Minnesota Department of Natural Resources

MNDNR

Ely Government Services Center, St. Louis County

Biomass Energy System

Preliminary Feasibility Report

FINAL

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Table of Contents

1.0 EXECUTIVE SUMMARY

The Ely Government Services Center (GSC) contains St. Louis County offices including veterans' services, environmental services, and public health and human services. Because of the abundance of wood resources in the area, St. Louis County is investigating whether it is feasible to install a wood energy system to supply heat. A wood heating system utilizing pellets or cordwood has the potential to reduce fuel costs and greenhouse gas emissions for this facility, while utilizing a renewable, local fuel source.

The GSC was built in 1996, is approximately 7,440 square feet, and is currently heated with propane. Table ES1 summarizes the fossil fuel usage for the past 3 heating seasons (July-June).

Table ES1 – Fuel Usage Summary

Heating Year	Propane Deliveries (gal)	Cost	Unit Cost	HDD	Deviation from Average HDD	gal/HDD
2013-2014	2,108	$4,496	$2.13	11,655	11%	0.18
2014-2015	1,212	$2,173	$1.79	10,475	0%	0.12
2015-2016	1,305	$1,691	$1.30	9,247	-12%	0.14
Average	**1,542**	**$2,787**	**$1.74**	**10,459**		**0.15**

Note: Assumptions are listed in Table 4. The average unit cost for propane shown in this table is a 3-year average. Data for the first part of 2013 was also obtained (Table 1), and these deliveries were incorporated into a different 4-year average ($1.75/gal), which is what was used in the analysis.

Modern biomass combustion systems can efficiently and cleanly utilize a variety of fuels with a wide range of moisture content. Due to the variations in the potential fuels available in various locations, there are differing systems for each fuel type. The option evaluated in this report would require an estimated annual use of 9 tons of wood pellets. Table ES2 compares the cost of delivered heat for wood and fossil fuels.

Table ES2 – Fuel Pricing and Cost per mmBtu

Technology, Unit	Cost/Unit	Input mmBtu /Unit	Assumed Efficiency	Output mmBtu /Unit	Output Cost /mmBtu
Cordwood[1], cord	$210	22.0	65%	14.3	$14.69
Wood Pellet[2], ton	$206	16.4	80%	13.1	$15.70
Dry Wood Chip[3], ton	$80	12.0	75%	9.0	$8.89
Propane (4-yr avg.), gal	$1.75	0.091333	85%	0.0776	$22.49

Note 1: Cost is for hardwood. Equivalent cost is $131 per ton after wood has been seasoned to 20% moisture content wet basis.
Note 2: Wood pellets are 6-8% moisture content wet basis. Price includes delivery by auger truck.
Note 3: Dry wood chips are approximately 25-30% moisture wet basis. They are not commercially available in Ely. Cost for dry wood chips is estimated by WES as a fair market price.
Note 4: Table 4 contains the assumptions used to develop the above values.

Option 1 – Wood Pellet Boiler: One wood pellet hot water boiler, rated 68,000 Btu/hr, would be installed in a back room of the GSC. A 4-5 ton indoor pellet storage with an outdoor filling spout would be installed to provide automatic fuel feed to the boiler. A 50 gallon thermal storage tank(s) would also be installed with the boiler. The pellet boiler would tie into the facility's heating system in the existing central boiler room, and would offset approximately 95% of the fossil fuel used annually by the facility.

A proposed system fuel use profile is provided in Table ES3 showing the estimated annual fuel use compared to the existing propane system.

Table ES3 – Proposed System Fuel Use Profile

Option	Current Annual Fuel Use	Estimated Annual Fuel Use with Proposed Biomass System		
	Propane (gal)	Biomass Demand Coverage	Biomass Use (tons)	Propane Use with Biomass System (gal)
1 - Pellet Boiler	1,542	95%	9	77

Note: Table 4 contains the assumptions used to develop the above values.

Table ES4 provides a comparison of fuel costs and operating costs for the option.

Table ES4 – Fuel and Operating Cost Comparison

Option	Current Annual Fuel Cost	Estimated Annual Costs with Proposed Biomass System			Estimated First Year Operational Savings
	Propane Cost	Biomass Cost	Propane Cost	O&M Increase	
1 - Pellet Boiler	$2,692	$1,785	$135	$767	$5

Note: Table 4 contains the assumptions used to develop the above values.

A summary of the estimated capital costs and payback is provided in Table ES5. This table also evaluates the option with an assumed 25% grant. No specific grant funding opportunity has been identified. Detailed financial analyses were generated and are included in Appendix C.

Table ES5 – Cost and Payback Analysis

Option	Estimated Capital Cost	Assumed Grant Funding	Financed Amount	Simple Payback Period (years)[1]	Net Present Value (25 years)
1 - Pellet Boiler	$44,050	$0	$44,050	-	($35,398)
1 - Pellet Boiler w/ grant	$44,050	$11,013	$33,038	-	($24,385)

Note 1: All options have a simple payback period significantly longer than the estimated useful life of the equipment.

A modern biomass boiler system would allow the Ely GSC to reduce fossil fuel usage while utilizing a local and renewable source of energy. The option evaluated in this report would provide benefits to St. Louis County as summarized:

- Option 1 is a boiler system capable of utilizing wood pellets. This project would provide an annual operating cost savings of $5 based on the 4-year average price of propane, and would have a capital cost of $44,050.

Financial performance of the evaluated option is heavily dependent on the cost of fossil fuels and wood fuels, as shown by the sensitivity analysis in Appendix C. If the cost of fossil fuel rises, then the savings will increase fairly dramatically.

Additional benefits provided through the use of local biomass at the facility include:

- Net reduction of greenhouse gas emissions by 6.2 metric tonnes annually,
- Keeping $1,785 per year spent on energy within the region,
- Diversification of fuels used by fleet of St. Louis County buildings,
- Reduction in operating budget volatility due to wide fluctuations in fossil energy pricing,
- Creating markets for low-value woody biomass to enhance opportunities for forest management activities to reduce pests and disease, prevent fires, and manage for ecological diversity, soil health, and water quality.

Should St. Louis County be interested in pursuing a biomass option at the Ely GSC, WES recommends that staff visit modern biomass boiler installations to develop a detailed understanding of the equipment and its capabilities. The MN SWET is available to assist in arranging tours of existing facilities. As St. Louis County continues to pursue renewable biomass energy options, WES recommends that the next level of evaluation includes detailed consideration of the following items:

- Work with the MN SWET to identify alternative funding sources (low interest loans, grants, and incentives).
    - Thermal Production Incentive
    - Community Facilities Direct Loan & Grant Program
- Perform construction investigations (firewalls, ventilation) for the conversion of the storage room to a boiler room and further develop the biomass plant layout and capital cost based on investigation results.
- Evaluate the performance of the existing heating system to further inform wood boiler sizing, and to ensure that the heat distribution system is able to supply the necessary heat on the coldest days of the year.
- Continue to explore viable options for the wood pellet supply, discussing collaborative sourcing efforts with other local agencies, such as MN DNR (Tower) and the Ely Highway Garage.
- Network with regional planning agencies to encourage widespread community support for this renewable energy project.

2.0 INTRODUCTION

2.1 MN SWET PROGRAM

The Minnesota Statewide Wood Energy Team (MN SWET) is working to implement commercially available wood energy systems by strategically identifying businesses, government buildings and other institutions that are:

- Currently using propane or fuel oil for heating and do not have direct access to natural gas
- Located in an area of the state with sufficient wood resources and in need of forest market expansion and/or wildfire risk management
- Capable of meeting the space and operational requirements needed for contemporary wood heating systems, and
- Financially committed to thermal wood energy options.

Wilson Engineering Services, PC (WES) was contracted by the Minnesota Department of Natural Resources (MN DNR), on behalf of the MN SWET, to provide Intermediate Woody Biomass Thermal Energy feasibility assessments. The feasibility assessments provide a preliminary engineering and financial analysis for potential projects that are recommended by MN SWET after preliminary screening. The purpose of the feasibility assessments is to facilitate sound decision making by the facilities regarding the installation of wood energy systems. The feasibility assessments address key design parameter choices, such as fuel type (chips, pellets, and cord wood), layout, thermal storage needs, heat distribution, and estimated capital and operating costs.

2.2 ST. LOUIS COUNTY, ELY GOVERNMENT SERVICES CENTER OPPORTUNITY

The Ely Government Services Center (GSC) contains St. Louis County offices including veterans' services, environmental services, and public health and human services. The GSC, shown in Figure 1, was built in 1996, is approximately 7,440 square feet, and is currently heated with propane. Because of the abundance of wood resources in the area, St. Louis County is investigating whether it is feasible to install a wood energy system to supply heat. A wood heating system utilizing pellets or cordwood has the potential to reduce fuel costs and greenhouse gas emissions for this facility, while utilizing a renewable, local fuel source.

Figure 1 – Ely GSC Aerial Photo (Google Earth Pro)

3.0 FACILITY OVERVIEW

WES personnel conducted a site visit on June 21, 2016 in order to evaluate the existing systems and become familiar with the physical plant layout. GSC is a single story office building located in Ely, MN, with a footprint of 7,440 square feet (Figure 2). At the time of the site visit, the building was undergoing roof renovations to allow for the installation of a photovoltaic array.

Figure 2 – Ely GSC

A hydronic boiler supplies all of the heat to the building, via radiant floor loops. There are two air handlers located in a mechanical room on the other side of the building from the boiler room. Each air handler has an energy recovery ventilator (ERV) to temper the outdoor makeup air, and there are also electric grids in the duct system as backup. Cooling is provided by DX units in the air handlers.

The boiler, shown in Figure 3, is a Buderus Logamax Plus GB 142-60, with a rated input of 214.3 MBH, and a rated output of 190.1 MBH. This boiler does not have an outdoor reset temperature control. According to maintenance staff, the boiler is getting a little old, and is on the list for replacement. Potential replacement boilers include the Lochinvar Knight series because replacement parts are available in Duluth. Anecdotal information indicates that on cold days, the boiler can barely keep up with demand.

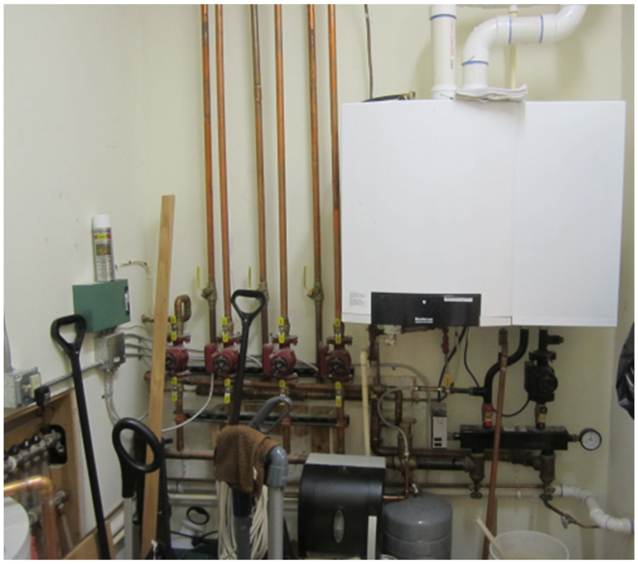


Figure 3 – Boiler and Hydronic Distribution

The system is filled with glycol, but the concentration is never checked. There are currently no hot water coils in the air handlers that would require glycol.

There is very little domestic hot water (DHW) use in the facility, only 3 hand sinks. Currently DHW is supplied by an electric water heater in the boiler room that is 50 gallons, has a maximum heating rate of 4,500 watts, and an energy factor of 0.92. Maintenance staff was interested in the idea of indirect hot water, given the perceived inefficiency of maintaining the 50 gallon tank at a constant temperature.

4.0 BUILDING HEAT DEMAND

GSC provided WES with propane fuel delivery data and weekly propane deliveries for the past 3 years. Table 1 lists the propane delivery amounts and costs. Figure 4 plots the cost per gallon data points listed in Table 1.

Table 1 – Propane Fuel Deliveries

Date	Delivery (gal)	Cost of Propane excl. tax[1]	Cost per gallon
1/18/2013	723	$1,170	$1.62
3/4/2013	800	$1,206	$1.51
10/23/2013	519	$837	$1.61
12/10/2013	479	$915	$1.91
1/16/2014	428	$1,032	$2.41
2/27/2014	467	$1,294	$2.77
5/29/2014	217	$418	$1.93
11/24/2014	327	$561	$1.72
12/30/2014	359	$653	$1.82
1/20/2015	200	$367	$1.83
2/25/2015	326	$592	$1.82
8/6/2015	300	$366	$1.22
12/15/2015	345	$455	$1.32
1/26/2016	350	$461	$1.32
3/15/2016	310	$409	$1.32
	6,148	**$10,735**	**$1.75**

Note 1: Recent legislation has exempted county governments from state sales tax. In order to provide comparable data, the fuel costs shown do not include sales tax even if it was paid on certain deliveries.

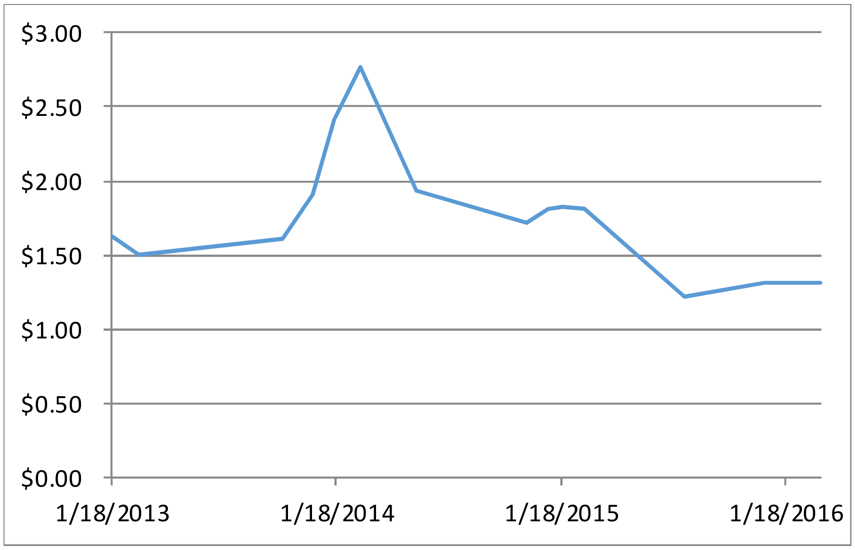


Figure 4 – Propane Historical Unit Prices per Gallon

Table 2 summarizes the propane usage for the past 3 heating seasons (July – June).

Table 2 – Fuel Usage Summary

Heating Year	Propane Deliveries (gal)	Cost	Unit Cost	HDD	Deviation from Average HDD	gal/HDD
2013-2014	2,108	$4,496	$2.13	11,655	11%	0.18
2014-2015	1,212	$2,173	$1.79	10,475	0%	0.12
2015-2016	1,305	$1,691	$1.30	9,247	-12%	0.14
Average	**1,542**	**$2,787**	**$1.74**	**10,459**		**0.15**

Note: Assumptions are listed in Table 4. The average unit cost for propane shown in this table is a 3-year average. Data for the first part of 2013 was also obtained (Table 1), and these deliveries were incorporated into a different 4-year average ($1.75/gal), which is what was used in the analysis.

Daily mean temperature weather data from Ely Municipal Airport were obtained for the time period encompassed by the fuel usage data. Daily temperatures are used to calculate the heating degree days for each day of the year, which are then used to proportionally distribute the annual fuel usage totals.

Figure 5 shows modeled daily average heat demand for the past 3 heating seasons (July-June). These models are based on the weekly tank level measurements, and use a HDD base temperature of 60°F.

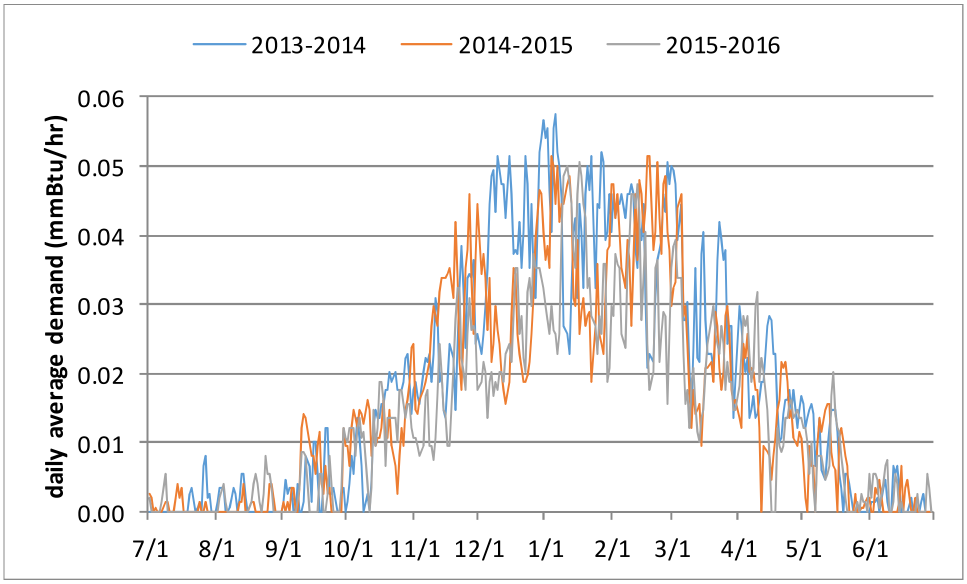


Figure 5 – Daily Average Demand for the Past 3 Heating Seasons

Note: Assumptions regarding system efficiencies are listed in Table 4. Values shown are daily average demands. During the course of a 24-hr period, it is anticipated that the hourly demand would fluctuate both above and below the values shown.

Figure 6 presents load duration curves (LDC) for these same years. These charts are sorted to present the daily heating loads in order from largest to smallest, not the order in which they actually occurred in time. It is important to note how these curves can be used appropriately. The curves shown in Figure 6 present the daily average demand. Over the course of a 24 hour period the loads at each facility will vary above and below the daily averages. Thus, the load curves are useful for sizing a biomass boiler to ensure it will run efficiently and cover significant portions of the system demand, but they do not indicate the peak or minimum demands.

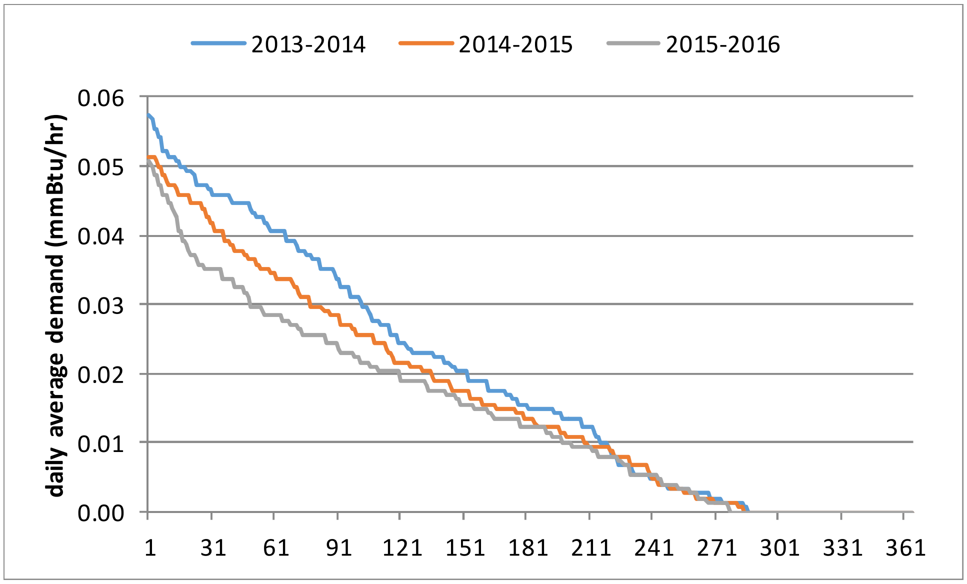


Figure 6 – Load Duration Curves

Note: Assumptions regarding system efficiencies are listed in Table 4. Values shown are daily average demands. During the course of a 24-hr period, it is anticipated that the hourly demand would fluctuate both above and below the values shown.

From Figure 6, it is apparent that the coldest day's average heat demand is approximately 0.06 mmBtu/hr (60,000 Btu/hr). Using the models and values previously discussed, WES estimates that the peak hourly demand for the facility is approximately 120,000 Btu/hr. It is important to remember that peak demands are only seen for an hour or two in a specific 24-hr period, on the coldest days of the year. The modeled peak hourly demand for this facility does not exactly agree with the information received from staff indicating that the boiler cannot keep up with the load on the coldest days of the year. However, another explanation for this is that it is possibly the radiant floor heat distribution system which cannot keep up with the demand, rather than the boiler. Prior to final sizing of a new boiler, system performance should be evaluated in the winter to determine the limiting factor of the existing system.

Metered domestic hot water usage data is not available. Estimated hot water usage for this office facility is 1 gallon per occupant per day, based on 20 occupants. This would use approximately 1,598 kWh per year ($160). Standby losses from the electric water heater can be estimated using the nameplate energy factor of 0.92, and the Energy Guide label indicating a nominal annual usage of 4,773 kWh, resulting in annual loss of 382 kWh ($38), in addition to the amount of energy used to heat the consumed water. Based on these figures, conversion of the electric hot water to indirect hot water using propane or wood is not appropriate.

5.0 BIOMASS AVAILABILITY AND PRICE

Modern biomass combustion systems can efficiently and cleanly utilize a variety of fuels with a wide range of moisture content. Due to the variations in the potential fuels available in various locations, there are differing systems for each fuel type. Wood pellet systems are commonly limited to firing on pelletized fuel or dry wood chips with allowable moisture content (wet basis) typically in the range of 5-30%. Systems capable of utilizing green wood chips are typically designed for fuel with a moisture content of 20-50%. Some manufacturers offer equipment able to utilize pellets or green chips, although the control parameters and system options may need to be adjusted when targeting one of these fuels in order to maintain efficiency. Cordwood systems are typically designed to use cordwood with a moisture content of approximately 20% wet basis, which is what can be achieved by air drying. Some cordwood systems are able to also use wood pellets following a manual adjustment of the grates.

The option evaluated in this report would require an estimated annual use of 9 tons of wood pellets.

Table 3 compares the cost of delivered heat for wood and fossil fuel (propane). The propane cost shown is the average of the past 4 years.

Table 3 – Fuel Pricing and Cost per mmBtu

Technology, Unit	Cost/Unit	Input mmBtu /Unit	Assumed Efficiency	Output mmBtu /Unit	Output Cost /mmBtu
Cordwood[1], cord	$210	22.0	65%	14.3	$14.69
Wood Pellet[2], ton	$206	16.4	80%	13.1	$15.70
Dry Wood Chip[3], ton	$80	12.0	75%	9.0	$8.89
Propane (4-yr avg.), gal	$1.75	0.091333	85%	0.0776	$22.49

Note 1: Cost is for hardwood. Equivalent cost is $131 per ton after wood has been seasoned to 20% moisture content wet basis.
Note 2: Wood pellets are 6-8% moisture content wet basis. Price includes delivery by auger truck.
Note 3: Dry wood chips are approximately 25-30% moisture wet basis. They are not commercially available in Ely. Cost for dry wood chips is estimated by WES as a fair market price.
Note 4: Table 4 contains the assumptions used to develop the above values.

5.1 PELLETS

Wood pellets are typically delivered in bulk loads of 10-30 tons. Wood pellets can be delivered in a variety of ways, depending on the storage system at the facility, and the capabilities of local truckers. Options include:

- End dump tractor trailer
- Walking floor tractor trailer
- Grain truck or trailer with auger
- Grain truck with pneumatic hose discharge (not available in MN)
- Mulch blower truck (nearest is in Minneapolis)

Delivery by grain truck is often the most convenient, because the pellets can be discharged directly into the top of a silo. Auger trucks in this region generally have a maximum height capability of 24'. Deliveries by a pneumatic delivery truck would involve the driver attaching a hose to a tube near the base of the silo. This tube would be permanently attached to the silo and would run up to the top to discharge the pellets. The higher cost and/or lower capacity of grain trucks can make walking floor or end dump delivery slightly cheaper. These methods would require a conveyor system to carry the pellets up to the top of the silo. Due to space constraints at the facility, end dump and walking floor deliveries are not appropriate. Wood pellets would be stored in a silo and conveyed to the pellet boilers automatically via a flexible auger.

Because the expected annual pellet usage is only 9 tons, indoor storage of pellets is an option for reducing capital costs. Indoor storage could be sized to hold 0.5-9 tons of pellets. Delivery of less-than-truckload volumes of pellets could greatly increase fuel costs, however. One option to mitigate this would be to combine bulk deliveries with another local facility using wood pellets, such as the DNR office in Tower, or the St. Louis County Highway Garage in Ely (project under consideration). In this case, the delivery truck would first deliver approximately 4 tons to the GSC, and then deliver the balance of the load to Tower or the Ely Highway Garage.

The nearest wood pellet plant that could supply the Ely GSC is Great Lakes Renewable Energy, located in Hayward, WI. Bulk pricing at the gate is approximately $170/ton, and trucking costs are in the range of $4-$5 per loaded mile, depending on the delivery vehicle. Assuming an auger truck will be used, a delivery cost of $5 per loaded mile is reflected in the pellet cost shown in Table 3.

5.2 CORDWOOD AND WOOD CHIPS

The energy cost of cordwood is very similar to that of pellets shown in Table 3. A cordwood system requires significantly more labor than a pellet system because wood must be loaded 2-3 times per day. Therefore, the labor cost component of a cordwood system makes such a system impractical for this facility.

Dried or partially dried chips are able to be used in many commercial pellet boilers, and represent a lower-cost fuel compared to wood pellets. Compared to the 2” whole tree chips being produced by in-woods chippers, these chips must be sized less than 1.5” and oversize pieces must be removed. These chips can be commercially produced by screening chips and then drying chips using a rotary dryer heated by a wood chip furnace. In some cases, facility owners themselves produce dry chips from dry residuals and use them in their own boilers. Rather than using a dryer, 30% moisture or less can be achieved if logs are air dried for a year prior to being chipped. There is the potential that a local logging or tree service company could be willing to stage logs and chip them, however, no potential suppliers have been identified at this time. A chip system would require a building for bulk storage of the chips, and a method of loading chips into a daybin, such as with a skidsteer loader. Based on the size and propane usage of this facility, a chip system is not appropriate due to the extra capital costs compared to a pellet system.

6.0 EVALUATED BIOMASS SYSTEMS

One biomass fueled hot water boiler system is evaluated for the Ely GSC. The biomass system option was sized and evaluated using the analysis in Section 4. The option includes the following equipment:

> **Option 1 – Wood Pellet Boiler:** One wood pellet hot water boiler, rated 68,000 Btu/hr, would be installed in a back room of the GSC. A 4-5 ton indoor pellet storage with an outdoor filling spout would be installed to provide automatic fuel feed to the boiler. A 50 gallon thermal storage tank would also be installed with the boiler. The pellet boiler would tie into the building’s heating system in the existing central boiler room.

6.1 OPTION 1 – WOOD PELLET BOILER SYSTEM

This option would install a 68,000 Btu/hr pellet boiler and a 50 gallon thermal storage tank in the storage room at the southeast corner of the building. The existing propane boiler would remain in place for backup and peaking. Pellet fuel would be stored in a 9’x9’x6’ fabric bin in the same room as the pellet boiler with an auger to feed the boiler. The storage bin would hold 4-5 tons of pellets, so it would have to be filled 2 to 3 times per year. Figure 7 shows an example indoor fabric pellet storage hopper.

The indoor pellet hopper could be filled via a chute passing through the wall. This would allow an auger truck to easily fill the bin in a matter of minutes. As mentioned previously, an auger truck would carry far more pellets than could be accommodated in this bin, and so deliveries would have to be coordinated with other nearby pellet users in order to share trucking costs.

An alternative to a fabric bin would be a wood-framed storage silo built into the room. This type of pellet store would be the size of a closet and would have a sloping plywood floor leading to a pellet collector which could either be a vacuum hose or a flexible auger. The built in pellet store would offer a more efficient use of space compared to a fabric bin, and if positioned along the outside wall, would make it easier to integrate the filling chute compared to a fabric bin. The cost of a built-in pellet store could be equal to or slightly less than a fabric bin.

Figure 7 – Indoor Pellet Storage

Appendix A includes a site plan and schematic for the system.

Wood pellet fueled biomass boilers operate most efficiently between 20% and 100% of their rated heating output. The pellet boiler would have an efficient operating range of 13,600 Btu/hr to 68,000 Btu/hr. However, the pellet boiler would include an automatic ignition system to allow it to turn on and off during times of light load (below 13,600 Btu/hr). For this reason, Figure 8 shows the pellet boiler covering 100% of the 2014-2015 load.

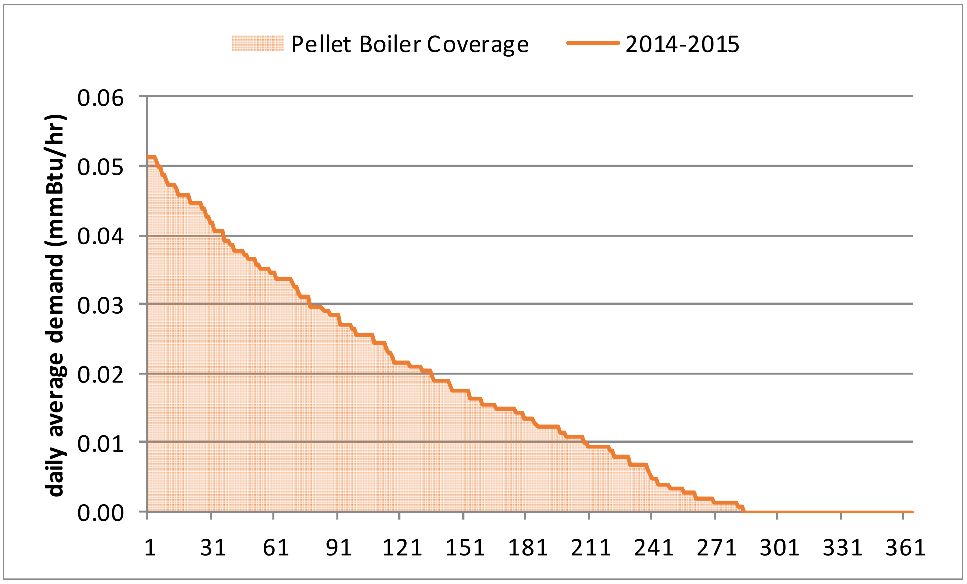


Figure 8 – 2014-2015 LDC and Coverage of Pellet Boiler

Note: Assumptions regarding system efficiencies are listed in Table 4. Values shown are daily average demands. During the course of a 24-hr period, it is anticipated that the hourly demand would fluctuate both above and below the values shown.

A value of 95% coverage of the load by the pellet boiler is estimated for the economic analysis in an average year. Exact sizing of the boiler would depend on the vendor selected, and their product offerings. A pellet boiler in the range of 60,000-100,000 Btu/hr would be in the appropriate range for this facility.

7.0 GRANTS AND INCENTIVES

7.1 BIOMASS THERMAL PRODUCTION INCENTIVE

Minnesota Statutes 2015, section 41A.18, and Minnesota Session Laws 2016, chapter 189, article 2, section 21 provide for a "biomass thermal production incentive" which pays eligible facilities $5 for each mmBtu of heat supplied to a building or process using biomass fuel. Specific sustainable harvesting and sourcing requirements have to be met. For facilities within 50 miles of the state border (this includes Ely), the material must be sourced from within Minnesota, or within a 100 mile radius of the facility, including areas outside Minnesota.

In order to be eligible, a facility must install a biomass boiler or other similar device after July 1, 2015, and this system must deliver no less than 250 mmBtu to the facility during one single calendar quarter. For a period of 10 years after qualification, the facility owner can receive $5 per mmBtu of thermal output for calendar quarters in which thermal production exceeds 250 mmBtu.

Based on assumptions in Table 4, 250 mmBtu of thermal output is approximately equal to using 3,220 gallons of propane or 19 tons of pellets. Based on this threshold, it is unlikely that the GSC could qualify for this incentive unless it was allowed by the Minnesota Department of Agriculture to aggregate its renewable thermal production with other county facilities. However, the wording of the statute appears to exclude the possibility of aggregation. For the purposes of this study, it is assumed that the GSC will not qualify for this incentive.

7.2 COMMUNITY FACILITIES DIRECT LOAN AND GRANT

The program, administered by the USDA, provides funding in the form of loans and grants to develop community facilities in rural communities. The program is open to public bodies, and community-based nonprofit corporations. The program is primarily geared towards loans, which can have terms of up to 40 years. Grant funding awards are determined with preference for smaller communities with lower household income relative to state medians.

8.0 BIOMASS SYSTEM ANALYSIS

Table 4 lists the values and assumptions used in the analysis.

Table 4 – Values and Assumptions

Assumption	Value	Unit	Source
Propane HHV	0.091333	mmBtu/gal	WES Assumption
Price of Propane (4-yr avg)	$1.75	$/ gal	St. Louis County
Propane Boiler Seasonal Efficiency	85%	percent	WES Assumption
Wood Pellet HHV	16.4	mmBtu/ton	WES Assumption
Wood Pellet Cost	$206	$/ton	WES Assumption
Wood Pellet Boiler Efficiency	80%	Percent	WES Assumption
Pellet Density	40	lb/ft^3	WES Assumption
HDD Base Temp	60	˚F	WES Assumption
Electric Cost	$0.10	$/kWh	St. Louis County
Labor Cost (at Facility)	$30	$/hr	WES Assumption
CO_2 emitted during combustion of Propane	62.87	kg/mmBtu	EPA
CH_4 emitted during combustion of Propane	0.003	kg/mmBtu	EPA
N_2O emitted during combustion of Propane	0.0006	kg/mmBtu	EPA
CO_2 emitted due to use of Electricity (includes line losses)	3.32	kg/kWh	EPA
CH_4 emitted due to use of Electricity (includes line losses)	6.44E-05	kg/kWh	EPA
N_2O emitted due to use of Electricity (includes line losses)	5.66E-05	kg/kWh	EPA
CH_4 100-year Global Warming Potential	25	* CO2	IPCC
N_2O 100-year Global Warming Potential	298	* CO2	IPCC

8.1 CAPITAL COST ESTIMATES AND OPERATING COST SAVINGS

The estimated capital cost for the biomass option is listed in Table 5.

Table 5 – Capital Cost Estimate

Option	Estimated Capital Cost
1 - Pellet Boiler	$44,050

Installed costs for the new system include the pellet boiler, pellet storage, controls, stack, and piping connection to the existing boiler room. A detailed breakdown of capital costs is provided in Appendix B.

Table 6 gives a breakdown of estimated operating and maintenance costs. During the heating season, the pellet boiler is estimated to require an average of 1 hour every 2 weeks for cleaning and ash removal.

Table 6 – Estimated Operating and Maintenance Costs

Option	Electric Usage	Maintenance / Wear Parts	Staff Time	Total O&M Cost
1 - Pellet Boiler	$67	$100	$600	**$767**

Note: No cost is included for ash disposal as this is a valuable soil amendment.

A proposed system fuel use profile is provided in Table 7 showing the estimated annual fuel use compared to the existing fossil fuel system.

Table 7 – Proposed System Fuel Use Profile

Option	Current Annual Fuel Use	Estimated Annual Fuel Use with Proposed Biomass System		
	Propane (gal)	Biomass Demand Coverage	Biomass Use (tons)	Propane Use with Biomass System (gal)
1 - Pellet Boiler	1,542	95%	9	77

Note: Table 4 contains the assumptions used to develop the above values.

Table 8 provides a comparison of fuel costs and operating costs.

Table 8 – Fuel and Operating Cost Comparison

Option	Current Annual Fuel Use	Estimated Annual Costs with Proposed Biomass System			Estimated First Year Operational Savings
	Propane Cost	Biomass Cost	Propane Cost	O&M Increase	
1 - Pellet Boiler	$2,692	$1,785	$135	$767	$5

Note: Table 4 contains the assumptions used to develop the above values.

A summary of the estimated capital costs and payback is provided in Table 9. This table also evaluates the option with an assumed 25% grant. No specific grant funding opportunity has been identified.

Table 9 – Cost and Payback Analysis

Option	Estimated Capital Cost	Assumed Grant Funding	Financed Amount	Simple Payback Period (years)[1]	Net Present Value (25 years)
1 - Pellet Boiler	$44,050	$0	$44,050	-	($35,398)
1 - Pellet Boiler w/ grant	$44,050	$11,013	$33,038	-	($24,385)

Note 1: All options have a simple payback period significantly longer than the estimated useful life of the equipment.

Detailed financial analyses were generated and are included in Appendix C.

9.0 EMISSIONS, PERMITTING, AND LICENSING

9.1 PARTICULATE MATTER EMISSIONS

All fuel combustion equipment emits some level of particulate matter from the combustion process. For all fossil fuels and renewable fuels, properly tuned systems are critical to ensure optimal conversion efficiencies and minimal emissions. Modern biomass boilers utilize oxygen sensors and variable speed drives to optimize the combustion process with the proper air/fuel mixture. This results in high combustion efficiencies and low emissions, and this section compares particulate matter emission rates for various fuels and equipment.

Note that in this section, the term lb/mmBtu refers to pounds of a certain pollutant emitted in the flue gas per million Btu of fuel (HHV) input. Based on the assumed efficiencies in Table 4, the wood pellet boiler proposed would have a maximum fuel input rate of 0.085 mmBtu/hr.

Minnesota Administrative Rules section 7011.0550 Table II sets the maximum particulate emissions from a boiler at 0.4 lb/mmBtu. This emission requirement can be met by modern wood boilers. Visually, the flue gas of a modern wood boiler would exhibit no opacity.

The EPA publishes emissions factors for a wide range of fuel burning devices in its publication AP-42. Table 10 presents these emissions factors along with the expected emissions factors for wood boilers based on stack test data obtained by WES.

Table 10 – Emissions Factors for PM

Fuel and Source	PM Emissions	Unit
Residential Fireplace[1]	2.01	lb/mmBtu
Residential Wood Stove[2]	1.12	lb/mmBtu
Wood Chip Boiler[3]	0.08 – 0.15	lb/mmBtu
Wood Pellet Boiler[3]	0.05 – 0.15	lb/mmBtu
#2 Fuel Oil Boiler[4]	0.014	lb/mmBtu
Propane Boiler[5]	0.008	lb/mmBtu

Note 1: EPA AP-42, PM10 value is 34.6 lb/dry ton, conversion based on 17.2 mmBtu/dry ton
Note 2: EPA AP-42, EPA Phase II noncatalytic, PM10 value is 14.6 lb/ton, conversion based on 13.0 mmBtu/ton
Note 3: Values are representative of independent lab testing of boilers comparable to the one in the proposed option
Note 4: EPA AP-42, boiler < 100 mmBtu/hr
Note 5: EPA AP-42

9.2 GASEOUS EMISSIONS

Besides PM, other pollutants from fuel combustion include VOC, NO_X (NO and NO_2), SO_X, and CO. Ozone (O_3) is a byproduct of NO_X and VOC emissions. Table 11 presents emissions factors for the gaseous pollutants mentioned.

Table 11 – Emissions Factors for Gaseous Pollutants

Fuel and Source	Emission Factors (lbs/mmBtu)			
	VOC	NOx	SOx	CO
Wood Pellet Boiler[1]	0.004	0.140	0.001	0.150
Wood Chip Boiler[1]	0.004	0.180	0.002	0.150
#2 Fuel Oil Boiler[2]	0.004	0.144	0.207	0.036
Propane Boiler[3]	0.005	0.142	0.0002	0.082
Natural Gas Boiler[4]	0.005	0.098	0.0001	0.082

Note 1: Wood chip and wood pellet values are obtained from stack test results.
Note 2: Oil factors are taken from AP-42 for boilers <100 mmBtu/hr, using values of 0.2% sulfur and HHV of 0.139 mmBtu/gal
Note 3: Propane factors are taken from AP-42, S content of 0.2 g/100ft^3
Note 4: Natural gas values taken from AP-42 for boilers <100 mmBtu/hr, and EIA listed values from IPCC for Industry

Based on this table, a wood boiler would be comparable to a propane boiler in terms of VOC and NO_X. The elevated level of SO_X is due to naturally occurring sulfur in the wood, and can vary regionally. While SO_X emissions for a wood boiler are an order of magnitude larger than for propane, they are two orders of magnitude smaller than for #2 fuel oil.

9.3 Greenhouse Gas Emissions Benefits

By displacing fossil fuel used for heating (propane), installation of a pellet boiler system would result in reduction of GSC's annual net CO_2 equivalent greenhouse gas emissions by up to 6.2 metric tonnes, as shown in Table 12. Although combustion of wood releases CO_2, the use of wood fuel provides net carbon benefit as long as the fuel is sourced in a sustainable manner. CO_2 equivalent values presented in this report include CO_2, as well as CH_4 and N_2O adjusted for their 100-year global warming potential relative to CO_2. These values are listed in Table 4.

Table 12 – Greenhouse Gas Emission (CO_2 equivalent) Reductions

Option	Current System	With Proposed Biomass System			Reduction in CO_2 Equivalent Emissions (tonnes)
	Propane CO_2 Equivalent Emissions (tonnes)	Biomass CO_2 Equivalent Emissions (tonnes)	Biomass Boiler Electric CO_2 Equivalent Emissions1 (tonnes)	Propane CO_2 Equivalent Emissions (tonnes)	
1 - Pellet Boiler	8.9	0.0	2.2	0.4	6.2

Note 1: Biomass boilers use more electricity than comparable gas boilers due to fuel handling equipment, larger blowers, etc. Table 4 contains the assumptions used to develop the above values.

9.4 Air Permitting

Boilers in Minnesota can be subject to both state and federal emissions and permitting requirements. Using EPA AP-42 factors for wood and propane boilers, the PTE (potential to emit) of the Ely GSC, with the addition of a pellet boiler, would not exceed the state or federal emissions thresholds for air pollutants. The PTE of a facility also includes non-combustion emissions sources such as VOCs and dust. WES estimates that there are no significant emissions sources at this facility that would affect the permitting status other than the boilers. Additionally, GSC would not be subject to any NSPS (New Source Performance Standards). Based on these calculations and assumptions, the addition of a wood boiler system as described would not trigger any state or federal permitting requirements.

9.5 ASH

Whole tree wood chips generally contain about 3% ash by weight, while wood pellets contain 0.5-1.0% ash by weight. Modern chip and pellet boilers have automated or semi-automated ash handling systems which deposit ashes in a drawer or portable metal container. The pellet boiler option described in this report has the potential to generate about 100 lbs. of ash per year.

Wood ash is a valuable soil amendment which has properties similar to lime. Studies have shown that land application of wood ash can improve forest health[1]. Wood ash is classified and regulated as a solid waste in Minnesota. However, the MPCA has a process whereby it will make a case-specific beneficial use determination (CSBUD) to decide whether a specific management option for the solid waste is a beneficial use. Because wood ash is known to have valuable properties when used as a soil amendment, the MPCA has made determinations for several other facilities with biomass boilers that ashes can be spread on land, and therefore it is likely that permission will be granted in future cases. Prior to implementation of a biomass project, a proposal should be submitted to the MPCA in order to gain permission for this use of the wood ash.

Beneficial use of the ash is anticipated to be significantly cheaper than landfilling, and for the purposes of this study, it is assumed that the ash can be used beneficially at no cost to the facility. In the Ely area, use of ash will primarily be on timber harvest sites, rather than on agricultural land. The Carlton County Extension Office can assist with finding beneficial use sites, and applying for a CSBUD. Additional information on ash use from UMN Extension is provided in Appendix D.

9.6 BOILER OPERATOR REQUIREMENTS

Minnesota Administrative Rules section 5225.1110 requires all boilers be operated, maintained, and attended by a licensed operating engineer, unless specifically exempted. Minnesota Statutes section 326B.988 exempts hot water heating boilers that do not exceed a combined heat input capacity of 750,000 Btu per hour. With the addition of a pellet boiler, the aggregate heating capacity of the GSC would fall under this threshold, and thus, there would be no new attendance or operator requirements for this facility.

10.0 CONCLUSIONS AND RECOMMENDATIONS

A modern biomass boiler system would allow the Ely GSC to reduce fossil fuel usage while utilizing a local and renewable source of energy. The option evaluated in this report would provide benefits to St. Louis County as summarized:

- Option 1 is a boiler system capable of utilizing wood pellets. This project would provide an annual operating cost savings of $5 based on the 4-year average price of propane, and would have a capital cost of $44,050.

Financial performance of the evaluated option is heavily dependent on the cost of fossil fuels and wood fuels, as shown by the sensitivity analysis in Appendix C. If the cost of fossil fuel rises, then the savings will increase fairly dramatically.

[1] https://www.forestry.umn.edu/sites/forestry.umn.edu/files/Staffpaper153.PDF

Additional benefits provided through the use of local biomass at the facility include:

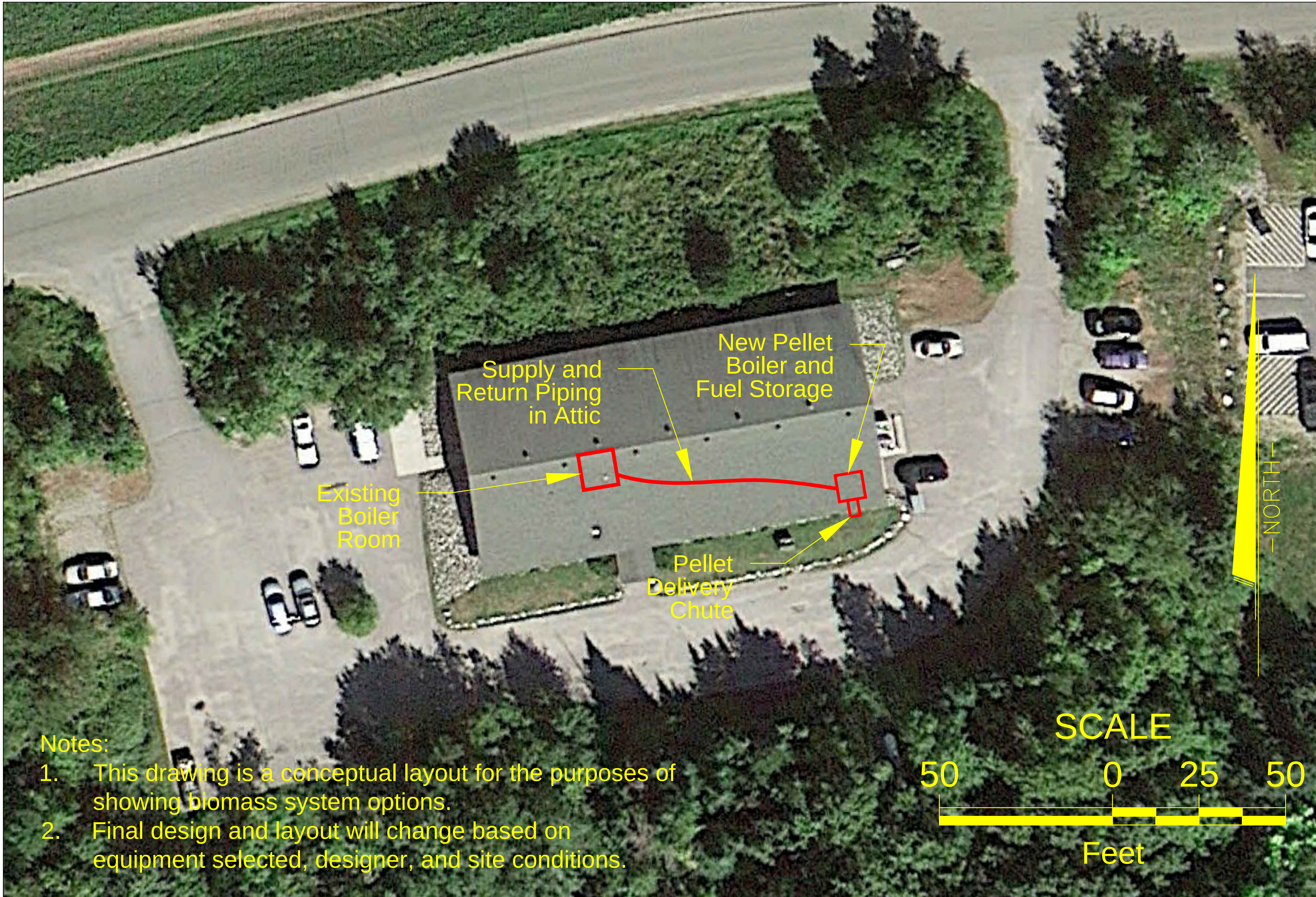
- Net reduction of greenhouse gas emissions by 6.2 metric tonnes annually,
- Keeping $1,785 per year spent on energy within the region,
- Diversification of fuels used by fleet of St. Louis County buildings,
- Reduction in operating budget volatility due to wide fluctuations in fossil energy pricing,
- Creating markets for low-value woody biomass to enhance opportunities for forest management activities to reduce pests and disease, prevent fires, and manage for ecological diversity, soil health, and water quality.

Should St. Louis County be interested in pursuing a biomass option at the Ely GSC, WES recommends that staff visit modern biomass boiler installations to develop a detailed understanding of the equipment and its capabilities. The MN SWET is available to assist in arranging tours of existing facilities. As St. Louis County continues to pursue renewable biomass energy options, WES recommends that the next level of evaluation includes detailed consideration of the following items:

- Work with the MN SWET to identify alternative funding sources (low interest loans, grants, and incentives).
    - Thermal Production Incentive
    - Community Facilities Direct Loan & Grant Program
- Perform construction investigations (firewalls, ventilation) for the conversion of the storage room to a boiler room and further develop the biomass plant layout and capital cost based on investigation results.
- Evaluate the performance of the existing heating system to further inform wood boiler sizing, and to ensure that the heat distribution system is able to supply the necessary heat on the coldest days of the year.
- Continue to explore viable options for the wood pellet supply, discussing collaborative sourcing efforts with other local agencies, such as MN DNR (Tower) and the Ely Highway Garage.
- Network with regional planning agencies to encourage widespread community support for this renewable energy project.

Appendix A – Drawings

- A.1 Site Plan
- A.2 Pellet Boiler Connection Schematic



Notes:

1. This drawing is a conceptual layout for the purposes of showing biomass system options.
2. Final design and layout will change based on equipment selected, designer, and site conditions.

Designed	PFO	11/17/16
Drawn	PFO	11/17/16
Checked	SFK	11/21/16

Approved ____ Date ____

Title ____ Job Class ____

St. Louis County Government Services Center

Ely, MN

Pellet Boiler Site Plan

WES

Wilson Engineering Services, PC

www.wilsonengineeringservices.com

902 Market St. Meadville, PA 16335

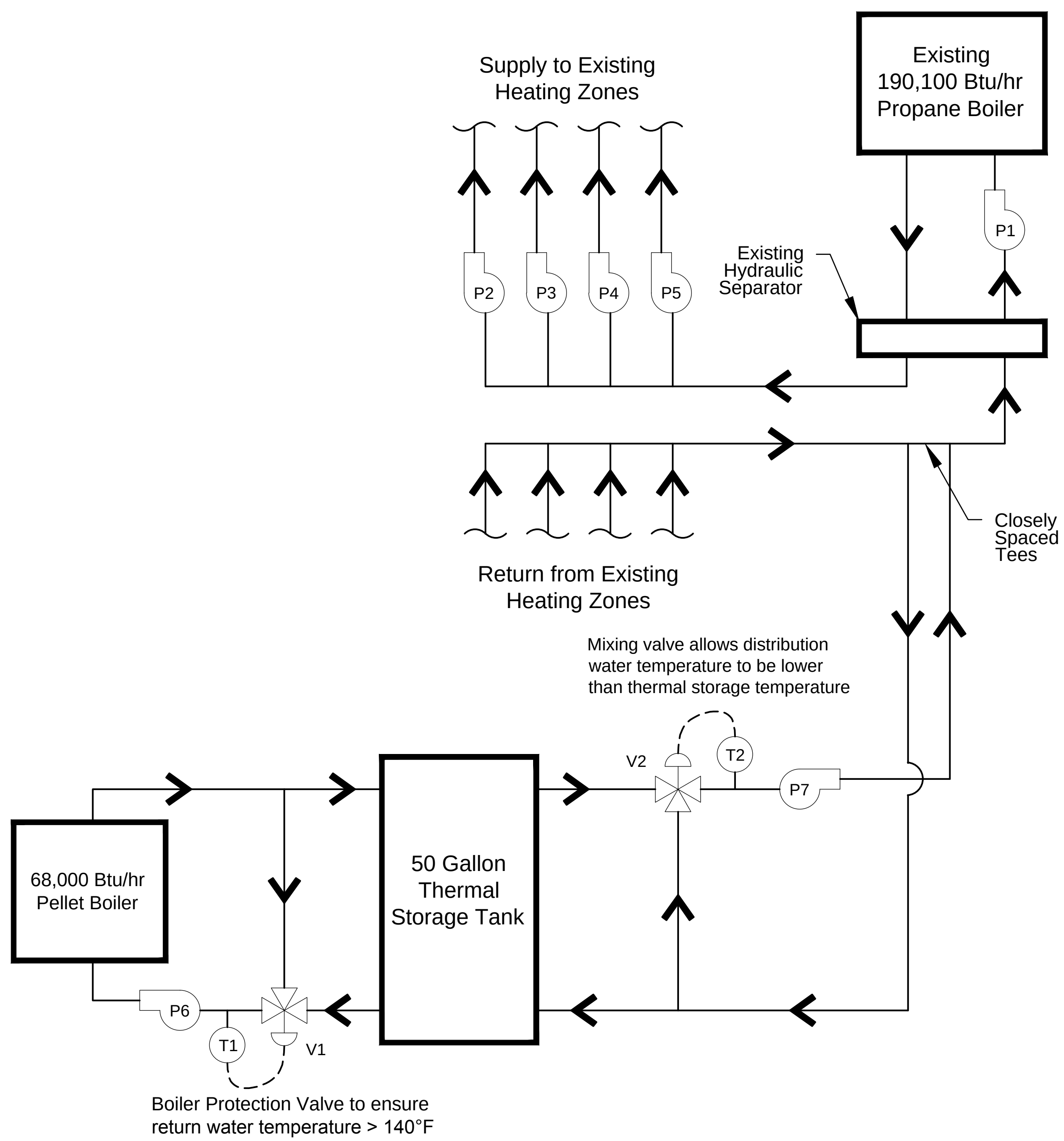
REVISIONS

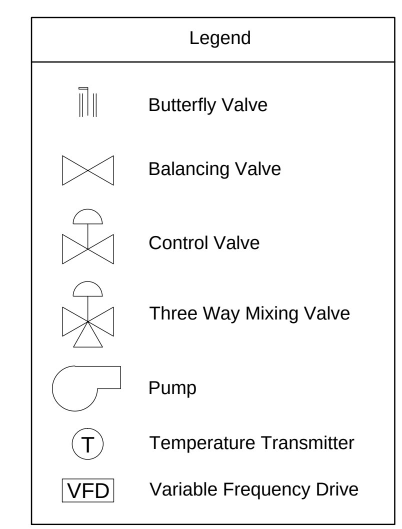
Date	Description	Approved

A.1

Sequence of Operations:

1. T1 controls mixing valve V1 which allows supply water from the pellet boiler to bypass the thermal storage, in order to maintain a return water temperature of at least 140°F to prevent flue gas condensation. This is mainly a concern during boiler startup and at times of heavy load.
2. The pellet boiler will be controlled to maintain 195°F in the thermal storage tank.
3. P7 injects hot water into the building loop, ahead of where the existing gas boiler ties in. T2 controls the temperature of the water after the injection point by modulating the position of V2 to blend hot water from the thermal storage tank with cooler return water from the building loop. The temperature set point for T2 is based on an outside reset schedule.
4. If T2 falls 5°F below the set point for 5 minutes, then the existing gas boiler will be enabled. The gas boiler will fire to maintain the building loop temperature as it is currently configured to do. When T2 reaches set point, the gas boiler will be disabled.





Notes:

1. This drawing is a conceptual layout for the purposes of showing biomass system options.
2. Final design and layout will change based on equipment selected, designer, and site conditions.

Pellet Boiler Connection Schematic

Appendix B – Capital Cost Estimates

- B.1 Option 1 – Pellet Boiler System

Option 1 - Pellet Boiler Capital Cost Estimate

Biomass Boiler Manufacturer Contract[1]

Line Item		Cost
68,000 Btu/hr pellet boiler, controls, ASME rated		$ 15,000
50 gallon thermal storage tank		$ 1,000
5 ton indoor pellet hopper		$ 3,000
Total Boiler Manufacturer Contract		**$ 19,000**

General Contract

Line Item		Cost
Pellet loading chute		$ 1,000
Stack		$ 2,000
Conversion of storage room to boiler room		$ 1,000
Pumps, valves, and connection to existing boiler room		$ 10,000
Sub-Total		$ 14,000
Contractor profit, overhead, and insurance	*16%*	*$ 2,240*
Total General Contract Building and Site[2]		**$ 16,240**

Total Project Cost

Line Item		Cost
Project Sub-Total (Boiler, General Contract, Additional Items)		$ 35,240
Professional Services[3]	*10%*	*$ 3,524*
Contingency	*15%*	*$ 5,286*
Total Project Cost		**$ 44,050**

Notes:
1 - Assumes that biomass boiler and general contract are bid separately.
2 - Costs are approximate. Estimate is based on competitive bidding.
3 - Professional Services includes engineering, permitting, legal, and project management.

Appendix C – Financial and Fuel Cost Analyses

- C.1 Option 1 Financial Analysis
- C.2 Option 1 Financial Analysis with 25% Grant
- C.3 Option 1 Fuel Cost Sensitivity Analysis

Option 1 - Pellet Boiler
25-year Cash Flow Analysis

Input Variables	Value	Units
Project Costs Financed	$44,050	$
Grant Amount	$0	$
Project Costs Financed	$44,050	$
Annual Propane Usage	1,542	gal
Average Propane Price	$1.75	$/gal
Pellet Usage	9	tons/yr
Year 1 Pellet Price	$206	$/ton
Annual Propane Usage w/ Wood System	77	gal
Fossil Fuel Escalation Rate (apr)	1.5%	Percent
Wood Fuel Escalation Rate (apr)	0.5%	Percent
Real Discount Rate (apr)	1.0%	Percent
Inflation Rate (apr)	2.7%	Percent
Added Annual O&M Costs for Biomass Plant	$767	$/year

Year	Total Fossil Fuel Cost, Current System	Wood Fuel Cost	Fossil Fuel Cost w/ Wood System	Added O&M Cost	Net Cash Flow	Present Value of Net Cash Flow
0	$ -	$ -	$ -	$ -	$ (44,050)	$ (44,050)
1	$ 2,692	$ (1,785)	$ (135)	$ (767)	$ 5	$ 5
2	$ 2,732	$ (1,794)	$ (137)	$ (767)	$ 34	$ 34
3	$ 2,773	$ (1,803)	$ (139)	$ (767)	$ 64	$ 62
4	$ 2,815	$ (1,812)	$ (141)	$ (767)	$ 95	$ 91
5	$ 2,857	$ (1,821)	$ (143)	$ (767)	$ 126	$ 120
6	$ 2,900	$ (1,830)	$ (145)	$ (767)	$ 158	$ 148
7	$ 2,944	$ (1,840)	$ (147)	$ (767)	$ 190	$ 177
8	$ 2,988	$ (1,849)	$ (149)	$ (767)	$ 222	$ 205
9	$ 3,033	$ (1,858)	$ (152)	$ (767)	$ 256	$ 234
10	$ 3,078	$ (1,867)	$ (154)	$ (767)	$ 290	$ 262
11	$ 3,124	$ (1,877)	$ (156)	$ (767)	$ 324	$ 291
12	$ 3,171	$ (1,886)	$ (159)	$ (767)	$ 359	$ 319
13	$ 3,219	$ (1,895)	$ (161)	$ (767)	$ 395	$ 347
14	$ 3,267	$ (1,905)	$ (163)	$ (767)	$ 432	$ 375
15	$ 3,316	$ (1,914)	$ (166)	$ (767)	$ 469	$ 404
16	$ 3,366	$ (1,924)	$ (168)	$ (767)	$ 506	$ 432
17	$ 3,416	$ (1,934)	$ (171)	$ (767)	$ 545	$ 460
18	$ 3,467	$ (1,943)	$ (173)	$ (767)	$ 584	$ 488
19	$ 3,519	$ (1,953)	$ (176)	$ (767)	$ 623	$ 516
20	$ 3,572	$ (1,963)	$ (179)	$ (767)	$ 664	$ 544
21	$ 3,626	$ (1,973)	$ (181)	$ (767)	$ 705	$ 572
22	$ 3,680	$ (1,982)	$ (184)	$ (767)	$ 747	$ 600
23	$ 3,735	$ (1,992)	$ (187)	$ (767)	$ 789	$ 628
24	$ 3,791	$ (2,002)	$ (190)	$ (767)	$ 832	$ 656
25	$ 3,848	$ (2,012)	$ (192)	$ (767)	$ 876	$ 683
					25-year Net Present Value	**$ (35,398)**

Note: All values are in real dollars.

Appendix C

Option 1 - Pellet Boiler
25-year Cash Flow Analysis with 25% Grant

Input Variables	Value	Units
Project Costs Financed	$44,050	$
Grant Amount	$11,013	$
Project Costs Financed	$33,038	$
Annual Propane Usage	1,542	gal
Average Propane Price	$1.75	$/gal
Pellet Usage	9	tons/yr
Year 1 Pellet Price	$206	$/ton
Annual Propane Usage w/ Wood System	77	gal
Fossil Fuel Escalation Rate (apr)	1.5%	Percent
Wood Fuel Escalation Rate (apr)	0.5%	Percent
Real Discount Rate (apr)	1.0%	Percent
Inflation Rate (apr)	2.7%	Percent
Added Annual O&M Costs for Biomass Plant	$767	$/year

Year	Total Fossil Fuel Cost, Current System	Wood Fuel Cost	Fossil Fuel Cost w/ Wood System	Added O&M Cost	Net Cash Flow	Present Value of Net Cash Flow
0	$ -	$ -	$ -	$ -	$ (33,038)	$ (33,038)
1	$ 2,692	$ (1,785)	$ (135)	$ (767)	$ 5	$ 5
2	$ 2,732	$ (1,794)	$ (137)	$ (767)	$ 34	$ 34
3	$ 2,773	$ (1,803)	$ (139)	$ (767)	$ 64	$ 62
4	$ 2,815	$ (1,812)	$ (141)	$ (767)	$ 95	$ 91
5	$ 2,857	$ (1,821)	$ (143)	$ (767)	$ 126	$ 120
6	$ 2,900	$ (1,830)	$ (145)	$ (767)	$ 158	$ 148
7	$ 2,944	$ (1,840)	$ (147)	$ (767)	$ 190	$ 177
8	$ 2,988	$ (1,849)	$ (149)	$ (767)	$ 222	$ 205
9	$ 3,033	$ (1,858)	$ (152)	$ (767)	$ 256	$ 234
10	$ 3,078	$ (1,867)	$ (154)	$ (767)	$ 290	$ 262
11	$ 3,124	$ (1,877)	$ (156)	$ (767)	$ 324	$ 291
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13	$ 3,219	$ (1,895)	$ (161)	$ (767)	$ 395	$ 347
14	$ 3,267	$ (1,905)	$ (163)	$ (767)	$ 432	$ 375
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21	$ 3,626	$ (1,973)	$ (181)	$ (767)	$ 705	$ 572
22	$ 3,680	$ (1,982)	$ (184)	$ (767)	$ 747	$ 600
23	$ 3,735	$ (1,992)	$ (187)	$ (767)	$ 789	$ 628
24	$ 3,791	$ (2,002)	$ (190)	$ (767)	$ 832	$ 656
25	$ 3,848	$ (2,012)	$ (192)	$ (767)	$ 876	$ 683
				25-year Net Present Value		**$ (24,385)**

Note: All values are in real dollars.

Option 1 - Pellet Boiler
Fuel Cost Sensitivity Analysis

Table Shows Sensitivity of Annual Operating Savings to Changes in Fossil Fuel and Wood Fuel Prices*

Price of Pellets - $/ton	Fossil Fuel Price, $/gal						
	$1.25	**$1.50**	**$1.75**	**$2.00**	**$2.25**	**$2.50**	**$2.75**
$180	($496)	($130)	$230	$602	$968	$1,334	$1,701
$185	($540)	($174)	$187	$559	$925	$1,291	$1,657
$190	($583)	($217)	$144	$515	$882	$1,248	$1,614
$195	($626)	($260)	$100	$472	$838	$1,204	$1,571
$200	($670)	($304)	$57	$429	$795	$1,161	$1,527
$206	($722)	($356)	$5	$377	$743	$1,109	$1,475
$210	($756)	($390)	($30)	$342	$708	$1,074	$1,441
$215	($800)	($434)	($73)	$299	$665	$1,031	$1,397
$220	($843)	($477)	($116)	$255	$622	$988	$1,354
$225	($886)	($520)	($160)	$212	$578	$944	$1,311
$230	($930)	($564)	($203)	$169	$535	$901	$1,267
$235	($973)	($607)	($246)	$125	$492	$858	$1,224
$240	($1,016)	($650)	($290)	$82	$448	$814	$1,181
$245	($1,060)	($694)	($333)	$39	$405	$771	$1,137

**Notes: All other costs fixed. Excludes financing costs.*

Appendix D –
UMN Extension By-Products Program Brochure

Why Recycle?

- Provide a beneficial use for products that were previously discarded in landfills
- Reduce landfill costs to government and industry and improve environmental quality by removing large volumes of by-products from concentrated landfill disposal
- Improve farm profitability by reducing fertilizer and lime costs
- Contribute to environmental quality and soil conservation by improving the economics of perennial forage crops as an alternative to row crops on more sensitive sites

Before any by-products are delivered to a field, the following requirements must be met:

1. Farmer must sign and follow Best Management Practices (BMP's)
2. Develop a farm plan, which includes crop rotation
3. Mapping and soil sampling of fields
4. Lease agreement signed if field is rented
5. Notification to township officers prior to hauling to site

If interested in receiving any of these by-products, contact the University of Minnesota Extension Service: Carlton County, P.O. Box 307, Carlton, MN (218) 384-3511 or 1-800-862-3760, ext. 223.

University of Minnesota Extension Service

Carlton County

By-products Program

By-products Program

Wood Ash
Bio-Solids
Lime

By-product Program Resources

Troy Salzer
Extension Educator, Agriculture

Dr. Carl Rosen
Soil Scientist – Fertility

Dr. Tom Halbach
Water quality & Waste Mgmt

Russ Mathison
Forage Specialist

Bob Olen
Extension Educator, Horticulture

Dr. George Rehm
U of M Soil Scientist

Paul Peterson
Forage Specialist

MPCA
University Testing Labs
Forestry Specialists
Animal Science Specialists
University Dept on GIS/ Global Positioning

Wood Ash

Recycling wood ash saves valuable landfill space and provides farmers with an excellent liming source, as well as many of the nutrients needed to increase soil fertility. Wood ash increases soil pH and adds elements to the soil, which includes potassium, phosphorus, boron, and sulfur. Wood ash is delivered at no cost, but the farmer is responsible for spreading and incorporation.

There are eight local companies supplying wood ash. Listed below are the companies and the approximate amount of wood ash delivered annually.

	Tons	Acres
Minnesota Power	10,000	800
Georgia-Pacific, Duluth	400	50
Ainsworth, Bemidji	10,400	1,340
Trus Joist	1,300	220
Jardon Home Brands	125	15
Sappi Cloquet LLC	20,000	2,800
Potlatch, Bemidji	400	40
DNR Fisheries	30	10
TOTALS	42,280	5,285

Bio-Solids

Bio-solids are rich in organic matter and will provide nitrogen, along with small amounts of phosphorus, potassium, and lime. Additional commercial fertilizer may be needed to meet soil test recommendations. Each site for bio-solids must be approved by the Minnesota Pollution Control Agency.

However, not all fields qualify for bio-solids application due to soil pH, water table level, or slope. Records are kept to ensure that Best Management Practices are followed. Crops that would respond to the nitrogen in bio-solids are corn, grasses, legumes, and small grains.

Bio-solids are provided by the Western Lake Superior Sanitary District in Duluth, and are hauled, spread, and incorporated at no charge to the farmer.

Lime

We currently have three sources for by-product ag lime. The largest source is from Sappi Fine Paper of North America who delivers and spreads their lime at no cost to the farmers. This lime is made available as they produce it. The product is only produced during scheduled and unscheduled maintenance of the reclaiming kiln. The Effective Neutralizing Power (ENP) of this lime is 1300.

Cutler-Magner in Superior, WI has been the first source of by-product ag lime. The ENP of this lime is 1840. Loads are delivered with a semi-end dump with loads averaging 23 tons per load. The lime is free and the price farmers pay is based on distance from the plant.

Another source of by-product lime in Northeast Minnesota is from Specialty Minerals, Inc. in Cloquet. The ENP of this lime is 1600. This lime is a wet product that's good for certain applications. The lime and trucking are free to the farmer.

Benefits to participating in the By-products Program:

- Proven track record with over a decade of beneficial reuse of by-products
- University research used for application recommendations
- Education programs and field days for both industries and producers to share current research data and cropping improvement technologies
- Unbiased 3rd party involvement
- Provide educational programming to local decision makers/residents describing the research on the re-use benefits of these products.
- Assisting producers in developing environmentally sound crop management systems including the use of industrial by-products as soil amendments.
- Develop packets for individual fields including information about land ownership, soil types, soil analysis, and determine application rates based on crop type and soil analysis.
- Develop, research and secure funding for new potential uses for by-products.