>($489,000)</td>
<td>($475,000)</td>
</tr>
<tr>
<td>Present Value of Project Benefits</td>
<td>$1,027,021</td>
<td>$788,970</td>
<td>$462,500</td>
<td>$333,272</td>
</tr>
<tr>
<td>Present Value of Operating Costs</td>
<td>($523,154)</td>
<td>($403,473)</td>
<td>($240,550)</td>
<td>($170,467)</td>
</tr>
<tr>
<td>Benefit / Cost Ratio of Project</td>
<td>0.75</td>
<td>0.76</td>
<td>0.45</td>
<td>0.34</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>($169,133)</td>
<td>($119,503)</td>
<td>($267,050)</td>
<td>($312,195)</td>
</tr>
<tr>
<td>Year Cash Flow is Net Positive</td>
<td>First Year</td>
<td>First Year</td>
<td>First Year</td>
<td>First Year</td>
</tr>
<tr>
<td>Payback Period (Year Accumulated Cash Flow &gt; Project Capital Cost)</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Community</th>
<th>Fuel Type</th>
<th>Units</th>
<th>Gross BTU/unit</th>
<th>System Efficiency</th>
<th>$/unit</th>
<th>Delivered $/MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairbanks</td>
<td>Wood Pellets</td>
<td>ton</td>
<td>16,600,000</td>
<td>80%</td>
<td>$275</td>
<td>$20.71</td>
</tr>
<tr>
<td></td>
<td>Heating Oil</td>
<td>gal</td>
<td>134,000</td>
<td>65%</td>
<td>$2.90</td>
<td>$33.30</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>kWh</td>
<td>3,413</td>
<td>99%</td>
<td>$0.20</td>
<td>$59.19</td>
</tr>
</tbody>
</table>

Coffman Engineers, Inc.
2. Introduction

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems for four elementary schools in the Fairbanks area of Alaska: Pearl Creek, Weller, Two Rivers and Salcha. The Fairbanks North Star Borough School District (FNSBSD) operates and maintains the elementary schools, while the Fairbanks North Star Borough (FNSB) provides capital for constructing the schools. The FNSB received a grant from the Fairbanks Economic Development Corporation (FEDC) for the feasibility study of the schools.

Figure 1 – Pearl Creek Elementary

Figure 2 – Weller Elementary
Figure 3 – Two Rivers Elementary

Figure 4 – Salcha Elementary
3. Preliminary Site Investigation

Building Descriptions

Each elementary school is occupied during the typical school day and was built with typical construction methods for their vintage in the Fairbanks area. Energy audits were completed for all schools in 2012. For each school, the square footage, date of construction, occupant characteristics and type of construction is shown in the following table.

<table>
<thead>
<tr>
<th>School</th>
<th>Square Footage</th>
<th>Year Built</th>
<th>Occupants</th>
<th>Type of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Creek</td>
<td>62,982</td>
<td>1983</td>
<td>500 students, 60 staff</td>
<td>CMU block and metal stud walls (R-19 to R-30) and built-up flat roof with rigid insulation (R-60)</td>
</tr>
<tr>
<td>Weller</td>
<td>65,259</td>
<td>1983</td>
<td>540 students, 40 staff</td>
<td>CMU block and 2x8 stud walls (R-26) and built-up roof with metal trusses (R-35)</td>
</tr>
<tr>
<td>Two Rivers</td>
<td>22,200</td>
<td>1982</td>
<td>90 students, 20 staff</td>
<td>CMU block and 2x8 stud walls (R-25) and hot roof with metal trusses (R-50)</td>
</tr>
<tr>
<td>Salcha</td>
<td>13,608</td>
<td>1963</td>
<td>88 students, 9 staff</td>
<td>2x6 and 2x12 stud walls (R-19 to R-28) and hot roof (R-60). A major upgrade was made in 2015 that improved building envelope.</td>
</tr>
</tbody>
</table>

Existing Heating System

All schools are heated with cast-iron sectional oil-fired boilers that serve air handlers, cabinet unit heaters, and perimeter base board using glycol. Domestic hot water (DHW) is provided by standalone oil-fired hot water heaters. All of the schools are controlled by direct digital control (DDC) systems that can be viewed and controlled remotely by the FNSBSD. All of the boilers are 1980’s vintage and appear to be working in adequate condition. There were no specific maintenance issues reported during the site visit. The following table shows the heating capacities of the boiler plants.

<table>
<thead>
<tr>
<th>School</th>
<th>Boiler Plant</th>
<th>DHW Plant</th>
<th>Fuel Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Creek</td>
<td>Two Weil McLain Boilers, Model BL-1386 S-W, 2,700 MBH Gross Output Each</td>
<td>Bock Hot Water Heater, Direct-Fired, 85 gal</td>
<td>5,000-gal underground fuel tank</td>
</tr>
<tr>
<td>Weller</td>
<td>Two Burnham Boilers, Model BF-507, 1,116 MBH Gross Output Each</td>
<td>Bock Hot Water Heater, Direct-Fired, 212 gal</td>
<td>5,000-gal underground fuel tank</td>
</tr>
<tr>
<td>Two Rivers</td>
<td>Two Burnham Boilers, Model PF-505, 786 MBH Gross Output Each</td>
<td>Bock Hot Water Heater, Direct-Fired, 135 gal</td>
<td>5,000-gal underground fuel tank</td>
</tr>
<tr>
<td>Salcha</td>
<td>Two Burnham Boilers, Model V-38, 438 MBH Gross Output Each</td>
<td>Bock Hot Water Heater, Direct-Fired, 50 gal</td>
<td>3,000-gal underground fuel tank</td>
</tr>
</tbody>
</table>
The boilers, central pumps and hot water heaters are located in mechanical rooms. The combustion efficiency of the boilers is unknown, as no combustion test reports were available. For this study, the Annual Fuel Utilization Efficiency of the boiler system is estimated at 65% to account for typical oil boiler inefficiencies, including short cycling, due to the age of the boilers.

Weller Elementary is unique in that it has a solar thermal system that provides supplemental heating to the building’s DHW system.

**Available Space, Street Access, Fuel Storage and Site Constraints**

Each school has site constraints associated with available space, access, and fuel storage. Most of the prime area around the schools are already in use as playgrounds, fields, parking lots, or view sheds from classrooms.

**Pearl Creek**

Pearl Creek is the largest elementary school studied. The oil boilers are located in a basement room that has limited access and no space for future biomass boilers or equipment. There are no other suitable locations inside the school for biomass equipment. A detached biomass boiler module or addition is required.

The school is built into a west facing hill, which limits access to the north of the building. There are also buried fuel tanks and fire water tanks at the north of the building. The west of the building is the playground and the entry way and garden are at the south of the building. Due to these constraints, the proposed location of a new biomass boiler module is on a new gravel pad to the east of the building. A new pellet silo would be on the gravel pad as well. A new gravel access driveway from the street would be required. This location was used for the basis of estimate.

A secondary option is to locate the biomass boiler module to the north of the building, however, significant excavation will be required due to the steep hill there.

A site layout of the major site constraints at Pearl Creek is shown on the following page.
Figure 5 – Pearl Creek Site Layout
Weller
The oil boilers at Weller Elementary are located on the second-floor mechanical room. There is no space inside this mechanical room for a biomass boiler or equipment. There is an adjacent mechanical room that contains water treatment equipment and is used as storage that has space that could be used for a biomass boiler system. However, this room is far from exterior walls, making it very difficult to transfer wood pellets from an exterior silo to the biomass boiler. Due to these constraints, a detached biomass boiler module is proposed.

All the space surrounding the school is currently being used. The north and east sides of the school are parking lots. The south side of the school is a grass field that is also the south view shed for two stories of classrooms. The west side of the school is the playground. Any location of a new biomass boiler module will impact any of these above locations. From a purely practical perspective, the most ideal location of the biomass module would be on the west side of the school, as this would be the shortest piping run to the school’s boiler room and easily accessible for pellet delivery. However, this location of the module would take away a section of the playground.

The north and east parking lots are surrounded by steep hills that make building in these areas difficult. The parking lot could also be used as a potential location, however trenching through the concrete parking lot will add significant cost.

For this feasibility study, no specific location was selected because the final location will depend of the priorities of the school. For cost estimating purposes, it is assumed the new biomass boiler module will be on the west side of the school.

A site plan of the major site constraints at Weller is shown on the following page.
Figure 6 – Weller Site Layout
Two Rivers

The oil boilers at Two Rivers Elementary are located on the first floor mechanical room. The mechanical room has below grade walls because the school is built into a south facing hillside. The existing boiler room is completely full of existing equipment and there is no available space for a new biomass boiler system. A new biomass boiler module is required.

There is limited space around the school for a new biomass boiler module. The north side of the school is a parking lot and has existing buried utilities and a maintenance access area. The west side of the school is the main entry. The south side of the school is the playground, fields and southern views for the classrooms. The only space that appears practical for a new module is to the east of the school, adjacent to the driveway. A new gravel pad would be required for the module and the pellet silo. This area is currently not in use and is relatively close to the existing mechanical room. There is a buried fuel tank near the school that would have to be avoided during trenching of the heat piping from the module to the school. A site plan of the major site constraints is shown below.

Figure 7 – Two Rivers Site Layout
Salcha
The oil boilers at Salcha Elementary are located in a first floor mechanical room, on the east side of the building. There is no available space in the existing mechanical room for a new biomass boiler system. A new biomass boiler module is required.

There is limited space and access around the school for a biomass boiler module. The parking lot is small and offers limited access to only the west side of the school. The south side of the school has the septic leach field. The school is surrounded by Nordic ski trails on the south, east, and north of the school. The playground and parking lot on situated on the west side of the school. Due to these site constraints, the only practical space for a new module and pellet silo is on the south side of the parking lot. This will reduce the parking area at the school. Siting of the module and silo will be constrained by the septic leach field, fire water pump house and power pole that exist in the area. A buried heat pipe can be trenched from the module around the south side of the school to the exterior wall of the school's mechanical room. A buried fire water line, sewer line and fuel line exist in this area, so caution will be required during trenching.

A site plan of the major site constraints at Salcha Elementary is shown on the following page.
Figure 8 – Salcha Site Layout
4. Biomass System

Biomass System Options

The biomass boiler system selected as the basis of design for the four elementary schools is a wood pellet boiler. Wood pellets are the best fit for the schools because they are fully automated boilers that require limited labor for operation and fuel handling. Cord wood boiler systems were not considered because they require manual loading and firing of cord wood, which requires significant labor. Wood chip systems were considered, but were not selected because of the availability of local wood pellets. The handling of pellets is much easier than wood chips or cord wood.

For this study, a Viessmann RF-300 wood pellet boiler was selected. The boiler has been successfully installed and operated in Alaska (at the Ketchikan Airport) and is a high-quality pellet boiler. The high efficiency boiler can modulate down to 4:1 and has ultra-low emissions. It has automatic ignition and low maintenance. Different boiler sizes were selected for each school. The 540kW (1,843 MBH) unit was selected for Pearl Creek, the 220kW (750 MBH) selected for Weller, and the 150kW (512 MBH) unit selected for Two Rivers and Salcha.

The biomass boiler would be installed in an 11.5ft wide x 10ft high x 29ft long insulated module. The module would be fabricated offsite and would include a thermal storage tank, pellet augers, cyclone separator, pumps, piping and wiring for a fully complete system. The module would be shipped to Fairbanks to be installed onsite. The module would be installed on a concrete pad with a pellet silo.
adjacent to it. Polydome pellet silos that can store 8.5 tons of pellets each, were selected as the basis of design because the local pellet supplier has had a good track record with these units.

The combustion efficiency of the pellet boiler can reach 85%. Using thermal storage will also help the unit run at higher efficiencies during normal operation. For this study, an Annual Fuel Utilization Efficiency of 80% was used, to account for normal operations throughout the year.

**Biomass System Integration**

Integration for all four of the elementary schools will be very similar. The detached biomass boiler module will house the pellet boiler and thermal storage tank. The pellet boiler and thermal storage tank are ASME rated and will operate with glycol. A buried, insulated piping loop will transfer heat using glycol from the boiler module to the school’s mechanical room. In the mechanical room, a new heat exchanger will transfer heat from the pellet boiler loop to the school’s heating glycol return loop. The heat exchanger is used to separate the school’s glycol from the pellet boiler’s glycol, to protect the school’s system from a potential leak in the pellet boiler’s heat loop. Glycol is used for freeze protection. A new pump will be required to pump glycol from the pellet boiler module to the school heat exchanger. The new pellet boiler module will require an electrical connection to power the pellet boiler and associated equipment.

The existing hydronic systems in the schools are set to operate at 180°F heating glycol supply / 160°F return, which the pellet boiler can reach. Controls for the new biomass systems can be integrated into the existing DDC controls at each facility.
5. Energy Consumption and Costs

Energy Costs

The table below shows the energy comparison of different fuel types in the community. 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, wood pellets are cheaper than fuel oil on a $/MMBTU basis in the Fairbanks area.

<table>
<thead>
<tr>
<th>Community</th>
<th>Fuel Type</th>
<th>Units</th>
<th>Gross BTU/unit</th>
<th>System Efficiency</th>
<th>$/unit</th>
<th>Delivered $/MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairbanks</td>
<td>Wood Pellets</td>
<td>ton</td>
<td>16,600,000</td>
<td>80%</td>
<td>$275</td>
<td>$20.71</td>
</tr>
<tr>
<td></td>
<td>Heating Oil</td>
<td>gal</td>
<td>134,000</td>
<td>65%</td>
<td>$2.90</td>
<td>$33.30</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>kWh</td>
<td>3,413</td>
<td>99%</td>
<td>$0.20</td>
<td>$59.19</td>
</tr>
</tbody>
</table>

Cord Wood

Cord wood was evaluated as a biomass fuel, but was not considered viable due to the additional handling requirements. In order to burn cord wood, a person is required to stack, move and fire cord wood daily, if not multiple times per day. Cord wood was not considered viable because the FNSB wishes to have a more automated biomass system that does not require additional labor.

Wood Pellets

The local wood pellet manufacturer is Superior Pellets, located in North Pole, AK, and sells bulk wood pellets at $275/ton including delivery. According to Superior Pellets, the cost of bulk pellets has stayed constant over the years and they do not anticipate large swings in pricing, such as is found with fuel oil. Superior Pellets are at 5% moisture content and have an energy content of 8,300 BTU/lb (16,600,000 BTU/ton). A bulk pellet truck can deliver up to 15 tons of wood pellets to the school on a scheduled or as needed delivery. Typically, an initial schedule is set up to determine the actual consumption of wood pellets and then the schedule is modified after that. Superior Pellets has been using Polydome silos for pellet storage in the Fairbanks area and has had good success with the units. For the basis of design, one 8.5-ton pellet silo is used for each school. The frequency of delivery will be different for each school depending on consumption.

Heating Oil

The high price of fuel oil is the main economic driver for the use of lower cost biomass heating. Fuel oil is currently purchased at $2.90/gal. The price of fuel oil has fluctuated greatly over time, and currently appears to be at a lower price than in the recent past. The wide variation of fuel oil prices is a disadvantage compared to more stably priced wood pellets. 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 the schools is provided by the Golden Valley Electric Association (GVEA). According to the utility data provided by the school district the effective electricity rate at the schools is $0.20/kWh. The effective electricity rate is the cost of all electric costs (demand, energy, customer charges) per kWH for a billing period. On a BTU basis, electricity is the most expensive energy source.
Existing Fuel Oil Consumption

An estimate of the schools’ heating oil consumption was made based on annual heating oil data provided by the FNSB from 2016, and are shown in the following table. Pearl Creek and Weller are the largest consumers of fuel oil.

<table>
<thead>
<tr>
<th>Building</th>
<th>Fuel Type</th>
<th>Annual Consumption</th>
<th>Net MMBTU/yr</th>
<th>Avg. Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Creek Elementary</td>
<td>Heating Oil #1</td>
<td>15,100 gal</td>
<td>1,315.2</td>
<td>$43,790</td>
</tr>
<tr>
<td>Weller Elementary</td>
<td>Heating Oil #1</td>
<td>11,600 gal</td>
<td>1,010.4</td>
<td>$33,640</td>
</tr>
<tr>
<td>Two Rivers Elementary</td>
<td>Heating Oil #1</td>
<td>6,800 gal</td>
<td>592.3</td>
<td>$19,720</td>
</tr>
<tr>
<td>Salcha Elementary</td>
<td>Heating Oil #1</td>
<td>4,900 gal</td>
<td>426.8</td>
<td>$14,210</td>
</tr>
</tbody>
</table>

Biomass System Consumption

It is estimated that the proposed biomass system at each school will offset approximately 95% of the heating energy for the building. The remaining 5% of the heating energy will be provided by the existing oil boilers. This result is based on an analysis of the school’s annual heating oil consumption, the heat output of the pellet boilers and BIN weather data for the area.

It is assumed that two existing oil boilers at each school were designed so that one boiler could reach the peak heating load of the school, with the other boiler as a fully redundant back up. The pellet boilers were selected at ¾ the size of one fuel oil boiler. The only exception is Salcha, where the pellet boiler was selected as the same size as the oil boiler, because there was no smaller pellet boiler option. For Salcha, it is assumed that the pellet boiler will offset 98% of the heating energy, with the remaining 2% coming from the oil boiler during peaking times.
<table>
<thead>
<tr>
<th>Building</th>
<th>Fuel Type</th>
<th>% Heating Source</th>
<th>Net MMBTU/yr</th>
<th>Annual Consumption</th>
<th>Energy Cost</th>
<th>Total Energy Cost</th>
<th>Annual Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearl Creek</td>
<td>Wood Pellets</td>
<td>95%</td>
<td>1249.4</td>
<td>94 tons</td>
<td>$25,873</td>
<td>$28,163</td>
<td>$15,627</td>
</tr>
<tr>
<td>Elementary</td>
<td>Fuel Oil</td>
<td>5%</td>
<td>65.8</td>
<td>755 gal</td>
<td>$2,190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional</td>
<td>Electricity</td>
<td>N/A</td>
<td>N/A</td>
<td>500 kWh</td>
<td>$100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weller</td>
<td>Wood Pellets</td>
<td>95%</td>
<td>959.8</td>
<td>72 tons</td>
<td>$19,876</td>
<td>$21,628</td>
<td>$12,012</td>
</tr>
<tr>
<td>Elementary</td>
<td>Fuel Oil</td>
<td>5%</td>
<td>50.5</td>
<td>580 gal</td>
<td>$1,682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional</td>
<td>Electricity</td>
<td>N/A</td>
<td>N/A</td>
<td>350 kWh</td>
<td>$70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Rivers</td>
<td>Wood Pellets</td>
<td>95%</td>
<td>562.7</td>
<td>42 tons</td>
<td>$11,652</td>
<td>$12,688</td>
<td>$7,032</td>
</tr>
<tr>
<td>Elementary</td>
<td>Fuel Oil</td>
<td>5%</td>
<td>29.6</td>
<td>340 gal</td>
<td>$986</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional</td>
<td>Electricity</td>
<td>N/A</td>
<td>N/A</td>
<td>250 kWh</td>
<td>$50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salcha</td>
<td>Wood Pellets</td>
<td>98%</td>
<td>418.3</td>
<td>31 tons</td>
<td>$8,661</td>
<td>$8,995</td>
<td>$5,215</td>
</tr>
<tr>
<td>Elementary</td>
<td>Fuel Oil</td>
<td>2%</td>
<td>8.5</td>
<td>98 gal</td>
<td>$284</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional</td>
<td>Electricity</td>
<td>N/A</td>
<td>N/A</td>
<td>250 kWh</td>
<td>$50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note – Based on wood pellets at $275/ton, heating oil at $2.90/gal and electricity at $0.20/kWh.
6. Preliminary Cost Estimating

An estimate of probable costs was completed for installing the wood pellet boiler systems at each school. The estimate is based on equipment quotes and from previous projects in Alaska. Project and Construction Management was estimated at 5%. Engineering design and permitting was estimated at 15% and a 15% contingency was used. Since Fairbanks is on the highway system, an additional remote factor to account for increased shipping costs was not included.

The main cost driver at all schools is the pre-manufactured biomass boiler module. As shown in the following table, the cost of the modules range in price from around $290,000 to $390,000, depending on boiler size.
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>School</th>
<th>Pearl Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Work</td>
<td>Site Grading for Module and Silo</td>
<td>$15,000</td>
<td>$4,000</td>
</tr>
<tr>
<td></td>
<td>Gravel Fill</td>
<td>$10,000</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td>Module Foundation</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td>Pellet Silo Foundation</td>
<td>$4,000</td>
<td>$4,000</td>
</tr>
<tr>
<td></td>
<td>Buried Utilities</td>
<td>$8,000</td>
<td>$5,500</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$42,000</td>
<td>$21,500</td>
</tr>
<tr>
<td>Electrical Utilities</td>
<td>Service Entrance</td>
<td>$5,000</td>
<td>$4,500</td>
</tr>
<tr>
<td></td>
<td>Conduit and Wiring</td>
<td>$6,000</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$11,000</td>
<td>$9,500</td>
</tr>
<tr>
<td>Biomass Boiler Module</td>
<td>Module (11.5’ W x 10’ H x 29’ L) including installation of Viessmann RF-300 Pellet Boiler, controller, multi-cyclone, 880gal ASME thermal storage tank, pellet auger, interior piping, valves, electrical, structural components for fully functional boiler module.</td>
<td>$342,594</td>
<td>$254,001</td>
</tr>
<tr>
<td></td>
<td>R-20 Module Insulation Package</td>
<td>$23,850</td>
<td>$23,850</td>
</tr>
<tr>
<td></td>
<td>Insulated SS Chimney</td>
<td>$3,982</td>
<td>$3,982</td>
</tr>
<tr>
<td></td>
<td>Commissioning and Training</td>
<td>$5,200</td>
<td>$5,200</td>
</tr>
<tr>
<td></td>
<td>Shipping from Enderby, BC to Fairbanks</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td></td>
<td>Pellet Silo (8.5 Ton)</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$390,626</td>
<td>$302,033</td>
</tr>
<tr>
<td>School Connection</td>
<td>Heat Exchanger</td>
<td>$12,000</td>
<td>$10,000</td>
</tr>
<tr>
<td></td>
<td>Insulated Pipe from School to Module</td>
<td>$15,000</td>
<td>$8,000</td>
</tr>
<tr>
<td></td>
<td>Piping Tie-in to Boiler Room</td>
<td>$14,000</td>
<td>$12,000</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$41,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Subtotal Material and Installation Cost</td>
<td></td>
<td>$484,626</td>
<td>$363,033</td>
</tr>
<tr>
<td>Project and Construction Management</td>
<td>5% of subtotal</td>
<td>$24,232</td>
<td>$18,152</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$508,858</td>
<td>$381,185</td>
</tr>
<tr>
<td>Design Fees and Permitting</td>
<td>15% of subtotal of materials and PM</td>
<td>$76,329</td>
<td>$57,178</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$585,187</td>
<td>$438,363</td>
</tr>
<tr>
<td>Contingency</td>
<td>15% of Materials, PM and Design</td>
<td>$87,779</td>
<td>$65,755</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>$673,000</td>
<td>$505,000</td>
</tr>
<tr>
<td>Total Project Cost</td>
<td></td>
<td>$672,966</td>
<td>$504,118</td>
</tr>
<tr>
<td>Total Budgetary Cost</td>
<td></td>
<td>$673,000</td>
<td>$505,000</td>
</tr>
</tbody>
</table>
7. Economic Analysis

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

<table>
<thead>
<tr>
<th>Table 9 – Discount and Escalation rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Discount Rate for Net Present Value Analysis</td>
</tr>
<tr>
<td>Wood Fuel Escalation Rate</td>
</tr>
<tr>
<td>Fossil Fuel Escalation Rate</td>
</tr>
<tr>
<td>Electricity Escalation Rate</td>
</tr>
<tr>
<td>O&amp;M Escalation Rate</td>
</tr>
</tbody>
</table>

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%, since there has been limited change in pellet costs in the Fairbanks region.

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 $600 per year. The estimate is based on annual maintenance time for Viessman Wood Pellet 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.

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 10 – Economic Definitions

<table>
<thead>
<tr>
<th>Economic Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>This is the opinion of probable cost for designing and constructing the project.</td>
</tr>
<tr>
<td>Present Value of Project Benefits (20-year life)</td>
<td>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.</td>
</tr>
<tr>
<td>Present Value of Operating Costs (20-year life)</td>
<td>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&amp;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.</td>
</tr>
</tbody>
</table>
| 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: \[ \text{Benefit / Cost Ratio} = \frac{PV(\text{Project Benefits}) - PV(\text{Operating Costs})}{\text{Project Capital Cost}} \] Where: PV = The present value over the 20-year period  
| 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: \[ \text{Installed Cost} \leq \sum_{k=0}^{J} R_k \] 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 to determine the simple payback, benefit to cost ratio, and net present value of the proposed wood pellet boiler systems at the elementary schools. At each school, a wood pellet boiler system would be located in a detached module and heating pipes would connect to the new heat exchanger in the school’s mechanical room. The wood pellet boiler would supplement heat for the existing oil boiler system. Pellet silos would be located next to the pellet boiler module, and filled by a local pellet supplier.

Due to the low price of heating oil at $2.90/gal, the benefit to cost ratios for each school are less than 1.0. Any project with a benefit to cost ratio less than 1.0 is not considered economically justified, and therefore the wood pellet systems at the schools are 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. For example, when heating oil reaches $3.50/gal the wood pellet boiler projects at Pearl Creek and Weller become economically justified. This can be seen in the sensitivity analysis on the next page.

The economic analysis shows that wood pellet boiler projects at Pearl Creek and Weller are more economic than at Two Rivers and Salcha. The reason for this is the greater amount of heating oil that can be offset in the larger schools of Pearl Creek and Weller, compared to the cost of the new pellet boiler system. Two Rivers and Salcha are less economic due to the relatively small heating oil offset and high project costs.

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>
<thead>
<tr>
<th>Item</th>
<th>Pearl Creek</th>
<th>Weller</th>
<th>Two Rivers</th>
<th>Salcha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>($673,000)</td>
<td>($505,000)</td>
<td>($489,000)</td>
<td>($475,000)</td>
</tr>
<tr>
<td>Present Value of Project Benefits (20-year life)</td>
<td>$1,027,021</td>
<td>$788,970</td>
<td>$462,500</td>
<td>$333,272</td>
</tr>
<tr>
<td>Present Value of Operating Costs (20-year life)</td>
<td>($523,154)</td>
<td>($403,473)</td>
<td>($240,550)</td>
<td>($170,467)</td>
</tr>
<tr>
<td>Benefit / Cost Ratio of Project (20-year life)</td>
<td>0.75</td>
<td>0.76</td>
<td>0.45</td>
<td>0.34</td>
</tr>
<tr>
<td>Net Present Value (20-year life)</td>
<td>($169,133)</td>
<td>($119,503)</td>
<td>($267,050)</td>
<td>($312,195)</td>
</tr>
<tr>
<td>Year Cash Flow is Net Positive</td>
<td>First Year</td>
<td>First Year</td>
<td>First Year</td>
<td>First Year</td>
</tr>
<tr>
<td>Payback Period (Year Accumulated Cash Flow &gt; Project Capital Cost)</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
<td>&gt;20 years</td>
</tr>
</tbody>
</table>

There are other wood pellet boiler manufactures that may reduce overall project costs at the schools. To see how this impacts the economics, a separate analysis was completed where the cost of the fabrication of the biomass boiler module was reduced by 25% (which includes cost of the boiler, pumps, electrical, etc.). The 20-yr benefit to cost ratios for each school with this updated cost are: Pearl Creek (0.91), Weller
(0.93), Two Rivers (0.55), and Salcha (0.42). The economics improve slightly, but all benefit to cost ratios are still below 1.0. For this prefeasibility study, the Viessman boiler basis of design is still used because it gives a more conservative estimate of project costs. During the next phase of engineering design, the project costs can be further refined.

Each school has site constraints that will affect the installation of the project. The projects at both Pearl Creek and Two Rivers have the least impact compared to the other projects because the pellet boiler modules can be installed in undeveloped locations to the east of the schools, but this will increase site development costs. At Weller, the pellet boiler module will either impact the playground, fields or parking lot depending on final location. Salcha has very limited space and the pellet module will impact the parking lot area.
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.

At a heating oil price of $3.50/gal and the current wood pellet price of $275/ton, the wood pellet boiler projects at both Pearl Creek and Weller are economically justified. This can be seen in the following two tables.

<table>
<thead>
<tr>
<th>B/C Ratios</th>
<th>Wood Pellet Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$225/ton</td>
</tr>
<tr>
<td>$2.75/gal</td>
<td>0.80</td>
</tr>
<tr>
<td>$3.00/gal</td>
<td>0.92</td>
</tr>
<tr>
<td>$3.25/gal</td>
<td>1.05</td>
</tr>
<tr>
<td>$3.50/gal</td>
<td>1.17</td>
</tr>
<tr>
<td>$3.75/gal</td>
<td>1.30</td>
</tr>
<tr>
<td>$4.00/gal</td>
<td>1.42</td>
</tr>
<tr>
<td>$4.25/gal</td>
<td>1.55</td>
</tr>
<tr>
<td>$4.50/gal</td>
<td>1.67</td>
</tr>
<tr>
<td>$4.75/gal</td>
<td>1.80</td>
</tr>
<tr>
<td>$5.00/gal</td>
<td>1.92</td>
</tr>
<tr>
<td>$5.25/gal</td>
<td>2.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B/C Ratios</th>
<th>Wood Pellet Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$225/ton</td>
</tr>
<tr>
<td>$2.75/gal</td>
<td>0.81</td>
</tr>
<tr>
<td>$3.00/gal</td>
<td>0.94</td>
</tr>
<tr>
<td>$3.25/gal</td>
<td>1.07</td>
</tr>
<tr>
<td>$3.50/gal</td>
<td>1.20</td>
</tr>
<tr>
<td>$3.75/gal</td>
<td>1.32</td>
</tr>
<tr>
<td>$4.00/gal</td>
<td>1.45</td>
</tr>
<tr>
<td>$4.25/gal</td>
<td>1.58</td>
</tr>
<tr>
<td>$4.50/gal</td>
<td>1.71</td>
</tr>
<tr>
<td>$4.75/gal</td>
<td>1.84</td>
</tr>
<tr>
<td>$5.00/gal</td>
<td>1.96</td>
</tr>
<tr>
<td>$5.25/gal</td>
<td>2.09</td>
</tr>
</tbody>
</table>
Two Rivers and Salcha become economically justified when heating oil prices reach $4.75/gal and $5.75/gal, respectively, at the current wood pellet price of $275/ton. This can be seen in the following two tables.

### Table 14 – Sensitivity Analysis – Two Rivers

<table>
<thead>
<tr>
<th>B/C Ratios</th>
<th>Wood Pellet Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$225/ton</td>
</tr>
<tr>
<td>Heating Oil Cost</td>
<td></td>
</tr>
<tr>
<td>$3.75/gal</td>
<td>0.79</td>
</tr>
<tr>
<td>$4.00/gal</td>
<td>0.87</td>
</tr>
<tr>
<td>$4.25/gal</td>
<td>0.95</td>
</tr>
<tr>
<td>$4.50/gal</td>
<td>1.03</td>
</tr>
<tr>
<td>$4.75/gal</td>
<td>1.10</td>
</tr>
<tr>
<td>$5.00/gal</td>
<td>1.18</td>
</tr>
<tr>
<td>$5.25/gal</td>
<td>1.26</td>
</tr>
<tr>
<td>$5.50/gal</td>
<td>1.34</td>
</tr>
<tr>
<td>$5.75/gal</td>
<td>1.41</td>
</tr>
<tr>
<td>$6.00/gal</td>
<td>1.49</td>
</tr>
<tr>
<td>$6.25/gal</td>
<td>1.57</td>
</tr>
</tbody>
</table>

### Table 15 – Sensitivity Analysis – Salcha

<table>
<thead>
<tr>
<th>B/C Ratios</th>
<th>Wood Pellet Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$225/ton</td>
</tr>
<tr>
<td>Heating Oil Cost</td>
<td></td>
</tr>
<tr>
<td>$3.75/gal</td>
<td>0.60</td>
</tr>
<tr>
<td>$4.00/gal</td>
<td>0.66</td>
</tr>
<tr>
<td>$4.25/gal</td>
<td>0.72</td>
</tr>
<tr>
<td>$4.50/gal</td>
<td>0.78</td>
</tr>
<tr>
<td>$4.75/gal</td>
<td>0.84</td>
</tr>
<tr>
<td>$5.00/gal</td>
<td>0.90</td>
</tr>
<tr>
<td>$5.25/gal</td>
<td>0.96</td>
</tr>
<tr>
<td>$5.50/gal</td>
<td>1.02</td>
</tr>
<tr>
<td>$5.75/gal</td>
<td>1.08</td>
</tr>
<tr>
<td>$6.00/gal</td>
<td>1.14</td>
</tr>
<tr>
<td>$6.25/gal</td>
<td>1.19</td>
</tr>
</tbody>
</table>
8. Forest Resource and Fuel Availability Assessments

Fuel Availability

For this study, the main fuel supplier is the local Fairbanks pellet manufacturer, Superior Pellets. According to discussions with Superior Pellets, they are operating at 15% of capacity and can easily take on 25,000 tons worth of orders without an issue. This is more than enough capacity to meet all the heating demand for the schools studied. No further forest resource assessments were obtained.

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.
9. 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, washateria, 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 °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](http://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.


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:

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
Pearl Creek

1. West Elevation of Building

2. South Elevation of Building

3. North Elevation of Building

4. North Elevation of Building

5. East Elevation of Building

6. Generator

Coffman Engineers, Inc.
Feasibility Assessment for Biomass Heating Systems

7. Boilers 1 and 2

8. Boiler 2

9. Hot Water Heater

10. Fire Pumps
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14. North Elevation of Building
15. Partial North Elevation of Building
16. Partial North and West Elevation of Building
17. Partial West Elevation of Building
18. South Elevation of Building
19. Partial East Elevation of Building
### Feasibility Assessment for Biomass Heating Systems

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<td><strong>25.</strong> Hydronic Pumps</td>
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<td><img src="image6.jpg" alt="Image" /></td>
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Coffman Engineers, Inc.
26. Mechanical Room with Fire Water Tank

27. Parking Lot Head Bolt Electrical Panel

28. Main Electrical Disconnect

29. Electrical Panels
Two Rivers

30. Partial South and East Elevation of Building

31. South Elevation of Building

32. Partial South and West Elevation of Building

33. Partial East and North Elevation of Building

34. Partial East and North Elevation of Building

35. Partial East and North Elevation of Building
40. Hot Water Heater
41. Generator
42. Hauled Water System
43. Well Water System
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<td>48. Fuel Oil Pump</td>
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Salcha

49. West Elevation of Building

50. Partial South and West Elevation of Building

51. Partial East and South Elevation of Building

52. Partial East Elevation of Building

53. Partial East Elevation of Building

54. North Elevation of Building
61. Boiler 1

62. Electric Generator
Appendix B
Economic Analysis Spreadsheets
### Economic Analysis Results

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<td>$25,850</td>
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<td>$26,894</td>
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<td>$50,692</td>
<td>$53,227</td>
<td>$55,888</td>
<td>$58,683</td>
<td>$61,617</td>
<td>$64,698</td>
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<td>$71,329</td>
<td>$74,896</td>
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<td>$86,701</td>
<td>$91,036</td>
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<td><strong>Annual Operating Cost Savings</strong></td>
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<td>$14,451</td>
<td>$15,988</td>
<td>$18,242</td>
<td>$19,983</td>
<td>$21,827</td>
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<td>$50,752</td>
<td>$54,361</td>
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<td><strong>Accumulated Cash Flow</strong></td>
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<td>$14,451</td>
<td>$30,438</td>
<td>$48,680</td>
<td>$68,663</td>
<td>$90,490</td>
<td>$114,270</td>
<td>$140,119</td>
<td>$168,158</td>
<td>$198,513</td>
<td>$231,320</td>
<td>$266,718</td>
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<td>$345,894</td>
<td>$389,993</td>
<td>$437,327</td>
<td>$488,078</td>
<td>$542,440</td>
<td>$600,612</td>
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### Pearl Creek Elementary School

**Location:** Fairbanks, Alaska

**Project Capital Cost:** $673,000

**Present Value of Project Benefits (20-year life):** $1,027,021

**Present Value of Operating Costs (20-year life):** ($523,154)

**Benefit / Cost Ratio of Project (20-year life):** 0.75

**Net Present Value (20-year life):** ($169,133)

**Year Accumulated Cash Flow is Net Positive:** First Year

**Payback Period (Year Accumulated Cash Flow > Project Capital Cost):** >20 years

**Discount Rate for Net Present Value Analysis:** 3%

**Wood Fuel Escalation Rate:** 2%

**Fossil Fuel Escalation Rate:** 5%

**Electricity Escalation Rate:** 2%

**O&M Escalation Rate:** 2%

**Existing Heating System Operating Costs:**

- **Existing Heating Oil Consumption:** $2.90
  - 15,100 gal
  - $43,790
  - $45,980
  - $48,278
  - $50,692
  - $53,227
  - $55,888
  - $58,683
  - $61,617
  - $64,698
  - $67,933
  - $71,329
  - $74,896
  - $78,641
  - $82,573
  - $86,701
  - $91,036
  - $95,588
  - $100,367
  - $105,386
  - $110,655

**Biomass System Operating Costs:**

- **Wood Pellet Cost (Delivered):** $275.00
  - 94.0 tons
  - ($25,850)
  - ($26,367)
  - ($26,894)
  - ($27,432)
  - ($27,981)
  - ($28,540)
  - ($29,111)
  - ($29,694)
  - ($30,287)
  - ($30,893)
  - ($31,511)
  - ($32,141)
  - ($32,784)
  - ($33,440)
  - ($34,109)
  - ($34,791)
  - ($35,487)
  - ($36,196)
  - ($36,920)
  - ($37,659)

- **Fossil Fuel:** $2.90
  - 94.0 gal
  - ($2,190)
  - ($2,299)
  - ($2,414)
  - ($2,535)
  - ($2,661)
  - ($2,794)
  - ($2,934)
  - ($3,081)
  - ($3,235)
  - ($3,397)
  - ($3,566)
  - ($3,745)
  - ($3,932)
  - ($4,129)
  - ($4,335)
  - ($4,552)
  - ($4,779)
  - ($5,018)
  - ($5,269)

- **Additional Electricity:** $0.20
  - 500 kWh
  - ($100)
  - ($102)
  - ($104)
  - ($106)
  - ($108)
  - ($110)
  - ($113)
  - ($115)
  - ($117)
  - ($120)
  - ($122)
  - ($124)
  - ($127)
  - ($132)
  - ($135)
  - ($137)
  - ($140)
  - ($143)
  - ($146)

- **Operation and Maintenance Costs:** ($600)
  - ($600)
  - ($612)
  - ($624)
  - ($637)
  - ($649)
  - ($662)
  - ($676)
  - ($689)
  - ($703)
  - ($717)
  - ($731)
  - ($746)
  - ($761)
  - ($776)
  - ($792)
  - ($808)
  - ($824)
  - ($840)
  - ($857)
  - ($874)

**Annual Operating Cost Savings:**

- $14,451
- $15,988
- $18,242
- $19,983
- $21,827
- $23,781
- $25,849
- $28,038
- $30,355
- $32,806
- $35,399
- $38,139
- $41,037
- $44,099
- $47,334
- $50,752
- $54,361
- $58,173
- $62,197
- $66,444

**Accumulated Cash Flow:**

- $14,451
- $30,438
- $48,680
- $68,663
- $90,490
- $114,270
- $140,119
- $168,158
- $198,513
- $231,320
- $266,718
- $304,857
- $345,894
- $389,993
- $437,327
- $488,078
- $542,440
- $600,612
- $662,809
- $729,253

**Net Present Value:**

- ($658,970)
- ($643,901)
- ($627,207)
- ($609,452)
- ($590,624)
- ($570,708)
- ($549,691)
- ($527,557)
- ($504,292)
- ($479,881)
- ($454,308)
- ($427,558)
- ($399,614)
- ($370,460)
- ($340,078)
- ($308,451)
- ($275,562)
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- ($205,921)
- ($169,133)
### Economic Analysis Results

#### Inflation Rates

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#### Annual Operating Cost Savings

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#### Accumulated Cash Flow

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</table>

#### Net Present Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Net Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>($494,429)</td>
</tr>
<tr>
<td>2</td>
<td>($483,057)</td>
</tr>
<tr>
<td>3</td>
<td>($470,303)</td>
</tr>
<tr>
<td>4</td>
<td>($456,734)</td>
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<tr>
<td>5</td>
<td>($442,339)</td>
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<tr>
<td>6</td>
<td>($427,108)</td>
</tr>
<tr>
<td>7</td>
<td>($411,029)</td>
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<tr>
<td>8</td>
<td>($394,093)</td>
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<tr>
<td>9</td>
<td>($376,287)</td>
</tr>
<tr>
<td>10</td>
<td>($357,600)</td>
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<tr>
<td>11</td>
<td>($338,020)</td>
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<tr>
<td>12</td>
<td>($317,535)</td>
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<tr>
<td>13</td>
<td>($296,132)</td>
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<tr>
<td>14</td>
<td>($273,798)</td>
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<tr>
<td>15</td>
<td>($250,521)</td>
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<tr>
<td>16</td>
<td>($226,287)</td>
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<tr>
<td>17</td>
<td>($201,082)</td>
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<tr>
<td>18</td>
<td>($174,893)</td>
</tr>
<tr>
<td>19</td>
<td>($147,705)</td>
</tr>
<tr>
<td>20</td>
<td>($119,503)</td>
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</tbody>
</table>

#### Summary

- **Project Capital Cost**: $505,000
- **Present Value of Project Benefits (20-year life)**: $788,970
- **Present Value of Operating Costs (20-year life)**: ($403,473)
- **Benefit / Cost Ratio of Project (20-year life)**: 0.76
- **Net Present Value (20-year life)**: ($119,503)
- **Payback Period (Year Accumulated Cash Flow > Project Capital Cost)**: >20 years
- **Discount Rate for Net Present Value Analysis**: 3%
- **Wood Fuel Escalation Rate**: 2%
- **Fossil Fuel Escalation Rate**: 5%
- **Electricity Escalation Rate**: 2%
- **O&M Escalation Rate**: 2%
### Economic Analysis Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Annual Energy Units</th>
<th>Total Heating System Operating Costs</th>
<th>Total Operating Cost</th>
<th>Annual Operating Cost Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Source</td>
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<tr>
<td>Proportion</td>
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<td>Annual Energy Units</td>
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<tr>
<td>Heating Source</td>
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</tr>
<tr>
<td>Wood Pellet Cost (Delivered)</td>
<td>$275.00</td>
<td>95%</td>
<td>$11,550</td>
<td>$11,680</td>
<td>$11,811</td>
</tr>
<tr>
<td>Fossil Fuel</td>
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<td>5%</td>
<td>$986</td>
<td>$1,035</td>
<td>$1,087</td>
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<tr>
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<td>$50</td>
<td>$51</td>
<td>$52</td>
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<tr>
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<td></td>
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</tr>
<tr>
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<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>Total Operating Cost</td>
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<td>$14,091</td>
<td>$13,780</td>
<td>$14,088</td>
<td>$14,404</td>
</tr>
<tr>
<td>Annual Operating Cost Savings</td>
<td>$5,934</td>
<td>$6,615</td>
<td>$7,961</td>
<td>$8,740</td>
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<tr>
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<td>($477,004)</td>
<td>($469,718)</td>
<td>($461,953)</td>
<td>($453,701)</td>
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<td>Proportion</td>
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<tr>
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<td>$50</td>
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<td>$52</td>
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<tr>
<td>Operation and Maintenance Costs</td>
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</tr>
<tr>
<td>Additional Operation and Maintenance Costs for first 2 years</td>
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<td>$0</td>
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<td>$0</td>
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<tr>
<td>Total Operating Cost</td>
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<td>$14,091</td>
<td>$13,780</td>
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<td>$6,615</td>
<td>$7,961</td>
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<td>$9,566</td>
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<tr>
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<td>($483,239)</td>
<td>($477,004)</td>
<td>($469,718)</td>
<td>($461,953)</td>
<td>($453,701)</td>
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</table>
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<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Heating Source</th>
<th>Proportion</th>
<th>Annual Energy Units</th>
<th>Energy Units</th>
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<td>Maintenance and Administration</td>
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</tr>
<tr>
<td>Total Annual Operating Cost</td>
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</tr>
<tr>
<td><strong>Annual Operating Cost Savings</strong></td>
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</tr>
<tr>
<td>Total Operating Cost</td>
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<td>($466,586)</td>
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<td>($470,970)</td>
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Appendix C
AWEDTG Field Data Sheets
ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)
PRE-FEASIBILITY ASSESSMENT FIELD DATA SHEET

| APPLICANT: | FNSB |
| 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: | Ben Loeffler |
| Mailing Address: | 1885 Marika Road |
| City: | Fairbanks |
| State: | AK |
| Zip Code: | 99709 |
| Office phone: | (907) 459-1335 |
| Cell phone: | ( ) |
| Fax: | (907) |
| Email: | bloeffler@fnsb.us |

| Facility Identification/Name: | Pearl Creek Elementary |
| Facility Contact Person: | SAME AS ABOVE |
| Facility Contact Telephone: | (907) SAME |
| Facility Contact Email: | SAME |

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

| SCHOOL FACILITY (Name: Pearl Creek Elementary) |
| School Type: | [ ] Pre-School [ ] Elementary [ ] Middle School [ ] Junior High [ ] High School [ ] Campus [ ] Student Housing [ ] Pool [ ] Gymnasium [ ] Other (describe): |
| Size of facility (sq. ft. heated): | 62,982 |
| Year built/age: | 1983 |
| Number of floors: | 2 |
| Year(s) renovated: | Unknown |
| Number of bdgs.: | 1 |
| Next renovation: | Unknown |
| # of Students: | 500 Students |
| Has an energy audit been conducted?: | Yes |
| If Yes, when? * | 2012 |
| # of Staff: | 60 |

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 bdgs.: | |
| 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)
- 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

HEAT DELIVERY (check all that apply)
- 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)
- Hot water boiler: ☑ natural gas ☑ propane ☑ electric ☑ #1 fuel oil ☑ #2 fuel oil
- 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:_____________________

GROSS OUTPUT

Heating capacity (Btu/h / kWh) | Annual Fuel Consumption | Cost
---------------------------------|-------------------------|-----
2 x 2,700 MBH | 15,100 gal | $2.90 / gal

TEMPERATURE CONTROLS (type of system; check all that apply)
- Thermostats on individual devices/appliances; no central control system
- Pneumatic control system
- Direct digital control system Manufacturer: Andover/Siemens Approx. Age: Unknown

Record Name Plate data for boilers (use separate sheet if necessary):
2 x Weil McLain, BL 1386 s-w, 2,700 MBH gross output

Describe locations of different parts of the heating system and what building areas are served:
Boiler room located in small space below grade. No access to outside.

Describe age and general condition of existing equipment:
Original 1983. No access to boiler room to remove boilers.

Who performs boiler maintenance? ___________ Describe any maintenance issues: Unknown

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

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
Underground fuel tank, 5,000 gal, spill containment unknown.

If this fuel is also used for other purposes, please describe:
School only
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): In boiler room

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

building envelope

Wall type (stick frame, masonry, SIP, etc.): CMU Block and Metal Studded Insulation Value: ~ R-19 + R-3

Roof type: Built-up flat roof w/ rigid insulation Insulation Value: ~ R-60

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

Outside Air/Air Exchange: ☒ HRV ☐ CO₂ Sensor

ELECTRICAL

Utility company that serves the building or community: GVEA

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

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

Electricity rate per kWh: $0.20/kWh Demand charge: __________________________ Effective Rate Used: __________________________

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 Limited space. See photos

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $295/ton Viable fuel source? ☐ Yes ☐ No
- Wood chip cost delivered to facility $________/ton Viable fuel source? ☐ Yes ☐ No
- Cord wood cost delivered to facility $________/cord Viable fuel source? ☐ Yes ☐ No
- Distance to nearest wood pellet and wood chip suppliers: Superior pellets in Fairbanks
- Can logs or wood fuel be stockpiled on site or at a nearby facility? Pellet silo required.

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

Source will be from pellet manufacturer.
FACILITY SITE CONSIDERATIONS

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

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? The school is on a hill, has buried fuel/water tanks, and playgrounds which make it difficult.

What are local soil conditions? Permafrost issues?

Is the facility in proximity to other buildings with biomass potential? If so, Which ones and How close?

No.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?

No space inside. New module could be placed in the northeast of the gym.

From school.

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

Yes, but there are other utilities in the area. Pipe could be routed through gym.

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 loop
- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot? Unknown
- 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? Reh-commissioning?
- 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)
ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)
PRE-FEASIBILITY ASSESSMENT FIELD DATA SHEET

APPLICANT: FNSB

Eligibility: (check one)
- Local government
- Federally Recognized Tribe
- Not-for-profit organization

□ State agency
□ Federal agency
□ School/School District
□ Regional ANCSA Corp.
□ Village ANCSA Corp.
□ Private Entity that can demonstrate a Public Benefit
□ Other (describe):

Contact Name: Ben Loeffler
Mailing Address: 1885 Marika Rd
City: 
State: AK Zip Code: 99709
Office phone: (907) 459-1335 Cell phone: ( )
Fax: (907)
Email: bloeffler@fnsb.us

Facility Identification/Name: Wellerd Elementary
Facility Contact Person: Ben Loeffler
Facility Contact Telephone: (907) 459-1335 ( )
Facility Contact Email: bloeffler@fnsb.us

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

SCHOOL FACILITY (Name: Wellerd Elementary)

<table>
<thead>
<tr>
<th>School Type: (check all that apply)</th>
<th>[ ] Pre-School</th>
<th>[ ] Elementary</th>
<th>[ ] Junior High</th>
<th>[ ] High School</th>
<th>[ ] Student Housing</th>
<th>[ ] Pool</th>
<th>[ ] Gymnasium</th>
<th>[ ] Other (describe):</th>
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<tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Number of bdgs.:</td>
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<td></td>
<td></td>
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<td>2012</td>
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<tr>
<td>If Yes, when? *</td>
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OTHER FACILITY (Name: )

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<thead>
<tr>
<th>Type:</th>
<th>[ ] Health Clinic</th>
<th>[ ] Water Plant</th>
<th>[ ] Multi-Purpose Bldg</th>
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<tbody>
<tr>
<td>[ ] Public Safety Bldg.</td>
<td>[ ] Washeteria</td>
<td>[ ] District Energy System</td>
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<td>[ ] Community Center</td>
<td>[ ] Public Housing</td>
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<td>Number of floors:</td>
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<tr>
<td>Frequency of Usage:</td>
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<td># of Occupants</td>
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<tr>
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<td>If Yes, when? *</td>
<td></td>
</tr>
</tbody>
</table>

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

CONFIGURATION (check all that apply)
- Hot water: ☐ 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

HEAT DELIVERY (check all that apply)
- 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)
- Hot water boiler: ☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil
- 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: ___________

HEATING CAPACITY (Btu/h)
- Heating Capacity: 2x1116 MBH
- Annual Fuel Consumption: 11,600 gal
- Cost: $2.90/gal

TEMPERATURE CONTROLS (type of system; check all that apply)
- Thermostats on individual devices/appliances; no central control system
- Pneumatic control system
- Direct digital control system
- Manufacturer: ANDOVER
- Approx. Age: UNKNOWN

Record Name Plate data for boilers (use separate sheet if necessary):
2x Burnham, BF-507, 1116 MBH CROSS OUTPUT, SN 7570499 ± SN 7570497

Describe locations of different parts of the heating system and what building areas are served:
Serves one building. Boilers located in second floor mech room.

Describe age and general condition of existing equipment:
OK condition. Appears original.

Who performs boiler maintenance? FNSBSD Maintenance
Describe any current maintenance issues: Unknown.

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

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

If this fuel is also used for other purposes, please describe:
Only for school.
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):

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

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): 2x8 stud + CMU
Insulation Value:

Roof type: Hot roof w/ metal trusses
Insulation Value:

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

Outside Air/Air Exchange:
- HRV
- CO₂ Sensor

ELECTRICAL

Utility company that serves the building or community:

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

Energy source:
- hydropower
- diesel generator(s)
- other:

Electricity rate per kWh: 0.20/kWh
Demand charge:
Effective rate used

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

Back-up generator on site:
- Yes
- No

If Yes, provide output capacity:
100 kW

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

Record MDP and electrical panel name plate information:

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $245/ton
  Viable fuel source? Yes No
- Wood chip cost delivered to facility $________/ton
  Viable fuel source? Yes No
- Cord wood cost delivered to facility $_____/cord
  Viable fuel source? Yes No
- Distance to nearest wood pellet and wood chip suppliers:
- Pellet silo required

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

Source will be from pellet manufacturer.
**FACILITY SITE CONSIDERATIONS**

Is there good access to site for delivery vehicles (trucks, chip vans, etc)?
There is access around two sides of the building. The other two sides have poor access due to playground + field.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)?
Playgrounds and views and topography limit space.

What are local soil conditions? Permafrost issues?
Discontinuous permafrost

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?
No

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?
No space in boiler room. There is space in Raw water storage room, but no exterior will access for connection to pellet silo.

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?
No good space for out build. Playground on one side, parking lot on 2 sides. Last side of building is view shed of classrooms and separate line utilities.

**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?
  - Loopy. Primary only.

- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot?
  - Unknown

- 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?
  - Retrofitting

- 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)
**ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)***

**PRE-FEASIBILITY ASSESSMENT FIELD DATA SHEET**

**APPLICANT:** FNSB

**Eligibility:**
- Local government
- Federally Recognized Tribe
- Not-for-profit organization
- Other (describe):
  - [ ] State agency
  - [ ] Federal agency
  - [ ] School/School District
  - [ ] Regional ANCSA Corp.
  - [ ] Village ANCSA Corp.
  - [ ] Private Entity that can demonstrate a Public Benefit

**Contact Name:** Ben Loeffler

**Mailing Address:**
- 1885 Marika Rd

**City:** Fairbanks

**State:** AK

**Zip Code:** 99709

**Office phone:** (907) 459-1335

**Cell phone:** (907) same

**Fax:** (907)

**Email:** bloeffler@fnsb.us

**Facility Identification/Name:** Two Rivers Elementary

**Facility Contact Person:** Same as above

**Facility Contact Telephone:** (907) Same

**Facility Contact Email:** Same

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

**SCHOOL FACILITY (Name: Two Rivers Elementary)**

<table>
<thead>
<tr>
<th>School Type</th>
<th>Pre-School</th>
<th>Elementary</th>
<th>Middle School</th>
<th>Junior High</th>
<th>High School</th>
<th>Campus</th>
<th>Student Housing</th>
<th>Pool</th>
<th>Gymnasium</th>
<th>Other (describe):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of facility (sq. ft. heated):</td>
<td>22,200 SF</td>
<td>Year built/age:</td>
<td>1982</td>
<td>Year(s) renovated:</td>
<td>Unknown</td>
<td>Next renovation:</td>
<td>Controls Upgrade 2017</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Number of floors:</td>
<td>2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Number of bldgs.:</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&quot;# of Students:</td>
<td>40 Students</td>
<td>Has an energy audit been conducted?:</td>
<td>Yes</td>
<td>If Yes, when? * 2012</td>
<td></td>
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<tr>
<td>&quot;20 Staff&quot;</td>
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</tbody>
</table>

**OTHER FACILITY (Name: )**

<table>
<thead>
<tr>
<th>Type</th>
<th>Health Clinic</th>
<th>Public Safety Bldg.</th>
<th>Community Center</th>
<th>Water Plant</th>
<th>Washeteria</th>
<th>Public Housing</th>
<th>Multi-Purpose Bldg</th>
<th>District Energy System</th>
<th>Other (list):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Facility (sq. ft. heated):</td>
<td>Year built/age:</td>
<td>Year(s) renovated:</td>
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<tr>
<td>Number of floors:</td>
<td>Next renovation:</td>
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<tr>
<td>Number of bldgs.:</td>
<td># of Occupants</td>
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<tr>
<td>Frequency of Usage:</td>
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</tr>
<tr>
<td>Has an energy audit been conducted?:</td>
<td>If Yes, when? *</td>
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</tbody>
</table>

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

CONFIGURATION (check all that apply)
- 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

HEAT DELIVERY (check all that apply)
- 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)
- Hot water boiler: ☐ natural gas ☐ propane ☐ electric ☑ #1 fuel oil ☐ #2 fuel oil
- 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: ___________________________

HEATING CAPACITY (Btuh / kWh) | ANNUAL FUEL CONSUMPTION | COST (gal)
--------------------------------|------------------------|------
2X 786 MBH | 6,100 gal | $2.90/gal

TEMPERATURE CONTROLS (type of system; check all that apply)
- Thermostats on individual devices/appliances; no central control system
- Pneumatic control system
- Direct digital control system
  Manufacturer: Siemens
  Approx. Age: In process of being upgraded in summer 2017.

Record Name Plate data for boilers (use separate sheet if necessary):
2X Burnham, PF-505, 786 MBH CROSS OUTPUT, SN 7573310 & SN 7571887

Describe locations of different parts of the heating system and what building areas are served:
Boilers located in below grade room.

Describe age and general condition of existing equipment:
OK condition, original.

Who performs boiler maintenance? FNSBSD Maintenance
Describe any current maintenance issues: Unknown

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

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
Underground, 5000 gal tank, secondary containment unknown.

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

Bock, 135 gal, oil-fired water heater.

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): Boiler room

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.): 2x8 stud and CMU Insulation Value: R-25

Roof type: Hot Roof Insulation Value: R-30

Windows: ☐ single pane ☑ double pane ☑ other: __________________________

Arctic entry(s): ☐ none ☑ 1st main entrance only ☑ at multiple entrances ☑ at all entrances

Drawings available: ☑ architectural ☑ mechanical ☑ electrical

Outside Air/Air Exchange: ☑ HRV ☑ CO2 Sensor

ELECTRICAL

Utility company that serves the building or community: GVEA

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

Energy source: ☐ hydropower ☑ diesel generator(s) ☑ Other: ________________

Electricity rate per kWh: $0.20/kWh Demand charge: ________________ Effective rate used: ________________

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

Back-up generator on site: ☑ Yes ☑ No If Yes, provide output capacity: 30 kW

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

Record MDP and electrical panel name plate information:

SEE PHOTOS FOR PANELS

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $295/ton Viable fuel source? ☑ Yes ☑ No
- Wood chip cost delivered to facility $_____/ton Viable fuel source? ☑ Yes ☑ No
- Cord wood cost delivered to facility $_____/cord Viable fuel source? ☑ Yes ☑ No
- Distance to nearest wood pellet and wood chip suppliers: Superior pellets in Fairbanks pellet silo required
- Can logs or wood fuel be stockpiled on site or at a nearby facility: ________________________________________________

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

Source will be pellet manufacturer.
FACILITY SITE CONSIDERATIONS

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

Good access on north side of school.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)?

Playgrounds and fields on west, south and east sides of school.

Is there any significant site constraints? Permafrost issues?

Discontinuous permafrost.

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?

No.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?

No room inside. Northeast storage room upstairs could work, but will be tight. New module could go in new grass and northeast of school.

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?

Piping could run underground. Enter second floor and drop into mech 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 loop primary loop

For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot?

Unknown.

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?

Retrofit commissioning.

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)
### ALASKA WOOD ENERGY DEVELOPMENT TASK GROUP (AWEDTG)
#### PRE-FEASIBILITY ASSESSMENT FIELD DATA SHEET

<table>
<thead>
<tr>
<th>APPLICANT:</th>
<th>FNSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility:</td>
<td>Local government</td>
</tr>
<tr>
<td>(check one)</td>
<td>State agency</td>
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<tr>
<td></td>
<td>Federal agency</td>
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<tr>
<td></td>
<td>School/School District</td>
</tr>
<tr>
<td></td>
<td>Federally Recognized Tribe</td>
</tr>
<tr>
<td></td>
<td>Regional ANCSA Corp.</td>
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<td>Village ANCSA Corp.</td>
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<tr>
<td></td>
<td>Not-for-profit organization</td>
</tr>
<tr>
<td></td>
<td>Private Entity that can demonstrate a Public Benefit</td>
</tr>
<tr>
<td></td>
<td>Other (describe):</td>
</tr>
<tr>
<td>Contact Name:</td>
<td>Ben Loeffler</td>
</tr>
<tr>
<td>Mailing Address:</td>
<td>1885 Marika Rd</td>
</tr>
<tr>
<td>City:</td>
<td>Fairbanks</td>
</tr>
<tr>
<td>State:</td>
<td>AK</td>
</tr>
<tr>
<td>Zip Code:</td>
<td>99709</td>
</tr>
<tr>
<td>Office phone:</td>
<td>(907) 459-1335</td>
</tr>
<tr>
<td>Cell phone:</td>
<td>( )</td>
</tr>
<tr>
<td>Fax:</td>
<td>(907)</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:bloeffler@fnsb.us">bloeffler@fnsb.us</a></td>
</tr>
</tbody>
</table>

**Facility Identification/Name:** Sulcha Elementary  
**Facility Contact Person:** Same as above  
**Facility Contact Telephone:** (907) Same  
**Facility Contact Email:** Same

### SCHOOL/FACILITY INFORMATION  (complete separate Field Data Sheet for each building)  
**SCHOOL FACILITY** (Name: Sulcha Elementary)

| School Type: | [ ] Pre-School  | [ ] Junior High |
| (check all that apply) | [ ] Elementary  | [ ] Student Housing |
| | [ ] Middle School  | [ ] Gymnasium |
| Size of facility (sq. ft. heated): | 13,608 sf |
| Year built/age: | 1963 |
| Number of floors: | 1 |
| Year(s) renovated: | 2015, 1984 |
| Number of bldgs.: | Main Bldg |
| Next renovation: | None |
| # of Students: | 88 Students |
| Has an energy audit been conducted?: | Yes |
| *If Yes, when?: | 2012 |

**OTHER FACILITY** (Name:)

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

Page 1 of 4
HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)
- Heat plant in one location: [x] 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

HEAT DELIVERY (check all that apply)
- Hot water: [ ] baseboard   [x] radiant heat floor   [ ] 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
- Hot water boiler: [ ] natural gas   [ ] propane   [ ] electric   [ ] #1 fuel oil   [ ] #2 fuel oil
- 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: ___________________

Annual Fuel Consumption | Cost
- 2x 438 MBH 4,100 gal

TEMPERATURE CONTROLS (type of system; check all that apply)
- Thermostats on individual devices/appliances; no central control system
- Pneumatic control system Manufacturer: ___________________ Approx. Age: ________
- Direct digital control system Manufacturer: ANOTHER Approx. Age: UNKNOWN

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

Nameplate Data

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

Boilers in mechanical room serve all school

Describe age and general condition of existing equipment:

1984 heating system

Who performs boiler maintenance? ENSSD Maintenance Describe any current maintenance issues: Unknown

2x Burkham, V-38, 438 MBH CROSS OUTPUT, SN 7580597 + SN 758065

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

Ceiling routing

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

Underground tank, 5000 gal, secondary containment unknown.

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

Only for school
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:

Bock, Sogal, Oil-Fired Water Heater

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.:
Same tank as boilers.

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.):

Insulation Value:

Roof type:

Insulation Value:

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

Outside Air/Air Exchange:
- ☐ HRV
- ☐ CO2 Sensor

ELECTRICAL

Utility company that serves the building or community:
GVEA

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

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

Electricity rate per kWh:
$0.20/kWh

Demand charge:
Effective Rate Used:
30 KW

Back-up generator on site:
- ☐ Yes
- ☐ No

If Yes, provide output capacity:

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

Record MDP and electrical panel name plate information:
see photos for panels

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $295/ton
  Viable fuel source? Yes ☒ No

- Wood chip cost delivered to facility $_____/ton
  Viable fuel source? Yes ☐ No

- Cord wood cost delivered to facility $_____/cord
  Viable fuel source? Yes ☐ No

- Distance to nearest wood pellet and wood chip suppliers:

- Can logs or wood fuel be stockpiled on site or at a nearby facility?

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

Source from pellet manufacturer.
**FACILITY SITE CONSIDERATIONS**

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

- Poor access. Not a lot of space. Only access is parking lot.

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)?

- Playground, ski trails, septic system, fire pump house.

What are local soil conditions? Permafrost issues?

- Discontinuous permafrost

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close?

- Music room 300 ft away.

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go?

- No space inside the school. A new module is needed. Very limited space. It could go to west of Fire pump module at edge of parking lot. (300 ft away from school)

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?

- Piping could be run underground. There is already insulated buried hydronic piping from school to Fire pump module. New lines would be required.

**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
- For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per linear foot? unknown
- 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? Retrocommissioning
- 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 is 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)