Comprehensive Energy Audit
For

Unalakleet Water Treatment Plant

Prepared For
City of Unalakleet

March 9, 2017

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ANTHC-DEHE
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PREFACE

This energy audit was conducted using funds provided by the United States Department of Agriculture as part of the Rural Alaskan Village Grant (RAVG) program. Coordination with the City of Unalakleet has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Unalakleet, Alaska. The authors of this report are Kevin Ulrich, Assistant Engineering Project Manager and Certified Energy Manager (CEM); and Martin Wortman, Supervisor of Utility Operations.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in December of 2016 by the Rural Energy Initiative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of Water Treatment Plant Operators Dwayne Johnson and Roger Nichols, and City Manager Shannon Hough.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Unalakleet. The scope of the audit focused on the Unalakleet Water Treatment Plant. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, and plug loads. An additional energy audit report has been developed for the Unalakleet Pump House, which supports the contents of this energy audit.

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $78,213 per year. Electricity represents the largest portion of the energy cost with an annual cost of approximately $63,471. This includes $29,162 paid by the City and $34,309 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel oil represents another main portion of energy costs with an annual cost of approximately $14,721. The Water Treatment Plant also uses a heat recovery system with a monthly flat operating charge of $485. This yields an annual cost of $5,820.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Unalakleet, the cost of electricity without PCE is $0.37/kWh and the cost of electricity with PCE is $0.17/kWh.

There is a heat recovery system in the power plant that transports heat from the generator cooling loops to the water treatment plant to heat the raw water as it enters the building. The heat recovery also provides heat to four unit heaters directly and ties in to a heat exchanger that delivers heat to the building hydronic heating system prior to the existing oil-fired boilers. The recovered heat is supplied by four power generators, each of which is rated for 475 kW. There is also an existing wind farm in the community with six turbines, each rated or 100 kW, that powers an electric boiler as a dump load. The electric boiler provides heat to the generator cooling loops. The heat recovery system also serves the high school and the Baler Building, which handles the garbage of the community. These two buildings are served first by the heat recovery system before the water treatment plant receives any remaining heat. As of the time of the site visit, the heat recovery system is the only source of heat to the community water supply within the water treatment plant.

Table 1.1 shows the predicted annual use of each fuel type for the Unalakleet Water Treatment Plant.

Table 1.1: Predicted Annual Fuel Use for the Unalakleet Water Treatment Plant

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	171,544 kWh	145,990 kWh
#1 Oil	3,392 gallons	2,135 gallons
Heat Recovery	1,462.10 million Btu	1,542.74 million Btu
Waste Oil	544 gallons	222 gallons

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building.

Table 1.2: Building Benchmarks for the Unalakleet Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	358.2	25.73	$10.90
With Proposed Retrofits	328.0	23.56	$8.82
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.3 below summarizes the energy efficiency measures analyzed for the Unalakleet Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Other Electrical: Lift Station 1 Portable Electric Heater	Unplug electric heater and use only in emergency purposes. This can only be accomplished with a repair of the electric heater in lift station 1.	$1,571	$500	36.90	0.3	7,216.7
2	Lighting: Exterior Lights	Replace with LED-equivalent light bulbs.	$144	$50	33.91	0.3	663.1
3	Setback Thermostat: Water Plant	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space. This retrofit can only occur if the unit heaters and other space heating components are repaired.	$2,606	$1,000	33.54	0.4	16,702.2
4	Setback Thermostat: Garage/Shop Space	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Garage/Shop Space space.	$1,351	$2,000	8.69	1.5	8,654.3
5	Lighting: Middle Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$1,569	$2,760	6.50	1.8	6,436.3
6	Lighting: Chemical Room Hallway	Replace with LED-equivalent light bulbs.	$83	$160	5.92	1.9	337.3
7	Lighting: Water Storage Tank Alcove	Replace with LED-equivalent light bulbs.	$83	$160	5.90	1.9	336.4
8	Lighting: Far Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$688	$1,380	5.68	2.0	2,775.5

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
9	Lighting: Process Room	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$778	$1,620	5.47	2.1	3,111.2
10	Other Electrical: Lift Station 1 Electric Water Heater	Replace thermostat in lift station and reduce temperature set point to 40 deg. F. This will allow the portable electric heater to be unplugged and used as a backup.	$891	$2,000	5.23	2.2	4,093.1
11	Lighting: Boiler Room	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$547	$1,300	4.78	2.4	2,165.9
12	Lighting: Police Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$540	$1,300	4.71	2.4	2,123.2
13	Air Tightening	Add weather stripping around garage doors and man doors, replace broken windows, repair wall damage in far garage, weatherize around insulated stack holes.	$2,590	$5,000	4.64	1.9	16,598.7
14	Lighting: Police Garage Bench	Replace with LED-equivalent light bulbs.	$59	$160	4.18	2.7	234.5
15	Lighting: Office Desk Light	Replace with LED-equivalent light bulbs.	$12	$40	3.42	3.3	47.8
16	Lighting: Apartment Lights	Replace with LED-equivalent light bulbs.	$117	$480	2.74	4.1	449.0
17	Lighting: Middle Garage Bench	Replace with LED-equivalent light bulbs.	$37	$160	2.62	4.3	146.8
18	Setback Thermostat: Apartment Space	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Apartment space.	$200	$1,000	2.57	5.0	1,281.8
19	Lighting: Office	Replace with LED-equivalent light bulbs.	$49	$240	2.33	4.9	195.6
20	Lighting: Middle Garage Storage	Replace with LED-equivalent light bulbs.	$15	$80	2.08	5.5	58.5
21	Garage Door: Garage 2 Door (Short)	Add insulating blanket to garage door.	$76	$542	1.82	7.1	490.1
22	Garage 3 Door (Short)	Add insulating blanket to garage door.	$95	$678	1.81	7.1	611.9
23	Garage 3 Door (Tall)	Add insulating blanket to garage door.	$137	$976	1.81	7.1	879.8
24	Garage 1 Door	Add insulating blanket to garage door.	$152	$1,084	1.81	7.1	976.5
25	Garage 2 Door (Tall)	Add insulating blanket to garage door.	$213	$1,518	1.80	7.1	1,363.9

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
26	HVAC and Domestic Hot Water	Repair unit heaters in chemical room hallway, process room, and boiler room. Clean and tune boilers. Replace Boiler 1 circ. pump. Open valve from power plant to maximize heat recovery system. This is necessary for water plant operations to be sustainable.	$297	$8,000	1.22	26.9	8,391.4
27	Lighting: Chemical Room Lighting	Replace with LED-equivalent light bulbs.	$38	$400	1.10	10.5	159.4
28	Water Circulation Heating	Install Heat Exchanger to allow heat add prior to the pressure pumps to the water circulation loops. Prevents freeze-ups in the lines and lowers maintenance costs. Also replace controls and program for more efficient operations.	-$1,856 + $3,000 Maintenance Savings	$15,000	0.94	13.1	-21,911.8
29	Raw Water Heating	Replace Heat Exchanger because it is old and single-walled. Maintenance savings for cost needed to monitor water.	$0 + $500 Maintenance Savings	$12,000	0.73	24.0	0.0
30	Other Electrical: Pressure Pump	Replace with new, more efficient pump.	$444	$11,000	0.66	24.8	1,816.8
31	Other Electrical: Northeast Loop	Replace with new, more efficient pump.	$379	$11,000	0.57	29.0	1,531.0
32	Other Electrical: West Loop Circulation Pump	Replace with new, more efficient pump.	$437	$13,000	0.55	29.8	1,762.2
33	Other Electrical: Southeast Loop Circulation Pump	Replace with new, more efficient pump.	$290	$10,000	0.48	34.5	1,169.1
34	Window: Process Room Windows (2)	Replace existing window with triple pane window.	$85	$2,966	0.45	34.8	502.7
35	Window: Boiler Room Windows (3)	Replace existing window with triple pane window.	$119	$4,449	0.42	37.2	703.7
36	Lighting: Restroom Lights	Replace with LED-equivalent light bulbs.	$3	$160	0.22	53.1	12.5
37	Lighting: Lift Station 1 Wet Side Lights	Replace with LED-equivalent light bulbs.	$1	$50	0.20	57.9	4.0
38	Lighting: Lift Station 4 Lighting	Replace with LED-equivalent light bulbs.	$2	$100	0.20	58.2	7.9
39	Lighting: Lift Station 3 Lighting	Replace with LED-equivalent light bulbs.	$3	$150	0.20	58.3	11.8
40	Lighting: Lift Station 2 Wet Side Lighting	Replace with LED-equivalent light bulbs.	$3	$200	0.19	61.3	15.0

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
41	Other Electrical: FAA Loop Circulation Pump	Replace with new, more efficient pump.	$43	$4,000	0.18	92.2	174.9
42	Lighting: Lift Station 2 Dry Side Lighting	Replace with LED-equivalent light bulbs.	$2	$160	0.14	86.4	8.5
43	Window: Chemical Room Window	Replace existing window with triple pane window.	$7	$1,483	0.08	199.4	43.8
44	Window: Apartment Windows (2)	Replace existing window with triple pane window.	$10	$1,968	0.08	199.3	58.2
45	Lighting: Lift Station 1 Dry Side Lights	Replace with LED-equivalent light bulbs.	$1	$100	0.06	198.4	2.3
	TOTAL, all measures		**$14,912 + $3,500 Maintenance Savings**	**$122,373**	**1.89**	**6.6**	**72,413.2**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $14,912 per year, or 19.1% of the buildings' total energy costs. These measures are estimated to cost $122,373, for an overall simple payback period of 6.6 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as Space Heating and Water Heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate									
Description	Space Heating	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Raw Water Heat Add	Water Circulation Heat	Total Cost
Existing Building	$20,076	$467	$3	$9,623	$243	$45,870	$1,920	$10	**$78,213**
With Proposed Retrofits	$14,298	$457	$3	$3,399	$243	$41,148	$1,835	$1,919	**$63,301**
Savings	$5,778	$10	$0	$6,224	$0	$4,722	$86	-$1,908	**$14,912**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Unalakleet Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and HVAC equipment, motors and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment (optional) & disposal

The building site visit was performed to survey all major building components and systems. The site visit included detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager were collected along with the system and components to determine a more accurate impact on energy consumption.

Details collected from Unalakleet Water Treatment Plant enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

Unalakleet Water Treatment Plant is made up of the following activity areas:

1) Water Plant: 2,395 square feet
2) Apartment Space: 680 square feet
3) Garage/Shop Space: 4,101 square feet

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; HVAC; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = **Savings** divided by **Investment**

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs $12,000 and results in a savings of $1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual SIR>=1 to make the cut. Next the building is modified and re-simulated with the highest ranked measure included. Now all remaining measures are re-evaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Unalakleet Water Treatment Plant

3.1. Building Description

The 7,176 square foot Unalakleet Water Treatment Plant was constructed in 1965 and houses the water treatment plant, three garages for city vehicles, and an apartment currently occupied by the city manager. The building is in operation every day from 8:00AM to 5:00PM with a one-hour lunch break. Typical operations include one water treatment plant operator and 2-3 maintenance workers for the city vehicles. There are additional city workers that routinely work in the building for short periods of time during the day.

Water is collected from Powers Creek at the pump house located approximately five miles north of the community. Water is heated at the pump house and transported to the water treatment plant through buried pipe. Upon entering the water treatment plant, the water is heated and injected with chemicals before being filtered and getting stored in the water storage tank. The water is injected with ferric chloride, which acts as a coagulant during the filtration process; soda ash, which maintains the acidity of the water; and chlorine, which treats the water. After getting stored in the one-million gallon water storage tank, the water is then distributed to the community through four distribution loops. The loop information is listed below.

FAA Loop:	Northwest area of the community. 4” Buried Steel Pipe Temperatures – 42 deg. F. supply, 36 deg. F, return Pressure – 34 psi Flow Meter Broken – Estimated 75 GPM
Southeast Loop:	Southeast area of the community. 4” Buried Steel Pipe Temperatures – 42 deg. F. supply, 42 deg. F, return Pressure – 47 psi Flow Rate - 195 GPM supply
West Loop:	West area of the community. Temperatures – 53 deg. F. supply, 38 deg. F, return Pressure – 47 psi Flow Rate - 225 GPM return
Northeast Loop:	Northeast area of the community. Temperatures – Readings were inaccurate Pressure – 36 psi Flow Rate – 60 GPM return

There are three garages that are used to store vehicles for the City as well as for repairs and maintenance to the vehicle fleet. Two large garages are dedicated to the fire department and one garage is dedicated to the police department. Maintenance workers are present year round to work on the vehicles.

There is a single apartment with two bedrooms that is used for guests related to the city operations. At the time of the site visit, the city manager was living in the apartment.

There are four lift stations in the community that are used to collect the sewage from the community and transport it to the sewage lagoon outside of town. The lift station information is listed below.

Lift Station 1 (Covenant):	Pump Rating – 3 HP Flygt Model 3085 Radiant Floor Heating with Electric Hot Water Heater – 1650 Watts Portable Electric Heater – 4000 Watts
Lift Station 2 (Midtown):	Pump Rating – 10 HP Flygt Model 3127.090.1030 Electric Heater - Broken
Lift Station 3 (FAA):	Pump – Removed for use in Lift Station 4 Previously rated for 1.5 HP Electric Heater – 3000 Watts
Lift Station 4 (Happy Valley):	Sewage Pump Rating – 1.5 HP Previously used Hydromatic 5HP pumps Flygt Grinder Pump – 550 Watts Plug-in Heater – 3000 Watts

<u>Description of Building Shell</u>

The exterior walls are single-stud wood-framed construction with 2x6 supports and approximately 5.5 inches of fiberglass batt insulation.

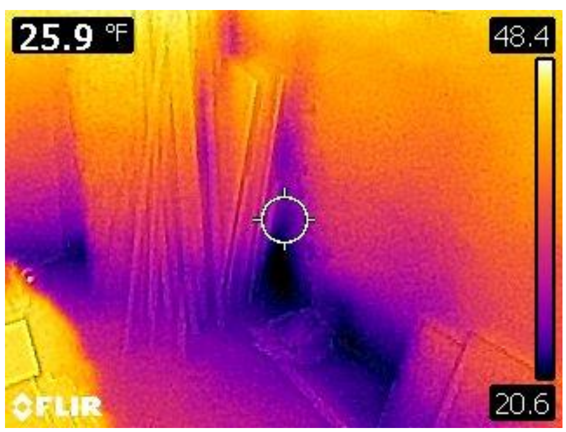


Figure 1: Thermal Image of a Damaged Wall Section in the Far Garage

The facility has cathedral ceilings throughout the building with an attic space in the apartment. The roof is constructed with single-stud wood framing with 2x6 lumber and approximately 5.5 inches of fiberglass batt insulation.

The building is constructed on grade with a concrete slab foundation. The foundation has been damaged in the garage areas from vehicle use. There was no insulation visible for the majority of the building floor.

The water treatment plant has six total windows, each of which is approximately 30”x45” with wood framing. The five windows in the process room and boiler room all have damage to the window panes or are boarded across. Additionally, the Apartment has two windows, each of which is approximately 28’x32” with wood framing.

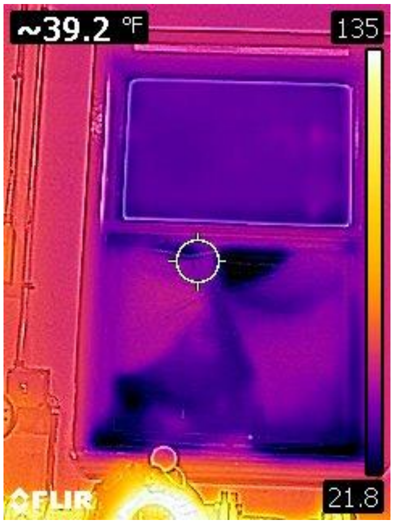


Figure 2: Thermal Images of a Broken Window and a Boarded Window in the Water Treatment Plant

There are standard-sized entrance doors in the police garage, far fire department garage, chemical room, and apartment. The police garage is used as the main entrance to the facility. The apartment is connected to the boiler room with a door that is typically locked. There are also five large garage doors present with one in the police garage and two each in both fire department garage areas.

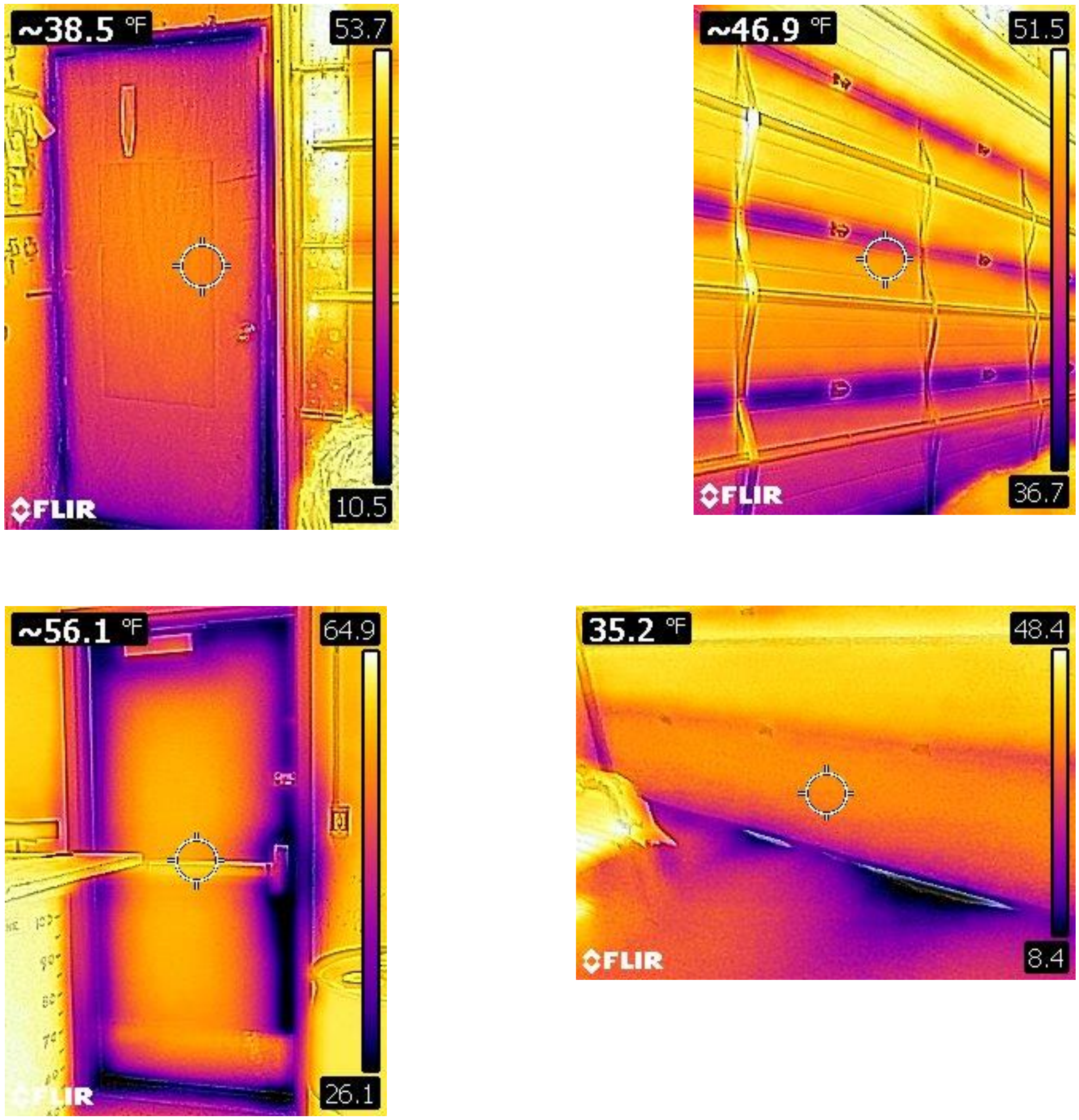


Figure 3: Thermal Images of Doors around the Water Treatment Plant and Garage Spaces.

Top Left: Main Entrance. **Top Right: Police Garage Door.**

Bottom Left: Chemical Room Entrance. **Bottom Right: Middle Garage Door**

<u>Description of Heating Plants</u>

The heating plants used in the building are:

Boiler 1

Nameplate Information:	Weil McLain Gold Model: P-WG0-6
Fuel Type:	#1 Oil
Input Rating:	184,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	0.5 %

Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Used for space heating, DHW, and the apartment Taco 1/25 HP Model 07-F5 Pump for circulation. Not operational.

Figure 4: Boiler 1 (Left Side)

Boiler 2

Nameplate Information:	Weil McLain Gold Model: P-WG0-6
Fuel Type:	#1 Oil
Input Rating:	184,000 BTU/hr
Steady State Efficiency:	78 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Used for space heating, DHW, and the apartment Grundfos UP 15-42 F circulation pump

Figure 5: Boiler 2

Heat Recovery

Fuel Type:	Heat Recovery
Input Rating:	425,000 BTU/hr
Steady State Efficiency:	95 %
Idle Loss:	0 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Pump located in the Power Plant This is supplied by the UVEC to the WTP after going to the school and the Baler Building

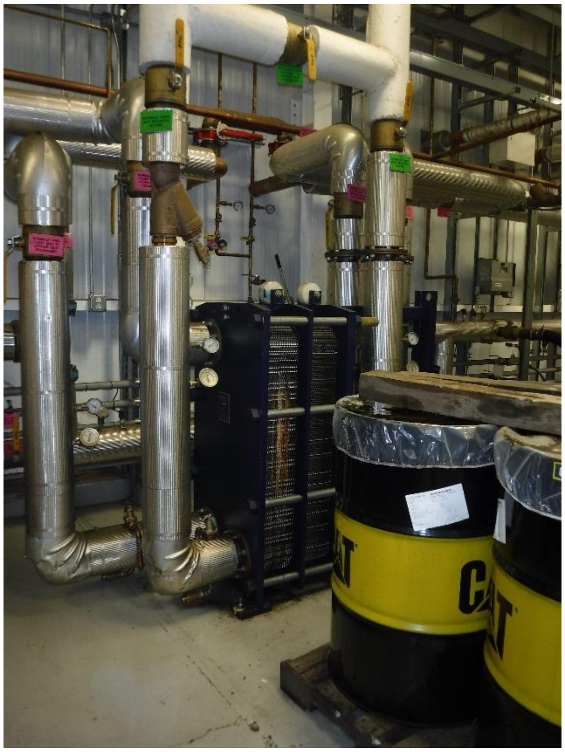


Figure 6: Heat Recovery Heat Exchanger in the Power Plant

Waste Oil Heater

Nameplate Information:	Blackgold EL-200H
Fuel Type:	Waste Oil
Input Rating:	200,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Air

Figure 7: Waste Oil Space Heater in the Middle Garage

Space Heating Distribution Systems

The building is heated by a combination of unit heaters for most of the building as well as some hydronic heating in the apartment area and a waste oil space heater in the middle garage. Information for the heating equipment is listed below:

Chemical Room Unit Heater: Modine HC 47, 30,940 BTUh, Operational

Chemical Room Hallway Unit Heater: Beacon HB 48, 30,000 BTUh, Broken

Process Room Unit Heater 1: Beacon HB 48, 30,000 BTUh, Broken

Process Room Unit Heater 2: Beacon HB 48, 30,000 BTUh, Broken

Boiler Room Unit Heater: Beacon HB 48, 30,000 BTUh, Operational

Police Garage Unit Heater: Beacon HB 48, 30,000 BTUh, Operational

Middle Garage Unit Heater 1: Beacon VB-62, 39,600 BTUh, Operational

Middle Garage Unit Heater 2: Beacon VB-62, 39,600 BTUh, Operational

Far Garage Unit Heater: Beacon VB-62, 39,600 BTUh, Operational

Domestic Hot Water System

There is a Weil McLain hot water heater with 50 gallons of storage that is used to heat water for use in the apartment and the restroom. The apartment includes a kitchen sink, restroom, and a clothes washer.

Heat Recovery Information

There is a heat recovery system in the power plant that transports heat from the generator cooling loops to the water treatment plant to heat the raw water as it enters the building. The heat recovery also provides heat to four unit heaters directly and ties in to a heat exchanger that delivers heat to the building hydronic heating system prior to the existing oil-fired boilers. The recovered heat is supplied by four power generators, each of which is rated for 475 kW. There is also an existing wind farm in the community with six turbines, each rated or 100 kW, that powers an electric boiler as a dump load. The electric boiler provides heat to the generator cooling loops. The heat recovery system also serves the high school and the Baler Building, which handles the garbage of the community. These two buildings are served first by the heat recovery system before the water treatment plant receives any remaining heat. As of the time of the site visit, the heat recovery system is the only source of heat to the community water supply within the water treatment plant.

During the site visit the heat recovery system was monitored over a few different times during the day. When school was in session, the school building received approximately 400-475 MBH of heat while the Baler Building received 15-25 MBH and the Unalakleet Water Treatment Plant received 30-40 MBH. During the evening when school was not in session, the school received 25-35 MBH, the Baler Building received 15-25 MBH, and the Unalakleet Water Treatment Plant received 350-425 MBH.

Description of Building Ventilation System

There is a small exhaust fan in the chemical room that is manually controlled whenever the operator needs to vent the room during chemical mixing. It had an estimated rating of 120 Watts, as the nameplate was not on the unit.

Lighting

Table 3.1 below shows detailed information on the lighting in the Unalakleet Water Treatment Plant as well as in the biomass building.

Table 3.1: Detailed Lighting Information for the Unalakleet Water Treatment Plant

Room	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Chemical Room	Fluorescent T8	5	2	471
Office	Fluorescent T8	3	2	613
Office	Fluorescent T8	1	1	119
Chemical Room Hallway	Fluorescent T8	2	3	579
Process Room	Fluorescent T8	14	3	4,050
Water Storage Tank Alcove	Fluorescent T8	2	3	579
Boiler Room	Fluorescent T8	10	3	2,893
Restroom	Fluorescent T8	2	2	38
Police Garage	Fluorescent T8	10	3	2,893
Police Garage Bench	Fluorescent T8	2	4	346
Middle Garage	Fluorescent T8	27	3	7,811
Middle Garage Bench	Fluorescent T8	2	3	267
Middle Garage Storage	Fluorescent T8	1	4	86
Fire Department Garage	Fluorescent T8	11	4	3,168
Water Plant Exterior	Incandescent 60W	1	1	526
Apartment Lights	Fluorescent T8	6	2	1,527

Lift Station 1 – Wet Side	Incandescent 60W	1	1	3
Lift Station 1 – Dry Side	Fluorescent T8	1	3	4
Lift Station 2 – Wet Side	High Pressure Sodium 50W	4	1	12
Lift Station 2 – Dry Side	Fluorescent T8	2	4	9
Lift Station 3	Incandescent 60W	3	1	9
Lift Station 4	Incandescent 60W	2	1	6

Plug Loads

The Unalakleet Water Treatment Plant has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. The use of these items is infrequent and consumes a small portion of the total energy demand of the building.

Major Equipment

Table 3.2 shows details of major electrical equipment located in the Unalakleet Water Treatment Plant. All electrical amperage draws for pumps were measured in the field and are recorded next to the nameplate rating.

Table 3.2: Major Equipment Information for the Unalakleet Water Treatment Plant

Equipment	Rating (Watts)	Annual Usage (kWh)
Cathodic Protection Rectifier	909	7,968
Pressure Pump	1,840 (5HP)	16,130
FAA Loop Circulation Pump	368 (0.33HP)	1,627
Southeast Loop Circulation Pump	2,484 (5HP)	10,984
West Loop Circulation Pump	3,818 (7.5HP)	16,883
Northeast Loop Circulation Pump	3,312 (5HP)	14,646
Hydronic Booster Pump	85	745
Ferric Chloride Mixer	100	219
Ferric Chloride Injection Pump	24	210
Ferric Chloride Mixer (2)	640	561
Soda Ash Mixer	187	410
Soda Ash Injection Pump	39	342
Chlorine Mixers	187	410
Chlorine Injection Pump	39	342
Backwash Pump	6,210 (10HP)	326
Air Scour	4800	187
Apartment Clothes Washer	1,200	63

Apartment Clothes Dryer	3,120	163
Apartment Refrigerator	75	657

The cathodic protection rectifier is a type of corrosion protection system that works by continuously adding an electric charge to the fluid to prevent charged metal particles in the pipe to transfer to the fluid and begin the corrosion process. It is operated constantly to insure proper corrosion protection.

The pressure pump is located after the water storage tank in the water system process and is operated constantly to pressurize the system and maintain proper flow in all water distribution loops.

The loop circulation pumps operate constantly during the winter months to circulate the water in the water loops and prevent the water from freezing in the service lines.

There is some miscellaneous electrical usage in the apartment that is estimated to account for approximately 1,096 kWh of annual electrical usage.

Table 3.3 shows details of all major electrical equipment present in the four lift stations.

Table 3.3: Major Equipment Information for the Unalakleet Lift Stations

Equipment	Rating (Watts)	Annual Usage (kWh)
Lift Station 1 Electric Heater	1,650	7,296
Lift Station 1 Heating Circulation Pump	85	376
Lift Station 1 Portable Electric Heater	4,000	4,422
Lift Station 1 Sewage Pump	4,600 (7.5HP)	7,258
Lift Station 2 Electric Heater	3,600	0 (Broken)
Lift Station 2 Sewage Pump	11,000 (10 HP)	2,893
Lift Station 3 Electric Heater	3,000	5,306
Lift Station 3 Sewage Pump	1.5	*2,411*
Lift Station 4 Grinder Pump	550	4,821
Lift Station 4 Sewage Pump	1,100 (1.5HP)	9,643
Lift Station 4 Plug-in Heater	3,000	6,235

The pump in Lift Station 3 was removed in October 2016 and installed into Lift Station 4 because the existing pump was no longer functioning. As a result, Lift Station 3 currently has no operable pump and will need one installed for proper operations to resume.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The Unalakleet Valley Electric Cooperative provides electricity to the residents of the community as well as to all commercial and public buildings.

The average cost for each type of fuel used in this building is shown below in Table 3.4. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.4: Energy Cost Rates for Each Fuel Type

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.37/kWh
#1 Oil	$ 4.34/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Unalakleet pays approximately $78,213 annually for electricity and other fuel costs for the Unalakleet Water Treatment Plant.

Figure 8 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the “Retrofit” bar in the figure to the “Existing” bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

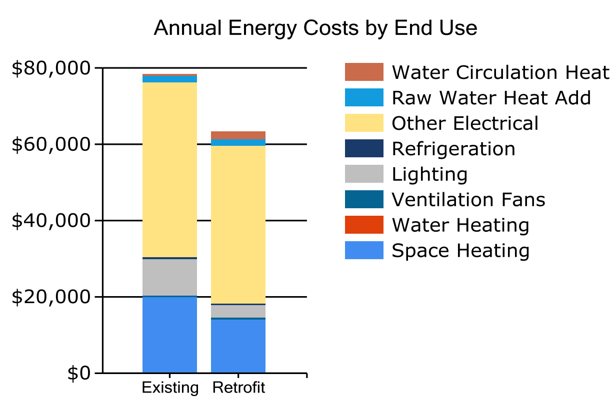


Figure 8: Annual Energy Costs by End Use

Figure 9 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

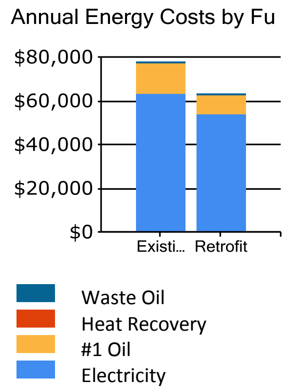


Figure 9: Annual Energy Cost by Fuel Type

Figure 10 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

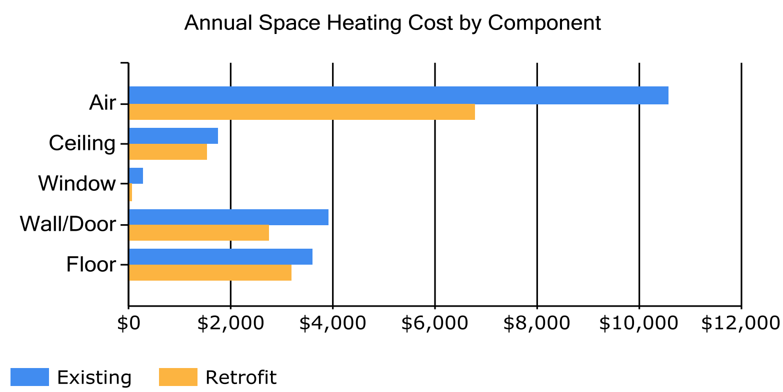


Figure 10: Annual Space Heating Costs

The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Table 3.5: Estimated Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	2272	2148	2023	1568	916	368	194	250	628	1067	1526	2278
DHW	40	36	40	39	40	39	40	40	39	40	39	40
Ventilation Fans	1	1	1	1	1	1	1	1	1	1	1	1
Lighting	2207	2011	2207	2136	2207	2136	2207	2207	2136	2207	2136	2207
Refrigeration	56	51	56	54	56	54	56	56	54	56	54	56
Other Electrical	16173	14738	16173	10501	4770	4616	4770	4770	4616	11023	15651	16173
Raw Water Heat Add	910	851	902	410	0	0	0	0	0	382	784	923
Water Circulation Heat	2	2	2	2	2	2	2	2	2	2	2	2

Table 3.6: Estimated Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	464	438	427	334	207	106	72	81	149	246	333	468
DHW	6	5	6	5	6	6	6	6	6	6	5	6

Table 3.7: Estimated Waste Oil Consumption by Category

Waste Oil Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	69	65	63	52	37	24	20	22	30	41	51	69

Table 3.8: Estimated Heat Recovery Consumption by Category

Heat Recovery Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	58	55	53	42	25	13	8	9	18	30	41	59
Raw Water Heat Add	196	189	193	73	0	0	0	0	0	52	144	203

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and

production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.9 for details):

Building Site EUI = (Electric Usage in kBtu + Fuel Usage in kBtu) / Building Square Footage

Building Source EUI = (Electric Usage in kBtu X SS Ratio + Fuel Usage in kBtu X SS Ratio) / Building Square Footage

where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.9: Unalakleet Water Treatment Plant EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	171,544 kWh	585,480	3.340	1,955,502
#1 Oil	3,392 gallons	447,745	1.010	452,222
Heat Recovery	1,462.10 million Btu	1,462,097	1.280	1,871,484
Waste Oil	544 gallons	75,084	1.010	75,835
Total		**2,570,405**		**4,355,043**
BUILDING AREA		7,176	Square Feet	
BUILDING SITE EUI		358	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		607	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.10: Building Benchmarks for the Unalakleet Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	358.2	25.73	$10.90
With Proposed Retrofits	328.0	23.56	$8.82
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The HVAC system and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Unalakleet Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Unalakleet was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Unalakleet. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail.

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Other Electrical: Lift Station 1 Portable Electric Heater	Unplug electric heater and use only in emergency purposes. This can only be accomplished with a repair of the electric heater in lift station 1.	$1,571	$500	36.90	0.3	7,216.7
2	Lighting: Exterior Lights	Replace with LED-equivalent light bulbs.	$144	$50	33.91	0.3	663.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
3	Setback Thermostat: Water Plant	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space. This retrofit can only occur if the unit heaters and other space heating components are repaired.	$2,606	$1,000	33.54	0.4	16,702.2
4	Setback Thermostat: Garage/Shop Space	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Garage/Shop Space space.	$1,351	$2,000	8.69	1.5	8,654.3
5	Lighting: Middle Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$1,569	$2,760	6.50	1.8	6,436.3
6	Lighting: Chemical Room Hallway	Replace with LED-equivalent light bulbs.	$83	$160	5.92	1.9	337.3
7	Lighting: Water Storage Tank Alcove	Replace with LED-equivalent light bulbs.	$83	$160	5.90	1.9	336.4
8	Lighting: Far Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$688	$1,380	5.68	2.0	2,775.5
9	Lighting: Process Room	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$778	$1,620	5.47	2.1	3,111.2
10	Other Electrical: Lift Station 1 Electric Water Heater	Replace thermostat in lift station and reduce temperature set point to 40 deg. F. This will allow the portable electric heater to be unplugged and used as a backup.	$891	$2,000	5.23	2.2	4,093.1
11	Lighting: Boiler Room	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$547	$1,300	4.78	2.4	2,165.9
12	Lighting: Police Garage	Replace with LED-equivalent light bulbs and add an occupancy sensor.	$540	$1,300	4.71	2.4	2,123.2
13	Air Tightening	Add weather stripping around garage doors and man doors, replace broken windows, repair wall damage in far garage, weatherize around insulated stack holes.	$2,590	$5,000	4.64	1.9	16,598.7

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
14	Lighting: Police Garage Bench	Replace with LED-equivalent light bulbs.	$59	$160	4.18	2.7	234.5
15	Lighting: Office Desk Light	Replace with LED-equivalent light bulbs.	$12	$40	3.42	3.3	47.8
16	Lighting: Apartment Lights	Replace with LED-equivalent light bulbs.	$117	$480	2.74	4.1	449.0
17	Lighting: Middle Garage Bench	Replace with LED-equivalent light bulbs.	$37	$160	2.62	4.3	146.8
18	Setback Thermostat: Apartment Space	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Apartment space.	$200	$1,000	2.57	5.0	1,281.8
19	Lighting: Office	Replace with LED-equivalent light bulbs.	$49	$240	2.33	4.9	195.6
20	Lighting: Middle Garage Storage	Replace with LED-equivalent light bulbs.	$15	$80	2.08	5.5	58.5
21	Garage Door: Garage 2 Door (Short)	Add insulating blanket to garage door.	$76	$542	1.82	7.1	490.1
22	Garage 3 Door (Short)	Add insulating blanket to garage door.	$95	$678	1.81	7.1	611.9
23	Garage 3 Door (Tall)	Add insulating blanket to garage door.	$137	$976	1.81	7.1	879.8
24	Garage 1 Door	Add insulating blanket to garage door.	$152	$1,084	1.81	7.1	976.5
25	Garage 2 Door (Tall)	Add insulating blanket to garage door.	$213	$1,518	1.80	7.1	1,363.9
26	HVAC and Domestic Hot Water	Repair unit heaters in chemical room hallway, process room, and boiler room. Clean and tune boilers. Replace Boiler 1 circ. pump. Open valve from power plant to maximize heat recovery system. This is necessary for water plant operations to be sustainable.	$297	$8,000	1.22	26.9	8,391.4
27	Lighting: Chemical Room Lighting	Replace with LED-equivalent light bulbs.	$38	$400	1.10	10.5	159.4
28	Water Circulation Heating	Install Heat Exchanger to allow heat add prior to the pressure pumps to the water circulation loops. Prevents freeze-ups in the lines and lowers maintenance costs. Also replace controls and program for more efficient operations.	-$1,856 + $3,000 Maintenance Savings	$15,000	0.94	13.1	- 21,911.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
29	Raw Water Heating	Replace Heat Exchanger because it is old and single-walled. Maintenance savings for cost needed to monitor water.	$0 + $500 Maintenance Savings	$12,000	0.73	24.0	0.0
30	Other Electrical: Pressure Pump	Replace with new, more efficient pump.	$444	$11,000	0.66	24.8	1,816.8
31	Other Electrical: Northeast Loop	Replace with new, more efficient pump.	$379	$11,000	0.57	29.0	1,531.0
32	Other Electrical: West Loop Circulation Pump	Replace with new, more efficient pump.	$437	$13,000	0.55	29.8	1,762.2
33	Other Electrical: Southeast Loop Circulation Pump	Replace with new, more efficient pump.	$290	$10,000	0.48	34.5	1,169.1
34	Window: Process Room Windows (2)	Replace existing window with triple pane window.	$85	$2,966	0.45	34.8	502.7
35	Window: Boiler Room Windows (3)	Replace existing window with triple pane window.	$119	$4,449	0.42	37.2	703.7
36	Lighting: Restroom Lights	Replace with LED-equivalent light bulbs.	$3	$160	0.22	53.1	12.5
37	Lighting: Lift Station 1 Wet Side Lights	Replace with LED-equivalent light bulbs.	$1	$50	0.20	57.9	4.0
38	Lighting: Lift Station 4 Lighting	Replace with LED-equivalent light bulbs.	$2	$100	0.20	58.2	7.9
39	Lighting: Lift Station 3 Lighting	Replace with LED-equivalent light bulbs.	$3	$150	0.20	58.3	11.8
40	Lighting: Lift Station 2 Wet Side Lighting	Replace with LED-equivalent light bulbs.	$3	$200	0.19	61.3	15.0
41	Other Electrical: FAA Loop Circulation Pump	Replace with new, more efficient pump.	$43	$4,000	0.18	92.2	174.9
42	Lighting: Lift Station 2 Dry Side Lighting	Replace with LED-equivalent light bulbs.	$2	$160	0.14	86.4	8.5
43	Window: Chemical Room Window	Replace existing window with triple pane window.	$7	$1,483	0.08	199.4	43.8
44	Window: Apartment Windows (2)	Replace existing window with triple pane window.	$10	$1,968	0.08	199.3	58.2
45	Lighting: Lift Station 1 Dry Side Lights	Replace with LED-equivalent light bulbs.	$1	$100	0.06	198.4	2.3
	TOTAL, all measures		**$14,912 + $3,500 Maintenance Savings**	**$122,373**	**1.89**	**6.6**	**72,413.2**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

In general, all projects are evaluated sequentially so energy savings associated with one EEM would not also be attributed to another EEM. By modeling the recommended project sequentially, the analysis accounts for interactive affects among the EEMs and does not "double count" savings.

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	**Location**	**Size/Type, Condition**	**Recommendation**
34	Window/Skylight: Process Room Windows (2)	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple pane window.

Installation Cost	$2,966	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$85
Breakeven Cost	$1,346	**Simple Payback (yrs)**	35	**Energy Savings (MMBTU/yr)**	2.9 MMBTU
		Savings-to-Investment Ratio	0.5		

Auditors Notes: Replacing the window will reduce air penetration and prevent further heat loss from the building.

Rank	**Location**	**Size/Type, Condition**	**Recommendation**
35	Window/Skylight: Boiler Room Windows (3)	Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11	Replace existing window with triple pane window.

Installation Cost	$4,449	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$119
Breakeven Cost	$1,885	**Simple Payback (yrs)**	37	**Energy Savings (MMBTU/yr)**	4.1 MMBTU
		Savings-to-Investment Ratio	0.4		

Auditors Notes: Replacing the window will reduce air penetration and prevent further heat loss from the building.

Rank	Location	Size/Type, Condition	Recommendation
43	Window/Skylight: Chemical Room Window	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$1,483	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$7
Breakeven Cost	$117	**Simple Payback (yrs)**	199	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.1		

Auditors Notes: Replacing the window will reduce air penetration and prevent further heat loss from the building.

Rank	Location	Size/Type, Condition	Recommendation
44	Window/Skylight: Apartment Windows (2)	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$1,968	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$10
Breakeven Cost	$156	**Simple Payback (yrs)**	199	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	0.1		

Auditors Notes: Replacing the window will reduce air penetration and prevent further heat loss from the building.

4.3.2 Door Measures

Rank	Location	Size/Type, Condition	Recommendation
21	Garage Door: Garage 2 Door (Short)	Door Type: Sectional, EPS core, 1-3/4", thermal break Insulating Blanket: None Modeled R-Value: 3.2	Add insulating blanket to garage door.

Installation Cost	$542	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$76
Breakeven Cost	$984	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	3.4 MMBTU
		Savings-to-Investment Ratio	1.8		

Auditors Notes: Insulating the garage door will reduce heat loss and air penetration into the building.

Rank	Location	Size/Type, Condition	Recommendation
22	Garage Door: Garage 3 Door (Short)	Door Type: Sectional, EPS core, 1-3/4", thermal break Insulating Blanket: None Modeled R-Value: 3.2	Add insulating blanket to garage door.

Installation Cost	$678	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$95
Breakeven Cost	$1,229	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	4.3 MMBTU
		Savings-to-Investment Ratio	1.8		

Auditors Notes: Insulating the garage door will reduce heat loss and air penetration into the building.

Rank	Location	Size/Type, Condition	Recommendation
23	Garage Door: Garage 3 Door (Tall)	Door Type: Sectional, EPS core, 1-3/4", thermal break Insulating Blanket: None Modeled R-Value: 3.2	Add insulating blanket to garage door.

Installation Cost	$976	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$137
Breakeven Cost	$1,767	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	6.1 MMBTU
		Savings-to-Investment Ratio	1.8		

Auditors Notes: Insulating the garage door will reduce heat loss and air penetration into the building.

Rank	Location	Size/Type, Condition	Recommendation
24	Garage Door: Garage 1 Door	Door Type: Sectional, EPS core, 1-3/4", thermal break Insulating Blanket: None Modeled R-Value: 3.2	Add insulating blanket to garage door.

Installation Cost	$1,084	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$152
Breakeven Cost	$1,961	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	6.8 MMBTU
		Savings-to-Investment Ratio	1.8		

Auditors Notes: Insulating the garage door will reduce heat loss and air penetration into the building.

Rank	Location	Size/Type, Condition	Recommendation
25	Garage Door: Garage 2 Door (Tall)	Door Type: Sectional, EPS core, 1-3/4", thermal break Insulating Blanket: None Modeled R-Value: 3.2	Add insulating blanket to garage door.

Installation Cost	$1,518	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$213
Breakeven Cost	$2,739	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	9.5 MMBTU
		Savings-to-Investment Ratio	1.8		

Auditors Notes: Insulating the garage door will reduce heat loss and air penetration into the building.

4.3.3 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
13		Air Tightness estimated as: 12134 cfm at 50 Pascals		Add weather stripping around garage doors and man doors, replace broken windows, repair wall damage in far garage, weatherize around insulated stack holes.	
Installation Cost	$5,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$2,590
Breakeven Cost	$23,213	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	115.8 MMBTU
		Savings-to-Investment Ratio	4.6		
Auditors Notes: There are significant air leaks in the garage areas from air gaps in the garage door, wall damage in the far garage, and broken windows. Reducing the air leakage through weatherization and through replacement of the windows.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
26	Repair unit heaters in chemical room hallway, process room, and boiler room. Clean and tune boilers. Replace Boiler 1 circ. pump. Open valve from power plant to maximize heat recovery system. This is necessary for water plant operations to be sustainable.				
Installation Cost	$8,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$297
Breakeven Cost	$9,788	**Simple Payback (yrs)**	27	**Energy Savings (MMBTU/yr)**	112.0 MMBTU
		Savings-to-Investment Ratio	1.2		
Auditors Notes: Many of the unit heaters were missing a fan blade and had no controls for operation. This makes the heat circulate without being dispersed efficiently and instead through line loss. Repairing these unit heaters will allow for more efficient heat distribution. The Boiler 1 circulation pump is not operating and needs replaced. Currently, the boiler will heat the glycol to a high temperature without the ability to distribute it properly. Replacing the pump will reduce the runtime of the boilers. The heat recovery system has a valve in the power plant that is used to control the flow to the water plant. The valve was not open fully during the site visit. After opening the valve and monitoring the behavior of the system it was determined that a fully opened valve would improve the heat delivery of the heat recovery system.					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
3	Water Plant			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2,606
Breakeven Cost	$33,542	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	116.5 MMBTU
		Savings-to-Investment Ratio	33.5		
Auditors Notes:					

Rank	Building Space			Recommendation	
4	Garage/Shop Space			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Garage/Shop Space space.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,351
Breakeven Cost	$17,380	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	60.4 MMBTU
		Savings-to-Investment Ratio	8.7		
Auditors Notes:					

Rank	Building Space			Recommendation	
18	Apartment Space			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Apartment Space space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$200
Breakeven Cost	$2,574	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	8.9 MMBTU
		Savings-to-Investment Ratio	2.6		
Auditors Notes:					

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating loads. The building heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
2	Exterior Lights	INCAN A Lamp, Std 60W		Replace with an LED-equivalent light bulbs.	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$144
Breakeven Cost	$1,695	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	33.9		
Auditors Notes: There is a single incandescent light bulb to be replaced.					

Rank	Location	Existing Condition		Recommendation	
5	Middle Garage	27 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost	$2,760	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,569
Breakeven Cost	$17,952	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-0.6 MMBTU
		Savings-to-Investment Ratio	6.5		
Auditors Notes: The room has 27 fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of 54 light bulbs to replace.					

Rank	Location		Existing Condition		Recommendation	
6	Chemical Room Hallway		2 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$83
Breakeven Cost		$947	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	5.9		
Auditors Notes: The room has two fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of four light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
7	Water Storage Tank Alcove		2 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$83
Breakeven Cost		$945	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	5.9		
Auditors Notes: The room has two fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of four light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
8	Far Garage		11 FLUOR (4) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs and add an occupancy sensor.	
Installation Cost		$1,380	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$688
Breakeven Cost		$7,841	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-1.2 MMBTU
			Savings-to-Investment Ratio	5.7		
Auditors Notes: The room has 11 fixtures with four bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of 22 light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
9	Process Room		14 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs and add an occupancy sensor.	
Installation Cost		$1,620	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$778
Breakeven Cost		$8,854	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-1.9 MMBTU
			Savings-to-Investment Ratio	5.5		
Auditors Notes: The room has 14 fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of 28 light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
11	Boiler Room		10 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs and add an occupancy sensor.	
Installation Cost		$1,300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$547
Breakeven Cost		$6,211	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-1.8 MMBTU
			Savings-to-Investment Ratio	4.8		
Auditors Notes: The room has 10 fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of 20 light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
12	Police Garage		10 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs and add an occupancy sensor.	
Installation Cost		$1,300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$540
Breakeven Cost		$6,125	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	-2.1 MMBTU
			Savings-to-Investment Ratio	4.7		
Auditors Notes: The room has 10 fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of 20 light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
14	Police Garage Bench		2 FLUOR (4) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$59
Breakeven Cost		$668	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.2 MMBTU
			Savings-to-Investment Ratio	4.2		
Auditors Notes: The room has two fixtures with four bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of four light bulbs to replace.						

Rank	Location		Existing Condition		Recommendation	
15	Office Desk Light		FLUOR T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED 17W Module StdElectronic	
Installation Cost		$40	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$12
Breakeven Cost		$137	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	3.4		
Auditors Notes: There is a single light bulb to be replaced with an LED light bulb equivalent.						

Rank	Location		Existing Condition		Recommendation	
16	Apartment Lights		6 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost		$480	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$117
Breakeven Cost		$1,315	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	-0.6 MMBTU
			Savings-to-Investment Ratio	2.7		
Auditors Notes: There are six fixtures with two light bulbs in each fixture for a total of 12 light bulbs to be replaced.						

Rank	Location		Existing Condition		Recommendation	
17	Middle Garage Bench		2 FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$37
Breakeven Cost		$419	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	2.6		
Auditors Notes: The space has two fixtures with three bulbs in each fixture to be replaced with two LED equivalent light bulbs in each fixture for a total of four light bulbs to replace.						

Rank	Location	Existing Condition		Recommendation	
19	Office	3 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$49
Breakeven Cost	$559	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	2.3		
Auditors Notes: There are three fixtures with two light bulbs in each fixture for a total of six light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
20	Middle Garage Storage	FLUOR (4) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost	$80	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$15
Breakeven Cost	$167	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.1		
Auditors Notes: There is a single fixture with four light bulbs to be replaced with two light bulbs for a total of two light bulbs to install.					

Rank	Location	Existing Condition		Recommendation	
27	Chemical Room Lighting	5 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost	$400	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$38
Breakeven Cost	$439	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.1		
Auditors Notes: There are five fixtures with two light bulbs in each fixture for a total of ten light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
36	Restroom Lights	2 FLUOR (2) T8 4' F32T8 25W Energy-Saver Instant EfficMagnetic		Replace with LED-equivalent light bulbs.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3
Breakeven Cost	$35	**Simple Payback (yrs)**	53	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2		
Auditors Notes: There are two fixtures with two light bulbs in each fixture for a total of four light bulbs to be replaced. One fixture has four-ft light bulbs and one fixture has three-ft. light bulbs					

Rank	Location	Existing Condition		Recommendation	
37	Lift Station 1 Wet Side Lights	INCAN A Lamp, Std 60W		Replace with LED-equivalent light bulbs.	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1
Breakeven Cost	$10	**Simple Payback (yrs)**	58	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2		
Auditors Notes: There is a single incandescent light bulb to be replaced.					

Rank	Location		Existing Condition		Recommendation	
38	Lift Station 4 Lighting		2 INCAN A Lamp, Std 60W		Replace with LED-equivalent light bulbs.	
Installation Cost		$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2
Breakeven Cost		$20	**Simple Payback (yrs)**	58	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: There are two incandescent light bulbs to be replaced.						

Rank	Location		Existing Condition		Recommendation	
39	Lift Station 3 Lighting		3 INCAN A Lamp, Std 60W		Replace with LED-equivalent light bulbs.	
Installation Cost		$150	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3
Breakeven Cost		$30	**Simple Payback (yrs)**	58	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: There are three incandescent light bulbs to be replaced.						

Rank	Location		Existing Condition		Recommendation	
40	Lift Station 2 Wet Side Lighting		4 HPS 50 Watt StdElectronic		Replace with LED-equivalent light bulbs.	
Installation Cost		$200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3
Breakeven Cost		$38	**Simple Payback (yrs)**	61	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: There are four HPS light bulbs to be replaced.						

Rank	Location		Existing Condition		Recommendation	
42	Lift Station 2 Dry Side Lighting		2 FLUOR (4) T8 4' F32T8 25W Energy-Saver Instant StdElectronic		Replace with LED-equivalent light bulbs.	
Installation Cost		$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2
Breakeven Cost		$22	**Simple Payback (yrs)**	86	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.1		
Auditors Notes: There are two fixtures with four light bulbs each to be replaced with two light bulbs in each fixture for a total of four light bulbs to be installed.						

Rank	Location		Existing Condition		Recommendation	
45	Lift Station 1 Dry Side Lights		FLUOR (3) T8 4' F32T8 25W Energy-Saver Instant StdElectronic		Replace with LED-equivalent light bulbs.	
Installation Cost		$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1
Breakeven Cost		$6	**Simple Payback (yrs)**	198	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.1		
Auditors Notes: There is a single fixture with three light bulbs in the fixture that will be replaced with two light bulbs.						

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing	Efficiency Recommendation		
1	Lift Station 1 Portable Electric Heater	Electric Heater	Unplug electric heater and use only in emergency purposes.		
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,571
Breakeven Cost	$18,450	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	14.5 MMBTU
		Savings-to-Investment Ratio	36.9		
Auditors Notes: There is an electric water heater that heats a radiant floor system in the lift station. This portable electric heater is not needed for freeze protection and should be only used when the existing heating system is unable to keep the space above 40 deg. F.					

Rank	Location	Description of Existing	Efficiency Recommendation		
10	Lift Station 1 Electric Water Heater	Radiant Floor Heating	Replace thermostat in lift station and lower temperature to 40 deg. F.		
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$891
Breakeven Cost	$10,464	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	8.2 MMBTU
		Savings-to-Investment Ratio	5.2		
Auditors Notes: The thermostat for the electric water heater was not functioning and the heater was attempting to heat the space to 60 deg. F. Replacing the thermostat and lowering the set point will allow the heater to prevent freezing without using any excess electricity.					

Rank	Location	Description of Existing	Efficiency Recommendation		
30	Pressure Pump	Pressure Pump	Replace with new, energy-efficient pumps		
Installation Cost	$11,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$444
Breakeven Cost	$7,314	**Simple Payback (yrs)**	25	**Energy Savings (MMBTU/yr)**	-0.2 MMBTU
		Savings-to-Investment Ratio	0.7		
Auditors Notes: The existing pump is very old and not in good condition. Replacing the pump will improve efficiency and stabilize operations in the water plant. The existing pump conditions are listed below. Unimount Model B073A 5.0 HP Rating 460V/9.4 Fl Amp rating, measured at 4 Amps in the field. This is constantly operating to boost the pressure and flow in all the circulation loops coming from the water storage tank.					

Rank	Location	Description of Existing	Efficiency Recommendation		
31	Northeast Loop	Circulation Loop	Replace with new, energy-efficient pumps		
Installation Cost	$11,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$379
Breakeven Cost	$6,220	**Simple Payback (yrs)**	29	**Energy Savings (MMBTU/yr)**	-0.5 MMBTU
		Savings-to-Investment Ratio	0.6		
Auditors Notes: The existing pump is very old and not in good condition. Replacing the pump will improve efficiency and stabilize operations in the water plant. The existing pump conditions are listed below.					

Rank	Location		Description of Existing		Efficiency Recommendation	
32	West Loop Circulation Pump		Circulation Pump		Replace with new, energy-efficient pumps	
Installation Cost		$13,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$437
Breakeven Cost		$7,164	**Simple Payback (yrs)**	30	**Energy Savings (MMBTU/yr)**	-0.7 MMBTU
			Savings-to-Investment Ratio	0.6		
Auditors Notes: The existing pump is very old and not in good condition. Replacing the pump will improve efficiency and stabilize operations in the water plant. The existing pump conditions are listed below.						

Rank	Location		Description of Existing		Efficiency Recommendation	
33	Southeast Loop Circulation Pump		Circulation Loop		Replace with new, energy-efficient pumps	
Installation Cost		$10,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$290
Breakeven Cost		$4,755	**Simple Payback (yrs)**	34	**Energy Savings (MMBTU/yr)**	-0.5 MMBTU
			Savings-to-Investment Ratio	0.5		
Auditors Notes: The existing pump is very old and not in good condition. Replacing the pump will improve efficiency and stabilize operations in the water plant. The existing pump conditions are listed below.						

Rank	Location		Description of Existing		Efficiency Recommendation	
41	FAA Loop Circulation Pump		Circulation Loop Pump		Replace with new, energy-efficient pumps	
Installation Cost		$4,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$43
Breakeven Cost		$711	**Simple Payback (yrs)**	92	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: The existing pump is very old and not in good condition. Replacing the pump will improve efficiency and stabilize operations in the water plant. The existing pump conditions are listed below.						

4.5.3 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
28			Water Circulation Heating		Install Heat Exchanger to allow heat add prior to the pressure pumps to the water circulation loops. Prevents freeze-ups in the lines and lowers maintenance costs.	
Installation Cost		$15,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	-$1,856
Breakeven Cost		$14,045	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	-247.9 MMBTU
			Savings-to-Investment Ratio	0.9	**Maintenance Savings ($/yr)**	$3,000
Auditors Notes: There is currently no method to heat the water for the circulation loops after it has left the water storage tank. Piping is available to provide heat after the water storage tanks prior to the pressure pumps if a heat exchanger is installed in an available spot for use by the heat recovery system. This would allow for more efficient heat distribution and reduce the freeze-ups in the service lines. There are existing heat recovery circulation pumps that would be used with the heat exchanger. They are detailed below. Heat Recovery Circulation Pumps: Aurora Model 5VF56T17D5523B D						

Rank	Location	Description of Existing	Efficiency Recommendation
29		Raw Water Heating	Replace Heat Exchanger because it is old and single-walled. Maintenance savings for cost needed to monitor water.

Installation Cost	$12,000	**Estimated Life of Measure (yrs)**	25	**Energy Savings ($/yr)**	$
Breakeven Cost	$8,707	**Simple Payback (yrs)**	24	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.7	**Maintenance Savings ($/yr)**	$500

Auditors Notes: The existing heat exchanger is original to the plant and is need of a replacement for maintenance purposes. It is also of concern because it is single-walled, which provides less protection to the raw water in the event of a break in the piping. Replacing this heat exchanger will reduce labor costs in the water plant and improve the heat recovery system operation.

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

In the near future, a representative of ANTHC will be contacting the City of Unalakleet to follow up on the recommendations made in this report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations in the 2017.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Unalakleet Water Treatment Plant	**Auditor Company:** ANTHC-DEHE
Address: P.O. Box 28	**Auditor Name:** Kevin Ulrich, Martin Wortman
City: Unalakleet	**Auditor Address:** 4500 Diplomacy Dr. Anchorage, AK 99508
Client Name: Dwayne Johnson, Roger Nichols	
Client Address: P.O. Box 28 Unalakleet, AK 99684	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 624-3531	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 7,176 square feet	**Design Space Heating Load:** Design Loss at Space: 177,869 Btu/hour with Distribution Losses: 222,337 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 338,928 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 4 people	**Design Indoor Temperature:** 65.3 deg F (building average)
Actual City: Unalakleet	**Design Outdoor Temperature:** -34 deg F
Weather/Fuel City: Unalakleet	**Heating Degree Days:** 13,919 deg F-days
Utility Information	
Electric Utility: Unalakleet Valley Elec. Coop.	**Average Annual Cost/kWh:** $0.37/kWh

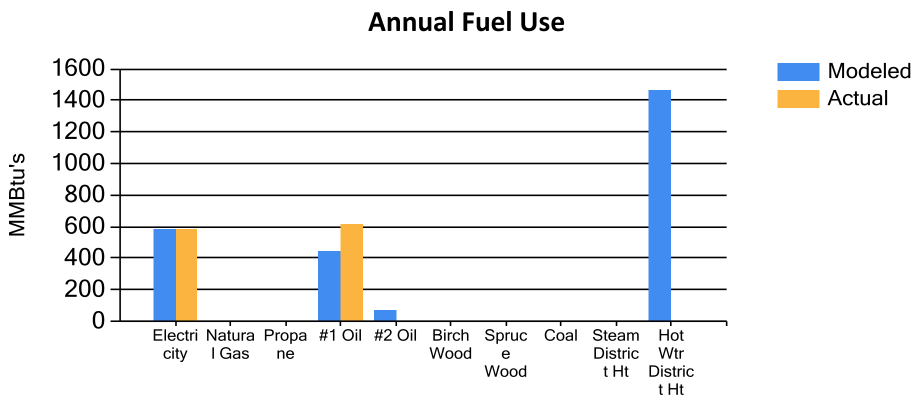
Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Raw Water Heat Add**	**Water Circulation Heat**	**Total Cost**
Existing Building	$20,076	$467	$3	$9,623	$243	$45,870	$1,920	$10	**$78,213**
With Proposed Retrofits	$14,298	$457	$3	$3,399	$243	$41,148	$1,835	$1,919	**$63,301**
Savings	$5,778	$10	$0	$6,224	$0	$4,722	$86	-$1,908	**$14,912**

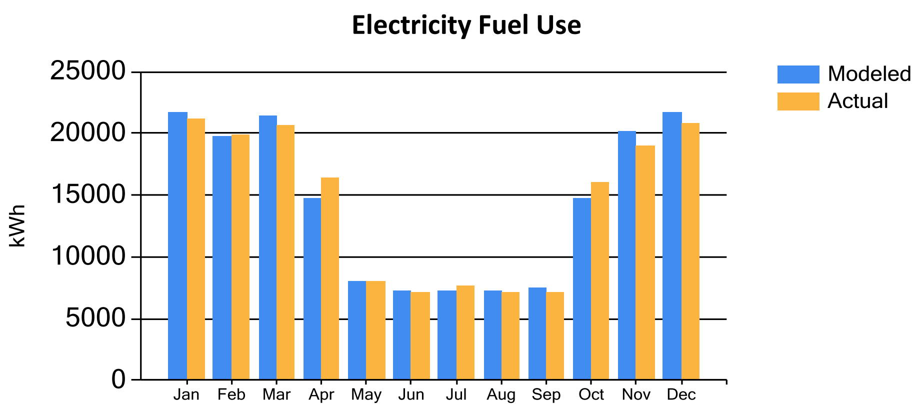
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	358.2	25.73	$10.90
With Proposed Retrofits	328.0	23.56	$8.82

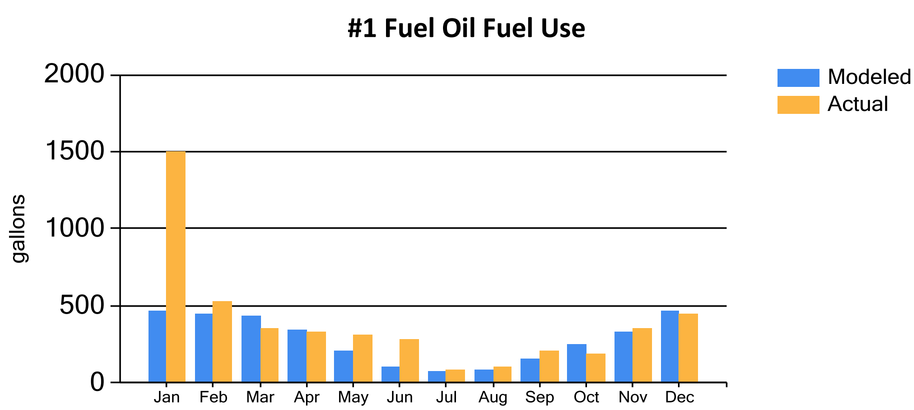
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

Appendix B – Actual Fuel Use versus Modeled Fuel Use

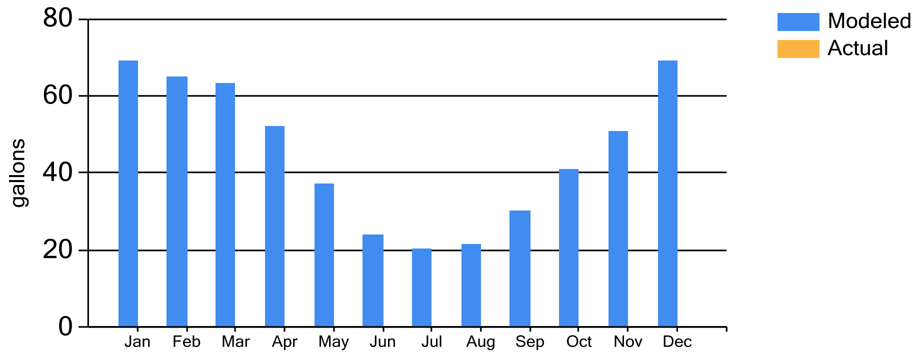
The graphs below show the modeled energy usage results of the energy audit process compared to the actual energy usage report data. The model was completed using AkWarm modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.



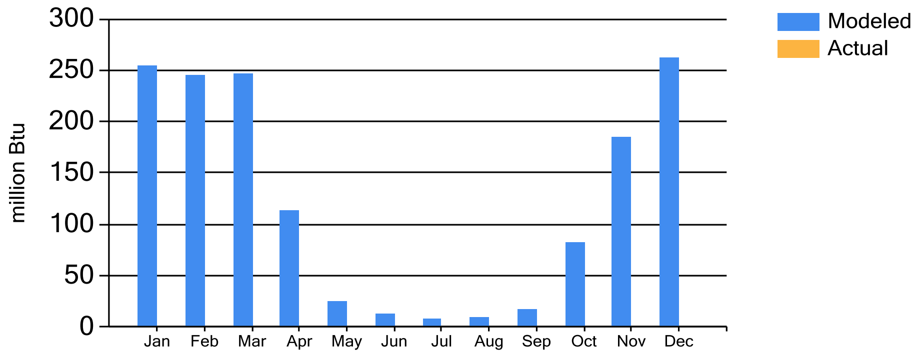




Waste Oil Fuel Use



Heat Recovery Ht Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	38.0	38.1	37.5	29.3	19.4	18.4	18.0	18.2	18.9	28.5	36.6	38.0
As Proposed	32.0	32.2	31.4	23.8	14.8	13.8	13.4	13.5	14.4	22.8	30.3	32.0

AkWarmCalc Ver 2.6.1.0, Energy Lib 8/9/2016