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

July 24, 2012

AVCP: Tugkar & Lomack Buildings Bethel, Alaska

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For
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In partnership with
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Alaska Wood Energy Development Task Group

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CTA Project: FEDC_BETHEL

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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 AVCP: Tugkar & Lomack Buildings. The Tugkar & Lomack buildings are on separate sites approximately 0.3 of a mile from each other. Each building was reviewed as a standalone system due to the cost of infrastructure to connect the buildings, as well as the additional energy needed to drive the increased pump size.

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

Table 1.1 - Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
Tugkar	Fuel Oil	5,017	$31,607	$6.29
Lomack	Fuel Oil	6,698	$42,197	$6.29

Table 1.2 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)	Chipped/ Ground Wood (Tons)
Tugkar	5,017	45.2	41.2	67.3
Lomack	6,698	60.3	54.9	89.9
Note: Wood fuel use assumes offsetting 85% of the current energy use.				

Based on the available wood fuel, a pellet option and cord wood option will be evaluated. The options reviewed were:

Pellet Wood Boiler Options:

B.1T: Tugkar Building.
B.1L: Lomack Building.

Cord Wood Boiler Options:
C.1T: Tugkar Building.
C.1L: Lomack building.

The table on the following page summarizes the economic evaluation for each option:

Table 1.3 - Economic Evaluation Summary
Bethel Tugkar and Lomack Biomass Heating Systems

	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
B.1T	$656,000	-$2,588	162,281	$57,108	0.09	0.25	$92,049	$319,361	>30
C.1T	$279,000	-$9,540	$55,611	-$37,797	-0.14	0.20	-$33,362	$170,253	>30
B.1L	$656,000	$239	$333,623	$148,273	0.23	0.51	$223,694	$623,391	>30
C.1L	$279,000	-$9,327	$150,815	$2610	0.01	0.54	-$48,443	$349,899	>29

The Tugkar and Lomack buildings appear to be poor candidates for the use of wood biomass heating systems. 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. Even with the high cost of fuel oil, each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings.

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 AVCP: Tugkar & Lomack Buildings. The Tugkar & Lomack buildings are on separate sites approximately .3 of a mile from each other. Each building was reviewed as a standalone system due to the cost of infrastructure to connect the buildings, as well as the additional energy needed to drive the increased pump size.

3.0 Existing Building Systems

AVCP: Tugkar (3rd and Main) Building

The Tugkar Building is a two story wood framed building constructed in 1990 and expanded in 1992. The facility is approximately 11,731 square feet and is heated by three 160,000 Btu/hr output hot water boilers. Domestic hot water is provided by an electric water heater rated at 4.5 KW input with a 28 gallon storage tank. One of the Burnham Boilers is original to the building and is in good condition. The remaining two Burnham Boilers have been installed as a replacement to the original boilers at an unspecified time.

AVCP: Lomack Building

The Lomack Building is a two story wood framed building constructed in 1987 and remodeled in 2004. The facility is approximately 14,714 square feet and is heated by two hot water boilers rated at 284,000 and 302,000 Btu/hr output. Domestic hot water is provided by one electric water heater rated at 4.5 KW input with a 50 gallon storage capacity. Both of the existing boilers are original to the building and are in fair condition.

Table 3.1 - Existing Heating System Summary

Building	Heat System	BTU/hr Output	Condition
Tugkar	Burnham Boiler	160,000	Good
	Burnham Boiler	160,000	Good
	Burnham Boiler	160,000	Good
Lomack	Burnham Boiler	284,000	Fair
	Burnham Boiler	302,000	Fair

4.0 Energy Use

Fuel oil bills for the facilities were provided. The following table summarizes the data:

Table 4.1 - Fuel Use Summary

Facility Name	Fuel Type	Avg. Use (Gallons)	Average Annual Cost	Average Cost/Gal.
Tugkar	Fuel Oil	5,017	$31,607	$6.29
Lomack	Fuel Oil	6,698	$42,197	$6.29

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 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
Tugkar	Burnham Boiler	Fuel Oil	160	0.66	106
	Burnham Boiler	Fuel Oil	160	0.66	106
	Burnham Boiler	Fuel Oil	160	0.66	106
Total					317
Lomack	Burnham Boiler	Fuel Oil	284	0.66	187
	Burnham Boiler	Fuel Oil	302	0.66	199
Total					387
Total Of All Buildings			**1066**		**704**

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
Tugkar	317	0.6	190
Lomack	387	0.6	232

The buildings are too far apart to consider a district heating system to connect them together. Each building would require its own wood fired boiler and the table above shows the estimated biomass boiler size.

6.0 Wood Fuel Use

The types of wood fuel available in the area include cord wood, wood pallets, 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 1.2 - Annual Wood Fuel Use Summary

	Fuel Oil (Gallons)	Cord Wood (Cords)	Wood Pellets (Tons)	Chipped/ Ground Wood (Tons)
Tugkar	5,017	45.2	41.2	67.3
Lomack	6,698	60.3	54.9	89.9

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%.

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	$5.50	$51.12	$40.89
					$6.29	$58.46	$46.77
					$7.00	$65.06	$52.04
Cord Wood	cords	16173800	0.65	10512970	$550.00	$52.32	$34.01
					$600.00	$57.07	$37.10
					$650.00	$61.83	$40.19
Pellets	tons	16400000	0.7	11480000	$400.00	$34.84	$24.39
					$460.00	$40.07	$28.05

Table 6.2 - Unit Fuel Costs Equalized to $/MMBtu		
$520.00	$45.30	$31.71

7.0 Boiler Plant Location and Site Access

The existing boiler rooms in both buildings are not 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 adjacent to each building as indicated on the site plans located in Appendix C.

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. For pellet boilers, this would require area for a trailer to turn around. A wood pellet boiler with an adjacent silo appears to be the most appropriate solution. Wood pellet fuel would need to be conveyed into the silo utilizing a pneumatic blower or grain auger. A pneumatic blower allows greater flexibility in the relationship between the delivery vehicle and silo.

8.0 Integration with Existing Heating Systems

Integration of a wood fired heating system varies from facility to facility. The integration of the building to the biomass boiler would require the installation of new heating hot water supply and return pipes to connect to the existing boiler supply and return pipes.

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

9.0 Air Quality Permits

Resource System Group (RSG) has completed and air quality feasibility study for three new wood boilers in Bethel, Alaska. Bethel has favorable meteorology for dispersion of emissions. Prevailing winds would likely blow emissions towards the southeast. In addition, the proposed wood boilers will be small emission sources, whose sizes preclude them from state permitting requirements. Therefore, we do not suggest advanced emission control such as an ESP or baghouse. However, other design criteria have been suggested to minimize emissions and maximize dispersion. These projects may be subject to federal requirements.

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.

Based on the available wood fuel, a pellet option and cord wood option will be evaluated. The options reviewed were:

Pellet Wood Boiler Options:

B.1T: Tugkar Building.

B.1L: Lomack Building.

Cord Wood Boiler Options:
C.1T: Tugkar Building.
C.1L: Lomack building.

Wood pellet boiler options assume a freestanding boiler building with adjacent free standing pellet silo. The cord wood boiler option assumes a free standing building with interior cordwood fuel storage.

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 $6.29/gal, electricity at $0.50/kwh, cord wood delivered at $600/cord, and wood pellets delivered at $460/ton. The fuel oil, electricity, and cord wood costs are based on the costs reported by the facility. Pellet costs were obtained from an engineering study investigating using pellet boilers at the AVCP Housing Authority Complex.

It is assumed that the 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
Bethel Tugkar and Lomack Biomass Heating Systems

	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
B.1T	$656,000	-$2,588	162,281	$57,108	0.09	0.25	$92,049	$319,361	>30
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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

AVCP may pursue a biomass project grant from the Alaska Energy Authority.

AVCP 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 roof and wall insulation and upgrading mechanical systems.

15.0 Summary

The Tugkar and Lomack buildings appear to be poor candidates for the use of wood biomass heating systems. 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. Even with the high cost of fuel oil, each building individually does not spend enough on heating fuel to be able to pay for a project through potential savings.

16.0 Recommended Actions

Because of the availability of wood pallets at low or no cost, further investigation into specialized wood stoves or boilers that can burn pallets would be recommended. Additional analysis would be required to determine the quantity and quality of wood pallets in Bethel, as well as the cost.

Additional investigation should also be completed on increasing the cord wood production volume and infrastructure. If the cost per cord could be reduced the project would become more viable.

APPENDIX A

Preliminary Estimates of Probable Cost

Preliminary Estimates of Probable Cost
AVCP Tugkar and Lomack Biomass Heating Options
Bethel, AK

Option B.1 - Tugkar

Biomass Boiler Building:		$90,000
Wood Heating, Wood Handling System, & Pellet Silo:		$140,000
Stack/Air Pollution Control Device:		$50,000
Mechanical/Electrical within Boiler Building:		$75,000
Underground Piping		$12,000
Tugkar Integration		$14,500
Subtotal:		$381,500
30% Remote Factor		$114,450
Subtotal:		$495,950
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$74,393
Subtotal:		$570,343
15% Contingency:		$85,551
Total Project Costs	**$**	**655,894**

Option C.1 - Tugkar

Biomass Boiler Building Including Wood Storage Area:		$97,500
Wood Boiler System:		$16,000
Stack:		$2,200
Mechanical/Electrical within Boiler Building:		$20,200
Underground Piping		$12,000
Tugkar Integration		$14,500
Subtotal:		$162,400
30% Remote Factor		$48,720
Subtotal:		$211,120
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$31,668
Subtotal:		$242,788
15% Contingency:		$36,418
Total Project Costs	**$**	**279,206**

Preliminary Estimates of Probable Cost
AVCP Tugkar and Lomack Biomass Heating Options
Bethel, AK

Option B.1 - Lomack

Biomass Boiler Building:		$90,000
Wood Heating, Wood Handling System, & Pellet Silo:		$140,000
Stack/Air Pollution Control Device:		$50,000
Mechanical/Electrical within Boiler Building:		$75,000
Underground Piping		$12,000
Lomack Integration		$14,500
Subtotal:		$381,500
30% Remote Factor		$114,450
Subtotal:		$495,950
Design Fees, Building Permit, Miscellaneous Expenses 15%:		$74,393
Subtotal:		$570,343
15% Contingency:		$85,551
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Option C.1 - Lomack

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Design Fees, Building Permit, Miscellaneous Expenses 15%:		$31,668
Subtotal:		$242,788
15% Contingency:		$36,418
Total Project Costs	**$**	**279,206**

APPENDIX B

Cash Flow Analysis

AVCP: Tugkar

Bethel, Alaska

Option B.1

Wood Pellet Boiler

Date: July 24, 2012
Analyst: CTA Architects Engineers - Jesse Vigil & Nathan Ratz

EXISTING CONDITIONS	**Tugkar**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$6.29				
Estimated Average Annual Fuel Usage:	5,017				5,017
Annual Heating Costs:	$31,557	$0	$0	$0	$31,557
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):	674,786,500	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	539,829,200	0	0	0	539,829,200

WOOD FUEL COST	**Wood Pellets**
$/ton:	$460.00
Assumed efficiency of wood heating system (%):	70%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 7% MC**	8200
Tons of wood fuel to supplant net equivalent of 100% annual heating load.	47
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	40
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	2

Project Capital Cost	**-$656,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$656,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	15650 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	2.0	40	80	$20.00	$1,600
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:	-253.5 years		
Net Present Value (30 year analysis):	$162,281	-$493,719	0.25
Net Present Value (20 year analysis):	$57,108	-$598,892	0.09
Year Accumulated Cash Flow > 0	8		
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	$6.29		5017	gal	$31,557	$33,135	$34,792	$36,531	$38,358	$40,276	$42,289	$44,404	$46,624	$48,955	$51,403	$53,973	$56,672	$59,505	$62,481	$79,743	$101,774	$129,893
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)	$460.00	85%	40	tons	$18,386	$18,938	$19,506	$20,091	$20,694	$21,315	$21,954	$22,613	$23,291	$23,990	$24,709	$25,451	$26,214	$27,001	$27,811	$32,240	$37,375	$43,328
Small load existing fuel	$6.29	15%	753	gal	$4,734	$4,970	$5,219	$5,480	$5,754	$6,041	$6,343	$6,661	$6,994	$7,343	$7,710	$8,096	$8,501	$8,926	$9,372	$11,961	$15,266	$19,484
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					$1,600	$1,632	$1,665	$1,698	$1,732	$1,767	$1,802	$1,838	$1,875	$1,912	$1,950	$1,989	$2,029	$2,070	$2,111	$2,331	$2,573	$2,841
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$7,825	$8,216	$8,627	$9,058	$9,511	$9,987	$10,486	$11,011	$11,561	$12,139	$12,746	$13,383	$14,053	$14,755	$15,493	$19,773	$25,236	$32,209
Annual Operating Cost Savings					***-$2,588***	***-$2,253***	***-$225***	***$204***	***$667***	***$1,166***	***$1,704***	***$2,282***	***$2,904***	***$3,571***	***$4,287***	***$5,054***	***$5,875***	***$6,754***	***$7,694***	***$13,437***	***$21,323***	***$32,030***
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					***(2,588)***	***(2,253)***	***(225)***	***204***	***667***	***1,166***	***1,704***	***2,282***	***2,904***	***3,571***	***4,287***	***5,054***	***5,875***	***6,754***	***7,694***	***13,437***	***21,323***	***32,030***
Accumulated Cash Flow					***(2,588)***	***(4,841)***	***(5,066)***	***(4,862)***	***(4,195)***	***(3,029)***	***(1,325)***	***957***	***3,861***	***7,431***	***11,718***	***16,771***	***22,646***	***29,400***	***37,094***	***92,049***	***181,911***	***319,361***

AVCP: Lomack

Bethel, Alaska

Option B.1

Wood Pellet Boiler

Date: July 24, 2012
Analyst: CTA Architects Engineers - Jesse Vigil & Nathan Ratz

EXISTING CONDITIONS	**Lomack**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$6.29			$4.10	
Estimated Average Annual Fuel Usage:	6,698				6,698
Annual Heating Costs:	$42,130	$0	$0	$0	$42,130
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):	900,881,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	720,704,800	0	0	0	720,704,800

WOOD FUEL COST	**Wood Pellets**
$/ton:	$460.00
Assumed efficiency of wood heating system (%):	70%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 7% MC**	8200
Tons of wood fuel to supplant net equivalent of 100% annual heating load.	63
Tons of wood fuel to supplant net equivalent of 85% annual heating load.	53
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	2

Project Capital Cost	**-$656,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$656,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	15650 kWh
Elec Rate	$0.500 /kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	2.0	40	80	$20.00	$1,600
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:	2,742.4 years		
Net Present Value (30 year analysis):	$333,623	-$322,377	0.51
Net Present Value (20 year analysis):	$148,273	-$507,727	0.23
Year Accumulated Cash Flow > 0	#N/A		
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	$6.29		6698	gal	$42,130	$44,237	$46,449	$48,771	$51,210	$53,770	$56,459	$59,282	$62,246	$65,358	$68,626	$72,057	$75,660	$79,443	$83,415	$106,461	$135,875	$173,415
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	$4.10		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)	$460.00	85%	53	tons	$24,547	$25,283	$26,042	$26,823	$27,627	$28,456	$29,310	$30,189	$31,095	$32,028	$32,989	$33,978	$34,998	$36,048	$37,129	$43,043	$49,898	$57,846
Small load existing fuel	$6.29	15%	1005	gal	$6,320	$6,636	$6,967	$7,316	$7,681	$8,066	$8,469	$8,892	$9,337	$9,804	$10,294	$10,809	$11,349	$11,916	$12,512	$15,969	$20,381	$26,012
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	$4.10	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					$1,600	$1,632	$1,665	$1,698	$1,732	$1,767	$1,802	$1,838	$1,875	$1,912	$1,950	$1,989	$2,029	$2,070	$2,111	$2,331	$2,573	$2,841
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632																
Additional Electrical Cost	$0.500				$7,825	$8,216	$8,627	$9,058	$9,511	$9,987	$10,486	$11,011	$11,561	$12,139	$12,746	$13,383	$14,053	$14,755	$15,493	$19,773	$25,236	$32,209
Annual Operating Cost Savings					***$239***	***$838***	***$3,148***	***$3,876***	***$4,658***	***$5,495***	***$6,392***	***$7,352***	***$8,378***	***$9,475***	***$10,647***	***$11,898***	***$13,232***	***$14,654***	***$16,170***	***$25,345***	***$37,785***	***$54,506***
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					***239***	***838***	***3,148***	***3,876***	***4,658***	***5,495***	***6,392***	***7,352***	***8,378***	***9,475***	***10,647***	***11,898***	***13,232***	***14,654***	***16,170***	***25,345***	***37,785***	***54,506***
Accumulated Cash Flow					***239***	***1,077***	***4,226***	***8,102***	***12,760***	***18,255***	***24,646***	***31,998***	***40,376***	***49,852***	***60,499***	***72,396***	***85,628***	***100,282***	***116,452***	***223,694***	***386,250***	***623,390***

AVCP: Tugkar

Bethel, Alaska

Option C.1

Cord Wood Boiler

Date: July 24, 2012
Analyst: CTA Architects Engineers - Jesse Vigil & Nathan Ratz

EXISTING CONDITIONS	**Tugkar**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$6.29				
Estimated Average Annual Fuel Usage:	5,017				5,017
Annual Heating Costs:	$31,557	$0	$0	$0	$31,557
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):	674,786,500	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	539,829,200	0	0	0	539,829,200

WOOD FUEL COST	**Cord Wood**
$/cord:	$600.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/cord) - **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.	51
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	44
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$279,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$279,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1150 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:	-29.2 years		
Net Present Value (30 year analysis):	$55,611	-$223,389	0.20
Net Present Value (20 year analysis):	-$37,797	-$316,797	-0.14
Year Accumulated Cash Flow > 0	23		
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	$6.29		5017	gal	$31,557	$33,135	$34,792	$36,531	$38,358	$40,276	$42,289	$44,404	$46,624	$48,955	$51,403	$53,973	$56,672	$59,505	$62,481	$79,743	$101,774	$129,893
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)	$600.00	85%	44	tons	$26,188	$26,974	$27,783	$28,616	$29,475	$30,359	$31,270	$32,208	$33,174	$34,169	$35,194	$36,250	$37,338	$38,458	$39,612	$45,921	$53,235	$61,714
Small load existing fuel	$6.29	15%	753	gal	$4,734	$4,970	$5,219	$5,480	$5,754	$6,041	$6,343	$6,661	$6,994	$7,343	$7,710	$8,096	$8,501	$8,926	$9,372	$11,961	$15,266	$19,484
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				$575	$604	$634	$666	$699	$734	$771	$809	$850	$892	$937	$983	$1,033	$1,084	$1,138	$1,453	$1,854	$2,367
Annual Operating Cost Savings					***-$9,540***	***-$9,205***	***-$7,167***	***-$6,720***	***-$6,229***	***-$5,691***	***-$5,104***	***-$4,463***	***-$3,767***	***-$3,010***	***-$2,190***	***-$1,304***	***-$345***	***$689***	***$1,803***	***$8,753***	***$18,552***	***$32,122***
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					***(9,540)***	***(9,205)***	***(7,167)***	***(6,720)***	***(6,229)***	***(5,691)***	***(5,104)***	***(4,463)***	***(3,767)***	***(3,010)***	***(2,190)***	***(1,304)***	***(345)***	***689***	***1,803***	***8,753***	***18,552***	***32,122***
Accumulated Cash Flow					***(9,540)***	***(18,744)***	***(25,911)***	***(32,632)***	***(38,861)***	***(44,552)***	***(49,656)***	***(54,119)***	***(57,885)***	***(60,896)***	***(63,086)***	***(64,390)***	***(64,735)***	***(64,046)***	***(62,244)***	***(33,362)***	***38,493***	***170,235***

AVCP: Lomack

Bethel, Alaska

Option C.1

Cord Wood Boiler

Date: July 24, 2012
Analyst: CTA Architects Engineers - Jesse Vigil & Nathan Ratz

EXISTING CONDITIONS	**Lomack**				**Total**
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil	
Fuel Units:	gal	gal	gal	gal	
Current Fuel Unit Cost:	$6.29				
Estimated Average Annual Fuel Usage:	6,698				6,698
Annual Heating Costs:	$42,130	$0	$0	$0	$42,130
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):	900,881,000	0	0	0	
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%	
Net Annual Energy Produced (Btu):	720,704,800	0	0	0	720,704,800

WOOD FUEL COST	**Cord Wood**
$/cord:	$600.00
Assumed efficiency of wood heating system (%):	65%
PROJECTED WOOD FUEL USAGE	
Estimated Btu content of wood fuel (Btu/cord) - **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.	69
Cords of wood fuel to supplant net equivalent of 85% annual heating load.	58
25 ton chip van loads to supplant net equivalent of 85% annual heating load.	N/A

Project Capital Cost	**-$279,000**

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$279,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use	
Est. Pwr Use	1150 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:	-29.9 years		
Net Present Value (30 year analysis):	$150,815	-$128,185	0.54
Net Present Value (20 year analysis):	$2,610	-$276,390	0.01
Year Accumulated Cash Flow > 0	19		
Year Accumulated Cash Flow > Project Capital Cost	29		

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	$6.29		6698	gal	$42,130	$44,237	$46,449	$48,771	$51,210	$53,770	$56,459	$59,282	$62,246	$65,358	$68,626	$72,057	$75,660	$79,443	$83,415	$106,461	$135,875	$173,415
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)	$600.00	85%	58	tons	$34,962	$36,011	$37,092	$38,204	$39,351	$40,531	$41,747	$42,999	$44,289	$45,618	$46,987	$48,396	$49,848	$51,344	$52,884	$61,307	$71,072	$82,391
Small load existing fuel	$6.29	15%	1005	gal	$6,320	$6,636	$6,967	$7,316	$7,681	$8,066	$8,469	$8,892	$9,337	$9,804	$10,294	$10,809	$11,349	$11,916	$12,512	$15,969	$20,381	$26,012
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				$575	$604	$634	$666	$699	$734	$771	$809	$850	$892	$937	$983	$1,033	$1,084	$1,138	$1,453	$1,854	$2,367
Annual Operating Cost Savings					***-$9,327***	***-$8,806***	***-$6,567***	***-$5,904***	***-$5,181***	***-$4,393***	***-$3,537***	***-$2,609***	***-$1,603***	***-$516***	***$657***	***$1,922***	***$3,284***	***$4,750***	***$6,325***	***$16,078***	***$29,700***	***$48,437***
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					***(9,327)***	***(8,806)***	***(6,567)***	***(5,904)***	***(5,181)***	***(4,393)***	***(3,537)***	***(2,609)***	***(1,603)***	***(516)***	***657***	***1,922***	***3,284***	***4,750***	***6,325***	***16,078***	***29,700***	***48,437***
Accumulated Cash Flow					***(9,327)***	***(18,132)***	***(24,700)***	***(30,604)***	***(35,784)***	***(40,177)***	***(43,714)***	***(46,323)***	***(47,926)***	***(48,443)***	***(47,786)***	***(45,864)***	***(42,579)***	***(37,829)***	***(31,504)***	***28,041***	***147,525***	***349,899***

APPENDIX C

Site Plan

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

BIOMASS PRE-FEASIBILITY ASSESSMENT
BETHEL OVERVIEW
BETHEL, ALASKA

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

SITE PLAN

Drawn By SSF
Checked By NHR
Date 07/24/2012
CTA # FEDC
Cad File: J:Bethel

BIOMASS PRE-FEASIBILITY ASSESSMENT
TUGKAR BUILDING
BETHEL, ALASKA

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

SITE PLAN

Drawn By SSF
Checked By NHR
Date 07/24/2012
CTA # FEDC
Cad File: J:Bethel

BIOMASS PRE-FEASIBILITY ASSESSMENT
LOMACK BUILDING
BETHEL, 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:	Bethel 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 Bethel. Bethel is located in southwest Alaska at the head of the Wood River and has a population of 6,000 people. The following equipment is proposed:

- A 250,000 Btu/hr (heat output) cord wood boiler at the Tukgar Building.
- A 3,100,000 Btu/hr (heat output) pellet boiler at the AVCP Housing Complex.
- A 250,000 Btu/hr (heat output) cord wood boiler at the Lomack Building.

STUDY AREA

A USGS map of the study area is provided in Figure 1 below. As shown, the area is flat with much low-lying areas along the Kuskokwin River. Relative to other sites in Alaska, the area is densely 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 Study Area

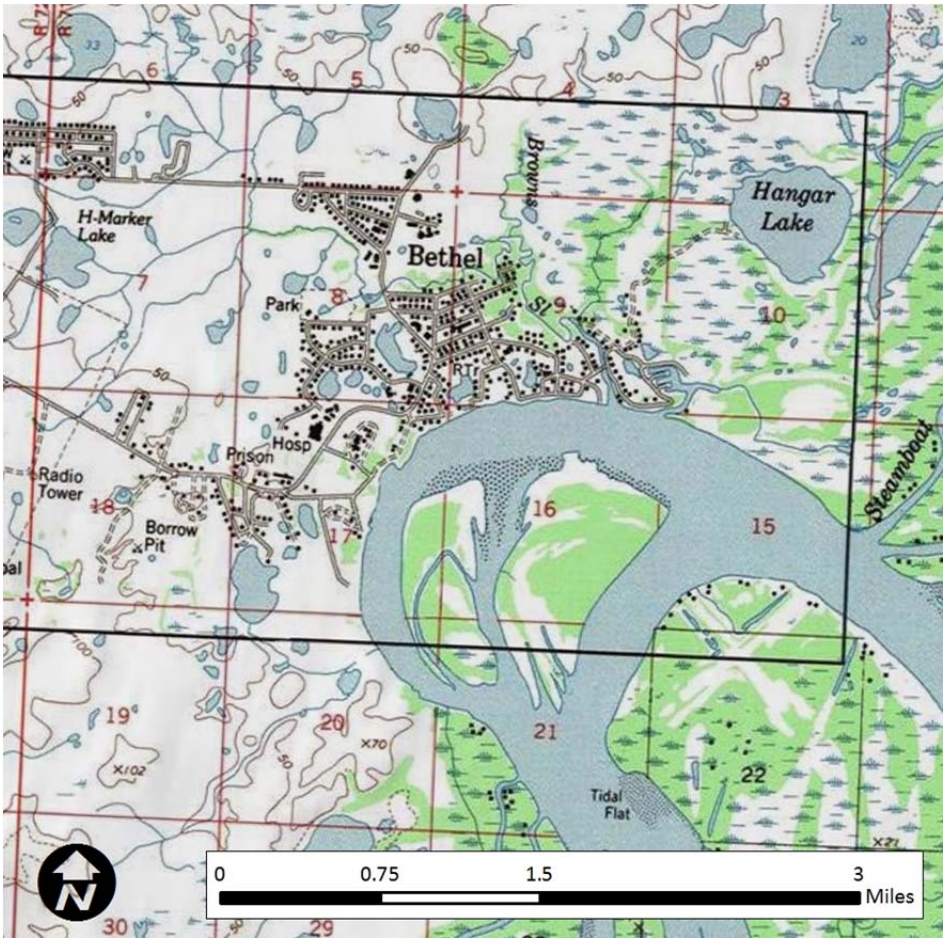


Figure 1 shows CTA Architects' plan of the location of the proposed biomass facility at the Tukgar Building and the surrounding buildings. As shown, two locations are being considered for the proposed biomass equipment. The site is relatively flat and relatively densely populated with one to two story tall buildings. The precise stack location and dimensions, and the biomass equipment specifications have not been determined.

Figure 1: Overview of Tukgar Site

Figure 2 shows CTA Architects' plan of the proposed biomass facility at the AVCP Building and the surrounding buildings. Most of the buildings are approximately one to two stories tall. A stand-alone biomass facility is planned on the southeast corner of the site. The remote location of the facility will provide a dispersion buffer between the stack and the office buildings.

Figure 2: Overview of AVCP Housing Site

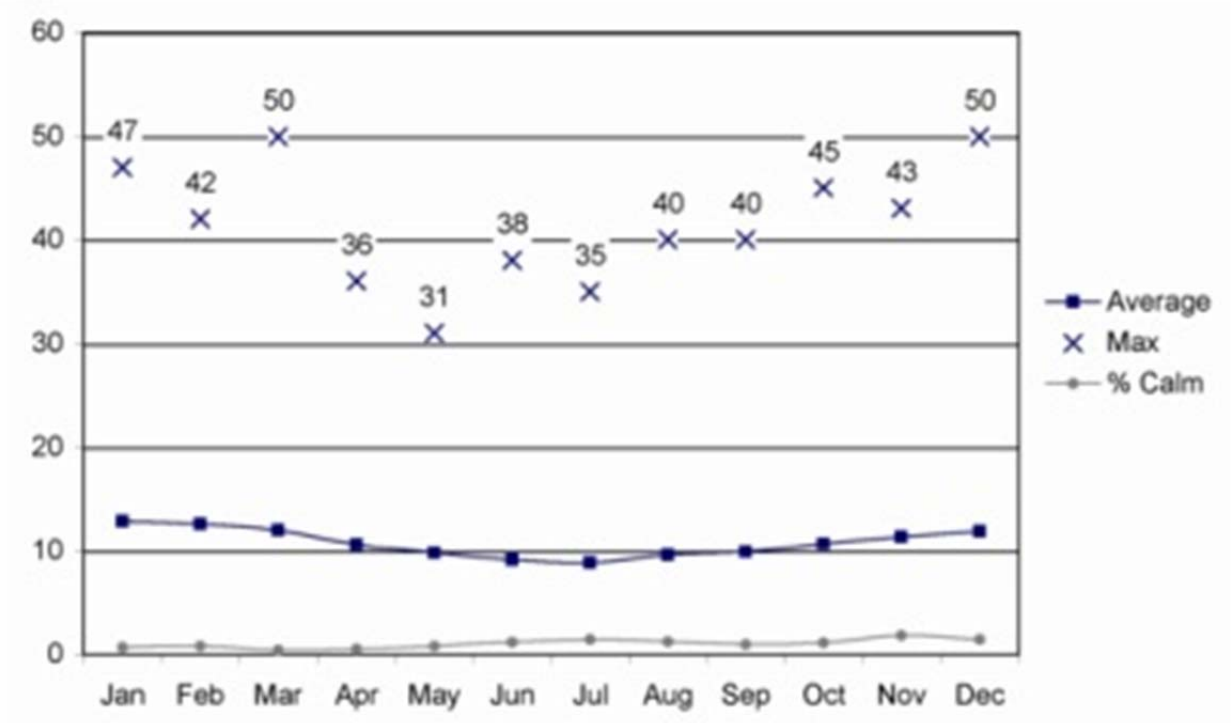
Figure 3 shows CTA Architects' plan of the proposed biomass facility at the Lomack Building and the surrounding buildings. Most of the buildings are approximately one to two stories tall. An addition is planned for the northern side of the building.

Figure 3: Overview of Lomack Building Building Site

METEOROLOGY

Meteorological data from Bethel, AK, was reviewed to develop an understanding of the weather conditions. As shown, there is a relatively low percentage of "calms" or times when the wind is not blowing.[1] This data indicates only 1% of the year when calm winds occur, which suggests there will be minimal time periods when thermal inversions and therefore poor emission dispersion conditions can occur.

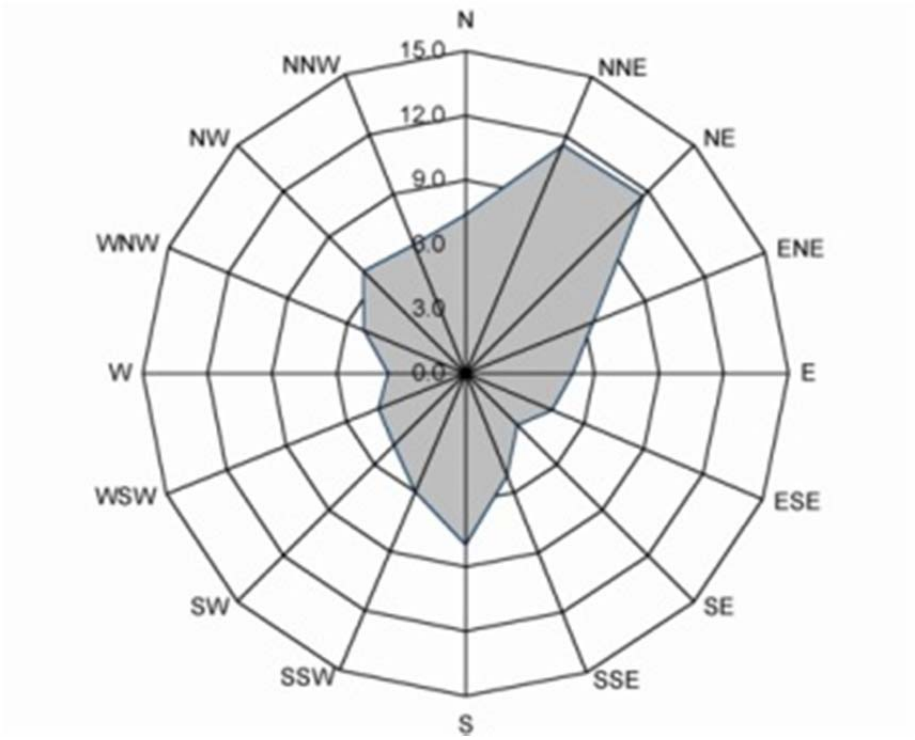
Figure 4: Wind Speed Data from Bethel, AK



[1] See: http://climate.gi.alaska.edu/Climate/Wind/Direction/Bethel/BET.html

Figure 5 is a wind rose developed from wind speed and direction data collected in Bethel.[1] This shows prevailing winds are from the northeast (NNE and NE), meaning, they frequently blow towards the southeast. Average wind speeds are up to 12 miles per hour in those directions. This suggests emissions would typically be blown towards the southeast.

Figure 5: Wind Rose Showing Wind Speed and Direction



[1] See: http://climate.gi.alaska.edu/Climate/Wind/Direction/Bethel/BET.html

DESIGN & OPERATION RECOMMENDATIONS

The following are suggested for designing this project:

- Burn natural wood, whose characteristics (moisture content, bark content, species, geometry) - result 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.

These design and operation recommendations are based on the assumption that state-of-the-art combustion equipment is installed.

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 three new wood boilers in Bethel, 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. We do not suggest advanced emission controls (ESP, baghouse) for the following reasons:

1. Bethel has favorable meteorology for dispersion of emissions.
2. The wood boilers will be relatively small emission sources.
3. There are no applicable federal or state emission limits.
4. The Bethel area is relatively rural with no significant emission sources.

Given the prevailing winds, we recommend wherever possible to construct boiler stacks on the south to southwest sides of buildings.

While not mandatory, we recommend exploring the possibility of a cyclone or multi-cyclone technology for control of fly ash and larger particulate emissions. 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