Pre-Feasibility Assessment for Integration of Wood-Fired Heating Systems Final Report

July 24, 2012

Manley Village Council
Manley Hot Springs, Alaska

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In partnership with
Fairbanks Economic Development Corporation
Alaska Wood Energy Development Task Group

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1.0 Executive Summary

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Village Express Maintenance Shop, the Manley Village Council Office, the Health Clinic and Washeteria, the Generator Plant and the Tribal Hall in Manley Hot Springs, Alaska.

The following tables summarize the current fuel use and potential wood fuel use:

Table 1.1 - Annual Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Current Cost/Gal.	Annual Cost
VE Maint. Shop	Fuel Oil	400	$3.90	$1,560
Health Clinic	Fuel Oil	700	$3.90	$2,730

Table 1. 2 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
Health Clinic	700	6.1	5.6
Maintenance Shop	400	3.5	3.2
MVC Office (Future Est.)	600	5.2	4.8
Tribal Hall (Future Est.)	1,200	10.5	9.6
HC + MS	1,100	9.6	8.8
HC + MS + MVC	1,700	14.9	13.5
HC + MS + MVC + TH	2,900	25.3	23.1

Note: Wood fuel use assumes offsetting 85% of the current energy use.

Due to the small volume of wood needed to heat each building and even the entire campus, the larger capital cost wood pellet and chipped/ground wood boiler options were not considered. Cord wood boilers were the only options reviewed and were as follows:

Cord Wood Boiler Options:

- C.1: Health Clinic/Washeteria only.
- C.2: Health Clinic and Maintenance Shop.
- C.3: Health Clinic, Maintenance Shop, and MVC Office.
- C.4: Health Clinic, Maintenance Shop, MVC Office, and Tribal Hall.

The following table summarizes the economic evaluation for each option:

Table 1.3 - Economic Evaluation Summary
Manley Hot Springs Biomass Heating System

	Project Cost	Year 1 Operating Savings	NPV 30 yr at 3%	NPV 20 yr at 3%	20 Yr B/C Ratio	30 Yr B/C Ratio	ACF YR 20	ACF YR 30	YR ACF=PC
C.1	$325,000	-$8,997	-$170,508	-$125,858	-0.39	-0.52	-$170,141	-$264,770	>30
C.2	$347,000	-$8,367	-$139,027	-$108,273	-0.31	-0.40	-$144,997	-$209,783	>30
C.3	$443,000	-$7,422	-$91,896	-$81,896	-0.18	-0.21	-$107,281	-$127,304	>30
C.4	$915,000	-$6,232	-$24,681	-$45,558	-0.05	-0.03	-$54,994	-$8,851	>30

The Manley Village Tribal Council appears to be a poor candidate for the use of a wood biomass heating system. With the current economic assumptions, the economic viability of all the options is poor and none of the options meet the minimum requirement of the 20 year B/C ratio exceeding 1.0. Each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings. Combining multiple buildings increases the project costs without substantially increasing the annual fossil fuel use.

2.0 Introduction

The following assessment was commissioned to determine the preliminary technical and economic feasibility of integrating a wood fired heating system in the Village Express Maintenance Shop, the Manley Village Council Office, the Health Clinic and Washeteria, the Generator Plant and the Tribal Hall in Manley Hot Springs, Alaska.

3.0 Existing Building Systems

The buildings are all owned and operated by the Manley Village Council. The buildings are all clustered on a single piece of property approximately 1.5 miles east of Manley Hot Springs on the Elliot Highway.

The Village Express Maintenance Shop is a prefabricated metal building with insulated metal wall panels constructed in 2010. The building serves as a bus barn for the village shuttle bus. The facility is approximately 2,000 square feet and is heated by a 40,000 Btu/hr output oil fired stove. There have been no major additions. No domestic hot water is provided. The existing stove is original to the building and is in good condition. The Council is looking into the possibility of installing a waste oil heater and using the waste oil from all the vehicle maintenance to heat the building.

The Manley Village Council Office is a wood framed building constructed in the mid 1990's. The facility is approximately 960 square feet and is heated by electric resistance baseboard heaters. Domestic hot water is provided by a 40 gallon electric water heater rated at 4.5 KW input. The building was originally heated with a wood stove, which has been removed. Electric heat was added along with several chest style freezers to help establish a base load for the electrical generators that serve the complex.

The Health Clinic and Washeteria is a wood framed building with urethane insulation in the walls, floor and roof constructed in approximately 1996. The building was prefabricated off site and then shipped to Manley Hot Springs. The building is approximately 740 square feet and is heated by a 143,000 Btu/hr output hot water boiler. Domestic hot water is provided by an 80 gallon indirect water heater using the boiler water as a heating source. The existing boiler is original to the building and is in fair condition. The heating system infrastructure is original to the building an in fair condition.

The Generator Plant is a wood framed building constructed in the 1990's and houses the electrical generators that serve the MVC buildings. The facility is approximately 320 square feet with no heat source, warmed only by the residual heat of the generators. The complex is approximately 1/2-mile from the main electrical grid of Manley Hot Springs, and so MVC must operate the generators to produce power for this campus

The Manley Village Tribal Hall is a log building constructed around 2000 and serves as a summer gathering place for the village. The facility is approximately 1,200 square feet and is heated by a cordwood stove. There is no domestic hot water in the building. The building is on the south side of the Elliot Highway away from the rest of the campus. The building also does not have any power. Portable generators are used at events.

Facilities Dropped from Feasibility Study
No facilities were dropped from the feasibility study.

Facilities Added to Feasibility Study
No facilities were added to the feasibility study.

4.0 Energy Use

The Minto Village Council purchases fuel oil in bulk and fills storage tanks which are then used to provide fuel to MVC vehicles, equipment, and building heat. The amount of fuel used at each building for heating is not currently tracked. The Village Council has estimated that 12,000 gallons is used for building heat at their facilities. CTA has estimated the potential fuel use at each building based on square footage and estimated heating energy use index. Fuel use summaries for the buildings were provided and the following table summarizes the data:

Table 4.1 - Annual Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Current Cost/Gal.	Annual Cost
VE Maint. Shop	Fuel Oil	400	$3.90	$1,560
Health Clinic	Fuel Oil	700	$3.90	$2,730

The Manley Village Council purchases fuel oil in bulk and fills a single large storage tank which is then used to provide fuel to MVC vehicles, equipment, and building heat. The fuel use for the buildings has been estimated based on fuel fill records. Overall, MVC purchases approximately 21,000 gallons of fuel oil annually for all uses.

Electrical energy consumption will increase with the installation of the wood fired boiler system because of the power needed for the biomass boiler components such as draft fans, etc. and the additional pumps needed to integrate into the existing heating systems. The cash flow analysis accounts for the additional electrical energy consumption and reduces the annual savings accordingly.

5.0 Biomass Boiler Size

The following table summarized the connected load of the heating equipment:

Table 5.1 - Connected Boiler Load Summary

			Output MBH	Peak Load Factor	Likely System Peak MBH
VE Maint. Shop	Stove	Fuel Oil	37	1.00	37
Health Clinic/ Washateria	Boiler	Fuel Oil	143	1.00	143
MVC Office (Est.)	Elect. BB	Elec	100	1.00	100
Generator Building	N/A	N/A		1.00	0
Tribal Hall (Est.)	Stove	Wood	75	1.00	75
Total Of All Buildings			**355**		**355**

Typically a wood heating system is sized to meet approximately 85% of the typical annual heating energy use of the building. The existing heating systems would be used for the other 15% of the time during peak heating conditions, during times when the biomass heating system is down for servicing, and during swing months when only a few hours of heating each day are required. Recent energy models have found that a boiler sized at 50% to 60% of the building peak load will typically accommodate 85% of the boiler run hours.

Table 5.2 - Proposed Biomass Boiler Size

	Likely System Peak MBH	Biomass Boiler Factor	Biomass Boiler Size MBH
VE Maint. Shop (MS)	37	1	37
Health Clinic/Washateria (HC)	143	0.6	86
MVC Office (OF)	100	0.6	60
Generator Building (GB)	0	0.6	0
Tribal Hall (TH)	75	1	75
MS + HC	180	0.6	108
MS + HC + OF	280	0.6	168
MS + HC + OF + TH	355	0.6	213

Because of the small scale of the heating system, the output will be based on the smallest cordwood boiler size available, or approximately 170,000 Btu/hr.

6.0 Wood Fuel Use

The types of wood fuel available in the area include cord wood and wood pellets. The estimated amount of wood fuel needed of each wood fuel type for each building was calculated and is listed below:

Table 6.1 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)
Health Clinic	700	6.1	5.6
Maintenance Shop	400	3.5	3.2
MVC Office (Future Est.)	600	5.2	4.8
Tribal Hall (Future Est.)	1,200	10.5	9.6
HC + MS	1,100	9.6	8.8
HC + MS + MVC	1,700	14.9	13.5
HC + MS + MVC + TH	2,900	25.3	23.1

Note: Wood fuel use assumes offsetting 85% of the current energy use.

The amount of wood fuel shown in the table is for offsetting 85% of the total fuel oil use.

The moisture content of the wood fuels and the overall wood burning system efficiencies were accounted for in these calculations. The existing fuel oil boilers were assumed to be 80% efficient. Cord wood was assumed to be 20% moisture content (MC) with a system efficiency of 65%. Wood pellets were assumed to be 7% MC with a system efficiency of 70%.

For comparison reasons only, an amount of fuel oil use was estimated for the MVC office and the Tribal Hall assuming they utilized some sort of fuel oil heat.

Based on the potential wood fuel use, the volume of wood is so low that a pellet and a chipped/ground wood system is not really practical and further analysis will look at cord wood fuel options.

The tribe and village corporation own over 69,000 acres of land, of which approximately 90% is forested. The tribe and village corporation do not currently have any active logging operations, but hire out local independent contractors to provide cord wood for the MVC firewood program. There appears to be a sufficient supply to support a wood fired boiler for this campus.

The unit fuel costs for fuel oil and the different fuel types were calculated and equalized to dollars per million Btu ($/MMBtu) to allow for direct comparison. The Delivered $/MMBtu is the cost of the fuel based on what is actually delivered to the heating system, which includes all the inefficiencies of the different systems. The Gross $/MMBtu is the cost of the fuel based on raw fuel, or the higher heating value and does not account for any system inefficiencies. The following table summarizes the equalized fuel costs at different fuel unit costs:

Table 6.2 - Unit Fuel Costs Equalized to $/MMBtu

Fuel Type	Units	Gross Btu/unit	System Efficiency	Net System Btu/unit	$/unit	Delivered $/MMBtu	Gross $/MMBtu
Fuel Oil	gal	134500	0.8	107600	$3.90	$36.25	$29.00
					$4.50	$41.82	$33.46
					$5.00	$46.47	$37.17
Cord Wood	cords	16173800	0.65	10512970	$150.00	$14.27	$9.27
					$200.00	$19.02	$12.37
					$250.00	$23.78	$15.46
Pellets	tons	16400000	0.7	11480000	$300.00	$26.13	$18.29
					$350.00	$30.49	$21.34
					$400.00	$34.84	$24.39

7.0 Boiler Plant Location and Site Access

None of the existing boiler rooms are large enough to fit a new biomass boiler so a new stand alone boiler plant would be required. The best location for a plant would be just west of the generator building.

Any type of biomass boiler system will require access by delivery vehicles. For cord wood systems this would likely be pick-up trucks and trucks with trailers. The proposed plant location would allow for good access since it will be on the road up to the maintenance shop, which is maintained year round. The Elliot Highway passes through the property, so access via the highway is very good.

8.0 Integration with Existing Heating Systems

Integration of a wood fired heating system varies from facility to facility. The Village Express Maintenance Shop would require the installation of a wall hung unit heater within the building.

Integration of a central heating system in the Village Council Office would require the installation of two wall hung unit heaters within the building or some heating hot water baseboard elements.

Integration of a central heating system in the Health Clinic and Washeteria would require piping heating hot water supply and return lines to the existing boiler room and tying into the existing boiler piping.

Integration of a central heating system in the Tribal Hall would require the installation of a wall hung unit heater within the building.

The generator building would not be connected to a central heating system.

The field visit confirmed the location of each boiler room and heating unit location in order to identify an approximate point of connection from a district heating loop to each existing building. Connections would typically be achieved with arctic pipe extended to the face of each building, and extended up the exterior surface of the building in order to penetrate exterior wall into the boiler room or building. Once the heating water supply and return piping enters the existing boiler room it would be connected to existing supply and return lines in appropriate locations in order to utilize existing pumping systems within each building.

9.0 Air Quality Permits

Resource System Group has done a preliminary review of potential air quality issues in the area. Interior Alaska is prone to meteorological conditions that create thermal inversions, which are unfavorable for the dispersion of emissions. The proposed boiler size at this location is small enough, that the boiler is not likely to require any State or Federal permits. See air quality memo in appendix D.

10.0 Wood Heating Options

The technologies available to produce heating energy from wood based biomass are varied in their approach, but largely can be separated into three types of heating plants: cord wood, wood pellet and wood chip/ground wood fueled. See Appendix E for these summaries.

Due to the small volume of wood needed to heat each building and even the entire campus, the larger capital cost wood pellet and chipped/ground wood boiler options were not considered. Cord wood boilers were the only options reviewed and were as follows:

Cord PB Wood Boiler Options:

C.1: Health Clinic/Washateria only.
C.2: Health Clinic and Maintenance Shop.
C.3: Health Clinic, Maintenance Shop, and MVC Office.
C.4: Health Clinic, Maintenance Shop, MVC Office, and Tribal Hall.

All options would be installed in a freestanding building with interior cordwood fuel storage. The central boiler plant would be located next to the generator building.

11.0 Estimated Costs

The total project costs are at a preliminary design level and are based on RS Means and recent biomass project bid data. The estimates are shown in the appendix. These costs are conservative and if a deeper level feasibility analysis is undertaken and/or further design occurs, the costs may be able to be reduced.

12.0 Economic Analysis Assumptions

The cash flow analysis assumes fuel oil at $3.90/gal, electricity at $0.50/kwh, and cord wood delivered at $200/ton. It is assumed that the cord wood boiler would supplant 85% of the estimated heating use, and the existing heating systems would heat the remaining 15%. Each option assumes the total project can be funded with grants and non obligated capital money. The following inflation rates were used: O&M - 2%, Fossil Fuel – 5%, Wood Fuel – 3%, Discount Rate for NPV calculation – 3%. The fossil fuel inflation rate is based on the DOE EIA website. DOE is projecting a slight plateau with a long term inflation of approximately 5%. As a point of comparison, oil prices have increased at an annual rate of over 8% since 2001.

The analysis also accounts for additional electrical energy required for the wood fired boiler system as well as the system pumps to distribute heating hot water to the buildings. Wood fired boiler systems also will require more maintenance, and these additional maintenance costs are also factored into the analysis.

13.0 Results of Evaluation

The following table summarizes the economic evaluation for each option:

Table 13.1 - Economic Evaluation Summary
Manley Hot Springs Biomass Heating System

	Project Cost	Year 1 Operating Savings	NPV 30 yr at 3%	NPV 20 yr at 3%	20 Yr B/C Ratio	30 Yr B/C Ratio	ACF YR 20	ACF YR 30	YR ACF=PC
C.1	$325,000	-$8,997	-$170,508	-$125,858	-0.39	-0.52	-$170,141	-$264,770	>30
C.2	$347,000	-$8,367	-$139,027	-$108,273	-0.31	-0.40	-$144,997	-$209,783	>30
C.3	$443,000	-$7,422	-$91,896	-$81,896	-0.18	-0.21	-$107,281	-$127,304	>30
C.4	$915,000	-$6,232	-$24,681	-$45,558	-0.05	-0.03	-$54,994	-$8,851	>30

The benefit to cost ratio (B/C) takes the net present value (NPV) of the net energy savings and divides it by the construction cost of the project. A B/C ratio greater than or equal to 1.0 indicates an economically advantageous project.

Accumulated cash flow (ACF) is another evaluation measure that is calculated in this report and is similar to simple payback with the exception that accumulated cash flow takes the cost of financing and fuel escalation into account. For many building owners, having the accumulated cash flow equal the project cost within 15 years is considered necessary for implementation. If the accumulated cash flow equals project cost in 20 years or more, that indicates a challenged project. Positive accumulated cash flow should also be considered an avoided cost as opposed to a pure savings.

14.0 Project Funding

The Manley Village Tribal Council may pursue a biomass project grant from the Alaska Energy Authority.

The Manley Village Tribal Council could also enter into a performance contract for the project. Companies such as Siemens, McKinstry, Johnson Controls and Chevron have expressed an interest in participating in funding projects of all sizes throughout Alaska. This allows the facility owner to pay for the project entirely from the guaranteed energy savings, and to minimize the project funds required to initiate the project. The scope of the project may be expanded to include additional energy conservation measures such as replacing the existing generators.

15.0 Summary

The Manley Village Tribal Council appears to be a poor candidate for the use of a wood biomass heating system. With the current economic assumptions, the economic viability of all the options is poor and none of the options meet the minimum requirement of the 20 year B/C ratio exceeding 1.0. Each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings. Combining multiple buildings increases the project costs without substantially increasing the annual fossil fuel use.

16.0 Recommended Action

Pursuing the installation of a waste oil heater in the maintenance shop is recommended. Another project to investigate further would be the upgrading and/or replacement of the generator plant. A more thorough analysis is recommended including temporarily installing a data logger to develop a good electrical load profile of the campus. If the generators are replaced, consideration should be given to capturing the heat from the generators and using that to heat the maintenance shop and/or the health clinic.

APPENDIX A

Preliminary Estimates of Probable Cost

Preliminary Estimates of Probable Cost
Biomass Heating Options
Manley Hot Springs, AK

Option C.1 - Health Clinic/Washeteria (HC)

Cord Wood Storage/ Boiler Building:		$97,500
Wood Heating Boiler:		$16,000
Stack:		$2,200
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$46,000
Health Clinic Integration		$7,250
Subtotal:		$189,150
30% Remote Factor		$56,745
Subtotal:		$245,895
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$36,884
Subtotal:		$282,779
15% Contingency:		$42,417
Total Project Costs	**$**	**325,196**

Option C.2 - HC + Maint Shop (MS)

Cord Wood Storage/ Boiler Building:		$97,500
Wood Heating Boiler:		$16,000
Stack:		$2,200
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$53,000
Health Clinic Integration		$7,250
Maintenance Shop Integration		$5,500
Subtotal:		$201,650
30% Remote Factor		$60,495
Subtotal:		$262,145
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$39,322
Subtotal:		$301,467
15% Contingency:		$45,220
Total Project Costs	**$**	**346,687**

Preliminary Estimates of Probable Cost
Biomass Heating Options
Manley Hot Springs, AK

Option C.3 - HC + MS + MVC Office (OF)

Cord Wood Storage/ Boiler Building:		$97,500
Wood Heating Boiler:		$16,000
Stack:		$2,200
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$95,000
Health Clinic Integration		$7,250
Maintenance Shop Integration		$5,500
Manly Village Council Office Integration		$13,750
Subtotal:		$257,400
30% Remote Factor		$77,220
Subtotal:		$334,620
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$50,193
Subtotal:		$384,813
15% Contingency:		$57,722
Total Project Costs	**$**	**442,535**

Option C.4 - HC + MS + OF + Tribal Hall

Cord Wood Storage/ Boiler Building:		$180,000
Wood Heating Boiler:		$32,000
Stack:		$4,400
Mechanical/Electrical within Boiler Building:		$30,300
Underground Piping		$245,000
Health Clinic Integration		$7,250
Maintenance Shop Integration		$5,500
Manly Village Council Office Integration		$13,750
Tribal Hall		$13,750
Subtotal:		$531,950
30% Remote Factor		$159,585
Subtotal:		$691,535
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$103,730
Subtotal:		$795,265
15% Contingency:		$119,290
Total Project Costs	**$**	**914,555**

APPENDIX B

Cash Flow Analysis

Manley Villiage Council

Manley Hot Springs, AK

Option C.1

Cord Wood Boiler
Health Clinic/Washateria

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

EXISTING CONDITIONS	**Health Clinic**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$3.90				
Estimated Average Annual Fuel Usage:	700				700
Annual Heating Costs:	$2,730				$2,730
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	94,150,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	75,320,000	0	0	0	75,320,000

WOOD FUEL COST	**Cord Wood**
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	7.2
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	6.1
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$325,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$325,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1000 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-36.1 years		
Net Present Value (30 year analysis):	-$170,508	Net Benefit	B/C Ratio
Net Present Value (20 year analysis):	-$125,858	-$495,508	-0.52
Year Accumulated Cash Flow > 0	31	-$450,858	-0.39
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$3.90		700	gal	$2,730	$2,867	$3,010	$3,160	$3,318	$3,484	$3,658	$3,841	$4,033	$4,235	$4,447	$4,669	$4,903	$5,148	$5,405	$6,899	$8,805	$11,237
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	6	cords	$1,218	$1,255	$1,292	$1,331	$1,371	$1,412	$1,454	$1,498	$1,543	$1,589	$1,637	$1,686	$1,737	$1,789	$1,842	$2,136	$2,476	$2,870
Small load existing fuel	$3.90	15%	105	gal	$410	$430	$451	$474	$498	$523	$549	$576	$605	$635	$667	$700	$735	$772	$811	$1,035	$1,321	$1,686
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$500	$525	$551	$579	$608	$638	$670	$704	$739	$776	$814	$855	$898	$943	$990	$1,263	$1,613	$2,058
Annual Operating Cost Savings					***-$8,997***	***-$9,135***	***-$7,608***	***-$7,713***	***-$7,817***	***-$7,921***	***-$8,024***	***-$8,126***	***-$8,226***	***-$8,326***	***-$8,423***	***-$8,519***	***-$8,613***	***-$8,705***	***-$8,794***	***-$9,190***	***-$9,472***	***-$9,584***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***								
Displaced System Replacement Costs (year one only)					***0***																	
Net Annual Cash Flow					***(8,997)***	***(9,135)***	***(7,608)***	***(7,713)***	***(7,817)***	***(7,921)***	***(8,024)***	***(8,126)***	***(8,226)***	***(8,326)***	***(8,423)***	***(8,519)***	***(8,613)***	***(8,705)***	***(8,794)***	***(9,190)***	***(9,472)***	***(9,584)***
Accumulated Cash Flow					***(8,997)***	***(18,132)***	***(25,741)***	***(33,454)***	***(41,271)***	***(49,192)***	***(57,216)***	***(65,342)***	***(73,569)***	***(81,894)***	***(90,318)***	***(98,837)***	***(107,450)***	***(116,155)***	***(124,948)***	***(170,141)***	***(216,993)***	***(264,770)***

Manley Villiage Council

Manley Hot Springs, AK

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

Option C.2

Cord Wood Boiler
Health Clinic/Washateria + Maint. Shop

EXISTING CONDITIONS	**Health Clinic**	**Maint. Shop**			**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$3.90	$3.90			
Estimated Average Annual Fuel Usage:	700	400			1,100
Annual Heating Costs:	$2,730	$1,560			$4,290
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	94,150,000	53,800,000	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	75,320,000	43,040,000	0	0	118,360,000

WOOD FUEL COST	**Cord Wood**
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	11.3
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	9.6
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$347,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$347,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1000 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-41.5 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	-$139,027	-$486,027	-0.40
Net Present Value (20 year analysis):	-$108,273	-$455,273	-0.31
Year Accumulated Cash Flow > 0	31		
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$3.90		700	gal	$2,730	$2,867	$3,010	$3,160	$3,318	$3,484	$3,658	$3,841	$4,033	$4,235	$4,447	$4,669	$4,903	$5,148	$5,405	$6,899	$8,805	$11,237
Displaced heating costs	$3.90		400	gal	$1,560	$1,638	$1,720	$1,806	$1,896	$1,991	$2,091	$2,195	$2,305	$2,420	$2,541	$2,668	$2,802	$2,942	$3,089	$3,942	$5,031	$6,421
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	10	cords	$1,914	$1,971	$2,030	$2,091	$2,154	$2,219	$2,285	$2,354	$2,425	$2,497	$2,572	$2,649	$2,729	$2,811	$2,895	$3,356	$3,891	$4,510
Small load existing fuel	$3.90	15%	105	gal	$410	$430	$451	$474	$498	$523	$549	$576	$605	$635	$667	$700	$735	$772	$811	$1,035	$1,321	$1,686
Small load existing fuel	$3.90	15%	60	gal	$234	$246	$258	$271	$284	$299	$314	$329	$346	$363	$381	$400	$420	$441	$463	$591	$755	$963
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$500	$525	$551	$579	$608	$638	$670	$704	$739	$776	$814	$855	$898	$943	$990	$1,263	$1,613	$2,058
Annual Operating Cost Savings					***-$8,367***	***-$8,460***	***-$6,885***	***-$6,939***	***-$6,989***	***-$7,036***	***-$7,078***	***-$7,116***	***-$7,149***	***-$7,177***	***-$7,199***	***-$7,215***	***-$7,224***	***-$7,226***	***-$7,221***	***-$7,060***	***-$6,610***	***-$5,766***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***								
Displaced System Replacement Costs (year one only)					***0***																	
Net Annual Cash Flow					***(8,367)***	***(8,460)***	***(6,885)***	***(6,939)***	***(6,989)***	***(7,036)***	***(7,078)***	***(7,116)***	***(7,149)***	***(7,177)***	***(7,199)***	***(7,215)***	***(7,224)***	***(7,226)***	***(7,221)***	***(7,060)***	***(6,610)***	***(5,766)***
Accumulated Cash Flow					***(8,367)***	***(16,827)***	***(23,712)***	***(30,650)***	***(37,639)***	***(44,675)***	***(51,753)***	***(58,869)***	***(66,018)***	***(73,195)***	***(80,393)***	***(87,608)***	***(94,832)***	***(102,059)***	***(109,280)***	***(144,997)***	***(179,082)***	***(209,783)***

Manley Villiage Council

Manley Hot Springs, AK

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

Option C.3

Cord Wood Boiler
Health Clinic/Washateria + Maint. Shop + MVC Office

EXISTING CONDITIONS	**Health Clinic**	**Maint. Shop**	**MVC Office**		**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$3.90	$3.90	$3.90		
Estimated Average Annual Fuel Usage:	700	400	600		1,700
Annual Heating Costs:	$2,730	$1,560	$2,340		$6,630
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	94,150,000	53,800,000	80,700,000	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	75,320,000	43,040,000	64,560,000	0	182,920,000

WOOD FUEL COST	**Cord Wood**
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	17.4
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	14.8
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$443,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$443,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1000 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-59.7 years	Net Benefit	B/C Ratio
Net Present Value (30 year analysis):	-$91,805	-$534,805	-0.21
Net Present Value (20 year analysis):	-$81,896	-$524,896	-0.18
Year Accumulated Cash Flow > 0	31		
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	**Unit Costs**	**Heating Source Proportion**	**Annual Heating Source Volumes**	**Heating Units**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 20**	**Year 25**	**Year 30**
Existing Heating System Operating Costs																						
Displaced heating costs	$3.90		700	gal	$2,730	$2,867	$3,010	$3,160	$3,318	$3,484	$3,658	$3,841	$4,033	$4,235	$4,447	$4,669	$4,903	$5,148	$5,405	$6,899	$8,805	$11,237
Displaced heating costs	$3.90		400	gal	$1,560	$1,638	$1,720	$1,806	$1,896	$1,991	$2,091	$2,195	$2,305	$2,420	$2,541	$2,668	$2,802	$2,942	$3,089	$3,942	$5,031	$6,421
Displaced heating costs	$3.90		600	gal	$2,340	$2,457	$2,580	$2,709	$2,844	$2,986	$3,136	$3,293	$3,457	$3,630	$3,812	$4,002	$4,202	$4,412	$4,633	$5,913	$7,547	$9,632
Displaced heating costs	$0.00		0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	15	cords	$2,958	$3,047	$3,138	$3,232	$3,329	$3,429	$3,532	$3,638	$3,747	$3,859	$3,975	$4,094	$4,217	$4,344	$4,474	$5,187	$6,013	$6,971
Small load existing fuel	$3.90	15%	105	gal	$410	$430	$451	$474	$498	$523	$549	$576	$605	$635	$667	$700	$735	$772	$811	$1,035	$1,321	$1,686
Small load existing fuel	$3.90	15%	60	gal	$234	$246	$258	$271	$284	$299	$314	$329	$346	$363	$381	$400	$420	$441	$463	$591	$755	$963
Small load existing fuel	$3.90	15%	90	gal	$351	$369	$387	$406	$427	$448	$470	$494	$519	$545	$572	$600	$630	$662	$695	$887	$1,132	$1,445
Small load existing fuel	$0.00	15%	0	gal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$500	$525	$551	$579	$608	$638	$670	$704	$739	$776	$814	$855	$898	$943	$990	$1,263	$1,613	$2,058
Annual Operating Cost Savings					***-$7,422***	***-$7,446***	***-$5,799***	***-$5,777***	***-$5,746***	***-$5,707***	***-$5,659***	***-$5,601***	***-$5,533***	***-$5,453***	***-$5,362***	***-$5,258***	***-$5,141***	***-$5,009***	***-$4,862***	***-$3,864***	***-$2,318***	***-$39***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***								
Displaced System Replacement Costs (year one only)					***0***																	
Net Annual Cash Flow					***(7,422)***	***(7,446)***	***(5,799)***	***(5,777)***	***(5,746)***	***(5,707)***	***(5,659)***	***(5,601)***	***(5,533)***	***(5,453)***	***(5,362)***	***(5,258)***	***(5,141)***	***(5,009)***	***(4,862)***	***(3,864)***	***(2,318)***	***(39)***
Accumulated Cash Flow					***(7,422)***	***(14,869)***	***(20,668)***	***(26,445)***	***(32,191)***	***(37,899)***	***(43,558)***	***(49,159)***	***(54,692)***	***(60,145)***	***(65,507)***	***(70,765)***	***(75,906)***	***(80,915)***	***(85,777)***	***(107,281)***	***(122,215)***	***(127,304)***

Manley Villiage Council

Manley Hot Springs, AK

Date: July 24, 2012
Analyst: CTA Architects Engineers - Nick Salmon & Nathan Ratz

Option C.4

Cord Wood Boiler
Health Clinic/Washateria + Maint. Shop +
MVC Office + Tribal Hall

EXISTING CONDITIONS	**Health Clinic**	**Maint. Shop**	**MVC Office**	**Tribal Hall**	**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$3.90	$3.90	$3.90	$3.90	
Estimated Average Annual Fuel Usage:	700	400	600	1,200	2,900
Annual Heating Costs:	$2,730	$1,560	$2,340	$4,680	$11,310
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)					
Fuel Heating Value (Btu/unit of fuel):	134500	134500	134500	134500	
Current Annual Fuel Volume (Btu):	94,150,000	53,800,000	80,700,000	161,400,000	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	75,320,000	43,040,000	64,560,000	129,120,000	312,040,000

WOOD FUEL COST	**Cord Wood**
$/cord:	$200.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 20% MC, 6,700 Btu/lb x 28.4 lb/cf x 85 cf**	16,173,800
Cords of wood fuel to supplant net equivalent of 100% annual heating load.	29.7
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	25.2
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$915,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$915,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	2400 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	10.0	40	400	$20.00	$8,000
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

		Net Benefit	B/C Ratio
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-146.8 years		
Net Present Value (30 year analysis):	-$24,681	-$939,681	-0.03
Net Present Value (20 year analysis):	-$45,558	-$960,558	-0.05
Year Accumulated Cash Flow > 0	31		
Year Accumulated Cash Flow > Project Capital Cost	31		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	5.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 20	Year 25	Year 30
Existing Heating System Operating Costs																						
Displaced heating costs	$3.90		700	gal	$2,730	$2,867	$3,010	$3,160	$3,318	$3,484	$3,658	$3,841	$4,033	$4,235	$4,447	$4,669	$4,903	$5,148	$5,405	$6,899	$8,805	$11,237
Displaced heating costs	$3.90		400	gal	$1,560	$1,638	$1,720	$1,806	$1,896	$1,991	$2,091	$2,195	$2,305	$2,420	$2,541	$2,668	$2,802	$2,942	$3,089	$3,942	$5,031	$6,421
Displaced heating costs	$3.90		600	gal	$2,340	$2,457	$2,580	$2,709	$2,844	$2,986	$3,136	$3,293	$3,457	$3,630	$3,812	$4,002	$4,202	$4,412	$4,633	$5,913	$7,547	$9,632
Displaced heating costs	$3.90		1200	gal	$4,680	$4,914	$5,160	$5,418	$5,689	$5,973	$6,272	$6,585	$6,914	$7,260	$7,623	$8,004	$8,405	$8,825	$9,266	$11,826	$15,093	$19,264
Biomass System Operating Costs																						
Wood Fuel ($/ton, delivered to boiler site)	$200.00	85%	25	cords	$5,046	$5,197	$5,353	$5,514	$5,679	$5,850	$6,025	$6,206	$6,392	$6,584	$6,781	$6,985	$7,194	$7,410	$7,632	$8,848	$10,257	$11,891
Small load existing fuel	$3.90	15%	105	gal	$410	$430	$451	$474	$498	$523	$549	$576	$605	$635	$667	$700	$735	$772	$811	$1,035	$1,321	$1,686
Small load existing fuel	$3.90	15%	60	gal	$234	$246	$258	$271	$284	$299	$314	$329	$346	$363	$381	$400	$420	$441	$463	$591	$755	$963
Small load existing fuel	$3.90	15%	90	gal	$351	$369	$387	$406	$427	$448	$470	$494	$519	$545	$572	$600	$630	$662	$695	$887	$1,132	$1,445
Small load existing fuel	$3.90	15%	180	gal	$702	$737	$774	$813	$853	$896	$941	$988	$1,037	$1,089	$1,143	$1,201	$1,261	$1,324	$1,390	$1,774	$2,264	$2,890
Additional Operation and Maintenance Costs					$8,000	$8,160	$8,323	$8,490	$8,659	$8,833	$9,009	$9,189	$9,373	$9,561	$9,752	$9,947	$10,146	$10,349	$10,556	$11,654	$12,867	$14,207
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$1,200	$1,260	$1,323	$1,389	$1,459	$1,532	$1,608	$1,689	$1,773	$1,862	$1,955	$2,052	$2,155	$2,263	$2,376	$3,032	$3,870	$4,939
Annual Operating Cost Savings					***-$6,232***	***-$6,155***	***-$4,400***	***-$4,264***	***-$4,112***	***-$3,944***	***-$3,759***	***-$3,557***	***-$3,335***	***-$3,092***	***-$2,828***	***-$2,542***	***-$2,231***	***-$1,894***	***-$1,530***	***$758***	***$4,010***	***$8,533***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***								
Displaced System Replacement Costs (year one only)					***0***																	
Net Annual Cash Flow					***(6,232)***	***(6,155)***	***(4,400)***	***(4,264)***	***(4,112)***	***(3,944)***	***(3,759)***	***(3,557)***	***(3,335)***	***(3,092)***	***(2,828)***	***(2,542)***	***(2,231)***	***(1,894)***	***(1,530)***	***758***	***4,010***	***8,533***
Accumulated Cash Flow					***(6,232)***	***(12,387)***	***(16,788)***	***(21,052)***	***(25,163)***	***(29,108)***	***(32,867)***	***(36,424)***	***(39,758)***	***(42,851)***	***(45,679)***	***(48,221)***	***(50,451)***	***(52,345)***	***(53,875)***	***(54,994)***	***(41,890)***	***(8,851)***

APPENDIX C

Site Plan

Drawn By SSF
Checked By NHR
Date 07/24/2012
CTA # FEDC
Cad File: J:\manley hot springs

BIOMASS PRE-FEASIBILITY ASSESSMENT
MANLEY VILLAGE COUNCIL CLUSTER
MANLEY HOT SPRINGS, ALASKA

CTA
MISSOULA, MT
(406)728-9522
Fax (406)728-8287

SITE PLAN

APPENDIX D

Air Quality Report

To:	Nick Salmon
From:	John Hinckley
Subject:	Fairbanks Cluster Feasibility Study
Date:	24 July 2012

INTRODUCTION

At your request, RSG has conducted an air quality feasibility study for three biomass energy installations in Manley, Minto and Nenana. These sites are located in the interior of Alaska near Fairbanks. The following equipment is proposed:

- Minto - one 300,000 Btu/hr (heat output) cord wood boiler at the Minto Health Clinic.
- Manley - one 150,000 Btu/hr (heat output) cord wood boiler at the Village Express Maintenance Shop.
- Nenana – one 4,200,000 Btu/hr (heat output) wood chip boiler at the Nenana School.

MINTO STUDY AREA

A USGS map of the Minto study area is provided in Figure 1 below. As shown, the area is flat with much low-lying areas to the east and hilly to the west. The site is adjacent to a hillside. The area is relatively sparsely populated. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

55 Railroad Row ▪ White River Junction, Vermont 05001
TEL 802.295.4999 ▪ FAX 802.295.1006 ▪ www.rsginc.com

Figure 1: USGS Map Illustrating the Minto Study Area

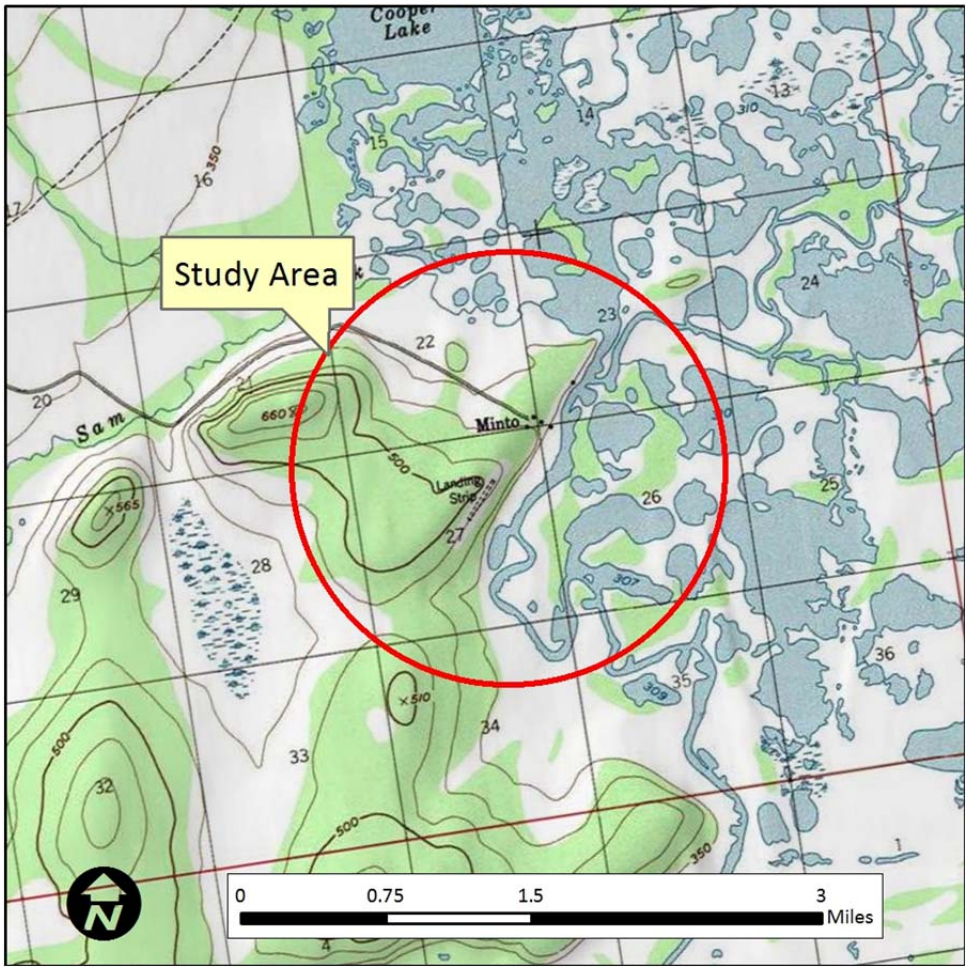


Figure 2 shows CTA Architects' plan of the location of the proposed biomass facility and the surrounding buildings in Minto. The site is relatively flat and sparsely populated with buildings. The facility will be located in a remote building on the southeast side of two buildings. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined. The degree of separation of the biomass building from the other buildings will create a buffer for emissions dispersion.

Figure 2: Location of Proposed Facility in Minto

A USGS map of the Manley study area is provided Figure 3. As shown, the area is hilly to mountainous to the north and flat to the south. The site is near the higher terrain to the north. The area is relatively sparsely populated. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 3: USGS Map Illustrating the Manley Hot Springs Study Area

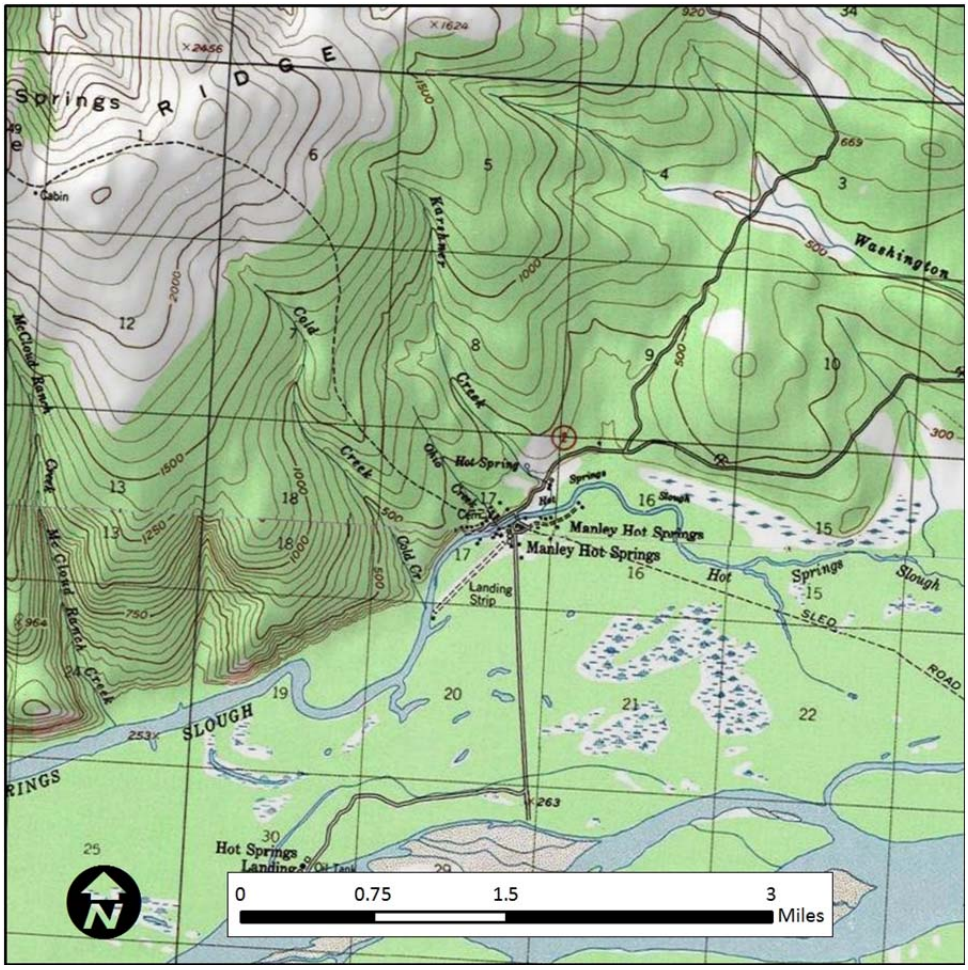


Figure 4 shows CTA Architects' plan of the location of the proposed biomass facility and the surrounding buildings. The site is surrounded by forest, relatively flat and has only a few buildings. The facility will be located in a new building on the west side of the site. A generator building is also indicated on the plan. The precise dimensions of that building, the stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 4: Location of Proposed Facility in Manley

A USGS map of the Nenana study area is provided Figure 3. As shown, the area is hilly to mountainous to the north and flat to the south and northeast. The site is across the river from higher terrain to the north. The area is moderately populated relative to the other sites discussed. Our review of the area did not reveal any significant emission sources or ambient air quality issues.

Figure 5: USGS Map Illustrating the Nenana Study Area

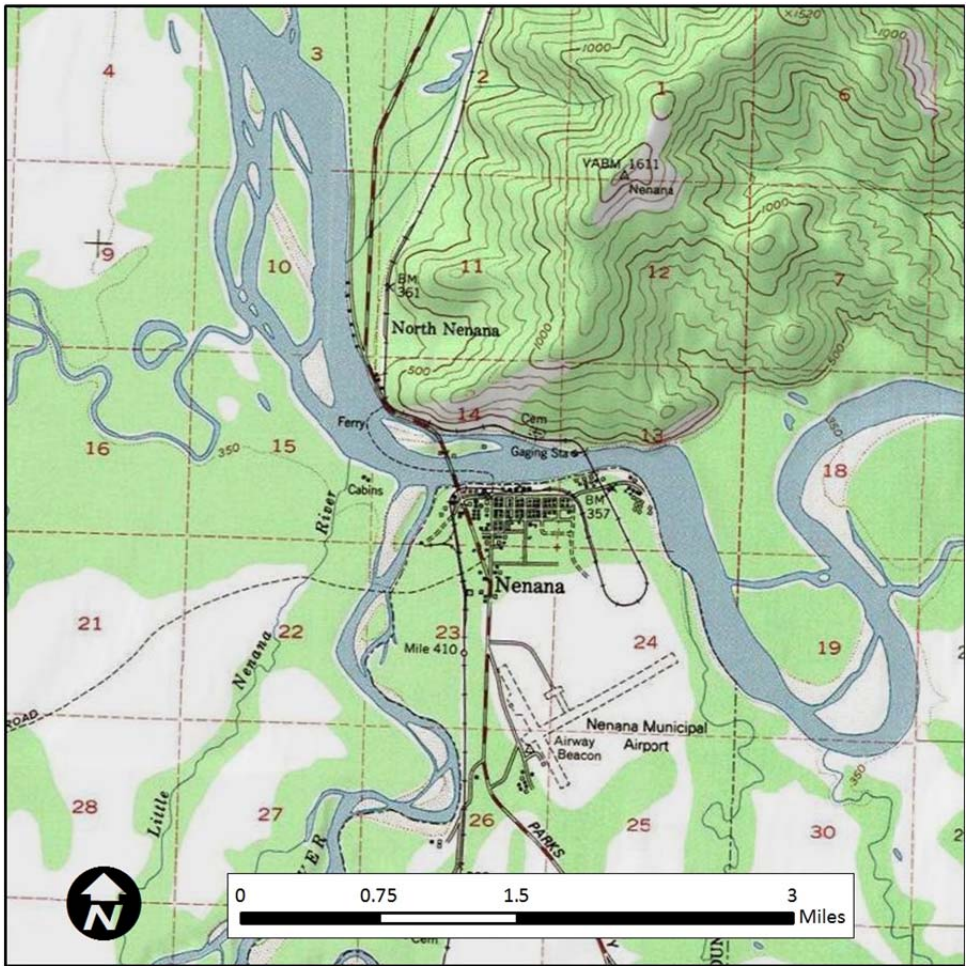
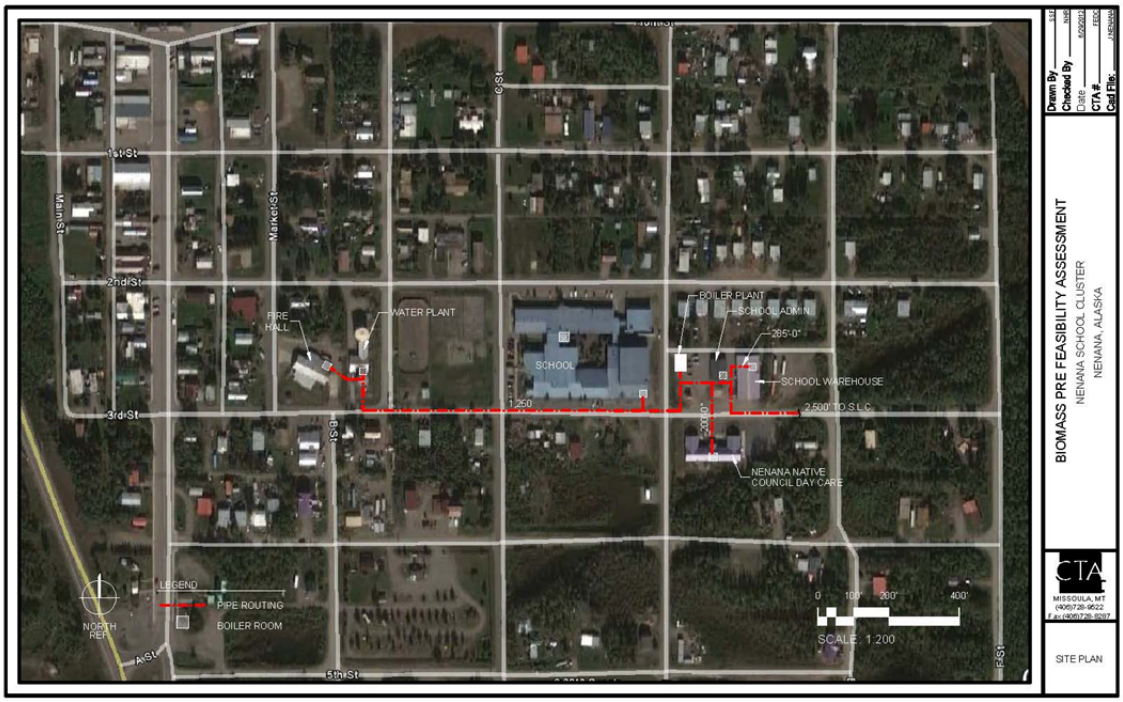


Figure 6 shows CTA Architects' plan of the location of the proposed biomass facility at the Nenana School and the surrounding buildings. The site is relatively flat and relatively densely populated with one to two story tall buildings. The proposed biomass equipment will be installed in a remote building located to the east of the school. This will provide a buffer for dispersion of air emissions between the stack and surrounding buildings. The precise stack location and dimensions, and the biomass equipment specifications have not been determined.

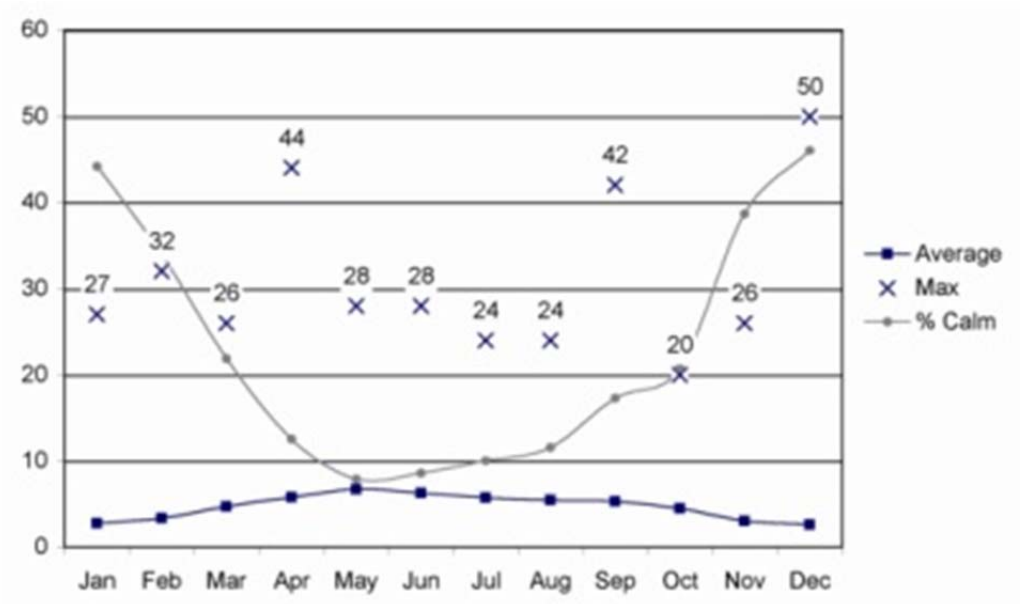
Figure 6: Overview of Nenana School Cluster Site



METEOROLOGY

Meteorological data from Fairbanks, AK was reviewed to develop an understanding of weather conditions. While Fairbanks is approximately 90 miles, 50 miles, and 45 miles away from Manley, Minto, and Nenana respectively, it is located in a similar climactic zone (Alaska Interior) and is therefore a good proxy of weather in those locations. As shown, there is a relatively high percentage of "calms" or times when the wind is not blowing during the colder months.[1] These conditions create thermal inversions which are unfavorable for the dispersion of emissions.

Figure 7: Wind Speed Data from Fairbanks, AK



DESIGN & OPERATION RECOMMENDATIONS

The following are suggested for designing the stack:

[1] See: http://climate.gi.alaska.edu/Climate/Wind/Speed/Fairbanks/FAI.html

- Burn natural wood, whose characteristics (moisture content, bark content, species, geometry) results in optimal combustion in the equipment selected for the project.
- Do not install a rain cap above the stack. Rain caps obstruct vertical airflow and reduce dispersion of emissions.
- Construct the stack to at least 1.5 times the height of the tallest roofline of the adjacent building. Hence, a 20 foot roofline would result in a minimum 30 foot stack.
- Operate and maintain the boiler according to manufacturer's recommendations.
- Perform a tune-up at least every other year as per manufacturer's recommendations and EPA guidance (see below for more discussion of EPA requirements)
- Conduct regular observations of stack emissions. If emissions are not characteristic of good boiler operation, make corrective actions.
- For the Nenana School: while there are no state or federal requirements mandating advanced emission control from and ESP or baghouse, we feel advanced emission control should be strongly considered. Alternatively, the school should consider using pellets in lieu of wood chips.

STATE AND FEDERAL PERMIT REQUIREMENTS

This project will not require an air pollution control permit from the Alaska Department of Environmental Quality given the boilers' relatively small size and corresponding quantity of emissions. However, this project will be subject to new proposed requirements in the federal "Area Source Rule" (40 CFR 63 JJJJJJ). A federal permit is not needed. However, there are various record keeping, reporting and operation and maintenance requirements which must be performed to demonstrate compliance with the requirements in the Area Source Rule. The proposed changes have not been finalized. Until that time, the following requirements are applicable:

- Submit initial notification form to EPA within 120 days of startup.
- Complete biennial tune ups per EPA method.
- Submit tune-up forms to EPA.

Please note the following:

- Oil and coal fired boilers are also subject to this rule.
- Gas fired boilers are not subject to this rule.
- More requirements are applicable to boilers equal to or greater than 10 MMBtu/hr heat input. These requirements typically warrant advanced emission controls, such as a baghouse or an electrostatic precipitator (ESP).

The compliance guidance documents and compliance forms can be obtained on the following EPA web page: http://www.epa.gov/boilercompliance/

SUMMARY

RSG has completed an air quality feasibility study for Minto, Manley, and Nenana, Alaska. The boilers are not subject to state permitting requirements, but are subject to federal requirements. Design criteria have been suggested to minimize emissions and maximize dispersion.

The following conditions suggest advanced emission control devices (ESP, baghouse) are not mandatory:

1. The wood boilers, with the exception of the boiler at Nenana, will be relatively small emission sources.
2. The wood boilers will be located in a separate building which will create a dispersion buffer between the boiler stack and the building.
3. There are no applicable federal or state emission limits.

Sustained poor meteorology suggests emissions should be minimized as much as possible.

Given these findings, we would recommend at minimum the following be done to minimize emissions:

1. Nenana: consider burning pellets in lieu of wood chips or consider advanced emission control. If wood chips are preferable, consider conducting air dispersion modeling to determine the stack height and degree of emission control.
2. While not mandatory, we recommend exploring the possibility of a cyclone or multi-cyclone technology for control of fly ash and larger particulate emissions for all the aforementioned boilers.
3. Obtain a not-to-exceed emission guarantees from boiler equipment vendors.

We also recommend developing a compliance plan for the aforementioned federal requirements.

Please contact me if you have any comments or questions.

APPENDIX E

Wood Fired Heating Technologies

WOOD FIRED HEATING TECHNOLOGIES

CTA has developed wood-fired heating system projects using cord wood, wood pellet and wood chips as the primary feedstock. A summary of each system type with the benefits and disadvantages is noted below.

Cord Wood

Cord wood systems are hand-stoked wood boilers with a limited heat output of 150,000-200,000 British Thermal Units per hour (Btu/hour). Cord wood systems are typically linked to a thermal storage tank in order to optimize the efficiency of the system and reduce the frequency of stoking. Cord wood boiler systems are also typically linked to existing heat distribution systems via a heat exchanger. Product data from Garn, HS Tarm and KOB identify outputs of 150,000-196,000 Btu/hr based upon burning eastern hardwoods and stoking the boiler on an hourly basis. The cost and practicality of stoking a wood boiler on an hourly basis has led most operators of cord wood systems to integrate an adjacent thermal storage tank, acting similar to a battery, storing heat for later use. The thermal storage tank allows the wood boiler to be stoked to a high fire mode 3 times per day while storing heat for distribution between stoking. Cord wood boilers require each piece of wood to be hand fed into the firebox, hand raking of the grates and hand removal of ash. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer.

Cordwood boilers are manufactured by a number of European manufacturers and an American manufacturer with low emissions. These manufacturers currently do not fabricate equipment with ASME (American Society of Mechanical Engineers) certifications. When these non ASME boilers are installed in the United States, atmospheric boilers rather than pressurized boilers are utilized. Atmospheric boilers require more frequent maintenance of the boiler chemicals.

Emissions from cord wood systems are typically as follows:

PM2.5	>0.08 lb/MMbtu
NOx	0.23 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	195 lb/MMbtu

Benefits:

Small size
Lower cost
Local wood resource
Simple to operate

Disadvantages:

Hand fed - a large labor commitment
Typically atmospheric boilers (not ASME rated)
Thermal Storage is required

Wood Pellet

Wood pellet systems can be hand fed from 40 pound bags, hand shoveled from 2,500 pound sacks of wood pellets, or automatically fed from an adjacent agricultural silo with a capacity of 30-40 tons. Pellet boilers systems are typically linked to existing heat distribution systems via a heat exchanger. Product data from KOB, Forest Energy and Solagen identify outputs of 200,000-5,000,000 Btu/hr based upon burning pellets made from waste products from the western timber industry. A number of pellet fuel manufacturers produce all tree pellets utilizing bark and needles. All tree pellets have significantly higher ash content, resulting in more frequent ash removal. Wood pellet boilers typically require hand raking of the grates and hand removal of ash 2-3 times a week. Automatic ash removal can be integrated into pellet boiler systems. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer. Pellet storage is very economical. Agricultural bin storage exterior to the building is inexpensive and quick to install. Material conveyance is also borrowed from agricultural technology. Flexible conveyors allow the storage to be located 20 feet or more from the boiler with a single auger.

Emissions from wood pellet systems are typically as follows:

PM2.5	>0.09 lb/MMbtu
NOx	0.22 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	220 lb/MMbtu

Benefits:

Smaller size (relative to a chip system)
Consistent fuel and easy economical storage of fuel
Automated

Disadvantages:

Higher system cost
Higher cost wood fuel ($/MMBtu)

Wood Chip

Chip systems utilize wood fuel that is either chipped or ground into a consistent size of 2-4 inches long and 1-2 inches wide. Chipped and ground material includes fine sawdust and other debris. The quality of the fuel varies based upon how the wood is processed between the forest and the facility. Trees which are harvested in a manner that minimizes contact with the ground and run through a chipper or grinder directly into a clean chip van are less likely to be contaminated with rocks, dirt and other debris. The quality of the wood fuel will also be impacted by the types of screens placed on the chipper or grinder. Fuel can be screened to reduce the quantity of fines which typically become airborne during combustion and represent lost heat and increased particulate emissions.

Chipped fuel is fed from the chip van into a metering bin, or loaded into a bunker with a capacity of 60 tons or more. Wood chip boilers systems are typically linked to existing heat distribution systems via a heat exchanger. Product data from Hurst, Messersmith and Biomass Combustion Systems identify outputs of 1,000,000 - 50,000,000 Btu/hr based upon burning western wood fuels. Wood chip boilers typically require hand raking of the grates and hand removal of ash daily. Automatic ash removal can be integrated into wood chip boiler systems. Ash is typically cooled in a barrel before being stock piled and later broadcast as fertilizer.

Emissions from wood chip systems are typically as follows:

PM2.5	0.21 lb/MMbtu
NOx	0.22 lb/MMbtu
SO2	0.025 lb/MMbtu
CO2	195 lb/MMbtu

Benefits:

Lowest fuel cost of three options ($/MMBtu)
Automated
Can use local wood resources

Disadvantages:

Highest initial cost of three types
Larger fuel storage required
Less consistent fuel can cause operational and performance issues